T.O. BMS1F-16CJ-1

FLIGHT MANUAL

Combatsimchecklist series

F-16C BMS 4.32

Block 50 and 52

March 28th, 2012

CHANGE 1.0

LIST OF EFFECTIVE CHANGES:

This document is bound to be updated according to BMS releases. You should consider the Dash one as a work in progress. It was started during BMS beta testing and updated to reflect the release version changes. It may already be outdated from the current beta BMS version but will be updated shortly after each release.

Change 0:

(V0.3 draft) published July 31st, 2011.

(V0.4 draft) published August 29th, 2011.

- Added UFC, MFD, Engine, Fuel, ECS, Hydraulic, FLCS, EPU, Gear, Autopilot chapters
- Document formatting
- Added BMS 4.32 callbacks
- Added HUD chapter
- Added Bibliography

(V0.5 draft) published August 31st, 2011.

- Various correction from proof readers
- Added Section2 – Normal Procedures

(V0.6 draft) published Dec 30th, 2011.

- Moved hotpit refuel & AA refuel to section II - normal procedure.
- Added Section III: Abnormal & Emergency procedures.
- Added Warning light & caution light Analysis.
- Added Ground, Takeoff, In-flight & Landing emergencies.
- Adapted changes for 4.32 Update 1 change log.

(V0.7 draft) published January 11th, 2012.

- Changed structure of chapters.
- Added Landing chapter in normal procedures
- Changed MARK POINTS section in UFC for OFLY, HUD, FCR & TGP mark.
- Added HUD Mark section in HUD chapter
- Added training for flameout situation

(V0.8 draft) published March 24th, 2012.

- Proof read corrections

(V1.0) published March 28th, 2012.

- First released version

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SECTION I

DESCRIPTION & OPERATION

1.1 THE AIRCRAFT

In BMS, you will mostly fly the F-16C block 50 with the F110-GE-129 engine. In the training TE you might also fly the dual seat F-16D block 50 also equipped with the GE129 engine. Depending on TE, you might also fly the MLU European variant with a F100-PW-220 engine or even Greek F-16C block 50+ with eventually conformal fuel tanks. All these versions have their own specificities but we will concentrate only on the only fully supported variant: the F-16C/D block50 GE-129.

Aircraft weights

The Gross Weight (GW) of the BMS F-16 (including oil, pilot, two wingtip AIM-120 missiles, a full load of 20mm ammunition is approximately 20500 lbs. With Full Internal fuel, the GW is approximately 28000 lbs. The Max Take-Off weight is 42300 lbs.

Fuel Weight is 7162 lbs internally in 7 fuel tanks:
Left wing (± 525 lbs),
Right wing (± 525 lbs),
Two forward fuselage F1 & F2, considered as a single F tank in BMS (± 3250 lbs)
One aft fuselage: A (± 2810 lbs)
And two reserve tanks: fwd reservoir and aft reservoir each holding ± 480 lbs.

The two fuselage tanks (F & A) supply fuel directly to the engine.

The D model has a smaller aft fuselage (A) fuel capacity because of the second cockpit (2675 lbs)

The F-16 can carry 3 external fuel tanks: 2 wing tanks of 370 Gallon (2516 lbs each) and a centreline 300 Gallons tank (2040 lbs)

Total fuel weight with three external tanks is thus 14234 lbs. We also have the capability to load 600 Gallons wing tanks but it is rarely done.

You may encounter TEs with Conformal Fuel tanks and these are considered internal tanks but bear in mind that the BMS fuel gauges are not optimized for this configuration.
Most of your flight will be done with a full load of internal fuel and 2x370 Gallons wing tanks.

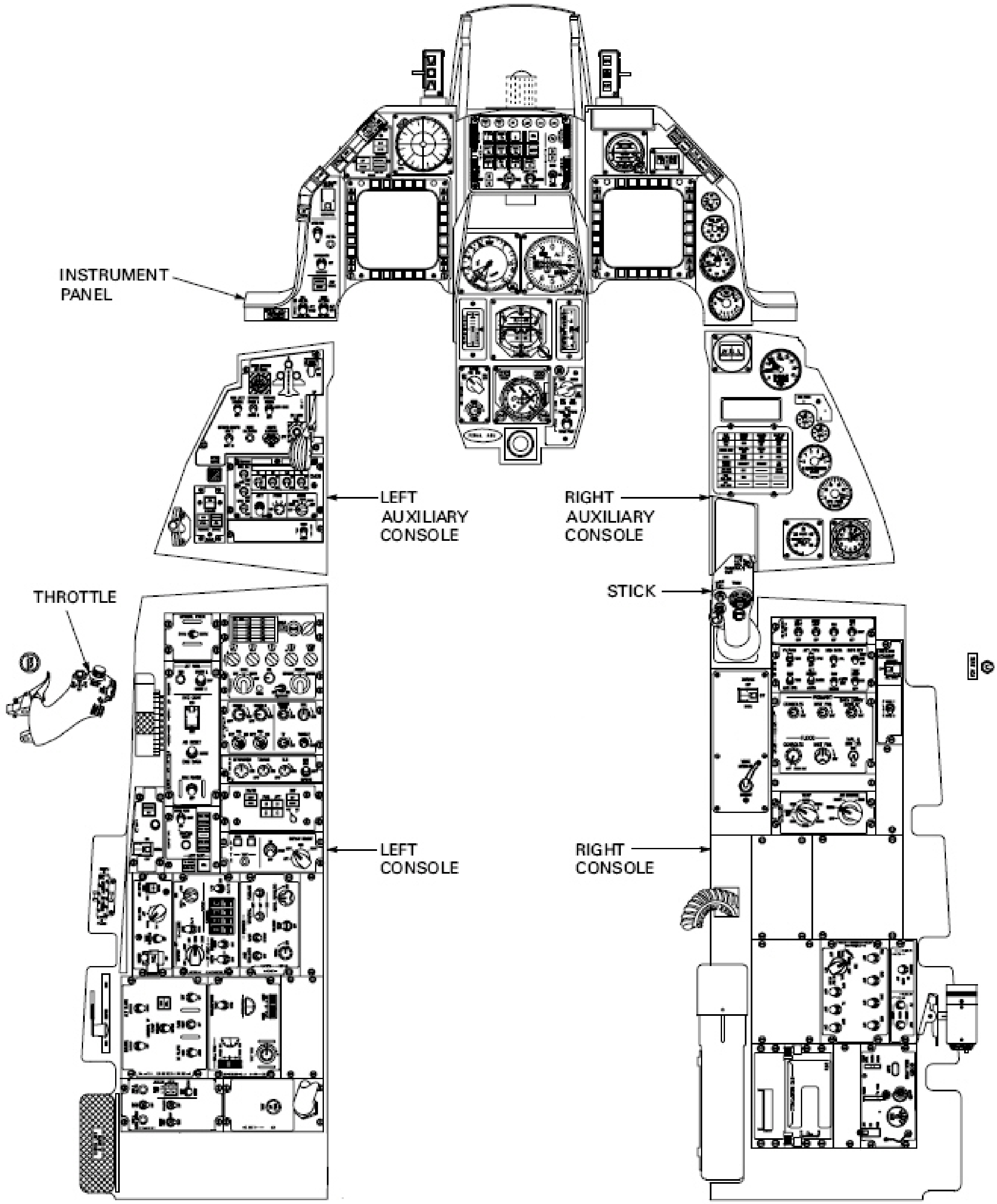
The F-16 has no capability to vent fuel overboard. Air to Air refuelling is provided through an AR point on top of the fuselage.

The F-16 doesn't have a maximum landing weight. This means that basically you can land the aircraft at any weight as long as the runway is long enough to accommodate the longer landing roll.

Aircraft speeds

Max Undercarriage speed is 305 knots.
The F-16 does not have a true corner velocity. It has a corner plateau from 330 to 440 knots that produces good turn rate based on available G.
Manoeuvre speed is 340 knots.

1.2 COCKPIT ARRANGEMENT



The F-16 cockpit is made up of the left console, left auxiliary console, centre panel, right auxiliary console and right console.
The left and right console are mainly used for start-up and ground ops, the auxiliaries and centre panels are mostly used in flight.

The heart of the onboard system is provided by the Up front Controller (ICP & DED) and the 2 MFDs. All primary system management can be set through those.

In BMS, we do not have a 2D cockpit anymore and our only interface with the sim is the 3D cockpit. View panning in the 3D cockpit is performed with the Track IR (TIR) but there is also a way to set snap view to selected panels. (More info can be found in the BMS 4.32 technical manual)

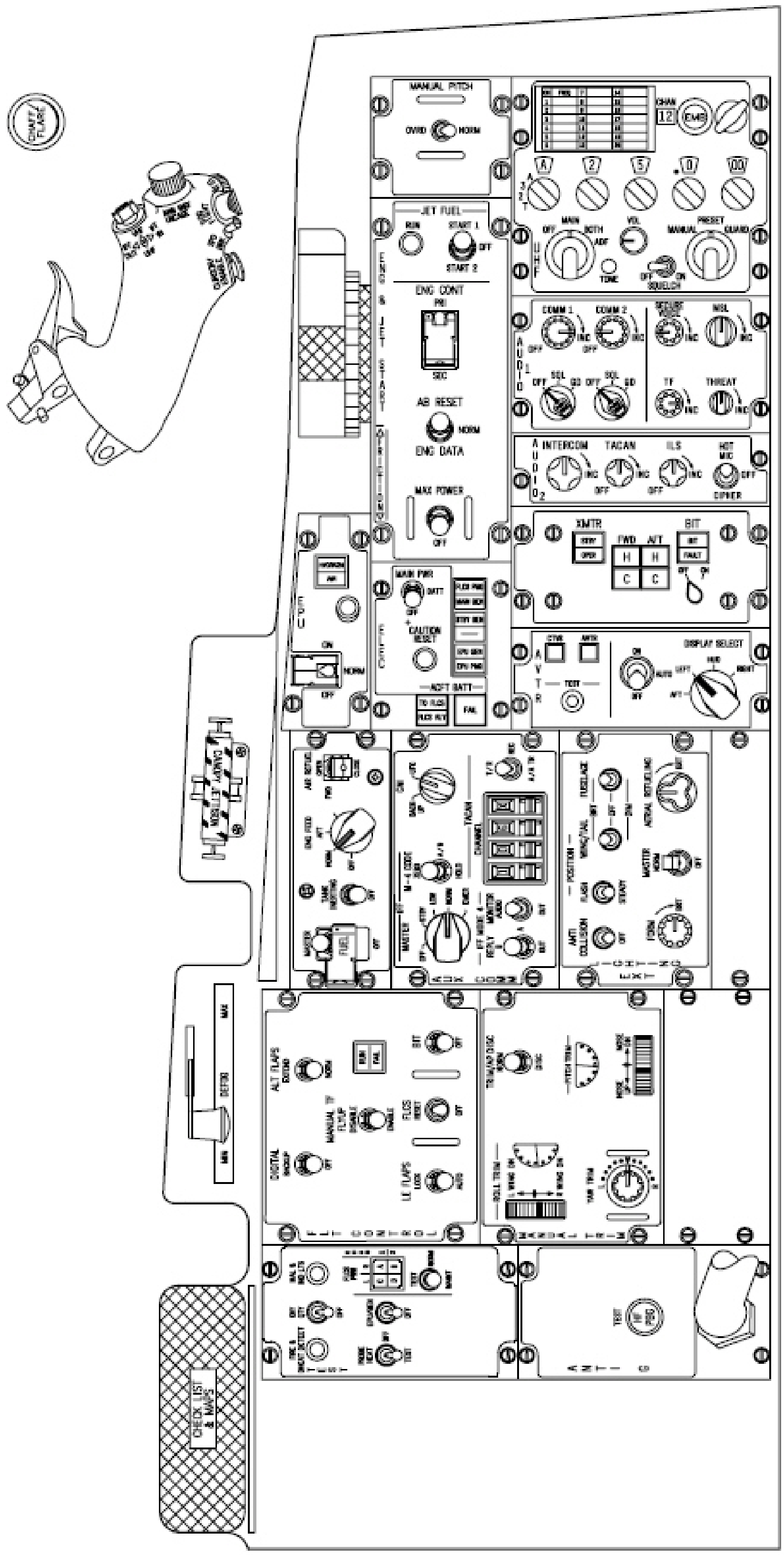
Each button or knob can be interfaced with the keyboard or with the mouse.

When interfacing switches with the keyboard, we use specifics key callbacks for that switch. They can be toggles, full states position switches, push button press, push button release.
Callbacks are listed in the key file (\User\Config folder) where they are declared as a keystroke.
In turn these keystrokes can be programmed as HOTAS buttons, or even full cockpit programming.

All active 3Dswitches can also be interfaced with the mouse. In this case, we use the 3D button hotspot on the 3D cockpit and the mouse buttons.
Hotspots are displayed in the 3D cockpit with a change of cursor colour. When your mouse cursor reaches a hotspot, it turns green, signalling the hotspot presence for the switch.
Usually moving the switch in one direction is made by depressing the left mouse button and moving it in the other direction is made with the right mouse button. The same is true for push buttons; they can be depressed with a mouse button and released with the other button.
Rotaries are usually incremented with the left mouse button and decremented with the opposite mouse button.
And finally encoders such as for instance the CRS and HDG knobs on the HSI can be fast incremented by using the mouse wheel. When the mouse is placed over a knob featuring that implementation, the cursor will display a rotating effect signalling that the mouse wheel can be used. This is much faster than using the old mouse button increment.

This chapter will review all cockpit panels and explain functionality of each one. We will start on the far left of the cockpit and move toward the right console. A red covered switch on cockpit panels means that this switch is not implemented in BMS. It has thus no key callback and no mouse hotspot.
At the end of each panel paragraph, you will also find a list of the relevant key callback for that panel. That will hopefully help a lot using the correct callbacks when one function needs to be programmed.
A full explanation of callbacks can be found on the BMS 4.32 technical manual.

1.2.1. LEFT CONSOLE



1.2.1.1 Test panel

The test panel is obviously used to perform some tests on different systems during Ramp start. In BMS, all switches and push buttons are implemented, except the FLCS TEST switch in his MAINT (Maintenance) position.

The FIRE & OHEAT DETECT button checks continuity for both engine fire and overheat detection systems. The overheat detection happens 100°C before the engine fire detection system. The overheat triggers the OVERHEAT caution light and the engine fire triggers the ENG FIRE eyebrow light. Those lights and the MASTER CAUTION light remain ON as long as the button is held depressed.

The second pushbutton on the panel is the MAL & IND LTS. It tests the illumination of all warning, caution, indicator lights, the Landing Gear warning Horn and all voice messages in sequence.

The OXY QTY is a momentary switch and tests the oxygen quantity. When depressed the pointer on the oxygen gauge should decrease to zero and when passing 0.5 Litre, the OXY LOW eyebrow light should illuminate for 10 seconds if no fault are present and remain ON if a fault is detected. Please note this switch is badly labelled and should be named OBOGS bit.

The PROBEHEAT switch is a three position switch: PROBE HEAT, OFF and TEST.
The pitot, fuselage air data, AOA and the total temperature probe heaters are ON anytime the aircraft is airborne, regardless of the TEST panel switch position.
The PROBEHEAT position allows energizing the probes on the ground. OFF de energize all systems on the ground. TEST (on the ground and in flight) performs a functional test of the PROBEHEAT monitoring system. The PROBEHEAT caution light flashes for a successful test. Failure of the PROBEHEAT caution light to illuminate or flash indicates a failure indicates a failure of the probe heat monitoring system.

The EPU/GEN test switch is spring loaded to the OFF position and provides a means to test the EPU generator and EPU PMG output to FLCS on the ground without using hydrazine. Hydrazine is highly toxic for ground personnel and special procedures have to be followed when EPU has run on HYDRAZIN.

The quad indicator labelled FLCS PWR is the indicator of the 4 redundant digital systems ABDC of the FLCS. In BMS, they are considered as one and light up always together.

The FLCS PWR TEST switch is a momentary switch to TEST. With the MAIN PWR switch in BATT closes the FLCS relay and allows verification of power output to the FLCC (Flight Control Computer) with the aircraft battery as the power source.

BMS Key Callbacks for the test panel:
SimOverHeat
SimOBOGSBit
SimMalIndLights
SimMalIndLightsOFF
SimProbeHeatMoveDown
SimProbeHeatMoveUp
SimProbeHeatOn
SimProbeHeatOff
SimProbeHeatTest
SimEpuGenTest
SimFlcsPowerTest

1.2.1.2 Flight Control Panel (FLCP)

Refer to the FLCS chapter for a full overview of the FLCS system.
The panel is made of 6 switches and 1 dual indicator light.

The DIGITAL BACKUP switch is a two position switch allowing the pilot to normally enter manually a backup software state of the FLCS but this is not implemented yet in BMS and the switch action provides only DBU eyebrow light illumination.

The ALT FLAP extend/norm switch controls the trailing edge flaps. In NORM they move automatically from FLCS input. If you want to extend them manually, place the switch in extend.

The LE FLAPS lock/auto switch commands the Leading edge flaps. They can be automatically controlled by the FLCS in AUTO position (functions of MACH, Altitude and AOA) or locked in current position in LOCK. When in LOCKED, the FLCS warning light illuminates and the PFD reports a FLCS LEF LOCK PFL.

The FLCS RESET switch is a momentary switch to RESET and allows the FLCS fault to be reset. The master caution reset doesn't clear FLCS related fault and the only way to reset the indicators, warning lights and PFL is by using the FLCS reset switch. FLCS fault may be reset in BMS to exit the FLCS standby gains activated on any FLCS fault (see FLCS section). Not all faults can be reset.

The MANUAL TF FLYUP switch is a two positions toggle switch. It is meant to disable or enable the FLYUP protection in manual TF (Terrain Following) but is not implemented in latest USAF inventory blocks and thus not implemented in BMS.

The BIT switch is a magnetically held switch in BIT. It performs the FLCS bit if weight on wheel switch is ON. BIT takes about 45 seconds during which the RUN green indicator light is illuminated. During the BIT all flight control surfaces move in sequence. (Those movements are visible through MP) If the BIT is successful, the switch snaps back in OFF position and the RUN light goes OFF.
In case of failure, the BIT switch returns to OFF and the yellow FAIL light illuminates. Failed BIT is not resettable and a new BIT needs to be run. During that second BIT, both FAIL and RUN light and upon successful completion the FAIL light will go OFF.

BMS Key Callbacks for the FLCS panel:

SimDigitalBUP
SimDigitalBUPOff
SimAltFlapsExtend
SimAltFlapsNorm
SimManualFlyupDisable
SimManualFlyupEnable
SimLEFLockSwitch
SimLEFLock
SimLEFAuto
SimFLCSReset
SimFLTBIT

1.2.1.3 MANUAL TRIM panel

The Manual TRIM panel provides an extra method for the pilot to trim the aircraft. Primary trims (roll & pitch) are on the stick. The wheels and indicators on the MANUAL TRIM provide a backup way to set the trims by using the relevant wheel or knob.
Rudder trim can only be set on the MANUAL TRIM panel via the YAW TRIM knob.
In BMS, trims are very much required, especially in asymmetric load conditions. Notice the 2 indicators, they move with stick trim input (when energized) and/or Manual trim input. The wheels have a white line marking their centre position.

The TRIM/AP DISC switch is a two positions toggle switch. In NORM, the stick trims are energized and AP operation is possible.
In DISC, the stick trims and the autopilot are inhibited. The MANUAL TRIM remains operative.

The MAN TRIM wheels and knobs can be interfaced through keystrokes, mouse clicks or analogue hardware such as potentiometers. The later solution gives much better and smooth results. A little warning about mouse clicks: the way they are implemented is almost impossible to manage correctly in flight and should be avoided. Left click start the trim movement and right click stop the trim action and start the action in the opposite way. If you need to use the MANUAL TRIMS, do it with keystrokes or analogue devices, not the mouse. Note that the YAW trim knob does not move in BMS when rudder trim is implemented and as a consequence you have no reference for the YAW TRIM position.

BMS Key Callbacks for the MAN TRIM panel:
SimTrimAPDISC
SimTrimAPNORM
SimTrimNoseUp
SimTrimNoseDown
SimTrimRollLeft
SimTrimRollRight
SimTrimYawLeft
SimTrimYawRight

1.2.1.4 FUEL PANEL

The FUEL MASTER switch is guarded in MASTER position. In some airforce, the guard is even secured in place with a wire. This switch is normally not operated by the pilot in normal operations. When placed in OFF, the fuel shutoff valved is closed, preventing fuel from reaching the engine.

The Tank Inerting switch is unsupported in BMS. In the real jet it reduces internal tank pressurization**.**

The ENG FEED knob controls the way the fuel is pumped to the engine. Note that the fuel goes to the engine by gravity feed, so the engine will not starve when the fuel pumps are OFF. Use of the pumps prevents fuel starvation during negative G maneuvers and allows manual fuel balance whenever necessary.

In OFF, all pumps are OFF.
In NORM, all pumps are ON, the CG (Center of gravity) is maintained automatically.
In AFT, the AFT pumps are energized. Fuel is transferred from the AFT tank to the engine. The CG moves forward.
In FWD, the FWD pumps are energized. Fuel is transferred from the FWD tank to the engine and the CG moves AFT.

The AIR REFUEL switch is a two position toggle switch. It opens or closes the Air Refuelling door. Upon Opening the AR door, the FLCS switches to takeoff and landing gains (if airspeed is below 400 knots). It also reduces internal tank pressurisation and depressurizes external tanks, so they can be filled at air to air refuelling.

BMS Key Callbacks for the FUEL panel:
SimToggleMasterFuel
SimMasterFuelOn
SimMasterFuelOff
SimDecFuelPump
SimIncFuelPump
SimFuelPumpOff
SimFuelPumpNorm
SimFuelPumpAft
SimFuelPumpFwd
SimFuelDoorToggle
SimFuelDoorOpen
SimFuelDoorClose

1.2.1.5 AUX COMM panel

The most important button on the AUX COMM panel is the CNI knob. It allows the pilot to toggle between the BACKUP system and the UFC (Up Front Controller).The heart of the F-16 cockpit is the UFC made of the ICP, the DED and the two MFDs. Those need the main generator running and are thus unavailable at ramp start, shut down or in the event of malfunction or battle damage. In that case, the CNI switch needs to be placed in BACKUP which provides alternate operations of the UHF TACAN and IFF.

None of the IFF systems are implemented in BMS for obvious reasons. So there is no need to explain the backup IFF mode4 operations from the AUX COMM panel.

The lower right part of the panel allows the pilot to set a TACAN channel, band and mode when the CNI switch is in backup. The TACAN channel is set into the first three windows. The fourth window is used to set the X or Y band.
The T/R, AA T/R switch provides control of TACAN functions when the CNI switch is in backup.
T/R: Transmit / receive mode. The system receives signals which result in bearing and course deviation on the HSI and transmit distance interrogation to the station to get DME information.
REC (Receive) is not implemented
AA T/R is the Air to Air Transmit and receive mode. The system interrogate and receive signal from aircraft having air to air capability, providing slant range (Nm) distance between aircraft operating 63 TACAN channels apart. (KC-10 also provides bearing information).

BMS Key Callbacks for the AUX COMMS panel:
SimAuxComBackup
SimAuxComUFC
SimCycleLeftAuxComDigit (cycle = move up)
SimDecLeftAuxComDigit (dec= move down)
SimCycleCenterAuxComDigit
SimDecCenterAuxComDigit
SimCycleRightAuxComDigit
SimDecRightAuxComDigit
SimCycleBandAuxComDigit
SimCycleBandAuxComDigit
SimTACANTR
SimTACANAATR
SimToggleAuxComAATR (toggle)

1.2.1.6 EXT LIGHT panel

All exterior lights except the taxi light are controlled from this panel.

The ANTI COLLISION switch is a two positions toggle switch that obviously toggles the white anti collision strobe situated on top of the tail. The AC light is always flashing at the same frequency in BMS and the COVERT options (IR) is not implemented either.

The POSITION FLASH/STEADY switch is a two positions toggle switch as well and is relevant only to the position lights (wingtips and fuselage in BMS). In FLASH, the wingtip and fuselage lights flash at a set frequency. In STEADY, the lights remain ON constantly.

IN BMS, the fuselage (intake), wingtips and tail position lights are considered a single entity and as such, only one switch drives them all. In the cockpit, both the WING/TAIL and FUSELAGE switch move together. Normally the FUSELAGE lights refers to the tail floodlight but those are not implemented in BMS. Furthermore, the DIM position is not implemented and we only can set them OFF or BRT (Bright).

Finally, the MASTER light switch as its name implies is the main switch for all lights. Toggling this one OFF will shut all lights OFF except the taxi light. Conversely, this switch needs to be ON for exterior lights to work as set (except taxi light)
Both the FORM and AERIAL REFUELING knobs are not implemented.

BMS Key Callbacks for the EXT LIGHT panel:
SimExtlMasterNorm
SimExtlMasterOff
SimExtlAntiColl (toggle)
SimAntiCollOn
SimAntiCollOff
SimExtlSteady (toggle)
SimLightsSteady
SimLightsFlash
SimExtlWing (toggle)
SimWingLightBrt
SimWingLightOff

1.2.1.7 AVTR panel

This panel is simply used to toggle the ACMI ON and OFF. None of the knobs are implemented and only the ON/AUTO/OFF switch is implemented. The green AVTR indicator light comes ON whenever the ACMI is recording. Note that an option in BMS config lets you display or not the HUD recording message. Of course, for realistic operation this message shouldn't be displayed and the green light on the AVTR panel used instead.

BMS Key Callbacks for the AVTR panel:
SimAVTRSwitch (toggle)
SimAVTRSwitchOff
SimAVTRSwitchAuto
SimAVTRSwitchOn
SimAVTRSwitchDown (toggle)
SimAVTRSwitchUp (toggle)

1.2.1.8 ECM panel

Due to its nature and the fact that most of ECM systems are classified, this panel is not implemented. The only switch used in BMS is the main toggle switch, labelled OPR, STBY, OFF.
BMS only uses the ON/OFF position and that switch needs to be placed in OPR for the ECM pod to be energized (if carried)

BMS Key Callbacks for the ECM panel:
SimEcmPowerOn
SimEcmPowerOff
SimECMOn (toggle)

1.2.1.9 ELEC Panel

The real electrical system of the F-16 is quite complicated with a main AC power system distributing current to the non essential, essential and emergency buses. A standby AC power system distributing power to the essential and emergency buses and an Emergency AC power supply distributing power to the emergency buses. A DC power and the FLCS power supply.

The main power switch is a three position switch.
In OFF, no electrical system receives power from the main generator, standby generator or battery. All systems are cold.
In BATT, the aircraft battery is connected and the battery bus is powered.
In MAIN, the MAIN generator and standby generator provides power to the aircraft systems

The CAUTION RESET push button is the only way to reset an ELEC fault, displayed as the amber ELEC SYS caution light. It also resets the main and standby generators.

FLCS PMG indicator light: When it lights up, it means that none of the FLCS branches are receiving power from the FLCS PMG (Permanent Magnet Generator). Basically that means the primary power source for the FLCS has failed.

When the MAIN GEN indicator comes ON, it means that the main generator is not connected to the non essential AC buses. In all likelihood, the main generator has failed.

Likewise, when the STBY GEN indicator lights up, it means that standby generator power is not available.

When the EPU GEN indicator light comes up, it means the EPU has been commanded ON but the EPU generator is not providing power to the emergency buses. Be aware that the light does not function with the EPU in OFF (WOW) and the engine running.

When the EPU PMG indicator light comes ON, it means that the EPU has been commanded ON but the EPU is unable to provide power to the FLCS branches (normally through the EPU PMG)

The two lower indicators refer to the aircraft battery:
When the TO FLCS indicator lights up, it means that the battery power is going to one or more FLCS branches. Basically, the battery runs the FLCS and will deplete fast.

When the FLCS RLY indicator light comes up, it means that one or more FLCC branches don't get adequate voltage from the battery.

When the FAIL indicator light comes up, it means that the aircraft battery failed or is failing to charge (on the ground)

BMS Key Callbacks for the ELEC panel:
SimMainPowerOff
SimMainPowerBatt
SimMainPowerMain
SimElecReset
SimMainPowerInc (toggle)
SimMainPowerDec (toggle)

1.2.1.10 EPU panel

The EPU is a self contained system that provides simultaneously emergency hydraulic to system A and emergency electrical power to the emergency buses. The EPU automatically activates when both main and standby generators fail or when the hydraulic pressure falls below 1000 Psi.
The EPU uses engine bleed air and/or hydrazine to operate. If engine bleed air is sufficient to maintain operating speed, the EPU doesn’t use hydrazine. Hydrazine is only used as a booster when bleed air is not sufficient.

The Main switch for the EPU is double guarded three position switch. With guard down, the switch is locked in NORM

In OFF, the EPU is prevented from running.
in NORM, the EPU is armed for automatic start upon failure of the main and standby generators.
The EPU will not start on shutdown (WOW and throttle OFF)
in ON, the EPU is commanded to RUN regardless of failure conditions.
As you see on the panel, the switch is guarded BUT any mouse click on the switch lift the guard and operates the switch at the same time !!! As a consequence, the guard has no effect in BMS.

The EPU RUN green light comes ON whenever the EPU turbine runs within the proper range and the EPU hydraulic pressure is above 2000 Psi.

The top indicator is telling the pilot if the EPU runs on engine bleed air and/or hydrazine.
When the yellow AIR indicator lights up (bottom light), the EPU runs on bleed air which is sufficient to maintain operating speed. If possible when the EPU runs, engine RPM should be maintained between 82 & 90% to prevent the EPU using hydrazin. Unfortunately, in Falcon, when the EPU needs to run, that’s because we usually lost the engine…
When the yellow HYDRAZN (top light) comes up, the bleed air is not sufficient to maintain operating speed and is augmented by hydrazine. In that case, both indicator lights are ON.
Hydrazine is limited and usually depletes in 10 minutes under normal load requirements. Increased flight control movement reduces this operating time further. Also bear in mind that when the EPU is your sole source of hydraulic and power, when hydrazine is depleted, you lose everything. As a consequence, when you start running on hydrazine, plan to be on the ground within the next 10 minutes. For more information about the EPU and which system are powered by the emergency bus, please refer to the Electrical and EPU section later in this manual

BMS Key Callbacks for the EPU panel:
SimEpuToggle
SimEpuOff
SimEpuAuto
SimEpuOn

1.2.1.11 AUDIO 2 panel

The AUDIO2 panel provides control to the less frequently used communications system. The intercom volume knob is used to control the volume of all sounds normally heard in the pilot helmet. It allows the user to set the respective individual volumes to a desired ‘mix’ level and then turn it up or down relative to the rest of the background sounds (those normally not heard in the pilot headset).
The TACAN volume is normally used to get the morse code of the emitting station in the headset but this is not implemented in BMS, so the volume control is not implemented. There is not even a need to switch to knob out of OFF for the TACAN to work, it’s coded always ON. Likewise, there is no ILS audio but this time the knob can be turned ON and OFF. Notice that the ILS knob always start in ON whatever the startup option (ramp, taxi or takeoff). Finally, the HOT MIC switch ios not implemented either. As a consequence, you can totally dismiss the AUDIO2 panbel for the time being.

BMS Key Callbacks for the AUDIO2 panel:
SimILSOn
SimILSOff
SimStepIntercomVolumeUp
SimStepIntercomVolumeDown

1.2.1.12 AUDIO1 panel

The Audio 1 panel provides controls to the primary communication systems. Unless otherwise specified, the controls are active regardless of the position of the CNI switch on the AUX COMM panel.

The COMM1 power knob has an ON/OFF switch and when rotated past the ON position increase volume for the COMM1 radio (UHF). This control can be set through an analogue potentiometer via the advanced setup or with regular keystrokes.

The COMM1 MODE knob has three positions: OFF, SQL and GD.
In OFF the squelch mode is disabled (Squelch is not implemented in BMS)
In SQL, the squelch mode is activated helping reduce background noise in normal operations.
In GD, the main received and transmitter are automatically tuned to the guard UHF frequency (243.000) Please note GD position is not functional when the CNI is in backup (guard is then selected from the backup UHF panel).The push function is not implemented in BMS.

The COMM2 power and mode knob have the same functions but for the second radio (VHF) GD position tunes to VHF guard (121.5)

The secure voice and TF knobs are not supported in BMS.

The MSL knob is used to set the sidewinder missile acquisition sound level. This control can be set through an analogue potentiometer via the advanced setup or with regular keystrokes. The knob has no ON/OFF position, but at ramp start the knob is turned completely CCW at minimal volume UNLESS you use a potentiometer to interface it. In that case, the volume is set at whatever position the pot was left during the last flight.

The THREAT knob is used to set the TWS (Threat Warning System) sound level. This control can be set through an analogue potentiometer via the advanced setup or with regular keystrokes. The knob has no ON/OFF position, but at ramp start the knob is turned completely CCW at minimal volume UNLESS you use a potentiometer to interface it. In that case, the volume is set at whatever position the pot was left during the last flight.

BMS Key Callbacks for the AUDIO1 panel:
SimStepComm1VolumeUp
SimStepComm1VolumeDown
SimComm1PowerOn
SimComm1PowerOff
SimStepComm2VolumeUp
SimStepComm2VolumeDown
SimComm2PowerOn
SimComm2PowerOff
SimStepMissileVolumeUp
SimStepMissileVolumeDown
SimStepThreatVolumeUp
SimStepThreatVolumeDown
SimAud1Com1Sql
SimAud1Com1Gd
SimAud1Com2Sql
SimAud1Com2Gd

1.2.1.13 ENG & JET START panel

In BMS the main purpose of this panel is to start the engine. That is done through the JFS (Jet Fuel Starter) switch. The JFS is an independent gas turbine and is started by 2 JFS/brake accumulators which are charged automatically by hydraulic system B. The JFS is used to start engine on the ground and to assist in engine airstarts.

The switch is a magnetically held 3 positions switch (magnetically held is START1 and START2). Currently in BMS, we only use the START 2 position.
When placed in START 2, the JFS engage and drives the main engine turbine shaft RPM up to 20-25%. At that time, the throttle can be moved out of its OFF position to idle which starts the main engine. In Falcon, this is (wrongly) done by hitting the throttle detent key callback, unless the idle cutoff option box is checked in BMS config. With that box checked, the engine is started as in the real jet by moving the throttle handle out of its CUTOFF position to IDLE. (Your HOTAS needs a strong detent) The JFS/brake accumulator start to recharge past 12% engine RPM and takes between 40 and 60 seconds to regain a full operating pressure charge. The JFS automatically shuts down when the engine accelerates past 55% RPM. The switch then snaps back to OFF.

The green JFS run light comes ON in BMS whenever the JFS is running.

The ENG CONT PRI/SEC is a two positions switch guarded in PRI, which is the normal (Primary) engine operating mode. The engine transfers automatically in SEC mode in case of failure of the Digital Electronic Control (DEC). It can manually be transferred to SEC by placing the ENG CONT switch in SEC. Transfer is indicated by the SEC caution light on the warning panel. When operating in SEC, the engine exhaust nozzle remains closed and Afterburner is inhibited.

The AB RESET and MAX POWER switch are not implemented in BMS.

BMS Key Callbacks for the ENG & JET START panel:
SimJfsStart
SimEngContPri
SimEngContSec

1.2.1.14 BACKUP UHF panel

The only backup radio available in the F-16 cockpit is the UHF radio. There is no VHF backup radio. For the backup radio to operate, the CNI switch on the AUX COMM panel needs to be in BACKUP position.

In BMS, only three knobs are implemented on this panel: the Function knob (lower left), the Mode knob (lower right) and the channel knob and its indicator (upper right).

The Mode knob has 4 positions, but only 3 are used in BMS: OFF, MAIN & BOTH. ADF is not supported.
In OFF, the backup UHF is not powered.
In MAIN, and as long as the COMM1 power switch on the AUDIO1 panel is ON, the UHF radio operates on the selected preset channel (displayed above on the 2 digits display). The manual frequency tuning is not supported in BMS.
In BOTH, the radio works normally and receives also the guard frequency. Note, receive only!

The mode functions knob has three positions. MNL, PRESET and GUARD.
MNL (MANUAL) is not supported. The UHF frequency is set manually.
PRESET, the frequency is determined by the channel knob and indicated by the 2 digits display.
GRD, The main receiver and transmitter are automatically tuned to the UHFguard frequency.

The channel knob selects one of the 19 presets available. In BMS, those presets are fixed and do not correspond to the ones set into the DTC. By default the panel selects channel 6.

The tiny volume knob has recently been implemented (no analogue values) mouse and keyboards entries only) to balance the IVC volume from humans volumes against AI volumes. It is not the real function of that knob, but quite useful in falcon where AI comms do not follow the same logic as the IVC humans coms on UHF & VHF

BMS Key Callbacks for the BACKUP UHF panel
SimCycleRadioChannel
SimDecRadioChannel
SimBupUhfOff
SimBupUhfMain
SimBupUhfBoth
SimBupUhfPreset
SimBupUhfGuard
SimBupUhfFuncDec
SimBupUhfFuncInc
SimBupUhfModeDec
SimBupUhfModeInc
OTWBalanceIVCvsAIUp
OTWBalanceIVCvsAIDown

1.2.1.15 MPO panel

The MPO switch is a two position switch momentary to OVRD. It provides a means for the pilot to Override the pitch FLCS and give direct controls of the elevators to the pilot. There is a stable trim point around 60° AOA, which allow the aircraft to enter a deep stall. In this configuration, the FLCS will always command maximum elevator pitch down angle, but in this configuration the aircraft will remain in the deep stall. In those deep stalls, the pilot needs to override the FLCS and pitch rocking the aircraft to exit the deep stall.

BMS Key Callbacks for the MPO panel
SimMPO
SimMPOToggle

1.2.1.16 Throttle grip and left side wall

The left sidewall has two important hotspots. Hotspots are areas where the mouse turns into a selective zone where a switch can be clicked.
The first one is the canopy area. Normally the canopy switch is hidden inside the left sidewall and protected with the yellow spider. The spider is just a switch guard. But in BMS, it is the switch itself if you are using the mouse to operate it. Click thus on the spider to open/close the canopy. Alternately, you can use the keystroke callback. The mission starts with canopy open at ramp start in BMS.

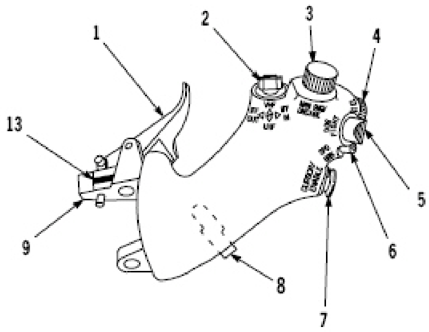
The second one is on the throttle itself and misnamed the idle detent. With the IDLE CUTOFF option disabled from the BMS config options, the idle detent need to be depressed when the JFS makes the engine run at 20% RPM for the engine to start. It was done so to simulate moving the throttle from the vertical cutoff position to the horizontal idle position. Likewise, to shut the engine down, the idle detent needs to be depressed when the throttle is idle for the engine to spool down. This was done to simulate lifting the throttle out of idle position to the vertical cutoff position. Note that the idle detent only works with the your HOTAS throttle sitting perfectly at the beginning of it’s analogue course.

There is a third feature on the left side wall that may be of interest: the SLAP switch. This is a pushbutton programmed to drop Countermeasure PGR 5. The pilot usually slaps it (don’t try in the sim) Still not having it, you give up an important capabilitiy to drop another CM program without switching the pgr knob on the CMDS. There is no mouse hotspot for that one in the 3D cockpit so you will have to use the key callback and you can assign it to any hardware button.

Not on the side wall, but close to the left console, you will find the seat arm lever on the left edge of the seat. This lever allows safing/arming the ejection seat. The lever in the UP position safes the seat and the lever in the DOWN position ARMs the seat.

BMS Key Callbacks for the left side panel:
AFCanopyToggle
SimSlapSwitch
SimSeatOn
SimSeatOff
SimSeatArm (toggle)
SimEject

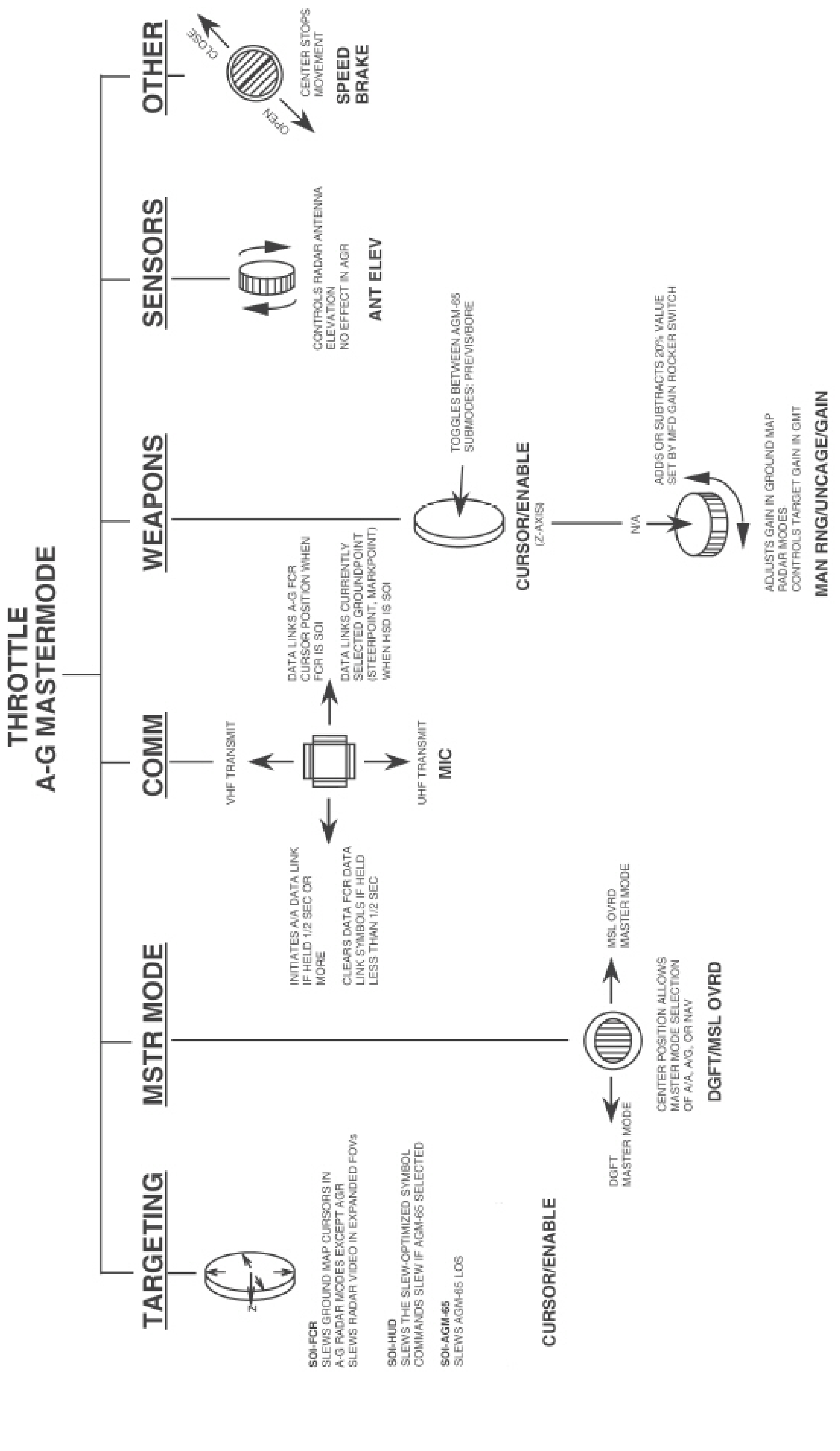
1. Cutoff release (wrongly called idle detent in Falcon)
2. Comms switch (left and right = IDM, up and down = radio comms
3. MAN RNG knob
4. ANTENNA knob
5. DOGFIGHT/ MRM mode switch
6. SPEEDBRAKE switch
7. Cursors
8. HOBO switch (not implemented in F4)

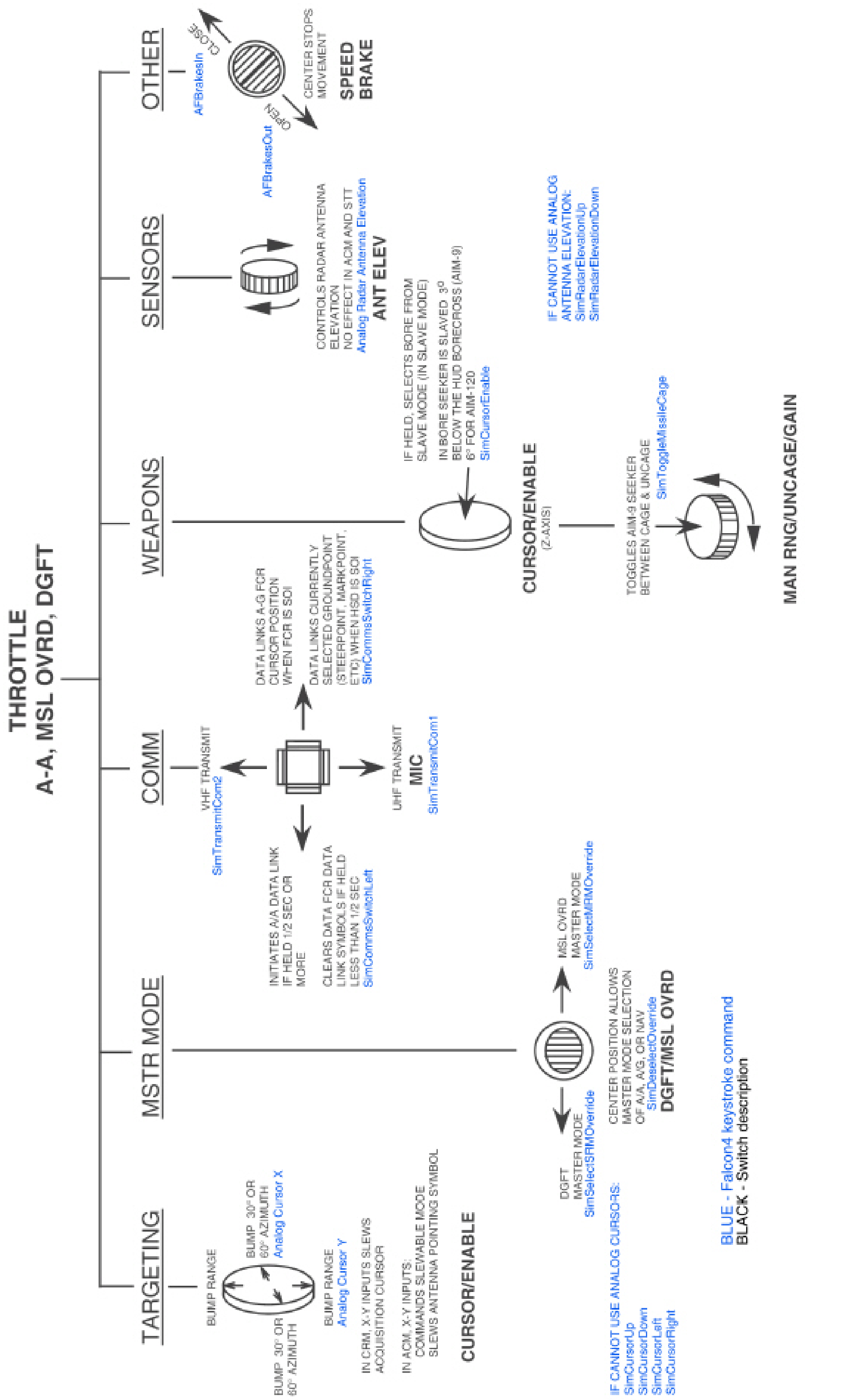


Flying a simulator, you of course have the choice how you program your HOTAS. We do advise you to use a programming as close as possible to the real F-16 HOTAS. The two following images illustrates the relation between the real throttle functions (AG and AA) and the BMS callbacks (taken from the BMS -34)

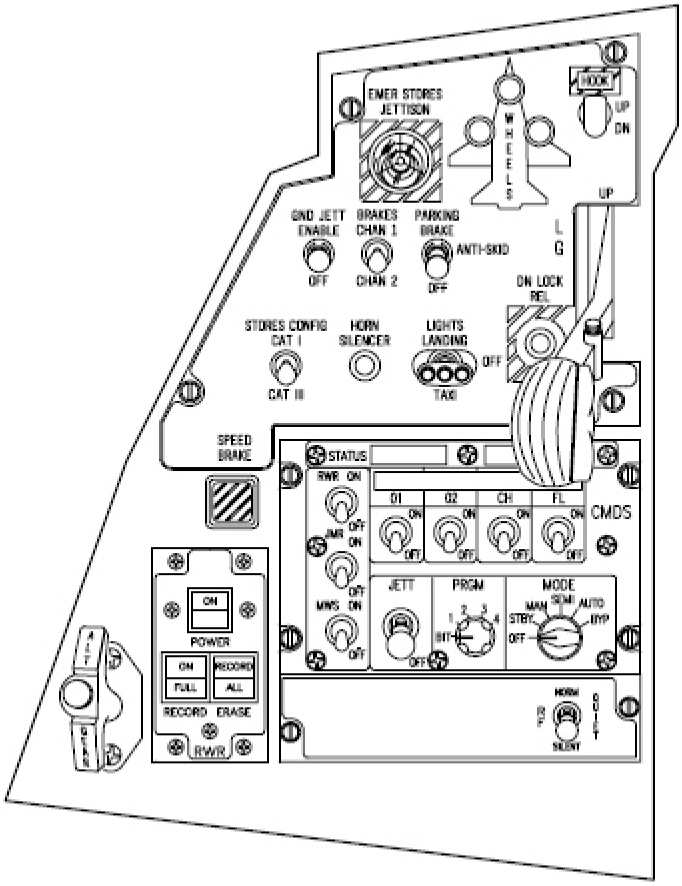
BMS Key Callbacks for the throttle:

SimTransmitCom1
SimTransmitCom2
SimCursorEnable
SimToggleMissileCage
SimSelectSRMOverride
SimSelectMRMOverride
SimDeselectOverride
AFBrakesOut
AFBrakesIn
AFBrakesToggle
SimCommsSwitchLeft
SimCommsSwitchRight
SimRadarCursorZero
SimCursorUp
SimCursorDown
SimCursorRight
SimCursorLeft
SimThrottleIdleDetent
SimRangeKnobUp
SimRangeKnobDown
SimRadarElevationUp
SimRadarElevationDown
SimRadarElevationCenter


THROTTLE
A-G MASTERMODE
OTHER
SENSORS
WEAPONS
COMM
MSTR MODE
TARGETING
CLOSE
OPEN
CENTER STOPS MOVEMENT
SPEED BRAKE
CONTROLS RADAR ANTENNA ELEVATION
NO EFFECT IN AGR
ANT ELEV
TOGGLES BETWEEN AGM-65 SUBMODES: PRE/VIS/BORE
CURSOR/ENABLE
(Z-AXIS)
N/A
ADDS OR SUBTRACTS 20% VALUE SET BY MFD GAIN ROCKER SWITCH
ADJUSTS GAIN IN GROUND MAP RADAR MODES
CONTROLS TARGET GAIN IN GMT
MAN RNG/UNCAGE/GAIN
DATA LINKS A-G FCR CURSOR POSITION WHEN FCR IS SOI
DATA LINKS CURRENTLY SELECTED GROUNDPOINT (STEERPOINT, MARKPOINT) WHEN HSD IS SOI
VHF TRANSMIT
UHF TRANSMIT
MIC
INITIATES A/A DATA LINK IF HELD 1/2 SEC OR MORE
CLEARS DATA FOR DATA LINK SYMBOLS IF HELD LESS THAN 1/2 SEC
MSL OVRD MASTER MODE
DGFT MASTER MODE
CENTER POSITION ALLOWS MASTER MODE SELECTION OF A/A, A/G, OR NAV
DGFT/MSL OVRD
SOI-FCR
SLEWS GROUND MAP CURSORS IN A-G RADAR MODES EXCEPT AGR
SLEWS RADAR VIDEO IN EXPANDED FOVs
SOI-HUD
SLEWS THE SLEW-OPTIMIZED SYMBOL
COMMANDS SLEW IF AGM-65 SELECTED
SOI-AGM-65
SLEWS AGM-65 LOS
CURSOR/ENABLE


THROTTLE
A-A, MSL OVRD, DGFT
TARGETING
MSTR MODE
COMM
WEAPONS
SENSORS
OTHER
BUMP RANGE
BUMP 30° OR 60° AZIMUTH
Analog Cursor X
BUMP 30° OR 60° AZIMUTH
BUMP RANGE
Analog Cursor Y
IN CRM, X-Y INPUTS SLEWS ACQUISITION CURSOR
IN ACM, X-Y INPUTS: COMMANDS SLEWABLE MODE SLEWS ANTENNA POINTING SYMBOL
CURSOR/ENABLE
IF CANNOT USE ANALOG CURSORS:
SimCursorUp
SimCursorDown
SimCursorLeft
SimCursorRight
DGFT MASTER MODE
SimSelectSRMOverride
MSL OVRD MASTER MODE
SimSelectMRMOverride
CENTER POSITION ALLOWS MASTER MODE SELECTION OF A/A, A/G, OR NAV
SimDeselectOverride
DGFT/MSL OVRD
BLUE - Falcon4 keystroke command
BLACK - Switch description
INITIATES A/A DATA LINK IF HELD 1/2 SEC OR MORE
CLEARS DATA FCR DATA LINK SYMBOLS IF HELD LESS THAN 1/2 SEC
SimCommsSwitchLeft
VHF TRANSMIT
SimTransmitCom2
UHF TRANSMIT
MIC
SimTransmitCom1
DATA LINKS A-G FCR CURSOR POSITION WHEN FCR IS SOI
DATA LINKS CURRENTLY SELECTED GROUNDPOINT (STEERPOINT, MARKPOINT, ETC) WHEN HSD IS SOI
SimCommsSwitchRight
IF HELD, SELECTS BORE FROM SLAVE MODE (IN SLAVE MODE)
IN BORE SEEKER IS SLAVED 3° BELOW THE HUD BORECROSS (AIM-9)
6° FOR AIM-120
SimCursorEnable
CURSOR/ENABLE
(Z-AXIS)
TOGGLES AIM-9 SEEKER BETWEEN CAGE & UNCAGE
SimToggleMissileCage
MAN RNG/UNCAGE/GAIN
CONTROLS RADAR ANTENNA ELEVATION
NO EFFECT IN ACM AND STT
Analog Radar Antenna Elevation
ANT ELEV
IF CANNOT USE ANALOG ANTENNA ELEVATION:
SimRadarElevationUp
SimRadarElevationDown
AFBrakesIn
CLOSE
OPEN
AFBrakesOut
CENTER STOPS MOVEMENT
SPEED BRAKE

1.2.2. LEFT AUXILIARY CONSOLE



1.2.2.1 ALT GEAR HANDLE

This handle is used to extend the landing gear when normal extension is not possible (in case of hydraulic failure for instance) Pulling the handle provides enough pneumatic pressure to open the gear doors and extend all gears. Please note you can lower the gear with the alternate handle only once as the pneumatic pressure cannot be recharged in flight.
The ALT GEAR RESET button (white button in the centre of the handle) allows retracting the gear after an alternate extension if hydraulic pressure is available.

BMS Key Callbacks for the ALG GEAR handle
AFAlternateGear
AFAlternateGearReset

1.2.2.2 TWA panel

The Threat Warning Aux panel is part of the EWS suite. It is made of 4 indicators (3 with pushbuttons): SEARCH, ACT/PWR, LOW ALTITUDE & POWER.

The Power button applies and removes power to the EWS suite. The green indicator comes ON when the EWS is powered.

The ACT/PWR button is a dual indicator and has no button. The top indicator labelled ACTIVITY comes ON if the EWS is powered and detects a radar painting the ownship. The bottom indicator labelled POWER is ON whenever the EWS suite is powered.

The SEARCH button allows "S" search symbols to be displayed on the RWR display, if the EWS is powered. By default they are not. SAM radar for instance displays an S well before showing its acquisition symbol. Displaying the S symbol on the RWR to search for a SAM will give you an early advantage in many cases.
With the SEARCH option not active, the green 'S' indicator on the TWA will blink at 4Hz whenever a search radar is painting ownship. In that configuration, the "S" symbol is not displayed on the RWR.
With the SEARCH option activated, the green 'S' indicator on the TWA will remain lighted as long as the SEARCH option is active. A further press of the button deactivates the SEARCH option.

The LOW ALTITUDE is a pushbutton and a dual indicator.
The pushbutton toggles between HIGH & LOW altitude threat assessment biasing. The EWS is able to categorize the SAM threat according to their lethality at low or high altitude.
The top indicator labelled LOW comes ON if the EWS is powered when the LOW option is selected.
The bottom indicator labelled ALTITUDE comes ON whenever the EWS suite is powered.

BMS Key Callbacks for the TWA panel:
SimRwrPower
SimRWRSetGroundPriority
SimRWRSetSearch

1.2.2.3 HMCS panel

The Helmet Mounted Cueing System displays weapon, sensor and flight information to the pilot through the helmet visor providing off-boresight missile capability. It is an extension of the HUD and considered as one SOI (HUD & HMCS).
The panel bears a single knob featuring and ON/OFF switch and a clockwise motion for increased brightness. The knob can be interfaced with an analogue device as well.
Refer to the HMCS section for further discussion of the HMCS.

BMS Key Callbacks for the HMCS panel:
SimHmsSymWheelUp
SimHmsSymWheelDn
SimHmsOn
SimHmsOff

1.2.2.4 CMDS panel

The CMDS panel is part of the EWS suite and mainly manages all countermeasures. It is used in conjunction with the CMS switch on the sidestick. (See stick section on the right console).
The RWR and JMR switches are two state toggle switches that control automatic dispensing of chaff and flares. The RWR switch must be ON for the SEMI and AUTO modes to function. The JMR switch needs to be ON for the EWS to be able to release countermeasures coordinated with the use of the Jammer pod.

The MWS switch is not implemented in the USAF latest block inventory jets, and this is not implemented in BMS.

The panel provides four categories of expendables. Only two are supported in the F-16. They are on the right side of the panel and labelled CH for chaffs and FL for flares. Category 01&02 are not implemented and can remain OFF. When the switch is OFF, the display above remains blank. Needless to say, both the CH and FL category switch needs to be ON for chaff and flares to be released. The above indicator displays the number of expendables remaining and when bingo level is reached (set through the DTC, or UFC) LO is displayed with the number remaining. When a category is exhausted, 0 is displayed.

The MODE knob selects the CMDS operating mode: OFF, STBY, MAN, SEMI, AUTO, and BYP. Whatever mode selected, the released countermeasure corresponds to the selected Program (PRGM knob)
. In OFF, the CMDS is not powered and countermeasure cannot be released.
. In STBY, the release parameters and programming can be manually changed through the UFC. It is the only mode allowing reprogramming. The CMDS cannot release countermeasure in that mode.
. In MAN (manual) only program 1 to 5 can be released manually by the pilot by using the CMS on the sidestick. CMS forward release whatever PGR is selected (1 to 4) through the PRGM knob. PGR 5 can also be released, not through the CMS but the slap switch on the left side panel.
. In SEMI, release is not automatic but the EWS will prompt the pilot through the VMS whenever the system feels countermeasures should be employed. The pilot then can give consent to release by depressing CMS aft. The program will be then released once. If the threat persists, the EWS will prompt for consent again (Counter). Consent must be given each time. Please note that for the SEMI mode to work, the RWR switch on the CMDS panel needs to be ON.
. In AUTO, Consent must be given once (CMS aft) and is assumed until it is explicitly cancelled with a CMS right. Deployment of countermeasure is thus automatic and can deplete your stores very fast depending on the selected program.

. BYP is a Bypass mode and is used when the CMDS fails. BYP allows the pilot to release one chaff and one flare only at each CMS forward command. BYP is always manual; no SEMI or AUTO functions are active while in BYP.

The PRGM knob allows the pilot to select one of the 4 pre-programmed countermeasure sequences. When CMS forward is depressed, the selected program is activated. There are a total of 6 programs but only 1 – 4 can be selected through the PRGM knob. PRG 5 is always activated by the slap switch on the left sidewall and PRG 6 is always activated by depressing CMS left. All 6 programs can be programmed through DTC or through the UFC whenever the CMDS mode in is STBY.
The BIT position is the CMDS self test and is not implemented in BMS.

The JETT switch is dumping all remaining flares at once (no visual effect implemented)

The top row indicators simply provide GO, NO GO, DISPENSE RDY messages.
GO means all system are in the green and the CMDS is ready
NO GO means the system is not ready (one of the system is not powered, failed or not ready,
DISPENSE RDY comes ON whenever the CMDS is ready to dispense but consent is required.

BMS Key Callbacks for the CMDS panel:
SimEWSRWROn
SimEWSRWROff
SimEWSRWRPower (toggle)
SimEWSJammerOn
SimEWSJammerOff
SimEWSJammerPower (toggle)
SimEWSChaffOn
SimEWSChaffOff
SimEWSChaffPower (toggle)
SimEWSFlareOn
SimEWSFlareOff
SimEWSFlarePower (toggle)
SimEWSModeOff
SimEWSModeStby
SimEWSModeMan
SimEWSModeSemi
SimEWSModeAuto
SimEWSModeByp
SimEWSPGMInc
SimEWSPGMDec
SimEWSProgOne
SimEWSProgTwo
SimEWSProgThree
SimEWSProgFour
SimEWSProgDec
SimEWSProgInc
SimEwsJett
SimEwsJettOff

1.2.2.5 Speedbrake indicator

A square mechanical indicator reports the speedbrake position to the pilot. Speedbrake are activated through the speedbrake switch on the throttle. Switch backwards extends the speedbrake (MOM) and switch forward closes the speedbrake. The speed brakes stop their motion once the switch is replaced in the centre. The indicator with 9 dots indicates a speedbrake OPEN and when it's closed, the indicator displays CLOSED.

1.2.2.6 Gear panel

The landing gear (LG) and its doors are operated by hydraulic system B. It has two main gears (MLG) and one nosewheel (NLG)

The gear handle commands LG retraction or extension. A red warning light in the top of the handle illuminates when the LG and doors are in transit or have failed to lock in position. The light also comes ON below 10000 feet when all LG are not down and locked and airspeed is less than 190 knots and rate of descend is greater than 250 feet per minute.

In real aircraft, the handle is locked in the up position to prevent inadvertent lowering of the gear. To lower the gear, the pilot has to depress the white pushbutton located on the landing gear handle. This is not implemented in BMS.

The DN LOCK REL button is not implemented either in BMS. In the real jet it allows the pilot to retract the LG on the ground by depressing this yellow button and moving the LG handle up. Indeed once WOW is activated, the landing gear can not be retracted unless this safety button is depressed.

What is implemented though is the WOW switch (Weight On Wheels). Once weight is on the gear struts, the WOW switch is activated allowing or terminating various system functions.

The three green wheels down indicators comes ON whenever the respective landing gear is down and locked. A full gear down and locked indication is given when all three greens are lighted and the red lollipop handle light is OFF.

The hook shaped switch above the LG handle is a two positions toggle switch operating the emergency arrestment system. While it is implemented on the BMS F-16, there is unfortunately no arrestment gear on any Falcon airbase implemented. So it can be considered procedural only.
When the hook is down, the hook caution light located on the caution panel (right aux) is lighted.

The LIGHTS LANDING/TAXI light has also a specific shaped cap and operates the landing/taxi light. The real jet has a three position switch because of the distinction made between the landing light and the taxi light. In BMS, we have no such distinction and the switch is a two positions toggle: UP for light ON and DOWN for light OFF. (Please note that the PER PIXEL shading options must be checked in the BMS config for the lights to be correctly visible)

The HORN SILENCER white pushbutton when depressed silences the VMS low speed/gear horn.
The horn becomes audible when the following conditions are met:
Below 10000ft, below 190 knots, gear not down and locked, sink rate greater than 250 fpm.

The STORES CONFIG CATI/CATIII switch is a two position toggle switch: CATI and CATIII. CATIII position should be selected when the aircraft is configured with a category III loading. AOA limiter is then provided. Please refer to the FLCS chapter for further discussion.

The GND JETT switch is a two position toggle switch ENABLE and OFF. In ENABLE, it allows the pilot to jettison his load on the ground. Obviously in OFF, the jettison is not possible.

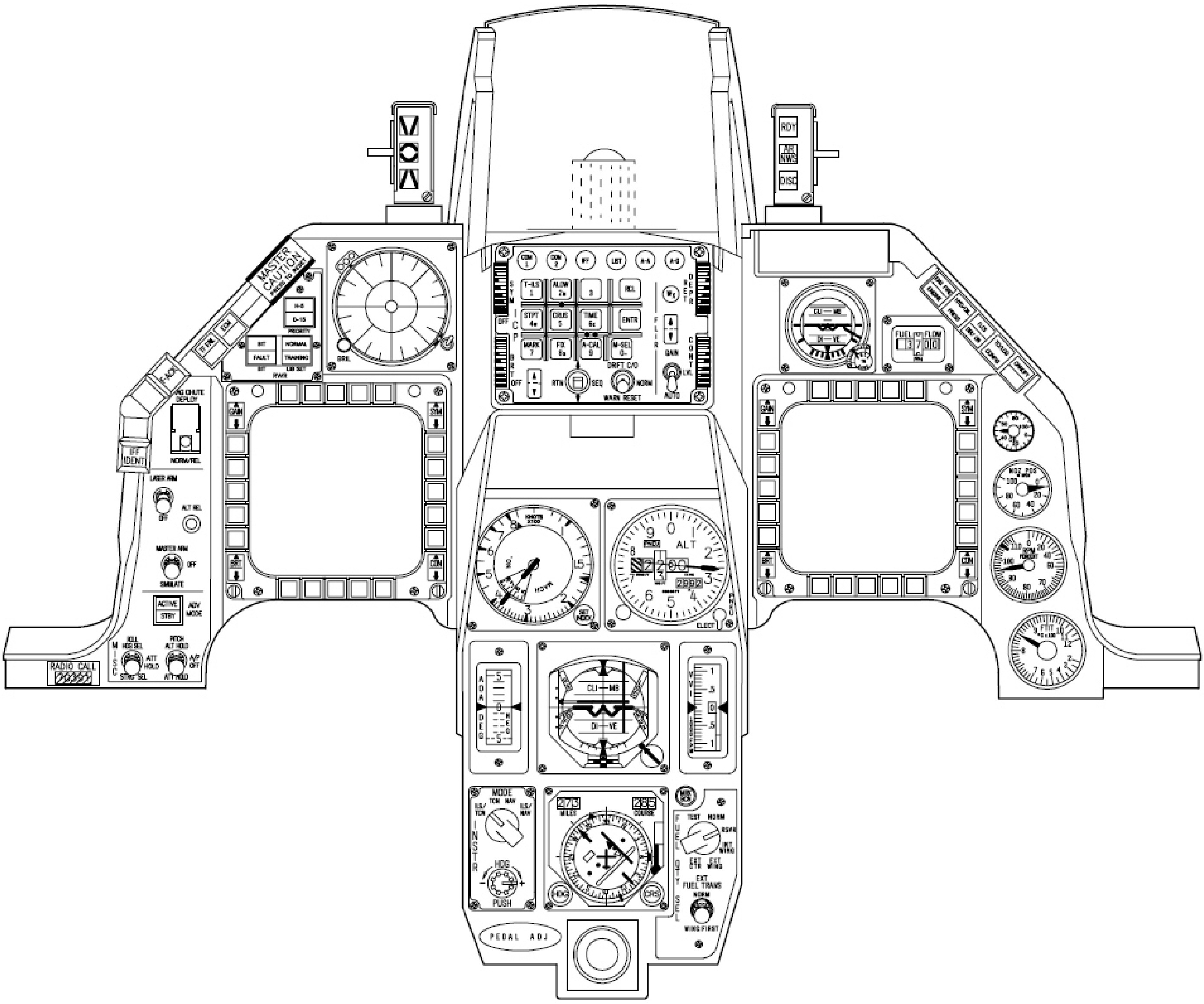
The BRAKES channel switch is not implemented in BMS. We only have one channel brake and aircraft braking is provided by the toebrakes. For those not having 3 axis rudder pedals, the toebrakes can also be implemented with a keystroke. It is strongly advised to use toebrakes pedals in BMS differential braking is implemented. Please refer to the brakes chapter for further discussion about the F-16 braking system.

The Parking brake switch is a magnetically held switch. In the real jet it has three positions but the ANTI-SKID functionality is not implemented in BMS and thus is a two position switch in the BMS cockpit.
The parking brake when engaged holds the aircraft stationary without the use of wheel brakes. Considering that a lightly loaded jet in BMS can move at idle power, it is important to use parking brakes to relieve the wheel brakes and their tendency to develop heat which decrease performance and may present hazardous situations.
In the real jet, the parking brakes are automatically de-energized when the throttle handle moves one inch past the idle point. In BMS, the parking brakes disengages automatically (that’s why it is a magnetic switch) above 80% RPM. There is no parking brake status indicator aside from the position of the switch.

The EMER STORES JETTISON when depressed for more than 1 second jettisons all AG stores and external fuel tanks. Air to air weapons and any HTS, TGP and ECM pods remain on board. While the emergency jettison is depressed, the MFD displays the SMS Jettison page

BMS Key Callbacks for the GEAR panel
SimGndJettOn
SimGndJettOff
SimGndJettEnable (toggle)
SimCATI
SimCATIII
SimCATSwitch (toggle)
SimSilenceHorn
SimLandingLightOn
SimLandingLightOff
SimLandingLightToggle
SimParkingBrakeOn
SimParkingBrakeOff
SimParkingBrakeToggle
AFGearUp
AFGearDown
AFGearToggle
SimEmergencyJettison
SimHookUp
SimHookDown
SimHookToggle

1.2.3. CENTER CONSOLE



1.2.3.1 MISC panel

The MISC panel may be different from one aircraft to another. BMS uses the Block 50/52 MISC panel featuring Autopilot, TFR, Master ARM, Laser, and RF switches.

The two lower switches are respectively the Autopilot ROLL switch (left) and the autopilot PITCH switch (Right). Both are three position switches.

The PITCH switch is the master switch and is a magnetically held in ALT HOLD and ATT hold position.
In ALT HOLD position the autopilot is engaged in ROLL and PITCH. The ROLL mode depends on the position of the ROLL switch (left) and the autopilot will maintain a constant altitude.
The centre position disengages the autopilot in both Pitch and Roll.
The ATT HOLD position engages Pitch and Roll autopilot. Roll is always depending on the ROLL switch position. Constant Pitch is determined by the INS at the time the PITCH mode switch was set.

The ROLL switch is functional only when the PITCH switch is engaged in ATT PITCH or ALT PITCH. When the PITCH switch is centred in A/P OFF, the ROLL switch is inoperative.
The HDG SEL position turns the aircraft to capture and maintain the heading selected by the heading marker on the HSI.
In ATT HOLD, the autopilot maintains ROLL attitude by INS at the moment the ROLL switch was set.
In STRG SEL, the autopilot steers the aircraft to the selected steerpoint.

The autopilot can be engaged only if certain conditions are met:
Gear up,
Air refuelling door closed,
No FLCS fault present,
Altitude must be lower than 40.000 feet,
speed must be less than 0.95Mach
Attitude must be within 60° of trimmed flight in both PITCH and ROLL.
AOA must be less than 15°
DBU not engaged
Stall Horn is silent.

When the autopilot is engaged and any of the above conditions are no longer met, the Autopilot disconnects automatically. The PITCH switch snaps back in A/P OFF position and a WARN message is displayed in the HUD.
The pilot can override the autopilot by depressing the stick paddle lever. While keeping the lever depressed he can change PITCH and ROLL input. Upon releasing the paddle, the AP will re-engage in the mode it was set.
Note that the Stick TRIM buttons are inoperative when the autopilot is engaged.
For further information about the autopilot system, refer to the autopilot chapter later in this manual.

The ADV mode pushbutton indicator refers to the Terrain Following system which is set through the TFR page of the MFD. The indicator has a pushbutton that allows turning ON/OFF the TFR system.
The top part of the indicator is labelled ACTIVE in green and comes ON when the TFR is enabled.
The lower part of the indicator is labelled STBY in yellow and indicates that the automatic terrain following system (ATF) is ready to take over. Automatic terrain following is not 100% implemented in BMS.

The MASTER ARM switch is a three position toggle switch labelled ARM, OFF and SIM.

The ALT REL is a pushbutton that works exactly as the pickle switch on the HOTAS stick.

The LASER ARM switch is a two positions toggle switch. In ARM, it enables the FLIR (Forward Looking InfraRed targeting pod laser. The laser needs to be fired to allow Laser Guided Bombs to guide on its reflected energy. The laser can be fired manually (stick trigger second detent) or automatically a few seconds before impact. Placing the switch is ARM doesn't fire the laser, it readies the system so the laser can be fired depending on the settings inputted in the UFC (LIST page – LASER)

The RF switch is a three position toggle switch and controls electromagnetic emissions from the aircraft. NORM is the default position and is used for normal operations of the aircraft electro magnetic emissions. QUIET is decreasing the level of EW emission by turning the radar to STBY
SILENT shuts down all EW emissions from the aircraft: RADAR, TFR, Radar Altitude, ECM. Placing the RF switch in SILENT will generate a TF FAIL message and a HUD WARN indication.

BMS Key Callbacks for the MISC panel:
SimLaserArmToggle
SimLaserArmOn
SimLaserArmOff
SimRightAPSwitch
SimLeftAPSwitch
SimLeftAPUp
SimLeftAPMid
SimLeftAPDown
SimLeftAPInc
SimLeftAPDec
SimRightAPUp
SimRightAPMid
SimRightAPDown
SimRightAPInc
SimRightAPDec
SimToggleAutopilot
AFDragChute
SimToggleTFR
SimStepMasterArm
SimArmMasterArm
SimSafeMasterArm
SimSimMasterArm
SimMasterArmDown
SimMasterArmUp
SimPickle
SimRFSwitch
SimRFSwitchUp
SimRFSwitchDown
SimRFNorm
SimRFQuiet
SimRFSilent

1.2.3.2 Left EYEBROW

The left eyebrow is made of a stack of pushbuttons and a stack of lights. Only one pushbutton is implemented: the F-ACK. Depressing that button, activates the PFL display on the right AUX console and enumerates faults (see RIGHT AUX section below) The IFF pushbutton is not implemented since we don't have IFF system in BMS.
The lights are made up of a red warning light for the Terrain following system that comes ON when the TF fails (but since partly implemented in BMS, we won't get too much in details about that one) and the very important amber caution light. This light comes ON (with a slight delay) as soon as the system detects a fault or failure. The light is coupled with a pushbutton that allows resetting it once the fault is acknowledged or solved. It is paramount to understand that the only way to extinguish the master caution light is not to reset it but to clear the fault. Let's have an example. During flight, you are CATIII and you jettison you load, switching to CATI. The system senses that but the pilot has to manually switch to CATI. The STORES CONFIG and the MASTER CAUTION light come ON. Obviously, resetting the MASTER CAUTION would extinguish it, but then the STORES CONFIG would stay ON and the fault wouldn't be cleared. The pilot, by switching the CAT switch to CATI clears the fault; extinguish the STORES CONFIG & the MASTER CAUTION lights.

BMS Key Callbacks for the LEFT eyebrow:
SimICPFAck
ExtinguishMasterCaution

1.2.3.3 Left MFD & RIGHT MFD

Both MFDS are the main displays giving invaluable information to the pilot. They each have 20 pushbuttons and four 2 positions rockers in each corner. Out of those 4, only two are implemented: the Brightness and Gain. The 20 pushbuttons arranged in 4 rows of 5 are called OSB for On Screen Buttons and labelled from 1 to 20 starting at the left button on the top row and going in the clockwise direction. The top row is thus made of OSB #1 to OSB #5. The displays have many different pages and subpages, which are explained later in the MFD chapter. As such the function of each button changes according to the active page and is always displayed just next to the button.

BMS Key Callbacks for the LEFT& RIGHT MFDs:

SimCBEOSB_1L	*SimCBEOSB_1R*
SimCBEOSB_2L	*SimCBEOSB_2R*
SimCBEOSB_3L	*SimCBEOSB_3R*
SimCBEOSB_4L	*SimCBEOSB_4R*
SimCBEOSB_5L	*SimCBEOSB_5R*
SimCBEOSB_6L	*SimCBEOSB_6R*
SimCBEOSB_7L	*SimCBEOSB_7R*
SimCBEOSB_8L	*SimCBEOSB_8R*
SimCBEOSB_9L	*SimCBEOSB_9R*
SimCBEOSB_10L	*SimCBEOSB_10R*
SimCBEOSB_11L	*SimCBEOSB_11R*
SimCBEOSB_12L	*SimCBEOSB_12R*
SimCBEOSB_13L	*SimCBEOSB_13R*
SimCBEOSB_14L	*SimCBEOSB_14R*
SimCBEOSB_15L	*SimCBEOSB_15R*
SimCBEOSB_16L	*SimCBEOSB_16R*
SimCBEOSB_17L	*SimCBEOSB_17R*
SimCBEOSB_18L	*SimCBEOSB_18R*
SimCBEOSB_19L	*SimCBEOSB_19R*
SimCBEOSB_20L	*SimCBEOSB_20R*
SimCBEOSB_BRTUP_L	*SimCBEOSB_BRTUP_R*
SimCBEOSB_BRTDOWN_L	*SimCBEOSB_BRTDOWN_R*

missing GAINS callbacks

1.2.3.4 TWP

The Threat Warning Prime panel is located right next to the RWR (Radar Warning Receiver) display and manages the information displayed on the RWR. It is made of 6 square lights all featuring a push button except the Missile Launch indicator.
Each indicator has multiple lights (top and bottom) the bottom light comes ON when the system is powered and the top light comes ON depending on the status of the relevant system – except again for the Missile launch indicator.
Here is a rundown of each indicator/ button:

- Handoff is used to set the mode of operation of the RWR. There are 4 modes of operations: Normal, Diamond Float, Transient and Latch. Those modes will be explained later in the Electronic Warfare System later in this manual. For now, you should simply know that the mode giving the best Situational Awareness is the Diamond float mode where the diamond floats to the highest priority symbol. That mode is entered with a short push (less than one second) on the handoff button.
  The bottom light of the indicator is ON as soon as there is power and the top indicator comes ON only when a handoff mode is engaged (Diamond float, transient, latch)

- Missile LAUNCH: this one is only a light and flashes ON at 4Hz as soon as the EWS (Electronic Warfare System) detects a radar missile launched at your ownship. The indicator is backed up by audible warning tones.

- PRIORITY: The Priority mode enables some declutter of the RWR display by displaying only the 5 most important symbols instead of the usual 12 symbols (16 when UNKNOWN mode is selected). When the PRI button is depressed, the RWR enters PRIORITY mode and the top light of the PRI indicator comes ON. The bottom light OPEN shuts off, as both lights are mutually exclusive.
  When PRIORITY mode is enabled, the top light PRIORITY will flash if the EWS detects more than 5 threat emitters.
  The RWR remains in this mode until the pilot exits the Priority mode by depressing again the button. At that time, the top light extinguishes and the bottom light OPEN lights up.

- UNKNOWN/NAVAL. This one has always been a tricky one for falcon flyers. The indicator has three lights instead of two. U (top), ship symbol (centre) and UNKNOWN (bottom). When depressed the top light illuminates (U) and the RWR displays U symbols (unknown) it can then displays 16 symbols instead of the usual 12. The pilot can deselect this mode by depressing again the pushbutton. The top light then extinguishes.

- SYS TEST is not implemented in BMS.

- TGT SEP: Depress this indicator when you want to have a better view of two emitters which are too close by each other. When depressed, the top light (TGT SEP) illuminates and the symbols on the RWR are spread out for 5 seconds. After that time, the RWR reverts to normal and the top light extinguish. The bottom light is ON as soon as power is applied.

BMS Key Callbacks for the TWP:
SimRWRSetPriority
SimRWRSetTargetSep
SimRWRSetUnknowns
SimRWRSetNaval
SimRWRHandoff

1.2.3.5 RWR

The RWR is displaying threat emitters depending on their azimuth relative to your ownship. It does not though give distance information. The display is made of two concentric circles: inner and outer. The threats are categorized by order of importance; the more lethal threats are placed into the inner circle while the secondaries are left in the outer threats.
The RWR scope also consists of four noise bars located around the centre circle at 6, 9, 12 and 3 o'clock. They indicate the status of noise in the bands 0, 1, 2, and 3 respectively; however this is not implemented and is graphical only. There is a cycle timer on the left end of the band 3 noise bar. This is a vertical bar that moves up and down. As the RWR becomes saturated with signal activity the cycle timer moves progressively slower. With no signal activity, it moves up and down in 1 second. With full RWR activity, it moves up and down at a rate of 2.6 seconds.

The symbols displayed on the RWR are depending on their radar type, a list is here included. Airborne symbols are displayed with an inverted V on top of them to differentiate them from the ground emitters.

AIR to AIR RWR SYMBOLS		
A: ATTACK	14: TOMCAT	23: MIG 23
B: BOMBER	15: EAGLE	25: MIG 25
S: AIRBORNE SEARCH	16: FALCON	29: MIG29/ SU27,30,33,35 SU37/F16 aggres/ J-11
E: EF-2000	18: HORNET	31: MIG 31
T: TORNADO	20: MIRAGE 2000	
4: PHANTOM	21: MIG 21/ J-7/ J-8	
5: F-5 TIGER	22: RAFALE/ RAPTOR/ JSF	

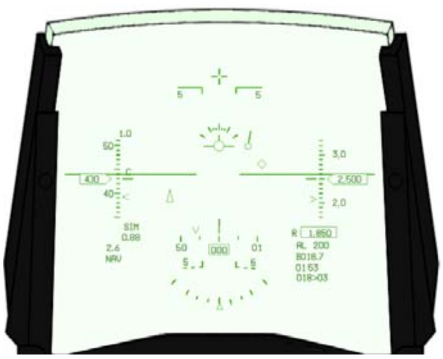
AIR to GROUND RWR SYMBOLS		
2: SA-2	11: SA-11	S: SEARCH
3: SA-3	15: SA-15	A: HB AAA
4: SA-4	17: SA-17	A: LB AAA
5: SA-5	19: SA-19	A: AAA
6: SA-6	N: NIKE	C: KSAM
8: SA-8	H: HAWK	P: PATRIOT
10: SA-10	U: Unknown	

1.2.3.6 Left INDEXER

The left indexer is made of three lights relevant to the Angle of Attack and is placed on the left of the HUD. It is a repeater of the AOA instrument on the centre console (see below) and the HUD AOA tape. The AOA is sensed by two conical sensors on each side of the nose of the F-16. AOA indication is valid for two point landing.

The top light points down and comes ON when the AOA is above 14° or above (on speed AOA too slow)
The centre light featuring a green doughnut comes ON if the AOA is between 11 and 14° (13° = on speed AOA for landing.)
The bottom light is an amber inverted V and comes ON when the AOA is below 11° (on speed AOA too fast for approach).
These lights are always ON, even when the gear is retracted allowing the pilot to quickly check his AOA in every flight situation.

1.2.3.7 HUD



The HUD (Heads Up Display) displays a variety of flight information through a collimating system. A more in depth explanation of the HUD can be found in the relevant chapter later in this manual. The HUD is powered ON through the BRT wheel on the ICP. That wheel features an ON/OFF switch at the beginning of its course which toggles the HUD ON/OFF. Once the HUD is enabled, the wheel sets the HUD brightness level.
Many settings on the HUD can be changed by the pilot through the UFC or the HUD control panel on the RIGHT Console (see RIGHT console section)

1.2.3.8 ICP & DED

The ICP (Integrated Control Panel) is the primary interface between the aircraft systems and the pilot. It is part of the UFC (Up Front Control) couple made of the ICP and the DED (Data Entry Display) where the ICP is the keyboard and the DED the display.
As a more complicated system, the UFC will have its own chapter with detailed information later in this manual.

BMS Key Callbacks for the ICP:
SimICPTILS
SimICPALOW
SimICPPrevious
SimICPNext
SimICPCrus
SimICPStpt
SimICPMark
SimICPEnter
SimICPCom1
SimICPCom2
SimICPNav
SimICPAA
SimICPAG
SimICPIFF
SimICPLIST
SimICPTHREE
SimICPSIX
SimICPEIGHT
SimICPNINE
SimICPZERO
SimICPResetDED
SimICPDEDUP
SimICPDEDDOWN
SimICPDEDSEQ
SimICPCLEAR
SimDriftCO
SimDriftCOOn
SimDriftCOOff
SimWarnReset
SimSymWheelUp
SimSymWheelDn
SimHUDPower
SimHUDOn
SimHUDPOff
SimRetUp
SimRetDown

1.2.3.9 MACHMETER

The Mach meter is a primary flight instrument giving indicated airspeed in both knots (nautical mile per hour) and Mach number. The indicated airspeed is given by the outer needle on the scale from 60-80 to 800 knots and the Mach number is given by the inner needle and the inner scale.
The Mach meter has two indicators: a red triangle illustrating the VNE (Never Exceed speed) which cannot be set and the green triangle which is a simple pilot selectable caret. It dos not work in the 3D cockpit of BMS but cockpit builders amongst you can have it implemented through the Mach meter knob when using MFDE which is a software that extracts instruments & displays. It is used as a visual aid to maintain the assigned speed when flying IFR for instance.

1.2.3.10 ALTIMETER

The altimeter gives altitude in feet. The needle reads from zero to one hundred feet on the outer scale and the large instrument window gives altitude rounded to the nearest hundred feet. To derive the current altitude, use the drum number and needle in combination. For the example shown at left, the drum read 3000 feet tending to 3100 feet and the needle reads 97 feet so in combination they show the present aircraft altitude as 3097 feet.

The smaller window on the right allows the pilot to input the local altimeter setting in mill bars (HectoPascal) or in inches of mercury depending on the options set in BMS config to compensate the instrument for the current atmospheric conditions. The pressure is changed through the altimeter knob on the bottom left of the instrument.
The instrument is flagged PNEU when it receives only PNEUMATIC pressure and no electrical power. In this case the instrument behaves as a standard pressure altimeter.

BMS Key Callbacks for the Altimeter:
SimAltPressInc
SimAltPressDec

1.2.3.11 AOA

The AOA indicator, located on the instrument panel, displays actual AOA in degrees. The indicator has a vertically moving tape display indicating an operating range of -32 to approximately +32 degrees. The tape is colour coded from 9 to 17 degrees to coincide with the colour coded symbols on the AOA indexer.
The instrument is flagged OFF when there is no power available.

1.2.3.12 ADI

The ADI (Attitude Direction Indicator) is the main attitude flight instrument and gives ownship attitude along pitch, roll and yaw axis supplied by the EGI/INS. The F-16 ADI is mainly used for IFR flying and features also ILS localizer and glideslope when the ILS modes are activated. The knob on the bottom right of the instrument is not implemented in Falcon due to the fact that it is used in reality to centre the instrument along the fixed horizontal reference (according to the seating position of the pilot)
The ADI features 4 flags. One in each corner of the instrument: OFF, LOC, GS and AUX.
The red OFF flags is displayed when the instrument does not receive power or when the INS totally failed.
The red LOC flag is displayed when the Localizer needle is unreliable
The red GS flag is displayed when the Glide slope needle is unreliable
The yellow AUX flag is displayed while the heading value of the INS is not reliable. During ramp starts, the AUX flag remains displayed until status 90, 60 seconds into the initial INS alignment. When the flag disappears, the heading value of the INS becomes reliable. In BMS, that is your cue for a short ramp start where as long as the GPS switch is ON, the INS will remain fully reliable.

1.2.3.13 VVI

The VVI (Vertical Velocity Indicator) located on the instrument panel displays vertical velocity in thousandths of feet per minute. The instrument features a vertically moving tape indicating an operating range from -6000 to +6000 feet/min.
The instrument is flagged OFF when there is no power available.

1.2.3.14 INSTRUMENT MODE panel

The bottom knob of the instrument mode is not implemented in BMS. In reality it is used to correct INS heading deviation, which never happens currently in our sim. The top knob is a four positions knob setting the instrument mode: ILS/TCN – TCN – NAV – NAV/ILS.

- **ILS/TCN:** This mode is one of the two modes to be used when needing the ILS needles. It activates the ILS symbology in the HUD, the ADI and the HSI. The course deviation indicator on the HSI gives the localizer deviation. The TO/FROM indicator is not displayed and the bearing pointer points at the active TACAN station. The range value in the DME window of the HSI is from the active TACAN station.
- **TCN:** In TACAN mode the HSI displays course deviation and distance from the active TACAN station. ILS symbology is not displayed. All HSI indicators points to the TACAN station. The TO/FROM indicator is displayed.
- **NAV:** In NAV mode, the HSI displays course deviation and distance from the steerpoint of interest (active UFC Steerpoint) and not the TACAN. The TO/FROM indicator is displayed.
- **ILS/NAV:** This is the second mode for ILS operation. As in the other mode, ILS symbology are displayed in the HUD, ADI and the HSI. The course deviation indicator on the HSI gives the localizer deviation, the TO/FROM indicator is not displayed, the range in the DME window is given to the steerpoint of interest and the bearing pointer on the HSI points to the steerpoint of interest as well.

BMS Key Callbacks for the INSTR MODE panel:
SimStepHSIMode
SimHSIIlsTcn
SimHSITcn
SimHSINav
SimHSIIlsNav
SimHSIModeInc
SimHSIModeDec

1.2.3.15 HSI

The HSI (Horizontal Situation Indicator) is the primary flight instrument for navigation. It features a top down view with your aircraft in the centre and a compass rose all around it. Its use is fully developed in the chart tutorial document that explains basic and advanced radio-navigation.
The instrument features two knobs on the bottom, the left one labelled HDG for Heading is used to set a heading caret on the compass rose to a heading of your choice (as a visual cue).
The right knob labelled CRS for Course is used to enter a course value manually which will be reflected on the course deviation indicator. That value is displayed on the top right window of the instrument. The top left window display the range to the selected destination, according to the position of the INSTR MODE knob as seen just above in this chapter.
The instrument is flagged with an OFF when no power is available.
For a full in depth review of the HSI use, please refer to the chart_tutorial_v2.pdf document. We cannot explain the HSI without explaining radio navigation.

BMS Key Callbacks for the HSI:
SimHsiCourseInc
SimHsiCrsIncBy1
SimHsiCourseDec
SimHsiCrsDecBy1
SimHsiHeadingInc
SimHsiHdgIncBy1
SimHsiHeadingDec
SimHsiHdgDecBy1

1.2.3.16 FUEL QTY panel

The Fuel Quantity Panel is made of one 6 positions knob and one 2 position switch. The top knob controls the fuel quantity displayed on the fuel QTY gauge on the RIGHT AUX console.

- **TEST:** AR & FR needles each points to 2000 and totalizer displays 6000, furthermore, both fuel low caution light illuminates on the caution panel (right AUX console)
- **NORM:** AL needle displays the quantity of fuel contained in the AFT (LEFT) reservoir and A-1 fuselage tanks. FR needle displays the quantity of fuel contained in the FORWARD (RIGHT) reservoir and F-1, F-2 fuselage tanks. The Totalizer displays the total fuel on board.
  The NORM position is the only position that enables the automatic forward fuel transfer system, trapped fuel warning and BINGO fuel computation based on fuselage fuel.
- **RSVR:** AL and FR needles points to fuel quantity left in the aft and forward reservoir tanks. The Totalizer displays the total fuel on board.
- **INT WING:** AL needle points to the fuel quantity left in the left internal wing tank. FR needle points to the fuel quantity left in the RIGHT internal wing tank. The Totalizer displays the total fuel on board. Please note, the fuel contained in the internal wings does not influence the fuel imbalance as they empty first into the fuselage tanks and the CG doesn't move as long as the fuselage tanks remain full.
- **EXT WING:** AL/FR needles points to the quantity of fuel left in the LEFT and RIGHT external fuel tanks. The Totalizer displays the total fuel on board
- **EXT CTR:** AL needle points to zero. FR needle points to the quantity of fuel remaining in the centre external tank. The Totalizer displays the total fuel on board.

The EXT FUEL TRANS SWITCH is used to control the priority of the fuel transfer from the wing external tanks and the centre external tank. In NORM (default position) the centreline external tank transfers first and in WING first, the external wing tanks transfer before the centreline external tank. That is thus used when the wing bags needs to be jettisoned before the centreline.

For further information, check the fuel chapter later in this document.

BMS Key Callbacks for the FUEL QTY panel:
SimExtFuelTrans
SimFuelTransNorm
SimFuelTransWing
SimIncFuelSwitch
SimDecFuelSwitch
SimFuelSwitchTest
SimFuelSwitchNorm
SimFuelSwitchResv
SimFuelSwitchWingInt
SimFuelSwitchWingExt
SimFuelSwitchCenterExt

1.2.3.17 MARKER BEACON

The marker beacon is located to the right of the HSI above the FUEL QTY panel. Unlike in the general aviation where the markers are colour coded; in the F-16, it is only green but blinks at a different frequency (with varying sound cues) according to the marker overflown.
Marker Beacons are short range transmitting devices placed alongside the ILS approaches and provide visual and audio cues when overflown. There are normally three markers: inner, outer and middle markers along an ILS track. In BMS, we only have outer (OM) and inner marker (IM) implemented. They 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 marker 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.
In BMS, both markers light up the MRK BCN indicator making it flashes at different frequency: (low freq for OM and higher freq for IM). See Chart tutorial V2.pdf document for further information.

1.2.3.18 FUEL FLOW indicator

Located above the RIGHT MFD, this gauge displays the current Fuel flow consumed by the engine (including in Afterburner) in pounds per hour (pph).
The gauge has a range from zero to 80.000 pph and is powered by the emergency bus.

1.2.3.19 backup ADI

The backup ADI is located above the RIGHT MFD and is the primary attitude backup instrument. It does not need power and will function even when the main ADI is flagged OFF.

1.2.3.20 Right INDEXER

The RIGHT indexer features three coloured indicators arranged vertically.
The top one is blue and labelled RDY. It is relevant to the AIR- REFUEL system and comes ON whenever the system is ready for AIR to AIR refuelling. In BMS, this indicator comes ON as soon as the AR door is opened.
The centre indicator is green and labelled AR/NWS. AR is also relevant to AIR to AIR refuelling (when the aircraft is in the air) and comes ON whenever the boom is inserted and has good contact with the AR receptacle on the back of the F-16.
The NWS is relevant only when the aircraft is on the ground. It comes ON when the NOSE WHEEL SYSTEM is engaged, allowing the pilot to steer the aircraft with the nose gear by depressing the rudders pedals to control direction. It is recommended that nose wheel steering only be engaged below 70 knots on landing and take off rolls and during taxi.
The Bottom indicator is amber and labelled DISC. It is again relevant to the AR system and illuminates when the pilot commands disconnect from the boom

1.2.3.21 Right EYEBROW

On the edge of the right glareshield, you will find a few more red warning lights: All those lights are powered by the emergency bus.

- **ENG FIRE / ENGINE** is a split face indicator with two separate illuminated cells. The top part (ENG FIRE) comes ON whenever the system detects a fire in the engine.
  The ENGINE warning light illuminates when RPM and FTIT indicator signals indicate that an engine over temperature or flameout has occurred. Illumination also occurs for an engine alternator failure and may occur as a result of an RPM or FTIT indicator failure. The warning light illuminates when the rpm decreases below idle or approximately 2 seconds after FTIT indication exceeds 1100°C. The warning light goes off when the condition that turned it on is eliminated.
- The **HYD/OIL PRESS** serves as a monitor of engine oil pressure and hydraulic system pressure. For engine oil pressure, the warning light illuminates when oil pressure has

been below approximately 10 psi for 30 seconds (time delay minimizes warning light illuminating for false warning during manoeuvring).The light goes out when oil pressure exceeds approximately 20 psi. For hydraulic pressure, the warning light illuminates when either A or B system pressure decreases below 1000 psi. The light goes out when both system A and B pressures are above 1000 psi. During engine start, the warning light usually goes off before reaching idle rpm; however, acceptable operation is indicated if the warning light goes off before exceeding 70 percent rpm and remains off when the throttle is retarded to IDLE.

- The middle light is also a split face indicator and refers to the FLCS and the Digital Backup (DBU)
  The FLCS warning light illuminates to indicate a dual malfunction in the FLCC electronics, including the processors, power supplies, input commands or sensors, AOA, or air data inputs. The FLCS warning light also illuminates if the LEF's are locked or FLCS BIT fails. The FLCS warning light remains illuminated until FLCS reset action is successful in clearing the failure. If an active warning fault exists and a subsequent warning level malfunction occurs, the FLCS warning light goes off momentarily to retrigger HUD WARN and voice warning
  The DBU ON light in BMS is eye candy only and comes ON whenever the DBU switch is activated on the FLCS panel.
- **TO/LDG CONFIG** illuminates in flight whenever pressure altitude is less than 10,000 feet, airspeed is less than 190 knots, rate of descent is greater than 250 fpm, and either of the following conditions exists:
  1. TEF's not full down.
  2. NLG or either MLG not down and locked (accompanied by LG warning horn).
- The rightmost indicator is again a split face indicator with the top part referring to the canopy and the bottom one to oxygen.
  The CANOPY light comes ON whenever the canopy is not locked in place.
  The OXY LOW light comes ON whenever the regulator pressure has dropped below 5 psi or when the bit detected a fault

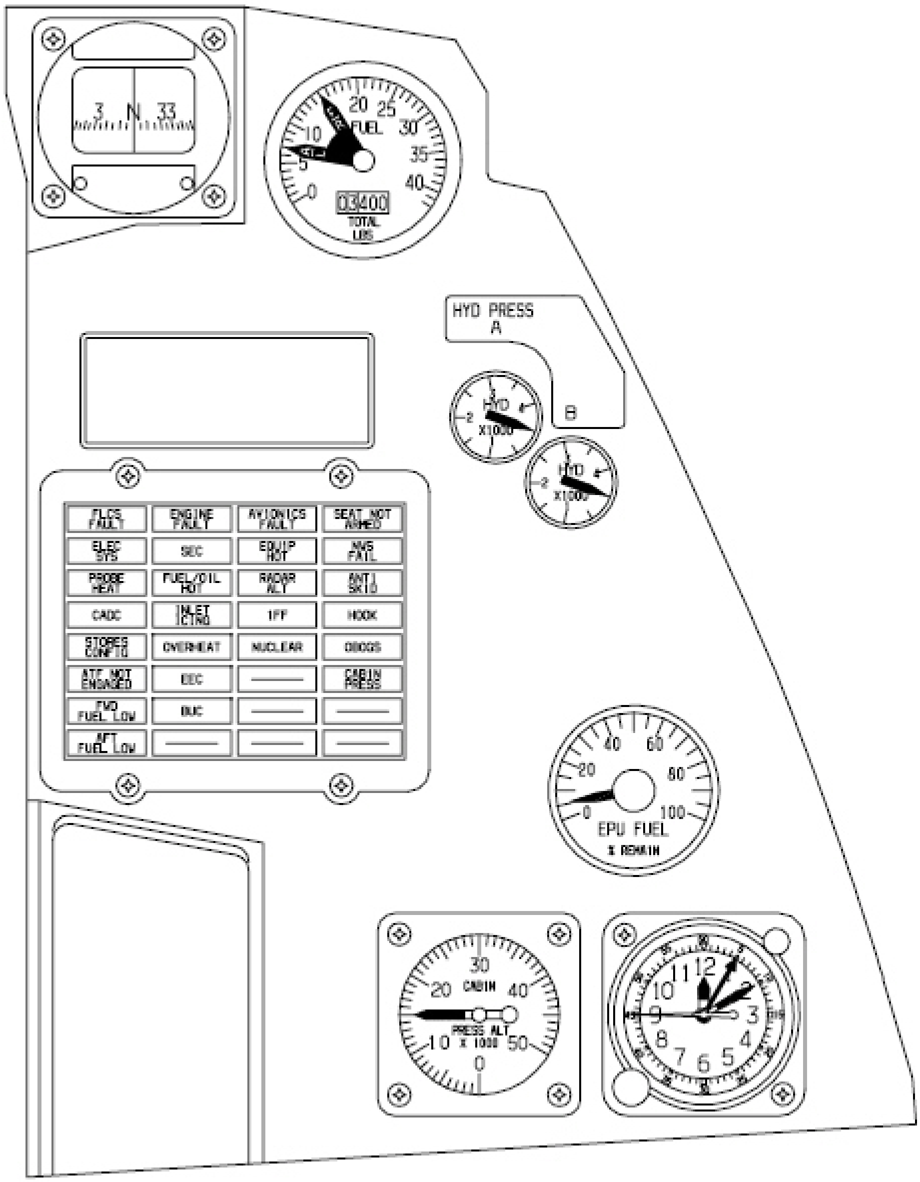
1.2.3.22 Right INSTRUMENT stack

The right instrument stack has four gauges all relevant to the engine. The top one is the OIL pressure indicator, the second one is the Nozzle position indicator, the third one is the RPM and the last one is the FTIT (Forward Turbine Inlet Temperature)

Please note in BMS you can fly the block 50 F-16 model featuring a GE 129 engine or a block 52 model featuring a PW229 engine. MLU variants can also be chosen and feature a PW engine.

- The OIL Pressure indicator displays engine oil pressure from 0 to 100 psi and is powered by emergency buses
- The NOZ POS indicator is a direct display of actual nozzle position ranging from 0 percent (closed) to 100 percent (full open). The indicator is powered by emergency buses
- The RPM indicator has a pointer display expressed in percent rpm from 0-110 (on Ge129 engine) or 0-100 (for PW229 engine).The indicator is powered by the battery bus.
- The FTIT indicator displays exhaust gas temperature (EGT) in degrees C. The indicator has a range of 200 to1200°C in major increments of 100°C and is powered by the battery bus.

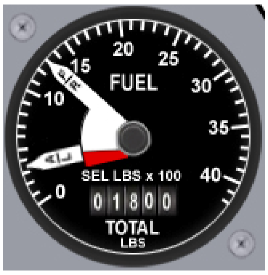
1.2.4. RIGHT AUXILIARY CONSOLE



1.2.4.1 Compass

The magnetic compass is completely autonomous and doesn't need any system power to work. It is your ultimate backup navigation instrument. All four cardinal directions are displayed as well as all 30° marks.

1.2.4.2 FUEL QTY indicator



The FUEL QTY indicator gives your total fuel remaining on board (totalizer) and its distribution in the internal forward / aft tanks or right /left tanks (needles). Two needles labelled F/R & A/L displays fuel quantity. The F/R needle indicates the amount of fuel in the FRONT tank or RIGHT tank depending on the position of the FUEL QTY selector knob. The A/L needle indicates the amount of fuel in the AFT tank or LEFT tank depending on the position of the FUEL QTY selector knob.
The aft needle has a red centre portion that is visible only when a fuel imbalance condition exists. For further information, please refer to the fuel chapter, later in this manual.

1.2.4.3 Pilot Fault Display

The Pilot Fault Display is the same type of screen as the DED and provides a list of fault detected in all systems. The display is blank until a fault is detected, MASTER CAUTION light comes ON whereupon the PFD displays the relevant fault.
The PFD can also be triggered manually by the pilot when depressing the F-ACK pushbutton on the left glare shied. When that button is depressed and no fault detected, the PFD displays NO FAULTS - ALL SYS OK. If faults are present, subsequent presses of the F-ACK button cycle to the next fault until all faults have been reviewed.

1.2.4.4 HYD PRESS system A & B gauges

The hydraulic system is a dual redundant system labelled A&B. You will find two hydraulic pressure gauges accordingly. Normal operation pressure is around 3100 PSI (12 o clock needles on the gauges). Critical systems are served by both system A and B and thus will fail only when both hydraulic systems have run out of pressure. EPU provides emergency hydraulic pressure to system A whenever required but is limited in autonomy.
Refer to the EPU & Hydraulic chapter for further information.

1.2.4.5 CAUTION light panel

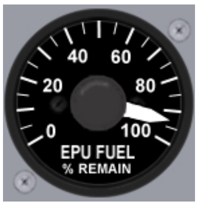
The caution light panel features 26 amber caution lights. Each of them will illuminate when a fault in the relevant system is detected. For a full overview of each caution light, please refer to the emergency checklists. Checklists_EP_0612.pdf

One additional note: the ELEC SYS light can only be reset with the ELEC CAUTION RESET button on the ELEC panel (left console).

1.2.4.6 LOX QTY gauge

The liquid oxygen gauges points to the remaining oxygen in litres remaining in the LOX tank.
Latest version of the F-16 do not have a liquid oxygen tank anymore has oxygen depends on electrical and engine bleed air to keep the supply going.
So this gauge may not be in your aircraft. When the oxygen is supplied by the engine, the caution light OXY LOW is replaced by the OBOGS caution light**.**

1.2.4.7 EPU FUEL QTY gauge



The EPU gauges indicates the quantity of EPU fuel remaining (Hydrazine). Hydrazine is used if insufficient engine bleed air is available for running the EPU. The gauge displays the percentage of EPU fuel remaining and depletes fast when hydrazine is used. In normal operations, 100% hydrazine provides EPU operating time of approximately 10 minutes. Use the following rule of thumb: 100%=10 minutes; 50% = 5minutes. Remember that in case of MAIN & STDBY GEN and EPU out of fuel situation, the hydraulic system is depleted and no flight controls inputs are possible. When the EPU is out, your only remaining option is to eject.

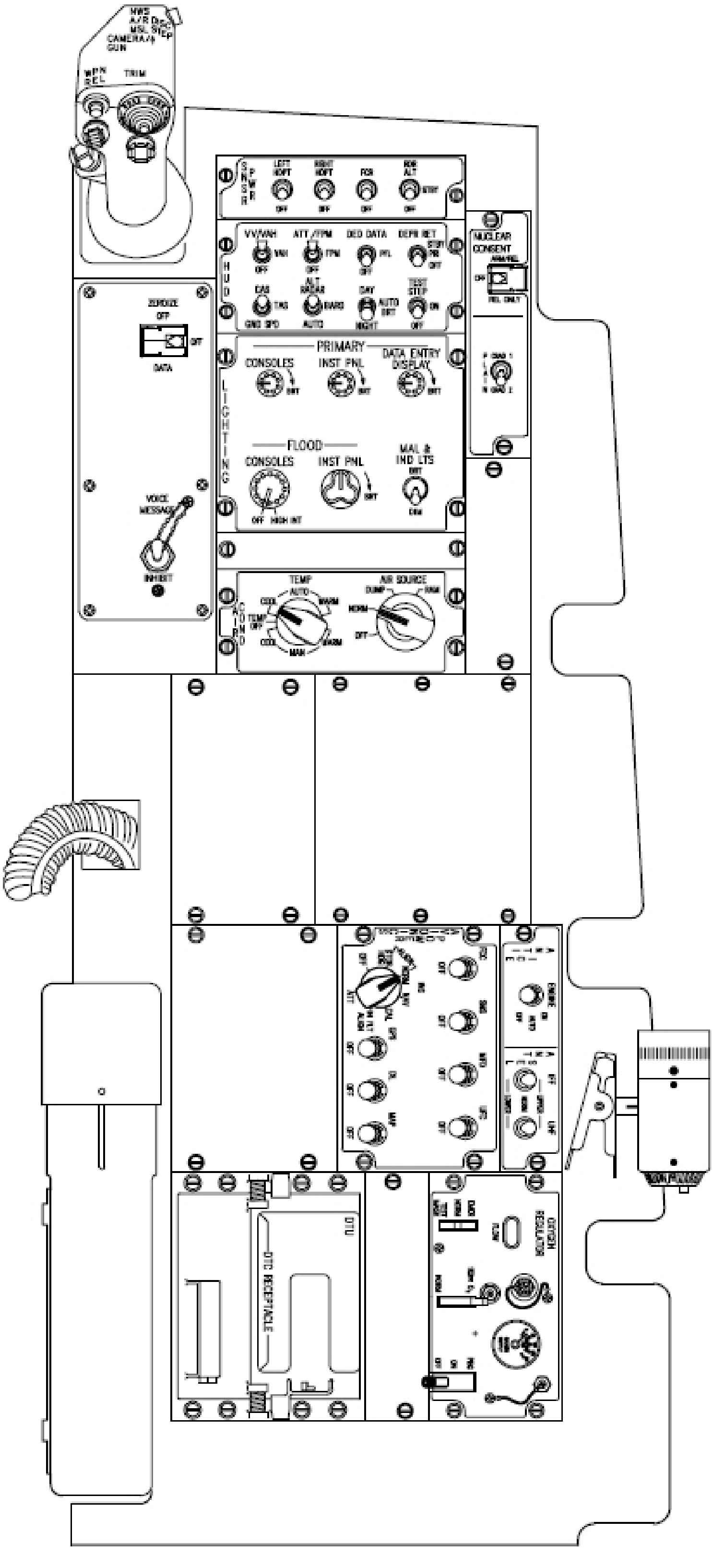
1.2.4.8 Cabin pressure gauge 1-177

The cabin pressure gauge indicates cockpit pressure altitude from zero to 50000 feet.

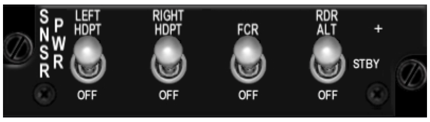
1.2.4.9 Clock

The clock, located on the right auxiliary console, is an 8 day, manually wound clock with provisions for an elapsed time indication up to 60 minutes. In BMS, it is automatically set to mission time and does not take the day into account.

1.2.5. RIGHT CONSOLE



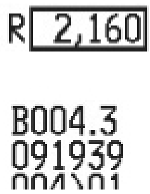
1.2.5.1 SNSR PANEL

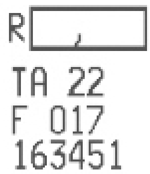


The SENSOR panel features 4 toggles switches. The two left most are power switches for the two chin intake pylons (**LEFT HDPT and RIGHT HDPT**). Those pylons can carry pods (TGP, navigation and FLIR and need power to function properly. When the switches are OFF, the pods don't get power and will not work. Be also aware that some of those pods need time after powering them up to be operational so power the pylons early enough in your flight.

The **FCR switch** is a two state switch that powers up the Fire Control Radar (FCR). When powered up, the FCR enters a Power ON Built-In Test (PO BIT) mode, visible on the MFD. The BIT lasts about 3 minutes after which the radar is set to standby, unless previously set to a specific mode. The PO BIT can't be interrupted in the middle of the test. The only way to 'truly' interrupt it is to turn the radar OFF.
Since the FCR is OFF at Ramp, the FCR PO BIT has to be run completely when starting the jet from cold for the FCR to function properly.
The PO BIT (3 minutes) is performed anytime the radar power is switched to OFF for more than 4 seconds. Manual BIT is also possible through the MFD OSB (FCR page) or by switching the FCR OFF for less than 4 seconds. In this case a shorter BIT is performed (Manual BIT) lasting about 30 seconds.

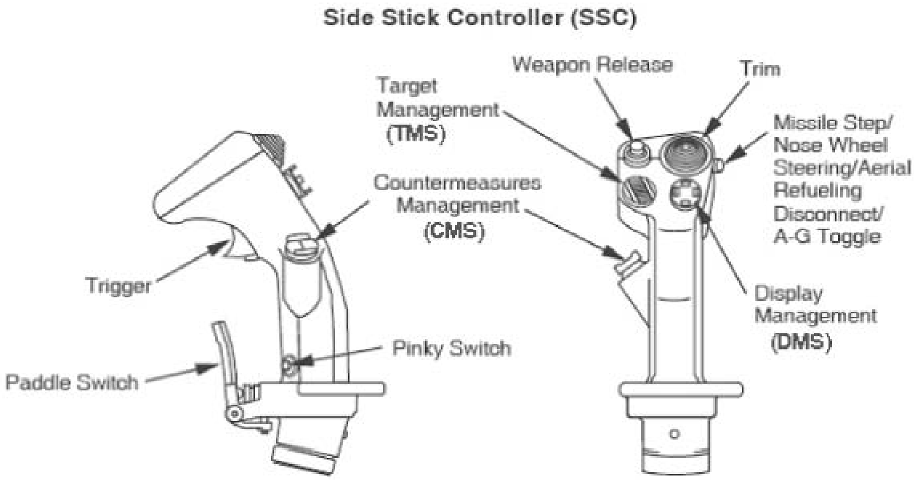
The **RDR ALT** switch is a three position switch relevant to the radar altimeter. When the switch is OFF the radar altimeter is inoperative. In STBY, the radar altimeter is placed in Standby mode (used on the ground to avoid frying the ground troops and when placed in RDR ALT, the radar altimeter system is fully operative.
When the RDR ALT is active, the radar altitude can be read in the HUD in a box preceded by the letter R.
Certain conditions must be met for the Radar altitude to be displayed, those conditions depends on altitude: At low level, the RALT will blank past 30° pitch and approximately 90° bank but at higher altitude, the displayed RALT will blank above 10° pitch and approximately 75° bank. Note the comma that remains displayed, even when the altitude is blanked.





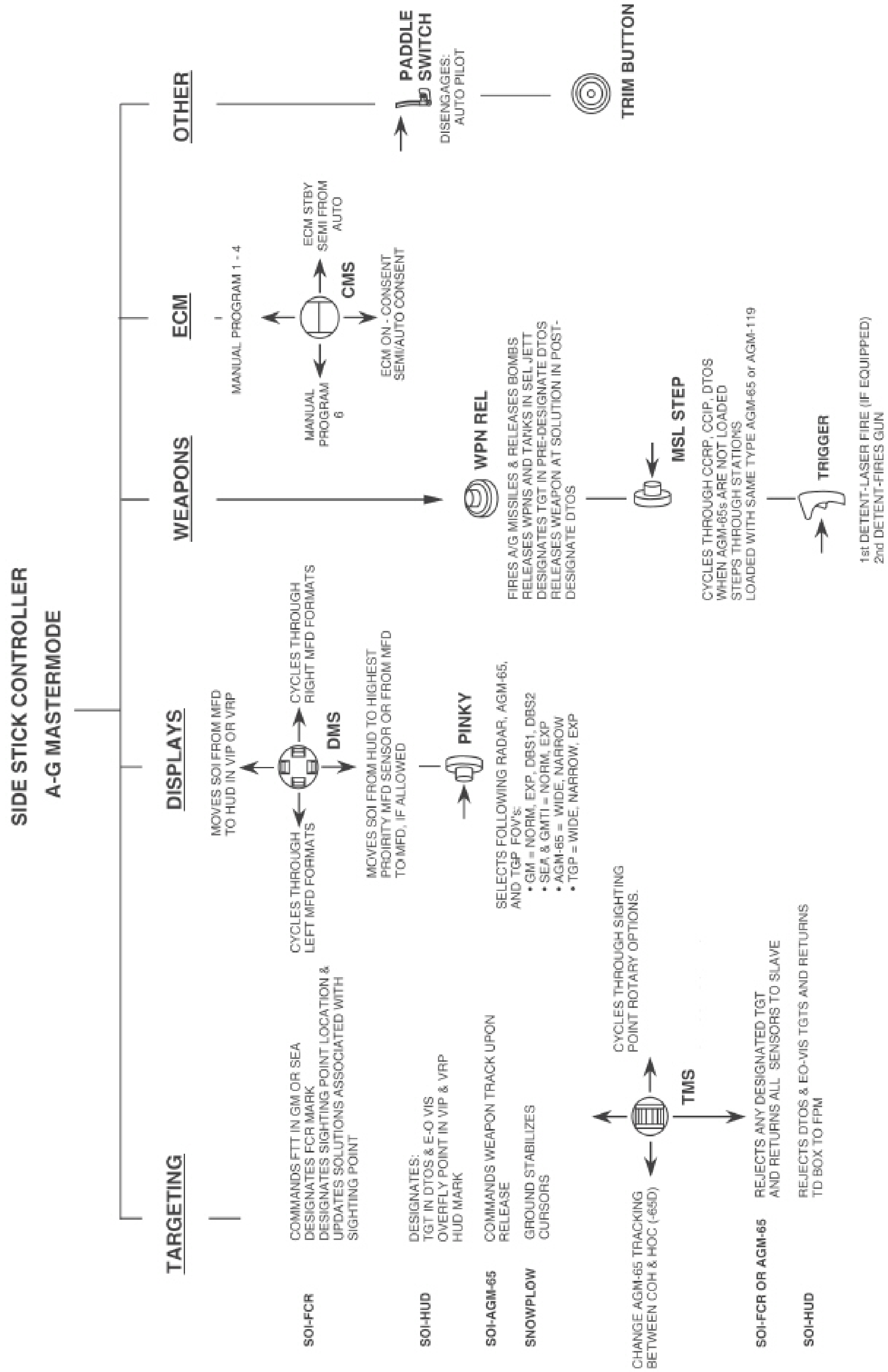
BMS Key Callbacks for the Sensor panel:
SimLeftHptPower
SimLeftHptOn
SimLeftHptOff
SimRightHptPower
SimRightHptOn
SimRightHptOff
SimFCRPower
SimFCROn
SimFCROff
SimRALTSTDBY
SimRALTON
SimRALTOFF
SimRALTUp
SimRALTDown

1.2.5.2 SIDESTICK CONTROLLER

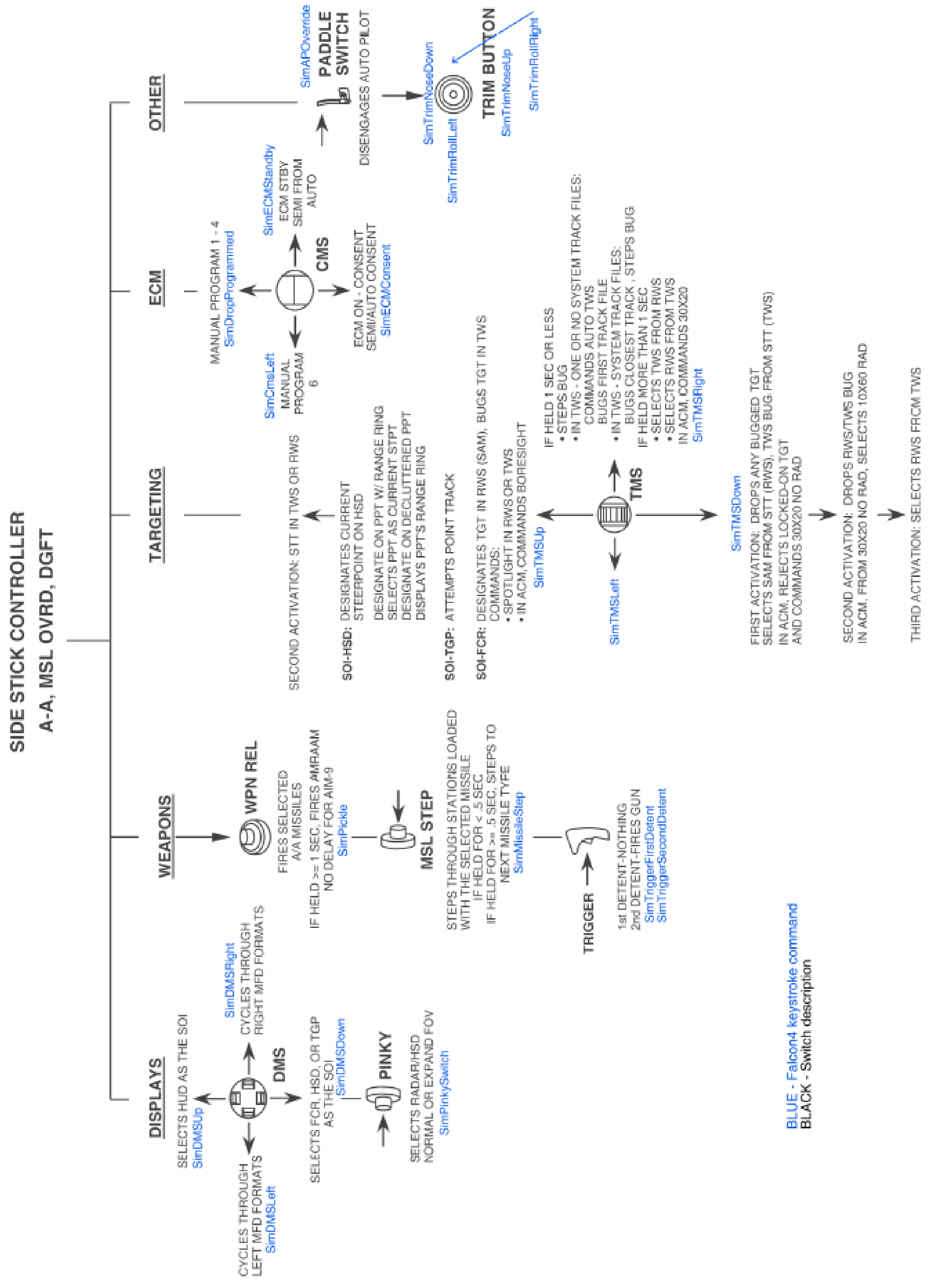


The stick in the real F-16 is a force sensing unit which contains transducers in both pitch and roll axes, moves approximately 1/4 inch in both axes, and is rotated slightly cw.
Refer to the diagrams on the two following pages for the function of each button.

BMS Key Callbacks for the Sidestick:
SimTMSUp
SimTMSDown
SimTMSLeft
SimTMSRight
SimDMSUp
SimDMSDown
SimDMSLeft
SimDMSRight
SimDropProgrammed
SimECMStandby
SimCMSLeft
SimCMSUp
SimCMSDown
SimCMSRight
SimPinkySwitch
SimHotasPinkyShift
SimAPOverride
SimTriggerFirstDetent
SimTriggerSecondDetent
SimMissileStep
SimPickle
AFAileronTrimLeft
AFAileronTrimRight
AFElevatorTrimUp
AFElevatorTrimDown
AFResetTrim



The sidestick functions in AA – MSL and Dogfight master mode



The sidestick functions in AA – MSL and Dogfight master mode

1.2.5.3 HUD PANEL

The HUD panel allows the pilot to set many parameters in the Head Up Display. The panel is arranged in two rows of four toggles switches:

- **VV/VAH – VAH – OFF** switch refers to the vertical velocity scales found on the HUD.
  In addition to the scales, in **VV/VAH t**here is a bank angle indicator tied on the FPM: 15/30/45/60° and in **VAH**, there is a roll indicator below the heading tape (if the DED is not displayed in the HUD) with 10/20/30 & 45° cues. In **OFF**, no scale or bank/roll indication is displayed.

- **ATT/FPM – FPM – OFF** switch refers to the pitch ladder and flight path markers (fpm). In **ATT/FPM**, pitch ladder and Flight Path Marker are displayed, in **FPM**, only the Flight Path Marker is displayed. In **OFF** neither pitch ladder nor Flight Path Marker is displayed.

- The **DED DATA – PFL – OFF** switch adds DED or PFL data on the bottom part of the HUD as display repeaters.
  When the switch is in **DED DATA**, the DED is displayed in the HUD.
  When the switch is centred on **PFL**, the Pilot Fault List is displayed on the bottom of the HUD.
  When the switch is set to **OFF**, neither the DED nor the PFL is displayed on the HUD.

- The **DEPR RET** switch is a three position switch labelled STBY, PRI and OFF. It is used for standby bombing mode.

- The **CAS –TAS – GND SPEED** switch controls display of the speed scale on the left of the HUD.
  When **CAS** is selected, the speed tape shows the CALIBRATED AIRSPEED (CAS). CAS is Indicated airspeed (IAS) corrected for position & instrument error.
  When **TAS** is selected, the speed tape shows the TRUE AIRSPEED. TAS is CAS corrected for pressure altitude, so it is the airspeed in the air mass at this altitude.
  When the switch is set to **GND SPEED**, the HUD tape shows the speed over the ground. Groundspeed is TAS corrected for winds.
  In groundspeed, a caret is also displayed on the heading tape. That caret means the system is now in wind corrected ground track as opposed to showing heading as magnetic track. Please note that if the gear is lowered while Groundspeed is selected, the HUD airspeed reverts back to CAS.

- The **ALT RADAR** switch is a three position switch labelled **RADAR** - **BARO** or **OFF (AUTO)** and is relevant to the altitude scale on the right of the HUD. Please note the current legend in the 3D pit is wrong and should be AUTO rather than OFF.
  When the switch is set in RADAR, the altitude tape indicates radar altitude
  When the switch is set in BARO, the altitude tape indicates barometric altitude
  When the switch is set in OFF (AUTO), the altitude tape indicates barometric altitude above 1500 feet and switches to radar altitude below 1500feet.

More information can be found in the chapter 1.5 Head Up Display

BMS Key Callbacks for the HUD panel:
SimHUDVelocityCAS
SimHUDVelocityTAS
SimHUDVelocityGND
SimHUDVelocity
SimHUDVelocityUp
SimHUDVelocityDown
SimHUDAltRadar
SimHUDAltBaro
SimHUDAltAuto
SimHUDRadar
SimHUDAltUp
SimHUDAltDown
SimHUDBrtDay

SimHUDBrtAuto
SimHUDBrtNight
SimHUDBrightness
SimHUDBrightnessUp
SimHUDBrightnessDown
SimReticleSwitch
SimReticleSwitchUp
SimReticleSwitchDown
SimReticlePri
SimReticleStby
SimReticleOff
SimHUDFPM
SimPitchLadderOff
SimPitchLadderFPM
SimPitchLadderATTFPM
SimPitchLadderUp
SimPitchLadderDown
SimScalesVVVAH
SimScalesVAH
SimScalesOff
SimHUDScales
SimHUDScalesDown
SimHUDScalesUp
SimHUDDEDDED
SimHUDDEDPFL
SimHUDDEDOff
SimHUDDED
SimHUDDEDDown
SimHUDDEDUp

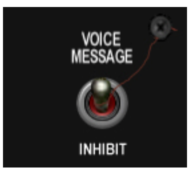
1.2.5.4 NUCLEAR PANEL

Currently not implemented.

1.2.5.5 ZEROIZE PANEL

Currently not implemented.

1.2.5.6 VMS PANEL



The Voice Messaging System (VMS) panel includes a single toggle switch. When placed in the INHIBIT position, VMS will be inhibited (Bitchin' Betty remains silent) and when placed in the UP position, VMS is operational.

BMS Key Callbacks for the VMS panel:
SimInhibitVMS
SimVMSOn
SimVMSOFF

1.2.5.7 INT LIGHT PANEL

The internal lights are not fully implemented in BMS. Only two knobs are available to control cockpit lightning: the Primary INST PANEL for backlight and the Flood Console knob for flood lights.
Please note: each knob has three positions: OFF, DIM, BRIGHT.
Those can not be assigned to an analogue value.
The third knob implemented is relevant to the DATA ENTRY display. As with the other knobs, it has three positions, OFF, Dim, FULL ON.

BMS Key Callbacks for the INT LIGHT panel:
SimInteriorLight
SimInteriorLightCW
SimInteriorLightCCW
SimInstrumentLight
SimInstrumentLightCW
SimInstrumentLightCCW
SimSpotLight

1.2.5.8 AIR COND PANEL

The AIR COND panel is made of two large knobs. The first one for TEMP is not implemented, but the second labelled AIRSOURCE is.
In **OFF** the engine bleed air valves closes. All air conditioning, cooling and pressurizing functions shut off. That means, no cockpit pressurisation, no system cooling, no external fuel tank pressurisation – preventing fuel transfer from those.
In **NORM**, the air conditioning system sets for automatic temperature and pressure regulation. Cockpit and fuel tanks are pressurized and avionics are cooled.
In **DUMP** Cabin pressurization is terminated and the cabin is vented to outside air pressure. This means cockpit pressure altitude will increase above 8,000 feet MSL. The CABIN PRESS caution will illuminate if cockpit pressure altitude exceeds 27,000 feet. All other ECS functions such as external fuel tank pressurization are unaffected.
in **RAM** Engine bleed air valves close. Cabin pressurization is terminated and the cabin is vented to outside air pressure. This means cockpit pressure altitude will increase above 8,000 feet MSL. The CABIN PRESS caution will illuminate if cockpit pressure altitude exceeds 27,000 feet. RAM air valves are opened to ventilate the cockpit and avionics. All other ECS functions such as external fuel tank pressurization & cooling are disabled.

BMS Key Callbacks for the AIRCOND panel:
SimIncAirSource
SimDecAirSource
SimAirSourceOff
SimAirSourceNorm
SimAirSourceDump
SimAirSourceRam

1.2.5.9 KY 58 PANEL

Currently not implemented.

1.2.5.10 ANTI ICE PANEL

Currently not implemented.

1.2.5.11 AVIONICS POWER PANEL

As the name implies, the AVIONICS POWER panel is used to power up avionic systems. It is made of 6 locking toggle switches and an INS knob.
The **MMC** switch (old FCC) enables power to the fire control computer (Mission Modular Computer).
The **ST STA** switch (old SMS) enables power to the store management system.
The **MFD** switch enables power to the Multi function Displays and the **UFC** switch does the same for the Up Front Controls. The **GPS** switch enables power to the GPS receiver – which in BMS will always ensure a perfect INS alignment - and the **DL** switch enables power to the data link receiver.
The INS knob is used to set and manage the Inertial Navigation System.
It has 6 positions labelled OFF, ALIGN STOR HDG, ALIGN NORM, NAV, IN FLT ALIGN & ATT. STOR HDG and ATT positions are not implemented in BMS.
OFF positions terminates all INS functions.
Place the knob to **ALIGN NORM** to start a normal alignment. The INS is usable after 90 seconds (provided the GPS switch is ON) when the INS has heading information. From that point, the AUX yellow flag on the ADI disappears and RDY is displayed steady in HUD and DED. Those are your visual cue for performing a short ramp procedure. Full alignment takes approximately 8 minutes. At that point, RDY flashes in the HUD and on the DED to indicate full alignment.
Once the INS is ready, switch the INS knob to **NAV** to allow the INS system to provide navigation information to the navigation system. Please note, navigation cues will only be displayed when the INS knob is set to NAV. During normal alignment, the navigation cues are not displayed (INS flight plan on HSD etc)
In case of INS failure or problem, an **IN FLIGHT** alignment can be performed. The INS is then realigned according to GPS data provided by the GPS system. During in-flight alignment, straight, level and un-accelerated attitude should be maintained until RDY flash in the HUD and DED. (Normally the magnetic heading should be entered manually in the DED, but that is not required in current BMS code)

BMS Key Callbacks for the AV Power panel:
SimINSInc
SimINSDec
SimINSNorm
SimINSNav
SimINSInFlt
SimSMSPower
SimSMSOn
SimSMSOff
SimFCCPower
SimFCCOn
SimFCCOff
SimMFDPower
SimMFDOn
SimMFDOff
SimUFCPower
SimUFCOn
SimUFCOff
SimGPSPower
SimGPSOn
SimGPSOff
SimDLPower
SimDLOn
SimDLOff
SimMAPPower
SimMAPOn
SimMAPOff

1.2.5.12 OXYGEN SUPPLY

The Oxygen panel is not implemented in BMS but the green lever can be used to toggle ON or OFF the sounds of the pilot breathing through the oxygen mask.

BMS Key Callbacks for the Oxygen panel:
SimOxySupplyToggle
SimOxySupplyOn
SimOxySupplyOff

1.2.5.13 DTU

Currently not implemented.

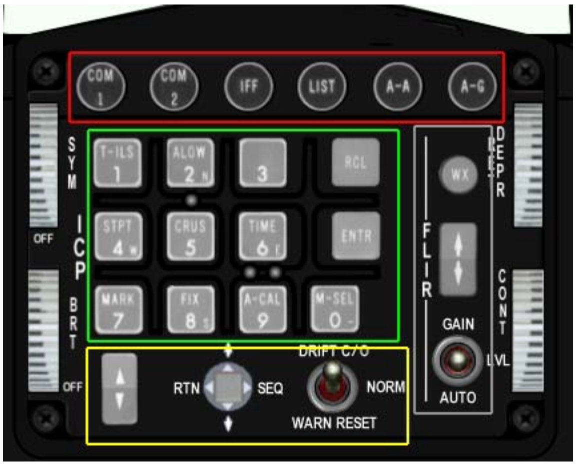
1.3 UP FRONT CONTROLS

The UFC are made of a display: the Data Entry Display (DED) and a keyboard known as the Integrated Control Panel (ICP)
Both work together to provide the pilot with an easy way to interface with the avionics system of the aircraft.
Every press on an ICP button opens a page or change information on the DED.

Fig1 : The ICP

Fig 2 : The DED

The ICP is arranged in 5 different areas:



The top row with round pushbuttons (red), the entry pad with square pushbuttons (green) the FLIR zone (grey) which is not implemented in BMS, the bottom part (yellow) with switches and the 4 outboard wheels.

More importantly, we can classify the ICP buttons in other, more relevant categories:

- Master Modes
- Override Modes
- Priority buttons.

The F-16 avionics system has the following components controlled from the ICP:

. 7 Master Modes

1. Air to Air (A-A ICP button)
2. Air to Ground (A-G ICP button)
3. NAV (when none of the A-A or A-G mode are engaged)
4. Dogfight (toggle switch on the throttle)
5. MRM - Medium Range Missile (toggle switch on the throttle)
6. S-J Selective Jettison (SMS page on MFD)
7. E-J Emergency – Jettison (while the E-J button is depressed)

Master Mode buttons automatically configures the system for specific actions. They can change MFD pages, DED pages and HUD pages all at once.

. 5 Override Modes

1. COM1 (ICP button)
2. COM2 (ICP button)
3. IFF (ICP button) Not implemented in BMS
4. LIST (ICP button)
5. F-ACK (left glareshield pushbutton)

Override modes provide direct access to the functions of the corresponding button. You can revert back to the initial page by depressing again the override mode button.
In addition to the 5 override modes, there is a special override mode that returns the UFC to the initial page: CNI (Communication, Navigation & Identification page) on the DED. That mode is accessed by depressing the DCS (Data Command Switch) to the left (RTN position)

.8 Priority/secondary buttons:

These are the ICP square buttons labelled T-ILS, A-LOW, STPT, CRUS, TIME, MARK, FIX and A-CAL. The two last are not implemented in BMS.
These buttons have a dual function; they are used to input numerical data into the UFC/DED or to enter UFC/DED subpages according to their labelling listed above.
Numerical values can be entered in the scratchpad. The scratchpad is the area between two asterisks displayed in the DED. Anytime you see the scratchpad active, the numerical value of the ICP button from 0 to 9 will be used when you press these buttons. Note that the numerical zero is entered using the M-SEL 0 button, this button has no secondary page call up function.

1.3.1. The Data Command Switch (DCS) & scratchpad

The DCS is a four way momentary switch situated on the bottom row of the ICP, next to the DRIFT/CO – WARN RESET switch.
The LEFT position is labelled RTN and allows exit from the current DED page or return to the CNI DED page.
The top position is labelled with an up arrow and cycles the DED cursors to editable functions (scratchpad) moving upward.
The bottom position is labelled with a down arrow and cycles the DED cursor to editable functions downward
The right position is labelled SEQ and is used to enter extra subpage or options of the current priority function.

1.3.2. The ENTR and RCL button.

Those two buttons have no priority functions and only serve to confirm or cancel the entered data. After entering data in the scratchpad, the ENTR button must be depressed to submit the changed data. The system checks if the data is valid and then moves on to the next editable area. If the data is invalid the inputted data will flash and the pilot will have to correct errors.
The RCL (Recall) will clear the last data entry. If pushed twice in succession, the entire scratchpad will be cleared.

1.3.3. The DED scratchpad:

The scratchpad is an editable area receiving alpha-numeric values from the ICP keys. The scratchpad area is displayed in the DED between two asterisks.
The scratchpad on the left picture is around the laser code.

The scratchpad is now on the laser time, any press on the ICP buttons will change the numerical value. For instance, let's depress 1 then 2 and the laser time will change to 12 seconds when the ENTR key is pressed.

The scratchpad is moved automatically to the next area upon depressing the ICP ENTR key (if data is valid) or manually by moving the DCS switch up or down.
To return to the original DED page, depress the DCS to the RTN (LEFT) position.

Anytime the scratchpad is not active, a press of a priority button will enter the relevant subpage. Each of them is covered later in this section.

1.3.4. CNI page

The Communication, Navigation and Identification DED page (CNI) is the default page for the DED.
It gives the pilot information about the current radio settings for both Com1 & Com2 radios, the active steerpoint, current time, IFF codes (NI) and active TACAN or DME when an air to air TACAN is active.
The CNI page is only accessible when the CNI switch on the AUX COMMS panel is set to CNI. When placed in BACKUP, the UFC is inoperative and all backup systems are active and controlled from the side consoles.
Note the up and down arrow on the steerpoint on the CNI page. This shows that the current steerpoint can be incremented or decremented with the PREV/NEXT button of the ICP (the rocker switch located left of the DCS) without leaving the CNI page. As with the scratchpad, the arrows can be cycled though the fields that can be edited by moving the DCS up and down.

Moving the DCS right to SEQ in the CNI page will display the current wind speed and direction on the DED but valid data is only available once sufficient airflow is feeding data to the probes. There is no wind indication on the ground in BMS as in the real aircraft.

The system time is displayed but is replaced by the hack clock when it is running (See TIME subpage)

1.3.5. T-ILS page (1)

This page refers to the TACAN – ILS settings. You can access it through the T-ILS ICP button.

The first line of the DED gives the TCN and ILS status. (ILS is turned ON/OFF with the ILS knob on the AUDIO2 panel)
The scratchpad is on the left between the two asterisks and that is where the TACAN & ILS frequencies are entered. The system is able to differentiate a valid TACAN channel (0-126) from a valid ILS freq (VHF 4 or 5 digits). The next line gives the current & active TACAN and ILS frequency and the last line displays the TACAN band (X or Y) and the set CRS for the ILS approach.

To enter a new TACAN channel or an ILS frequency simply input the relevant numbers within the asterisks and hit ENTR.
To change the TACAN band: input 0 (zero) in the scratchpad and press ENTR. That toggles from X to Y to X and so on.
To change the TACAN from TR (ground domain) to AATR (air domain), use the DCS SEQ button.

ILS CMD STRG can be inhibited or activated by placing the scratchpad over it and Mode Selecting it with the 0 (Zero – Mode Select) ICP pushbutton. When activated, the line CMD STRG in the DED is highlighted indicating that Command Steering is active.
To change the ILS course, place the scratchpad on the CRS field using DCS up/down and enter the correct runway heading for the active ILS. Press ENTR to input the data into the system.

1.3.6. A-LOW page (2)

The A-LOW page lets the pilot set different values for the altitude advisory system.
It is made up of three lines but before we get to that, please note the top right number with the arrows on the right. This is the active steerpoint; the arrows mean that the active steerpoint can be changed with the PREV/NEXT buttons of the ICP without leaving the A-LOW page.

Move the scratchpad up and down with DCS up and down to select a field to edit.

CARA ALOW is the altitude in feet where you want an advisory altitude warning. It is mainly used for low altitude flying. The inputted value is repeated in the HUD behind the AL notation and flashes when the actual altitude goes below that CARA A-LOW. If the gear is up VMS will also produce an aural Altitude call.
A caret is placed at the ALOW height on the (radar) altitude HUD scale.
The CARA ALOW function will work only if the radar altimeter is operating.

MSL FLOOR is your Minimum Safe Level floor. It is DTC loadable and one typical approach is to set this to 14000 feet to correspond with the transition altitude in Korea. That ensures that when descending below 14000, the VMS calls Altitude reminding the pilot to switch to local QNH for the altimeter calibration setup.

TFR ADV is an advisory altitude for the TFR system which is not fully implemented in BMS.

1.3.7. STPT (Steerpoint) page (4)

The steerpoint page gives the pilot information about the INS steerpoint.
The first line allows the pilots to toggle the active steerpoint with the NEXT/PREV ICP buttons (notice the up & down arrows) and the MAN or AUTO steerpoint function, which can be toggled with DCS SEQ. MAN means that the new steerpoint has to be manually selected. AUTO will increment to the next steerpoint automatically when the INS detects the proximity of the current waypoint. In AUTO mode, an “A” symbol is displayed on the CNI page next to the steerpoint, as seen on the left picture.

The second line is the LATITUDE of the currently selected steerpoint. Placing the scratchpad there will let the pilot enter a latitude for this particular navigation point.

The third line is the LONGITUDE of the selected steerpoint, it can also be changed by placing the scratchpad accordingly and entering new coordinates

The fourth line is the elevation of the steerpoint (the altitude at which you are supposed to overfly the steerpoint according to your INS flight plan. This is different from the real jet that has the ground spot height for steerpoint in this field (it is quite relevant to TGP mechanisation and finding target)

The fifth line is the TOS (Time Over Steerpoint) which gives you the local time the steerpoint will be reached, if you are following the route of flight as planned.

1.3.8. CRUS (Cruise) page (5)

The cruise page provides access to 4 submodes: TOS, RNG, HOME and EDR and gives relevant information for navigation, time and fuel while cruising.
Each submode MUST be Mode Selected to become active and supply accurate information and cues. Remember an M-SEL is made with the 0 (zero) button of the ICP and when active, highlights the area.

The submodes of the CRUS page are accessed sequentially with DCS SEQ or by pressing any secondary ICP button.

When first entering the CRUS page, it defaults to the first subpage: TOS (Time Over Steerpoint)

When TOS is Mode Selected, a caret is displayed on the HUD speed tape. To ensure that you reach the steerpoint on the exact time for TOS, then match your airspeed with the caret. The ETA (Estimated Time of Arrival) to the steerpoint is also displayed in the HUD
When TOS is not mode selected, no caret is active on the HUD speed tape and the ETE (Estimated Time Enroute) is displayed in the HUD.

You can change your TOS and assign a new one by simply inputting a new value in the scratchpad when the asterisks are around the DES TOS.
Further information on the TOS page includes the current system time, ETA at steerpoint and required ground speed to get there at the indicated TOS.

The next Submode is the RNG for Range.

When RNG is Mode Selected a caret is displayed on the HUD speed tape to pinpoint the best conserve fuel speed at this altitude. Optimum speed for fuel conservation changes with altitude.
When RNG is not mode selected, there is no caret displayed on the HUD Speed tape. Please note on the picture, RNG mode is NOT mode selected. Only the active steerpoint can be toggled on this subpage. Further information given on this page shows fuel remaining when reaching the active steerpoint and wind direction and speed.

A further press of the DCS SEQ brings the HOME subpage.

When HOME subpage is Mode Selected, two carets are displayed in the HUD on the speed tape and on the altitude tape. Following those two carets will establish the best profile to reach Home Plate (or any selected steerpoint designate as the home point).
The procedure to fly this profile is to select full military power, reach the speed caret first then pitch to reach the altitude mark while maintaining the speed on the caret. Altitude may vary according to fuel burned. Please note, optimal altitude is given in radar altitude on the DED, but may be different on your HUD scale depending on the altimeter setting. Check the picture on the right, both carets are followed and the optimum altitude in the DED matches the HUD radar altimeter. If you follow both carets, you will reach the home point at the selected optimum altitude.
The altitude caret will disappear once you can start your descent.
Further information displayed on this page indicates home point (can be changed to any INS steerpoint (e.g. alternate)), onboard fuel quantity remaining when reaching active steerpoint, optimum altitude for the HOME profile, and wind direction and speed.

The last subpage of the CRUS page is the Endurance mode (EDR)

When EDR mode is mode selected a speed caret is placed on the HUD tape to give a reference speed for best endurance at this altitude. This is very useful for holding patterns or maximum endurance cruise for instance. Further information given is time to bingo, optimum Mach number and wind.

It is important to realize that when toggling from one submode to another, you MUST ALWAYS Mode Select the new mode. If you don't do so the caret may be relevant to the previous CRUS submode. So to avoid any confusion make sure you always Mode Select the submode!

1.3.9. TIME page (6)

The TIME page allows the pilot to set a hack timer and a delta TOS for ROLEX calls.
The first line gives the current system time.
The second line is the hack timer. As the arrows indicate, pressing the ICP NEXT rocker button will start/freeze/resume the timer and ICP PREVIOUS rocker button will reset the hack timer to zero.
When the HACK timer is running it is also visible on the CNI page.

ROLEX calls are initiated when all TOS for all steerpoints need to be adjusted. This is done through the TIME page by changing the DELTA TOS. Place the scratchpad on the DELTA TOS line and input the ROLEX value. If a minus is required, start your input with the 0 (zero) ICP key for the minus sign.
For instance; Mamba flight Rolex +2 => TIME, DCS down to DELTA TOS: 2, 0, 0 ENTR
Mamba flight Rolex -3 => TIME, DCS down to DELTA TOS: 0, 3, 0, 0 ENTR

1.3.10. MARK page (7)

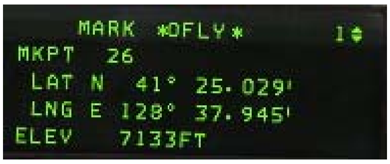
The Mark page is used to create markpoints. Own ship markpoints are stored in steerpoints bank 26-30. Mark points can be made from 4 different systems. OFLY (Overfly), FCR (Fire Control Radar), HUD (Heads Up Display) or TGP (Targeting Pod). There are thus 4 sub modes in the MARK page. To toggle between the sub modes, use DCS SEQ. The system defaults to a specific subpage according to master mode and sensor of interest and may make automatic markpoint recording.

- If the master mode is NAV or AG mode, and the FCR is Sensor of Interest & designating:
  => entering the Mark page will default to FCR Mark. The first markpoint will remain blank until TMS is moved up. At that point, the markpoint is created.

- If the master mode is NAV or AG mode, and the TGP is Sensor of Interest & ground stabilized:
  => entering the Mark page will default to TGP Mark. As with FCR, the markpoint needs to be manually done with TMS up.

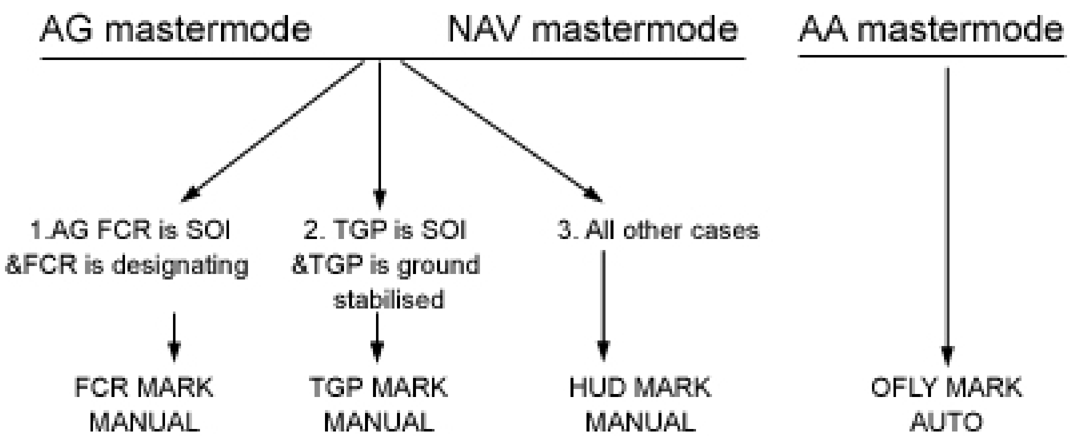
- If the master mode is NAV or AG mode, and the FCR or TGP are not in use (or not SOI and not designating or not ground stabilized) :
  => entering the Mark page will default to HUD Mark. No automatic markpoint is created.

  Markpoint must be done manually by moving the HUD mark cue (HMC – a small slewable circle appearing near the FPM in pre-designate) with the cursor (HUD SOI) and moving TMS up. The first press of TMS UP will ground stabilize the HMC and the second TMS-up will save the Markpoint. HMC must be on the ground for correct implementation, pointing at the sky will not work obviously.

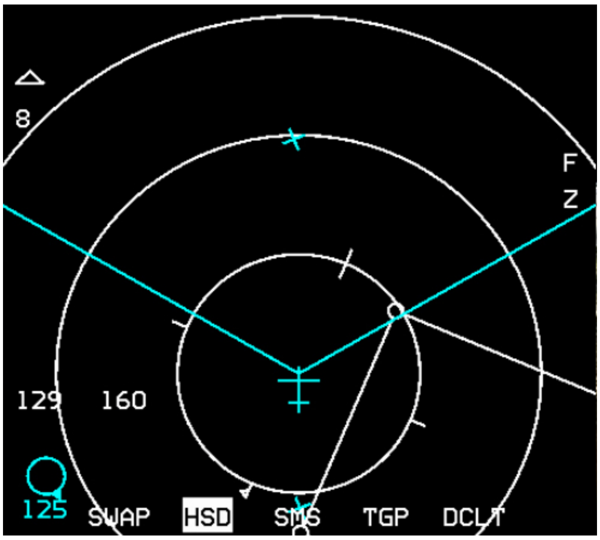


- If the master mode is AA mode
  => entering the Mark page will default to OFLY Mark and an automatic markpoint will be created.

Please note, the ICP ENTER key is no longer used to create markpoints – the TMS forward (TMS up) creates markpoints.
Mode Selecting (M-SEL ICP key 0) any valid markpoint will make this markpoint the active steerpoint.



As with any type of steerpoint, markpoints can be sent over the IDM - Refer to the Data-link chapter in the BMS Manual for further information. Markpoints are visible on the HSD page once created as a cyan cross.



In any mark mode, manual markpoints can be done by setting the correct mark subpage according to active sensor. Move the cursor to the desired spot and move TMS up once or twice depending on mark mode. If previous automatic markpoints were recorded, the markpoint rotary will increment and the next available steerpoint in the mark bank will be selected. Ownship markpoints are stored in Steerpoint bank #26 to #30. Once #30 is filled, the next markpoint will overwrite #26 and so on.

1.3.11. FIX page (8)

Not implemented.

1.3.12. A-CAL page (9)

Not implemented.

1.3.13. COM1 Override Mode

Pressing the COM1 ICP button brings up the UHF radio page. The first line gives the status of the radio, in this case it's set to BOTH (Preset and Guard) and the set frequency is 297.500 Mhz. The scratchpad is ready to receive a new frequency or the new preset. Another way to change the UHF radio is to use the ICP NEXT/PREV ICP buttons to directly change the preset (notice the double arrow cursor right next to the 6?) - 349.000 Mhz is the frequency for UHF preset #6. Presets are set in the DTC.

1.3.14. COM2 Override Mode

The COM2 ICP button brings up the VHF radio page.
The first line gives the status of the radio, in this case it's ON and the set frequency is preset #1.
The scratchpad is ready to receive the new frequency or the new preset.
133.150 is the frequency for VHF preset #6..

1.3.15. IFF page:

Not implemented.

1.3.16. LIST page

The LIST page is used to access additional subpages. Each page can be accessed by depressing the relevant ICP button: 1 for DEST, 2 for BNGO, etc. Please note, RCL, ENTER and Zero key are also used to enter INTG, DLINK and MISC subpages respectively.

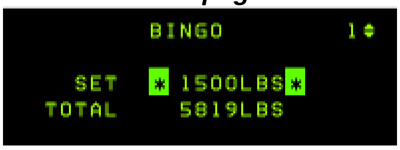
Once again, note the 4 and double arrows on the top right corner, allowing the pilot to change the current steerpoint without exiting the LIST page. It is not the case on the picture but if VIP & VRP are mode selected they appear highlighted in the LIST page.

1.3.16.1 DEST page

The DEST page looks similar to the STPT page. The main difference is that you can change any steerpoint coordinates without direct effect on the HSD. Indeed, when you change a steerpoint with the STPT page, the effects are immediate since that particular steerpoint is active. Not in the DEST page. That is quite handy to make steerpoints more precise (recon windows) or simply to add new steerpoints.

Depressing DCS to SEQ with any steerpoint selected enters the Offset aim point 1 & 2 subpages. That lets the pilot set two offset aim points for each INS steerpoint. More information about offset aim points can be found in the VIP/VRP section of this manual.

1.3.16.2 BINGO page



The Bingo page is where you input your briefed Joker/Bingo settings. It is made up of two lines, the first one is where you enter your Joker or Bingo setting, the second line is the total fuel remaining on board. If the FUEL QTY knob is in NORM, the VMS will call BINGO upon reaching the value set in the first line. It is common practise as a mission begins to input the Joker value. You can then reset it to the briefed BINGO value once Joker fuel is reached. Please note that as the arrows are next to the active steerpoint, you can change it with the NEXT/PREV button of the ICP.

1.3.16.3 VIP page

This page is used to enter VIP settings. VIP can be calculated manually but it is advised to enter data given by a tool like WDP. These data are DTC loadable and WDP can set your DTC automatically as well. Nevertheless, should you need to input the data manually; it is possible using this page. The VIP page must be mode selected (with the zero key) for the VIP symbology to be visible in the HUD (the text between the asterisks is then highlighted). Moving the DCS to the right (SEQ) will enter the VIP-to-PUP page

1.3.16.4 NAV page

The NAV page is eye candy as it refers to the accuracy of the navigation system which is always very good in BMS and does not drift.

1.3.16.5 MAN page

The MAN page is used to set to adjust the GUN EEGS Funnel width setting for cannon firing. The setting is entered in feet and should match the wingspan of the expected target. The default is 35 feet and is DTC settable. On the right is a table from the SP3 manual for the most common aircraft wingspan values.

Aircraft	*Span (ft)*
A-10	58
F-111	48
F-14	51
F-15	43
F-16	31
F-18	38
F-4	39
F-5	27
MiG-21	24
MiG-23	37
MiG-25	46
MiG-29	36
MiG-31	46
Su-24	44
Su-25	51
Su-27	42

1.3.16.6 INS page

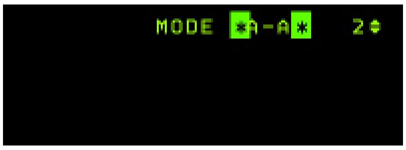
The INS page is relevant to the Inertial Navigation System. It is made up of 5 lines. The first one gives status of the INS (status 10 means fully aligned) and as always the active steerpoint can be changed without leaving this page with the NEXT/PREV ICP buttons. The second line gives your current latitude and the third line gives your current longitude. The next line gives your barometric altitude and the last line gives your true heading and groundspeed. This last bit of information is quite useful when taxiing as it is the only way to see information about your taxi speed..

1.3.16.7 EWS page

The Electronic Warfare System page is where you setup your EWS
Normally all those settings are in your DTC but you can also reprogram them on the fly through this page. Programming is only possible when the CMDS mode knob is placed in STBY.

The main section of the EWS page allows changes to the chaff and flare bingo settings and to enable or disable the REQCTR (request to counter), FDBK (feedback) and BINGO VMS calls.
Moving DCS to SEQ displays the expendable category (chaff then flares) for manual programming (1 to 6) The arrows now designate the possibility to toggle among the 6 available CMDS PGM to reprogram them. You toggle from the chaff page to the flare page using DCS SEQ. For each program and each expendable type, you are allowed to set the Burst Quantity (BQ) Burst Interval (BI) Sequence quantity (SQ) and Sequence Interval (SI) just like in the DTC. For further information, please refer to the BMS Manual EWS chapter.

1.3.16.8 MODE page



The Mode page provides an alternative way to change the Master mode without using the ICP buttons. Use the DCS to SEQ to toggle the Master mode and Mode select it with the 0 (zero) key to make it active. NAV mode defaults when none of the other (A-A) or A-g) are Mode selected.

1.3.16.9 VRP page

This page is used to enter VRP settings. VRP can be manually calculated but it is advised to enter data given by a tool such as WDP. These data are DTC loadable and WDP can set your DTC automatically as well. Nevertheless, should you need to input the data manually; it is possible to do so using this page. The VRP page must be mode selected (with the zero key) for the VRP symbology to be visible in the HUD (the data between the asterisks is then highlighted). Moving the DCS to the right (SEQ) will enter the VRP-to-PUP page
Exit the VRP page with DCS RTN to CNI page.

1.3.16.10 INTG page

Interrogation pages refer to the IFF and is not implemented.

1.3.16.11 A-G DLINK page

The Data Link pages are used to set your in-flight data-link settings. There are only two selectable options in the Air to Ground page: the transmit address and the FILL option.
The transmit address is your ownship IDM address.
The Fill option determines whether the system stores (ALL) or ignores (NONE) all received data-link steerpoints. When the option is set to FILL, the received steerpoints are stored in the steerpoints databank between #71-#80. When more than 10 IDM steerpoints are received, position #71 is overwritten.
When option NONE is selected, the system doesn't store received markpoints and the pilot gets no HUD and no VMS message.

If DCS is moved to SEQ the INTRAFLIGHT subpage is displayed allowing the pilot to select up to 7 team addresses. This is where other flight IDM addresses need to be entered to be able to enable Data-link with them in both A-A and A-G mode.
Ownship (#1) cannot be changed. Usually use the first column for your own flight and the second column for extra flights. Simply enter the IDM addresses of flight members you wish to add. For instance, if your flight IDM is 20 (21 – 22 – 23 – 24), Strike flight IDM is 10: 11-12 and SEAD IDM is 30: 31-32-33-34. The first column is fully completed with your flight IDM, and you only have 4 slots in the second column, so the compromise in such a case would be to enter the sweep address in position #5 and #6 and enter lead and element lead of the SEAD flight (31-33) in position #7 and #8. That is left to the pilot appreciation, but it is important to set multi-package IDM correctly to maintain a good SA during our COMAO TE's.

1.3.16.12 MISC page

The MISC page leads to yet another list of submodes. The principles of operation are the same as the list page, depress the corresponding button listed on the MISC page to access the subpage.

1.3.16.12.1. CORRection page

Not implemented.

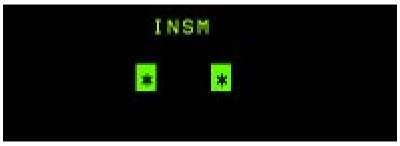
1.3.16.12.2. MAGnetic Variation page

Displays the actual Magnetic variation at this aircraft location. It would be used to correct INS navigation error should they happen in BMS. At the moment, this is done automatically by the code.

1.3.16.12.3. Operational Flight Program (OFP) page

Not implemented.

1.3.16.12.4. Inertial Navigation System Memory (INSM) page

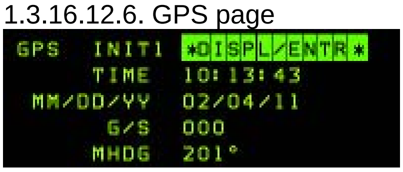


Not implemented.

1.3.16.12.5. LASeR page

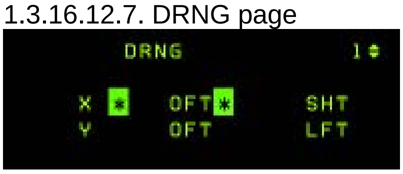
This page is used to set the Laser system. It is made of two lines. The first sets the laser code which should normally match the targeting laser pulse code which is not implemented at this time and the second line sets the laser timer. The targeting laser is fired for final weapon guidance xx seconds before impact. The timer sets the xx seconds; it defaults to 8 seconds and is DTC loadable.

1.3.16.12.6. GPS page



Displays information about the GPS system.

1.3.16.12.7. DRNG page



Not implemented.

1.3.16.12.8 BULLseye page

This is where you manage the system Bullseye.
Two interesting things to note here:

First the Bullseye is by default assigned to STPT #25 but you can change it to any steerpoint by using the PREV/NEXT ICP button

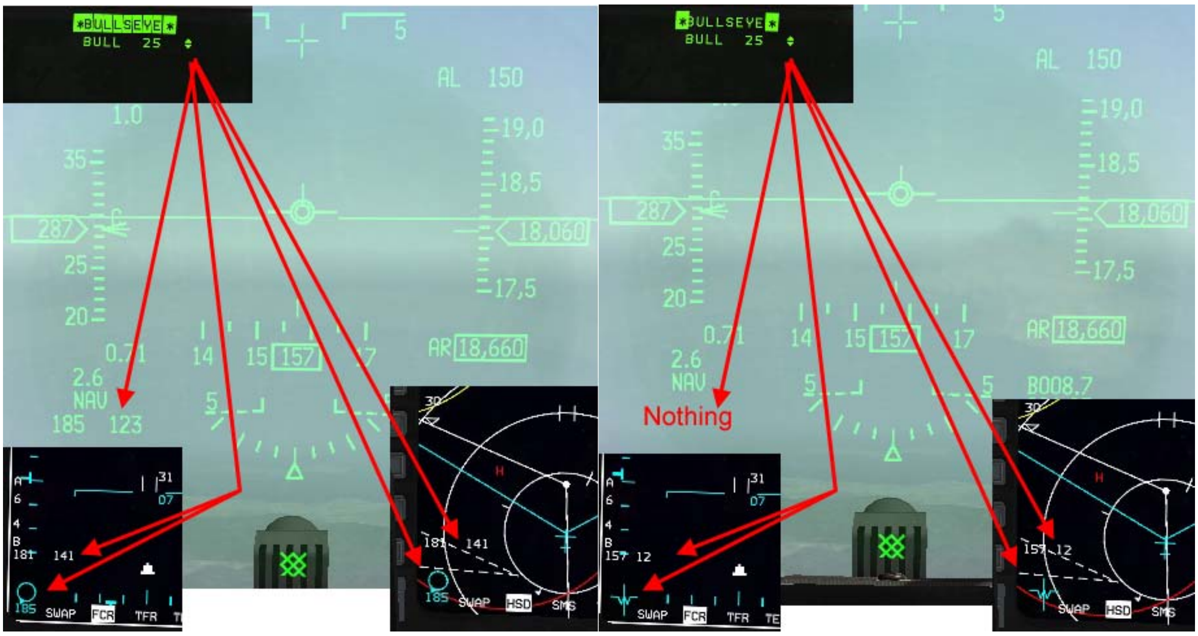
Secondly, bullseye displays change depending on whether the BULLSEYE is Mode Selected or not. Mode Selection is toggled by pressing MSEL/0 when the asterisks surround the 'BULLSEYE' text.

In the bottom left corner of the HUD, the Bullseye bearing and range is displayed when the Bullseye is mode selected. When it is not mode selected, you have no bearing and range indication to Bullseye in the HUD.

In the MFDs (FCR and HSD pages) the bearing and range indication (relevant to the cursor positions) are shown relative to the Bullseye position when the bullseye is mode selected and relative to the active steerpoint when the bullseye is NOT mode selected.
The bullseye symbol & circle is not displayed on the MFDs when the bullseye is not mode selected. Instead of the Bullseye circle, a waterline flight director symbol relative to the current active steerpoint is displayed.

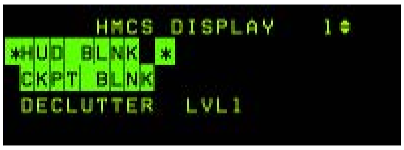
Please note that when the bullseye distance is more than 99Nm the distance is not displayed inside the bullseye circle (two digit possible only) on the MFD page.

So to be able to maintain a good Situational Awareness when calling contacts on bullseye range and bearing, you need to have your Bullseye Mode Selected, which is the default setting.



The left picture shows the HUD, FCR and HSD Bullseye symbols when the Bullseye is mode selected, the right picture shows the same elements when the Bullseye is not mode selected.

1.3.16.12.9. HMCS page.



The HMCS (Helmet Mounted Cueing System) display page allows the pilot to control the HMCS for supported aircraft.
The first line enables the HUD blanking when Mode selected. The HMCS will not be displayed when looking at the HUD.
The second line enables blanking the HMCS when the pilot looks inside the cockpit.
The third line allows a selection of three levels of de-clutter for the HMCS displays. Highlight that line with DCS down and hit any ICP secondary button to change from level 1 to level 2 to level 3 to level 1.

If you depress the DCS to SEQ while in the HMCS display page, another subpage will be displayed but is not implemented at this time.

See the HMCS chapter for further information about the HMCS displays & capabilities.

1.3.17. DRIFT C/O switch

The DRIFT C/O switch is a three position switch with a momentary position to WARN RESET.
Upper and middle positions manage the DRIFT of the flight path marker according to winds. The centre position, labelled NORM take winds into account and lets the FPM drift to the side according to crosswinds, giving you a visual cue of beta angle (sideslip crabbing into the wind).
In the NORM position, the FPM indicates where in 3D space the aircraft will fly towards with the current flight conditions and no additional control inputs. In other words, if you hold what you have on the controls, the FPM will show you where the jet will ultimately end up.
This is particularly useful for landing because it lets you picture the wind visually so you compensate automatically.
On the other hand, it may be an annoyance at hi altitude with strong winds (which may throw the FPM off the edges of the HUD) and the upper position labelled DRIFT C/O maintains the FPM in the centre of the HUD regardless of the winds. The switch should be placed to NORM before landing.

The lower momentary position is labelled WARN RESET and is used to reset the HUD WARN message.

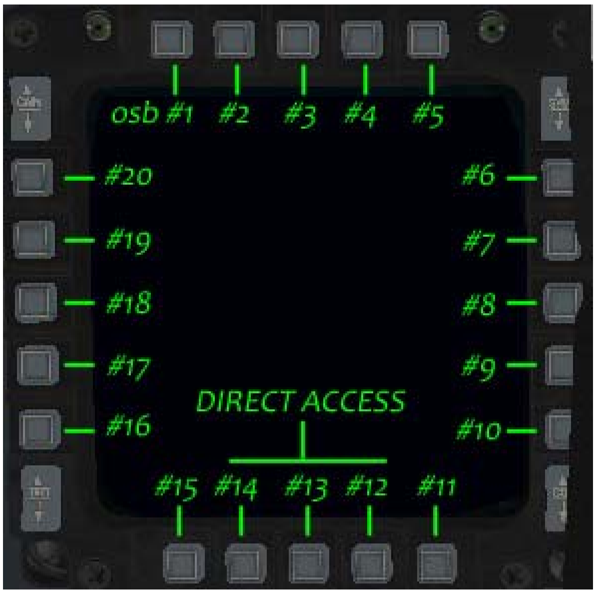
1.3.18. The ICP Thumbwheels

Only two side wheels are implemented: the top left and the top right.
The top left is labelled SYM and used for HUD brightness. The wheel has an ON/OFF switch and that is where the HUD is powered up.
The other wheel implemented is the one labelled DEPR RET and lets the pilot manage the backup bombing mode.
The other two wheels are not implemented at this time.

It is possible to control the implemented wheels with the mouse, the keystrokes or an analogue axis.

1.4 MULTI FUNCTION DISPLAYS

The MFDs are the two displays situated on the front dash featuring 20 pushbuttons and four rocker switches on each. Both displays are independent. MFDS are powered by the MFD switch on the Avionic Power panel on the right side console.
The push buttons are called Option Selection Buttons (OSB) and are numbered from 1 to 20, starting at the left button of the top row and moving clockwise to the top button of the left row.
The function of the button changes according to the displayed page and the button's legend is displayed next to the button.
The top, left and right rows of buttons are typically assigned customized functions depending on the page being displayed. By contrast, the bottom row (OSB 11 to 15) operates more or less the same way regardless of page format:



- OSB #15 is always a SWAP button that will swap over the left and right display. OSB #11 is always the declutter option. The only page where OSB #11 is not used for declutter is the SMS page where OSB #11 selects the S-J (Selective Jettison) master mode.
- The three centre OSB (#12, #13, #14) are Direct Access (DA) buttons and provide direct access to the DTC saved MFDs displays according to master mode. Up to three pages for each MFDs may be assigned to the DA buttons for each master mode. The displayed page format has its mnemonic highlighted. These are easily toggled by pressing the corresponding direct access OSB button or they can be cycled even faster with the HOTAS buttons: DMS right for the right MFD and DMS left for the left MFD. Please note you can not have the same page displayed on both MFDs at the same time, so if you try to display the FCR on the right MFD while it is already being displayed on the left MFD, the FCR will simply be stolen from the left MFD leaving an empty DA slot where it was originally assigned.

1.4.1. Menu page

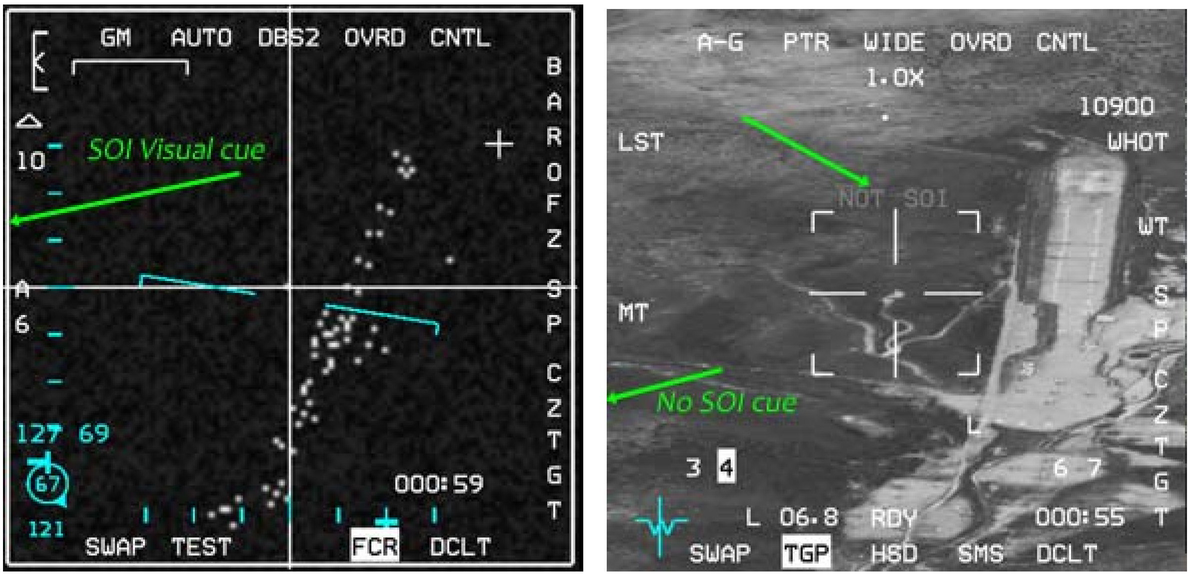
Although it is advised to set the three most required MFD pages for each master mode in the DTC it is also possible to set them in the cockpit by modifying the direct access button setting, while the desired master mode is engaged.
To do so, first set the desired master mode, then display the page you want to change (its mnemonic is highlighted). Press the DA button that is highlighted and the MFD displays the MENU page. From there simply select the new page you want to have accessible and the new page mnemonic appears on the direct access row, replacing the previous one. You can now easily toggle it with the DMS HOTAS button.

The Menu page is the link between all subpages. It is displayed when the DA button is depressed while that particular page was already displayed (Pressing FCR when FCR is already displayed for instance).

You can thus access any subpages whatever your master mode from this page: Store Management System (SMS), Horizontal Situation Display (HSD), Data Transfer Equipment (DTE), Test page, FLCS page, Forward Looking Infra Red (FLIR) page, Terrain Following Radar (TFR), Weapon (WPN) page, Targeting Pod (TGP) page; Fire Control Radar (FCR), Blank page, HARM as Display (HAD) page, Reconnaissance (RCCE) and RESET page.

1.4.2. Sensor of Interest (SOI)

You will need to work on one MFD rather than the other one sometimes. To let the system know where you are focusing you need to use the sensor of interest mechanisation. Imagine the following example: the FCR is SOI and set on the left MFD and the HSD is on the right. You would like to delete a threat ring on the HSD but if you move your cursor the captains bar moves both in the HSD and the FCR. To tell the system that you want to work specifically on the HSD, you need to make the HSD SOI. To do so, simply move the DMS (Display Management Switch) on your HOTAS down. The SOI toggles from one MFD to the other. The visual cue for a MFD SOI is the big square box drawn outside the OSB labels. If a MFD is not SOI the text NOT SOI is displayed in the centre, reminding the pilot that this display is not the sensor of interest.



Above, the FCR on the LEFT MFD is the SOI and displays the large square SOI cue around the edge of the display. The TGP on the RIGHT MFD does not display the SOI cue and instead shows the NOT SOI cue in grey in the middle. Only one MFD can be SOI at a time.
DMS up selects the HUD as SOI (if the HUD is in a mode allowing SOI). In this case, the SOI cue is an asterisk shown in the top left corner of the HUD. DMS down toggles SOI from one MFD to the other.

1.4.3. HSD page.

The Horizontal Situation Display page provides a god's eye view around your own ship with information such as your radar cone, concentric range circles, radar cursor position, bullseye position and/or bearing and range, INS flight plan with steerpoints, Lines, PPT (Pre Planned Threat points) and their programmed range rings, IDM information and so on.

OSB #19 and #20 are used to change the HSD range. In the image on the right only OSB #20 is available to increase the range. Note the absence of a down arrow next to OSB #19 as the HSD is at its minimum decoupled range of 8 Nm.

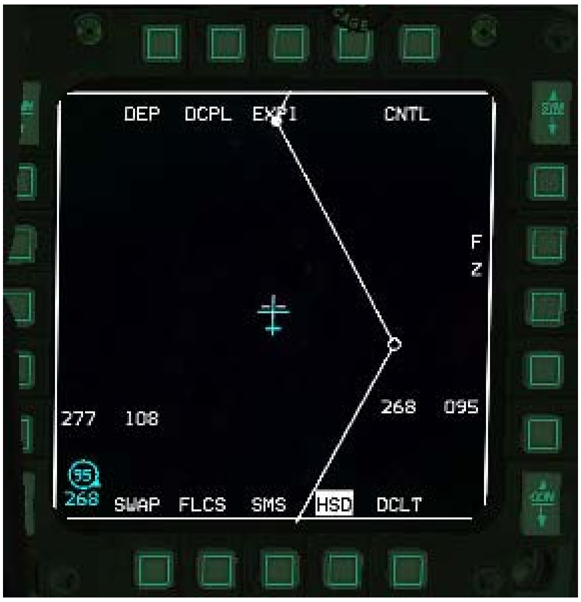
The concentric ranges circles are dependant on the current range but you will always have three of them, with the last one being at the set range shown at the upper left. The closest one is thus at 1/3 of that range and the middle one at 2/3 of the range.

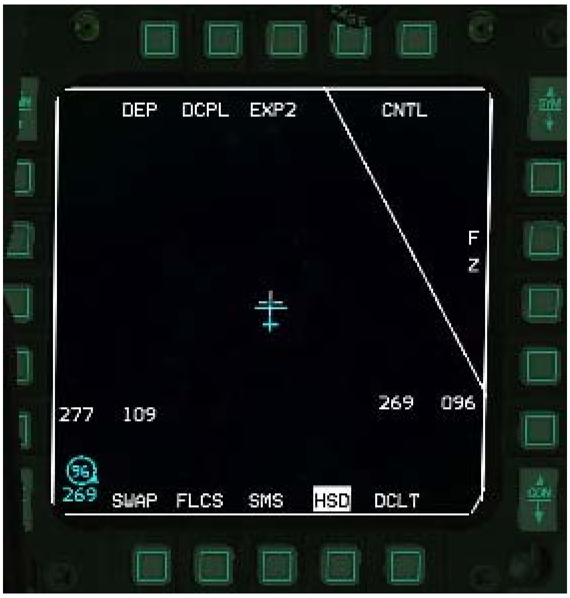
OSB #1 is labelled DEP (Depressed) and when pressed toggles to CEN for Centred.
In DEP, own ship is pictured below the centre of the MFD one quarter of the way up from the bottom and visibility is better in front of the aircraft than to the rear. When CEN is selected own ship is placed in the middle of the display and the visibility is equal in front or behind own ship. Please note, ranges are also different in DEP or CEN. The minimum range for DEP is 8Nm, while you can go as low as 5 Nm in CEN. CEN mode also matches the FCR ranges better.

OSB #2 is labelled DCPL (Decoupled) and when depressed toggles to CPL (Coupled) which ties the HSD to the FCR range. In CPL mode OSB #19 and #20 are inhibited (no arrows displayed) and the HSD will change scale according to the FCR scale (range).

To maintain a good correspondence between the HSD and the FCR (which helps SA), it is advisable to work with the HSD in CPL and CEN modes. This ensures that both ranges are the same and move together according to the FCR range.

OSB #3: When the HSD is SOI, OSB #3 labelled NORM/EXPAND changes the FOV of the HSD. This is done by pressing OSB3 or by using the HOTAS pinky switch. This option is invisible when the HSD is not SOI. The EXP mode has two levels: EXP1 and EXP2





OSB #5 is the CNTL (Control) page for the HSD. When depressed a series of options are displayed on most buttons. Highlighted options are currently active and therefore displayed on the HSD. When the corresponding OSB is depressed the option becomes inactive (not highlighted) and the related symbology is blanked from the HSD.

Options are
FCR: displays the fire control radar cone and the ghost radar cursors.
PRE: pre planned steerpoints and their threat rings.
AIFF: should display IFF response but is not currently implemented
Line 1: displays DTC line #1 (stpt #31 to #35)
Line 2: displays DTC line #2 (stpt #36 to #40)
Line 3: displays DTC line #4 (stpt #41 to #45)
Line 4: displays DTC line #4 (stpt #46 to #50)
Rings: displays the concentric range rings from ownship.
ADLINK: Air to Air data-link information
GDLINK: Air to Ground data-link information
NAV3, 2 & 1: Are relevant to the INS flight plan but only NAV1 is implemented in BMS and will displays the whole INS flight plan.

Exit the Control page by pressing OSB #5 CNTL. Please note the direct access buttons are displayed as usual and OSB #11 remains the declutter option and OSB #15 remains the SWAP option.

OSB #7 labelled FZ on the main HSD page format freezes the display at the current world position and orientation of the ownship.
The aircraft now moves around with the world position fixed on the MFD (ownship is free to fly around and off the HSD) instead of the world moving with reference to the aircraft. Pressing the FZ button again unfreezes the HSD world position.

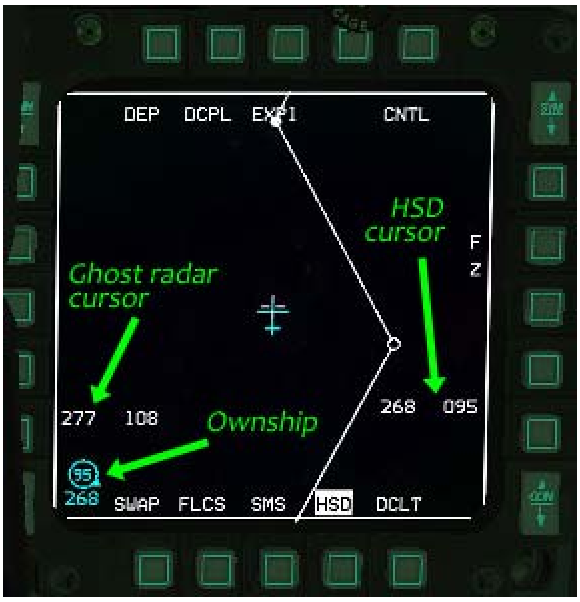
BOTTOM ROW is displayed as usual with declutter and swap buttons (#11 & #15) and the direct access buttons between them.

HSD cursor
When the FCR and the HSD are both displayed and the FCR is SOI, the HSD displays the ghost radar cursors moving within the radar scan zone depicted on the HSD.
When the HSD is made SOI the ghost radar cursor is replaced with the HSD cursor which is shown as a cross. Any cursor movement will then move this HSD cursor and not the radar cursor.
This cursor can then be used to select new steerpoints of interest and toggle ON or OFF specific threat rings on PPTs displayed on the HSD. TMS up when depressed over a HSD steerpoint makes that steerpoint the new steerpoint of interest, TMS down on a PPT will deactivate the associated threat ring. This cursor has its own bullseye reading on the right side of the HSD, between OSB #9 and #10.

Cursor bumping.
To change the range of the HSD you can use OSB#19 / #20 in DCPL mode or change the FCR range in CPL mode.
There is a third way to change the HSD range (which is also valid for the FCR) that is called cursor bumping. It is done by moving the cursor to the lower or upper edge of the display. When the cursor gets there the range will automatically change up or down according to which edge it goes through.
This is done mainly on the FCR because most of the time the FCR is SOI, but it is also valid on the HSD when it is SOI.
If the HSD is in CPL mode the first hit on any top or bottom edge will switch the HSD to DCPL mode and subsequent hits will change the range.

Bullseye symbols
There are many different bullseye symbols on the HSD page.
You can find your ownship actual Bearing and Range (BRAA) information from Bullseye
The ghost radar cursor BRAA from Bullseye and the HSD cursor BRAA from Bullseye when it is displayed.

Ownship bullseye information is always displayed in the bottom left corner of the HSD. It is the same information that is displayed in the Bottom left corner of the HUD when Bullseye is Mode Selected in the UFC (List-Misc-Bull page). If the Bullseye is not Mode Selected this symbol is replaced by a mini flight director relative to the active steerpoint. Own ship Bullseye is coloured cyan and the bearing is below the circle and the distance is in the circle. Distance is limited to 2 digits and if the bullseye is further away than 99Nm the circle is empty.



The ghost radar cursor bullseye information is displayed in white on the left side of the MFD. The fist number is bearing in degrees and the second number is distance in Nm.

The HSD cursor Bullseye readout if displayed (HSD SOI) is on the right side of the screen and has the same structure as the ghost radar cursor information, i.e.: bearing then distance.

1.4.4. TEST page.

The TEST page shows various Built-In Tests (BIT). Pages one and two display the maintenance fault list (MFL) encountered during a flight. Each fault encounter logs the following:
1. Fault type. This is the first mnemonic that's appears on the F-ACK list.
2. Test number that failed.
3. Number of failures.
4. Time of the first fault. The time is relative in minutes and seconds since startup.

Two pseudo-faults are recorded; the take-off time (TOF), and landing time (LAND). Pressing the CLR button will clear the fault list. A maximum of 17 faults (including the two pseudo-faults) may be recorded. Subsequent faults are not recorded, unless they are duplicates.

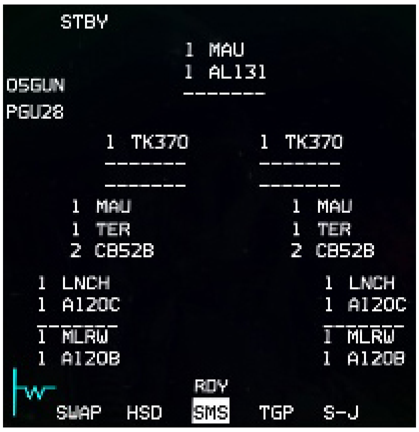
PAGE 1
OSB #1 BIT1 Indicates BIT1 tests. Pressing this button changes to the BIT2 page.
OSB #3 CLR Clears the Maintenance Fault List (MFL) if displayed in the centre of the MFD.
OSB #6 MFDS MFD Self Test (N/I)
OSB #7 RALT Radar Altimeter test (N/I)
OSB #8 TGP Targeting Pod test (N/I)
OSB #9 FINS Fixed Imaging Navigation Set (N/I)
OSB #10 TFR Terrain Following Radar Test (N/I)
OSB #16 RSU Rate Sensor Unit (N/I)
OSB #17 INS Inertial Navigation System test (N/I)
OSB #18 SMS Stores Management System test (N/I)
OSB #19 FCR Fire Control Radar test switches the MFD to the FCR page and starts the FCR BIT.
OSB #20 DTE Data Test Loading (N/I)

PAGE 2
This page contains additional built-in tests. OSB 1 BIT2 Indicates that these are the BIT 2 tests. Pressing this button will change to the BIT 1 page.
OSB 3 CLR Clear fault list (N/I)
OSB 6 IFF1 IFF1 self test (N/I)
OSB 7 IFF2 IFF2 test (N/I)
OSB 8 IFF3 IFF3 test (N/I)
OSB 9 IFFC IFF Mode C test (N/I)
OSB 10 TCN TACAN Test (N/I)
OSB 19 TISL Target Identification Set, Laser (N/I)
OSB 20 UFC Up-Front Controls (N/I)

1.4.5. SMS page.

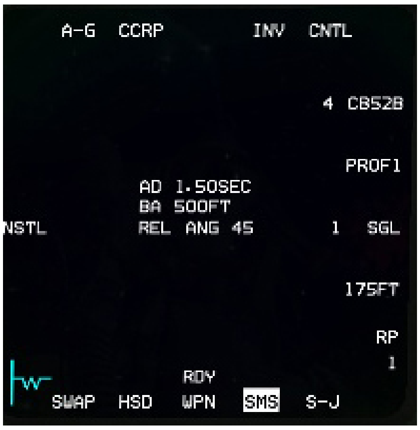
The SMS page will be different depending on the Master Mode you are in when it is selected:

1.4.5.1 SMS in NAV mode:



The SMS page will display the system inventory page, displaying graphically the loading of your aircraft with all its stores and pylons. In the real jet, this page is fully programmable but in BMS, it always reflects the pre-loaded stores perfectly.
Please note the usual de-clutter option on OSB #11 is replaced by the S-J page access. Pressing the S-J button enters the Stores Jettison Master Mode and associated MFD subpage, which is documented further in this manual.

1.4.5.2 SMS in AG mode:

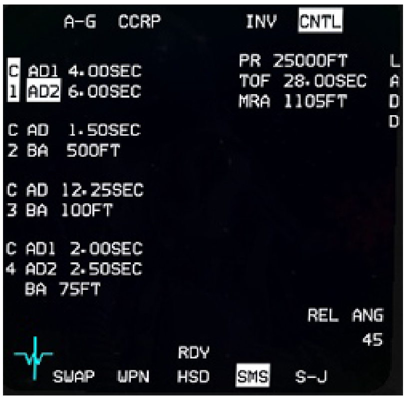


When the SMS is selected and the Master Mode is in Air to Ground the SMS page displays only information relevant to the Air to Ground weapons.
The information displayed in the centre is the current weapon arming setting from the CNTL page.

- OSB #1 displays the current Master Mode and if depressed selects the AG strafe gun mode and associated SMS subpage.
- OSB #2 is used to toggle delivery mode CCIP – CCRP – DTOS – LADD & MAN. Each has an associated subpage.
- OSB #4 is labelled INV and displays the Inventory page, should it be needed outside of NAV mode.
- OSB #5 is the Control page for the currently selected weapon (see below)
- OSB #6 shows the currently active weapon, type and quantity aboard. When depressed the next different AG weapon type is selected in sequence. Please note the MSL STEP button on the sidestick does not perform the same function - it switches to the next pylon loaded with the same type of AG ordinance. This allows the pilots to pre-program two missiles differently if needed such as in the case of HARM missiles for EOM POS shots.
- OSB #7 is labelled as the currently loaded profile for freefall AG stores The SMS is able to save two different weapon profile PROF1 & PROF2. By default CNTL settings refers to PROFILE1 but if you depress OSB #7 and select PROFILE2 all settings made will be recorded for the second weapon delivery profile. This allows the pilot to save two weapon settings and toggle easily from one to another depending on the situation.
- OSB #8 is Single or Pair release for A-G stores. Pressing the button will toggle from single to pair etc
- OSB #9 is the set spacing for A-G ripple stores. When pressed, the SMS enters a specific page where a new spacing value in feet can be input. This is relevant when dropping more than one weapon to correctly disperse the weapon hits.
- OSB #10 is the ripple value for A-G stores. This is the number of weapons that will be released each time you pickle. When depressed the SMS enters a specific page where the new value can be inputted.

- OSB #18 is the fusing option for A-G stores. When depressed it toggles between NOSE, TAIL and NSTL (both Nose+Tail) fuses.

SMS AG Control Page



While the CNTL page is displayed OSB #5 remains highlighted.

The top & bottom OSB lines are the same as the main SMS page. What is of interest is the left line of OSB buttons (#16 to 20) and OSB #6 to the right, which give access to 5 different weapons settings: C1 to C4 & LADD.

.C1 (OSB #20) is relevant to General Purpose weapons or Laser guided weapons and provides two different arming delays. One for the NOSE fuse and the second for the TAIL fuse. Depress OSB #20 to enter a subpage where both timings can be set.

.C2 is relevant to Cluster Bomb Units or any weapon requiring a Burst Altitude (BA). Pressing OSB #19 will enter a SMS subpage where both the arming delay and the burst altitude can be set.

.C3 is an extra setting for CBUs, as with C2, you can set the weapon Arming Delay (AD) and Burst Altitude (BA)

.C4 is specifically for double fused CBUs. On this page AD1, AD2 and BA can be set.

. LADD stands for Low Altitude Drogue Delivery and although OSB #6 has a profile for it, it is currently not implemented in BMS.

OSB #10 is the setting for the planned release angle. This value is required by the computer to calculate the correct symbology for DTOS deliveries.

Most of the time, C1 & C2 are used if you deploy GP/LGBs or CBUs.

The way settings are input is always the same:
Depress the relevant OSB (C1 – C4) and the subpage is displayed with the settings in the middle of the page.
The current active setting is displayed between asterisks and numbers 0 to 9 are displayed next to the left and right rows of OSB buttons.
To enter a new value simply use the OSB next to the number you want until the correct value is set, then use OSB #2 ENTR to confirm the value. And the next line of setting will be selected for change. If there is no next line available, the ENTR button will exit the CNTL page and revert to the SMS base page.
OSB #3 (RTN) returns to previous value/page
OSB #4 (RCL) deletes the last alphanumerical value input.

1.4.5.3 SMS in AA mode:

The AA SMS base page has the same structure as the AG SMS page.

- OSB #1 displays the current Master Mode and if pressed selects the AA gun SMS subpage
- OSB #3 is active when infrared weapons are carried and is displayed SPOT. It changes the AIM seeker from SPOT to SCAN.
- OSB #4 is labelled INV and displays the Inventory page, should it be needed.
- OSB #5 is the Control page for the currently selected weapon. (see below)
- OSB #6 shows the currently active hardpoint and weapon loaded. When depressed the next different AA weapon loaded hardpoint is selected in sequence. Please Note the MSL STEP button on the sidestick perform the same function if held for more than half a second. If held for less than half a second it switches to the next hardpoint carrying the same type of AA missile type. You can see the hardpoint configuration in the picture above Station #1 is currently selected and carrying an AIM-120B. Station #9 carries the same type of weapon and station #2, #3, #7 & #8 carry Medium range missiles (M)
- OSB #8 is active when infrared weapons are carried and allows you to select WARM or COOL setting for the IR seeker on the missile.
- The bottom row has the usual functions including S-J available.
- OSB #18 is dependent on missile type.
  For radar missiles it sets the PRF range and toggle between unknown, large, medium and small targets. Large is used for bombers, medium is used fighters and small is used to intercept missiles (not implemented)
  For IR missiles; it toggles from BP (Bypass) to TD (Threshold detection) When set the TD the missile will automatically uncage. When set to BP the missile needs to be uncaged manually.
- OSB #19 toggles SLAVE or BORE
  Radar missiles can be set to SLAVE or BORE. When set to SLAVE the missile is slaved to the FCR and when set to BORE the missile is pointed six degrees below the gun cross and will fire without command guidance. It will switch on its own radar and go autonomous right after launch. That's a MADDOG shot.

Depressing OSB #1 selects the AA gun and the AA gun SMS subpage is displayed:

OSB #1 displays GUN
OSB #2 sets the AA Gun mode (EEGS, etc) through a subpage)
OSB #4 displays the Inventory page
OSB #6 displays the amount of ammo remaining for the gun. 51 means 510 rounds. Each burst is 10 rounds by default.
The bottom row as the usual functions.
OSB #20 is labelled SCOR and toggles ON or OFF.
When ON it allows the BATR circle to be displayed in the HUD while the gun is fired as well as the FEDS markers.

The BATR (Bullets at Target Range) circle for EEGS is a 6-mil circle displayed after the trigger squeeze and the bullet travels to the targets range. It disappears after the last bullet passes the target range (well actually it disappears 1 second after the trigger is released--that is good enough for the time being). The BATR is nothing more than a record of where the gun cross has been pointed (corrected for gravity drop).

Depressing OSB #5 enters the CNTL page:

When the AA CNTL page is selected OSB #5 remains highlighted.

There is not much to set here, except maybe the MSL ID which should match your flight # ID. It is good practice to set your MSL ID to #2 for instance if you fly as wingman in a two ship. This would serve the FCR datalink should it be implemented one day. For the moment it is not implemented in BMS.

1.4.5.4 Selective Jettison (S-J)

The SMS S-J page is accessible in NAV, AG and AA modes from the SMS base page OSB #11.
Selective Jettison is a Master Mode.
This allows the pilot to jettison weapons and racks unarmed or unguided from selected aircraft stations. Only jettisonable stores will be displayed for selection. The pilot presses the OSB adjacent to the station displayed on the S-J page. The selected station's bottom-most store is highlighted on the S-J page, indicating that it is selected. If a jettisonable rack is also loaded it may also be selected with a second press of the OSB. A third press will then deselect all stores on that station. The pilot can preselect a selective jettison configuration while in S-J Master Mode, which will be remembered during Master Mode transitions. The stores are jettisoned using the pickle button when the Master Arm switch is in ARM. After the stores are released the highlighted stations are removed from the S-J page and the associated weapon quantity reads zero. The S-J mode also bypasses any other weapons settings.

1.4.6. TFR page

The Terrain Following Radar page can be reached from the menu page by depressing OSB #17

It is a short range (36000ft) forward and down radar that allows you to follow the terrain at very low altitude offering automatic fly up protection.
It is worth mentioning that the TFR in the current version of BMS is far from being accurately implemented.

Normally, the TFR is part of the LANTIRN suite that can provide a forward IR view. In BMS the TFR is available to us even though the pod is not carried on the left chin hardpoint.
Another point is that TFR should be slaved to autopilot and that's not the case in BMS. Finally, it is dependent on the radar altimeter and that is not the case either in BMS.
So implementation of the current TFR is far from correct and its use is quite limited. It works well though for long overwater flight at very low altitude. For the rest I would advise NOT to use it. You can hand fly the aircraft at lower level than the TFR.

Please note, the terrain following radar is inhibited when the RF switch (MISC panel) is set to SILENT.

The TFR has six modes of operations: NORM, LPI, STBY, WX, ECCM, VLC. In BMS, we mostly use NORM and STBY.

- OSB #1: Toggles TFR mode between STBY and NORM
- OSB #2: Ride type (Hard/Soft/Smooth) determines how aggressively the system should follow the terrain (how many Gs the Autopilot is allowed to pull to avoid terrain)
- OSB #4: Toggle On/Off to enable or disable the TFR system
- OSB #5: Current radar channel (Not implemented)
- OSB #6: Set 1000 feet AGL terrain clearance
- OSB #7: Set 500' feet AGL terrain clearance
- OSB #8: Set 300' feet AGL terrain clearance
- OSB #9: Set 200' feet AGL terrain clearance
- OSB #10: VLC Set very low clearance (only over sea or extremely flat land)
- OSB #11,12,13,14 &15 are arranged as usual and provide the Declutter option, the three Direct Access modes and the SWAP option.
- OSB #16 : Emission Control Mode (Not implemented)
- OSB #17: Weather mode settings (rainy or clear conditions - (not implemented)
- OSB #18: Selects standby mode
- OSB #19: Low probability of intercept mode (TFR only scans forward and less often – not implemented)
- OSB #20: Selects normal mode

When the TFR is in NORM automatic fly up protection will be provided. Obstacle or fly up message are displayed in the HUD and on the TFR MFD and the aircraft pitches up to avoid the terrain.

When the TFR is activated but in STBY mode the HUD and MFDs messages are displayed but there is no automatic fly up protection.
This function may be used while flying visually at low level to get terrain advisory messages. (FLY UP or OBSTACLES)

While the TFR is engaged stick input has no effect unless the AP paddle is depressed (HOTAS S4 btn) While the paddle is held in, the pilot has control of the aircraft. When the paddle is released the TFR resumes flying the aircraft.

Procedure to initiate a TFR leg:

1. Check that the radar altimeter is operating and correct HUD symbology is displayed.
2. Set A-LOW 10% lower than intended TFR altitude (900ft).
3. Set TFR to STBY.
4. Set TFR to 1000ft (OSB #6).
5. Engage TFR and check that aircraft pitches down not exceeding -12°.
6. Monitor the level off at 1000ft.
7. After level off, reset A-LOW to 10% of TFR mission altitude & set TFR mission altitude.
8. Monitor descent and level off.
9. Keep monitoring TFR and fly up messages.

1.4.7. DTE page

The DTE page is accessed from the menu page by depressing OSB #8.

It is used to load the Data Cartridge prepared during mission planning in the UI into the aircraft computer. Loading is done (usually at ramp start right after switching the CNI to UFC) by depressing OSB #3.

Each displayed system (FCR, DLINK etc) is highlighted in sequence during loading and the DTC changes should be visible in the DED (presets for VHF and UHF amongst others)

1.4.8. FLCS page.

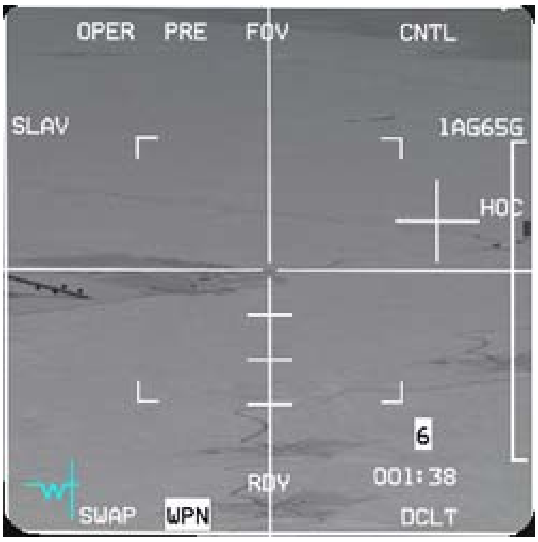
The DTE page is accessed from the menu page by depressing OSB #10.

The FLCS page is of no interest at this time in BMS as it is currently not implemented.

1.4.9. FLIR page

The FLIR page is accessed from the menu page by depressing OSB #16. As with the TFR the FLIR (Forward Looking InfraRed) is contained in the Navigation pod of the LANTIRN Suite which is normally carried on the left chin hardpoint.
Contrary to the TFR the FLIR is only available when the pod is carried and we can currently not load the pod on the F-16. The FLIR is thus of no use on the block 50/52 F-16 (the one we fly in BMS) which is quite accurate since only block 40/42 F-16s are able to carry the LANTIRN pod.

1.4.10. WPN page



The WPN page is accessed from the menu page by depressing OSB #18.
It gives the pilot access to onboard weapons sensors. Some weapons such as the AGM-65 Mavericks and the AGM-88 HARM have onboard sensors that may be used to acquire and lock targets. Since the sensor is onboard the missile, it should be obvious that once the missile is away the TGP can no longer display the sensor image.

HARMs:
POS EOM is displayed on the WPN page when the HARM is selected and ready.
See further weapon specific documentation for HARM deployment.

Mavericks:
the IR image from the missile head is displayed in the WPN MFD page once the IR head has been unstowed: that is when the missile is uncaged.

- OSB #1: report status
- OSB #2: toggles PRE-VIS-BORE
- OSB #3: sets the Field of View
- OSB #5 access the control page
- OSB #6 displays the type of weapon currently selected
- OSB #7 gives polarity
- Bottom row has the usual Declutter, Direct Access and Swap buttons
- OSB #20 selects the SLAVE options

For further information, please refer to the AGM-65 weapon deployment in the BMS manual.

1.4.11. TGP page

The TGP page is accessed from the menu page by depressing OSB #19.

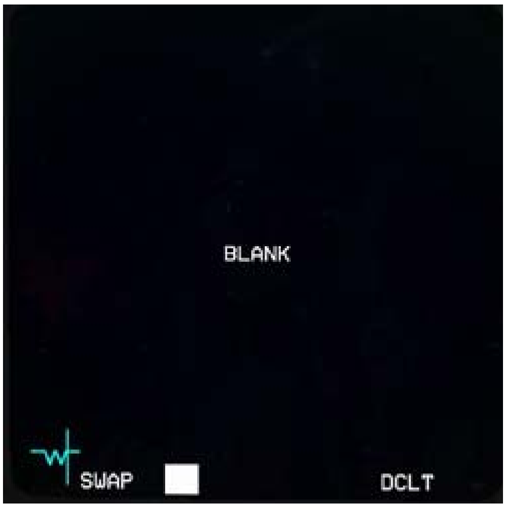
It is active when the TGP pod is carried on the right chin pylon. The pylon must be powered up for the pod to work correctly. This is done on the SNSR panel with the RIGHT hardpoint switch. The TGP needs to cool down after powering up and the TGP page will display NOT TIMED OUD out as long as the pod is not ready.

1.4.12. HAD page

The HAD is selected from the main MFD menu by pressing OSB #2. The HAD may be selected in any Master Mode but it can only be operated in A-G Master Mode with a HTS pod and AGM-88s loaded. Selection of the HAD page without AGM-88s loaded will yield a BLANK MFD page.
Operation is very similar to the previous HTS page (they were previously embedded in the AGM-88 SMS page), but the HAD shares many common display features as the HSD.
HAD cursor movement and expanded FOV (OSB 3 or pinky switch) options are similar to the HSD as well. The pilot may select the HAD range (with HAD as the SOI) by slewing the cursors up and down the display to bump range or by pressing OSBs #19 and #20. The HAD is not the primary way to deploy AGM-88s. POS EOM is accessible through the TGP page with HARMs loaded.

The HARM WEZ/Footprint is based on Rmax of the AGM-88 and will increase/decrease in size according to your speed and altitude. If the HARM WEZ is greater than the selected display range the lines will be dashed.
Detected emitters are coloured as follows:
Green = emitter not active
Yellow = emitter active
Red = emitter tracking
Flashing Red = emitter launching

1.4.13. BLANK page

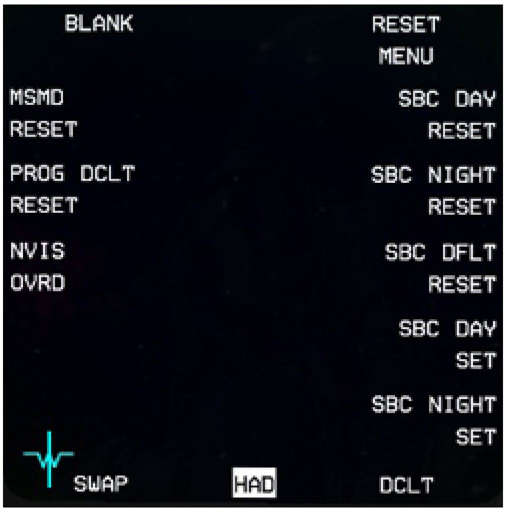


It is possible to turn OFF one MFD by selecting the blank page accessible from the OSB #1 of the Menu page. Although you may think that it is completely pointless, it may be helpful when you need only one MFD page active from the Direct Access row for a specific Master Mode. Let's say that you only want FCR to be displayed for AA Master Mode on the left MFD, you will then need to program FCR – BLANK – BLANK in the DTC.

1.4.14. RCCE page

The RCCE page (OSB #4 from the menu page) is normally intended for interfacing reconnaissance pods, but this is not implemented in BMS. Even the low altitude camera we have in the weapon inventory does not use it.

1.4.15. RESET MENU page



The Reset menu is accessed via OSB #5 of the menu page but has no purpose in BMS. None of its functionality is implemented.

1.4.16. FCR page

The Fire Control Radar page is accessed from the menu page by depressing OSB #20.
The FCR deserves a full document on its own but here is a short introduction which hopefully will meet your immediate needs. Obviously this page displays what the radar sees. It can be set to AA radar and its submodes or AG radar depending on your Master Mode.

1.4.16.1 FCR in AA modes

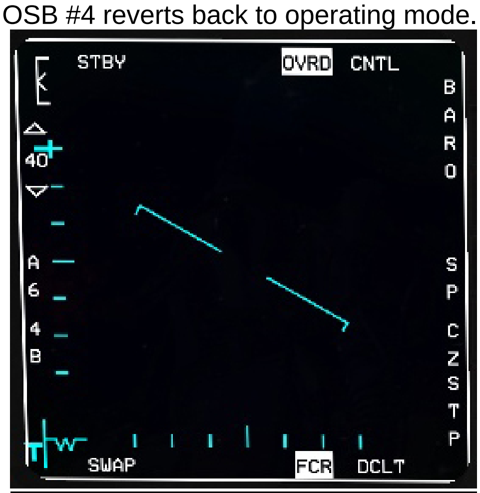
The FCR is switched ON by the FCR switch on the SNSR panel and once powered enters a BIT (Built IN Tests) that may last a few minutes. If the FCR is switched OFF in flight for longer than 4 seconds then the BIT will be reinitialised.
Once the BIT is complete the FCR becomes available and usually defaults to AA CRM (Combined Radar Modes)

OSB #1 states the current mode the FCR is in and if depressed displays a page where all other modes can be chosen from the side MFD buttons: GM (Ground Mapping), GMT (Ground Moving Target), SEA (Anti-Ship), STBY (standby) on the right and CRM and ACM (Air Combat Manoeuvring) on the left. Depressing any of the corresponding OSBs will enter that mode. Please note BCN (Beacon) mode is not implemented

OSB#2 will select the corresponding submode.
If the FCR is in CRM the submodes are RWS (Range While Search), ULS (=LRS: Long Range Scan), VSR (=VS Velocity Search), TWS (Track While Scan).
If the FCR is in ACM the submodes are 20 (HUD), Slew, Bore, 60 (Vertical).

OSB #3 is FOV and is obviously not available in all modes. It is displayed only when available. It will toggle between NORM and EXP. This can also be done with the pinky switch (S3) on your stick. When toggled to EXP, the area around the cursor is expanded and illustrated by the blue square drawn on the MFD. The EXP label also flashes.

OSB #4 places the FCR in standby mode. All symbology is deleted from the MFD and OVRD is highlighted. A further press on OSB #4 reverts back to operating mode.



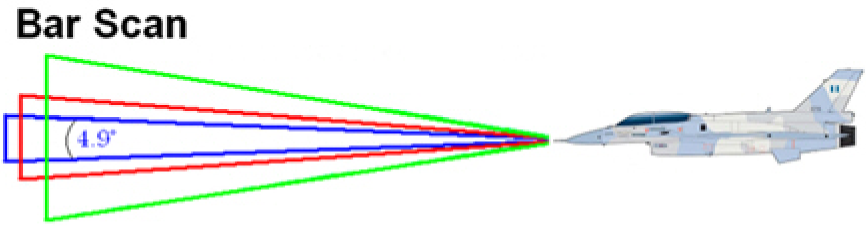
OSB #5 enters the FCR control page. The left and right rows of OSBs can set different options but most of those are not implemented and eye candy only, except for target history that sets the number of toned down contacts you see after the main contact. The control page is the same for both AA & AG FCR and is detailed in the AG FCR section further down this chapter.

OSB #6 is the IDM mode. It defaults to ASGN (Assign) but can be toggled to CONT (Continuous) or DMD (Demand). Please refer to the IDM chapter of the BMS manual for further information on AA IDM.

OSB #7, #8, #9 & #10 are labelled 1, 2, 3 and 4 and correspond to your flight members. These are used to select a specific flight member to send IDM data to. Please refer to the IDM chapter of the BMS manual for further information on AA IDM.

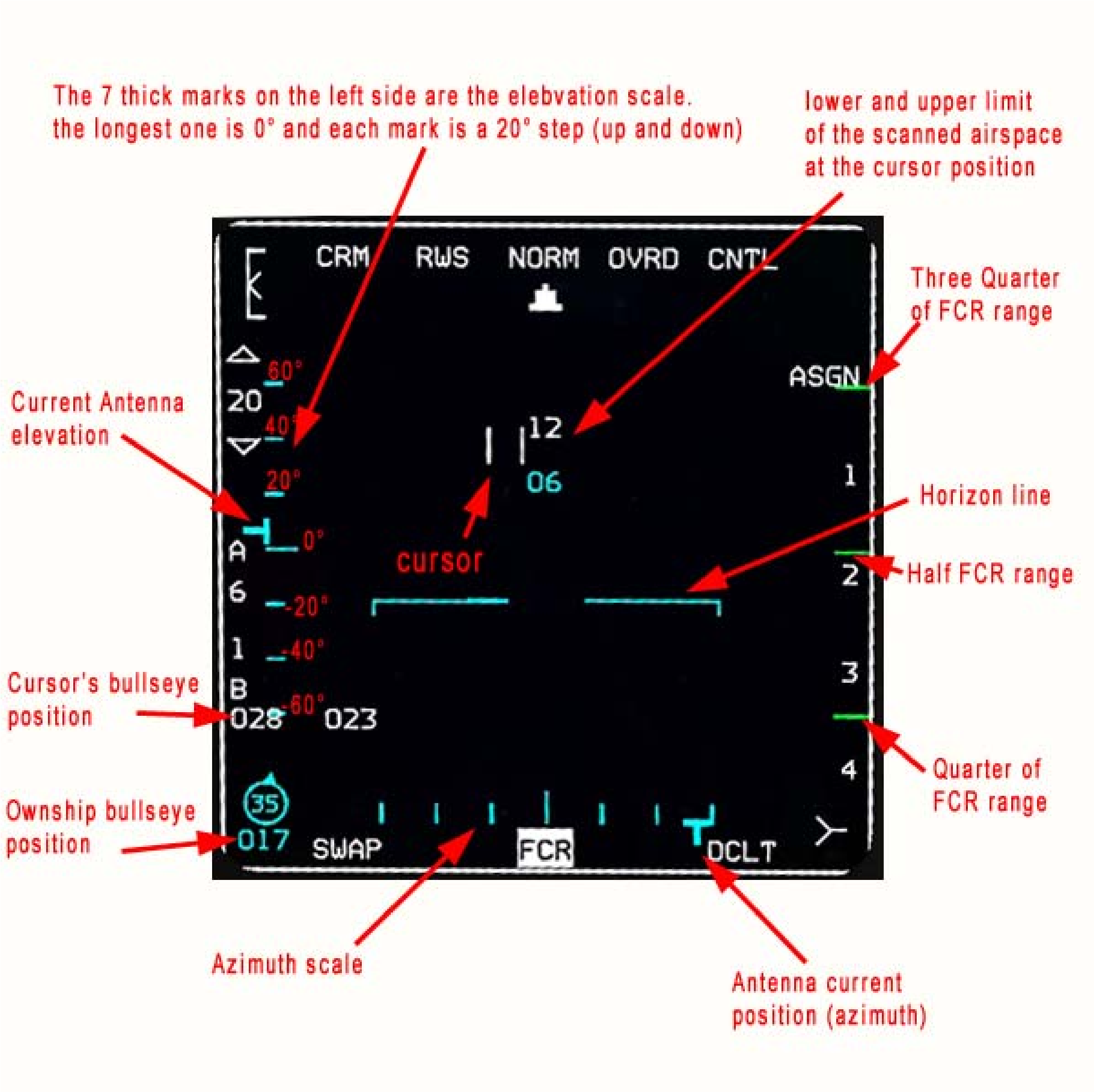
The bottom row are as usual Direct Access buttons with Declutter on OSB #11 and SWAP on OSB #15

OSB #17 is the bar scan and can be toggled from 1 bar to 4 bar.
The FCR scans the horizon by physically moving the antenna. The beam that the antenna normally emits is not able to scan more than 4.9° in the vertical. So with this set to 1 the radar will scan just the single 4.9 slice of airspace. Set to 2 the radar will scan 2 bars of airspace, set to four it will scan four bars. It takes 2.5 seconds to scan one bar and another 0.5 seconds to move the antenna up and start on the next bar, so a full 4 bar scan will take 12 seconds, whereas a 1 bar scan will take just 2.5 seconds. Obviously decreasing the bar scan will quicken the scan but will reduce the search area. Whatever the bar scan setting the radar can always be tilted up or down with the ANTENNA elevation control on the throttle.



OSB #18 is azimuth setting and toggles from a cone of 60° (A6) to 30° (A3) to 10° (A1).
Blue lines are drawn on the FCR to illustrate the reduced search cone and it is also displayed similarly on the HSD. The obvious advantage is that the smaller the search area the quicker the scan happens. The disadvantage is that it becomes easier to miss a contact that might be outside your search area. When the azimuth is less than 60° the search area is slewable.

OSB #19 & 20 are used to set the FCR range when the mode allows it. Depressing OSB#19 decreases range and OSB#20 increases range. Another way to set the range is by cursor bumping (if the FCR is SOI) when the cursors hit the top or bottom edge of the FCR.


The 7 thick marks on the left side are the elebvation scale.
the longest one is 0° and each mark is a 20° step (up and down)
lower and upper limit
of the scanned airspace
at the cursor position
CRM RWS NORM OVRD CNTL
Three Quarter
of FCR range
ASGN
Current Antenna
elevation
20
60°
40°
20°
0°
-20°
-40°
-60°
12
06
1
Horizon line
cursor
A
6
1
B
2
Half FCR range
3
Cursor's bullseye
position
028
023
4
Quarter of
FCR range
35
Ownship bullseye
position
017
SWAP
FCR
DCLT
Azimuth scale
Antenna current
position (azimuth)

1.4.16.2 FCR in AG modes

The FCR will switch automatically to AG FCR upon entering AG Master Mode. If you need to set FCR specifically to a certain mode you can use the menu page to select any submodes.
The left side OSBs show the AA modes and the right side OSBs access the Ground submodes:

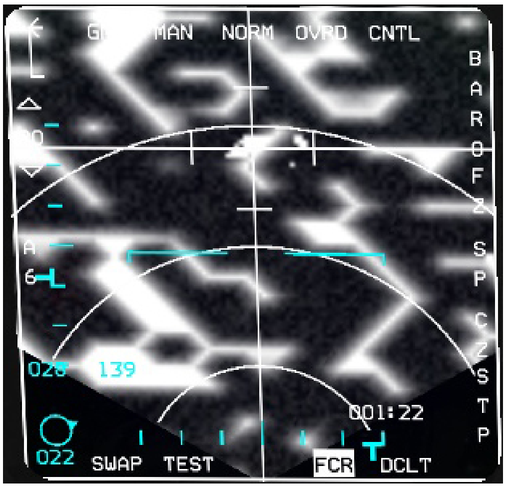
GM: Ground Map
GMT: Ground Moving Targets
Sea: for naval targets
BCN stands for Beacon and is not implemented in BMS.

Mechanisation of the AG FCR is the same for all different AG submodes, only the sensibility differs to pick up relevant targets. We will use Ground Map (GM) Mode to illustrate the AG FCR in this chapter.

Upon first entering GM mode the FCR is scanning ahead and is pointing at the current active steerpoint. The time needed to reach the steerpoint is displayed in the bottom right corner of the FCR, in this case 33 seconds. This timer may be specific to other things such as pull up cue, bomb impact for LGBs. It depends on Master Mode, SOI and SMS.

As with the AA FCR the cursor's bullseye position is displayed near OSB#17 (189 00) and your ownship bullseye position would be displayed in the bottom left corner of the MFD, if your Bullseye was mode selected in the DED (LIST – 8 page). In the picture on the right, Bullseye is NOT mode selected and thus the MFD displays the aircraft reference symbol (W) and the azimuth steering bar.

The AG radar is able to paint the terrain in different colour depth. Contacts returns appear as bright white dots. The AG FCR gain can be set with the throttle RNG knob or through the GAIN rocker switch (top left corner). The gain changes the intensity of the terrain and is indicated with the Gain marker displayed on the top left corner of the MFD. The two pictures below illustrate the AG FCR gain set to maximum (left picture - notice the gain meter set to the highest point) and the gain set to minimum (right picture - notice the gain meter set all the way to the bottom of the scale). Please note the gain meter is displayed both in AA & AG FCR.

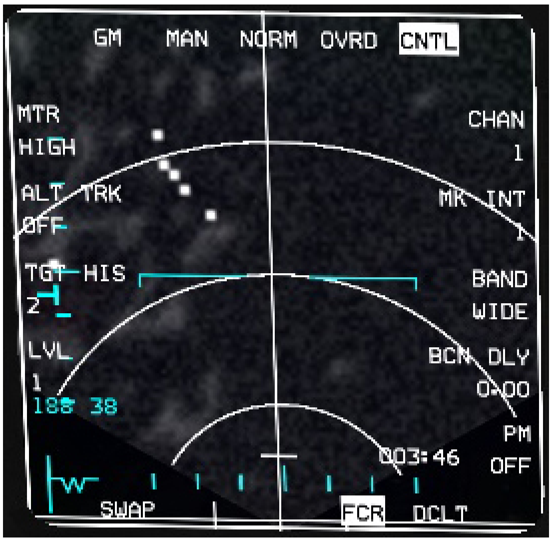


OSB #1 is the current submode. If pressed the FCR will show other submodes as in the STBY page above.

OSB #2 sets the option to have AUTO or MANUAL range switching. This switching is available in GM, EXP, DBS1, DBS2, GMT & SEA. In MANUAL the range must be manually changed with OSB 19& 20. In AUTO the range switches automatically when the cursor position enters the next available range setting of the FCR. It defaults to AUTO.

OSB #3 is Field of View and has 4 levels: NORM, EXP, DBS1 and DBS2 (Doppler Beam Sharpening). When the AG FCR is SOI the pinky switch on the sidestick toggles all available FOV settings. EXP mode expands the radar display around the cursors and centres it on the scope. DBS1 refines the EXP mode, providing more detail but no more magnification. DBS2 is the highest level of magnification.
EXP is available in GM, GMT & SEA. DBS1&2 are only available for GM within a 20Nm range. They are not available to GMT and SEA.

OSB #4 is the Override mode. When pressed the radar goes into standby and the FCR MFD goes blank. OVRD is highlighted. To resume radar operation the OVRD button has to be pressed again.



OSB #5 enters the Control page
Please Note the FCR CNTL page is the same for AG and AA FCR.
The display remains (and keeps being updated) but OSB changes to CNTL options. Currently none of these Control options are enabled in BMS for the AG FCR. The options can be toggled but the consequences are nil in the code.
In the real aircraft, OSB #6 changes the radar channel to avoid interferences from other aircraft, (NI) OSB #7 is the Marker intensity button and ranges from 1 to 4. This allows a different intensity for the range markers than the overall symbol intensity set through the SYM rocker (NI).
OSB #8 is bandwidth select from narrow to wide (NI).
OSB #9 is an option to set the beacon delay from 0.00 to 99.9 through the data entry display (NI).
OSB #10 is Power management and alternates between PM ON & PM OFF (NI).
OSB #17 toggles between ECCM level 1 and level2 (NI).
OSB #18 sets target history and that is the only option working for AA FCR. History can be set from 1-4 providing a trail for radar targets in AA.
OSB #19 is Altitude Liner blanker option ON or OFF (NI).
OSB #20 is the level declutter option on AG & AA radar rejecting targets below certain radial velocities (NI).

OSB #6 is BAROMETRIC but not implemented in BMS.

OSB #7 is FZ for Freeze. When depressed the AG FCR image is frozen and the coordinates of the ground stabilized point are displayed on the top right part of the MFD. The azimuth and distances are displayed in the bottom left part of the MFD.
FZ mnemonic remains highlighted as long as FREEZE mode is active.
It is particularly useful for zooming in and creating an accurate lock on a specific target easily recognizable on the radar. To unfreeze it press OSB #7 again and the FCR will radiate again. Changing FOV will also cancel freeze mode.

OSB #8 is SP for SNOWPLOW. As mentioned above, the FCR points at the current steerpoint of interest by default. In some cases, you may need to have the FCR scanning a point ahead of you. Snowplow mode does just that, placing the FCR cross dead ahead of your trajectory at half the range of the AG FCR range.
In Snowplow mode the terrain moves under the radar designating cross and thus is not ground stabilized. The mnemonic SP remains highlighted as long as snowplow mode is active. To revert to STPT mode press OSB #8 again.

OSB #9 is CZ for Cursor ZERO. It resets the cursors to their initial position. It will negate all the cursor movement induced by the pilot and send them back to their default position. It is especially useful when you have lost track of where the cursors are pointing.

OSB #10 is the sighting point rotary. It will be STP in NAV mode, TGT in AG master mode, OA1 or OA2 if data has been entered for the applicable steerpoint, RP if VRP mode selected and IP if VIP mode has been selected. Please note: TMS right changes the sighting point rotary selection as well.

As usual OSB #11-15 at the bottom are the Direct Access buttons (OSB #12-#13-#14) and the usual declutter (OSB#11) and Swap buttons (OSB#15)

OSB #18 allows azimuth setting of 120°, 60° and 20°. 6, 3 & 1 stand for 60°, 30° and 10° of the longitudinal reference lines, giving you a total scan of 120° when A6 is selected - 60° when A3 is selected and 20° when A1 is selected. As with the air to air modes the smaller the azimuth setting the quicker the radar updates.

OSB #19 & 20 are used to set Radar range. OSB #19 decreases range. OSB #20 increases range. Range varies from 10 to 80 Nm in AG mode. Optimal efficacy is usually obtained under 20 Nm though.

There is probably much more to learn about the FCR, but it goes beyond the purpose of this section and will be covered in other specific chapters as well as the BMS manual.

1.4.17. Setting the MFDs according to master modes (DTC)

As you have noticed the 3 centre buttons on the bottom row of the MFDs are the Direct Access buttons and remain visible whatever page is displayed.

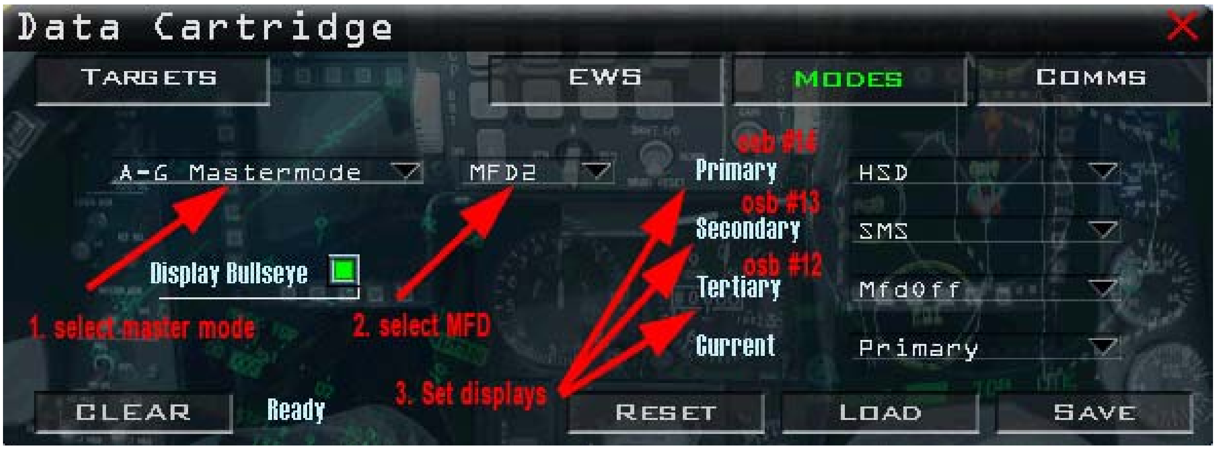
Each Master Mode has 3 MFD slots available for Direct Access, OSB #12, #13 & #14.
They need to be programmed through the DTC and then can be toggled with DMS left for the left MFD and DMS right for the right MFD in flight. Of course the relevant MFD button can also be pressed instead of using DMS.

Programming can also happen in flight. To change the DTC programming press the Direct Access button twice to enter the menu page and from there another page can be selected for the current Master Mode. This selection is saved by the system and will be recalled when the same Master Mode is selected again.

It is advised though to build your own MFD configuration at least once from the DTC – which is saved in your pilot.ini file and will be remembered. You will not have to redo it for each TE through the DTC.
Common DTC settings are saved in the pilot.ini file.
TE specific DTC settings are saved in the TE.ini file.

Making your own MFD configuration:

Open any TE and select the DTC button. Select the MODES tab to set your MFDs.



The first menu is to select Master Mode. The second menu is to select the MFD (MFD1 is left MFD, MFD2 is right MFD, MFD3 is top left MFD in 1 view (not realistic) and MFD4 is top right MFD in 1 view (not realistic)).
Primary is used to select the left Direct Access button on OSB #14.
Secondary is used to select the middle Direct Access button on OSB #13.
Tertiary is used to select the right Direct Access button on OSB #12.
The Current option sets which of the three is displayed by default when the Master Mode is entered.

Please note, each Master Mode needs to be programmed and you need at least to program MFD1 and MFD2 for each Master Mode.

On the image above you may notice that the Tertiary mode is left OFF. That means there will be only two pages available from Direct Access button for that MFD in that Master Mode. You do not need to specifically have 3 pages and having 2 or even 1 may be less confusing or provide faster toggling from one page to another.

Once you are satisfied with the configuration you can save your DTC. The MFD settings will be saved in your pilot.ini file and will be available to you (from the moment the DTC is loaded in the 3D cockpit) as long as you use the same logbook.

Recommended DTC settings for the MFDs
Here is a suggestion on how to set the MFDs. You are free to use your own configuration and use this only as a base to build your own:

Air to Air:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)
You don't risk losing the FCR on the left MFD with an inadvertent press of DMS left thanks to the two empty pages.

Air to Ground:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

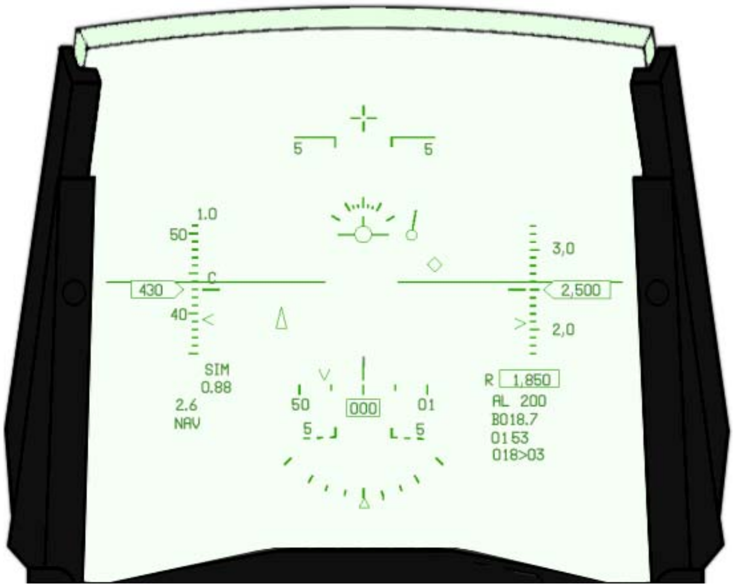
Nav Mode:
Left MFD (1): **FCR** – DTE – FLCS (current = primary for FCR)
Right MFD (2): **TEST** - SMS – HSD (current = primary for TEST – but switched to HSD after gear up)

MRM mode:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

Dogfight mode:
Left MFD (1): **FCR** – blank – blank (current = primary for FCR)
Right MFD (2): **HSD** – SMS – blank (current = primary for HSD)

1.5. THE HEAD UP DISPLAY (HUD)

The HUD is a combining glass that provides information for essential aircraft data such as airspeed, altitude, heading flight path marker.
It also provides flight symbols relating to Master Modes.



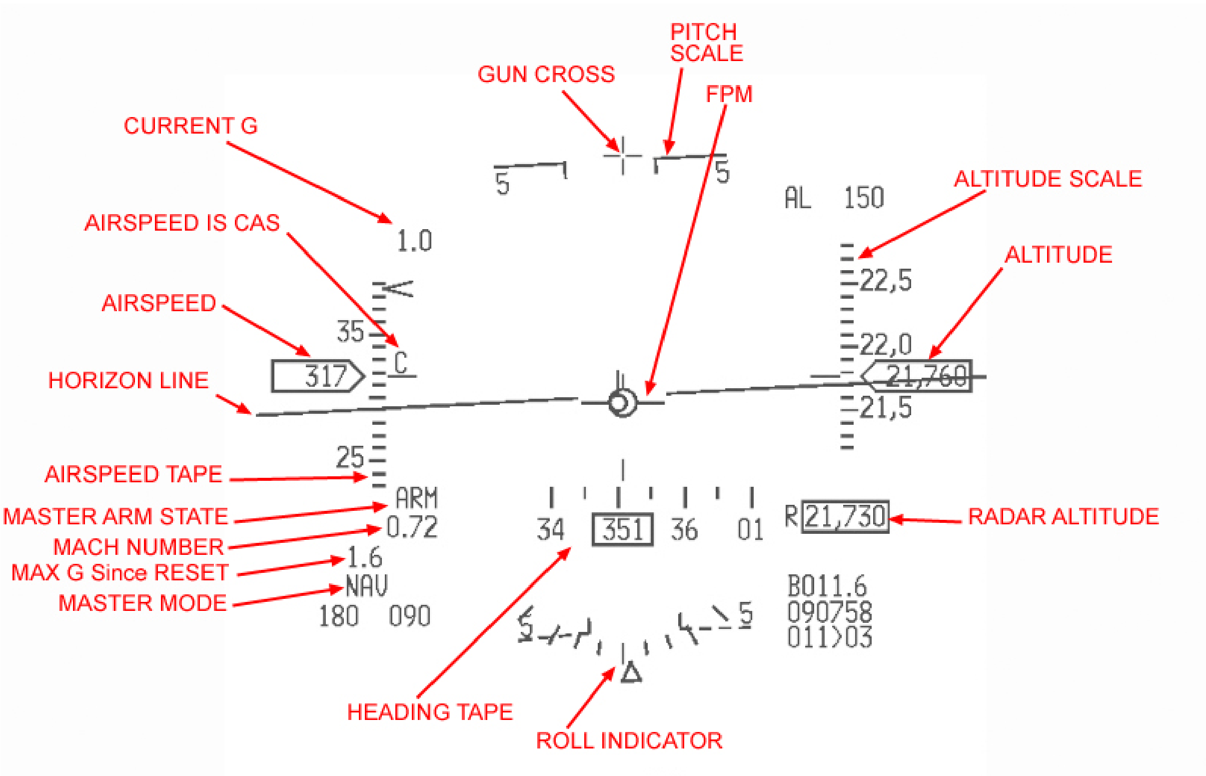
The HUD is switched ON by the SYM wheel on the ICP. Brightness can also be set through the SYM wheel or by assigning an analogue axes in the advanced controller menu.

1.5.1. HUD SETTINGS

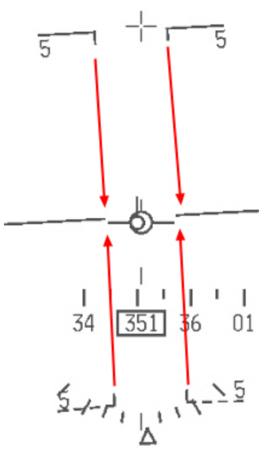
In all Master Modes VELOCITY or airspeed is always displayed on the left, ALTITUDE on the right and HEADING on the top or the bottom.

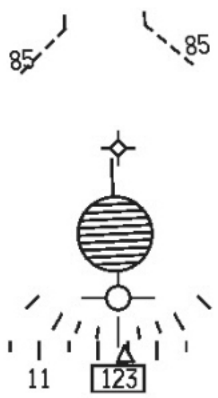
Some HUD features can be set through the HUD panel on the right console (See cockpit arrangement section: 5.3 HUD panel).

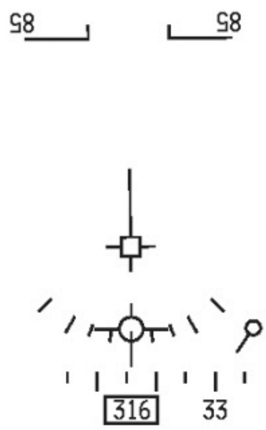
- The airspeed tape can be displayed as CAS (Calibrated), TAS (True) or Groundspeed.
- The FPM and pitch scale lines can be removed.
- The DED or PFL can be displayed on the bottom of the HUD.
- Brightness can be auto adjusted for day/night.
- A vertical velocity indicator can be displayed (see below VV/VAH).
- Altitude scales can display barometric, radar or auto altitude (see below altitude scale).



The centre of the HUD usually features the horizon line with pitch scales every 5° up (solid lines pointing to horizon) and down (dashed lines pointing to the horizon). When the horizon line is outside the HUD Field of View it is replaced by a dashed ghost horizon line.
The pitch bars are also bent incrementally when the aircraft is in a dive. The bend varies between 8 and 45°. There are two specific symbols at +90° (zenith) and at -90° (nadir) pitch as seen on the pictures below:





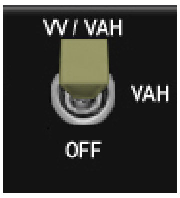


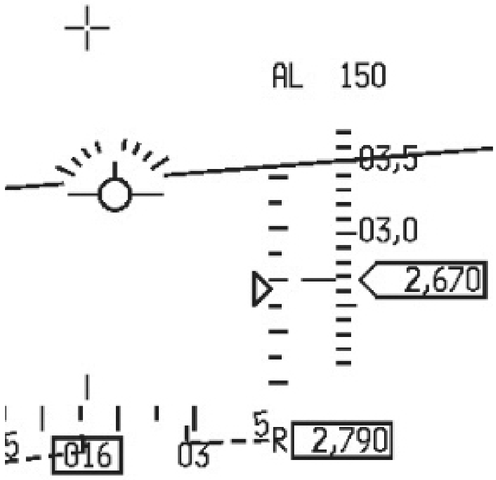
The FPM is an invaluable cue flying the aircraft. It represents your instantaneous flight path vector and is not affected by AOA. It is represented by an aircraft viewed from behind symbol.
The FPM can drift according to the wind and in some occasion may be pushed outside the HUD FOV. In this case a cross is superimposed on the FPM to indicate that it is not to be used.
The wind drift can be cancelled out with the DRIFT C/O switch on the ICP. The FPM is then brought back into the middle of the pitch scale bars.

On top of the HUD you will find the GUN CROSS or Boresight cross which represents the fuselage reference line. It displays zero degree azimuth in all modes. It is also therefore a very important HUD cue.

The Roll indicator is located on the bottom of the HUD. Each tick mark represents 10° of roll except the last ones which are set at 45°. The roll indicator is not displayed when the DED/PFL is displayed, when the pitch bars are de-cluttered or if the INS data is invalid.

Vertical velocity scale (VV/VAH)



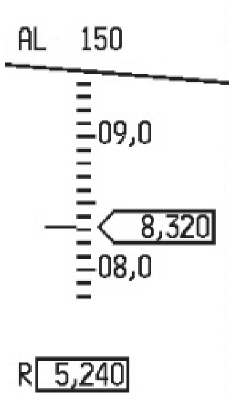


Moving the top left switch of the HUD CNTL panel to VV/VAH displays the Vertical Velocity, Velocity, Altitude and Heading on the HUD. The vertical velocity is placed inboard of the airspeed tape. The VV scale features 500 feet interval marks and a moveable triangular caret displaying the actual vertical velocity (the same as the VVI)
When the vertical velocity is displayed the roll indicator usually found on the bottom of the HUD is replaced by a smaller roll indicator located just above the FPM.

When the switch is placed to VAH, the HUD displays Velocity, Altitude and Heading information only. This is the default display of the HUD

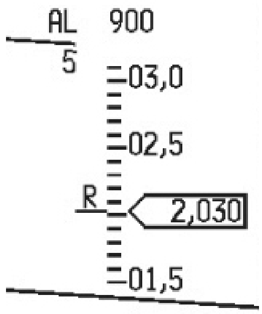
Placing the switch to OFF turns off display of the HUD scales.
The current values for altitude, speed and heading are then displayed in boxed windows.

Altimeter scales



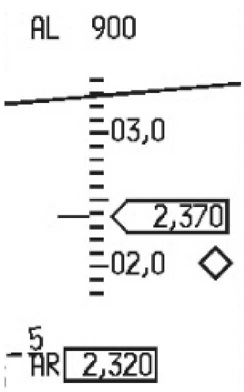
There are three possibilities for the altimeter scale according to the position of the corresponding switch on the HUD panel: RADAR, BAROMETRIC of OFF (which is actually should read AUTO)

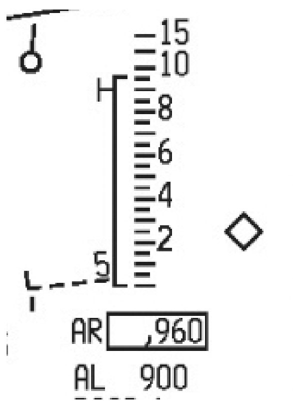
The default setting is BAROMETRIC and displays barometric altitude changing with local altimeter setting. It displays altitude in hundredths of feet with 100 feet marks (20 feet marks when the gear is down).The radar altitude (CARA) is also displayed below the altitude scale in a boxed window with the letter R in front of it if the CARA is active and within operating limits.



When the switch is placed in ALT RADAR position the altimeter scale displays RADAR altitude. To avoid confusion the mnemonic R is added next to the fixed index mark on the altimeter tape.
The marks are the same as the barometric scale: 100 feet scaling and 20 feet when the gear is down.
Obviously the radar altimeter box usually placed below the airspeed tape is not displayed in this mode.

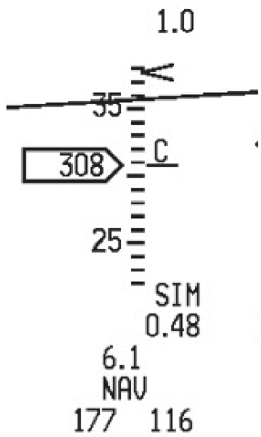
The last position of the switch is labelled OFF but should actually be named AUTO in the 3D cockpit.
It is an automatic scale using barometric altitude above 1500 feet and switching automatically to radar altitude under 1200 feet.
Above 1500 feet the radar altitude is displayed in its usual box but with the mnemonic AR (Automatic Radar) instead of the usual R. When descending below 1200 feet the radar scale will replace the barometric altitude. A T-bar is displayed next to the tape showing the A-LOW setting. In the example below, it is set at 900 feet. Note the AL line has switched to the bottom of the HUD, right under the AR window. When climbing the radar scale remains displayed till 1500 feet AGL, then is replaced by the barometric scale.





Airspeed scales

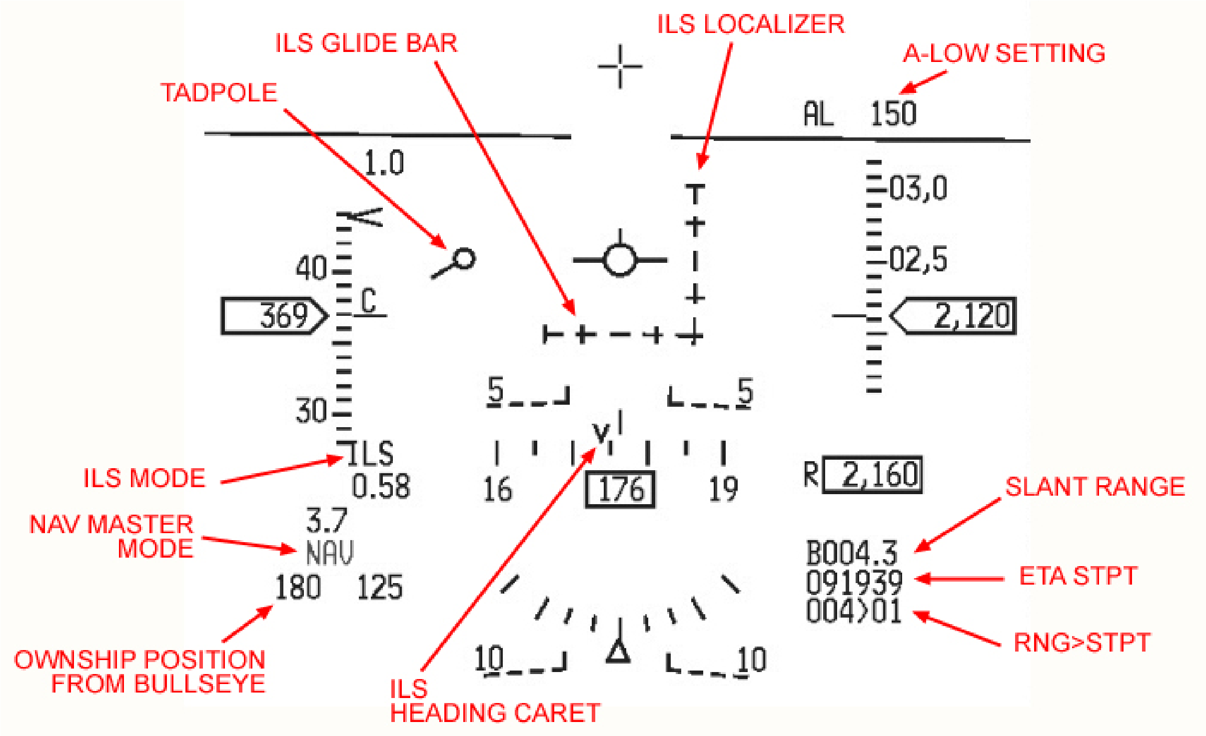
On the ground the airspeed tape cannot display airspeeds (CAS) lower than 60 knots.
The displayed airspeed may change according to the position of this HUD panel switch. In all modes the airspeed is marked every 10 knots and labelled in 50 knot increments.
IN CAS the airspeed tape displays Calibrated Airspeed.
A mnemonic C is placed next to the HUD speed tape.



Moving the switch to the TAS position switches the airspeed tape to TRUE airspeed. In this case the T mnemonic is displayed.

Ground speed can also be set and the mnemonic then is G. When ground speed is selected a ground heading track caret is displayed as an inverted triangle on the heading tape.
When the gear is lowered the airspeed scale automatically reverts to CAS whatever the position of the HUD panel switch. The heading track caret will remain displayed if the switch remains in the Groundspeed position.

1.5.2. HUD in NAV mode



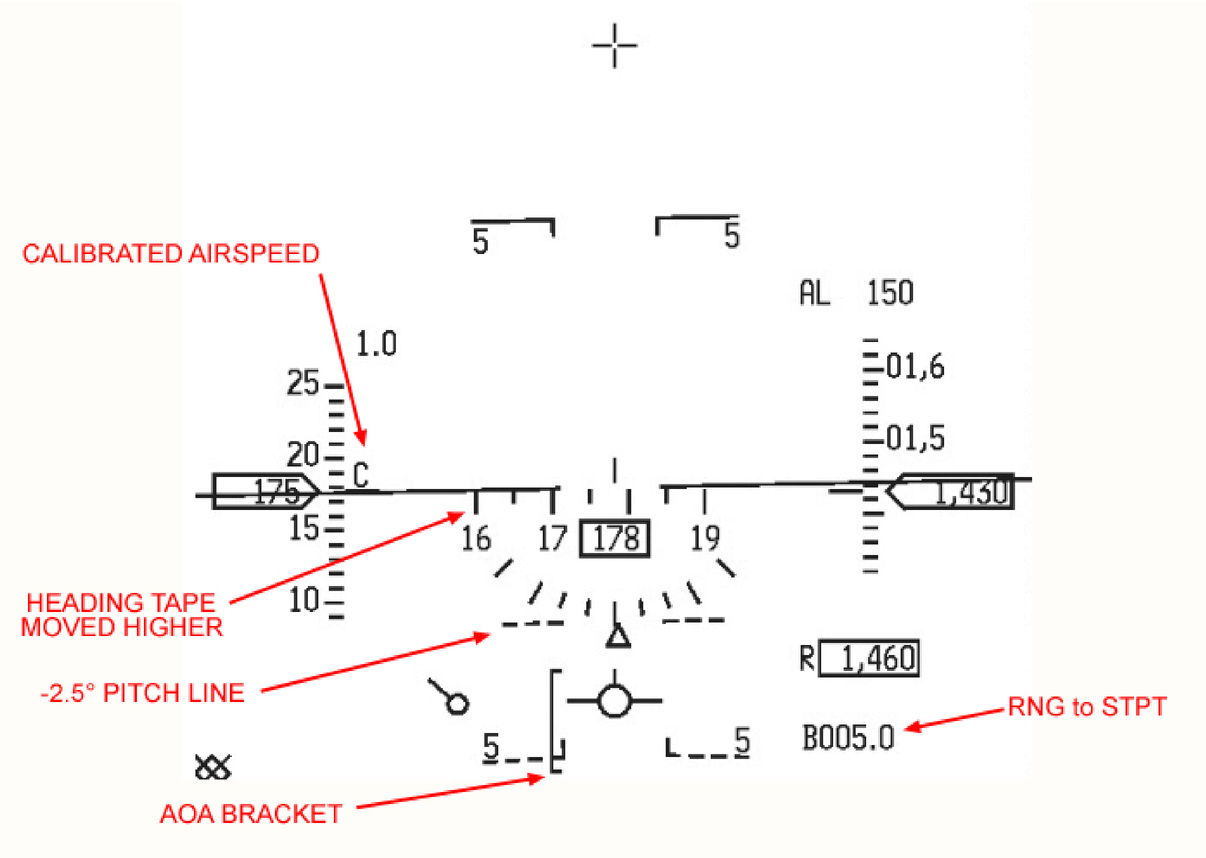
Most of the displayed features are not specific to NAV mode but active in all Master Modes.

- The tadpole points to the currently selected steerpoint. The steerpoint is also displayed on the HUD with a diamond. When outside the HUD field of view a cross is superimposed on the diamond and the crossed diamond remains on the edge of the HUD, towards the direction of the steerpoint (that is why you do not see it on the picture above)
- The A-LOW setting on top of the altitude scale corresponds to the first line set in the UFC A-LOW page.

As always, different information can be displayed according to the way various subsystems are set.

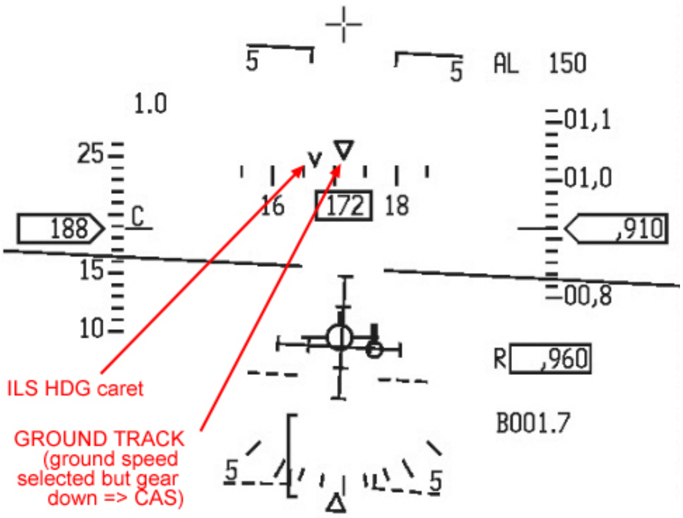
- If the HSI is switched to NAV/ILS or TCN/ILS the HUD will display the ILS localizer and glide slope and the CMD STRG cue if activated in the UFC T-ILS page
- The ETA to steerpoint can be replaced by ETE (Estimated Time Enroute) according to the UFC CRUS TOS page settings.
- Different carets can be displayed around the tapes to give visual cues for airspeed, altitude and heading, again according to UFC subsystems.
- The ownship position from bullseye can be displayed or not depending on the Bullseye being Mode Selected in the UFC LIST MISC 8 page.
- The Radar altitude will blank if you are outside of its attitude and altitude limits.
- The inverted V on the heading tape is displayed when the ILS mode is selected and represents the ILS heading caret. It is the wind corrected heading required to maintain the selected ILS approach course

1.5.3. HUD with GEAR DOWN



When the gear is lowered some specific items are displayed or changed.

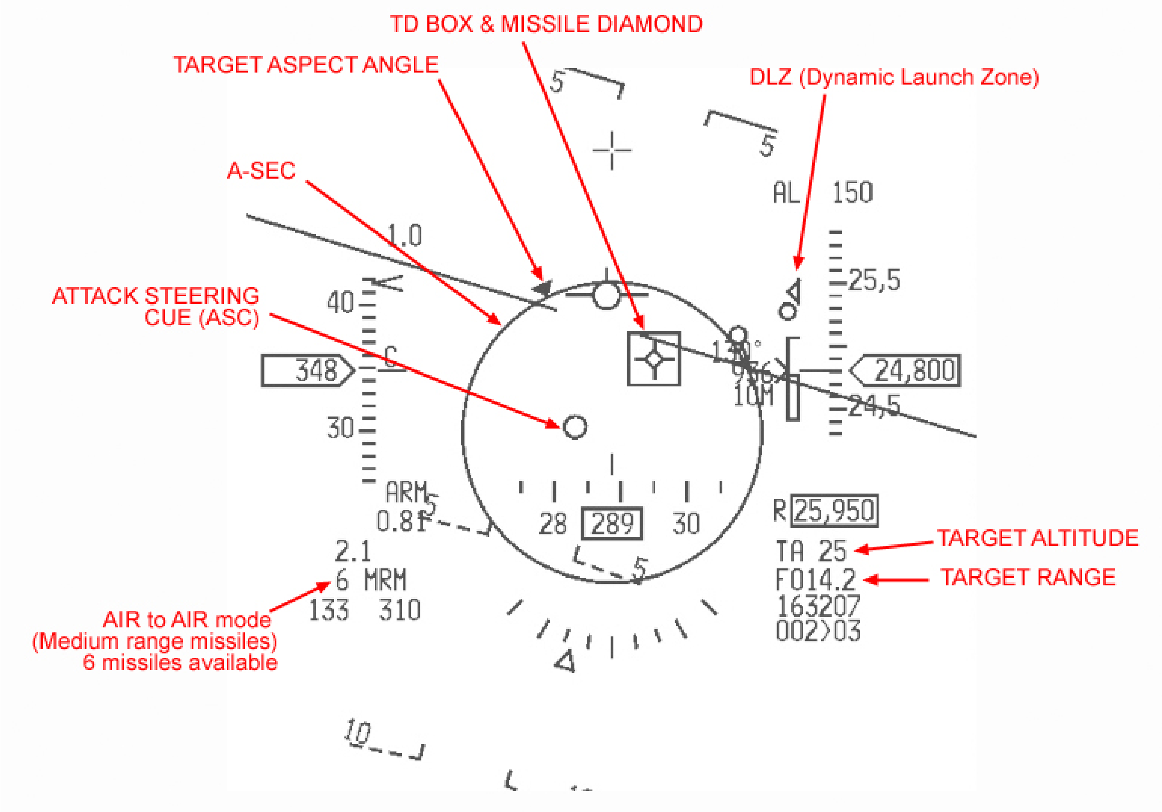
- The Heading tape is moved higher in the HUD. It will go to 50 mill radians above the FPM or on top of the HUD whichever is lower.
- The AOA bracket is displayed and represents optimal AOA for landing. The top mark is 15° AOA and the lower mark is 11° AOA. The two marks correspond to the red and yellow chevrons on the AOA indexer, just to the left of the HUD. On speed AOA for landing is obtained by placing the FPM in the middle of the AOA bracket as pictured above thus maintaining an AOA around 13° (corresponding to the green doughnut on the AOA indexer).
- A new dashed pitch line is also displayed between the horizon line and the -5° pitch line. It is the -2.5° pitch line that represents the glideslope for landing.
- When the gear is down the displayed airspeed is always CAS, even if the Speed switch on the HUD panel is set to TAS or GS. The ground heading track (inverted triangle on the HUD heading tape displayed with groundspeed) is still displayed when the gear is down. With ILS enabled you might have two different carets on the heading tape: the inverted V for the ILS heading and the inverted triangle for the ground heading track.

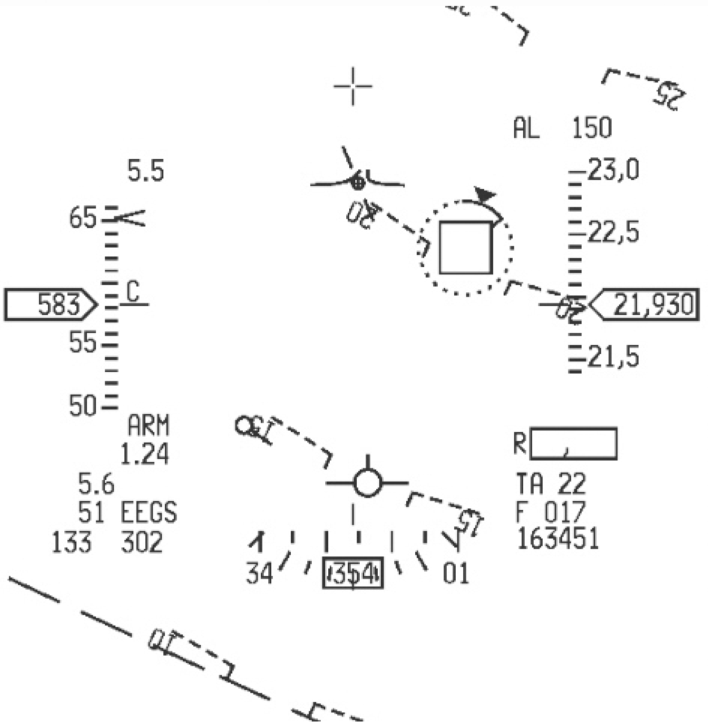


- Some data blocks usually displayed on the bottom of the HUD are blanked to allow better visibility of the critical HUD landing symbology.

1.5.4. HUD in AIR to AIR mode

The HUD will display different information depending on the active weapon in AA mode.
Air to Air Weapon parameters are displayed in the HUD repeating the cues on the MFDs (usually AA FCR)

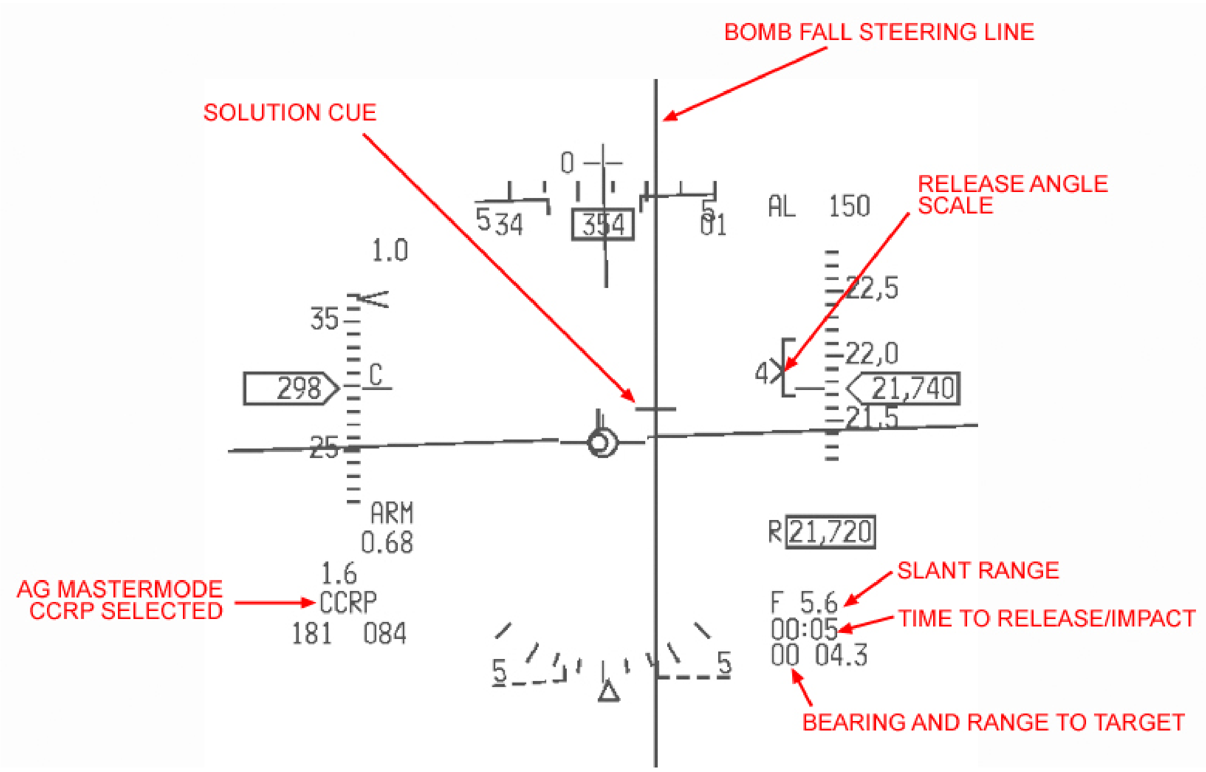




In the image above the AA gun has been selected in EEGS mode. Note the inverted attitude and the radar altimeter which is blank.

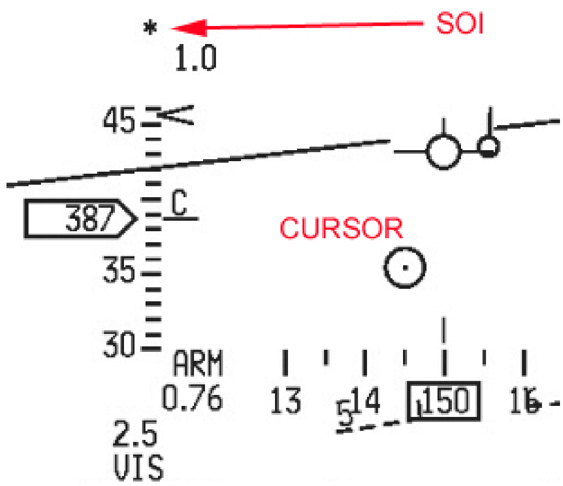
1.5.5. HUD in AIR to GROUND

As in AA mode weapon and release mode cues are displayed in the HUD in AG Master Mode.



The HUD can display many different cues in Air to Ground modes depending on release solution or even weapons including CCRP, CCIP, DTOS, STRAFE, HARMS and other AG missiles.
Please refer to the BMS manual for weapon employment specifics.

1.5.6. HUD as SENSOR OF INTEREST (SOI)

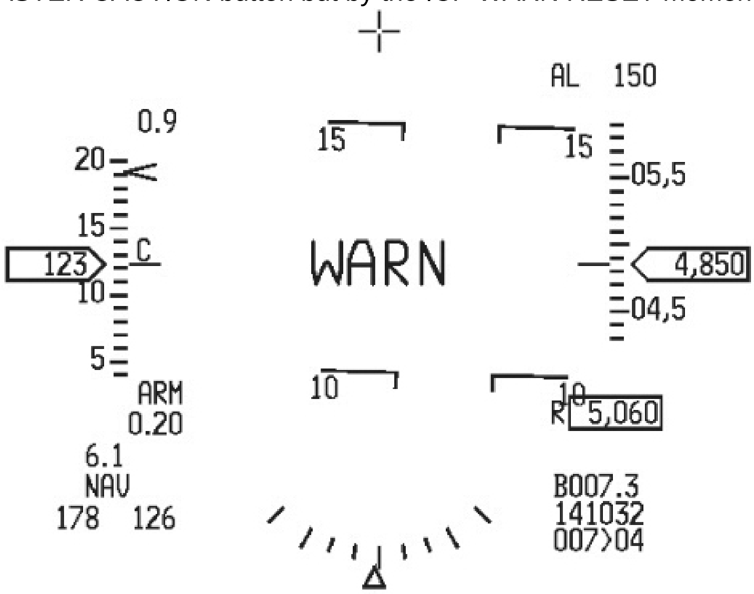


As with the left or right MFD, the HUD can be selected as Sensor Of Interest (SOI)
This is done with DMS up on the sidestick. When the HUD is SOI an asterisk is displayed in the top left corner of the HUD.

The HUD is used as SOI for HUD mark points, AG missile employment in VIS mode. When the HUD is SOI a slewable cursor or target designator box is displayed on the HUD which can be moved with the cursor switch on the throttle and ground stabilised/designated with the TMS switch on the sidestick.

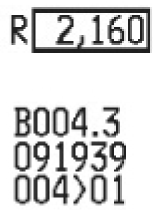
1.5.7. HUD WARNING

When a relevant malfunction occurs the HUD may displays a flashing WARN message in its centre. The VMS provides an audio WARNING - WARNING message. The flashing WARN in the HUD cannot be reset with the MASTER CAUTION button but by the ICP WARN RESET momentary switch instead.



Other smaller warnings may accompany the WARN HUD message such as flashing FUEL message in the middle of the HUD, although smaller and below than where the WARN message is displayed or a steady TRP FUEL on the left of the HUD for instance replacing the NAV mode indication.

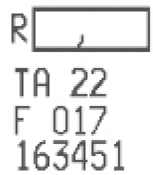
1.5.8. HUD CARA



The Combined Altitude Radar Altimeter provides accurate reading of aircraft altitude above the surface (AGL).
The Radar altitude is displayed on the HUD below the altitude tape, in a box preceded by the letter R.

The CARA is controlled by the radar altimeter switch on the SENSOR panel, located on the right console. When the switch is placed in RDR ALT the CARA is functional. Radar Altitude advisory is provided by the A-LOW page of the UFC that sets the CARA A-LOW (1st line)
The set altitude is then repeated on the HUD above the altitude tape. When altitude goes lower than the CARA A-LOW the VMS calls ALTITUDE ALTITUDE and the HUD A-LOW flashes.
When the gear is down VMS altitude calls are inhibited but the HUD CARA A-LOW still flashes.

The CARA has limitations depending on altitude and pitch roll (bank angle).
Pitch or roll angle limits are 10° at 50000 feet, 15° at 25000 ft, 25° at 10000 ft, 30° at 5000 ft and 30° in pitch and 60° in roll at 3000 ft.
A combination of pitch and roll angles further reduces CARA altitude capability.
When outside the specification of the CARA altitude the HUD CARA display is blanked.
CARA is therefore most useful at low altitude below 3000 ft !

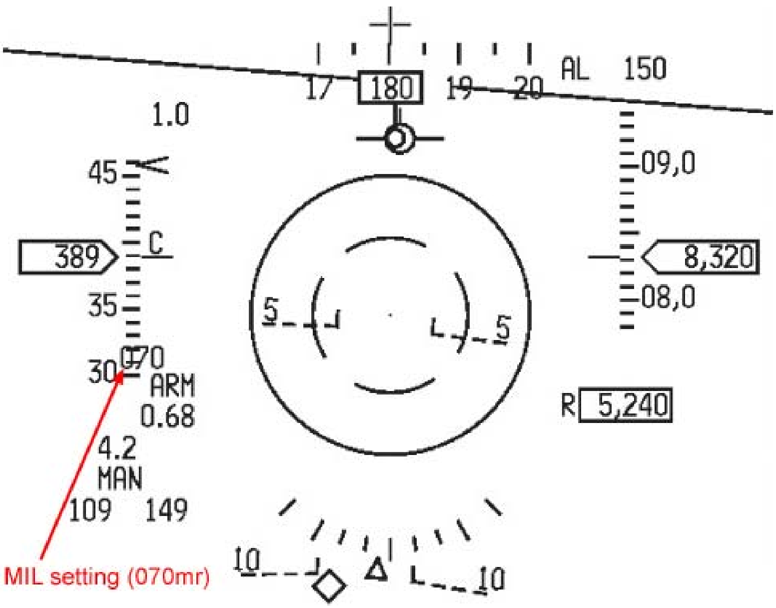


1.5.9. DEPRESSIBLE RETICLE SWITCH

MANUAL bombing mode selected through the SMS AG MFD (OSB #16) uses a backup bombing reticle that is normally used when the primary systems and avionics have failed.

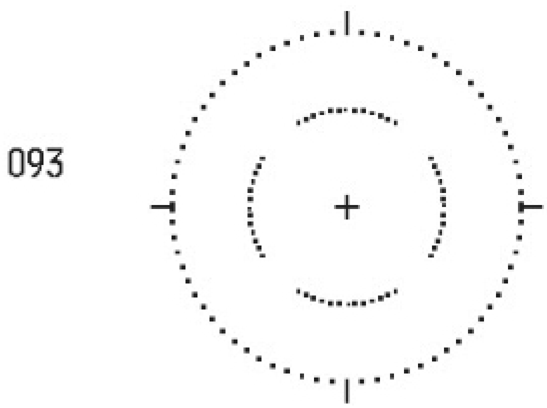
The manual bombing reticles are controlled by the DEPR RET switch on the HUD panel. The switch has three positions and features a primary reticle (PRI) and standby (STBY) reticle. The reticles are comparable in use to old WWII aiming devices.

The Primary reticle does not change actual HUD symbology (except for the bombing mode symbols) and consists of a centre pipper with a dashed inner circle (50mil) surrounded by a solid outer circle (100mil).



The reticle can be moved UP and DOWN in the HUD by using the DEPR RET ICP wheel (top right wheel). The depression is displayed on the left of the HUD in milliradians.

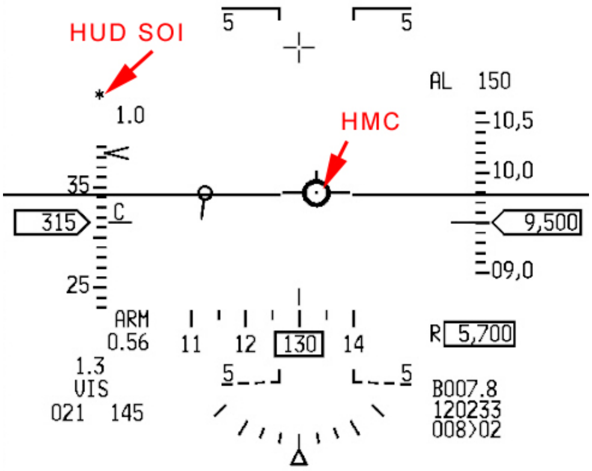
The standby reticle is a centre cross with a dotted inner circle (50 mils) surrounded by another dotted circle (100mil). The STBY reticle blanks out all other HUD symbols except the mil setting set by the ICP DEPR RET wheel. The standby reticle is visible even with the HUD damaged.

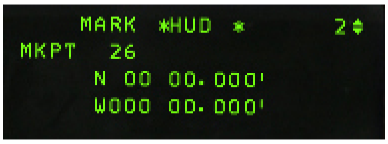


1.5.10. HUD MARK

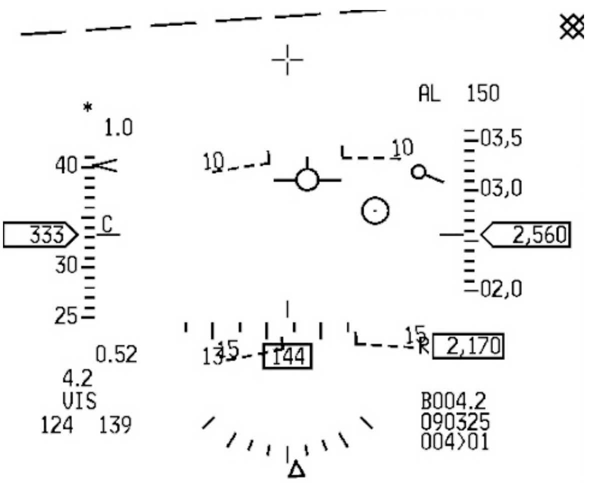
Manual markpoints can be created on landmarks within the HUD field of view by using the HUD Mark page. Whenever the Master Mode is set to AG or NAV and the FCR or TGP is not in use or sensor of interest and designated, depressing the ICP #7 button will default the markpoint mode to HUD.

The HUD will display a HUD mark cue (HMC) consisting of a small 12 milliradian pipper with a dot in the centre. There are 2 states for MARK HUD mode, pre-designate and post designate.
In pre-designate mode the pipper will be placed on the FPM.





The HUD is automatically made SOI and the pipper can be moved to any ground landmark within the HUD field of view. A first TMS up will ground stabilize the pipper which can then be moved into position. The coordinates in the Mark UFC page will remain blank as the markpoint is not saved yet. Pressing TMS down at this point will cancel ground stabilisation and return the HUD mark cue to pre-designate position.



A further press of TMS up will store the markpoint in the steerpoint bank. A small cross will be displayed on the HSD at the location of the markpoint. Depressing M-SEL on the newly made markpoint will select it as steerpoint of interest.

1.6 THE ENGINE

There is not much to be said about the F-16 engine in BMS.
There has been a mismatch between BMS coders the avionics systems have been coded according to the block 50 F-16 using the GE129 engine and the flight model has been coded using documentation available to them for the PW229.

The result is a hybrid BMS specific F-16 with a flight model from a PW229 engined F-16 engine and avionics consistent with the GE129 equipped F-16.

The BMS F-16 is powered by a single afterburning turbofan engine. The engine control system is composed of two major components: the Fuel Control (see Fuel chapter), and the Digital Electronic Engine Control (DEEC). The engine has two modes of operation: Primary (PRI) and Secondary (SEC)

1.6.1. Primary (PRI) and Secondary (SEC) engine control

PRI mode is the nominal mode of operation and the engine receives fuel input as a function of throttle inputs and the DEEC controls ignition, engine operation, AB operation and nozzle actuation.
SEC mode prevents AB operation and is used in the event of a DEEC failure or malfunction. SEC is manually selected by the ENG CONT switch on the JET START PANEL or automatically by the DEEC During SEC operation, the SEC caution light illuminates and the nozzle remains closed.

1.6.2. Exhaust nozzle

The exhaust nozzle is variable and controlled by the DEEC as a function of throttle input.
In PRI with the LG handle down, the nozzle is greater than 80% open at IDLE. As the throttle is advanced, the nozzle closes. With the LG handle up the nozzle is near minimum except near MIL power where the nozzle controls engine pressure according to fan speed.
When the throttle is advanced in AB range the nozzle is opened to compensate for increasing AB fuel flow.
In SEC the nozzle is closed to 0% and AB operation is inhibited.

1.6.3. Engine Oil System

Lubrication of the engine is done with a self-contained oil system totally irrelevant to BMS as it is not implemented.

1.6.4. Engine Anti-Ice system.

No component of this system is currently implemented in BMS 4.32.
The Anti ice switch and the INLET ICING caution light are eye candy.

1.6.5. Jet Fuel Starter (JFS).

The JFS is a gas turbine which operates on aircraft fuel. The JFS receives fuel at all times regardless of the FUEL MASTER switch position. The JFS is started from two accumulators used either singly (START 1) or together (START 2). In BMS we only have the option to use them both at the same time (START 2 option).
If you do not succeed starting the engine after JFS discharge you will not be able to start your engine for this mission.
In the future START 1 will be coded to allow at least a second attempt using the accumulators singly
Besides starting the engine on the ground without any external aid the JFS is used to assist in engine air start. In flight the accumulators are charged automatically by hydraulic system B in about 60 seconds.

1.6.6. Engine Warning & Caution lights

. The engine fault caution light indicates a PFL (Pilot Fault List) item listed. The caution light will go off when the fault is acknowledged.
. The SEC caution light illuminates when the engine is operating in SEC (Secondary) mode of operation.
. The EEC and BUC caution lights are deactivated (may come on during tests) but bear no real significance.
. The HYD/OIL PRESS warning light (right eyebrow) is used to monitor the engine oil and hydraulic system pressure. For engine oil pressure, the light comes ON when the pressure has been below 10 psi for 30 seconds (this delay minimizes false warning due to manoeuvring). The light goes off when pressure exceeds 2 PSI.
For hydraulic pressure, the light goes ON when either A or B system decreases past 1000 PSI.
At ramp start the light usually goes off before reaching idle RPM but it is within acceptable limits if the light goes off before exceeding 70% RPM.
. The engine warning light illuminates when RPM and FTIT indicate an engine over temperature or a flameout has occurred. It could also light in the case of RPM and/or FTIT indicator failure. The warning light illuminates when the RPM decreases below 55% or approximately 2 seconds after FTIT exceeds 1100°C.

1.6.7. Engine instruments

The RPM indicator expresses RPM in percent and is powered by the battery bus.
The NOZ POS indicator gives the position of the exhaust nozzle in percent (0%=closed – 100%=open) This indicator is powered by the emergency bus.
The FTIT indicator displays average FTIT temperature in degree Celsius from 200 to 1200°C. It is powered by the battery bus.
The fuel flow indicator displays the total fuel flow to the engine, including AB. This indicator has a range of 0 to 80.000 pph. It is powered by the emergency buses.
The Oil pressure indicator displays oil pressure from 0 to 100 Psi and is also powered by the emergency buses.

1.6.8. Throttle

The engine is controlled by the throttle with detents at OFF, IDLE and MIL and AB.
The OFF (cutoff) position terminates engine ignition and fuel flow.
The IDLE position commands minimum thrust (which may be enough to move a lightly loaded jet).
From IDLE to MIL the throttle controls the output of the engine.
Past MIL the throttle modulates the use of the afterburner.

Normally the real jet does not need to depress an idle detent to be started or shut down.
In cutoff the throttle is lifted vertically and advancing and lowering the handle to the idle point suffice to start the engine, once the JFS has increased the RPM to 20%. The idle detent was invented in Falcon to overcome the lack of cutoff position on the falcon and most hardware throttles.
To shut down the engine the handle is simply brought over the idle detent and lifted vertically, shutting down the ignition and starving the engine of fuel.

1.6.9. Ground operations

Ground idle provides the lowest level of idle thrust. Be aware that it may be just enough to move a lightly loaded jet so be sure to use the chocks (ask tower to put them on the wheels and to remove them (ATC tower menu) or parking brakes.
Under chocks you can increase RPM up to 80-85% but chock jumping is a real possibility so beware while performing your ramp checklists. Always back up the chocks with toe brakes when performing checks needing higher power settings (EPU, SEC, etc)
Parking brakes are usually automatically deactivated around 83-85% RPM as well. (The real value is when the throttle foes further than one inch past the idle point, but that is not easily quantifiable in the simulator).
Do not exceed 80% RPM for taxiing. A small increase of RPM is usually enough to start rolling and then the RPM can be decreased to maintain a constant speed on the ground. Beware not to speed up past 25 knots and 15-10 knots in turns. You can see your ground speed in the INS UFC page (LIST - #6)

1.7 FUEL SYSTEM

DISCLAIMER: This chapter refers only to the single seat F-16 Block 50 / Block 52 in BMS. Block 52+ with their conformal fuel tanks and F16D two seat variants of the block 50 & 52 are not documented in this manual. The reason is that the fuel system in BMS is not coded for those variants, although we can fly them.
The Fuel gauge & FUEL QTY knob do not take the CFT into account and the F16D has a different fuselage tank capacity and thus creates fake fuel imbalance problems on the Fuel QTY gauge.

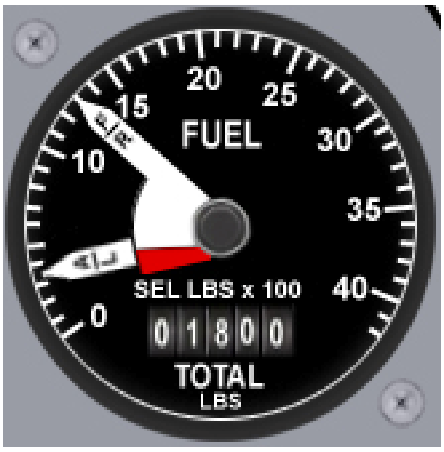
The F-16 block 50 and block 52 in BMS are able to carry 7162 lbs of JP5/8 fuel internally.

The amount of fuel carried externally differs from one variant to another.
Wing tanks can be 370 gallon or 600 gallon but the latter are hardly used. We will work on the assumption that the normal external fuel load consists of two 370 gallon wing tanks (capacity 2516 lbs each) and one 300 gallon centreline tank (capacity 2040 lbs)
In this scenario the maximum load of external fuel is 7072 lbs.
The maximum fuel load is thus 7162 + 7072 = 14134 lbs.

The internal fuel system is made of 6 tanks:
Left wing tank with a capacity of 550 ± 100 lbs.
Aft fuselage tank + Aft reservoir fuselage tank with a capacity of 2810 ± 100 lbs.
Forward fuselage tank 1 & Forward fuselage tank 2 (making a unique forward fuselage tank in BMS) + Forward reservoir fuselage tank with a capacity of 3250 ± 100 lbs.
Right wing tank with a capacity of 550 ± 100 lbs.

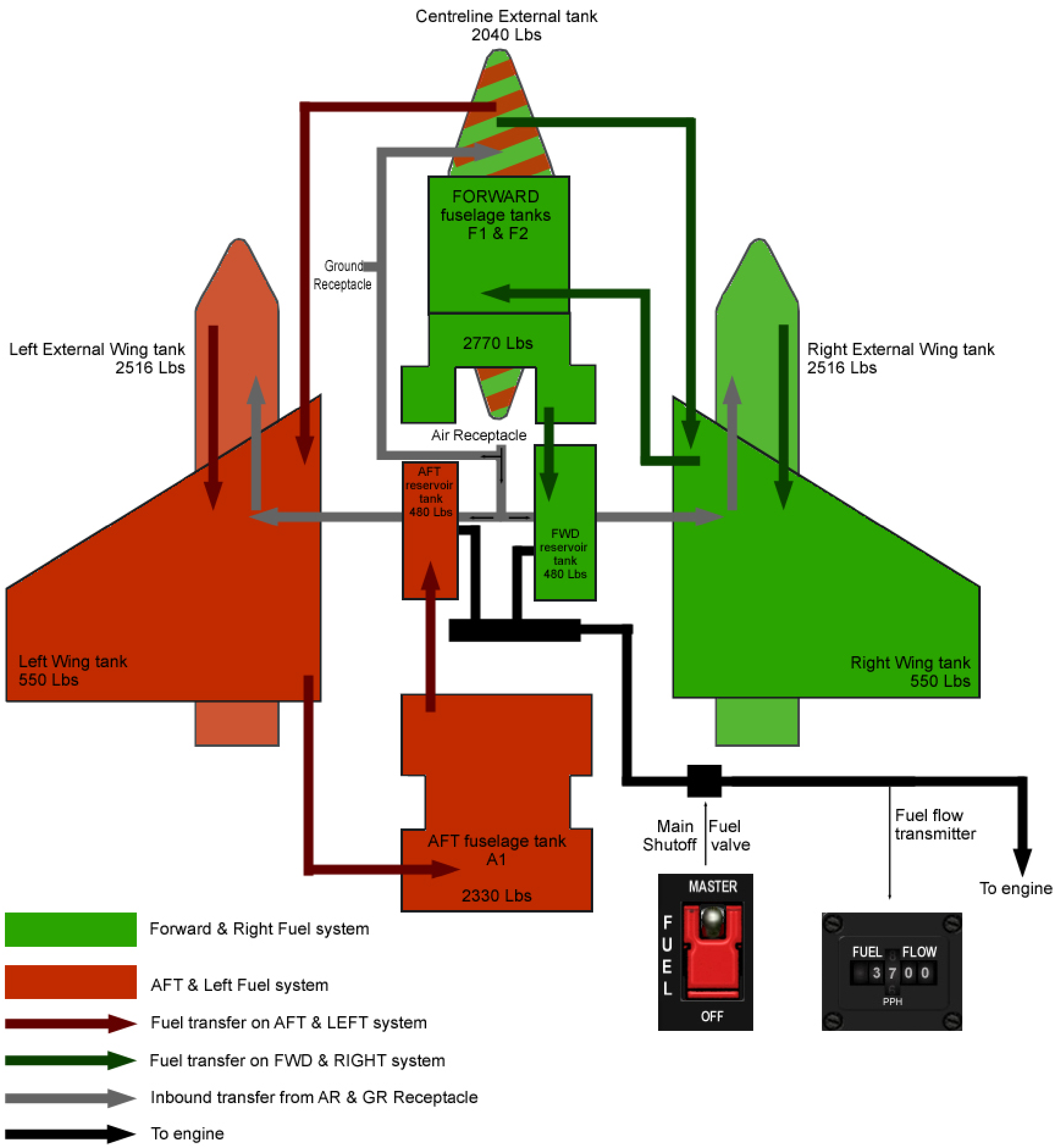
The total fuel system is divided in two parts:

- AFT & LEFT tanks (A/L) in red in the following image
- FORWARD & RIGHT tanks (F/R) In green on the following image



That is why you find two different needles on the fuel quantity gauge on the right aux console. One for the A/L fuel system, the second for the F/R fuel system.
We will cover this gauge at a later stage.

Please note, the centreline external tank is part of both systems as it transfers into both F/R and A/L systems.

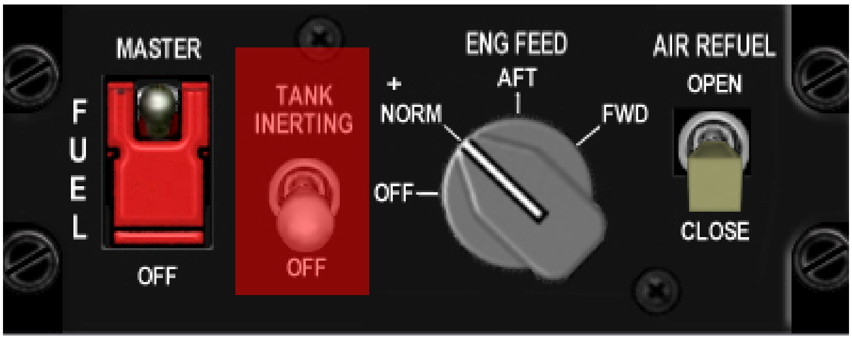

Centreline External tank
2040 Lbs
FORWARD
fuselage tanks
F1 & F2
2770 Lbs
Ground
Receptacle
Left External Wing tank
2516 Lbs
Right External Wing tank
2516 Lbs
Air Receptacle
AFT
reservoir
tank
480 Lbs
FWD
reservoir
tank
480 Lbs
Left Wing tank
550 Lbs
Right Wing tank
550 Lbs
AFT fuselage tank
A1
2330 Lbs
Main
Shutoff
Fuel
valve
MASTER
FUEL
OFF
Fuel flow
transmitter
FUEL FLOW
3700
PPH
To engine
Forward & Right Fuel system
AFT & Left Fuel system
Fuel transfer on AFT & LEFT system
Fuel transfer on FWD & RIGHT system
Inbound transfer from AR & GR Receptacle
To engine

The normal path of a drop of fuel in either the A/L or F/R system would be:
From the external tank to the wing tank to the fuselage tank to the reservoir fuselage tank to the engine.
This path is illustrated on the image above by the dark red or dark green arrows.
So the external wing tank(s) always empty first into the relevant internal wing tank.
The wing tank transfers to the relevant fuselage tank: Right wing goes to Forward fuselage and Left wing goes to Aft fuselage tank).
And each fuselage tank transfers to its relevant reservoir tank before being fed to the engine.
The only exception to that as noted above is the centreline external tank that feeds both wing tanks at the same time.

The normal path of a drop of fuel at filling (on the ground for Hotpit refuel – or in the air during A/A refuel) would be:
From the receptacle to the centreline tank (if carried) to the wing tank and to the external wing tanks if carried. This path is illustrated on the image above by grey arrows.

1.7.1. Fuel SHUTOFF valve.

The fuel shutoff valve illustrated on the image above allows the engine to be starved of fuel. That valve is driven by the MASTER FUEL switch located on the FUEL panel on the left side console.



The switch has two positions MASTER and OFF and is guarded in the MASTER position. In some air forces it is even securely wired and cannot be moved by the pilot unless in an emergency.
In BMS that switch is in MASTER at all times as well, especially at ramp start. You should never shut down the engine by shutting off the fuel valve. You would only shut it off in case of emergency to prevent a fire when crash landing for instance.

1.7.2. Fuel pumps

The primary transfer system for fuel through tanks and to the engine is by gravity and siphoning but it is also backed up by pumps as gravity wouldn't dry a tank fully and wouldn't work correctly in negative G situations. Fuel pumps therefore operate at the same time and independently of gravity feed.

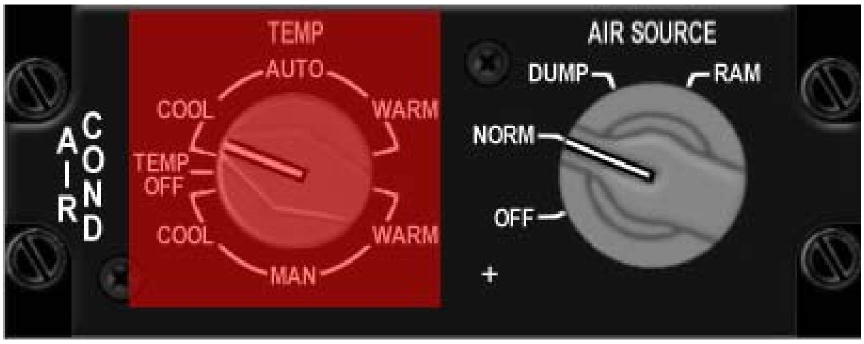
Fuel is pumped from both reservoir fuselage tanks to the Fuel Flow Proportioner (FFP) which adjusts flow rates from both the F/R and A/L systems to maintain the balance of fuel and hence the CG position. The FFP is driven by the A hydraulic system.
It is thus possible to have fuel imbalance problems occurring even when pumps are operating if there is a failure on hydraulic BUS A which drives the FFP.

The fuel pumps from the fuel tanks to the FFP are operated through the ENG FEED knob located on the FUEL PANEL on the left console. It operates as follows:

- When the knob is placed in OFF none of the pumps are working and fuel transfer occurs only via gravity and siphoning action. In case of heavy manoeuvring or negative G the engine may flame out.
- The NORM position activates pumps for both systems (F/R & A/L) and maintains CG position automatically.
- When the knob is placed in AFT only the AFT pump works and pumps fuel from the AFT reservoir tank to the engine. The CG moves forward
- When the knob is placed in FWD only the FWD pump works and pumps fuel from the FWD reservoir tank to the engine. The CG moves aft.

1.7.3. Fuel pressurisation

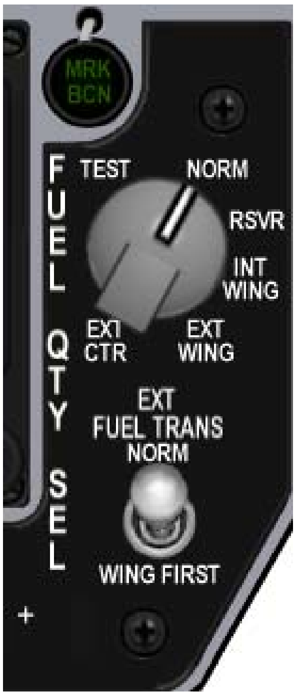
Fuel pressurisation is only partially implemented in BMS.
For fuel to transfer from the external tanks they have to be pressurized. That is done with the AIRSOURCE knob on the AIR COND panel on the right console:



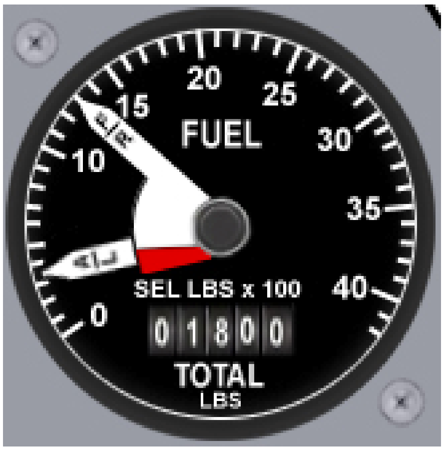
This knob controls the ECS system and thus pressurisation of the cockpit and the fuel tanks. Fuel tanks are pressurized only in NORM and DUMP position. In NORM both the cockpit and fuel tanks are pressurized, in DUMP only the fuel tanks are pressurized
This is implemented and failure to pressurize the fuel tanks with the AIR SOURCE knob may trigger TRP FUEL conditions.

On the other hand, when air refuelling the fuel goes from the AR receptacle to the wing tanks and to external tanks if carried. Normally to allow the fuel to transfer into the external tanks the pressurisation would need to be decreased.
This would normally be done with the TANK INERTING switch located on the fuel panel in the left console. Unfortunately that function is not implemented in BMS and as a consequence AA and hotpit refuelling does not require tank inerting when external tanks are carried.
That being said, some depressurisation is simulated in the current code when opening the AR door. This prevents fuel from flowing from the external wing tank to the internal wing tank when the AR door is opened.

1.7.4. Fuel quantity indicating system.



The main fuel quantity gauge is located on the right AUX console and indicates many different things depending on the position of the FUEL QTY SEL knob placed on the centre pedestal (right of the HSI).



1. Total usable fuel remaining onboard is given on the bottom of the gauge in pounds of fuel (numerical value) (except in TEST)
2. The F/R needle points to the amount of fuel in pounds remaining in the forward/right fuel system according to the FUEL QTY SEL knob position.
3. The A/L needle points to the amount of fuel in pounds remaining in the aft/left fuel system according to the FUEL QTY SEL knob position.

Here is a table explaining the interaction between the two instruments:

Fuel QTY SEL	Fuel Totalizer (lbs)	A/L needle (in hundredths of pounds)	F/R needle (in hundredths of pounds)
TEST	6000	20	20
NORM	**Total lbs Fuel onboard**	**Total Lbs fuel AFT FUSELAGE (max=28)**	**Total lbs fuel FWD FUSELAGE (max=32)**
RSVR	Total lbs Fuel onboard	Total lbs fuel AFT RSVR (max=4.8)	Total lbs fuel FWD RSVR (max=4.8)
INT WING	Total lbs Fuel onboard	Total lbs fuel LEFT internal wing (max =5.5)	Total lbs fuel RIGHT internal wing (max =5.5)
EXT WING	Total lbs Fuel onboard	Total lbs fuel LEFT external wing (max =25 for 370Gal)	Total lbs fuel RIGHT external wing (max =25 for 370Gal)
EXT CTR	Total lbs Fuel onboard	0	Total lbs Fuel external tank (max 2.0)

It is very important to know that the NORM position is the ONLY position ensuring automatic fuel transfer, trapped fuel warning and Bingo fuel computation based on fuselage fuel.
As a consequence if that knob is any other position than NORM, you may NOT get accurate BINGO or TRP FUEL warnings.

1.7.5. External fuel Transfer switch

The two positions switch located under the fuel quantity selection knob is used to invert the way the external tanks feed into the internal wing tanks. Obviously it is used only when both external wing and centreline tanks are carried.
Normally the centreline tank empties first into both the internal wing tanks. It is therefore the first tank that is emptied. This is what happens when the switch is in NORM position.
But in some cases the mission may dictate that the wing tanks are emptied first so they can be jettisoned (think CATI). In this case, the switch would be placed to the WING FIRST position so the external wing tanks empty first into the internal wing tanks and can be jettisoned. The centreline tank would then start to empty into the internal wing tanks.

1.7.6. Fuel checks

Keeping a close eye on your fuel system is paramount to mission success. Flight Leads will often request fuel state or an ops check to ensure that no one in their flight runs out of fuel or has an imbalance problem. But you are the pilot and your fuel is your responsibility so don't wait for your Flight Lead to check it for you. Check it as often as possible and not only the fuel gauge, but also the fuel remaining at different steerpoints on your route particularly at home plate.

There are three types of check your lead can request from you:

1. Fuel state
2. Ops check
3. FOS (Fuel Onboard at Station)

Fuel state is simply the total fuel remaining on board. You find that one on the fuel quantity gauge, at the bottom of the instrument on the digital readout.

- Mamba flight, fuel state when able Lead is 9.6
- 2 is 9.4

Ops checks are much more complete.
First the call has to be acknowledged:

- Mamba flight, Ops check
- 2
- One is 28-32 10.4 feeding
- Two is 28-32 10.2 feeding

The format is:
Call sign (Number in the flight), A/L needle value, F/R needle value, Total Fuel, FEEDING if external tanks are carried and feeding the internal wing tanks and DRY if the external tanks are empty.
Once dry has been said once it does not have to be repeated.

An imbalance condition is illustrated on the fuel quantity gauge when the red portion of the needles is visible. So each pilot can check it visually at a glance. Lead on the other hand has to ensure that the difference between the A/L and the F/R needle values do not exceed 600 Pounds each way.

The FOS check is a request to check fuel reaching a specific waypoint (usually home) and it is answered by giving the fuel state in the CRUS HOME page, ensuring that the correct steerpoint is selected.

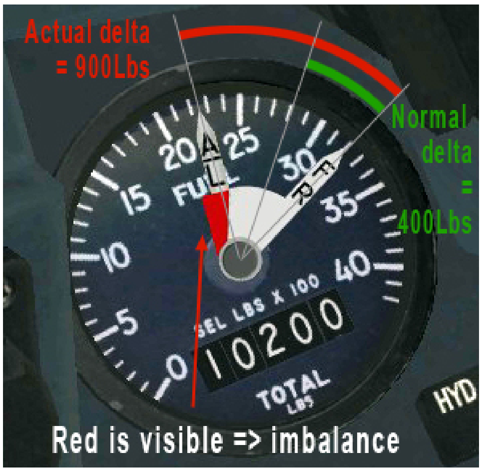
1.7.7. Fuel imbalance

As you know, aircraft behaviour in the air greatly depends on the position of the centre of gravity.
And obviously the centre of gravity moves according to the way the aircraft is loaded. In this way fuel load and fuel transfer will greatly impact the centre of gravity position.
The CG moves along two axes depending on the load and must remain within limits for the aircraft to remain controllable.
In the same way asymmetric weapon loadouts induce the heavy wings to drop, a fuel heavy wing will drop as well.
But fuel transfer can also induce a forward or aft shift of the CG if there is only one of the two fuselage tanks that is feeding the engine. In that case the fuselage fuel load does not decrease evenly in the forward and the aft of the aircraft and the CG will move accordingly.
This CG longitudinal shift is much more subtle than left & right shift because it often goes unnoticed and may induce quicker departure at higher AOA, especially dangerous for aerobatics, approach and landing.

We can therefore define two types of imbalance and luckily the least dangerous one will probably happen before the more dangerous one, which will help you to correct it before it becomes serious.

Since the left and right side empty first into the fuselage any kind of imbalance happening soon after takeoff will probably induce a shift of the CG to the left or to the right, inducing a roll which can be neutralized with the aileron trim in the exact same way an asymmetrical loadout is compensated.
That roll will be noticed before the external wing tanks are empty and if you succeed in overcoming the temptation to check the possibility of joystick drift, you will probably realise something is wrong with your load. Since your weapons haven't been dropped yet you should think about a potential fuel imbalance problem.
Furthermore as said above, when one of the wing tanks starts to empty you might get a TRP fuel warning signalling you that some fuel is trapped in the other external tank.
That is your second clue. (If you need a third clue, you should consider playing PS3 games ☺)

The second type of imbalance will happen when the wing tanks are empty (both external and internal) and concerns only the internal fuselage tanks. If they empty into the FFP unevenly the difference in weight will induce a shift of the CG forward or backward.
That imbalance is much harder to detect by simply flying the aircraft and may induce serious problems in some envelopes of the flight model: the aircraft becomes more prone to departure of controlled flight under certain AOA.
The only way to detect such a condition early is to check the needles on the fuel quantity gauges as often as possible. As long as you don't see the red portion of the needles there is no fuel imbalance problem. The red portion of the needles becomes visible when the difference between the two needles is more than 600 lbs.



Remember you may not feel this kind of imbalance before it is too late.
That is why Ops checks are so important.

Aft CG saves fuel – but forward CG makes the aircraft more responsive to pilot input.
When staying within the established %Mac CG loading of course.

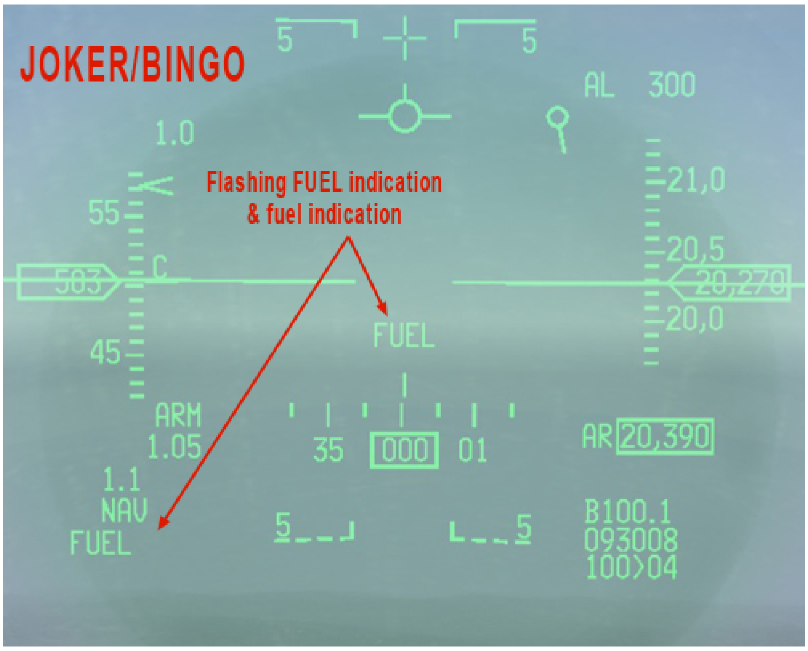
1.7.8. Analysis of the caution lights & HUD messages relevant to the fuel system:

Beside the needles and the fuel totaliser there aren't many caution lights for the fuel system.

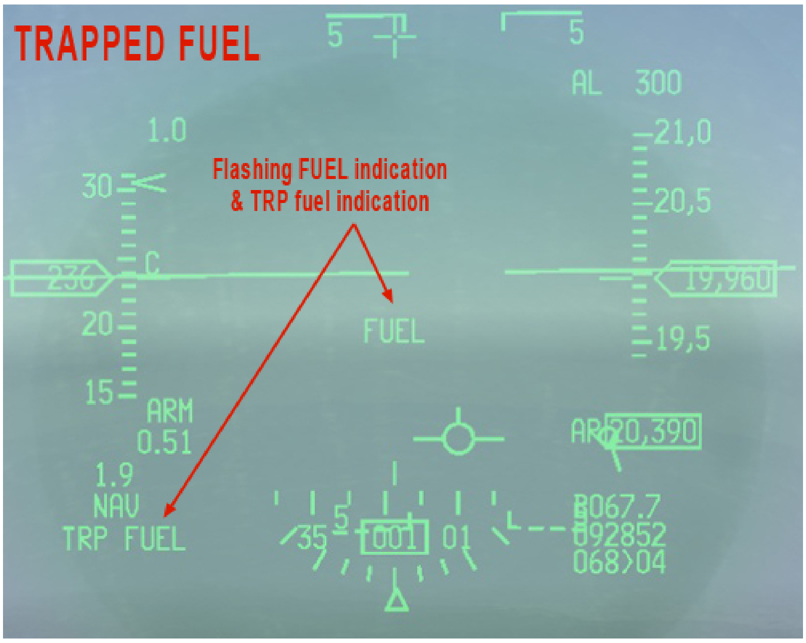
The two main ones are located on the caution panel and come ON when the level of fuel in the fuselage reservoir tanks reach 400 lbs for the FWD reservoir and 250 lbs for the AFT reservoir.

Obviously the FWD caution light is relevant to the F/R fuel system (Forward fuselage reservoir) and the AFT caution light is relevant to the A/L fuel system and more specifically to the AFT fuselage reservoir. The MASTER CAUTION light will come ON as well. Those lights are powered by the emergency DC bus n°1 and are independent from the fuel totaliser.
Usually when these two come ON you're in trouble because you only have a few seconds of engine power left and you should land right away.
You've also busted the minimum fuel needed on board when landing which is 800 lbs

Fuel management calls for setting a Joker and a Bingo setting in the UFC. This in turn will make Betty call Bingo - Bingo when that fuel state is reached (if the FUEL QTY SEL knob is in NORM)
A flashing FUEL indication will also be displayed in the HUD. That warning message can be reset with the HUD WARN RESET switch on the ICP.



Another HUD message relevant to the fuel system is the TRP FUEL, meaning a condition of TRAPPED FUEL has occurred. Again it can be reset with the WARN RESET switch (TRP FUEL will remain displayed on the left of the HUD) but it is much better to solve the problem at its source.



Trapped fuel condition may happen in abnormal situations such as:

- **Imbalance situation.** For instance if the A/L system feeds the engine alone (ENG FEED to AFT) and the aircraft carries two external wing tanks; the left wing tank will empty in the left internal wing tank but the right external wing tank will remain full. When the left external wing tank is empty and the left internal wing tank starts to empty into the aft fuselage tank a trapped fuel message will be displayed on the HUD notifying the pilot that some fuel is trapped in external tanks. In this case in the right external wing tank.
  You will get a TRP FUEL warning when fuel remains in the external tanks and the amount of fuel in any internal tank is decreasing.
- **AR door open for too long.** When the AR door is opened the external tanks depressurise a bit to allow the fuel coming from the AR door to actually be transferred to the external tanks (if carried) In this case, the external tanks are not transferring fuel to the internal tanks anymore, because of the drop in pressure.
  If the external tanks are kept depressurised for too long it may be possible that the fuel left inside cannot reach the internal wing tank. In that case a TRP FUEL condition may develop.
- **AIR SOURCE to OFF or RAM**. The same is true if the AIR SOURCE knob is placed in any other position than NORM or DUMP. Both these positions besides activating the ECS, pressurise the fuel tanks. If they are not pressurised, the fuel may not transfer correctly. That being said, if you leave the AIR SOURCE knob set incorrectly the problems induced on the ECS system will happen much quicker than the fuel pressurisation problems. So chances are that you will notice quickly and fix the problem before fuel pressurisation problems happen.

Five conditions must be met for a TRP FUEL warning to occur:

- FUEL QTY SEL knob is in NORM.
- Aerial refuelling has not occurred within the previous 30 - 90 seconds
- Fuselage fuel has been at least 500 pounds less than fuselage capacity for 30 seconds.
- Total fuel has been at least 500 pounds greater than fuselage fuel for 30 seconds.
- Fuel flow has been less than 18,000 pph for 30 seconds

A TRP FUEL warning may also occur with prolonged AB use if fuel flow to the engine exceeds the maximum transfer rate from the external tanks. This is not really a true TRP fuel and will clear as soon as AB is disengaged or when the fuel transfer rate decreases back within the maximum possible transfer rate of the external tanks.

1.7.9. Managing Fuel: Joker & Bingo

As Flight Lead, you may have to set a Joker/Bingo level for the whole flight. But first let's define BINGO and JOKER

BINGO FUEL is the amount of fuel that once reached automatically necessitates a turn towards home plate.
It accounts for the fuel needed to fly the return leg of the flight, the fuel required to fly the briefed approach, the fuel to go to alternate and the emergency fuel which is not supposed to be used except in an emergency. That emergency fuel is 1200 lbs for the F-16 block 40-52 and 800 lbs for earlier blocks.

JOKER fuel is usually set above BINGO as a warning that the bingo is approaching. We usually set it 1000 lbs above Bingo to allow 1 minute of combat time in AB. But that rule is not fixed in stone and may vary.

As you may understand by now the planned BINGO is dependant on many factors that need or may not need to be taken into consideration.
How is the weather? What are the chances to being rerouted to the alternate? What is the type of mission? Patrol at loiter speed or bombing or escort or SEAD tactics on multiple threats? What is the expected opposition on the return leg? The possibility to Air to Air intercepts? Do we fly low level or high level egress? Is there a tanker available?
All this makes BINGO computation quite mission specific but here is one way (amongst other) to compute Bingo conservatively.

1. Min FUEL on landing for F-16 Block 50/52: 1200 lbs (800 lbs for earlier blocks).
2a. If VMC (Visual Meteorological Conditions): 1 pattern = 400 lbs - so add 400 lbs just in case you screw up the overhead and need to go around.
2b. If IMC (Instrument Meteorological Conditions): 1 STAR = 800 lbs, so add 800 lbs just in case you have to go missed approach and re-do the STAR.
3. Compute fuel needed to go the alternate. If alternate is say 70Nm from home, multiply by 10 = 700 lbs to get there.
4. Final calculation is from the furthest steerpoint of the flight plan.
Take the return leg distance (along the route, not in a straight line) into consideration and multiply it by 15 to estimate fuel needed: (15 lbs/Nm for mid altitude - use x20 if low altitude egress)
So if the furthest point is 200 Nm away from home plate calculate 200x15=3000 lbs

So BINGO is the sum of all that:
1200+400+700+3000= 5300 for VMC
1200+800+700+3000= 5700 for IMC.

Joker is 1000 more: 6300 and 6700.

As you can see BINGO is tied to a steerpoint. If you did not reach your computed Joker or Bingo level for that steerpoint and started your egress there is no real reason to call your fuel state over the radio. But the situation remains dynamic and if something happens on the return leg you may have to recompute a bingo. Doing this is easy just select the CRUS page and HOME subpage and check your fuel state at home plate at any moment in your flight. Make sure that fuel is above minimum fuel (emergency + approach + alternate = 1200 + 400(or 800) + 700 = 2300 (or 2700)) and as soon as the fuel remaining over home is equal to this value you're BINGO. Add 1000 and you're Joker.

BINGO and JOKER are entered at the same spot in the UFC:
LIST – 2(BINGO) page.
Obviously you first enter JOKER and when you reach that you reset the numbers to BINGO.

When reaching the fuel state inputted in the UFC the pilot will receive visual (HUD) and audio (BETTY) warnings.

Bingo fuel warning is based either on fuselage fuel with the FUEL QTY SEL knob in NORM or on total fuel with the FUEL QTY SEL knob out of NORM.
With the FUEL QTY SEL knob in NORM the bingo computation is based on the lesser of fuselage fuel weight or total fuel weight.
In other words with the FUEL QTY SEL knob in NORM bingo fuel warning will be triggered as soon as either fuselage fuel or total fuel decreases below the bingo fuel value. With the FUEL QTY SEL knob out of NORM, the warning will only be triggered when total fuel decreases below the bingo value.
With trapped external fuel this could lead to fuel starvation before the bingo warning is triggered.

It is thus very important that the FUEL QTY SEL knob is placed in NORM

1.8 ENVIRONMENTAL CONTROL SYSTEM (ECS)

The ECS provides air-conditioning and pressurisation driven by engine bleed air.
Not much from these two systems are currently implemented in BMS.
In BMS the air-conditioning system provides cooling of the avionics (the fresh air for the virtual pilot is not needed here) and the pressurisation system provides canopy seal, pseudo cockpit pressurisation, fuel tank pressurisation and simulated OBOGS (pressure breathing).

All of those functions are lost when the AIR source knob is placed in OFF position.
Please refer to the cockpit arrangement section in this manual for an overview of the air source knob.
In BMS, we basically use two positions: OFF (both air-conditioning and pressurisation systems shut off) and NORM (both system working automatically).

The Temp knob is used basically for cockpit air-conditioning and is not implemented. The same is true of the defog lever (outside the left console towards the rear of the cockpit) and obviously the Anti-G system.

1.8.1. ECS Caution/Warning lights

Two caution lights are relevant to the ECS: the EQUIP HOT and the CABIN PRESS lights. The Equip Hot comes ON when the cooling of the avionic systems is insufficient, which happens very quickly if you forget to put the air source in NORM. The Cabin press light comes ON when the cockpit pressure altitude is above 27000 feet.
There is also a warning light relevant to the ECS, the canopy warning light on the right eyebrow. It comes ON when the canopy is not locked tight.

1.9 ELECTRICAL SYSTEM

The real electrical system in the F-16 is extremely complicated with multiple AC and DC buses. BMS has simplified things while maintaining correct behaviour for ramp starts, flight and shutdown but without the possible malfunctions. Work on the electrical system is still in progress so hopefully; this will get simpler in the future. But for now the BMS electrical system might be even harder to understand than the real one.

The biggest difference is that BMS does not differentiate AC and DC power. The next difference is that BMS does not model the actual physical routing for the bus wiring. For instance the real F-16 has multiple essential & non-essential buses scattered in different locations, BMS only has one of each electrical bus. Finally the real FLCS has a four branch power supply (ABDC) but BMS considers them a single unit.

So basically what we have in BMS is a set of generators (MAIN GEN, STBY GEN, EPU GEN) that are linked to engine output and hydrazine reserves. These feed models of the various electrical buses (battery, emergency, essential and non-essential buses)

The MAIN GEN supplies power to the non-essential, essential and emergency buses.
The STBY GEN supplies power to the essential and emergency buses and comes online whenever the MAIN GEN is not supplying power and as long as the MAIN PWR switch is in MAIN PWR.
The EPU GEN comes online when both the MAIN and STBY GEN fail, providing power to the emergency buses.

1.9.1 Electrical System Normal Operation:

Prior to engine start the MAIN PWR switch is placed to BATT to permit a check of the aircraft battery.
The ELEC SYS, MAIN GEN, STBY GEN, and FLCS RLY lights come on.
The FLCS RLY light illuminates because the FLCS relays are open and the FLCC is not connected to the aircraft battery.

The FLCS PMG light is not illuminated since it requires FLCS power.
The ACFT BATT TO FLCS light does not illuminate since the FLCS relays are open.
With the FLCS PWR TEST switch held in TEST the FLCS relays close but do not latch.
The FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FLCS RLY light goes off.
The FLCS PWR lights on the TEST switch panel illuminate, indicating that the power output of the FLCC is good. With the FLCS PWR TEST switch in NORM and the MAIN PWR switch positioned from BATT to MAIN PWR the lights do not change.

When the JFS switch is moved to either start position the FLCS PMG light (and ACFT BATT TO FLCS light if engine is started on battery power) illuminates and the FLCS RLY light goes off, indicating that the FLCS relays have closed.

During engine start the FLCS PMG light (and ACFT BATT TO FLCS light if engine is started on battery power) goes off at approximately 30% engine rpm.
The STBY GEN light goes off at approximately 60% engine rpm.
The MAIN GEN light goes off approximately 5-10 seconds later if both generators are operating normally.

Anytime after selecting MAIN PWR, including in flight, the FLCS PWR TEST switch may be held momentarily in TEST to check FLCC power output. During the EPU test the FLCS PWR lights come on to indicate that EPU PMG power is available to the FLCS.
During engine shutdown the ELEC SYS caution light and FLCS PMG, MAIN GEN, and STBY GEN lights come on as the engine spools down. The ACFT BATT TO FLCS light also illuminates.

1.9.2. Electrical caution/warning lights

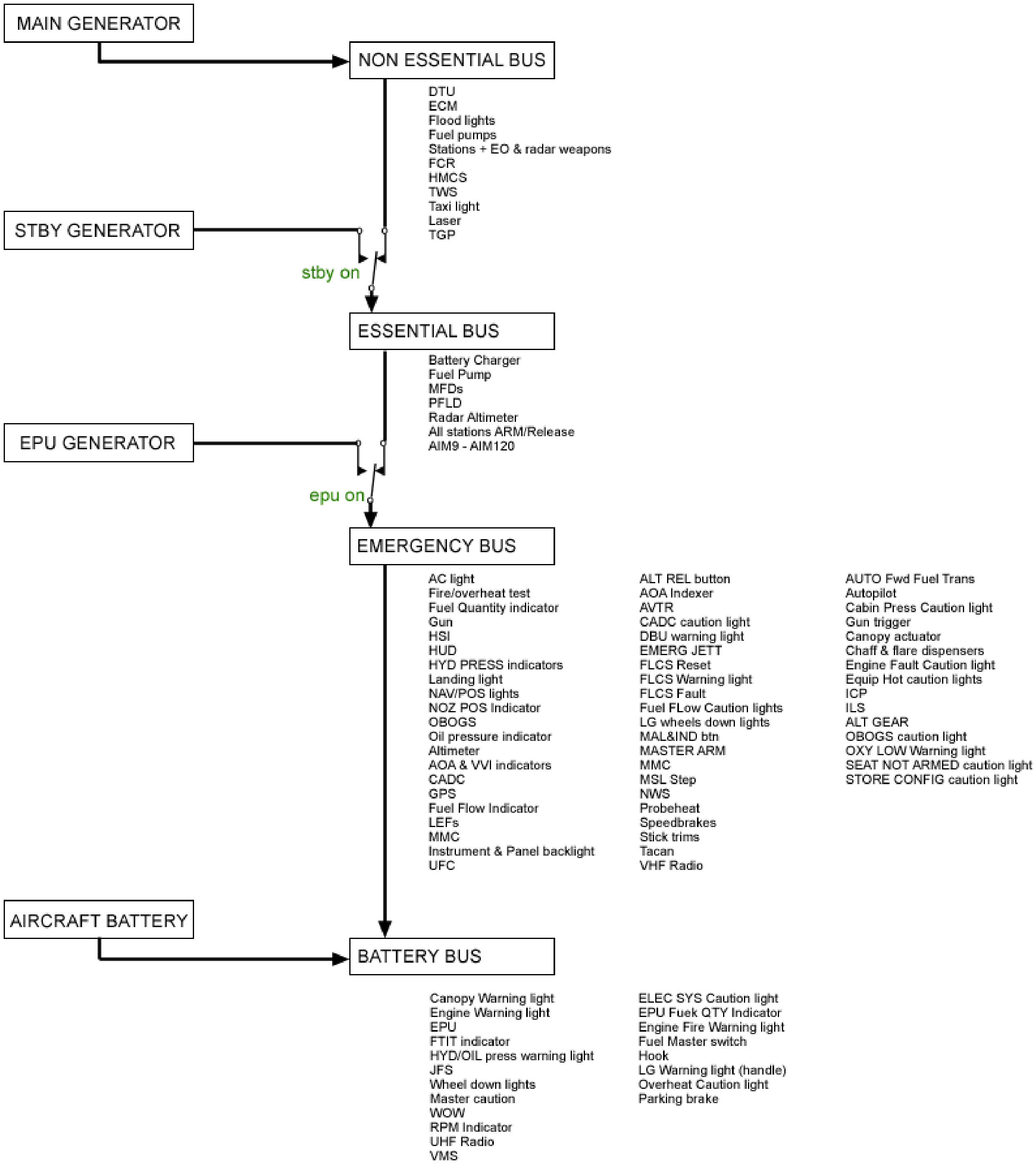
. FLCS PMG light: This light comes ON whenever there is no power applied to the FLCS PMG.
. MAIN GEN light: Comes ON when the MAIN generator is not online.
. STBY GEN light: Comes ON whenever the STBY generator is not online.
. EPU GEN light: Indicates that the EPU has been commanded to run but the EPU generator is not providing power to the emergency bus. (can't work when EPU switch is OFF).
. EPU PMG light: Indicates that the EPU has been commanded to run but the EPU PMG power is not providing power to the FLCS.
. ACFT BATT FAIL light: Indicates an aircraft battery failure or failure to charge.
. ACFT BATT To FLCS light: Indicates that the Battery is powering up the FLCS.
. ACFT BATT FLCS RLY: Indicates that the Battery is not connected to the FLCS.

. ELEC SYS caution light (CAUTION panel) Comes ON with any of the lights above.

. FLCS PWR light (TEST panel): ABDC – a single light in BMS, as the 4 FLCS branches are considered a unique branch: Illuminates to indicate proper power output of FLCC during FLCS power test.

The white pushbutton on the ELEC panel labelled CAUTION RESET is fully implemented in BMS and resets the ELEC SYS CAUTION light and clears MASTER CAUTION light for future indications. It also resets the MAIN and STBY generators.
Although in flight Electrical system failure hardly ever happens, the only way to properly use it is to really mess up the start up sequence.

BMS F-16C Block 50/52 Power Distribution



1.10 HYDRAULIC SYSTEM

The hydraulic pressure is supplied by two independent simultaneously working engine driven pumps A & B. Should one of the systems fail the remaining system provides sufficient hydraulic pressure. This hardly ever happens currently in BMS.
It is indeed much more common to see both systems A&B fail together in BMS. In that case a third hydraulic pump located on the EPU provides emergency hydraulic pressure for a limited time to system A.

HYD PRESS Indicators.
There are two hydraulic pressure indicators located on the right aux console. One for each system A & B. They are powered by the emergency bus. In flight, normal position of the needles should be at 12 o' clock. (approx 3100 PSI)

HYD/OIL PRESS Warning light.
Located on the right glareshield the HYD/OIL press light comes ON whenever system A or B pressure drops below 1000 PSI or when the engine OIL pressure drops below 10 PSI. The light is powered by the battery bus.

1.11 EMERGENCY POWER UNIT (EPU)

The EPU is a self contained system whose purpose is to provide emergency electrical and hydraulic pressure. The EPU automatically activates (if the EPU switch is in NORM) whenever both MAIN & STBY GEN drop offline and/or when both hydraulic system pressure drop below 1000 psi.
The EPU can also be operated manually by placing the EPU switch to ON.
When the EPU is operating power is supplied to the emergency bus (the non-essential and essential buses are unpowered). The hydraulic system A is also supplemented by EPU hydraulic pressure.

The EPU uses engine bleed air to operate if engine RPM is sufficient. When bleed air becomes insufficient EPU uses hydrazine to operate. Hydrazine is a highly toxic gas and is contained in a specific tank allowing around 10 minutes of EPU operation.

EPU lights
. EPU RUN light located on the EPU panel, comes ON whenever the EPU is running.
. HYDRAZN light, comes ON whenever the EPU uses Hydrazine.
. AIR light, comes ON whenever the EPU is running on engine bleed air only. This light remains ON even when the EPU uses hydrazine.

EPU indicators
. The EPU Fuel Quantity Indicator located on the right aux console is graduated from 0 to 100% and indicates the hydrazine remaining in the tank. When the hydrazine is depleted and the engine bleed air is not sufficient to maintain EPU operation the aircraft receives no power or hydraulic pressure and can't be salvaged. The only option is ejection. When the EPU is activated plan to land as soon as practicable, especially if engine bleed air is not sufficient to run the EPU. Remember once you start using hydrazine you have about ten minutes left of power and hydraulic pressure left.
Unfortunately when the EPU is fired up in BMS it is highly unlikely that the engine would still be operating and thus the EPU will not be able to run on engine bleed air only.

1.12 FLIGHT CONTROL SYSTEM (FLCS)

The FLCS is a digital fly-by-wire system which controls the flight surfaces hydraulically. The main component of the FLCS is the Flight Control Computer (FLCC) that translates electrical signals generated at the flight controls to hydraulic pressure moving all primary and secondary flight controls, taking into account other sources of data such as AOA, air data probes, INS, etc
Pitch motion is provided by symmetrical movement of the horizontal tails, Roll is controlled by differential movement of the flaperons and horizontal tails and Yaw is controlled by the rudder.
The FLCS provides roll coordination automatically through the ARI system (Aileron Rudder Interconnect) which is not activated with WOW and until a few seconds after gear retraction.

The FLCS is meticulously coded in BMS as it is one of the main components of the BMS advanced flight model. It is a combination of three modules:

- Pitch FLCS
- Roll FLCS
- Yaw FLCS

FLCS limiters are provided in all three axes to help prevent departure/spins.

The FLCS has three operational modes that are called GAINS:

- Standby gains
- Takeoff & Landing gains
- Cruise gains (normal operating mode)

The normal mode of operation is cruise gains. The takeoff and landing gains is activated whenever the following conditions are met:

1. Landing Gear handle in Down position.
2. ALT FLAPS switch in extend position and airspeed less than 400 knots.
3. Air refuel door switch is open and airspeed less than 400 knots.

The standby gains are coded in BMS but are relatively transparent to the user. They kick in automatically when the FLCC detects a FLCS failure indicated by the FLCS FAULT caution light.

1.12.1 CRUISE GAINS

1.12.1.1 Pitch FLCS

The purpose of the Pitch FLCS is to limit the requested G to control the natural pitch instability of the F-16. It is important to understand that when the pilot applies pressure on the sidestick in the pitch axis he commands a number of G. The FLCS translates that to flight control surface motion to deliver the intended G number, taking into account other flight parameters such as AOA.

At low AOA (below 15°) the maximum positive G is 9G, but as AOA increases maximum G decreases. The limit depends also on the STORES CONFIG switch. Two settings are possible: CATI and CAT III. CAT I is the least limiting position and intended for a clean configuration (centreline and AA weapons can be carried). CAT III is the most limiting position to avoid stressing the airframe when carrying loads on the wing stations (fuel tanks, AG bombs, etc)
In CAT I the pilot can request from -3G to +9G. The AOA remains a factor in the maximum possible G. At 20° AOA it will reach 7.3G and at 25°AOA the max G reachable is 1G (level flight)
In CAT III the AOA is limited from a certain angle to prevent higher G being reached. This AOA limit is around 15.5 – 15.8° AOA. That means that in CAT III below 15° AOA, the airframe might be able to pull 9G but as soon as the AOA reaches 15° the CAT III limits additional AOA increase therefore limiting the number of available G.
The CAT config does not limit G, it limits AOA which as a consequence limits maximum G available.

1.12.1.2. Roll FLCS

The main purpose of the Roll FLCS is to prevent roll coupled departures by limiting the roll rate.
Four parameters contribute to a roll coupled departure:
. AOA (the higher it is, the more critical)
. Elevator position (the higher, the more critical)
. Dynamic pressure (the lower the more critical – dynamic pressure is lower at high altitude.)
. Rudder position commanded by the Yaw FLCS module

As a consequence pilots should be very aware of roll coupled departure when performing low speed barrel rolls at high altitude, which assault two limiters at the same time (roll and pitch).

The CAT switch also plays a part in Roll FLCS by limiting the roll rate. In CATIII the aircraft is more prone to roll coupled departure due to higher gross weight and position of the centre of gravity. The maximum commanded roll rate is thus further reduced by 40% of the maximum commanded roll rate in CAT I.

1.12.1.3. Yaw FLCS

Since the rudder is mostly controlled in flight by the FLCS through the ARI (Aileron Rudder Interconnect) the pilot should in theory never use the rudder in flight. To prevent pilot induced rudder movement which can create adverse effects the FLCS automatically limits its use.
Rudder authority is reduced as a function of AOA, roll rate and CAT config to prevent departure from controlled flight.
In CAT I the maximum deflection starts to be limited around 14° AOA and reaches zero deflection possible at 26° AOA.
In CAT III the maximum deflection starts to be limited at 3° AOA and reaches zero deflection at 15° AOA.

The ARI provides automatic coordinated turns by moving the rudder along with the ailerons to compensate for aileron induced yaw effect.
Nevertheless in a crosswind take-off/landing situation the pilot may need to put the rudder and ailerons in the same direction to compensate for winds. To allow this the ARI is inactive when the main gear speed is greater than 60 knots or if AOA exceeds 35°.
When the gear is retracted the wheels slow down and thus the ARI becomes active again (usually 2 seconds after landing gear up). If the gear is kept down the ARI may take longer to become active again, unless the pilot brakes the wheels with the gears.

1.12.2. TAKEOFF & LANDING gains

The FLCS automatically switches to Takeoff & Landing gains whenever the following conditions are met:

- Landing Gear in the down position or
- ALT FLAPS switch in EXTEND and below 400 knots or
- Air Refuel door open and below 400 knots.

1.12.2.1 Pitch FLCS

The pitch FLCS operates as a pitch rate command until 10° AOA. It means that the pilot commands a pitch rate and not a G value as in Cruise gains. As a consequence when no pressure is applied the FLCS maintains a 0° pitch rate, the nose will stay steady and the FPM will move up and down according to the AOA.
Above 10° AOA the FLCS commands pitch in a blended mode of pitch rate and AOA command. This was created to give more feedback to the pilot for landing – indeed constant back pressure will be required for the nose to keep its attitude, giving classic feedback for non fly-by-wire aircraft during landing.

1.12.2.2. Roll FLCS

The roll rate is limited to half the value of the Cruise gains. It is totally independent of AOA, airspeed and horizontal tail position.

1.12.3. STANDBY gains

The FLCS Standby gains is a backup mode that automatically kicks in whenever a FLCS fault is detected (i.e. whenever the FLCS warning light and FLCS FAULT caution light are illuminated). Control response is then tailored for a fixed speed and altitude (around 600 knots for gear up and 230 knots for gear down). If the FLCS Fault can be reset with the FLCS reset switch the FLCC will revert to its previous gains, clearing the Standby gains. This is indicated by the warning light going off.

Action of FLCS limiters in three FLCS axis (Cruise and LG gains)

	PITCH AXIS	ROLL AXIS	YAW AXIS
CAT I	Maximum AOA=25° g command system until 15° AOA g/AOA command system above 15° AOA	Maximum roll rate command decreases with: • AOA above 15° • Airspeed less than 250 knots • Horizontal tail deflection more than 5° trailing edge down • Total rudder command (from pilot and FLCS) exceeding 20° • Combination of horizontal tail greater than 15° trailing edge down and AOA above 22°	Maximum deflection (pedal command) reduced for: • AOA>14° (zero roll rate) • Roll rate>20°/sec **NOTE:** Zero rudder authority available at 26° AOA
CAT III	Maximum AOA=16°-18° (depending on GW) g command system until 7° AOA at 100 knots to 15° AOA at 420 knots and above g/AOA command system above these values	Maximum roll rate command reduced by approximately 40 percent of CAT I authority. Additional decreases as function of AOA, airspeed, horizontal tail position, and total rudder command	Maximum deflection (pedal command) reduced for: • AOA>3° (zero roll rate) • Roll rate>20°/sec **NOTE:** Zero rudder authority available at 15° AOA
NOTES	1. In takeoff/landing gains, the FLCS operates as a pitch rate command system until 10° AOA and a pitch rate/AOA command system above 10° AOA 2. +9g available until 15° AOA. Maximum g decreases as a function of AOA and airspeed	1. In takeoff/landing gains, maximum roll rate is fixed at approximately one-half the maximum roll rate available in cruise gains, regardless of AOA, airspeed, or horizontal tail deflection 2. Above 35° AOA, the yaw rate limiter cuts out stick roll commands and provides roll axis antispin control inputs	1. Above 35° AOA, the yaw rate limiter provides yaw axis antispin control inputs 2. Below -5° AOA and less than 170 knots, the yaw rate limiter provides antispin rudder inputs; pilot roll and rudder commands are cut out only when MPO is engaged 3. Maximum deflection (30°) always available thru ARI and stability augmentation

1.12.4. Gun compensation:

The FLCS automatically compensates for the off centre gun firing and the gun gas emissions during gun firing by moving the rudder and flaperons. Gun compensation is optimised for the 0.7 – 0.9 Mach range. Firing outside of that speed range may create adverse effects. Furthermore if the FLCS is damaged, firing the gun may be totally impossible because of the lack of compensation.

1.12.5. Leading Edge Flaps (LEF) and Trailing Edge Flaps (TEF)

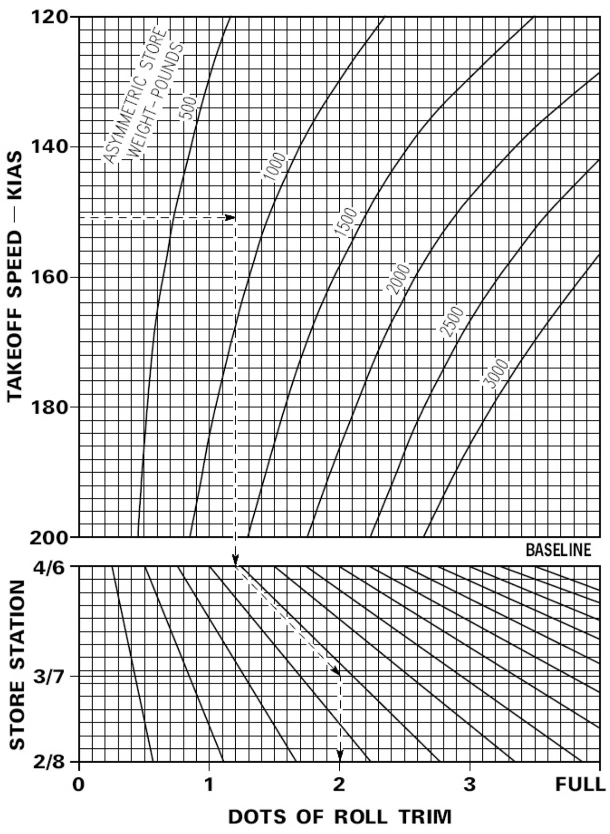
BMS also models the impact of the LEF and TEF motion behaviour. Normally these flight controls are totally commanded by the FLCS but can be locked in place through the FLCP (FLCS Panel) switches or by malfunctions/ damage.
LEF are controlled by the FLCS as a function of MACH and AOA.
TEF are controlled by the FLCS as a function of Landing Gear handle position, ALT FLAPS switch and airspeed.

1.12.6. Digital Backup (DBU).

The DBU provides a software backup in the event of FLCS problems. It automatically engages when the FLCC detects a majority of FLCS branches in a failed state. The DBU operation does not significantly impact the normal cruise operation or landing and as such is not coded in BMS. The DBU light and DBU switch on the FLCP are eye candy but will nevertheless disengage autopilot if engaged.

1.12.7. Asymmetrical loading

The FLCS does not provide automatic roll trim function to compensate for asymmetric loading of the wings (fuel or weapons) As a consequence the pilot will need to constantly adjust the roll trim of the F-16 when loaded asymmetrically or when the Fuel is draining unevenly from the wing fuel tanks.
This should normally be done prior to take off (if the conditions exists) or in-flight after weapon release (if the condition exists).



1.12.8. FLCS BIT

The FLCS can be tested at ramp start by using the FLCS BIT switch, although it has no real significance in BMS. In real-life it is a magnetic spring-loaded 2 position switch. When engaging the FLCS BIT a green RUN light comes ON and the FLCS goes through a full series of tests lasting approximately 45 seconds. During the tests the flight controls will move and this movement will be visible over the multiplayer network.
The test can fail and failure is indicated by the illumination of the FAIL light on the FLCS panel. FLCS warning light and WARN HUD messages will also be displayed. A failed test can only be reset by rerunning the test again until successful completion.
A successful test is indicated by the green RUN light going off and the FLCS BIT switch snapping back to the OFF position. We do not have the MFD FLCS bit page implemented, so we can’t track the FLCS bit on the MFDs currently.

1.12.9. FLCS warning/caution lights

There are many caution and warning lights about the FLCS scattered on the TEST, FLCS, warning panel, ELEC panel etc.

.The FLCS warning light located on the right glareshield illuminates to indicate a failure of the FLCS. It also comes ON to indicate if the LEF are locked or a failed FLCS BIT.
. The DBU warning light comes ON whenever the FLCC engages the digital backup software to replace the FLCS primary system. In BMS it comes ON only when the DBU switch of the FLCP is switched to ON. (eye candy)
.The FLCS Fault caution light illuminates when a FLCS PFL fault is listed. It goes OFF whenever the PFL fault is acknowledged or if the caution condition has been reset.
. The STORE CONFIG caution light comes ON whenever the CAT switch is placed opposed to what the FLCS detects for CAT loading. The light resets whenever the switch and the FLCS are synchronised again.

1.13 LANDING GEAR & BRAKES

The Landing Gear is operated by hydraulic system B and consists of two main gears (MLG) and a nose wheel (NLG). When hydraulic system B is inoperative the gear can be lowered once pneumatically with the alternate gear handle located outboard of the left auxiliary console. Once depleted the pneumatic pressure can not be restored but the reset button allows retracting the gear after an alternate extension if system B hydraulic power becomes available again.

The main landing gear handle is the primary control to extend and retract the gear. A red warning light is located in the lollipop and comes ON whenever the gear and doors are in transit or when the landing gear has failed (open or closed). The lollipop warning light also comes ON when the TO/DLG CONFIG warning light comes ON (right eyebrow) The conditions are airspeed less than 190 knots, rate of descent greater than 250ft/min, altitude less than 10000feet and any gear leg is not down and locked. The gear operating limit speed is 305 knots. All gear legs must be retracted before reaching that speed to prevent gear damage or failure in flight.

On the ground the gear is locked in place mechanically and can not be retracted (unless using the DN LOCK REL button prior to raising the handle, but that is not implemented in BMS)
A switch is activated when there is weight on wheels (WOW) that activates or deactivates aircraft systems depending on if the aircraft is on the ground or in flight.

1.13.1. Nose Wheel Steering

The nose wheel can be steered on the ground when the NWS system is active. Nose wheel steering is powered by hydraulic system B and as such is not available after an alternate gear extension.
The NWS A/R MSL STEP button on the stick toggles NWS ON and OFF when there is WOW (Weight On Wheels). A green NWS light illuminates on the right indexer when the NWS is engaged. Nose wheel steering is automatically disengaged when the nose landing gear strut is extended but the NWS needs to be manually disengaged above 70 knots to avoid uncontrolled nose wheel rotation on the take off and landing roll. Failure of the NWS is indicated by the NWS FAIL caution light.

1.13.2. Wheel brakes

BMS features two types of wheel brakes for users with or without rudder equipped toe brakes.
Users without toe brakes (or using no rudder at all) have a wheel brake implemented by a keystroke that brake both main landing gear wheels at the same time.
Users using rudder with toe brakes can program differential brakes as axes in the UI controller setup. In this case each main landing gear wheel can brake separately allowing steering on the ground.
Brake hydraulic power is supplied by system B. There is no emergency brake implemented in BMS. In the real jet, the JFS accumulator is able to power the brakes in case of a dead stick landing. To overcome the issue BMS toebrakes remains active even when the aircraft runs on EPU.

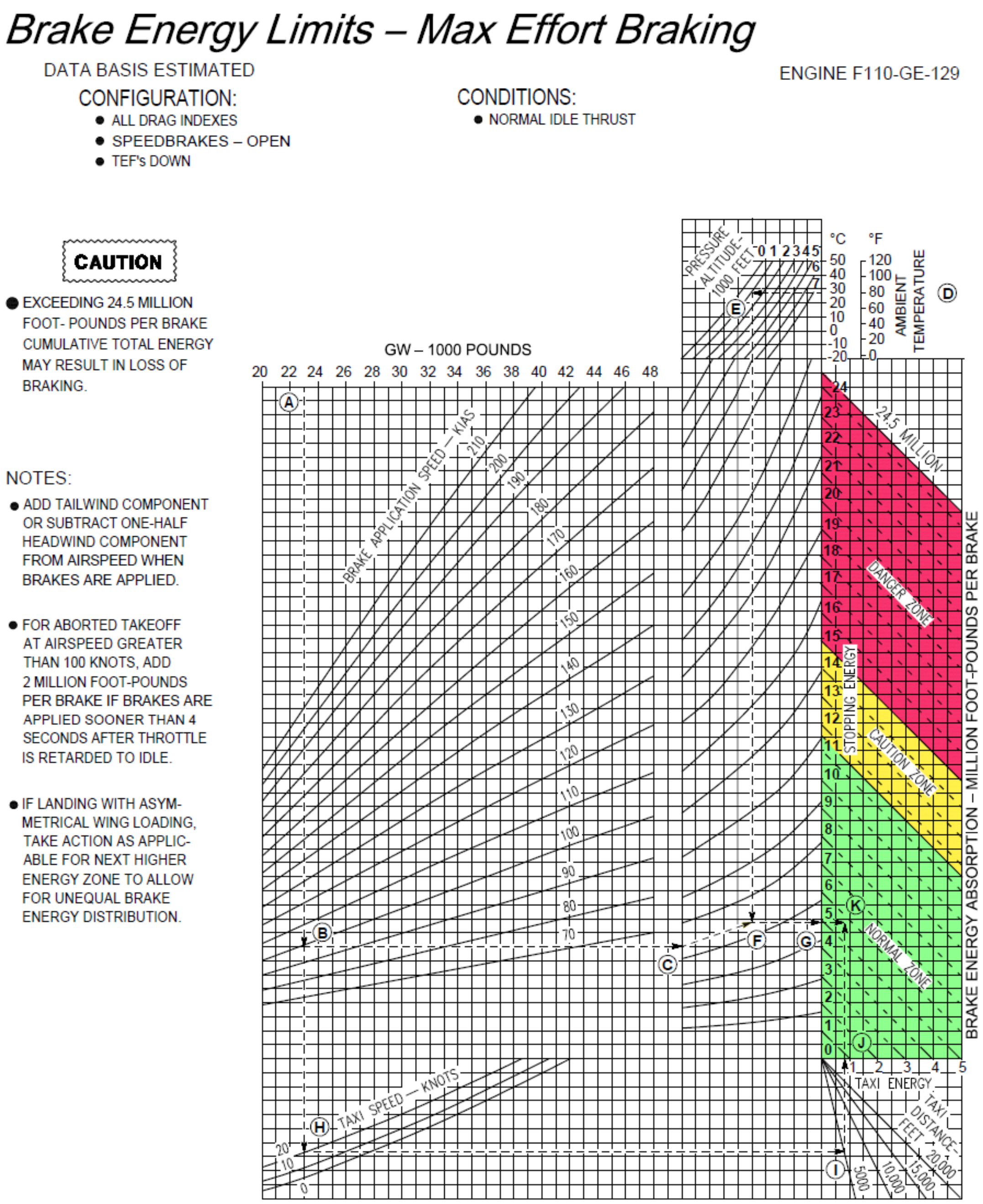
BMS features accurate brake energy limits based on gross weight, temperature, pressure altitude and speed. Brakes generate a great deal of heat when used and uncontrolled heat build-up can lead to brake melting, tyre blow outs, brake hydraulic pressure failure and even landing gear failure. As a consequence it is important in BMS to use the wheel brakes correctly.

Brake heat builds up not only on rejected takeoff and landing but also when taxiing. An F-16 with a low gross weight can start moving and even accelerating in idle power and brakes will be required to control taxi speed. Heavy use of the brakes when taxiing will increase brake heat energy build up.
A higher gross-weight F-16 will not move on idle power, thus requiring less braking to control taxi speed.
For comparison a 20000 lbs GW F-16 taxied at 10 knots over 20000 feet will develop around 4.3 million ft-lbs energy needing to be absorbed by the brakes. The yellow caution zone in the graph below starts at 11.5 million ft-lbs energy. If a rejected takeoff follows a heavy braking taxi, brake problems are likely to happen.

It takes about 5 to 9 minutes for the brake energy to build up after braking; that is when problems may occur. To avoid problems real life taxi procedures should be enforced:

- Maximum taxi speed: 25 knots & 10 knots in turns
- Do not ride the brakes, allow speed to increase to 25 knots and then slow down moderately to 15 knots allowing the speed to increase again to 25 knots.
- Taxi speed is displayed in LIST #6 INS UFC subpage.

The way the brakes are used during the landing roll greatly impacts the possibility of brake failure. It is best to hit the brakes hard for a shorter time than to brake early but longer as your speed will be higher and the brake will generate more heat energy doing so.
Use aerodynamic braking till the nose gear comes down and then use the brakes around 90-80 knots until you reach taxi speed or come to a full stop.
Do not start braking around 110-120 knots; the heat build up will be much higher.



Zone 1 : Green: Normal zone 0 - 11.5 million ft-lbs, nothing happens
Zone 2: Yellow: Caution zone 11.5 - 15 million ft-lbs, 30% chance of brake problems
Zone 3 : Red: Danger zone 15 - 24.5 million ft-lbs, 90% of problems
Zone 4 : Over 24.5 million lbs: Danger zone + immediate braking failure

1.13.3. Parking brake & Chocks

To overcome the correct behaviour of the AFM (Advanced Flight Model) of the BMS F-16, the virtual pilot will need to use the newly implemented chocks at ramp start and shut down and the parking brake if a full stop is required on the taxiway or at EOR (End Of Runway) checks for instance.

The parking brake is activated by the antiskid/parking brake switch on the gear panel. The anti-skid system is not implemented in BMS. The parking brake is a magnetic switch held automatically in position as long as the throttle is not pushed further than one inch past the idle point (in BMS, that translates to 83-85% RPM). Once the parking brake is not able to hold against the engine RPM the switch is released and the parking brake deactivated. The parking brake is powered by the battery bus and system B hydraulics.

The chocks are now ON by default at ramp start and they need to be removed prior to taxi. Normally this is done with the crew chief, but we don't have them in BMS, so the request is done through the ATC tower menu. Bear in mind that you need to have a correct tower frequency set on your radio. Likewise at shut down chocks can be requested to be placed through the same ATC tower menu. Although the chocks will prevent the aircraft moving during ramp start, it is possible to jump them if a high enough power (over 85%) setting is used. Be careful then during SEC and EPU checks which require higher power settings. Always back up the chocks with toe brakes. You can not backup these checks with the parking brake as it would be deactivated over such power settings.

1.13.4. Speed brake System

The speed brake system consists of two pairs of clamshell surfaces located on each side of the engine nozzle and inboard of the horizontal tail and is powered by hydraulic system A.
The speed brakes open to 60 degrees with the gear not down and locked. With the gear down and locked speed brake opening is limited to 43 degrees to prevent the lower surfaces from striking the runway during landing. This limit can be overridden by holding the SPD BRK switch in the open (aft) position. When the NLG strut compresses on landing the speed brakes can be fully opened and remain fully open without holding the SPD BRK switch.

The Speed brake switch
The SPD BRK switch, located on the throttle, is a thumb activated three position slide switch.
The open (aft) position is spring loaded to off (centre) and allows the speed brakes to be incrementally opened.
The closed (forward) position locks in place, allowing a single motion to close the speed brakes.

The speed brake position indicator
A three position indicator is located left of the LG control panel.
Positions are:

- CLOSED
- 9 dots symbol: The speed brakes are not closed (thus open but it is not possible to say how open they are)
- Diagonal lines: Electrical power is removed from the indicator.

1.14 AUTOPILOT OPERATION

The F-16 features an autopilot system interfaced through the two three positions switches located at the bottom of the MISC panel.
The left one labelled ROLL is a standard 3 position switch, the right one labelled PITCH is the master autopilot switch. It is a magnetic switch held in place in the up and down position. It snaps back to the centred position when the A/P is disengaged. The left switch is operative only when the right switch is placed out of OFF.

The autopilot provides the following modes:

- Roll Attitude hold
- Heading select (Roll switch)
- Steering select (Roll switch)
- Altitude hold (Pitch switch)
- Pitch Attitude hold

There are two more important switches relevant to the autopilot system. The TRIM A/P DISC switch on the MANUAL TRIM panel disengages the autopilot and the paddle switch (S4 on the Cougar) on the sidestick overrides the autopilot while depressed. More on this later.

1.14.1 Altitude Hold

Placing the right PITCH switch to ALT HOLD results in the aircraft maintaining a constant altitude. The reference altitude is the altitude the aircraft was at when the AP switch was engaged +/- 100 ft. (Vertical velocity above +2000 ft/min or below -2000 ft/min may prevent the correct altitude capture)
The FLCS limits the pitch command to 0.5 to 2.0G when PITCH ALT HOLD is engaged.
The AOA also plays an important role in altitude capture. It remains accurate only below 5° AOA.

Stick steering & Autopilot override
If the pilot moves the stick while the A/P is engaged the aircraft will respond to pilot input, although the stick will feel slower than usual. Upon releasing the stick the Autopilot will resume its previous settings. For example if you were flying 15000 feet with ALT HOLD engaged, and pulled the stick back climbing slowly to 20000 feet, when you released the stick the aircraft would descent back to 15000 feet.
If on the other hand you want the aircraft to remain at 20000 feet in this example, you would need to depress the paddle switch when leaving 15000 feet (overriding the AP setting), climb slowly to 20000 feet and then release the paddle switch. Upon releasing the paddle the A/P will take this new actual altitude as the reference.

1.14.2. Attitude Hold (Pitch)

Placing the right PITCH switch to ATT HOLD mode result in the aircraft maintaining the current pitch attitude. Angles above or below 60° in pitch will not be captured. As in altitude mode stick steering is available and the pitch could be changed with stick input but the autopilot will revert to its captured pitch angle upon releasing the stick.
If the stick paddle is held prior to stick input the A/P will capture a new pitch attitude to follow when the paddle is released.

1.14.3. Heading Select (Roll)

Placing the left ROLL switch to HDG SEL will turn the aircraft towards the heading selected in the HSI through the heading bug. The heading bug is visible on the picture as white captain's bars on the HSI compass rose. It is set to 360° in the picture. You can rotate the heading bug by using the HDG knob on the bottom left of the instrument. Two key callbacks are useable: increment by 1° or by 5° if you use the keyboard, joystick programming or even encoders. It can also be done with the mouse wheel for rapid increment (this mouse behaviour is valid for all cockpit knobs (encoders)).

In this mode the FLCS limits bank angle to 30°. Stick steering remains possible but the A/P will resume following the HSI heading bug as soon as the stick is released. The paddle switch has no effect in this mode as the paddle switch cannot change the HSI heading bug and this is the sole signal that is valid for Heading Select mode.

1.14.4. Attitude Hold (Roll)

Placing the left ROLL switch to ATT HOLD results in the aircraft maintaining the current roll attitude. Angles above or below 60° in roll will not be captured. Stick steering and paddle override remains available with the known restriction of each mode.

1.14.5. Steering Select (Roll)

Placing the left ROLL switch to STRG SEL will result in the aircraft flying to the steerpoint of interest. As in Heading Select mode, the bank angle will be limited to 30°. If AUTO steerpoint is selected in the UFC the A/P will steer to the next waypoint when reaching the vicinity of the current steerpoint (it follows the steerpoint of interest which in AUTO is automatically switched to the next waypoint). If MANUAL is set, the A/P will circle the steerpoint at a 30° bank angle. Stick steering remains useable but paddle override has no effect since the paddle is not able to change the steerpoint of interest.

1.14.6. Autopilot limits

In all modes the autopilot will refuse to engage or will automatically disengage if one of the following conditions become active:

- Gear is down
- AR door is open
- ALT Flaps switch is in EXTEND
- AOA greater than 15°
- DBU is engaged
- MPO switch is held in OVRD
- A/P failure or FLCS failure PFL message (thus STANDBY gains will be active as well)
- TRIM A/P DISC switch is placed in DISC
- Altitude higher than 40000 feet
- Speed above Mach 0.95
- Attitude is above 60° of level flight (pitch and roll)
- Stall Horn is active

The Autopilot has a final mode beside the ones set by the roll and pitch switches: the TFR.
See the MFD chapter for further information about the TFR.

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SECTION II

NORMAL PROCEDURES

2.1. RAMP START in 3 SWEEPS

Ramp start in BMS can be overwhelming at first when transitioning from another version of Falcon.
Of course you can follow the BMS checklists but you will soon realise that by doing it often you will be quickly developing your own routine to start the jet.
This chapter is presented to share such a routine with you.

BMS avionics are the most complete Falcon avionics around but a number of ramp start items are, at this stage, simple eye candy. Some users like to do them, yet these items are not mandatory for a fully mission capable jet.

For the sake of completeness this guide will include all of those optional steps. I will clearly identify them so they can be overlooked if you lack some time or do not wish to perform them.

Anyway, let's get back to work.
We separate the F-16 cockpit into three main sections: See Figure1 on the following page.

- Left console = Left AUX + left console
- Centre console
- Right console = RIGHT AUX + right console.

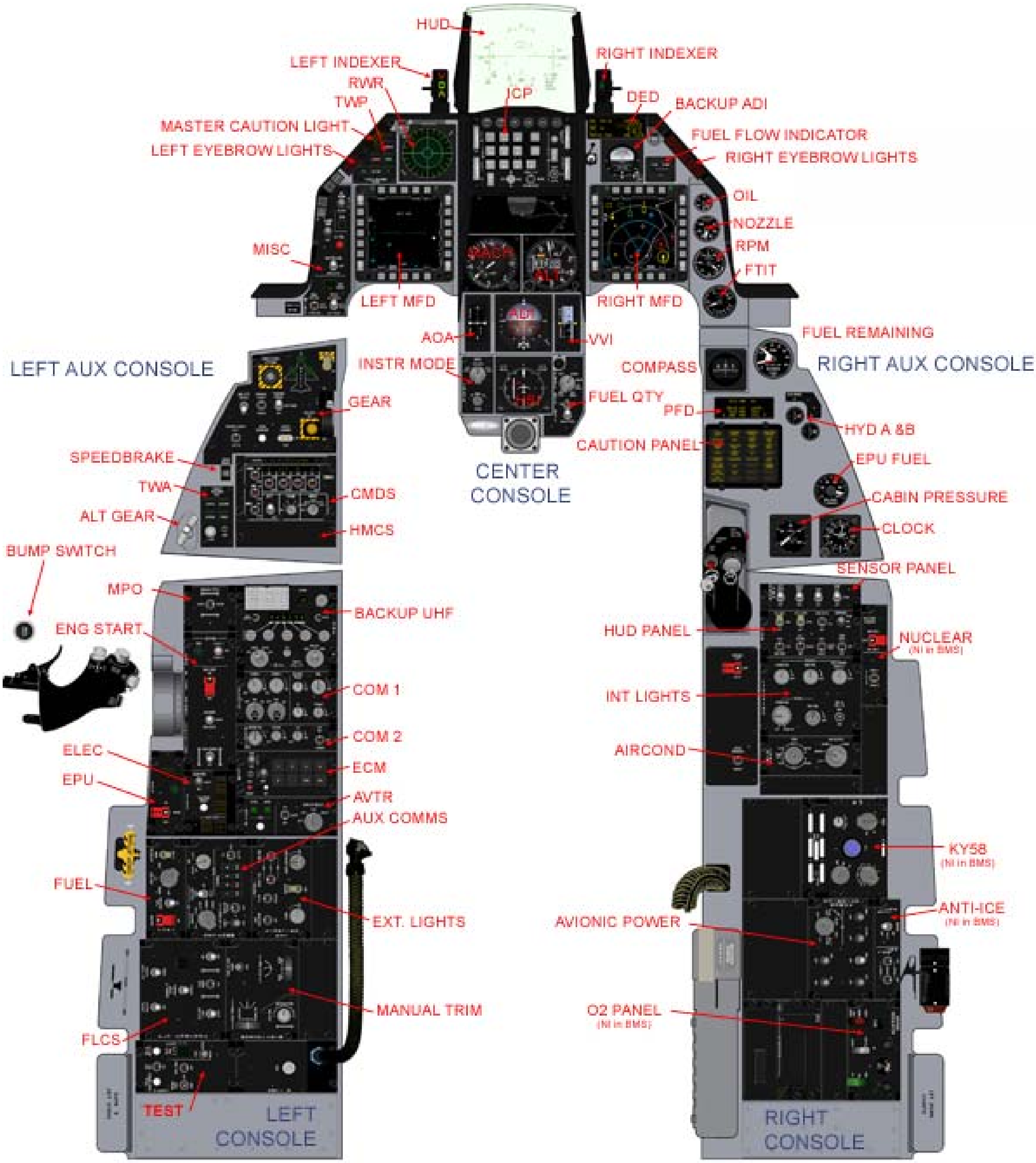
Mouse vs Keystrokes.
You can move cockpit switches with the relevant keystroke or the mouse. With keystrokes, you will have to find the corresponding key for each switch state; with the mouse you will have to use left or right-click to move switches up or down and rotate knobs clockwise or counter-clockwise.

Starting the jet is done by making three consecutive sweeps from left to right beginning at the back end of the left console, moving to the front panel and around to the back end of the right console.

When you enter the pit for a ramp start your jet is cold, the canopy is open and all switches are set and ready for start-up.

1st Sweep: Before starting the engine

We thus start the first sweep which I call the before starting engine sweep.
Looking towards the back of the left console, we start by setting the systems correctly so they begin working from the moment that power is received from the battery.



F-16 b50/52 cockpit layout and panels

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

2. Moving up we quickly check the AUX COMM panel to check that the CNI knob is in backup position. We move one step further up and check that the MASTER FUEL switch on the FUEL panel is positioned to MASTER and that the guard is down. These should be correctly preset at ramp. The ENG FEED knob, though, needs to be rotated to NORM. Failure to do so may induce fuel system malfunction later in the flight by lack of proper operation of the fuel pumps. As you see to the right, the TANK INERTING switch is not implemented in BMS.

3. Let's set the comms so we're quickly ready to use the radio after engine start. Moving forward to the AUDIO1 panel we rotate the COMM1 (UHF) volume knob out of OFF to fully-clockwise position and do the same for COMM2 (VHF). Note that the first step out of the full counter-clockwise position actually represents the ON/OFF switch. Bear in mind that for the backup UHF panel to work the COM1 volume on the AUDIO1 panel needs to be out of the OFF position.

The two mode knobs for COM1&2 should already be set to SQL and do not need to be moved for ramp start. They have no function anyway with the CNI switch in the backup position.
Set the MSL & THREAT volumes to fully clockwise. These two do not have ON/OFF switches at CCW position ***but are very often forgotten which may induce problems later on.***

4. Moving forward to the backup UHF panel the left function knob should be rotated from OFF to BOTH and the right mode knob set to preset or GRD depending on briefing. In PRESET the radio is tuned to the selected channel (#6 by default) and GRD sets the backup UHF to guard. Please note that the F-16 only has a backup radio for UHF and not for VHF. The backup UHF radio only works when the CNI switch is in the BACKUP position. As usual the controls under the transparent red layer are not implemented in BMS. It is strongly advised to set the backup radio correctly as briefed such that your lead or any member of the flight is able to communicate if needed. Indeed before switching to CNI the backup UHF radio is your only means of communication.

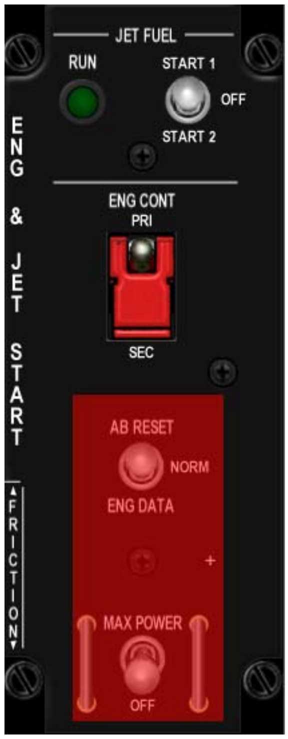
5. Since there is nothing to set on the front panel during this sweep we move straight to the right console. If you need internal lighting you can set up the LIGHTING panel accordingly.
PRIMARY INST PANEL (backlighting) and DATA ENTRY DISPLAY (DED&PFD) and FLOOD CONSOLES (all cockpit floodlights) can be rotated fully clockwise. The highlighted knobs are not implemented. Again, as the aircraft doesn't yet have power, the lights won't come on when you move the switch but rather as the relevant buses receive power.

6. The final item to check in this sweep is to make sure that the AIRSOURCE knob is out of the OFF position and set to NORM. Failure to do so will induce a EQUIP HOT caution light as soon as the systems are powered by the main generator because they will not be cooled correctly.

2nd Sweep: Starting engine & systems

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

1. On the ELEC panel move the MAIN PWR switch out of OFF to BATT (battery). The ELEC SYS (caution panel), MAIN GEN, STBY GEN, and FLCS RLY (ELEC panel) lights come on.
The aircraft battery needs to be tested. The FLCS PWR TEST switch on the TEST panel (rearmost panel on the left console) is moved from NORM to TEST and held.
While the TEST switch is held, the FLCS PMG and the ACFT BATT TO FLCS lights illuminate and the FLCS RLY light goes out. On the TEST panel the four FLCS PWR lights (ADBC) come on indicating a good power output to the FLCC. You can now release the FLCS PWR TEST switch. The lights reset to their initial state. This check is eye candy and is not mandatory.
The MAIN PWR switch can then be moved to MAIN PWR. The lights do not change. Please note one of the common mistakes is to start the jet in BATT which prevents the systems to come online later on as the main generator is not online.



2. Moving forward you can close the canopy (spider). It is advised to do so before engaging the JFS. Move on to the ENG&JET START panel. The JFS switch is moved to START2; the JFS RUN light comes ON and RPM increases steadily to 20%. At that point, you move the throttle forward (click the idle detent) and monitor lights and engine gauges:
. SEC caution light goes off around 20% RPM.
. FLCS PMG light (ELEC panel) goes off around 40-45% RPM
. The JFS shuts off around 55% RPM (the switch automatically snap back to the OFF position)
. ENGINE light (right eyebrow) & STBY GEN light (ELEC panel) go off around 60% RPM and the MAIN GEN light (ELEC panel) goes OFF around ten seconds later.
. HYD/OIL PRESS light (right eyebrow) goes off between 15 and 70% RPM

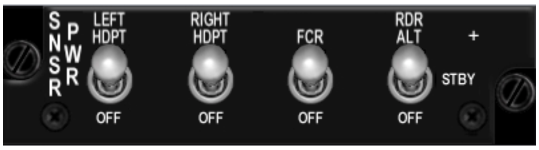
With the engine running steadily you can check the engine gauges such as fuel flow (700-1700 PPH), oil pressure (MIN 15 PSI), nozzle position (greater than 94%), FTIT (Below 650°C) and HYD A& B pressure at the 12o'clock position.

With the MAIN GEN online all systems should get proper current and the systems you previously set should be online (NAV lights for instance). You can now proceed to set the next ones.

3. Move straight to the AVIONICS POWER panel to quickly begin the INS alignment.
Power up the MMC, ST STA (SMS), MFD, UFC, GPS, DL switches. Then rotate the INS knob from OFF to ALIGN NORM.
Normally, this is done at a later stage but you will soon discover that your lead expects you to have a ready jet way before the real life 30+ minutes a ramp starts takes. This is the reason why you should try to start INS alignment as soon as possible after engine start.

At this point, I usually sweep back from right to left instead of starting again on the left side.

4. So I move forward to the SNSR panel and power the FCR and place the RDR ALT in STBY. Depending on the mission requirement you can also power the left and right hardpoints. Please note those are the chin hardpoints found on the left and right-hand side of the intake and usually carry the FLIR, the TGP and HTS pod. There is no need to power them if you have nothing loaded on those stations. Failure to do so however can prevent any pods from being powered in time as they may require a cool down before being operational.



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

6. Power the HUD through the ICP thumbwheel and reset the MASTER CAUTION light as well so you are aware of the next time it comes on. Try to reset the MC light as soon as you acknowledge a fault so you don't miss the next one, but never reset it without knowing why it came ON in the first place.

7. Move to the left console and rotate the CNI switch from BACKUP to UFC so you can start using the primary onboard systems. Your lead will soon initiate radio contact on pre-briefed frequency and you better be ready. With that done the Up Front Controller comes online and it is suggested that you set the radios through the UFC right away. But before doing so load up the data cartridge into the system. The DTC contains all the information that was set in mission planning. Normally, it's a tape the pilots carry with them and load into the DTC receptacle on the right console. In BMS we load the DTC by selecting the DTE page on the MFD and selecting the LOAD button, (OSB #3). The reason we do this before setting the radios is that since the DTC has a comms section, the presets might be different than the ones pre-briefed. If you load the DTC after setting the UFC radios you might not be on the good frequency anymore. That being said; smart pilots configure their DTC with the briefed frequencies to avoid the problem altogether. For more information about the data cartridge refer to the DTC section in the BMS manual. ***This item is very often forgotten by fresh BMS pilots and can induce problems later on in the flight.***
If you didn't set the comms plan in the DTC while in the UI push COM1 on the ICP and enter the pre briefed preset UHF frequency (usually the tower frequency). Push the COM2 button and enter the pre-briefed VHF frequency/preset. You are now ready for the initial radio contact.

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

3rd Sweep: The final sweep

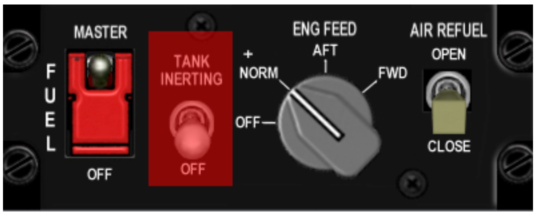
1. The TEST panel is the first to be used in this sweep. Depress and hold the FIRE & OHEAT DETECT button and monitor the lights:
. ENG FIRE warning light on.
. OVERHEAT caution light on.
. MASTER CAUTION light on.
All lights go off when the button is released.

Press and hold the MAL&IND LTS and check the correct operation of the Voice Message System (VMS) and that all lights are illuminated.
Flip the PROBE HEAT switch to the upper position and check that the MASTER CAUTION light remains off. Move the switch to the lower TEST position and check that PROBE HEAT flashes on the caution panel. Once you are satisfied that the system works as advertised you can place the switch to OFF again. We will come back later to test the EPU and the oxygen system.

The TEST panel is mostly eye candy and there is no consequence to your flight if the above checks are skipped.

2. Move one panel forward to test the FLCS. Before doing so; cycle and check the flight controls (stick and rudder) to assist in warming up the hydraulic fluid and removing air from the system.
Flip the FLCS BIT switch. It's a magnetic switch that stays in place for the duration of the bit test. The green RUN light comes on and the flight controls are tested in sequence; progress can be monitored by looking out of the cockpit at the flight controls. Members of your flight are also able to see your flight controls moving. At the end of the self-test the switch will revert back to its original position and the RUN light will go out. In some cases the test might fail and the amber FAIL light will then be illuminated. If that happens the only way to reset is to perform the BIT again.
The next check is the Digital Backup operation, simply toggle the DIGITAL BACKUP switch out of OFF and check that the DBU on the right eyebrow is illuminated. Move the flight controls and check them visually for correct operations. Once satisfied return the switch to the OFF position and check that the eyebrow light goes off.
Both the FLCS bit & DBU are eye candy in BMS and bear no consequence if you skip them.

3. Move down to the MANUAL TRIM panel. A good habit is to always check that all needles are centred, especially if you have a cockpit where knobs might not be so! Place the TRIM/AP DISC switch in DISC and ensure that stick trim actions do not induce flight control movement or needle deviation. Return the switch to NORM, apply stick trim to check needle deviation and re-centre.
Failure to set the trims properly may induce problems during or immediately after the take-off roll.
Those checks may appear like eye candy but as asymmetric drag is implemented in BMS, ensuring proper trim settings before takeoff is strongly advised!



4. If your mission calls for air-to-air refuel you need to test the AR system. On the FUEL panel; open the AR door by flipping the AIR REFUEL switch to OPEN and check the right indexer for a blue RDY light. Hit the stick DISC button and RDY is replaced by an amber DISC indication. After three seconds DISC goes out and the blue RDY light returns. Move the AR switch to CLOSE and the blue RDY light goes out.
Falcon rarely develops any fault into the AR system, so this check might be categorized as un-necessary.

5. Move to the EPU panel and cycle the EPU to OFF and back to NORM. With the mouse, make sure you use a left-click to move it from NORM to OFF; a right-click would engage the EPU which is generally avoided on the ground. The real reason is of no significance to us; it may hurt ground crews but we don't have them in Falcon.

Check first that both the EPU GEN and EPU PMG lights are OFF on the ELEC panel. Testing the EPU is made with the EPU/GEN switch on the TEST panel. Engine RPM needs to be around 80% and parking brake can't be engaged so make sure your aircraft is still on chocks and back them up with toe brakes. Place the Oxygen to 100% move the throttle to 80% RPM, toggle and hold the EPU/GEN switch on the test panel and check lights:
. EPU AIR light ON (EPU panel).
. EPU GEN and EPU PMG lights OFF (elect panel).
. FLCS PWR 4 lights ON (test panel).
. EPU RUN light (EPU panel) comes on after five seconds.

You can then release the test switch and return the throttle to IDLE and reset the O² lever to NORMAL.
If the green run light fails to come on reinitiate the test with a slightly higher throttle setting.
This check can be omitted as, with the EPU switch in the NORM position, the system will run automatically whenever needed.

6. Check the ECM panel and toggle the power switch to OPR. This is the only switch implemented on the ECM panel. While you are there check the AUDIO panels one last time for correct volumes on COMM1, COMM2 and INTERCOM. TACAN volume is not implemented and ILS volume is fully clockwise by default. No further action should be required as you set COMM1 and 2, THREAT and MSL tone volume knobs earlier.

7. SEC check is performed next to ensure that the engine can operate in secondary control mode. SEC mode might be entered automatically in case of an engine failure. The pilot thus needs to ensure that SEC mode works correctly. Parking brakes shouldn't be engaged and ensure that aircraft is on chocks and back them up with toe brakes. Lift the guard and move the ENG CONT switch to SEC. The MASTER CAUTION light and the SEC caution light come on. The engine nozzle closes and should indicate less than 5% on the NOZ POS indicator on the right instrument stack.
In SEC, RPM might be lower than in PRI mode. Check smooth RPM operations while in SEC and, when satisfied, return the ENG CONT switch in PRI and close the guard. The MASTER CAUTION and SEC lights should go out and the nozzle open up to more than 94%.
As you might have guessed by now; SEC check is not mandatory to have a ready-to-go jet.

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

9. The defence suite power-up starts at the TWA (Threat Warning AUX) located on the LEFT AUX console. Depress the lower right POWER button and the SYSTEM POWER green light illuminates.

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

The PRGM knob can be set to any program (preset through DTC) you like and you should rotate the MODE knob as desired or pre-briefed. Once all is set correctly (and you didn't forget to move the ECM switch to OPR) the GO status indicator should come on telling you that all systems are ready to be deployed.
You may also power up the HMCS at this stage but it's something I personally prefer doing at fence in.
A quick check of the system should be performed.

Moving up to the gear panel; quickly set CAT I or III according to your loadout (check the STORES CONFIG caution light) and confirm that all three gear lights are green.
Move up to the TWP (Threat Warning Prime) and depress the Handoff button so your RWR is set to diamond float mode. ***This item is very often overlooked and, if omitted, will prevent the RWR suite from appropriately warning you of threats!***

10. While you are busy on the centre panel you can set your MFDs and UFC according to your mission. Setting A-LOW, ILS, AA TACAN or ground TACAN, pre-briefed JOKER setting, Weapons settings, Check SMS, Set Selective Jettison, MODE SELECT Bullseye, VIP, VRP settings, etc

You don't have to do all this now but remember; the more you do on the ground the less you will have to do while maintaining formation with your flight in the air. Plan on being very busy once the wheels lift off the ground; make your job a little easier by performing a maximum of tasks on the ground.

11. Move down to the instruments and if you weren't previously notified by your lead, request the local altimeter setting and dial in the altimeter accordingly.
Note that, normally, only lead should request QNH to tower and make sure all flight members have received the information. This may come at any moment so be ready to write it down when it is given to you. Check the remaining instruments and ensure that no flags are visible. Red GS and LOC flags might be displayed on the ADI if the instrument mode knob is set to ILS/NAV or ILS/TCN. Place it in TCN mode. If your flight calls for an instrument departure it is a very good idea to set your HSI correctly (HDG and CRS) at this stage.

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

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

Never forget to return the knob back to NORM after checks because NORM this is the only position where you get proper operation of the automatic forward fuel transfer system, trapped fuel warning and for BINGO fuel warning computation based on fuselage fuel.
In other words you will not get TRAPPED FUEL or BINGO fuel warning if the knob is not in NORM!

13. Moving to the right AUX console; check the warning light panel and EPU fuel quantity which should be between 95 and 102%.

14. The final step in this sweep is to confirm that the INS is fully aligned by checking to see if ALIGN is flashing in the lower left corner of the HUD and, if so, toggle the INS knob from ALIGN NORM to NAV on the AVIONIC POWER panel.

You are now almost ready to taxi. Arm your seat and enable nose wheel steering; confirm NWS is illuminated on the right indexer. Apply toe brakes or set parking brakes and ask tower to remove the chocks.
You can now tell your lead you have a good jet and you are ready to taxi as per your own SOPs.

That’s it! The explanation may seem pretty long-winded but all steps can be covered in less than fifteen minutes in the cockpit. With a little experience you will develop your own routine and it will become second nature. Bear in mind that the procedure is quite flexible and you may develop your own routine as long as all required items are performed and that in the end you have a mission-ready jet.

Of course once lead initiates radio comms he might be busy communicating relevant information or requests considerably shortening your ramp start routine. Don’t stay idle waiting for the INS to align; perform as many items while you can because there are many other checks lead will call for from his flight such as IDM, alpha checks, etc.

2.2. REFUELLING

2.2.1 Hotpit refuelling

It is possible to request a hotpit refuel in BMS. Any airbase is able to provide this feature and all you need to do is get on the tower frequency, stop on the taxiway and request hotpit refuel via the ATC radio menus. Unfortunately, there is no specific hotpit area coded, so any area in any airbase will work.
To observe the fuel transfer enter the UFC LIST-2 page.

Although not necessary, the external fuel tanks should be depressurized to allow the fuel to transfer to them. This is normally done by opening the air refuel door on the ground and keeping it open for the duration of the refuelling process.
The main BMS checklist volume includes a section entitled HOTPIT REFUEL should you need it.

2.2.2 Air to Air refuelling (AAR)

For long mission, it is not uncommon to need air-to-air refuelling. This service is provided in BMS by KC-10 and KC-135 aircraft.

Where is he?
First, you need to find the tanker. The easiest way is to use the DTC lines on the HSD is the mission was correctly planned and the TE designer placed a box around the tanker track.

Secondly you can use the air-to-air TACAN. BMS uses three different TACAN systems:

- Ground beacon: provides bearing and range to a ground station
- Airtac beacon: provides only range to an airborne station.
- Mitac beacon: provides bearing and range to an airborne station.

The Ground TACAN is self-explanatory. Airtac is used by fighters and the KC-135, and the Mitac is only used by the KC-10. As a consequence only the KC-10 will provide bearing information. All other airborne stations will provide distance only and the bearing pointer on the HSI will spin around the instrument indicating lack of bearing information.

In addition, the AA FCR comes handy to detect the tanker at long range and practise of the bracket intercept is always welcome for rejoin.

Distance matters
Before refuelling you will need to establish radio contact with the tanker to ask for fuel. Depending on your distance from the tanker when you make the initial contact the answer will be two fold:

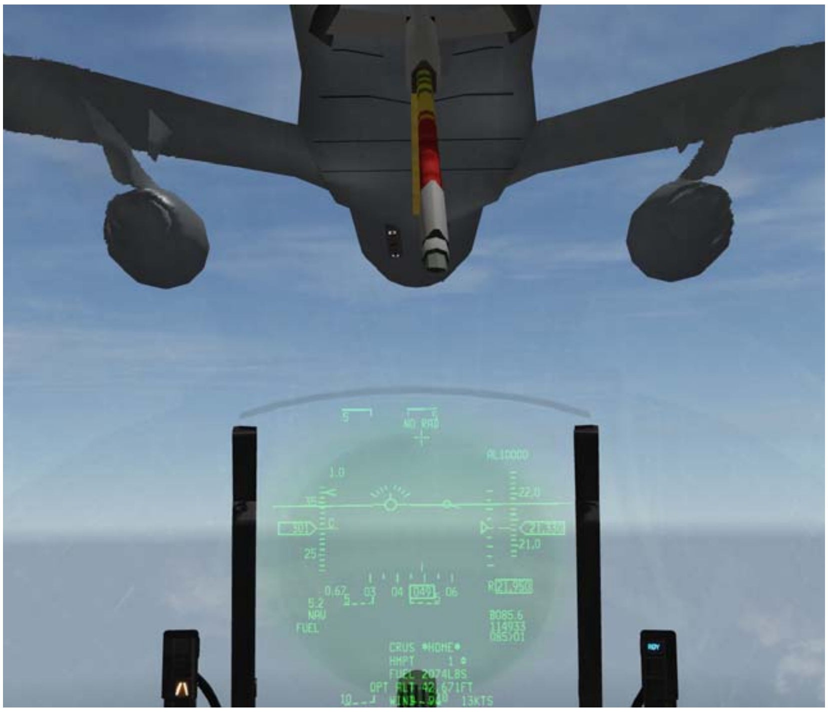
- If you are further than 10 Nm the tanker will respond with heading and distance for rejoin.
- If you are at or within 10 Nm you will be cleared directly to the pre-contact position.

Obviously you will need to open the AR door with the relevant switch on the FUEL panel on the left console. It is good practice to open it three to five minutes prior refuelling to allow the external tanks to depressurize slightly, but not too early due to the possibility of creating a trapped fuel situation.

Cleared to Pre-Contact position

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

The best method to get that position correctly is to use the FPM and the boom. When the "request fuel" radio call is acknowledged by the tanker, he lowers the boom half way. The position of the boom gives you the direction of the pre-contact position. Just follow the lower part of the boom by aligning the FPM with it.



Be advised, there is absolutely no director light at this stage. You just need to hold position a few feet behind the boom. When the boom operator has a good visual with you the tanker will call "call sign, cleared to contact position". At that point, the red director lights **F** (Forward) and **U** (Up) will switch on to give further positional guidance. Start to move towards the boom and it will move to left or right to let you get into contact position.

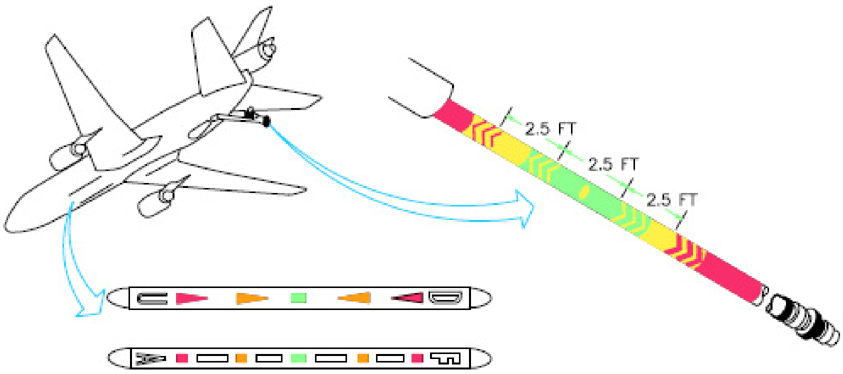
Turn the lights on please

BMS uses an EMCON 2 (Emission Control) procedure. It means that no verbal directions will be given by the boom operator to guide you into the contact position. Boom operators will only use the radio for the pre-contact position, to announce contact position, disconnect and the infamous "tanker entering turn" call. Well they also call the tanker formation to go spread but that is a bug.

This means that you'll only have visual aids to find the right contact position; help is provided by the director lights.

The director lights will be switched on only when the pre-contact position as been established. If you don't see them that's because you haven't yet reached the pre-contact position.

Go back and find it!



Once you have reached the pre-contact position only red director lights will illuminated. Steady for correction and blinking for fine tuning. When all the lights go out; don't move! The boom operator is trying to connect. You will need to hold this position for a few seconds.

Once contact has been made the yellow and green lights will become active; these will help you to adjust your position to stay connected with the boom.

If, in all older versions of Falcon, you remember the boom "snapping" you in the correct position no matter what; this is no longer the case with BMS. You keep flying the aircraft. The boom will remain connected as long as you stay within its manoeuvring envelope.

When the boom connects the blue RDY light on the right indexer shuts off and the green AR/NWS light comes on.

Quick-Flow Procedure
In accordance with ATP-56 B; the new pre-refuelling 'observation' position is on the left tanker wing. Post refuelling position is mirrored on the right tanker wing

A new AI formation is used for AAR in BMS: the "quick-flow procedure". Human players will also benefit from it. The idea is to prevent any waste of time between two aircraft in the refuelling queue.
The second aircraft in the queue takes a close-up (echelon) formation on the one currently connected to the boom.

The advantage of this refuelling procedure is that, if formation is maintained correctly, the flight members are cleared directly to contact, thus avoiding the pre-contact position.

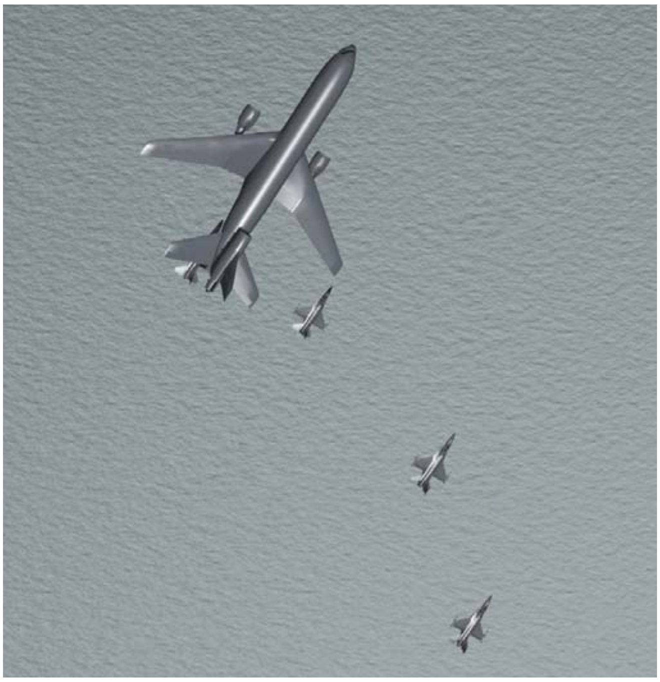
1. Leader in pre-contact position. #2, #3 and #4 waiting in pre-refuelling observation position

2. Leader in contact. #2 closes up to echelon left. #3 and #4 stay in position on the left tanker wing.

3. Leader done refuelling and moves to the right tanker wing. #2 contacts, #3 closes up to echelon on #2. #4 is waiting in position.

4. #2 done refuelling and rejoins the leader on the right wing. #3 Contact with #4 closing up.

5. #3 done refuelling and rejoins on the right wing. #4 in contact.



We typically offload a certain amount of fuel which is usually briefed. You thus have to know when you reach that amount. Simply select the UFC Bingo page and monitor your total fuel load as it increases to the desired quantity.
At that point you hit the A/R DISC switch on the sidestick and take your place in the formation again. The tanker needs to be called with a "done refuelling" for the next flight member to be cleared for refuel.

Thanks to Amraam for his permission to reproduce part of his refuelling BMS article.

2.3. LANDING

Landing the F-16 is rather easy; the aircraft is very stable from a pilot point's of view. This chapter will go through a straight-in visual landing scenario but the final approach steps are quite relevant to any type of landing.

In BMS the F-16 is able to land on any in theatre runway; airstrips included. Generic airbases always have the same lengths and only specific airbases have the longer runways as in real life, i.e. Kunsan, Kimpo, Osan, & Seoul. BMS does not take into account the runway conditions. The airstrips are considered short field landing.

Besides the runway length another aspect to be taken into account before landing is the weather. Visibility and winds are implemented. Crosswind landings with limited visibility may then happen but that is outside the scope of this chapter and is detailed in the BMS chart tutorial document.
That being said; wind must always be checked before landing. This can be done by depressing DCS right while displaying the CNI UFC page.
Landing should be performed with the Drift mode in NORM, this allows the pilot to visually see the effect of the wind through the offset of the HUD flight path marker.
Plan to touch down on the upwind side of the runway; the side opposite the FPM offset.

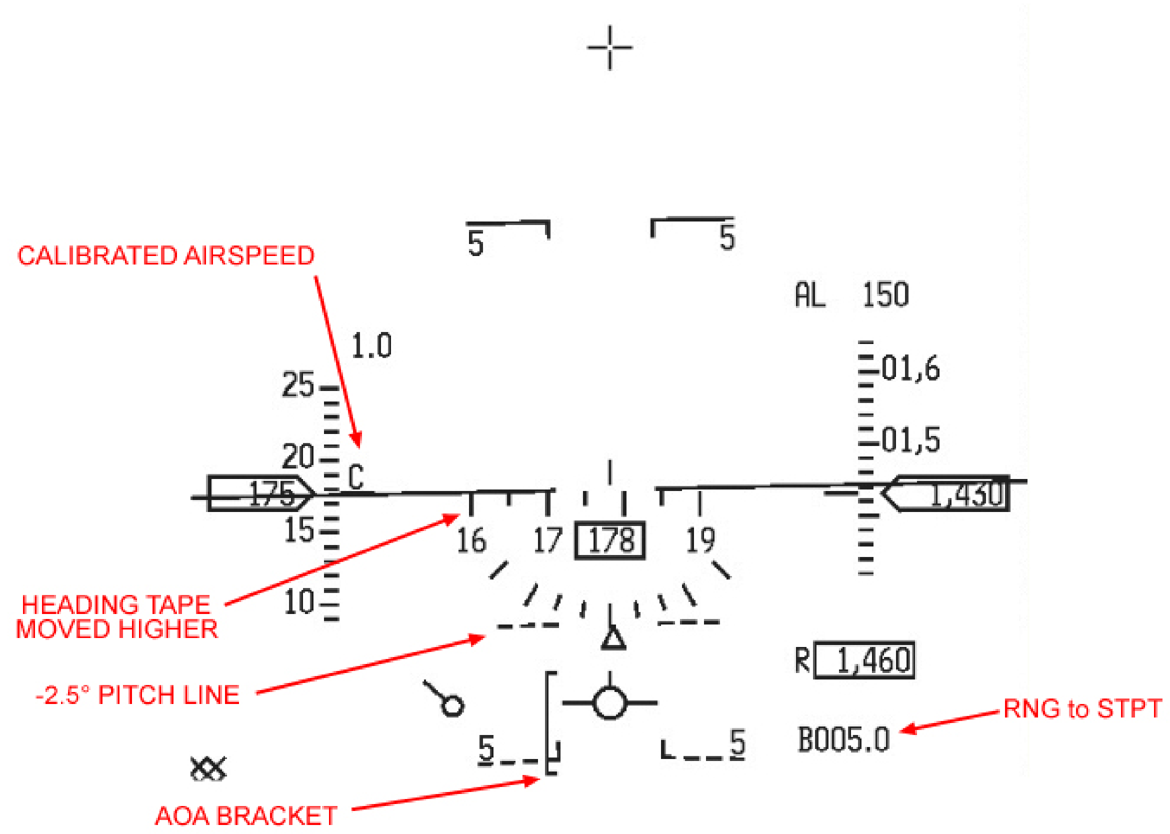
A straight-in landing is a long, controlled descent to the runway; usually beginning at a distance between six to nine nautical miles. The landing phase will start aligned with the runway axis; you can use the airbase TACAN to do that but it can be done visually as well. Altitude should be 2000 feet and airspeed less than 300 knots for safe extension of the landing gear. Due to the low drag nature of the F-16 speedbrakes may be opened to reduce speed.

From this point on we will no longer refer to airspeed but instead to angle of attack, AOA. The optimal approach airspeed depends on your gross weight and the best way to be 'on speed' is to forget all about airspeed and think 13° AOA for landing.

First lower your landing gear. Doing so will automatically deploy leading and trailing edge flaps, and the FLCS will switch to takeoff and landing gains. The drag induced by dirtying up your aircraft configuration will further decrease your airspeed and pitch the nose down a bit.
The HUD symbology will also change; notably an AOA bracket will be displayed. This symbol is used in conjunction with the flight path marker and the Indexer lights as your main cues for controlling the approach.

The glide slope is usually 2.5° to 3° down to the runway, hence the -2.5° dashed line on your HUD. By placing the FPM on the -2.5° dashed line you should fly a correct profile for your descent to the runway.
Most of runways in BMS are equipped with visual landing aid systems known as Precision Approach Path Indicator or PAPI. It consists of four equally spaced lights situated to the side of the runway. The lights will be seen as white or red according to the position of the aircraft with respect to the optimal glideslope.
The more red lights visible from the landing aircraft the lower you are from the glideslope.
The more white lights seen from the aircraft the higher you are above the glideslope.

The optimal glideslope is thus flown when 2 red and 2 white lights are seen.
As a rule of thumb to remember: Red is dead !



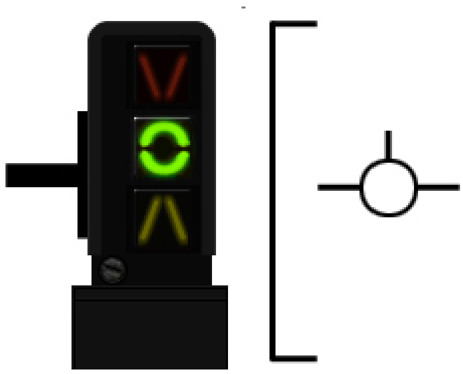
So there you are with the runway and PAPI in visual at around 6 Nm, aligned correctly with the centreline at 2000 feet, gear down and flying around 250 knots.

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

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

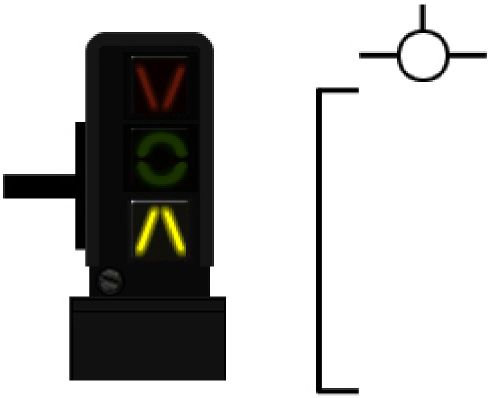
AOA is the angle between the aircraft wing chord line (equivalent here to the airframe longitudinal axis) and the relative vector of motion of the aircraft. Basically it's the angular difference between where the aircraft is pointing and where it is going.

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



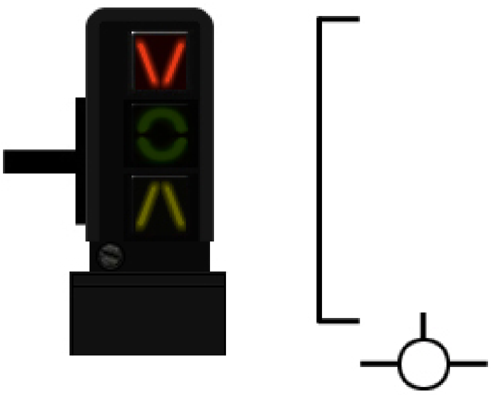
The top of the HUD AOA bracket indicates 11° AOA and the bottom mark of the HUD AOA bracket indicates 15° AOA. The bracket therefore corresponds to 5° AOA: from 11 (top) to 15° (bottom)

AOA is controlled by the power setting. Increasing power makes the nose pitch up and thus AOA decreases. Reducing power makes the nose drop, thus increases AOA.



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

You are too fast.



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

You are too slow

The approach is made around 11° AOA (FPM at the top of the HUD AOA bracket) on a 2.5° glideslope to the runway with speedbrake opened and landing gear obviously deployed. The FPM should be just on the runway threshold and the PAPI should indicate two red and two white lights. The picture on the left depicts the situation although the AOA is a bit too low and fast. The throttle was then decreased to increase AOA and bring the FPM on top of the bracket.

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

The next phase will be the flare just prior to touch down. The F-16 does not require much flare. The idea here is to transition the FPM from the top of the AOA bracket (11° AOA) to the centre of the bracket (13° AOA & green doughnut illuminated on the left indexer)
Decreasing power setting is usually all it takes to transition to 13° AOA. Once there maintain it until the wheels kiss the ground and decrease power to idle. If you land with the correct on-speed AOA the aircraft will not bounce on the runway and will not want to fly again unless you increase power.

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

Around 90 knots the nose gear will drop to the runway. Gently cushion it by pulling the stick.
Wheel braking can then be initiated considering hot brakes scenario and nosewheel steering can be engaged once below control speed (70-80 knots) to steer the aircraft on the ground.

SECTION III

ABNORMAL & EMERGENCY PROCEDURES

3.1. WARNING AND CAUTION LIGHT AND PILOT FAULT SYSTEM.

This section covers the operation of the aircraft during abnormal/emergency situations.
When dealing with emergencies, it is essential to determine the best course of action by using sound judgment. When practical your flight members should be made aware of your problems and your course of action to correct them.

There are three basic rules to apply to all emergencies:

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

The warning/caution system is made of different level subsystem:

- Warning lights (amber lights on the eyebrows).
- Master Caution light (press to reset amber light on the left eyebrow).
- Caution lights (yellow lights on the right auxiliary console caution panel).
- PFLD (Pilot Fault List Display - the small screen on the right auxiliary console, accessed with the F-ACK button on the left eyebrow).
- VMS (Voice Message System – aka Bitching Betty).
- HUD messages.

3.1.1 MASTER CAUTION light

The MATER CAUTION light illuminates shortly after any individual light on the Caution Panel illuminates. It does not illuminate in conjunction with the warning lights.
The MASTER CAUTION light can be reset by pressing it, unless the triggering caution light is the ELEC SYS light.

The light should be reset as soon as possible so that other triggering event may then be visible. Unless it is reset the MASTER CAUTION light will remain illuminated as long as the individual caution light is illuminated.

3.1.2 Caution lights

The caution light panel is located on the right auxiliary console. It is a placeholder for 32 indicators, of which 20 are fully supported in BMS. The ELEC SYS caution light cannot be reset with the MASTER CAUTION light. The only way to reset it is to use the ELEC CAUTION RESET push button on the ELEC panel. The light may not be resettable in some situations. Some lights such as the AVIONICS FAULT, ENGINE FAULT and FLCS FAULT may be reset with the F-ACK button (PFLD message)

3.1.3 Warning lights

The warning lights are located on the eyebrows.

3.1.4 Pilot Fault List Display (PFLD)

The PFLD is a small screen located on the right auxiliary console. Its purpose is to display a system code to identify the active fault.
There are two types of PFLD messages:

- Warning level.
- Caution level.

The warning level PFL are associated with the FLCS. When a warning PFL occurs the PFL message and the FLCS error code are displayed on the PFLD, the FLCS caution light illuminates, the HUD flashes the WARN message and VMS is activated (WARNING - WARNING).

When a caution level PFL occurs the PFL and error code are displayed in the PFLD, the appropriate caution light panel illuminates and the MASTER CAUTION light lights up as well.

PFL are acknowledged and recalled by depressing the F-ACK button on the left eyebrow. Multiple faults can occur at the same time and it may be necessary to toggles through additional pages on the PFLD with the F-ACK to review them all.

Acknowledging a caution level PFL clears it from the PFLD and extinguishes the relevant caution light. Acknowledging a warning level PFL clears it from the PFLD however the FLCS warning light remains ON.

3.1.5 Voice Message System (VMS)

The VMS provides an audible warning to back up warning and caution visual cues. VMS can be turned OFF with the VMS inhibit switch on the right console. The volume of the VMS can be set through the INTERCOM volume (all volumes normally heard in the pilot's headphones are changed according to the intercom volume position).

The WARNING – WARNING message is automatically activated 1.5 seconds after illumination of any warning light.
The CAUTION – CAUTION message is automatically activated 7 seconds after illumination of any caution panel light. If the MASTER CAUTION light is reset within the 7 seconds the audio cue is inhibited.

Besides the WARNING and CAUTION messages, the VMS provides discrete voice messages for specific conditions:

- ALTITUDE – ALTITUDE advises that descent is occurring after take off, radar altitude is below the CARA A-LOW setting, or barometric altitude is below the MSL A-LOW setting.
- BINGO – BINGO is played when the fuel quantity reaches the set Bingo setting in the UFC, if the FUEL QTY SEL is in NORM.
- JAMMER is played if the CMDS REQJAM is activated and warns the pilot that use of jammer is advised and consent is required.
- COUNTER advises that a dispense command should be initiated (active in CMDS semi mode).
- LOCK - LOCK advises the pilot that the FCR has locked on a target.
- PULLUP – PULLUP advises that the ground proximity warning has been activated and a 4G pull is immediately required to avoid terrain.
- CHAFF – FLARE: advises that CMDS has initiated a dispense program release (active if FDBK is turned ON in the DED CMDS page).
- LOW: advises that expendables have reached their bingo level (if turned ON in the CMDS UFC page).
- DATA is played when the IDM receives data link information.
- VMS is also able to play the LOW SPEED warning tone and Landing Gear warning horn.

The VMS is inhibited with WOW but can be tested with the MAL & IND light test button. During test, each word is heard once in sequence.

3.2. WARNING LIGHT ANALYSIS.

3.2.1. ENG FIRE

Illumination of the ENG FIRE should be followed by immediately retarding the throttle to idle.
The likely cause is engine compartment fire.
If there are other signs of engine fire such as visual, FTIT, Overheat, engine response, and if the warning light remains ON eject immediately.
If there are no other signs then the cause is probably a malfunction in the fire detection system. In that case land as soon as possible.

3.2.2. TO / LDG CONFIG

This warning light refers to a wrong configuration for landing or takeoff.

- On the ground with the landing gear handle up the warning light means that the Trailing Edge Flaps (TEF) are not fully down. That hardly happens in BMS and that's good because you should abort the aircraft.

- In the air with the landing gear handle up the light comes ON to warn the pilot that the aircraft is not correctly configured for landing. The light comes ON when the following conditions occur:
  1. Below 10.000 feet
  2. Airspeed < 190 knots
  3. 250 fpm descent

  The VMS warning horn will sound.
  To address the problem stop your rate of descent and accelerate or lower the landing gear handle if you intend to land.

- In the air with the landing handle down the light indicates a malfunction in the gear or in the TEF. To work out where the problem lies first check the individual gear lights. If all three of them are green then the gear is fully down and locked and the problem is relevant to the TEF. In that case land using normal AOA (about 20 knots faster than normal)
  If one of the gear lights is not green that gear is not fully down and locked. Refer to landing emergencies chapter 3.8.3 landing with gear Unsafe/up later this section

3.2.3. CANOPY

Illumination of this warning light indicates that the canopy hooks or locks are not secured or there has been a loss of cabin pressure. Descend below 10.000 feet and land as soon as possible.

3.2.4. FLCS

The FLCS warning light comes ON whenever there is a PFL warning message relevant to FLCS. Refer to the Pilot Fault List message.

3.2.5. HYD / OIL PRESS

This warning light indicates a low pressure condition in one or both hydraulic systems, or a low engine oil pressure condition. Both systems will therefore need to be checked:

1. Check the oil pressure gauge. If the pressure reads normal the problem is not the oil pressure. If the pressure is below 15 PSI, the engine has low oil pressure. Limit throttle movement and land as soon as possible.

2. Refer to the hydraulic system A & B gauges on the right auxiliary console and check pressure there.

If only system A is below 1000 PSI, there is a single system A hydraulic failure (refer to SYSTEM A Hydraulic failure in the EP checklists).

If system B gauge is under 100 PSI, check the EPU:
- If the EPU RUN light s OFF there is a single system B hydraulic failure (refer to SYSTEM B Hydraulic failure in the EP checklists).
- If the EPU run light is ON check the ELEC SYS caution light:
  - If ELEC SYS ON the problem is PTO shaft failure.
  - If ELEC SYS OFF both hydraulic system A & B have failed (refer to DUAL Hydraulic failure in the EP checklists).

If both hydraulic indicators show under 1000 PSI with EPU switch in NORM or ON the aircraft suffered a total hydraulic failure and will become uncontrollable as soon as the EPU runs out of fuel. When that happens get ready to eject.

3.2.6. OXY LOW

The OXY LOW warning light illuminates when OBOGS BIT has detected a fault or when regulator pressure is below 5 PSI. Refer to OBOGS malfunction.

3.2.7. DBU ON

The DBU warning light illuminates whenever the FLCC is running in digital backup mode. This is eye candy in BMS and happens only when DBU is tested.

3.2.8. TF FAIL

Indicates a Terrain Following Radar failure. An immediate climb to a safe altitude should be initiated.

3.2.9. ENGINE

The ENGINE warning light illuminates due to other engine problems. Causes include engine flameout, alternator failure, over temperature…
. If RPM is abnormally low but not showing zero the engine has flamed out.
=> place throttle OFF and initiate an air start. (refer to 3.7.5.1 Air start chapter later this section).

. If RPM is low and reading zero the aircraft has suffered an alternator failure.
. If RPM is not abnormally low but FTIT is abnormally high the engine is suffering from over temperature=> land as soon as possible
. If RPM is not abnormally low and FTIT not abnormally high it is an engine warning system failure or RPM/FTIT indicator failure.
=> Land as soon as practical.

3.2.10. GEAR HANDLE LIGHT

The red light in the gear handle (lollipop) is also considered a warning light. It refers to the landing gear or landing gear doors not being in the position commanded by the handle unless the gear is in transit.
Normal operation of this light is to be illuminated while the gears are in transit.
If the light remains ON after moving the handle a failure has occurred.

If the light remains ON after placing the gear handle up it indicates that one or more gear has not fully retracted or a landing door has not closed (refer to 3.8.2 LG extension malfunctions later this section).

If the light remains ON after placing the gear handle down it indicates that one or more gear is not fully down and locked. Check the individual gear light to know which one and refer to 3.8.2 LG extension malfunctions later this section).

3.2.11. HUD WARN

The HUD WARN message comes ON whenever one of the warning lights illuminates.
Refer to the relevant warning light and reset the HUD with the WARN RESET switch on the ICP.

3.3. CAUTION LIGHT ANALYSIS.

3.3.1. MASTER CAUTION

The MASTER CAUTION light comes ON whenever one of the caution light panel illuminates (except IFF). Check for the specific caution light and take relevant action.
The MASTER CAUTION light can be reset by pressing the light face. It cannot be reset when the ELEC SYS caution light is illuminated. The ELEC CAUTION RESET pushbutton needs to be pressed in this situation.

3.3.2. CAUTION PANEL LIGHTS

A FLCS fault is detected. Refer to the PFL display.

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

Single generator failures are not coded for the moment in BMS, so when the ELEC SYS caution light comes ON check the relevant ELEC lights and press the ELEC CAUTION RESET to try to reset the fault. If it does not reset land as soon as possible.

Probe heater failure or monitoring system failure. Probeheat is not fully implemented in BMS and not yet necessary since there are no possible icing conditions. The system can be tested with the probe heat switch on the TEST panel. Probe heat should be turned ON in flight but is not mandatory in BMS. As such illumination of the Probeheat caution light has no consequence and no further action is required.

The CADC caution light is not implemented in BMS. It does come ON at MAL & IND test though.

The STORES CONFIG switch on the gear panel (left auxiliary console) is not in the correct position relevant to the loaded SMS. To extinguish the caution light simply toggle the STORES CONFIG switch.

This caution light is not implemented in BMS. It refers to an Automatic Terrain Following failure. It has no consequence in BMS. It does comes ON at MAL & IND test though.

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

The AFT FUEL LOW caution light comes ON whenever the aft reservoir contains less than 400 pounds of fuel (C model) or 250 pounds of fuel in the D model.

Engine fault(s) detected. Refer to the PFL displayed message and press F-ACK button to reset the engine fault caution light. Perform fault recall with a further press of the F-ACK to determine if the failure condition still exists.
Engine failures are hard to come by in BMS unless due to battle damage.

The SEC caution light illuminates when the engine operates in secondary mode.
Check the position of the ENG CONT switch on the JET ENG panel (left console). If the switch is on PRI an automatic transfer to SEC happened (this is not implemented in BMS) So your switch must be in SEC and the BMS pilot commanded the SEC mode. In SEC the nozzle remains closed and afterburner is inhibited.

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

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

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

An avionics fault was detected. Refer to PFL message and press F-ACK button to reset the avionics fault caution light. Perform fault recall with a further press of F-ACK to determine if the failure condition still exists.

Cooling of the avionics equipment is insufficient. AIR SOURCE knob should be checked immediately for NORM position. If AIRSOURCE was not in NORM place it in NORM and the fault will clear as soon as cooling becomes effective again. If AIR SOURCE was in NORM expect degraded avionic equipment performance and FCR shutdown. Retard throttle to 80% and shut down non essential avionics. Land as soon as practical.

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

Failure of the IFF mode 4 reply which is irrelevant in BMS. This caution light is advisory and has no consequence in BMS.

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

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

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

The anti-skid system is not implemented in BMS. This caution light has no consequence. It does comes ON at MAL & IND test though.

The hook is not up and locked. Cable arrestment system is not implemented in BMS and the hook has no real purpose. Change the position of the HOOK switch on the gear panel to clear the fault.

The OBOGS caution light illuminates when the ECS air supply has dropped below 10 psi. Oxygen production has stopped (not that it really matters to us). Expect an OXY LOW warning light.

The cabin pressure caution light comes ON when the cockpit pressurisation is above 27000 feet. Check AIR SOURCE knob for NORM position. If caution light remains illuminated descend below 25000 feet and reduce speed to 500 knots maximum. Flight can be continued below 25000 feet as long as oxygen is available and set to 100%.

3.4. PILOT FAULT LIST ANALYSIS.

Will be documented for 4.33

3.5. GROUND EMERGENCIES.

3.5.1 HUNG START / NO START

A hung start happens when the RPM does not increase past 20% (with JFS running) irrespective of the idle detent keystroke or the throttle position (out of OFF). This is a hardware problem with your throttle (probably not correctly calibrated) or an idle detent keystroke problem. Abort the aircraft and check your hardware / Config settings.
No start means that the JFS cannot recharge and a second JFS activation is not (yet) possible in BMS.

3.5.2 ENGINE START IN BATTERY

Although not an emergency it is not uncommon to see virtual pilots trying to light up the engine in battery power. Initial indication of a battery start is the ELEC SYS light on the caution panel remaining ON throughout the engine start (it will extinguish when RPM reaches 50% during a normal start). Many virtual pilots miss this though and realize the situation only when the avionics (MFDs, UFC, etc) refuse to start.
A battery start has no consequence in BMS and normal operation can be regained when the MAIN POWER switch is placed to MAIN, even after the engine has stabilized at idle.

3.5.3 EQUIP HOT CAUTION LIGHT

If the EQUIP HOT caution light illuminates during ramp start check AIR SOURCE knob position is set to NORM. If it was not in NORM the ECS can not provide cooling to avionics. If EQUIP HOT remains ON one minute after AIR SOURCE is set to NORM place all nonessential avionics to OFF and abort the aircraft.

3.5.4 FLCS BIT FAILURE

FLCS BIT fail is indicated by the FAIL light on the FLCS panel coming ON. The only way to clear the failed BIT is to reinitiate a FLCS BIT. During that BIT both the RUN and FAIL light will be ON. At the end of the new FLCS BIT the FAIL condition may clear. If FAIL did not clear execute BIT till the conditions clears.

3.5.5 HOT BRAKES

It is the pilots responsibility to determine when a hot brake condition exists. BMS now features accurate modeling of the real F-16 brake energy limits. The limits are based on gross weight, temperature, pressure altitude and airspeed at which an abort (on takeoff roll) or braking on landing was initiated.
Refer to the chart on the next page for brake energy limits.

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

Brake Energy Limits – Max Effort Braking

DATA BASIS ESTIMATED

ENGINE F110-GE-129

CONFIGURATION:

- ALL DRAG INDEXES
- SPEEDBRAKES – OPEN
- TEF's DOWN

CONDITIONS:

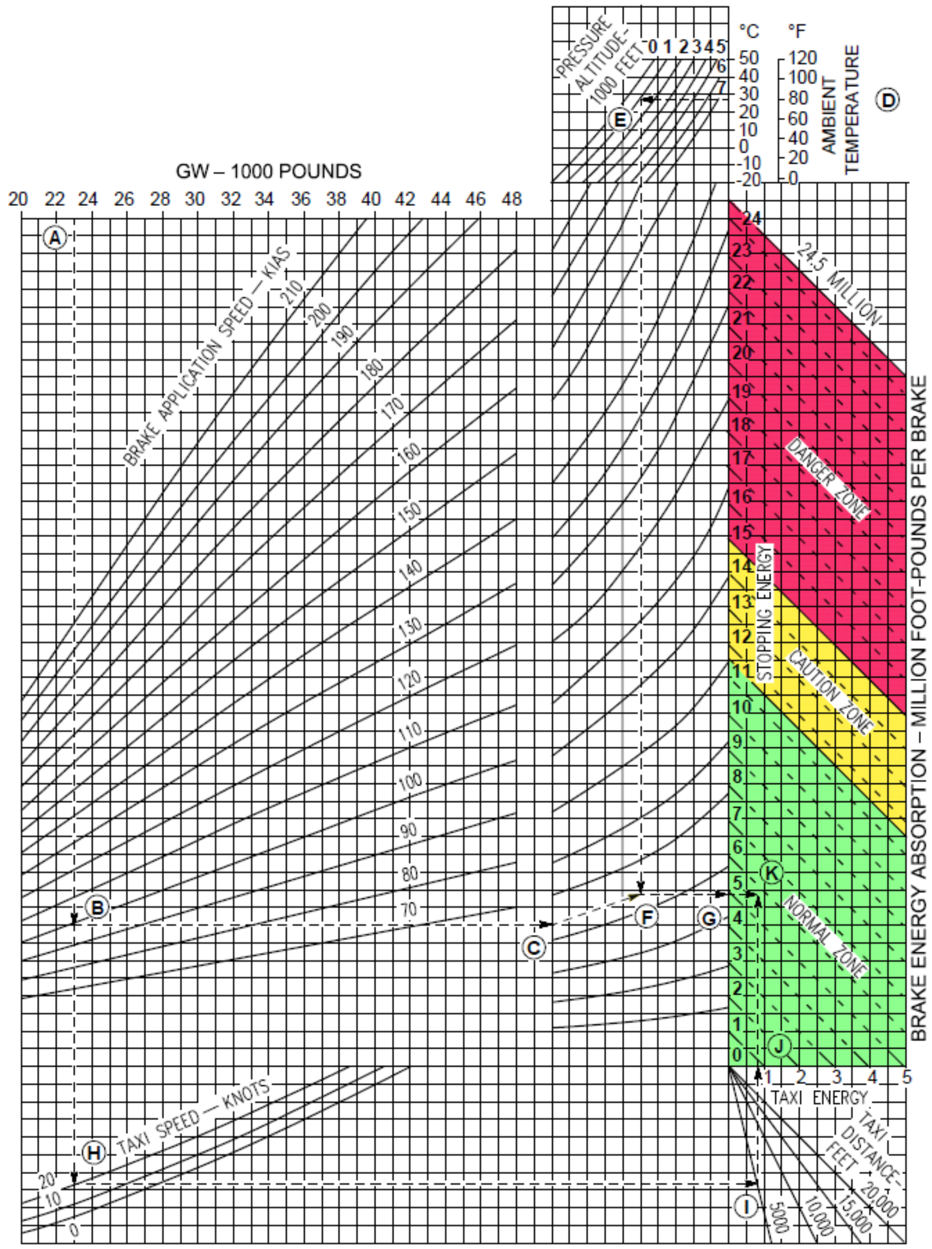
- NORMAL IDLE THRUST

CAUTION

- EXCEEDING 24.5 MILLION FOOT- POUNDS PER BRAKE CUMULATIVE TOTAL ENERGY MAY RESULT IN LOSS OF BRAKING.

NOTES:

- ADD TAILWIND COMPONENT OR SUBTRACT ONE-HALF HEADWIND COMPONENT FROM AIRSPEED WHEN BRAKES ARE APPLIED.
- FOR ABORTED TAKEOFF AT AIRSPEED GREATER THAN 100 KNOTS, ADD 2 MILLION FOOT-POUNDS PER BRAKE IF BRAKES ARE APPLIED SOONER THAN 4 SECONDS AFTER THROTTLE IS RETARDED TO IDLE.
- IF LANDING WITH ASYMMETRICAL WING LOADING, TAKE ACTION AS APPLICABLE FOR NEXT HIGHER ENERGY ZONE TO ALLOW FOR UNEQUAL BRAKE ENERGY DISTRIBUTION.



Zone 1 : Green: Normal zone - 0-11.5 million ft-lbs, nothing happens
Zone 2: Yellow: Caution zone - 11.5-15 million ft-lbs, 30% chance something bad happens
Zone 3 : Red: Danger zone - 15-24.5 million ft-lbs, 90% chance something bad happens
Zone 4 : Over 24.5 million lbs: Danger zone + immediate braking failure likely

When a hot brake condition is suspected brake use should be minimized and if possible aircraft stopped and chocked in the nearest designated hot brakes area (do not use the parking brake). Turn EPU OFF, set Throttle OFF to shut down the engine (IRL hot brakes present a fire hazard) then turn MAIN Power switch OFF.

A BMS hot brake situation may deteriorate to the following situations depending on how much energy the brakes absorbed:

• Blowing tyre fuse plugs - tyre(s) go flat which causes much more longitudinal friction and less lateral friction. Fusible plugs in aircraft tyres are designed to melt at specific temperatures to relieve tyre pressure and thus keep them from exploding.
• Brake hydraulic pressure line failures - brake reaction is reduced or lost completely.
• Main gear tyre fire, hydraulic fluid fire, exploding tyres and gear failure - the affected gear fails completely.

3.5.6 NWS FAILURE / HARDOVER

NWS failure may be detected by the NWS FAIL caution light. In that case do not engage NWS. A NWS malfunction may cause abrupt turns, tyre skidding or blowouts and departure from the paved surface.
Use rudder and brakes as required to steer the aircraft on the ground. Beware of increase hot brakes conditions when using differential brakes to steer the aircraft.
Remember NWS is not to be used at speeds higher than 70 knots. Doing so may cause abrupt turns, tyre skidding or blowouts and departure from the paved surface as well.

3.6. TAKEOFF EMERGENCIES.

3.6.1 ABORT / REJECTED TAKEOFF

Normally with the short takeoff distance capability of the F-16 aborting should not be a problem unless directional control is a factor (blown tyre). An early decision to abort provides the most favourable circumstance.
Aborting after rotation should not be done in Falcon as runway distances are often too short to allow it. Flying to a key position is advised instead.

When aborting retard throttle to idle and apply maximum wheel braking (maximum pedal pressure while maintaining directional control). When the nose wheel is on the ground apply maximum braking effort (full aft stick, fully opened speedbrake and maximum wheel braking).
You may lower the hook if you feel like it but as there is no cable arrestment system in BMS it is not required.
NWS should be engaged only if directional control becomes a problem.
Consider following hot brakes procedure after any abort. Taxiing after an abort will further increase the likelihood of hot brakes.

3.6.2 LG FAILS TO RETRACT

If the landing gear handle warning light remains ON after the handle has been moved up the landing gear or landing gear doors are not fully retracted. In BMS chances are that you oversped the jet with gear down (>305 knots)
If this is the case reduce speed immediately to below 300 knots and replace the gear handle in the down position.

If landing gear comes down normally land as soon as possible. Do not try to retract the gear as it may induce further damage and prevent further gear extension.

If the landing gear does not indicate down reduce speed further to below 190 knots and use the alternate gear extension handle. Bear in mind that NWS is not available after an alternate gear extension.

If gear indicates safe eventually ask a visual confirmation that your gear is down (if flying MP) and land normally. Use differential braking for directional control.

If gear still indicates unsafe apply alternating G forces (-1.0 to +3.0G) to try to free the landing gear. Although that does not work in BMS, it’s still cool to try.
Consider Landing with LG unsafe/up or ejection.

- Consider diverting to a runway with a minimum crosswind component.
- If wing fuel tanks are carried keep them but jettison all armament and centreline station (if possible).
- Ensure wing fuel tanks are empty and decrease gross weight as much as possible (that means burning fuel since the F-16 does not have a fuel dump system). If you have no choice but to land immediately and can not empty the wing fuel tanks, jettison them as well.
- Open the AR door to depressurize the wing tanks (once the wing tanks are emptied) Shut FCR & ST STA/ HDPT and ECM power OFF.
- Extend ALT FLAPS.
- Place the EPU to ON.
- Fly a low angle approach at 13° AOA & place the throttle to CUTOFF immediately before touchdown.

3.6.3 BLOWN TYRE ON TAKEOFF

A blown tyre condition is difficult to recognize. The directional control loss may be confused with crosswind.
Aborting takeoff may be more dangerous than continuing, especially if speed is already high.
If takeoff is continued do not retract the landing gear, reduce the gross weight and plan to land as soon as practical. (refer to landing emergencies chapter 3.8.1 Landing with a blown tyre later this section)

If aborting the takeoff try as best as you can to maintain directional control with rudder, differential braking and NWS when at control speed. Stop straight ahead and shut down the aircraft. Do not taxi further unless in case of an emergency.

3.7. IN FLIGHT EMERGENCIES.

3.7.1 COCKPIT PRESSURE MALFUNCTIONS

Illumination of the CANOPY warning light indicates a loss of cockpit pressure. It may be caused by the canopy seal or a failure or shutdown of the ECS system. If cockpit pressure exceeds 27000 feet the CABIN PRESS caution light will illuminate.
In that case place oxygen to 100% (not that we really need it), descend below 25000 feet altitude and maintain speed under 500 knots.
The flight can be continued below 25000 feet.

3.7.2 EQUIP HOT CAUTION LIGHT

As always in this case the first item to check is the position of the AIR SOURCE knob to NORM. Reduce power to 80%RPM. Another reason why the equip hot might be illuminated is flying for long period with the gear extended at low level. Indeed if flying below 8000 feet for more than 7 to 8 minutes with gear down might shut the ECS off.
If EQUIP HOT remains ON shut down all non essential avionics (the FCR will be shut down automatically) and land as soon as practical.

3.7.3 EJECTION

Since there is absolutely zero risk of injury or even death in our hobby, there is no further consideration to ejection. When the time comes simply pull the handle and off you go to meet the silk.

3.7.4 ELECTRICAL SYSTEM FAILURE

This section will be documented when electrical failure is coded in BMS.

3.7.5 ENGINE MALFUNCTIONS

There is no engine malfunction per se in BMS. The engine is perfectly maintained and never fails.
The only reason except battle damage for the engine to stop is fuel starvation.
We will thus detail two abnormal or emergency procedures: air starts and flame out landings.

3.7.5.1 Air Start

Air start procedures may differ depending on the idle cutoff config being activated or not.
With that config option deactivated you will need the idle detent keystroke (unrealistic). If on the other hand you have the idle cutoff config activated then you rely on your flight controllers mechanical detents for the idle/cutoff point, making the keystroke unnecessary.

The first indication of an engine shutdown is a decrease in RPM and FTIT. If the EPU is in NORM it will immediately engage and power the emergency and hydraulic buses. Depending on RPM % the EPU may also deplete the hydrazine. Remember the EPU running on hydrazine only has an autonomy of about 10 minutes.

When the engine stops in flight the RPM may still remain at a high value thanks to the air flow spinning the turbine and thus providing RPM. That may then provide sufficient pressure to restart the engine if the RPM value is above 20-25%.

Air start can thus be initiated without the use of the JFS. It will only be needed when the RPM has decayed below the 20-25% limit. It may also be interesting to note that air start efficiency in BMS is not currently dependent on altitude.

To initiate an air-start with sufficient engine RPM place the throttle in OFF position and then move it past the idle/cutoff point (idle detent keystroke) and place it at mid range. Then monitor the signs of engine relight such as FTIT & RPM increasing.

If RMP alone isn't sufficient to air-start the engine and if you have altitude to spare, you can dive the aircraft to windmill the turbine and provide sufficient pressure to relight the engine.

If on the other hand you do not have the altitude to increase speed by diving you will need to use the JFS to assist the air-start. The JFS has an operating range and should be engaged only below 20.000 feet and at airspeed below 400 knots.
Once in the JFS envelope and with the throttle in OFF start the JFS to assist increasing the RPM up to 20-25%. At that point move the throttle handle to mid range and monitor RPM and FTIT for engine relight.
The JFS will shut down automatically when the engine reaches 50% RPM. Be aware that as on the ground you only have one shot at the JFS. If you fail to relight the engine the JFS cannot recharge and you will not be able to restart the JFS. The JFS in BMS recharges only when the engine is running.

After engine relight and with engine thrust sufficient to sustain level flight set the throttle as desired and verify that both MAIN GEN and STBY GEN lights are OFF. Use the ELEC CAUTION RESET pushbutton to clear any ELEC SYS caution lights and reset the EPU to OFF, then back to NORM.

3.7.5.2. Flameout Landing

Landing the aircraft with no engine is not easy and must be carefully considered before being attempted. The current weather (visibility, wind) must be taken into consideration but also the amount of training and the success rate the pilot demonstrated in simulated flameout exercises (SFO).
That being said failing does not bear any consequence and the BMS ejection envelope is rather large.

Beside battle damage flameout landing will happen in BMS mostly because of fuel starvation. In that case it is rather obvious that air-start should not even be attempted.

To perform a flameout landing turn immediately towards the nearest runway, jettison stores to decrease drag and establish best range airspeed. Sounds simple but you first need to be able to know where you are and where the closest runway is and to know what your best range airspeed is.
Solving the first issue is outside the scope of this manual and greatly depends on your situational awareness and correct flight planning. The latter depends on Gross Weight and is 200 knots for GW of 20000 lbs and 205 knots for 21000 lbs GW. Add 5 knots per 1000 lbs of additional GW.
For reference, an F-16 empty of fuel and having jettisoned stores (with a centreline pod and air to air missiles carried) weighs around 22000 lbs or 21000 lbs without the centreline ECM pod.

The best range speed is thus typically set to 210 knots. To find out your best range speed in any configuration fly a 7° AOA attitude. To maintain that speed, the F-16 will trade 1000 feet of altitude every nautical mile approximately, giving a glide ratio of one for one. Granted it is an approximate rule but it is very handy to estimate your range and deciding which available runway to use. (The real dash 1 manual says that the F-16 will go 7nm over the ground for every 5,000 ft of altitude you lose. This makes gliding calculations tricky in an emergency so just use 1:1).
Another consideration for long glides to the runway is EPU fuel for hydraulics and emergency power. Once the hydrazine is depleted the EPU will shut down and the F-16 will be as controllable as a brick. At that point your only way out is to eject. The EPU has about 10 minutes of autonomy running on hydrazine. Don't plan for a glide and flameout landing taking more than 10 minutes!

There are two basic types of flameout approaches: direct (straight in) and overhead. The direct approach may look simpler but provides no extra room for error. The overhead pattern is by far the safest as it provides good visual cues against known references (that is if you know them by heart)

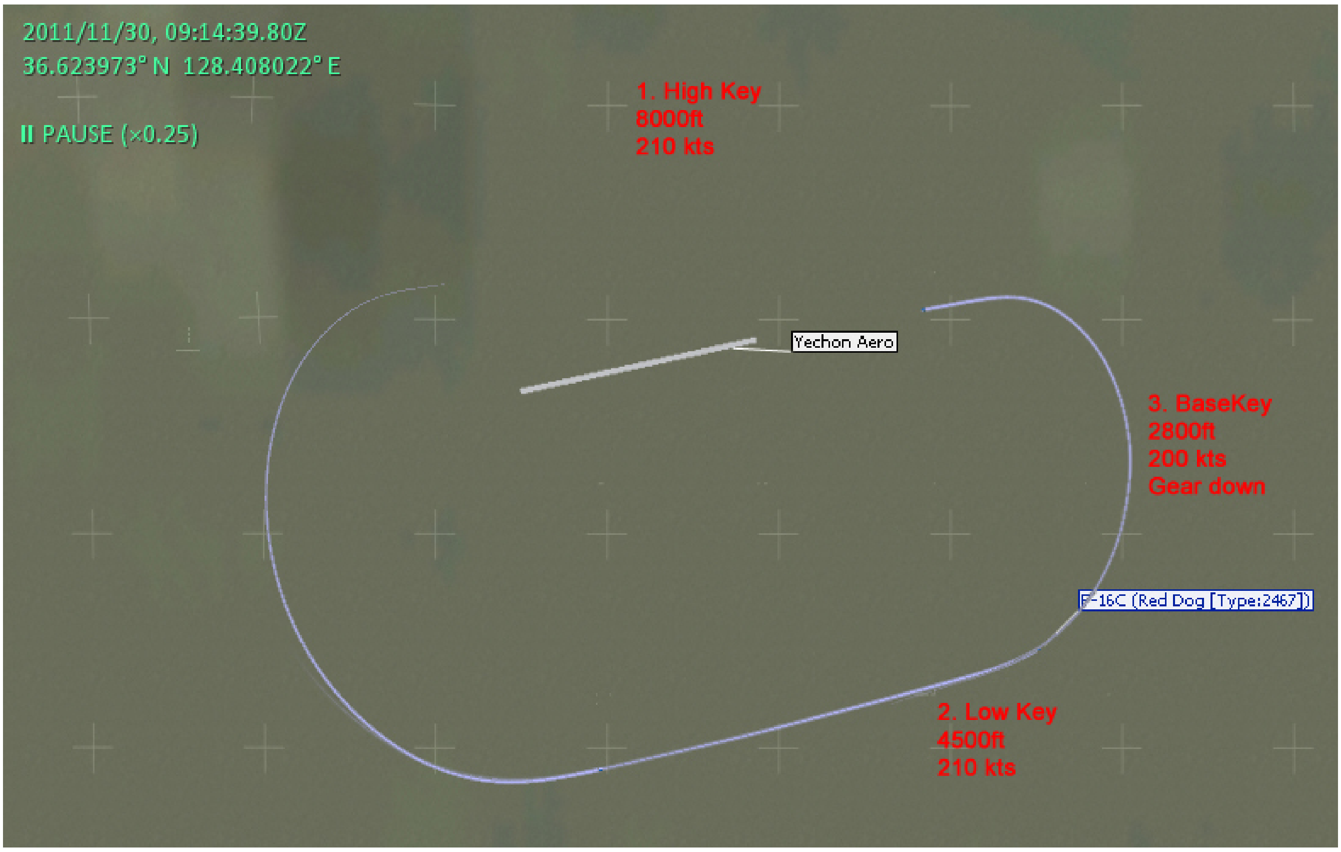
The overhead approach

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

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

The whole approach is flown at best range airspeed (210 knots) gear up. Optimum bank angles are 50° for gear up and 55° gear down. Anything above optimum bank angle induces a significant loss of altitude per degree of turn.

The gear is lowered ONLY when it becomes certain that BASE key altitude can be reached. Best range speed with gear down is 10 knots less than gear up best range speed (200 knots). Beware you may need to use the alternate gear handle to lower the landing gear.
If EPU fuel is less than 25% when reaching high key you may run out of EPU fuel during the procedure, ejection will then be your only way out.

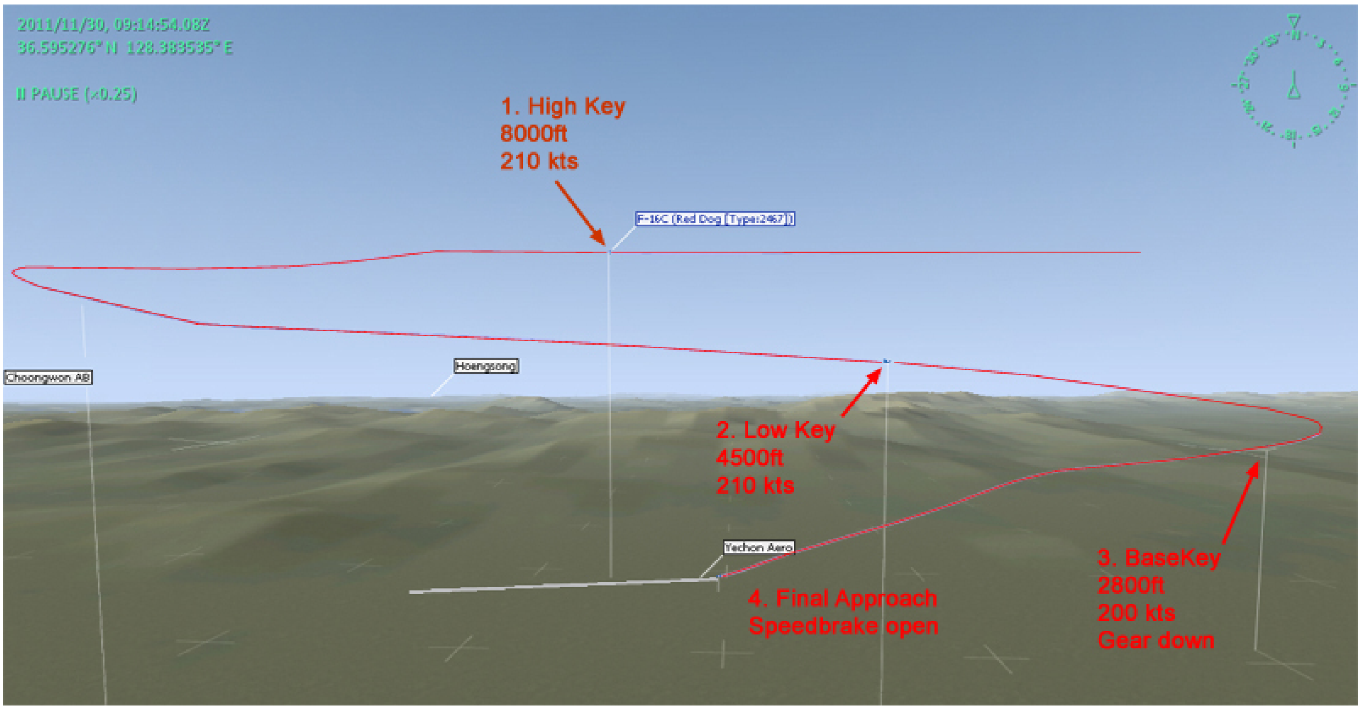


Passing High Key within the altitude limits (7000-10.000 feet) execute a 50° bank descending turn (180° of turn) to downwind while maintaining 210 knots aiming for Low Key.

Low Key is the point where you start your final 180° turn towards the runway and should be reached between 3000 and 5000 feet AGL. Execute a 50° bank angle descending turn towards the runway, still maintaining best range airspeed towards Base Key.

Base Key is the mid-point of the turn and should be reached no lower than 2000 feet AGL. At that point the gear should be down. Speedbrakes can be used to bleed off excess altitude or just move the touchdown point past the runway threshold.

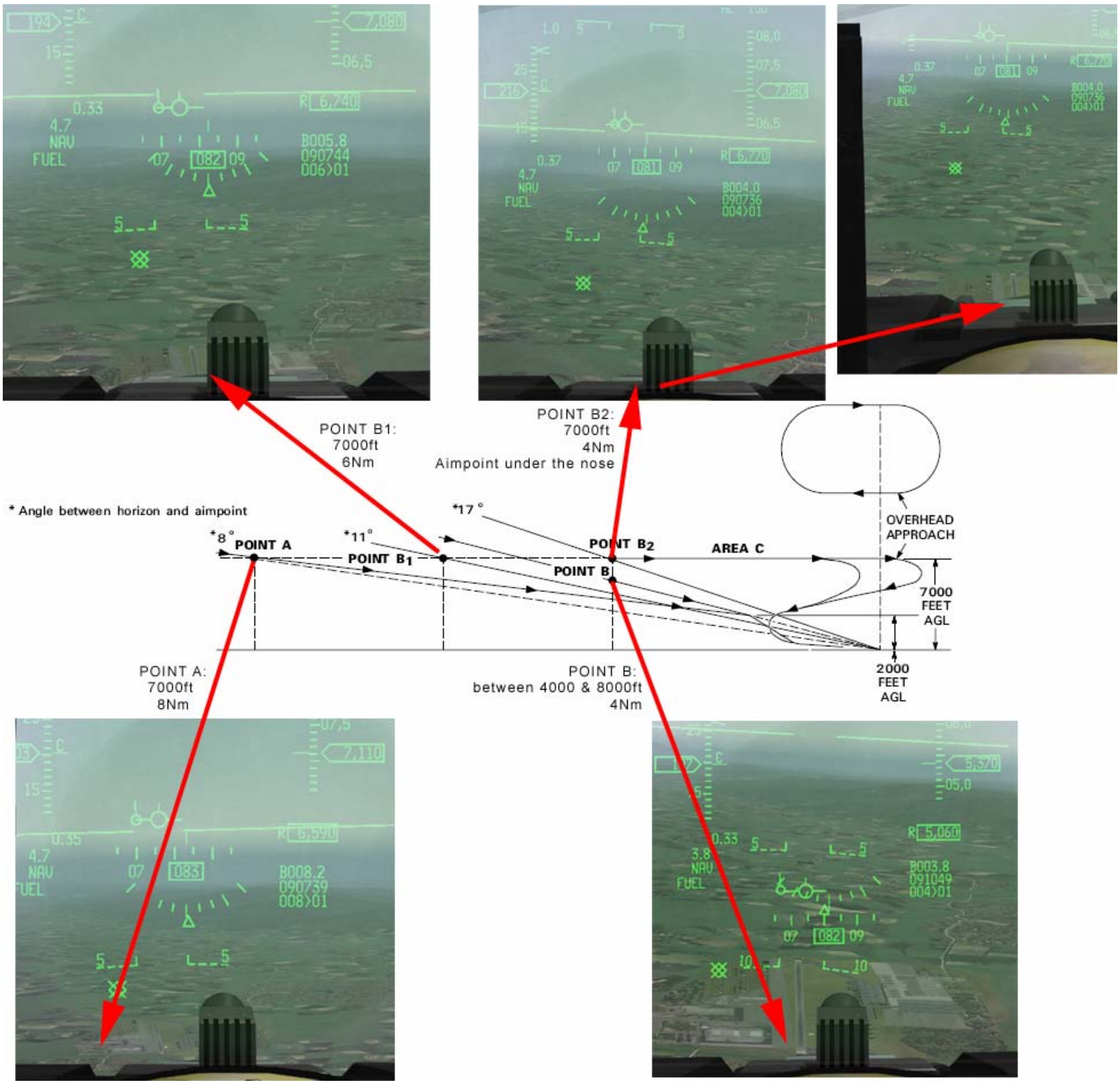
Maintain 11-13° AOA in final approach and use speed brakes as required. On touch down, maintain aero-braking as in a normal landing and when the nose wheel is on the ground apply full aft stick, fully open the speedbrakes and engage wheel brakes.



The straight in approach

This flameout procedure is comparable to a long 7° AOA glide to the runway threshold at best range speed (210 knots) with the gear up until the initial aim point is 11-17° below the horizon. Then the landing gear should be lowered and the glide continued at best range speed with gear down (200 knots) until the flare.
As in the overhead pattern 3 points can be defined, each with a reference altitude.

- POINT A: 8 Nm from the runway (aligned), with an altitude of 7000 feet AGL.
- POINT B: 4 Nm from the runway (aligned), with an altitude of 4000-6000 feet AGL.
- AREA C: between zero and 4 Nm from the runway threshold



Judging when the aim point is 11-17° below the horizon to start your final descent is not easy.
A good visual cue is when the aim point (runway touch down point) is at the bottom of the HUD.

If the altitude of 7000 feet was maintained, the aim point would disappear under the nose between 6 (point B1) and 4 Nm (Point B2) from the runway. The straight in approach would be successful at this altitude up to point B2.
Past B2 you would have too much energy to succeed in landing even with full speed brakes and landing gear deployed.

As you see on the left picture, if a dive was initiated at point B2 the FPM if placed on the aimpoint would be 17° from the horizon.
Such a dive will increase your airspeed, even with gear and speed brakes deployed.
The speed will be too high for a safe landing.

If you find yourself in such a situation you must bleed energy to salvage the approach.
Delay landing gear extension, maintain your glide at best range speed and enter a flameout overhead pattern shooting for any reachable key position.
If you are high, but not high enough for an overhead pattern, use the speedbrakes and a series of S-turns back and forth to get down to the proper 11-17° glide path.

As a rule of thumb for straight in approach, maintain the aim point in the bottom of the HUD while gliding at best range speed.
If the aim point moves up in the HUD you are running out of energy and you will not make the runway, ejection is your only option.
If you aim point disappears under the nose you have too much energy and you must deploy speed brakes or enter a flameout overhead pattern.

Once at 2000 feet AGL with the aimpoint at the bottom of the HUD, lower the landing gear (alternate gear extension) and control your final descent, usually steeper with speed brakes.

When starting a straight in approach take the weather and the EPU fuel remaining when reaching POINT A into consideration.
IMC penetration can be performed but ideally VMC should be attained no later than 3Nm from the runway at 3000 feet AGL.
EPU Fuel should not indicate less than 40% at point A to ensure that the EPU does not run out of hydrazine before landing.

After touchdown open the speedbrakes fully, apply full aft stick and wheel brakes in one single moderate and steady application. NWS will remain available even after an alternate landing gear extension in BMS, so you can still steer the aircraft on the ground after a flameout landing. Exit the runway and park (chock) the aircraft on the taxiway.

Training for flameout landing.

The biggest issue performing flameout landings is the ability to gauge if the approach is achievable or not. Unfortunately it only comes with experience only and thus needs to be practised as often as possible.

You can simulate a flameout landing (depending on remaining stores) in any mission by simply placing the throttle to idle and leaving it there until landing. To keep a realistic setup and to compensate for a real engine out situation open the speedbrakes for one second then leave them slightly opened for the duration of the flameout scenario. The speedbrakes will add a small amount of drag simulating the same conditions of a real flameout.
In such a scenario the gear will lower normally and the alternate gear will not be required. On the same note the EPU will not run and thus not deplete your EPU fuel.
If the simulated flameout cannot be concluded by landing safely then you can simply increase power and try again.

Another way to do it is on a specific flameout training mission like the test flight done after an engine change.

Plan for a clean jet with 2000 LBS fuel on board. Take off in military power and level off 50/100 feet over the runway and accelerate to 400 knots without afterburner, flying on the runway heading.
Then pull up maintaining buster into an Immelmann over the runway. Rolling out at the top simply simulate an engine failure and you should be in perfect parameters for an flameout overhead at high key.

Since we are in a simulator real engine out situations can be practised and are actually advised. In those test flights we encourage you to simply cut off the engine and train the real flameout landings.

3.7.6 JETTISON

Both Selective Jettison & Emergency Jettison are Master Modes.
Selective Jettison is used to release selected stores and rack (Air to Air missiles and ECM pods cannot be selected) and can be programmed in advance through the SMS S-J page.
Emergency Jettison is a one-step operation to lighten the Gross Weight in an emergency situation by releasing all stores except Air to Air and ECM pods.

Selective Jettison
It is good airmanship to preselect the stores that may be jettisoned at some point in the flight (e.g.fuel tanks).
Access the SMS MFD page and select the S-J subpage with OSB #11.

The first press on the OSB next to a station selects the store(s) and a second press selects the rack if available for jettison. In the picture on the left L117 are the Maverick racks and the L88 are the AGM-88 racks.

The pilot can preselect a selective jettison configuration while in S-J Master Mode, which will be remembered during master mode transitions.

The stores are jettisoned using the pickle button when the Master Arm switch is in ARM.

After the stores are released the highlighted stations are removed from the S-J page and the associated weapon quantity reads zero.

The S-J mode bypasses any other weapons settings.

Emergency Jettison
Emergency Jettison clears all expendable stores and rack from the aircraft. While the button is depressed the SMS page displays the E-J subpage. Emergency Jettison does not require Master ARM to be activated.

Warning

While uncommon in BMS jettisoning stores with the gear down may result in collision and should be avoided. Ensure the gear is up before jettisoning.

Jettison is possible on the ground only when the GND JETT ENABLE switch located on the gear panel is set to ENABLE. But it should be used as a last resort.

3.7.7 INS In-Flight Alignment (AFI)

Although not fully implemented in-flight INS alignment may be performed in BMS.
BMS models only the AUTO IFA to some extent. It thus relies on GPS for internal alignment and does not require a fix to be made by the pilot. If one day MANUAL AFI is implemented, then fix taking will be required.

When in-flight alignment is required fly a straight, level and non-accelerated attitude.
Place the INS knob to OFF for 10 seconds (both OFF and AUX flags should be displayed on the ADI) then move it to in-flight ALIGN position.
The DED will display the INS page where INS status can be followed. The HUD will display ALIGN.
You cannot enter the magnetic heading manually in the UFC the BMS process is fully automatic.

As with ground alignment all data IS removed from the HUD and MFDs during in-flight alignment.
There is no end of alignment notification and the alignment will continue until the INS knob is placed back to NORM.

An INS status of 8.1 / 10 is sufficient (actually as with ground align the alignment in BMS is accurate with GPS as soon as the AUX flag disappears from the ADI). The INS knob can then be replaced to NORM and data will be displayed in the HUD and MFDs.

3.7.8 Controllability Check

A controllability check should be performed anytime a structural damage or any failure impacting aircraft handling is suspected or detected. The following action should be accomplished:

- Attain a safe altitude.
- Reduce Gross Weight.
- Lock LE FLAPS if LEF damage is observed.
- Determine the optimum configuration for landing by dirtying up to landing configuration and assess best AOA/ landing speed.
- Land using the above found settings.

If the aircraft is not controllable to a reasonable landing speed consider controlled ejection.

3.7.9 Out of Control Recovery

Recovery from most departures is usually automatic in 10-20 seconds as long as the controls are released. Recovery is detected by the nose pitching down and airspeed increasing.
To prevent another departure the pilot should wait until airspeed had reached 200 knots before moving the controls.

Deep Stall recovery.
A deep stall will not be recovered automatically because the normal range of movement of the flight controls is not enough to provide recovery. If the aircraft did not self recover after 20 seconds actions must be taken by the pilot to recover from a deep stall condition.
MPO switch should be held in override until recovery is complete. Whilst holding MPO in override (luckily the mouse code does not force the virtual pilot to keep the mouse button IN on the MPO hotspot) the pilot should apply stick pitch movement in phase with the aircraft pitch oscillation (usually plus or minus 15° with a slight nose down attitude) and reverse direction every 3 seconds. Sink rate is usually around 10000-15000 feet per minute.
Once recovery is initiated the nose will drop down into a steep dive, the oscillations will stop, airspeed will increase and AOA will return to a normal range (below 25°) Maintain MPO until airspeed indicates 200 knots and initiate dive recovery.
Recovery may be longer depending on stores carried. Consider jettison (in upright deep stall) if altitude is a concern.
An inverted deep stall recovery is similar to an upright deep stall recovery. Pilot roll and rudder

command should be avoided. MPO & Pitch stick command are the same as in an upright deep stall condition. It is not impossible that the inverted deep stall transitions to an upright deep stall before recovery.

3.8. LANDING EMERGENCIES

In case of suspected or fully developed in-flight failure, the type of landing pattern should be decided according to the following factors:

- Nature of the emergency
- Weather and time of day
- Fuel
- Aircraft response to pilot inputs

A straight in landing is recommended to minimise inputs on hydraulic, flight controls and electrical systems.
A simulated flameout pattern may be best suitable if engine failure is possible. If the engine fails the SFO pattern will provide sufficient energy to land the damaged aircraft safely.

3.8.1 LANDING WITH A BLOWN TYRE

The main danger from landing with a blown tyre is the blown tyre gear collapsing and directional control on the landing run. If a blown tyre condition is suspected gross weight should be reduced to a minimum before landing. External fuel tanks should be retained if empty. In that case, they should be depressurized to avoid explosion probability. This is done by opening the AR door at the expense of the NWS is BMS. Landing with the AR door open will prevent the NWS system being engaged.
Since explosion isn't really modelled, NWS might be more critical.

Land on the side of away from the blown tyre.
Use roll control to relieve pressure on the blown tyre and NWS to maintain directional control. Brake on the good tyre.

Stop the aircraft straight ahead and shut down the engine. Do not attempt to taxi unless an emergency situation exists.

3.8.2 LG EXTENSION MALFUNCTIONS

Malfunctions in the landing gear are usually indicated by a constant illumination of the gear handle red light or by lack of corresponding green wheel down lights.
The lollipop (handle) red light indicates a problem and the wheel down green lights indicate the localisation of the problem.

In BMS the landing gear handle will always move down (unlike in real life) but gear malfunction may occur nevertheless and is usually a consequence of over-speeding the aircraft above maximum undercarriage down speed, or hydraulic failure.

Alternate gear extension provides a pneumatic 'use only once' means to lower the landing gear. It should be accomplished at the lowest possible airspeed below 300 knots and preferably below 190 knots.

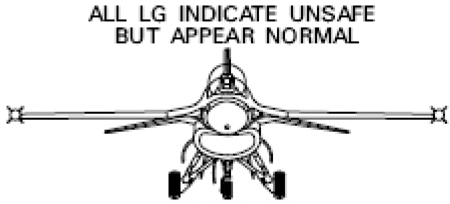
Alternate gear extension should be confirmed visually if at all possible. Any human wingman can confirm the correct position of the landing gear.

If the gear is confirmed down and locked, land normally. If any landing gear is still unsafe or up refer to landing with gear UNSAFE/UP bellow.

3.8.3 LANDING WITH GEAR UNSAFE/UP

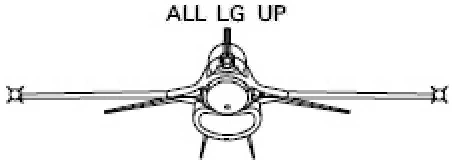
With most gear problems on landing retain empty fuel tanks and reduce gross weight. Because of the high probability of crash you may also consider shutting down the FCR and all unnecessary avionics

- **All landing gear indicate unsafe but appear normal:**



Be prepared for any gear failure on landing.
Shut down all non critical avionics before landing (FCR, SMS)
Land Normally

- **All landing gear UP:**



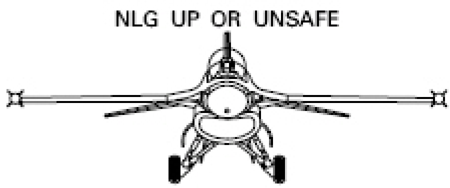
EPU ON
EXTEND ALT FLAPS
Land from a low angle apprach at 13° AOA.
Throttle OFF immediately prior touch down.

- **Both main landing gear up or unsafe:**

Alternate Gear handle IN & wait 5 seconds.
Landing Gear handle UP.
Depress Alternate Gear reset button.

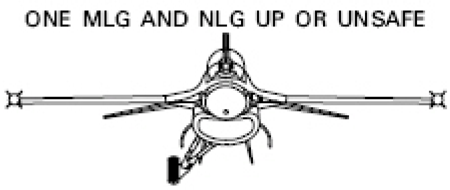
If nose landing gear does not retract, consider a low angle approach at 13° AOA with empty fuel tanks carried.

- **Nose landing gear up or unsafe:**



EPU ON
Consider low angle approach at 13° AOA
Throttle OFF after touchdown
Lower the nose to the runway before control effectiveness begins to decay
EPU OFF once stopped.

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

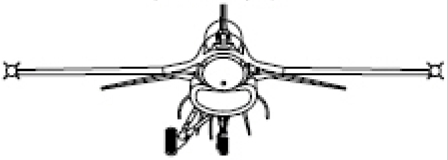


Alternate Gear handle IN & wait 5 seconds.
Landing Gear handle UP.
Depress Alternate Gear reset button.

If landing gear does not retract,
Consider landing from a low angle approach at 13° AOA with empty external tanks.
If external tanks are not carried, consider ejection.

Land on the side of the runway AWAY from the unsafe gear.

- **One main landing gear unsafe of up**



Alternate Gear handle IN & wait 5 seconds.
Landing Gear handle UP.
Depress Alternate Gear reset button.

If landing gear does not retract,
Consider landing from a low angle approach at 11° AOA with empty external tanks.
After touch down use roll control to hold wing up.
If external tanks are not carried, consider ejection

Land on the side of the runway AWAY from the unsafe gear.

3.8.4 BRAKE MALFUNCTIONS

Refer to Hot brakes, ground emergencies earlier in this chapter.

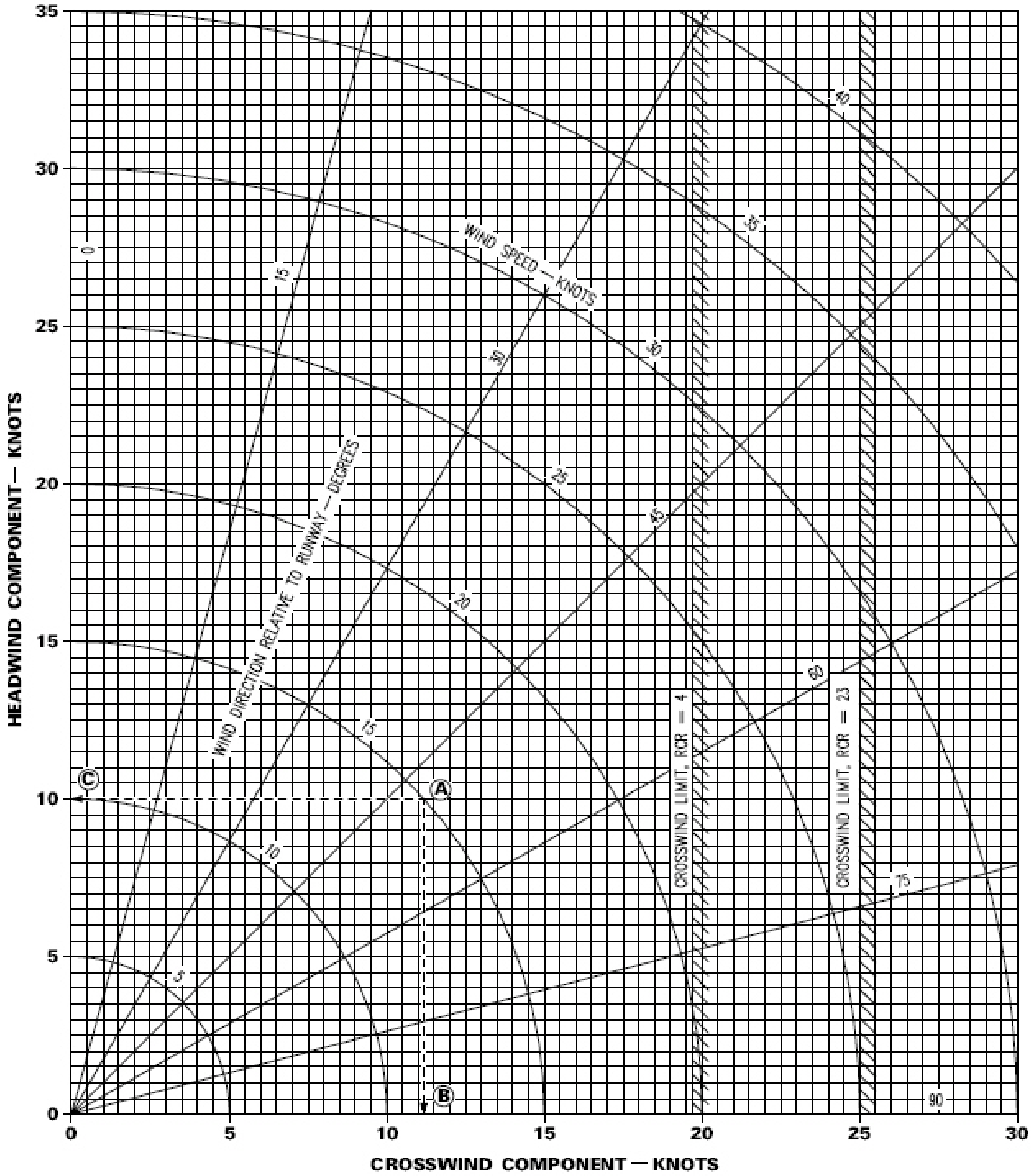
3.8.5 NOSE WHEEL STEERING MALFUNCTION

Refer to NWS failure, ground emergencies earlier in this chapter.

3.8.6 TAKEOFF & LANDING IN CROSSWINDS

The first step for managing the wind is to know the wind direction and speed.
On the ground your only information is from your briefing and from the tower. Since BMS 4.32 Update1, the tower is able to give out the wind speed and direction prior to departure.
In the air you can receive the wind from the F-16 data probes by using the DCS right on the UFC CNI page.
The second step is to calculate the real annoying component of the wind: the full crosswind. As you know the headwind is wanted for take-off and landing.
When the wind is not fully headwind or tailwind the crosswind component will push the aircraft to the side the wind is blowing to.
The wind force can be defined in two components: the head or tail component and the full cross component.
This is done with the following graphic, knowing the wind direction relative to the runway orientation, and the wind speed. See the example on the next page.

Since BMS does not implement RCR (runway condition) we can define a crosswind limit of 25 knots for BMS from the graph below. Any crosswind situation up to 24 knots can be dealt with in BMS but anything over 25 knots means diverting to an alternate runway with more favourable wind conditions.



Let's consider the following example:
Runway heading is 360° and a wind blows from 330° at 20 knots.
You enter the graph on the line giving the wind direction relative to the runway, 360-330=30 degrees.
You then find the wind speed on the left of the graph and follow the curve until you intersect the first line.
By plotting the found coordinates on the two axes you will have the full headwind and full crosswind component of this scenario.
In this case 17.5 knots headwind and 10 knots crosswind.

Takeoff in crosswind should be done on the upwind side of the runway centreline and directional control is to be maintained with rudder until the ARI (Aileron Rudder Interconnect) kicks in.
In BMS the crosswind will mostly be felt once the main wheels leave the runway. The FPM will drift to the side of the HUD.

Landing in crosswind may be a little bit more complicated.
There are usually two techniques for crosswind landings in aviation. The first is to put one wing down and side slip with rudder to the runway, the second is to simply crab the aircraft wing level into the wind all the way to the runway.
Because of the ARI that connects Aileron to Rudder, the wing down sideslip is to be avoided with the F-16. The rudder should not be used in landing the F-16!
So the wing level crab is the best technique for landing the F-16. Take your feet off the rudder and let the aircraft nose point into the wind. In high crosswinds situations, the FPM may drift outside the HUD field of view and you may have to centre the FPM with the drift C/O switch.

Always plan your touch down point on the upwind side of the runway.

On touchdown the ARI switches out and undesirable yaw transients may occur if roll control is being applied at this time. The aircraft will steady itself after a short while. Refrain the urge to counter with flight controls and let the aircraft steady itself (the transition to WOW should be better handled in BMS 4.32 Update 1 than with earlier BMS versions)
Maintain aerobraking and use the rudder and aileron to maintain directional control.
As the airspeed decreases the amount of rudder input to maintain directional control increases.
Once the nose gear is firmly on the ground you can start braking and maintain directional control with the rudder, differential braking and NWS once below control speed.
Excessive differential braking may result in a hot brakes condition.

4. BIBLIOGRAPHY

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- F-16 dash 1
- BMS manual (ex dash 34)
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- BMS website published articles
- Chart tutorial V2
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- Vol 5 Basic Employment Manual

5. ACKNOWLEDGMENT

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Nevertheless I take full responsibility for any error remaining in the document.

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Obviously, this manual wouldn't have been possible without the tremendous work done by the BMS team. So big thanks go to all coders and beta testers who to this day make the update process of this book a nightmare because of all the changes and new additions to BMS ☺.
I love it and hope I can keep this manual updated for the next 10 years.