



# DCS: M-2000C

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*The information provided in this manual is preliminary and subject to revision.*

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**By RAZBAM**

Revision 0.10.0

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# Introduction

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The M-2000C is a French single engine fourth generation fighter. Designed in the late 1970s as a lightweight fighter for the French Air Force (*Armée de l'Air*). Later evolved into a multirole aircraft with several variants developed, with sales to a number of nations. Over 600 aircraft were built and it has been in service with nine nations.

The M-2000 was initially intended to replace the previous generation Mirage III for the export market, and was smaller and cheaper than the aircraft proposed to the French Air Force, called the Avion de Combat Futur ACF (Futur Combat Aircraft). The project was first known as the "Super Mirage III", then "Delta 1000", "Delta 2000", "Super Mirage 2000" to finally settle for "Mirage 2000".

Unlike the ACF, which was a strike aircraft with secondary capabilities as interceptor, the M-2000C was designed as an interceptor. When the ACF project was cancelled, the M-2000C was offered as a cheaper alternative to the French government and was approved on December 1978.

The M-2000C was also designed to compete with the General Dynamics F-16 in the lucrative European market, which was interested in small, but agile, lightweight fighters.

The M-2000C features a low-set thin delta wing with cambered section, 58 degrees leading-edge sweep and moderately blended root; area-ruled; two small canard wings, fixed, placed just behind the air intakes. The flight surfaces on the wings are composed of four elevons and four leading edge slats. Its neutral point is in front of its center of gravity of an aircraft, giving the fighter relaxed stability to enhance maneuverability. It incorporated negative stability and fly-by-wire controls with four analog computers. Airbrakes are fitted above and below each wing in an arrangement very similar to that of the Mirage III and IV. A noticeably taller tailfin allows the pilot to retain control at higher angles of attack, assisted by the small strakes mounted along each air intake.

The aircraft uses retractable Tricycle type landing gear. A runway tailhook or a fairing for a brake parachute can be fitted under the tail, which can operate in conjunction with the landing gear's carbon brakes to shorten landing distances. A removable refueling probe can be attached in front of the cockpit, offset slightly to the right of center.

## Cockpit

The Mirage 2000 is available as a single-seat or two-seat multi-role fighter. The pilot flies the aircraft by means of a center stick and left hand throttles, with both incorporating hands-on-throttle-and-stick (HOTAS) controls. The pilot sits on a license-built version of

the British Martin-Baker Mark 10 zero-zero ejection seat. Unlike in the F-16, the pilot sits in a conventional position, without the steep backward slope of the F-16 seat.

The instrument panel is dominated by the head-up display which presents data relating to flight control, navigation, target engagement and weapon firing, and the radar screen located centrally below it. To the lower left is a stores management panel, above which are the navigation instruments and altimeter. The right half of the instrument panel accommodates the engine and systems displays. Located on the left side of the cockpit, just ahead of the throttle, are controls for the communications equipment.

## **Engines**

The SNECMA M53 afterburning turbofan was developed for the ACF, and was available for the M-2000C project. The first 37 aircraft were equipped with the SNECMA M53-5 engine version; later aircraft were equipped with the SNECMA M53-P2 version. The M53-P2 provides 64.3 kilonewtons (14,500 lbf) of thrust dry and 95.1 kilonewtons (21,400 lbf) in afterburner. The first 37 aircraft were equipped with the SNECMA M53-5 engine version; later aircraft were equipped with the SNECMA M53-P2 version. The air intakes are fitted with an adjustable half-inlet cone-shaped center body, which provides an inclined shock of air pressure for highly efficient air intake. Total internal fuel capacity is 3,978 litre (1,051 US gal). There are also provisions for a jettisonable 1,300-litre (340 US gal) centerline fuselage fuel tank and for a 1,700-litre (450 US gal) or 2,000-litre (528 US gal) drop tank under each wing.

## **Payload and armaments**

The M-2000C is equipped with built-in twin DEFA 554 30 mm revolver-type cannons with 125 rounds each. The cannons have selectable fire rates of 1,200 or 1,800 rounds per minute.

The aircraft can carry up to 6.3 tons (13,900 lb) of stores on nine pylons, with two pylons on each wing and five under the fuselage. External stores can include Matra Super 530D medium-range semi-active radar-guided air-to-air missile on the inboard wing, and Matra Magic II short-range infrared-seeking AAM on the outboard wing pylons.

## **Sensors and avionics**

Avionics for the M-2000C include the Sagem ULISS 52 inertial navigation system (INS), TRT radio altimeter, Dassault Electronique Type 2084 central digital computer, Digibus digital data bus and Sextant Avionique Type 90 air data computer. The communication equipment package includes the LMT NRAI-7A IFF transponder, IO-300-A marker

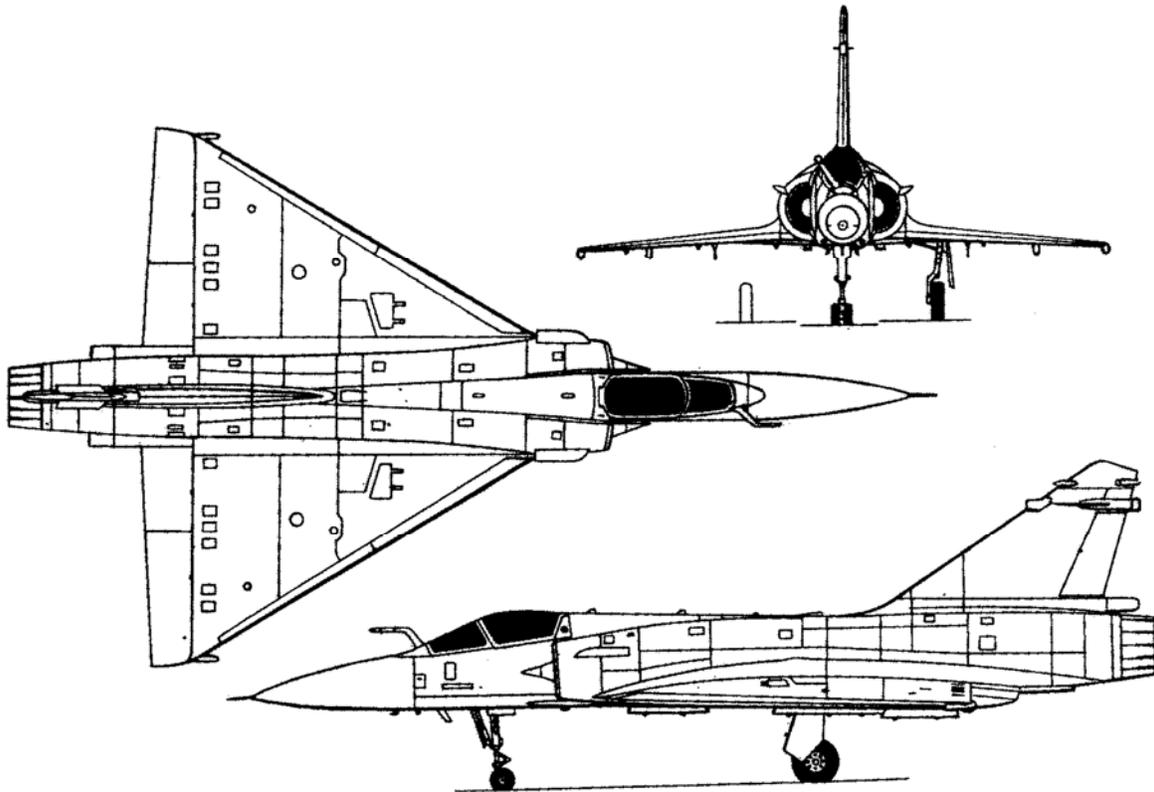
beacon receiver, TRT ERA 7000 V/UHF com transceiver, TRT ERA 7200 UHF or EAS secure voice communications.

The aircraft has a redundant fly-by-wire automatic flight control system, providing a high degree of agility and easier handling, together with stability and precise control in all situations. The fighter's airframe is naturally unstable, and so it is coupled with FBW commands to obtain the best agility; however, in override mode it is still possible to exceed a 270 deg/sec roll rate and allows the aircraft to reach 11 g (within the 12 g structural limit), instead of 9 g when engaged.

The aircraft uses the RDI pulse-Doppler radar with an operating range of 54 nm (100 km / 62 miles). This unit was an evolution of Cyrano radars, with more modern processing units and look-down/shoot-down capabilities.

The M-2000C is equipped with a radar warning receiver (RWR) with antennas on the wingtips and on the rear of the top of the tailfin. It is also equipped with the Sabre radar jamming and deception in a pod below the bottom of the tailfin, with the antenna in a fairing on the front of the tailfin. Countermeasures are provided by Spirale dispensers, each fitted on the extensions behind the rear of each wingroot, giving a total capacity of 112 chaff cartridges, the flares dispensers are located under the wing roots with a total of 16 cartridges.

# General Characteristics



<i>Primary function:</i>	Interceptor with some CAS (Close Air Support)
<i>Power plant:</i>	1 × SNECMA M53-P2 afterburning turbofan
<i>Thrust:</i>	<b>Dry thrust:</b> 64.3 kN (14,500 lbf) <b>Thrust with afterburner:</b> 95.1 kN (21,400 lbf)
<i>Wingspan:</i>	9.13 m (29 ft)
<i>Length:</i>	14.36 m (47 ft 1 in)
<i>Height:</i>	5.20 m (17 ft)
<i>Weight:</i>	<b>Empty weight:</b> 7,500 kg (16,350 lb) <b>Loaded weight:</b> 13,800 kg (30,420 lb)
<i>Maximum takeoff weight:</i>	17,000 kg (37,500 lb)
<i>Fuel capacity:</i>	3978 litres (1050 US gallons; 875 Imp gallons)
<i>Speed:</i>	Mach 2.2 (2,530+ km/h, 1,500+ mph) at high altitude/ 1,110 km/h (690 mph) at low altitude
<i>Range:</i>	1,550 km (837 nmi, 963 mi) with drop tanks
<i>Ceiling:</i>	17,060 m (59,000 ft)
<i>Armament:</i>	<b>Guns:</b> 2 × 30 mm (1.18 in) DEFA 554 revolver cannon, 125 rounds per gun

**Hardpoints:**

9 total (4× under-wing, 5× under-fuselage) with a capacity of 6,300 kg (13,900 lb) external fuel and ordnance

**Rockets:**

2x Matra 68 mm unguided rocket pods, 18 rockets per pod

**Air-to-air missiles:**

2× Matra R550 Magic-II and

2× Matra Super 530D

**Bombs:**

8× Mk.82

8x Mk.82SE

9x GBL-66 Belouga cluster bombs

1x BAP-100 anti-runway dispenser.

4x GBU-12

1x GBU-16

1x GBU-24

*Crew:*

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# Acknowledgments

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We would like to take a moment first to thank the following people involved on the project and who made possible the release of this aircraft.

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# Keyboard Map

## Communications

Panel	Btn/Sw	DCS Function	Key
		Request AWACS Available Tanker	LWin + I
		Receive Mode	Rshift + \
U/VHF Radio	Mode Selector	U/VHF Radio OFF	
		U/VHF Radio ON	
		U/VHF Guard Mode	
		U/VHF Manual Mode	
		U/VHF Preset Mode	

## Engine and Fuel

Panel	Btn/Sw	DCS Function	Key
		Engines START	RShift + Home
		Engines STOP	RShift + End
		Fuel Dump Start	R
	Left Fuel Boost Pump	Left Fuel Boost Pump ON	
		Left Fuel Boost Pump OFF	
	Right Fuel Boost Pump	Right Fuel Boost Pump ON	
		Right Fuel Boost Pump OFF	
	Fuel Emergency Cutoff	Fuel Emergency Cutoff Switch Cover CLOSE	
		Fuel Emergency Cutoff Switch Cover OPEN	
		Fuel Emergency Cutoff Switch ON	
		Fuel Emergency Cutoff Switch OFF	
	Start Button	Start Button Safety Cover CLOSED	
		Start Button Safety Cover OPEN	
	Starter Fuel Pump	Starter Fuel Pump ON	
		Starter Fuel Pump OFF	
	Ignition Selector	Ignition Selector Switch LEFT (G)	
		Ignition Selector Switch RIGHT (D)	
		Ignition Selector Switch OFF (VENT)	
	Air Refuel Transfer	Air Refuel Transfer Switch OFF	
		Air Refuel Transfer Switch ON (DAY)	
		Air Refuel Transfer Switch ON (NIGHT)	
	Afterburner Cutoff	Afterburner Cutoff Switch Cover CLOSE	
		Afterburner Cutoff Switch Cover OPEN	
		Afterburner Cutoff Switch OFF	
		Afterburner Cutoff Switch ON	
	In-Flight Start	In-Flight Start Switch OFF	
		In-Flight Start Switch ON	
Air Flow Control	SOURIS	Engine Inlet Cones AUTO	
		Engine Inlet Cones R	
	PELLES	Engine Slats AUTO	
		Engine Slats R	

## Flight Control

Panel	Btn/Sw	DCS Function	Key
		Aircraft Pitch DOWN Aircraft Pitch UP Aircraft Bank LEFT Aircraft Bank RIGHT Aircraft Rudder LEFT Aircraft Rudder RIGHT Throttle UP Throttle DOWN Trim RUDDER LEFT Trim RUDDER RIGHT Slats RETRACT	
Left Inst. Panel	BECS	Slats AUTO Slats EXTEND	
Landing Gear	GAIN	FBW Gain Cover CLOSED FBW Gain Cover OPEN FBW Gain NORM FBW Gain EMER FBW G-Limiter Mode TOGGLE	
Main Inst. Panel	SPIN	FBW Spin Switch TOGGLE	
		Flight Control	

## External Illumination

Panel	Btn/Sw	DCS Function	Key
		Landing Lights TOGGLE Anti-Collision Lights TOGGLE Navigation Lights TOGGLE Formation Lights TOGGLE	
	Police Lights	Police Lights Disabled Police Lights Enabled	
	Landing Lights	Landing Lights OFF Landing Lights TAXI Landing Lights LANDING	
	Refuel Lights	Refuel Lights Disabled Refuel Lights Enabled	
External Lights	Anti-Collision	Anti-Collision Lights OFF Anti-Collision Lights DIM Anti-Collision Lights BRIGHT	
	Navigation	Navigation Lights OFF Navigation Lights DIM Navigation Lights BRIGHT	
	Formation	Formation Lights OFF Formation Lights DIM Formation Lights BRIGHT	

## Weapons Manager

Panel	Btn/Sw	DCS Function	Key	
PCA	Master Arm	Master Arm TOGGLE	0	
	Gun Arm	Gun Arm TOGGLE	LCtrl + 6	
	TR Button 1	PCA Button 1 SELECT	1	
	TR Button 2	PCA Button 2 SELECT	2	
	TR Button 3	PCA Button 3 SELECT	3	
	TR Button 4	PCA Button 4 SELECT	4	
	TR Button 5	PCA Button 5 SELECT	5	
	AG Gun	AG Gun SELECT	LCtrl + 0	
	BR Button 1	Stores 1 SELECT	LCtrl + 1	
	BR Button 2	Stores 2 SELECT	LCtrl + 2	
	BR Button 3	Stores 3 SELECT	LCtrl + 3	
	BR Button 4	Stores 4 SELECT	LCtrl + 4	
	BR Button 5	Stores 5 SELECT	LCtrl + 5	
	Selective Jettison		Selective Jettison Safety Cover OPEN	
			Selective Jettison Safety Cover CLOSED	
			Selective Jettison ON	
Selective Jettison OFF				
Emerg. Jett.		Smoke (Smokewinders)	T	
		Emergency Jettison	LShift + E	

## Weapons Preparation

Panel	Btn/Sw	DCS Function	Key	
PPA	Missile Selector	Missile Selector: Fire Left 530D First		
		Missile Selector: Automatic 530D Fire Selection		
		Missile Selector: Fire Right 530D First		
	Super 530D Preparation		MIS PREP: Super 530D Standby Toggle	
			MAG PREP: MAGIC II Standby Toggle	
	Bomb Fuze Selector		Bomb Fuze: INERT	
			Bomb Fuze: RET	
			Bomb Fuze: INST	
	Bomb Release Quantity Selector		Bomb Qty Increase	
			Bomb Qty Decrease	
	Bomb Release Interval Selector		Bomb Release Interval Increase	
Bomb Release Interval Decrease				
Salvo Firing Selector		530D/Rockets/Guns TOT/PAR Firing Mode Toggle		

## Sensors

Panel	Btn/Sw	DCS Function	Key
RADAR	Radar Operation	Radar OFF	
		Radar WARM UP	
		Radar STANDBY	
		Radar ON	
	Radar Range Selector	Radar Range DECREASE	
		Radar Range INCREASE	
		PRF Selector Low -> Int -> High PRF Selector High -> Int -> Low	
	PRF Selector	PRF Selector Low	
		PRF Selector Int	
		PRF Selector High	
	Radar Azimuth	Radar Azimuth WIDE	
		Radar Azimuth MIDDLE	
		Radar Azimuth NARROW	
	Radar Bars	Radar Scan 4-LINE	
Radar Scan 2-LINE			
Radar Scan 1-LINE			
Radar Display mode	Radar PPI Mode (Radial Top-Down)		
	Radar B-Scope Mode (Square Projection)		
Radar TDC Mode	TDC Mode Switch S		
	TDC Mode Switch Z		
ECM	RWR	RWR OFF	
		RWR ON	
		RWR TEST	
HUD	Radar Altimeter	Radar Altimeter OFF	
		Radar Altimeter ON	
		Radar Altimeter TEST	
Radar IFF	IFF Power	Radar IFF OFF	
		Radar IFF SECTOR	
		Radar IFF CONT	

## Seat adjustment

Button	Function	DCS Function	Key
	Seat Adjustment	Seat Up	LShift + S
		Seat Down	LShift + LAlt + S
Cockpit Camera		Camera Up	RCtrl + RShift + Keypad Up Arrow
		Camera Down	RCtrl + RShift + Keypad Down Arrow
		Camera Left	RCtrl + RShift + Keypad Left Arrow
		Camera Right	RCtrl + RShift + Keypad Right Arrow

## Autopilot System

Button	Btn/Sw	DCS Function	Key
		Autopilot On/Off	A
		Barometric Altitude Hold	H
		Selected Barometric Altitude Hold	LShift + H
		Autopilot Standby	LAlt + A
		Autopilot Disconnect/Hard Stop Enable	LShift + A
		Approach Hold	F

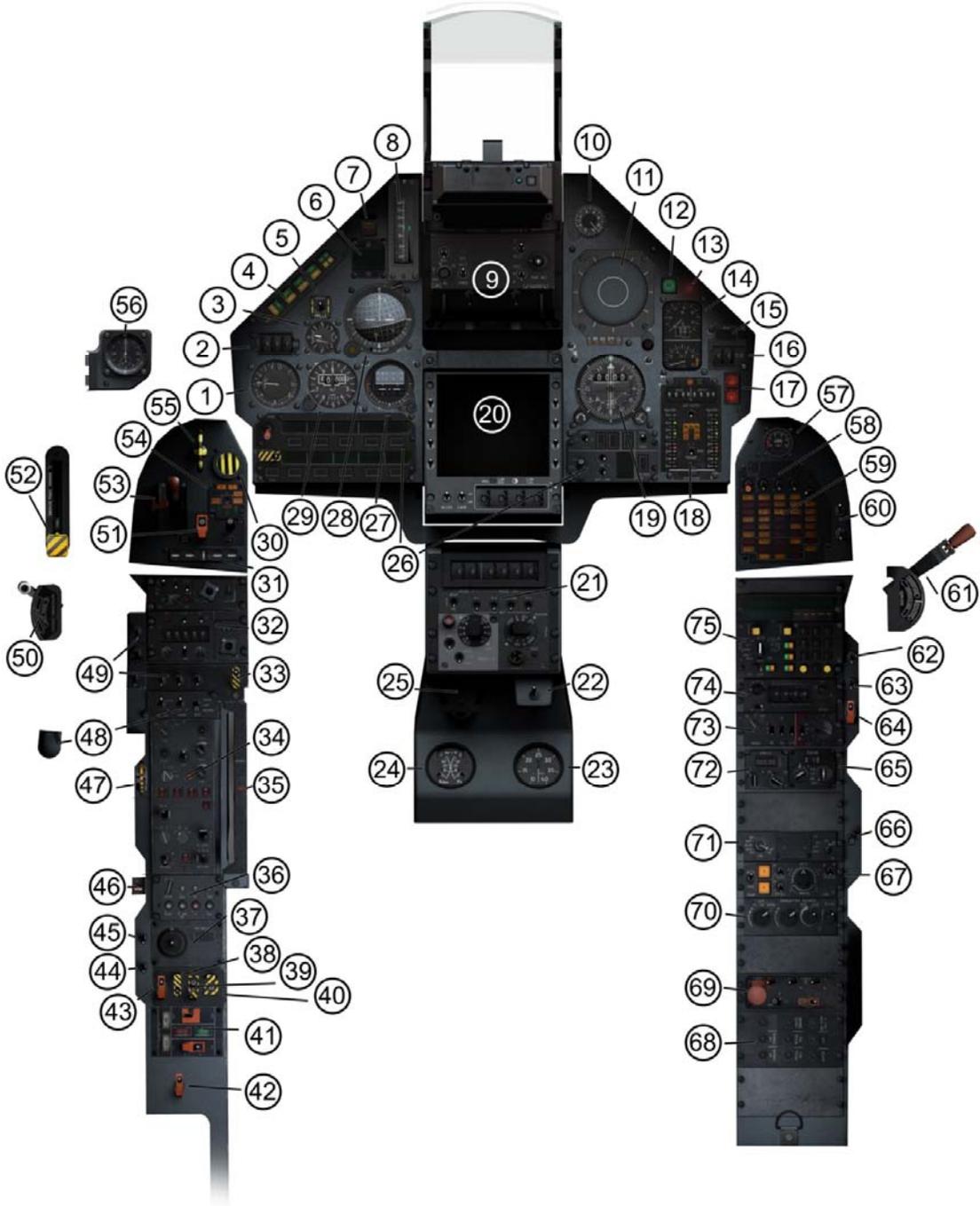
## System

Button	Btn/Sw	DCS Function	Key
		Master Caution Reset	LCtrl + R
		Wheel Brake On/Off (In Air: Control Hard Stop	W

Note: The functions that have a blank space in the key combination column do not have a default key combination. You can choose your own.

# Chapter 1: Instruments Layout

## Instruments Panel Map.



# Main instruments panel and center console

1. *Airspeed Indicator* Displays indicated airspeed in knots and mach.
2. *Autopilot Altitude Selector* Adjust autopilot altitude hold value.
3. *Vertical Velocity Indicator* Displays vertical velocity in feet/min.
4. *Autopilot Controls/Indicator Lights* Pushbuttons that enable/disable the autopilot functions and indicates the system status.
5. *Fly-By-Wire Spin switch* Two position switch:
  - Norm: FBW system is in control
  - Vrille (Spin): FBW limiter is overridden. To be used only in emergencies during a flat spin stall.
6. *Radio Frequency display* Indicates the selected frequencies in both radio transmitters. V/UHF main radio on top. UHF auxiliary radio on the bottom.
7. *Master Caution/Warning Lights* Two tones lights that indicate the presence of a warning/caution condition:
  - Amber light: indicates that there is a problem, but aircraft safety is not immediately imperiled.
  - Red light: indicates that there is an emergency condition that requires urgent action. Aircraft safety is compromised.
8. *AOA Indicator* Indicates the aircraft's current angle of attack in degrees.
9. *HUD Pedestal* Contains the HUD controls and the HUD itself.
10. *G Meter* Indicates current vertical acceleration forces in G.
11. *Radar Warning Receiver (RWR)* Shows any radar emitters around the aircraft.
12. *Afterburner Status Light* Indicates when the engine is using the afterburner.
13. *Engine Start Light* Indicates that the engine is starting-up.
14. *Engine Instruments* Indicates engine RPM and Temperature.
15. *Fuel Flow Indicator* Indicates current engine fuel flow in Kg/min
16. *Bingo Fuel Selector* Adjust the value for the Bingo Fuel warning.

<i>17. Engine Fire Warning Lights</i>	Two lights that indicate an overtemp, possible fire condition. They correspond respectively to the engine center and the engine tailpipe.
<i>18. Fuel Control Panel</i>	Indicates current fuel quantity in Kilograms and controls the tanks crossfeed valve.
<i>19. HSI</i>	Horizontal Situation Indicator.
<i>20. VTB/HDD</i>	Radar display.
<i>21. IFF Panel</i>	Information Friend of Foe control panel.
<i>22. Hydraulic Pressure Selector</i>	Selects the hydraulic pump for the hydraulic pressure indicator.
<i>23. Cabin Pressure Indicator</i>	Indicates current cabin pressure in bars.
<i>24. Hydraulic Pressure Indicator</i>	Indicates hydraulic pressure for both System 1 and System 2 in bars.
<i>25. Rudder pedals adjustment lever</i>	Adjusts the height of the rudder pedals.
<i>26. Weapons Management Panels</i>	Consists of two panels on both sides of the VTB. PCA (Poste de Commande Armement – Weapons Control Panel): This panel controls weapons selection and navigation parameters. It also controls HUD display modes. PPA (Poste de Préparation Armement – Weapons Configuration Panel): This panel controls how the selected weapon will be used.
<i>27. Standby Attitude Indicator</i>	Auxiliary attitude indicator. Only shows pitch and roll.
<i>28. Main Attitude Indicator</i>	Show pitch, roll and heading. Additionally, it has glideslope and course deviation bars for use during ILS landings.
<i>29. Altitude Indicator</i>	Indicates barometric altitude (MSL) in feet up to 49,999 feet.

## Left instruments panel

- |   |  |
|---|--|
| <i>30. Emergency Jettison Button</i>                  | The emergency jettison button, drops all weapons except the Magic missiles.  |
| <i>31. Trim Indicators</i>                            | Indicate trim position for the control surfaces in the wings and tail.   |
| <i>32. Communication Radios</i>                       | Both main (VHF/UHF) and auxiliary (UHF) radios. The main radio can be identified by the manual frequency selectors.  |
| <i>33. Anti-Skid Switch</i>                           | Enables/disables the anti-skid system.   |
| <i>34. Radar control panel</i>                        | Controls and configures radar operational parameters.  |
| <i>35. Engine shutdown button</i>                     | Allows the throttle to be retarded from the Ground-Idle position back to the Stop position.  |
| <i>36. Audio control panel</i>                        | Controls the volume of the following components: Communication radios, TACAN, VOR/ILS, Markers, Magic seek and lock tones.   |
| <i>37. Trim control panel</i>                         | Emergency pitch/roll trim control (overrides the trim hat of the stick) and yaw trim control.  |
| <i>38. Emergency Oil pump switch</i>                  | Enable/disables the emergency oil pump.  |
| <i>39. Emergency Computer switch</i>                  | Activates an emergency computer if the main computer fails. It is a get-you-home system.   |
| <i>40. Fuel dump switch</i>                           | Dumps all the fuel that exists in the external tanks (if mounted).   |
| <i>41. Fly-By-Wire and Autopilot test panel.</i>      | Tests the FBW and Autopilot controls. Must be performed after engine start and before flight.  |
| <i>42. Fly-By-Wire Emergency Channel</i>              | The FBW emergency channel is a last resort system in case of total FBW failure. The aircraft is put in a get-you-home condition. Not to be used for normal flight. |
| <i>43. Afterburner cutoff switch</i>                  | Enable/disables the engine afterburner.  |
| <i>44. Radar Ground Emitting Authorization switch</i> | Used by maintenance personnel only. It overrides the safety system that prevents the radar from emitting while on the ground.                                      |
| <i>45. Tape Recorder Switch</i>                       | Self-explanatory.  |

<i>46. Mid-Air startup switch</i>	Starts the engine while in flight.
<i>47. Emergency Throttle</i>	Secondary throttle control, to be used in emergency situations.
<i>48. Flight controls panel</i>	Controls the aircraft's automatic flight control surface: Souris = Engine shockwave cones. Pelles = Engine scoops that force airflow into the auxiliary intakes for increased air circulation at high AOA. Beccs = Wing slats that are controlled by the FBW system.
<i>49. Exterior Lights panel</i>	Switch bank for the Navigation, Anti-collision strobe and Formation lights.
<i>50. Drag chute deploy handle</i>	Deploys the aircraft drag chute when installed.
<i>51. Flight-By-Wire limiter switch</i>	Selects FBW operational mode: A/A – For air-to-air combat (Default). CHARGES (Stores) – For carrying any load heavier than air-to-air missiles and empty central tank.
<i>52. Canopy breaking handle</i>	To open the canopy if the handle fails.
<i>53. Landing Gear Lever</i>	Actuates the landing gear.
<i>54. Configuration indicator panel.</i>	Indicates brakes, landing gear, hook, NWS and Anti-Skid status.
<i>55. Emergency Landing Gear Lever</i>	Lowers the landing gear in case of primary system failure.
<i>56. Clock</i>	Analog clock with current ZULU time.

## Right instruments panel

<i>57. Oxygen Quantity Indicator</i>	Indicates Oxygen supply quantity.
<i>58. Power Switches</i>	Activates the aircraft's electrical power system: BATT – Activates the main battery. ALT1 – Engages Alternator 1. ALT2 – Engages Alternator 2. TRN – Enable power transfer between buses.
<i>59. Caution/Warning Advisory Panel</i>	Indicates emergency/anomalous conditions in the aircraft. It is tied to the Master Caution/Warning lights.

Amber lights are caution lights indicating an anomalous condition.

Red lights are warning lights indicating emergency situations that put the aircraft in peril.

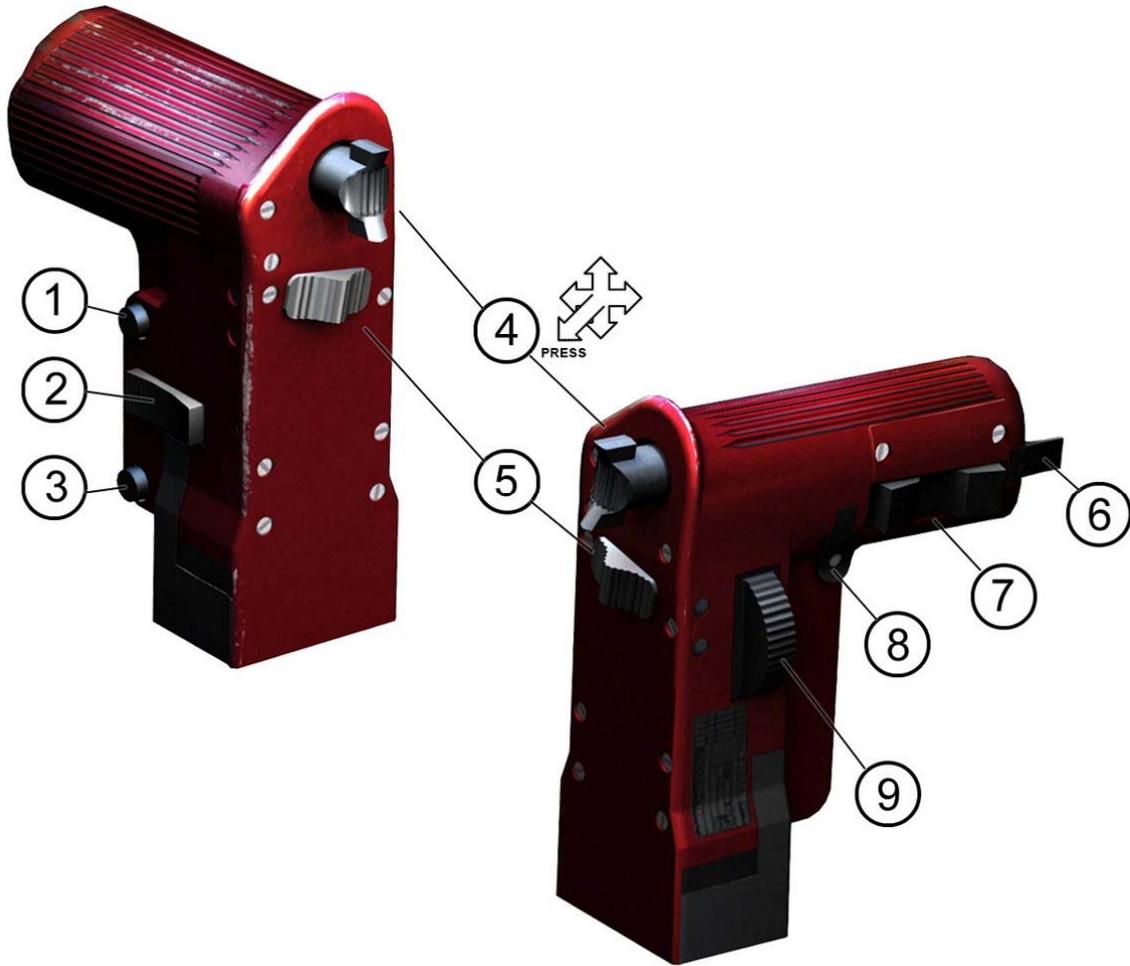
<i>60. Blank Switch</i>	Not used.
<i>61. Canopy Unlock/Lock handle</i>	Locks/unlocks the canopy.
<i>62. Emergency Hydraulic Pump Switch</i>	Enables/disables the emergency hydraulic pump. Three-position switch: Off – Auto – Test.
<i>63. Audio Alert Switch</i>	Enables/disables the aircraft's audio alerts. It does not control landing gear, AOA and missile tone.
<i>64. Pitot Anti-Ice Switch</i>	Enables/disables the pitot anti-ice system.
<i>65. TACAN panel</i>	Controls the TACAN radio.
<i>66. Emergency Horizon Switch</i>	Activates an emergency artificial horizon.
<i>67. Environment control panel</i>	Controls the cockpit and instruments air conditioning system.
<i>68. Circuit Breakers</i>	Electrical circuit breakers.
<i>69. Engine Start panel</i>	Controls engine fuel pumps and startup system. It also has the engine fuel shut-off valve switch ("robinet coupe-feu").
<i>70. Interior Lights panel</i>	Controls the interior lights system.
<i>71. INS PSM/MIP Panel</i>	Controls INS operation. Also has the access port for navigational data cartridges.
<i>72. VOR/ILS Panel</i>	Controls the VOR/ILS radio.
<i>73. Electronic Warfare Panel</i>	Controls the RWR, Jammer, Missile launch detector and Chaff/Flares operation.
<i>74. Radar IFF panel</i>	Controls the radar IFF interrogation system.
<i>75. INS Panel</i>	Display and data entry panel for the INS system.

# Hands-On-Throttle-And-Stick (HOTAS) System

The M-2000C has an integral HOTAS system that allows the pilot to control multiple functions.



Button	Function	DCS Function	Key
1	Trigger Safety Flag		
2	Magic Search/Nav Update	NAV Update/MAGIC unlock	
3	Trim	Trim UP	RCtrl + S
		Trim DOWN	RCtrl + W
		Trim LEFT	RCtrl + A
		Trim RIGHT	RCtrl + D
4	Use Selected Decoy Program Release	Decoy Program release	Delete
		Special Modes FWD	
5	PIP	Special Modes AFT	
		Target Unlock/Special Modes	
		Deselect	Back
6	Trigger: MICROB	Weapons FIRE/Bombs Release	Space
7	AP Disengage	Autopilot Standby Mode	
8	AA Radar Modes	STT/TWS Toggle (Target Lock)	Enter
9	NWS/IFF Interrogator	Nose wheel Steering/IFF	
		Interrogate	
10	AP Disconnect	Autopilot Disconnect/Exceed	
		Elastic Limit	



Button	Function	DCS Function	Key
1	Jammer Priority Selector: Radar or Jamming.	Jammer ACTIVATE/Standby Toggle	E
2	Radio Selector: Left - UHF / Right - V/UHF	Main U/VHF Radio SELECT	LShift + Num +
3	Use EMERG Decoy Program Release	Aux. UHF Radio SELECT Decoy PANIC release	LAlt + Num - Insert
4	TDC	TDC Up TDC Down TDC Left TDC Right TDC Center	; . , / 
5	Air Brake In/Out	Airbrake TOGGLE Airbrake ON Airbrake OFF	B LShift + B LCtrl + B
6	Police Light On/Off	Police Light Toggle	

Button	Function	DCS Function	Key
7	Weapon Selection: AA Gun/PCA/Magic	AA Gun SELECT PCA Select MAGIC SELECT Magic Slave/AG	C
8	AG Designator/Magic Slave	Designate/ INS Position Update	
9	Radar Antenna Elevation/"DEC" Height Select <sup>1</sup>	Radar Antenna UP Radar Antenna DOWN Radar Antenna CENTER	

**Note:**

Buttons without a DCS Function are not operational/available in DCS.

1: "DEC" Height Select is not available in this version.

## HOTAS Functions Description

### Stick Functions

- **Special Modes FWD:** Its functionality depends on the selected attack mode.
  - **AA Mode:** It engages Close Combat Mode, cycling between Boresight and Vertical Scan modes.
  - **AG Mode:** It engages Air to Ground Attack mode.
- **Special Modes AFT:** Its functionality depends on the selected attack mode.
  - **AA Mode:** It engages Close Combat Mode, cycling between Horizontal Scan 1 and Horizontal Scan 2 modes.
  - **AG Mode:** It sets the system to NAV mode despite weapons selection.
- **STT/TWS Toggle (Target Lock):** It is only functional when the system is in AA or POL Modes. If there is no locked radar target, it will lock the target below the TDC. Otherwise it will cycle between TWS (PID) and STT (PIC) modes.
- **Nose Wheel Steering/IFF Interrogate:** Its functionality changes on whether the aircraft is on the ground or on the air.
  - **In the ground:** It engages/disengage the nose wheel steering system (NWS).
  - **In the air:** If the radar IFF interrogator is enabled, it interrogates radar contacts to determine if they are friend or foe.
- **Autopilot Standby Mode:** While this button is pressed, the autopilot is disconnected in order to maneuver the aircraft using the flight controls.
- **Magic Search/Nav Update:** Its functionality depends on system Master Mode.
  - **NAV Mode:** Starts INS Position Update (equivalent to clicking on the REC button in the PCN). Please see INS Position update chapter.
  - **AA Mode:** If the selected weapon is Magic and it has a lock, it clears the lock so the seeker starts searching again.

## Throttle Functions

- **AA Gun Select:** It selects the DEFA guns for use and sets the system in AA mode overriding any PCA weapons selection. PCA selection is saved in system memory.
- **PCA Select:** It selects the weapon that was activated via PCA (Weapons Control Panel). Sets the system in AA or AG mode based on weapons selection.
- **MAGIC Select:** It selects MAGIC missiles for use and sets the system to AA mode overriding any PCA weapons selection. PCA selection is saved in system memory.

**Note:** If there are no MAGIC missiles onboard the aircraft, the DEFA guns will be selected instead.

- **Magic Slave/AG Designate/Radar INS Calibration:** Its functionality depends on system Master Mode.
  - **NAV Mode:** Starts Radar INS Position Update. It uses the radar TAS mode to calculate the difference between INS position and the radar cross so the INS can update its position.
  - **AA Mode:** It slaves the Magic missile seeker to the radar or viceversa. Only works when there is a locked radar target and Magic missiles have been selected.
  - **AG Mode:** Its functionality is based on attack mode:
    - **CCRP Direct (No INS):** It designates the ground under the diamond reticle as a bombing target. If a target has been designated, it clears the designation.
    - **INS Bombing (IP/BAD):** It works similar to NAV Mode, except that it is the IP position that is updated.

# Ejection Seat

The M-2000C uses a licensed version of the Martin Baker Mk10 zero-zero ejection seat.



The seat can be raised or lowered as the pilot sees fit.

Button	Function	DCS Function	Key
	Seat Adjustment	Seat Up Seat Down	LShift + S LShift + LAlt + S
	Cockpit Camera	Camera Up Camera Down Camera Left Camera Right	RCtrl + RShift + Keypad Up Arrow RCtrl + RShift + Keypad Down Arrow RCtrl + RShift + Keypad Left Arrow RCtrl + RShift + Keypad Right Arrow

# Chapter 2: Engine

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## SNECMA M53-P2 Engine Information

The M-2000C uses the SNECMA M53-P2, afterburning turbofan engine. The M53 is single shaft driving both the turbofan and compressor. The M53 is relatively older in design in comparison to the newer engine design of the same generation, it retains very desirable traits for military use. This can cut maintenance and cost for service and reliability.

The single spool design of the turbofan engine has its draw backs. When one compressor section stalls on a single-spool fan, it directly effects the entire spool. With the two-spool engine, if the one compressor stalls, the remaining compressor and turbine continue to function independently, maintaining partial thrust, making it easier to get the stalled compressor working again, without having to rely on "wind milling" for engine to start.

The M53 is the only known single-spool turbofan extant as of 2013, while SNECMA transitioned to a more conventional two-spool design such as the M88.



### General characteristics M53-P2

Type:	Afterburning single-shaft turbofan
Length:	5,070 mm (199.60 in)
Diameter:	796 mm (31.33 in) inlet
Dry weight:	1,515 kg (3,340 lb)
Compressor:	8-stage axial compressor
Combustors:	annular
Turbine:	2-stage axial turbine
Dry thrust:	64.7 kN (6,600 kgp / 14,500 lbf)
Afterburning thrust	95.1 kN (9,700 kgp / 21,400 lbf)

# Engine Control

The engine throttle is located on the left instrument panel. The throttle is controlled by a lever in the center of the throttle quadrant.

## Engine Startup Panel

The M-2000C does not have an Auxiliary Power Unit, instead it relies on a jet starter to start the SNECMA M53-P2 engine. The jet starter uses both internal fuel and battery power to do its job, although a Power Cart is preferred to prevent draining the battery of all power.

To control the start of the engine, there is a startup and control panel on the right console that will allow this operation.



- |                                |   |
|--------------------------------|---|
| 1. Starter button              | Starts the engine.  |
| 2. Starter fuel pump           | Used to supply fuel to the engine during start sequence.  |
| 3. Boost fuel pumps            | Left (G) and Right (D) boost fuel pumps.  |
| 4. Ignition/Ventilation Switch | Selects the jet starter ignition.<br>Three-position switch:<br>VENT (default), Left (G) and Right (D) |
| 5. Fuel Shut-Off Valve Switch  | Set the shut-off fuel valve in the closed (left) or open (right) position.                            |

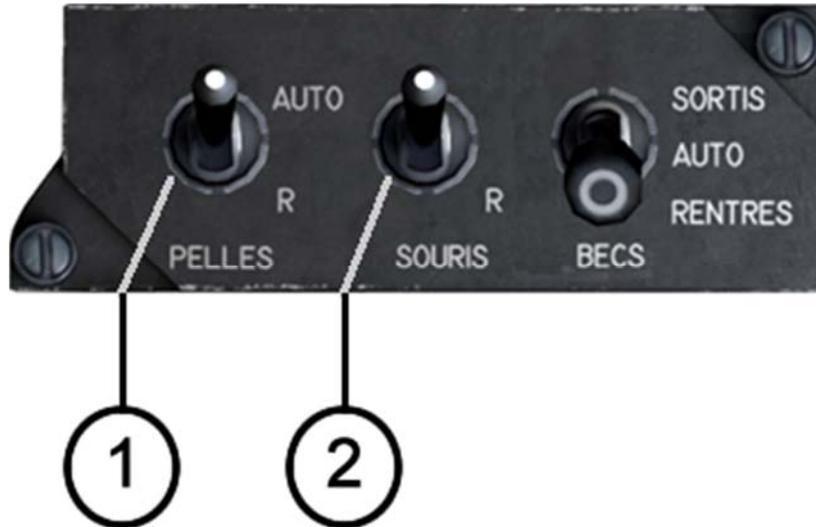
## Engine's air flow controls

The M-2000C has two devices that assure the correct air flow to the engine.

- Two inlet cones inside each air intake that slows the speed of the flow of air to the engine when the aircraft speed is above Mach 1.2. The cones move automatically based on the aircraft Mach number. Below Mach 1.2 they return to the normal (retracted) position.
- Four slats in the exterior of the air intakes that are opened/closed based on the angle of attack (AOA) to assure that enough air is being feed to the engine.

These devices are automatically operated and do not require pilot intervention except during emergencies.

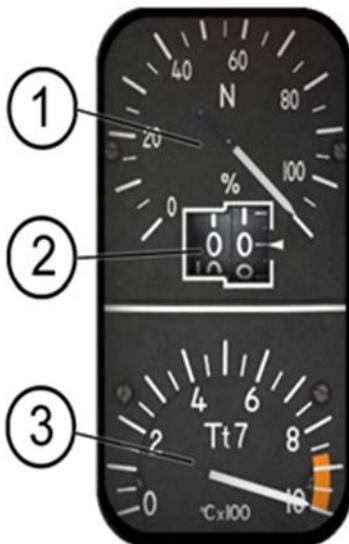
The air flow control devices are controlled by two switches located below the main radio panel.



1. Engine Slats control switch: AUTO (Default) / R (emergency close).
2. Inlet Cones control switch: AUTO (Default) / R (emergency return).

## Engine Gauges

The M-2000C engine gauges consist of 3 indicators that display engine RPM and temperature.



1. Engine RPM (N) Needle.
2. Engine RPM (N) Display.
3. Engine T7 Temperature indicator.

# Engine Warning Lights



## Start Up Light

The Start Up Light is located on the upper right area of the main panel. When the engine is in start mode the light will illuminate. Once the engine has started the light will go out.



## Afterburner Status Light

The Afterburner Status Light is located on the upper right area of the main panel (next to the Start Up Light). When the Afterburner is in use, the light will illuminate.



## Engine Fire Warning Light

Illuminates when there is a fire in the engine's secondary and/or in the afterburner chambers.



The Inlet Cones are damaged and/or the SOURIS switch is in the R position.



The Engine Slats are damaged and/or the PELLES switch is in the R position.



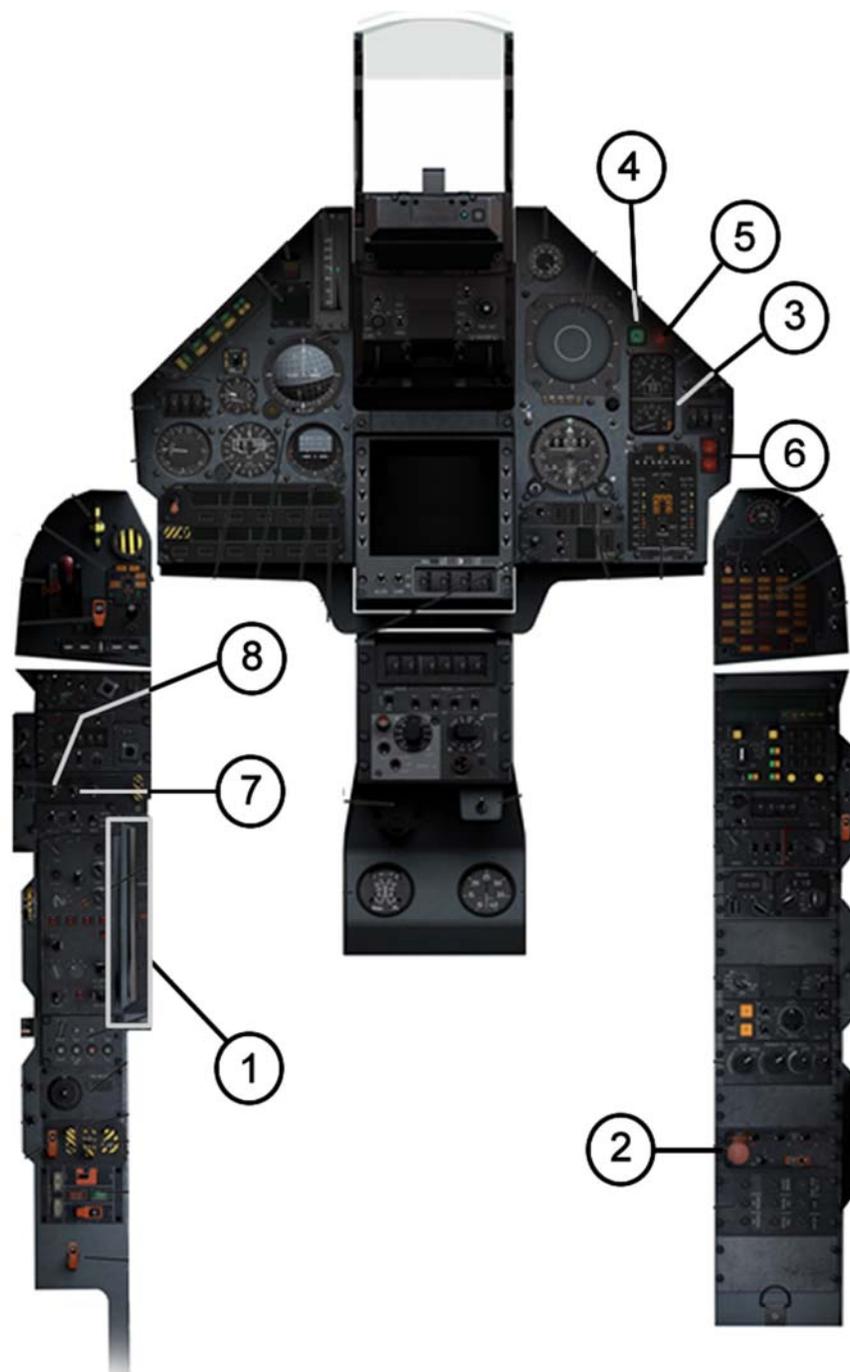
The engine control computer is damaged.



Engine lubrication is deficient.



Engine T7 temperature is above 800° Celsius.



*Figure 1 Engine panels locations*

1. Throttle Quadrant.
2. Engine Startup panel.
3. Engine Gauges.
4. Afterburner Status light.
5. Engine Startup light.
6. Engine Fire warning light.
7. SOURIS (Inlet Cones) switch.
8. PELLES (Engine Slats) switch.

## Chapter 3: Fuel System

The M-2000C fuel system consists of left and right fuel groups each one consisting of a wing tank, a feeder tank and a forward tank in the fuselage. Also in the front of the aircraft, just aft of the cockpit the engine central tank is located. All fuel tanks are part of the aircraft structure. The aircraft also has three wet points, under each wing and under fuselage in the centerline, for three external fuel tanks that can duplicate total fuel load.

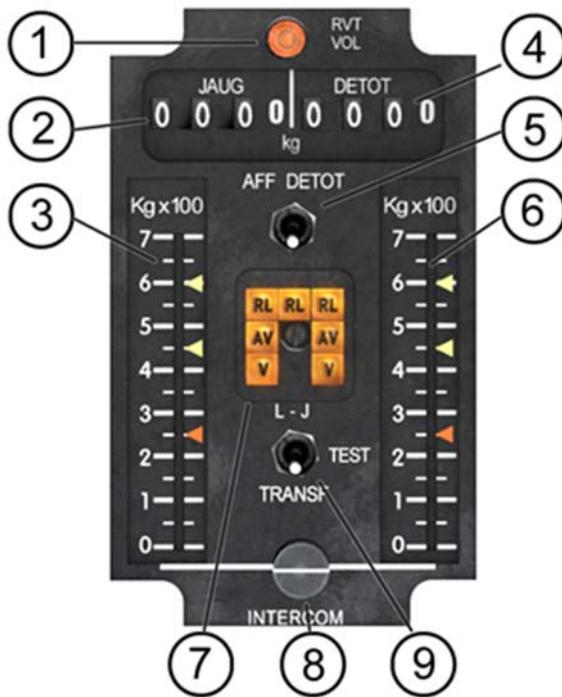


Description	Capacity			
	Kg	Lbs	US Gals	Liters
1 Right group forward tank	304.0	670.0	101.7	385.0
2 Right group wing tank	523.0	1154.0	175.0	662.5
3 Right group feeder tank	592.5	1306.0	198.1	750.0
4 Left group feeder tank	592.5	1306.0	198.1	750.0
5 Center tank	320.0	705.0	107.0	405.0
6 Left group forward tank	304.0	670.0	101.7	385.0
7 Left group wing tanks	523.0	1154.0	175.0	662.5
<b>Total Internal fuel:</b>	<b>3160.0</b>	<b>6966.0</b>	<b>1056.6</b>	<b>4000.0</b>
RP-522 centerline tank	995.0	2194.0	332.9	1300.0
<b>Total Internal + RP-522 fuel:</b>	<b>4155.0</b>	<b>9160.0</b>	<b>1389.7</b>	<b>5260.0</b>
RP-541 wing tank (each)	1580.0	3482.3	528.6	1700.0
<b>Total Internal + 3 ext. fuel:</b>	<b>7315.0</b>	<b>16122.26</b>	<b>2446.9</b>	<b>8660.0</b>

The aircraft has aerial refueling capability using a detachable probe on the starboard side just in front of the cockpit.

# Fuel Gauge

Displays the fuel weight and controls transfer of the fuel system. All values displayed in this gauge are in Kilograms.



## 1. Refuel Transfer Light

Displays when Aerial Refueling Switch is on.

## 2. JAUG Fuel Amount Counter

Displays Total Internal fuel amount. This number is a measure by sensors mounted inside the internal tanks (except wing ones, which are estimated).

## 3. Left feeder fuel level indicator

Displays the left feeder tank fuel amount.

## 4. DETOT Fuel Amount Counter

Displays Total fuel available to the aircraft, internal + external tanks. This number is the result of subtracting the (measured) fuel consumption from the starting total (value set before engine start).

## 5. AFF DETOT Fuel Display Switch

Displays/refresh information for the DETOT Fuel counter.

## 6. Right feeder fuel level indicator

Displays the right feeder tank fuel amount.

## 7. Fuel warning Lights

Indicates when a fuel tank is empty.

## 8. Internal Fuel Transfer Control

Allows the Fuel transfer to keep fuel level balanced.

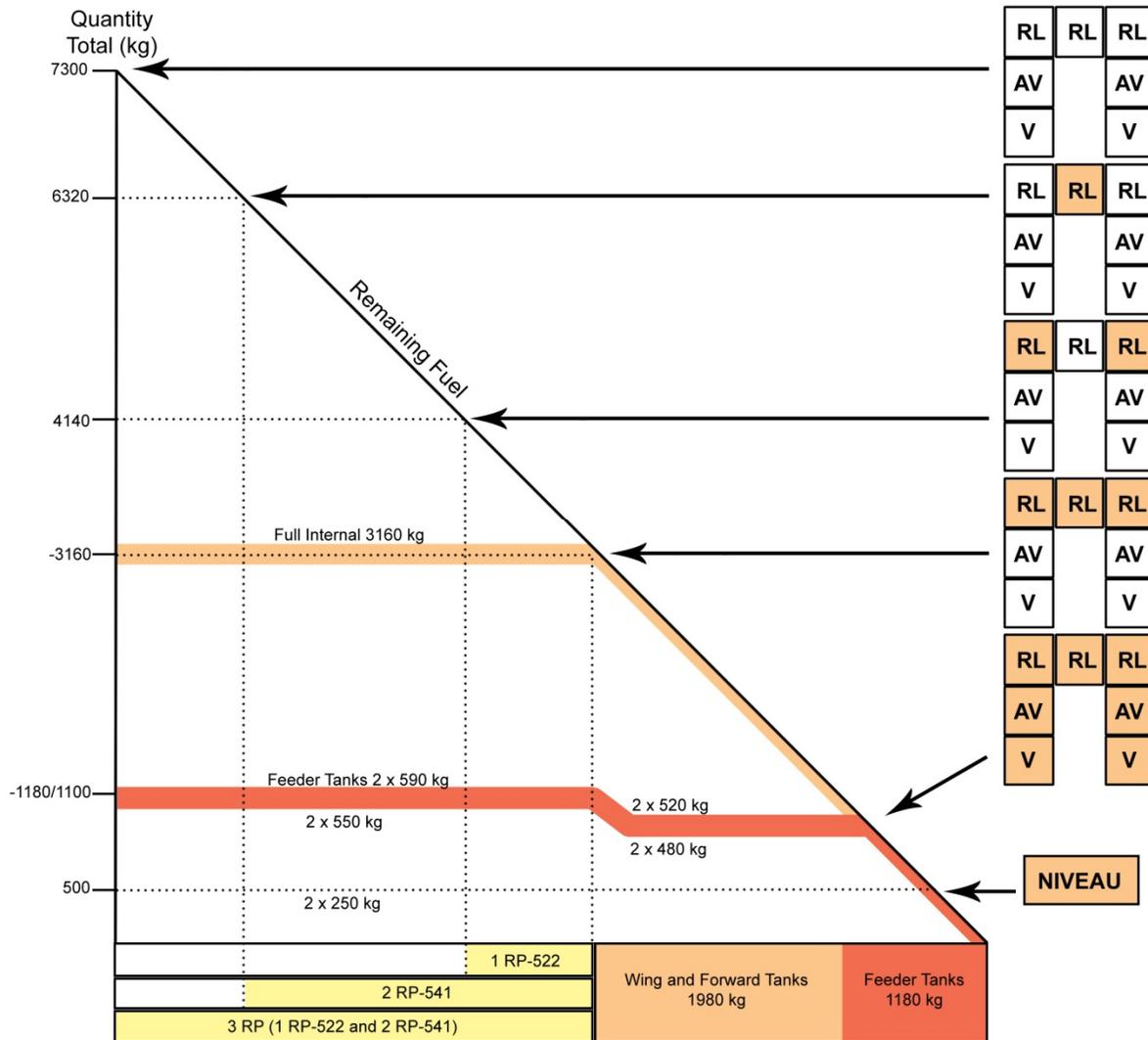
## 9. TRANSF Test Switch

Test Fuel Transfer circuit.

# Fuel warning lights

The fuel warning lights indicate when a given fuel tank is empty. They consist of three groups:  
 RL = External fuel tanks. There is one light for each tank.  
 AV = Forward fuselage tanks. There is one light for each group: Left and Right.  
 V = Wing fuel tanks. There is one light for each group: Left and Right.

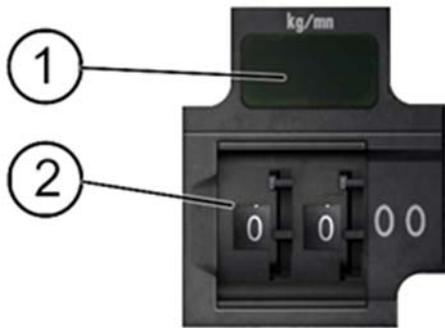
The following image shows when each group of lights is lit and the amount of fuel remaining at the time.



The Master Warning **NIVEAU** light will turn on when the fuel remaining falls below 500 Kgs. At that time, you have a few minutes before flameout.

# Fuel Flow Gauge and Bingo fuel selector

Located on the Main Panel it displays the fuel flow and controls the Bingo fuel alarm.



## 1. Fuel Flow

Displays the engine fuel consumption in kilograms per minute Kg/mn

## 2. Bingo fuel selector

The drums are used to activate the Bingo Fuel Alarm

**Note:** “Bingo” is used to indicate the minimum amount of fuel required for a safe return to base. If an aircraft keeps flying after the “Bingo” mark it will require air refueling to return.

# External tanks fuel dump switch.



The M-2000C can only dump the fuel that exist in the external tanks. The switch that controls the fuel dump is in the rear of the left instrument panel, above the FBW and Autopilot Test Panel. It is a guarded switch with a yellow/black striped cover. Once opened, you cannot close the dump valve.

## Fuel Dump Times:

RP-522 = 2m30s

RP-541 = 4m

# Fuel boost pumps.

The aircraft has two boost pumps to ensure fuel flow into the engine during inverted flight. The time of inverted flight is limited to 15 seconds and only if the level in the feeder tanks is equal or above 320 Kgs each when inverted flight is entered.

The switches for the fuel boost pumps are in the Engine Start Panel.



*Figure 2 Fuel panels locations*

1. Fuel gauge
2. Fuel Flow gauge
3. Bingo Fuel selector
4. External tanks Fuel Dump switch.
5. Boost Pumps switches.

# Chapter 4: Electrical Power Supply System

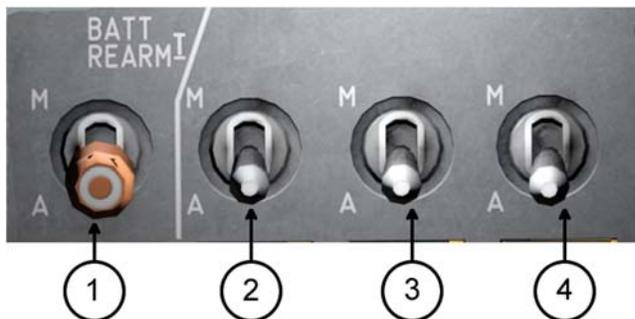
The M-2000C power supply system consists of an alternating current (AC) and a direct current (DC) circuits.

- 2 115/200 V, 20 KVA three-phase alternators (57 A per phase).
- 2 150 A/28 V transformers-regulators (one for normal use, the other for emergencies).
- 1 24 V, 40 A/h rechargeable battery.
- 1 200 VA power converter.
- 1 100 VA three-phase converter for the flight computer.

The aircraft also has connectors for external power supply (very often used when on the ground, to keep battery life up).

## Electrical Power Controls

The aircraft power supply is controlled by a four-switch bank located on top of the right instruments panel, just above the Warning/Caution Lights panel.



1. Master Battery Switch
2. Main Transformer Switch
3. Alternator 1 Switch
4. Alternator 2 Switch.



Figure 3 Circuit breaker panel



*Figure 4 Power Supply panels*

1. Main battery switch.
2. Main transformer switch.
3. Alternator 1 switch.
4. Alternator 2 switch.
5. Circuit breakers panel.

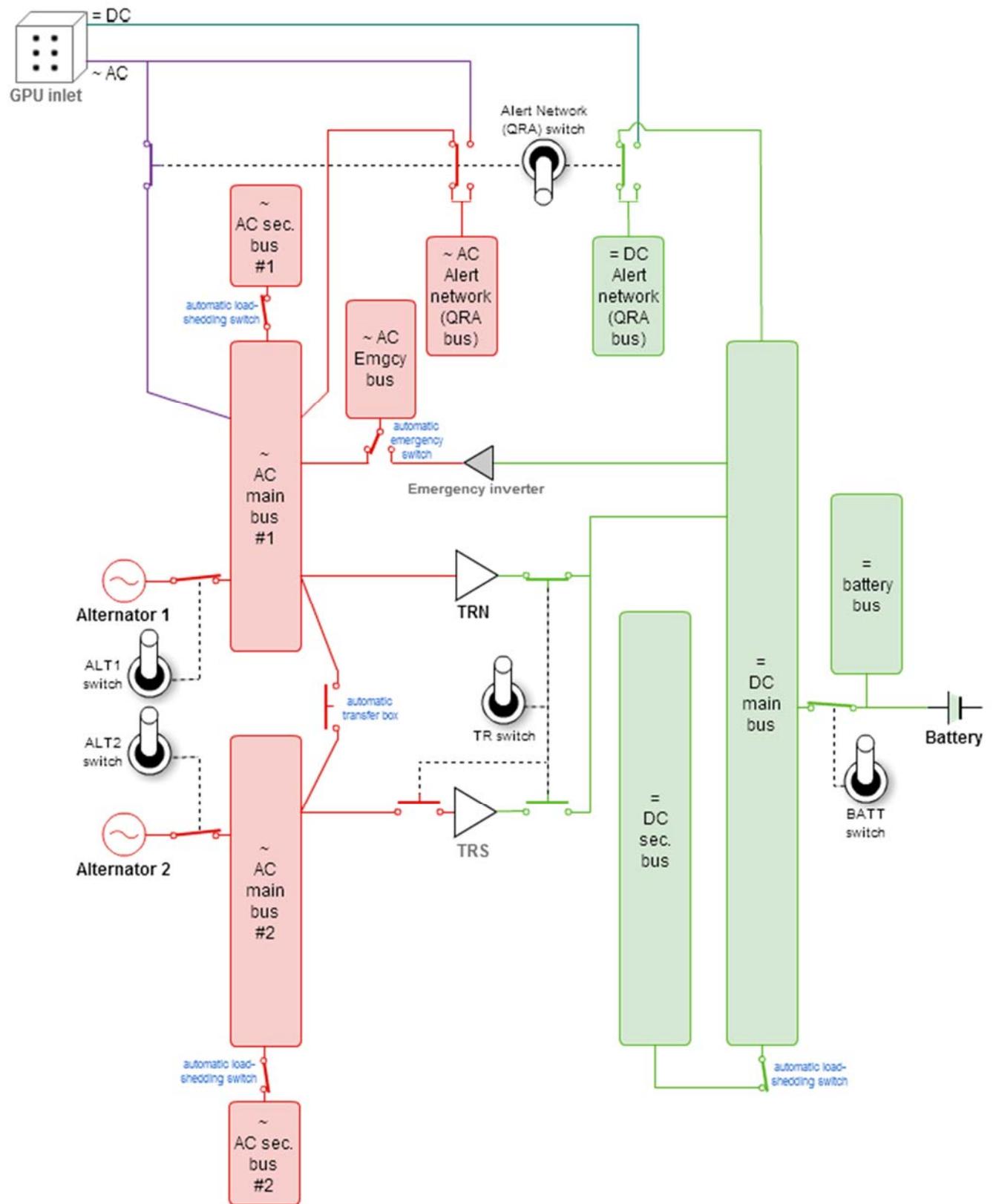
# Power Distribution Schematics

Both the AC and DC circuits are divided into the following buses:

1. 6x AC buses
  - 1.1. AC 1 Main bus
  - 1.2. AC "réseau d'alerte" (QRA) bus
  - 1.3. AC 1 Emergency bus
  - 1.4. AC 1 Secondary (load-shedable) bus
  - 1.5. AC 2 Main bus
  - 1.6. AC 2 Secondary (load-shedable) bus
2. 4x DC buses
  - 2.1. DC Main bus
  - 2.2. DC "réseau d'alerte" (QRA) bus
  - 2.3. DC Secondary (load-shedable) bus
  - 2.4. Battery bus

## **Note about AC & DC "réseau d'alerte" (QRA) buses:**

These are in fact part of the AC main 1 bus and the DC main bus, that can be powered separately, only when the aircraft is on the ground (with GPU) on QRA duties; those buses allow some devices to remain powered during alert so that start-up and take-off will be speeded up (most obvious example: the INS, which remain powered = aligned = ready to go). In the air, "Alert Network" switch being off, those buses are powered from the AC main 1 bus and the DC main bus.



## Electrical Power Warning Lights

<b>BATT</b>	Main battery is disconnected/failed
<b>TR</b>	Main Transformer is disconnected/failed or Auxiliary transformer has failed.
<b>ALT 1</b>	Alternator 1 is disconnected/failed
<b>ALT 2</b>	Alternator 2 is disconnected/failed
<b>CC</b>	Battery is discharging. Only 30 minutes of DC power remain.

## Electrical Power Emergency Conditions

Situation	Alarm light(s)	~ AC busses	= DC busses	Remarks
GPU On	<b>ALT 1</b> <b>ALT 2</b>	All On	All On	Lights are just indicating the alternators are offline, all is OK.
GPU On + BATT switch Off	<b>ALT 1</b> <b>ALT 2</b> <b>BATT</b>	All On	All On	Battery powers its own bus but is not connected, not reloaded.
GPU On + QRA switch On (up)	None (***)	AC QRA On All others <b>Off</b>	DC QRA On All others <b>Off</b>	Normal situation when aircraft is on QRA duty, on ground but ready to go.
Alternator 1 failure (or switched off)	<b>ALT 1</b>	AC Sec. 1 <b>Off</b> (*) AC Main 1 On	All On	Both AC main buses are powered by remaining alternator (**) As a consequence, both AC Sec. buses are switched <b>Off</b> (*)
Alternator 2 failure (or switched off)	<b>ALT 2</b>	AC Emergency On AC QRA On AC Main 2 On AC Sec.2 <b>Off</b> (*)		

Situation	Alarm light(s)	~ AC busses	= DC busses	Remarks
Double Alternator failure (or switched off)	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center; margin-bottom: 2px;"><b>ALT 1</b></div> <div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center; margin-bottom: 2px;"><b>ALT 2</b></div> <div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>TR</b></div>	AC Emergency On All others <b>Off</b>	All On – powered by battery only	Anticipate quick <b>CC</b> failure because of battery discharge. AC Emergency bus is powered from battery via emergency inverter.
TRN failure (+ TR switch up)	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>TR</b></div>	All On	All On – powered through TRS	TRS comes online automatically – pilot confirms this by flipping down the TR switch = the <b>TR</b> status light then comes off.
TRS failure (+ TR switch down) <i>or</i> TRN+TRS failure (whatever TR switch position is)	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>TR</b></div>	All On	All On – powered by battery only	Anticipate quick <b>CC</b> failure because of battery discharge.
Battery discharge, tension on DC buses < 26V	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center; margin-bottom: 2px;"><b>TR</b></div> <div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>CC</b></div>	All On	DC Main: On DC QRA: On DC Sec: <b>Off</b> (*) Batt: On	Land in less than 30 minutes, battery discharge.
Failure on main Alt bus 1 (e.g. major short circuit)	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center; margin-bottom: 2px;"><b>ALT 1</b></div> <div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>TR</b></div>	AC Sec. 1 <b>Off</b> (*) AC Main 1 <b>Off</b> AC Emergency On AC QRA <b>Off</b> AC Main 2 On AC Sec.2 <b>Off</b> (*)	All On – powered through TRS	TRS comes online automatically – pilot confirms this by flipping down the TR switch = the status light then comes off. AC Emergency bus is powered from battery via emergency inverter.
Failure on main Alt bus 2 (e.g. major short circuit)	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>ALT 2</b></div>	AC Sec. 1 <b>Off</b> (*) AC Main 1 On AC Emergency On AC QRA On AC Main 2 <b>Off</b> AC Sec.2 <b>Off</b> (*)	All On	
Battery failure	<div style="border: 1px solid black; background-color: yellow; padding: 2px; text-align: center;"><b>BATT</b></div>	All On	DC Main: On DC QRA: On DC Sec: On Batt: <b>Off</b>	Provided AC power and TR are available, only the Batt bus is lost (Batt switch comes automatically offline if battery failure occurs)

Situation	Alarm light(s)	~ AC busses	= DC busses	Remarks
Battery isolated (switch down)	<b>BATT</b>	All On	All On	Battery not reloaded anymore; IRL it's forbidden to do so in flight.
Battery isolated (switch down) + Double TR failure	None (***)	All On	DC Main: <b>Off</b> DC QRA: <b>Off</b> DC Sec: <b>Off</b> Batt: On	Near total electric failure situation.
Battery failure + Double TR failure	None (***)	All On	All <b>Off</b>	Total electric failure situation.

(\*) by automatic load shedding

(\*\*) powered by the remaining alternator through a transfer box between Alt1 & Alt2 main busses

(\*\*\*) the alarm panel is not powered anymore: all alarms lights are off

# Chapter 5: Lighting

## Interior lights.

The interior lights consist of:

- Main panel instruments backlighting
- Side panels instruments backlighting
- Red flood lights for low vision use.
- White flood lights.

The panel is located on the right instruments panel, below the Air Conditioning panel. Interior lights are fed from the battery

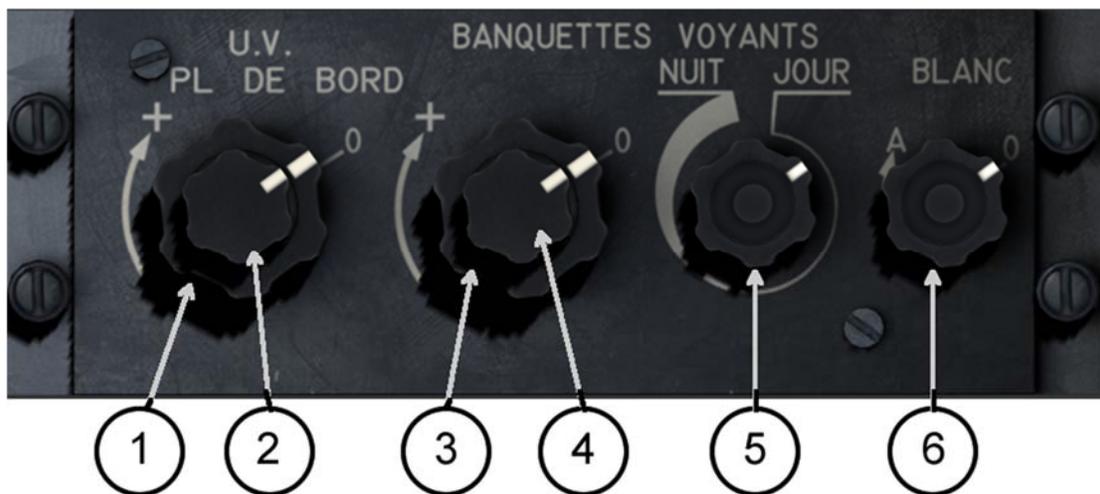


Figure 5 Interior lights panel

1. **U.V.:** Nonfunctional.
2. **PL DE BORD:** Main instruments panel backlight.
3. **BANQUETTES VOYANTS (Outer):** Cockpit red flood lights.
4. **BANQUETTES VOYANTS (Inner):** Side instrument panels backlight.
5. **BANQUETTES VOYANTS (NUIT – JOUR):** Nonfunctional.
6. **BLANC:** Cockpit white flood lights.

## Exterior lights.

The exterior lights consist of:

- 3 navigation lights, controlled by the “FEUX NAV” switch.
- 6 formation lights, controlled by the “FEUX FORMAT” switch.
- 2 anti-collision lights, controlled by the “ANTI COLL” switch.
- 1 Police searchlight on the left side of the aircraft.
- 2 air-refueling lights.
- 2 Landing/taxi lights in the nose wheel, controlled by the “PHARES” switch in the left instruments panel. The switch has three positions: Off, Taxiing and Landing. The lights are automatically disconnected when the landing gear is raised.



*Figure 6 Exterior lights switches: Navigation, formation and anti-collision.*

### Police Light

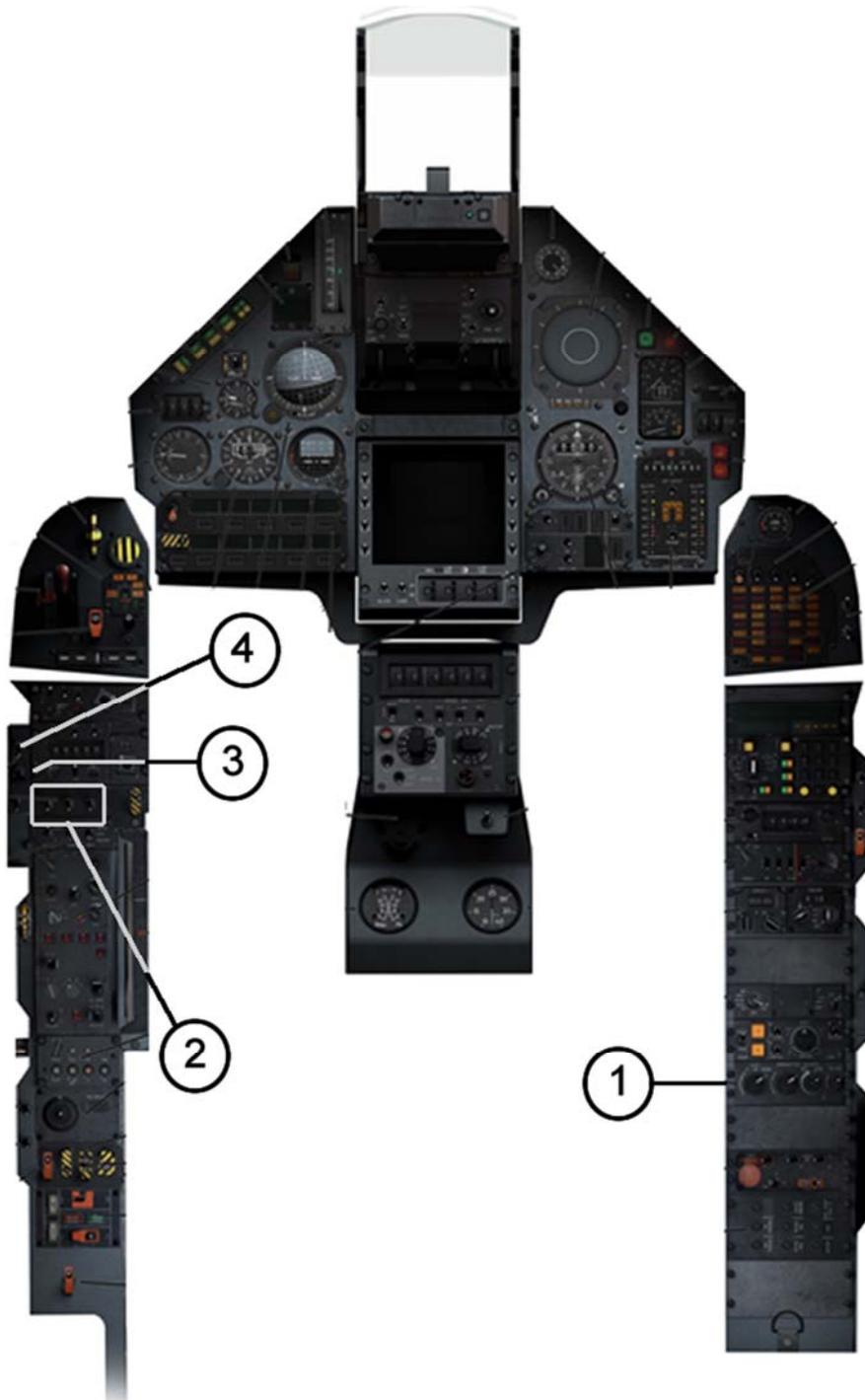
Used to identify unknown aircrafts in the dark. The light is controlled by two switches: The main switch is in the left instruments panel, labeled “PHARE POLICE”. When it is in the ON position the Police Light is enabled. To turn On or Off the police light the pilot must use the HOTAS throttle button.

### Air-refueling light system

Used to facilitate the air-refueling process in the dark. It consists of the following lights:

- 1 foldable light mounted on the right-hand fuselage to light the basket and
- 1 Light on the tip on the aircraft nose, at the bottom of the air refueling probe, to enlighten the tip of the probe.

Both are enabled by the “RVT” (Air Refueling) switch, and their intensity controlled by the “PHARE RAVIT” knob.



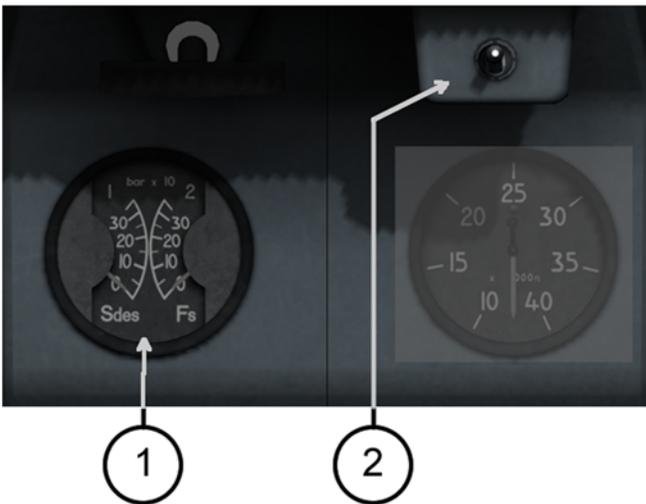
*Figure 7 Internal and External lights panels*

1. Interior lights panel
2. Navigation, formation and anti-collision lights switches.
3. Landing/taxi lights switch.
4. Police light main switch. (Light is activate by HOTAS throttle button).
5. Air-refueling lights: Not shown. The RVT switch is on the cockpit left bulkhead.

# Chapter 6: Hydraulic System

The aircraft's hydraulic system includes two independent systems with the same power. Each system has a 110 liter/min self-regulating pump with 280 bars of pressure. Additionally, there is a reserve electrical pump (EP) which is connected to system 2 and that automatically starts when the pressure in system 2 falls below 160 bars. This pump provides 190 bars of pressure only, for flight controls and parking brake/emergency brakes accumulator.

## Hydraulic System Controls and Gauges



1. Hydraulic Pressure Gauge
2. Hydraulic System selector (for gauge display).

## Hydraulic System feeds description

- |          |   |
|----------|---|
| System 1 | <ul style="list-style-type: none"><li>• Air brakes</li><li>• Slats (becs)</li><li>• Engine shock cones (souris)</li><li>• Engine scoops (pelles)</li><li>• Landing gear (normal)</li><li>• Wheel brakes (normal).</li></ul> |
| System 2 | <ul style="list-style-type: none"><li>• Emergency landing gear actuator.</li><li>• NWS</li><li>• Emergency brakes</li><li>• Parking brakes.</li></ul>   |

## Hydraulic System Warning Lights

**HYD 1**

System 1 pressure is below 195 bars

**HYD 2**

System 2 pressure is below 195 bars

**HYDS**

System 2 pressure is below 140 bars, or the EP switch is in Off.

**EP**

The reserve pump (EP) is active.



*Figure 8 Hydraulic System Panels*

# Chapter 7: Flight Controls

---

## Description

The M-2000C has a Fly-By-Wire (FBW) system with 4 channels of control plus a fifth emergency one. The FBW allows the aircraft to:

- Control an unstable aircraft, especially when carrying external stores which have a significant impact on performance.
- Help the pilot to prevent loss of control by overriding flight commands that are outside their parameters.

### Mobile surfaces.

- 4 elevons for pitch and roll control.
- 1 rudder
- 2 pairs of automatic slats (becs).

The elevons and the rudder are controlled by an electro-hydraulic servo connected to the two hydraulic circuits (HYD1 and HYD2). The servos are connected to two motor-servos (NORMAL and EMERGENCY).

The slats are controlled by a pair of motors that are actuated by HYD1 and move depending on the flight conditions.

## Normal Operation

### Elevators

Stick displacement:

Up	Elastic stop at 43.2 mm Mechanical stop at 54 mm.
Down	Mechanical stop at 30 mm.

The elastic stop provides a restraint that limits the load factor or AOA while allowing override during hard maneuvers.

The stick movement is filtered and reduced so that the total displacement + trim does not exceed the elastic stop unless that is the pilot's will. The deflection order has an airspeed limiter to prevent high loads.

Flight commands are regulated to avoid high Gs when speeds are above 300 knots.

The control stick allows the pilot to control the load factor.

At low airspeed, the AOA is the primary parameter for flight control.

The aircraft stabilization is a function of load factor, pitch angle, AOA and dynamic pressure.

## **Ailerons**

Stick displacement:  $\pm 12^\circ$

The stick movement is filtered and reduced to maintain the roll speed limit, as a function of elevator command and load factor in order to reduce the roll speed and acceleration during high AOA and wing loads.

The aileron trim is added to the stick movement.

Aircraft stabilization is achieved as a function of roll angular speed.

## **Rudder**

Pedals displacement:  $\pm 28.5$  mm.

Rudder authority is limited by stick pull-up command.

A transverse accelerometer provides static stabilization.

A yaw gyro provides with dynamic dampening.

There is a yaw stabilization function that maintains zero lateral acceleration during steady flight (no cross maneuvers). If active, rudder trim is redundant since both devices tend to cancel each other out. Yaw stabilization is particularly important in aiding fast rolling and turning coordination to prevent departure from controlled flight.

### **ATTENTION**

The rudder has a limited role in steering the aircraft. It is unnecessary except in certain regiments as during air refueling, air-to-ground targeting or crosswind landing. To cover the latter case, the authority of the rudder is increased when the landing gear is down.

# Fly-By-Wire

## Slats (becs)

The automatic slats are controlled by AOA. They begin to operate at  $\alpha = 4^\circ$  and are fully extended when  $\alpha = 10^\circ$ . Extension depends on speed and mach. The slats are automatically retracted when the landing gear is down.

### ATTENTION

To cover certain cases when landing speed is too low due to engine damage, the slats can be extended manually, when the landing gear is down, by clicking the **BECS** switch to the **SORTIS** position.

### DECOL

The **DECOL** (DÉCOLLAGE/TAKE-OFF CONFIG) warning light turns on if:

- The cover for the FBW test switch is open.
- The FBW test warning light is red.
- The aircraft is not trimmed for take-off
- Emergency trim is selected.
- **BECS** switch is not in the **AUTO** position.
- **ANEMO** switch is in the **OFF** position



Figure 9 BECS (slats) switch



Figure 10 Wing slats

## FBW Modes Switch

The FBW mode switch is used by the pilot to adapt the FBW system to the stores loaded into the aircraft. There are two modes Air/Air and Charges (Load).

### Air/Air Mode (Default)

- Limits load factor for the elevator elastic stop to 8.5 g ( $\pm 0.5$  g).
- Limits AOA to 27° when speeds are under 100 knots, otherwise the limit is 29°
- Limits the roll speed and angular acceleration to 270°/sec.
- Audio warning when alpha  $\geq 29^\circ$ , stick at full aft position, or indicated air speed below 100 knots.

This mode is allowed when the aircraft is clean (no loads), or with a load limited to air-to-air missiles (Magic and/or 530D) and an empty centerline fuel tank.

### Charges Mode

- Limits load factor for the elevator elastic stop to 5.5 g ( $\pm 0.5$  g).
- Audio warning when alpha  $\geq 20^\circ$ . The pilot must abide to this limit by himself.
- Limits pilot roll command based on load factor.
- Limits roll angular speed to 150°/sec.

This mode must be used when the aircraft carries any of the following load: non-empty centerline droppable fuel tank, any wing droppable fuel tank, any bomb or rockets pod.

### Degraded mode operation

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*To be described in full release manual*

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### Emergency mode operation

---

*To be described in full release manual*

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## Controls



Figure 11 FBW Mode switch



Figure 12 FBW Mode switch location

## FBW Warning Lights

MAN
DOM
BECS
GAIN
US EL
DECOL
$\alpha$

Damage to the control gyros (roll and yaw).

Damage to flight control surfaces control.

Slats functionality is compromised

Emergency FBW computer in use

“LAST EMERGENCY” enabled.

Take-Off configuration incorrect (refer to the Slats entry).

Damage to AOA sensors.

# Trim System



*To be described in full release manual*



# Automatic Pilot

## Description

The Automatic Pilot (AP) have two operational modes:

### Basic mode

Attitude hold (pitch and heading). If the roll angle is higher than 10° when the AP is engaged, then instead of heading hold, the AP will hold the roll angle.



**NOTE:** WHEN AP IS ENGAGED, THE PILOT CAN USE THE TRIM HAT OF THE STICK TO COMMAND A TURN OR A CLIMB/DIVE.

### Advanced mode

- Current altitude hold.
- Selected altitude hold.
- Localizer and Glideslope hold (Approach hold). In this mode the AP automatically follows an ILS course and glideslope to the runway threshold (Autoland).

## Normal Operation

### Operational limits

Max altitude	50,000 feet
Max pitch angle	40°
Max AOA	18°
Max Roll	65° (will return to 60° when engaged)
Max speed	50 KIAS less than the operational limit for current configuration
Minimum speed	200 KIAS
Minimum altitude	Normal mode: 500 feet
	Localizer and Glideslope hold 200 feet
	Selected altitude hold 1,000 feet

### AP engagement/disconnect.

1. Click on the  button in the PA control panel. The  light will turn on, indicating that the PA system is armed.
2. Click again on the  button. The  light will turn off and the  light will turn on, indicating that the PA system is engaged.

### Current Altitude Hold.

1. Click on the  button. The  light turns on indicating that the system is armed.
2. Click again on the  button. The  light turns on and the aircraft will level at the current altitude.

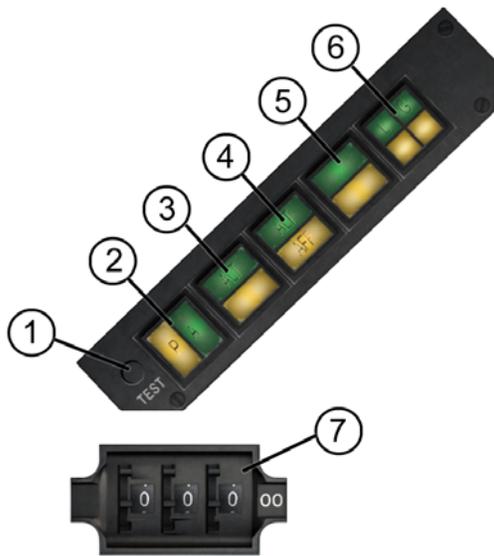
### Selected Altitude Hold.

1. Select the desired altitude by clicking on the selector drums. Minimum altitude is 1,000 feet.
2. Click on the  button. The  light turns on indicating that the system is armed.
3. Click again on the  button. The  light turns on and the aircraft will level at the selected altitude.

### Localizer and Glideslope Hold.

This AP function is not available on the Beta version.

## Controls



1. Autopilot test button.
2. Autopilot Master Switch.
3. Altitude Hold button.
4. Selected Altitude Hold button.
5. Not used.
6. Localizer and Glideslop Hold button.
7. Altitude Selector Drums.



*Figure 13 Autopilot panel location*

## Warning Lights

The **AP** light will turn on in case of any problem with the AP system.

# Chapter 8: Landing Gear

The M-2000C has a tricycle landing gear. The nose wheel is composed of two small tires and has a steering assembly. The main gears have a single large tire and are equipped with carbon disk brakes. The aircraft is equipped with an anti-skid system and a parking brake.

They are operated by the HYD1 system with the HYD2 for emergency use.

## Controls

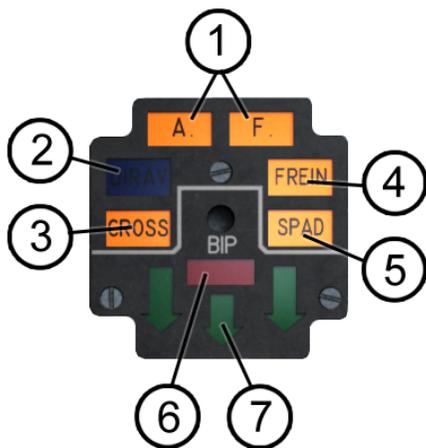


Figure 14 Landing gear panel

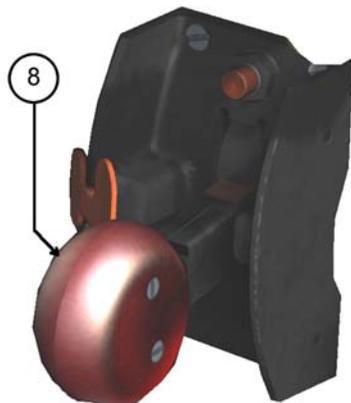


Figure 16 Landing gear lever

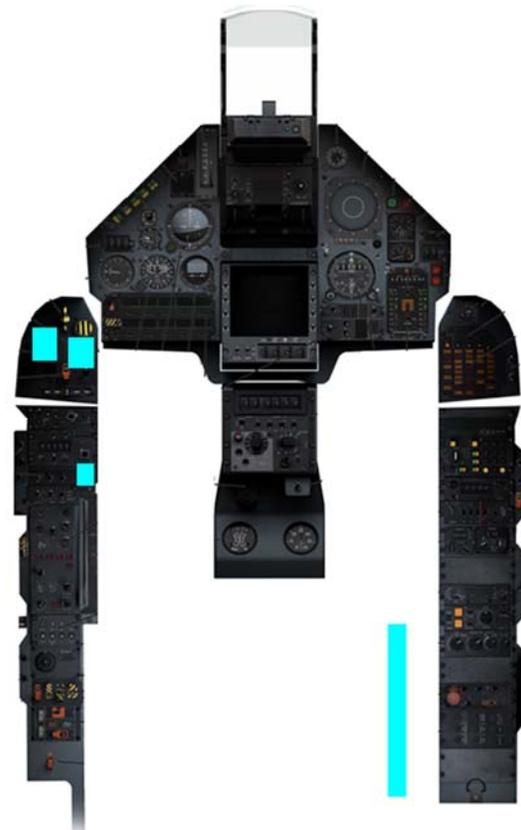


Figure 15 Landing gear controls locations



Figure 17 Anti-Skid switch

1. AF (short for Aéro Freins, Air brakes advisory lights).
2. DIRAV (short for Dirigeabilité Roue Avant, Nose Wheel Steering) advisory light.
3. CROSS (short for Crosse, Tailhook) advisory light
4. FREIN (Brakes) advisory light
5. SPAD (Système Perfectionné Anti-Dérapant, Anti-Skid) warning light
6. 3xLanding Gear in transit advisory lights
7. Landing Gear Down and Locked advisory light
8. Combination Landing Gear Handle and Landing Gear Warning light.

## Warning Lights

- The **A** and **F** advisory lights turn on when the airbrakes are activated.
- The **DIRAV** advisory light turns on when the NSW system is engaged. Be aware that the light remains ON when it automatically disconnects when ground speed is over 40 knots.
- The **FREIN** advisory light turns on when wheel brakes are applied.
- The **SPAD** warning light flashes when the landing gear is in transition. Remains On if the anti-skid system automatic test fails.
- The **PARK** warning light turns on when the parking brake is set.
- The landing gear warning light flashes when:
  - Landing gear is down and speed is above 260 KIAS.
  - Landing gear is up and speed drops below 230 KIAS.
  - The warning light is accompanied by a warning horn. The warning horn is only active when the aircraft systems are in NAV or APP modes.

## Precautions

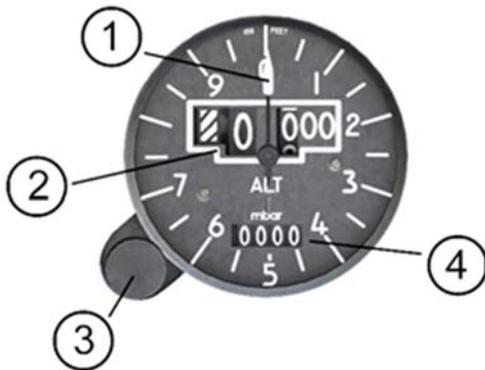
- The NWS is very sensitive, especially at speeds above 30 knots GS.
- The NWS automatically disconnects when speed is over 40 knots GS.
- After landing AVOID applying brakes until your speed is below 100 knots. Prefer aero-braking at higher speeds.
- The braking should be made with “press and release” technique: apply brakes one second, release for one second, apply again... and so on.
- The aircraft is very sensitive to rudder when rolling for take-off or landing, even if the NSW is not active.

# Chapter 9: Flight Instruments

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## Altitude Indicator

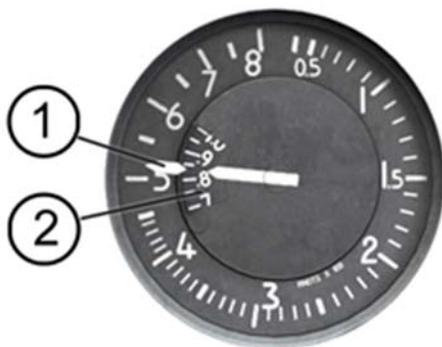
The Altitude Indicator displays the Aircraft's barometric altitude in feet above mean sea level in feet. The readings are taken from the pitot tube on the nose of the aircraft.



1. Hundreds feet indicator.
2. Thousands feet indicators
3. Barometric setting adjustment knob.
4. Barometric setting display (in millibars).

## Airspeed Indicator

The Air Speed Indicator displays the Aircraft's speed in knots and mach. The needle rotates around the indicator to 800 Knots. While the Mach wheel rotates underneath, correlating to the knots' needle position to display the mach.



1. Knots indicator
2. Mach indicator

## Vertical Velocity Indicator

Displays the aircraft vertical velocity in feet/min. The number represents 1000 feet.



## Attitude Direction Indicator ADI (“Boule”)

The Attitude Direction Indicator displays the Aircraft's pitch, bank, and compass heading direction. The pitch markings on the sphere are in graduations of  $5^\circ$ , the Bank markings begin at  $10^\circ$  increments with major markings at  $30^\circ$ , then  $45^\circ$ , and  $60^\circ$ . Signals are received from the pitot and INS system.

The ADI also displays Localizer and Glide slope information for ILS landing and steer modes.



1. Roll angle indicator
2. Off flag
3. Aircraft symbol (fixed)
4. Marker light
5. Turn slip ball
6. Course deviation needle
7. Glideslope deviation needle
8. Cage knob

## AOA Indicator



The AOA Indicator displays the Aircraft's Angle of Attack. The markings go from  $-2^{\circ}$  to  $32^{\circ}$  of AOA, with a green mark at 14 degrees for optimal glide pitch during landing approaches.

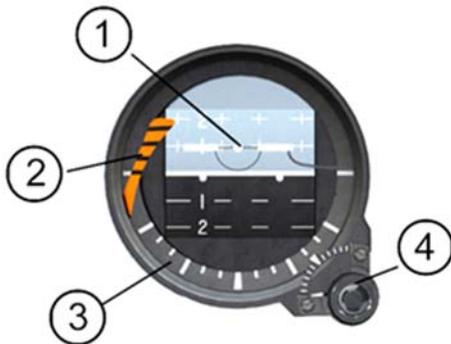
The AOA Indicator sounds an alarm when AOA values approach the aircraft flight limits. The AOA limits are configured depending on the FBW's mode switch.

The warning sound cannot be switched off and will remain on while the extreme flight condition remains.

An OFF flag appears when for any reason the AOA indicator is not operational.

## Standby Attitude Indicator

The Standby attitude indicator is an independent instrument that provides pitch and roll information in case of the main ADI failure



1. Aircraft symbol (adjustable).
2. OFF flag.
3. Roll angle indicator.
4. Cage/Aircraft symbol adjustment knob.

## G Force Indicator

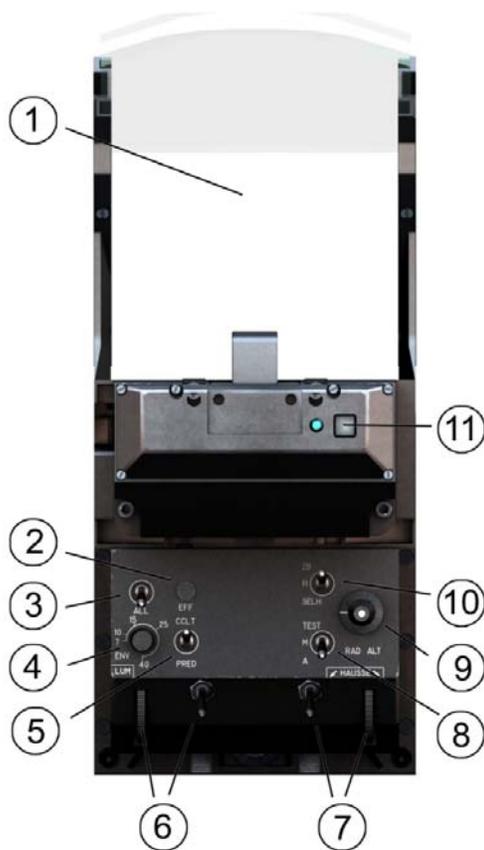


Displays the vertical acceleration forces experienced by both the aircraft and the pilot.

# Chapter 10: Heads Up Display HUD

The HUD control panel is located on the center and top of the Main Instruments panel. The HUD displays navigation, flight control and weapons delivery information in symbolic and alphanumeric format. HUD navigation, flight and weapons symbols are positioned depending on display mode (Master Mode) selected.

## Controls



1. Reticle glass.
2. EFF switch.
3. Symbology de-clutter switch.
4. Target wingspan scale.
5. Gun piper selector.
6. Power switch and brightness control.
7. Backup fixed sight and boresight adjustment.
8. Radar altimeter switch:
9. Minimum altitude selector
10. Altitude display selector:
  - a. ZB: Barometric.
  - b. H: Radar altimeter.
  - c. HG: Minimum altitude.
11. Gun camera switch.

## Operation

To turn on the HUD, click on the power switch once. The next click will activate the self-test.

## **Altitude display**

By default, only barometric altitude, Mean Sea Level altitude, is shown, if you require Above Ground Level altitude you must activate the radar altimeter:

1. Click on the radar altimeter switch once. The next click will activate the self-test.
2. Click on the altimeter selector switch. By default, it will be in the ZB (barometric altitude) position. Click once to put it in the H (radar altimeter) position.
3. Both the barometric and radar altitudes will be visible in the HUD.

Be aware that the radar altimeter has a limit of 5,000 feet AGL. Asterisks will be displayed when the aircraft AGL altitude is above 5,000 feet. Asterisks will also be displayed whenever the aircraft roll angle is higher than 20°, since at that angle the radar altimeter beam cannot give a reliable measure.

## **Minimum Altitude display**

The Minimum Altitude (MA) display indicates the minimum safe altitude that you can fly. During landings and when the HUD is in APP (approach) mode, the MA also works as the Decision Height selector.

To operate the MA you need to have the radar altimeter activated. To activate it, you only need to click the altimeter selector to the HG position. The MA display will appear below the AGL altitude display.

To select the desired MA value, click on the knob located between the radar altimeter and the altimeter selector switches. The values will change in tens of feet.

Left click increases the value.

Right click decreases the value.

## **De-clutter switch (ALL)**

The de-clutter switch suppresses some of the HUD's symbols in order to clear the display for a better view forward. By default, it is in the Off position.

## **Target Wingspan scale (ENV)**

See Guns under AA mode.

## Gun piper selector

See Guns under AA mode.

## Backup fixed sight and boresight adjustment

Not available in Open Beta.

## Operational Modes

The HUD display information based on the current operational mode, also known as Master Mode. The HUD current Master Mode is selected by the Armament Control Panel.

There are three main Master Modes and each one have their own sub-modes:

1. Navigation NAV
  - a. Normal, (or Taxi/Take-Off, engaged automatically by weight-on-wheels sensor)
  - b. Approach APP
2. Air-to-Air AA
  - a. Guns
  - b. Magic
  - c. 530
3. Air-to-Ground
  - a. Guns/Rockets
  - b. CCRP
  - c. CCIP
4. Interception Director
5. Auxiliary Gunsight

## HUD Display

No matter what Master Mode/Sub-mode is active all of them share the following data:

**Note:** The HUD's waterline, the aircraft's vertical reference against which several readings are compared, is located slightly below the Heading scale. There are no visible representations of its position in the HUD. In the image below, the dotted red line indicates the waterline position.

### **1. Indicated Air Speed (IAS)**

Located to the left of the Heading Scale, it shows the current aircraft speed in knots. The display is only shown when the airspeed is above 30 knots.

### **2. Heading Scale (HS)**

The Heading Scale moves horizontally against a fixed caret index indicating aircraft magnetic heading from 0° to 360°. The scale is numbered every 10 degrees, with a dot representing the 5 degree halfway mark between two numbers. The two-digit display is expressed in degrees x 10; e.g.: 10° is displayed 01 and 250° is displayed 25.

### **3. Barometric Altitude (BA)**

Located to the right of the Heading Scale, it shows the current aircraft altitude above sea level. The numbers representing values below one hundred are shown in a smaller font.

### **4. Flight Path Marker (FPM)**

The Flight Path Marker also known as the Velocity Vector Indicator (VVI) is an aircraft shaped symbols that shows in the HUD where the aircraft's instantaneous flight path with respect to the earth. The wings of the symbol always remain parallel to the wings of the aircraft. The vertical relationship between the waterline and the FPM indicates true AOA. The FPM displacement from the HUD centerline indicates drift.

### **5. Horizon Line (HL)**

A component of the Flight Path Pitch Ladder, it indicates the relative position of the horizon. The higher the aircraft's altitude, the higher the position of the HL with respect of the actual horizon. When the FPM is at the same level of the HL, the aircraft is in level flight neither climbing nor descending.

### **6. Flight Path Pitch Ladder (FPPL)**

The vertical flight path angle of the aircraft is indicated by the position of the FPPL relative to the position of the FPM. The aircraft pitch attitude is indicated by the position of the HUD waterline with respect to the FPPL about the stabilized wings of the FPM. The HL and the FPPL angle lines are displayed for each 5° with the angle value being displayed every 10° between 0 and ±90°. Positive pitch lines are solid and negative pitch lines are dashed. The tabs at the end of each segment points towards the horizon.

## 7. Acceleration Vector (AV)

The Acceleration Vector chevrons indicate the aircraft longitudinal acceleration. It is a way to display aircraft's current energy state visually. The AV chevrons move in relation to the FPM: when the chevrons and the FPM are at the same level, the aircraft is flying at a constant speed. If the chevrons are above the FPM, then the aircraft is accelerating. If the chevrons are below the FPM, the aircraft is decelerating. Chevron position above or below the FPM is relative to the acceleration rate.

## 8. Mach number

The Mach number is displayed in all modes and only when the value is above 0.6 Mach.

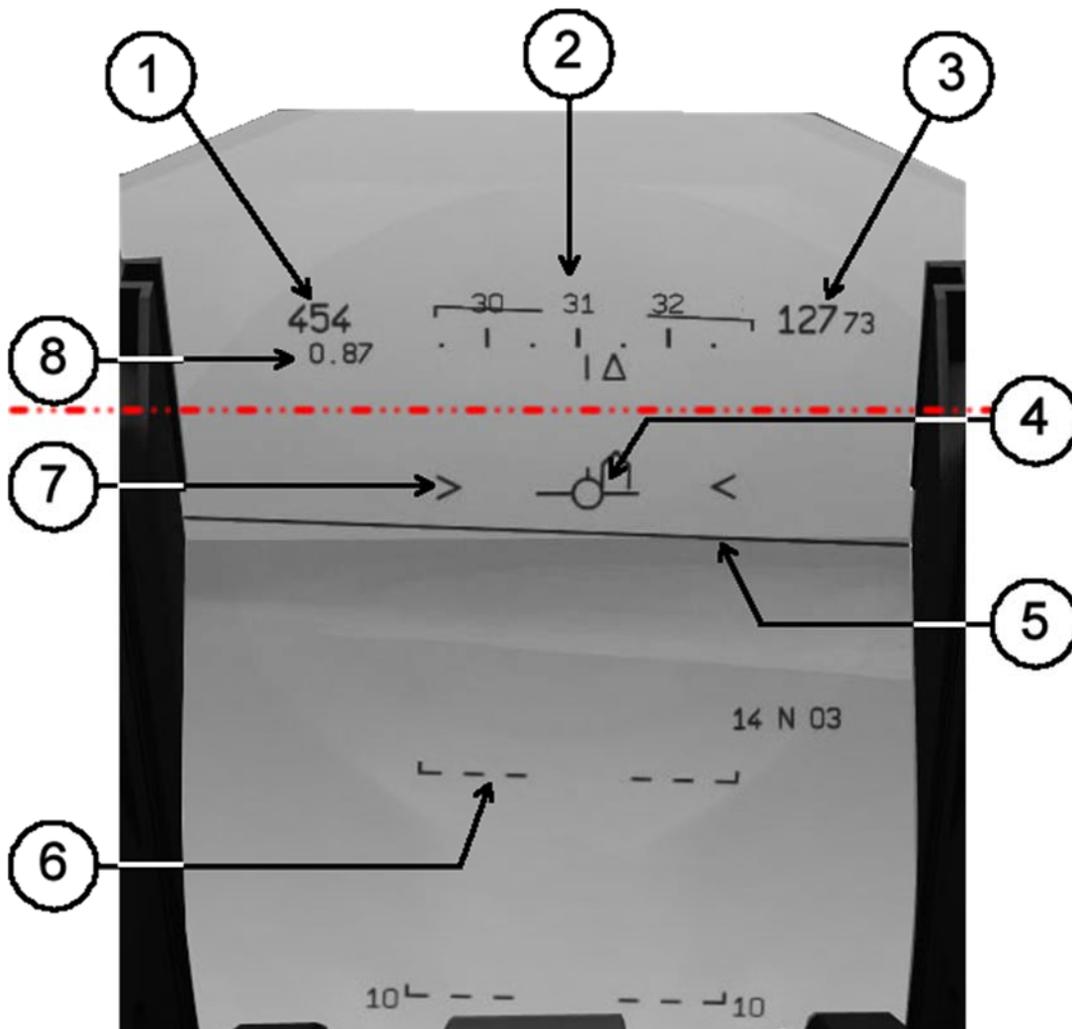
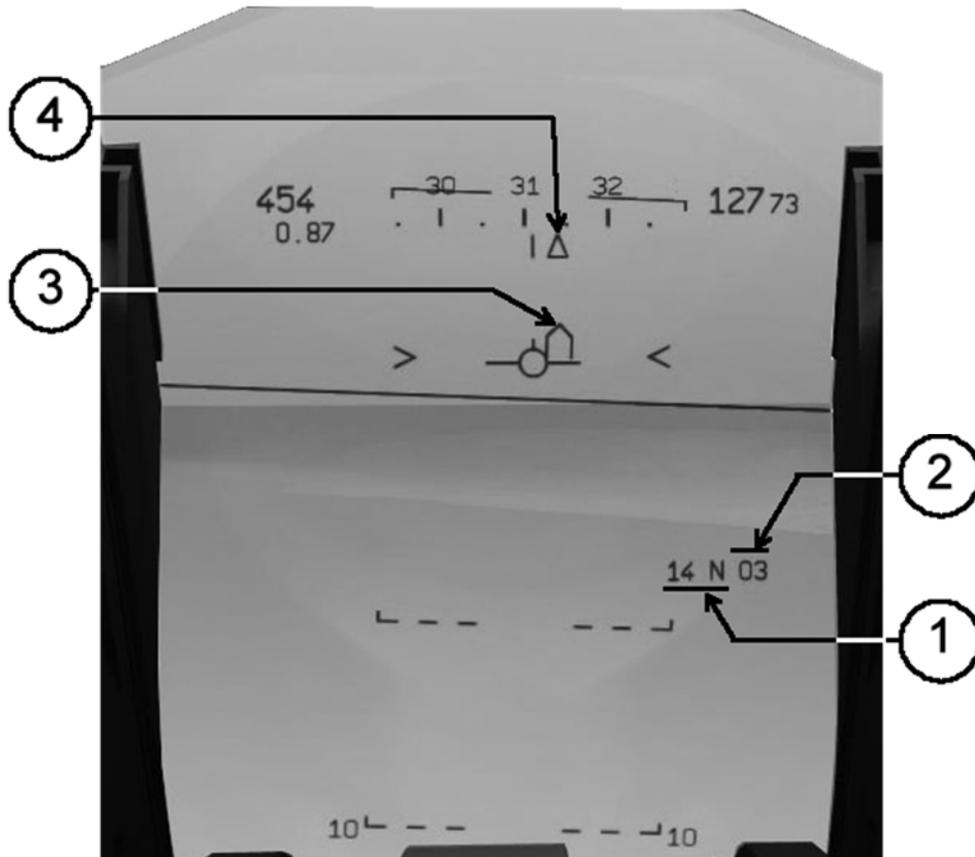


Figure 18 HUD common symbols. The waterline position is marked as a red dotted line (only as a reference, it is not visible in the aircraft).

## NAV

Navigation model (NAV) is the aircraft's default Master Mode. It displays navigation data and provide steer instructions as indicated by the INS.



1. Distance to Waypoint (in nautical miles).
2. Waypoint number.
3. Waypoint track angle error.
4. Selected route (for Auto-Pilot).

### Notes:

- a. The waypoint track angle error follows the height of the FPM in the HUD.
- b. When the distance to the waypoint is less than 10 nautical miles, the waypoint track angle error is substituted by a target cross which is placed at the exact geographical position of the waypoint.
- c. When the distance is below 4 nautical miles, the waypoint symbols will tend to drift. This is normal since it is a secondary effect of the large circle navigation calculations being made by the INS.

- d. The waypoint automatically changes to the next when distance is below 1.5 nautical miles.

## APP

It is a sub mode of NAV and is used during landings. In this mode the HUD display ILS cues.

**Note:** In APP mode the BA, HS and IAS move from the top of the combiner glass down to the center. In APP mode is necessary to move the seat up in order to increase the field of view.

### Before glideslope capture

#### 1. Angle of Attack guide.

Indicates the optimum angle of attack for landing the aircraft. You must place both the FPM and the AV chevrons within the brackets for a perfect landing.

The brackets represent an AOA value of  $14^{\circ} \pm 0.5^{\circ}$

**Note:** The analog AOA indicator (refer to the flight instruments chapter) also has the AOA for landing zone marked in green.

#### 2. Localizer deviation.

Indicates the angle of deviation to the localizer signal. It is visible only after the localizer capture.

#### 3. Localizer Symbol

The open box symbol represents the localizer station position in the horizon. It moves laterally depending on the signal angle of deviation. It is only visible after the localizer is captured.

#### 4. Runway Symbol

Represents the position of the runway on the horizon.

#### 5. Angle of Attack reading.

Displays current AOA value.

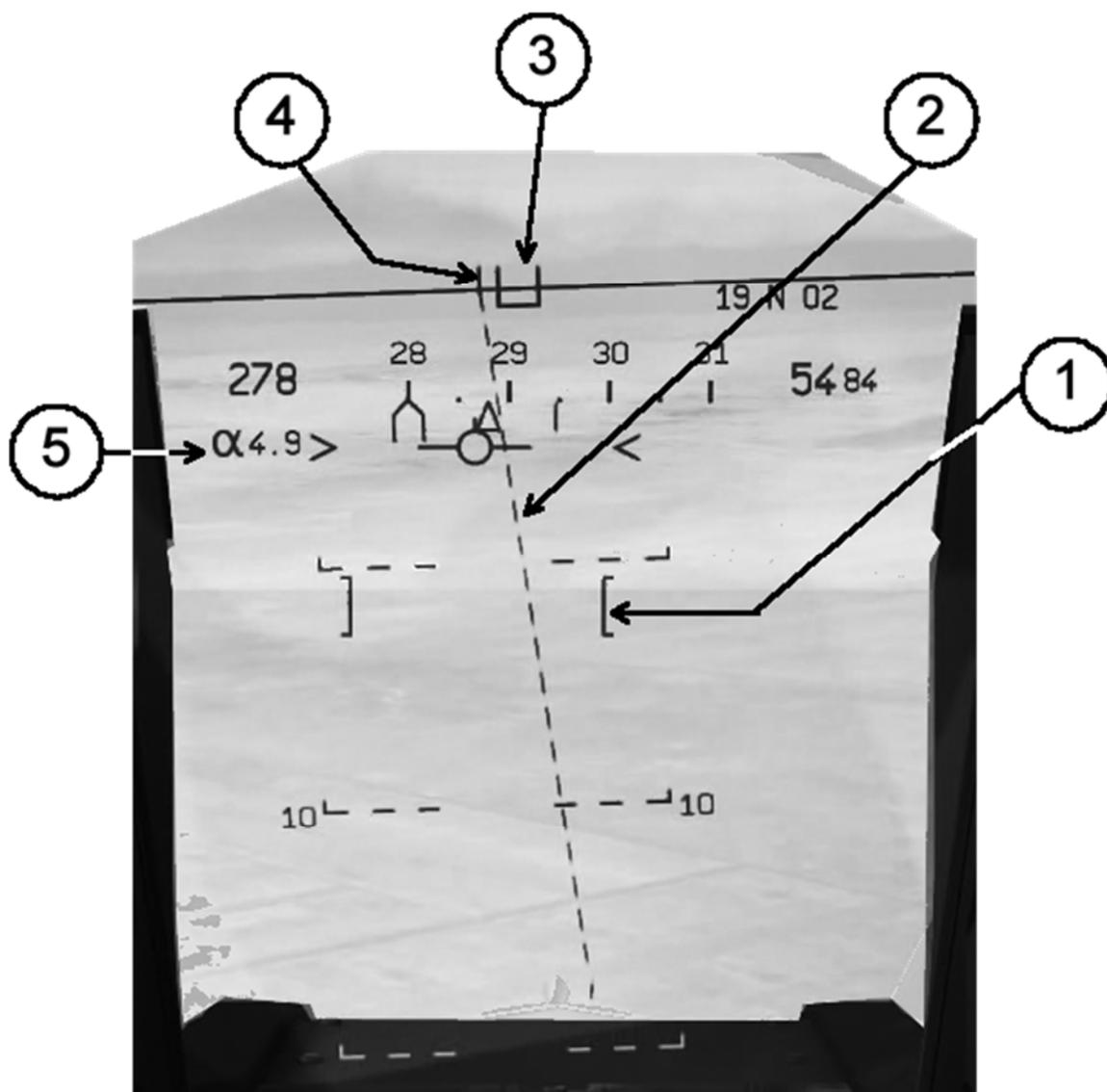


Figure 19 HUD ILS display after localizer capture and before glideslope capture.

## After glideslope capture

### 1. ILS Guide

Visible only when both localizer and glideslope have been captured. It moves in relation to the FPM showing both glideslope and course deviation. To maintain a perfect approach, you have to place the FPM inside the box.

If the deviation from either glideslope or course is too large, a flashing triangle (not shown) will appear indicating that a course/elevation change is required.

### 2. Synthetic Runway

The synthetic runway symbol is an aid for locating the real runway, especially during low visibility conditions. It is only visible when:

- a. The INS is on.
- b. The airport is the current fly-to waypoint.
- c. The runway data (heading and glideslope) were entered.
- d. Both localizer and glideslope have been captured
- e. The runway is less than 10 nautical miles away.
- f. Lateral deviation is less than 7°.

The synthetic runway will be overlaid on top of the runway and the rectangle will grow as the distance to the runway decreases.

The synthetic runway is removed from the HUD as soon as there is weight on the landing gear's wheels.

### 3. Marker Symbol

The flashing "M" symbol is shown when the aircraft's system detects the airport's Outer, Middle and Inner markers.

### 4. Radar altitude

Shown below the FPM if the radar altimeter is On and when the radar altitude is below the Decision Height value.

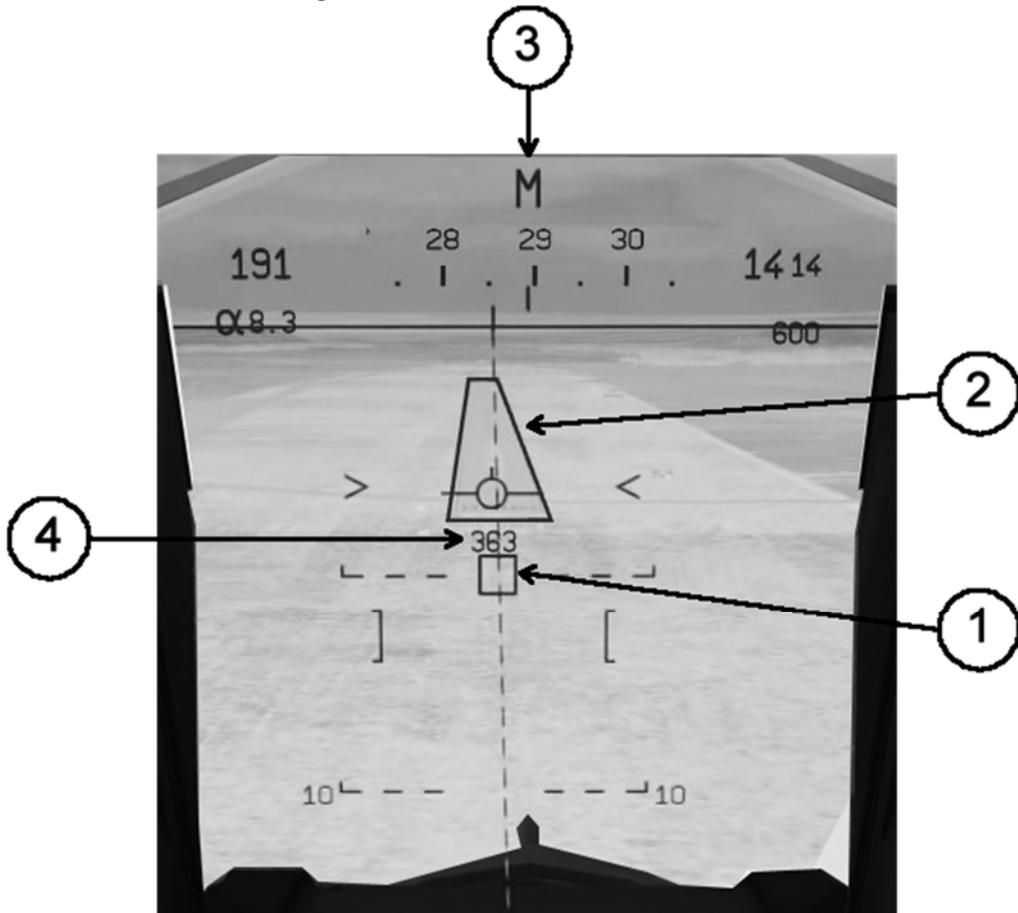


Figure 20 HUD ILS display after glideslope capture.

## AA

As its name implies it is used for air-to-air combat. It has two weapons based sub modes: guns and missiles. No Navigation data is displayed in this mode.

### Guns

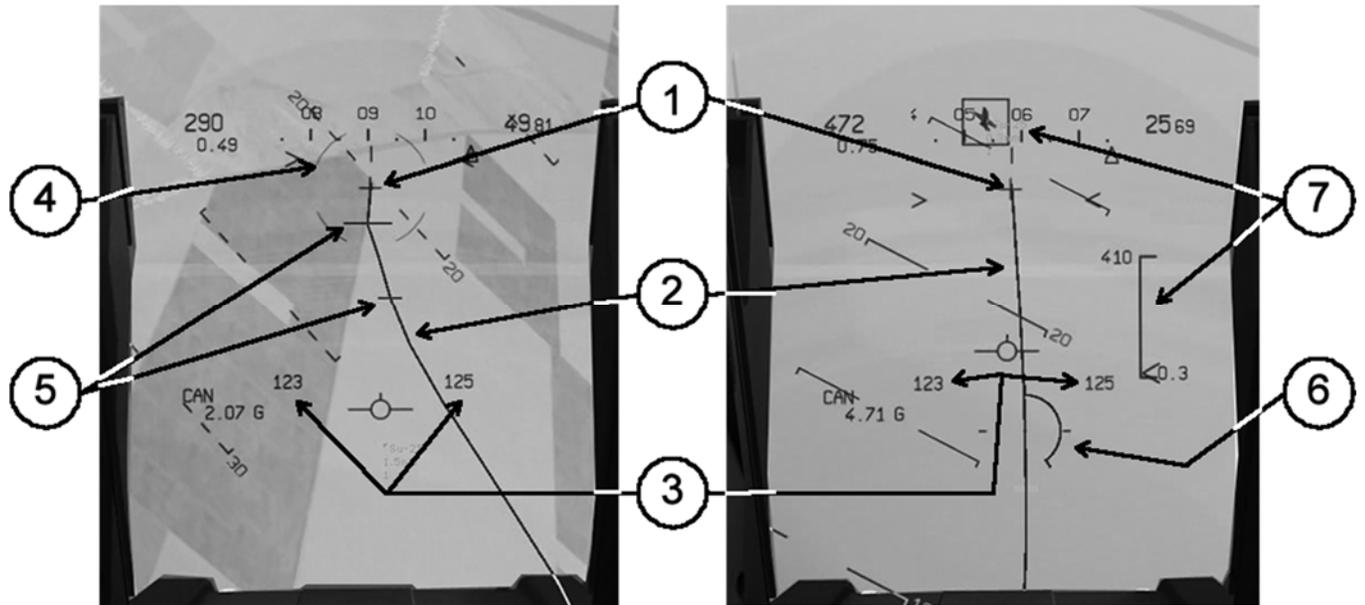


Figure 21 HUD AA Gun mode: No radar lock

Figure 22 HUD AA Gun mode: No radar lock

#### 1. Gun Cross

Indicates the guns' boresight. It is placed on the conjunction of the HUD centerline and the aircraft's waterline. The boresight has a max range of 200 meters.

#### 2. Bullet path prediction (Gun Snake)

The gun snake shows the flying path of a stream of bullets fired for 25 seconds. It has a max range of 1,000 meters.

#### 3. Ammo count

Shows the current count of 30 mm ammunition for each gun.

#### 4. Close Combat mode designation

Indicates which close combat mode is being used.

#### 5. Wingspan markers

These lines are placed at the 300 and the 600 meter range in the gun snake and are used to represent a target wingspan in order to help determine its range. The wingspan markers are not static and their width can be dynamically changed by using the ENV knob (ENV is short for *envergure*, wingspan in French). The ENV knob

changes the wingspan marker width to represent a target from 7 meters up to 40 meters.

The wingspan markers are visible only when there is no radar lock.

## **6. Radar gun piper**

The radar gun piper indicates the exact range to an air target that has a radar lock. It moves alongside the gun snake, indicating the exact position of the target in the bullet stream.

## **7. Radar lock elements**

Please refer to the radar chapter for a description of these elements.

### [How to use the “gun snake”](#)

The gun snake is an air gunnery targeting help. It depicts the path of a bullet stream fired for 25 seconds. The “tail” of the snake is located at the gun cross. The “head” of the snake ends at the 1000 meter range.

To hit a target you must put the gun snake alongside its flight path. You must take care of placing the target at the correct snake position based on its range. The closer to the gun cross, the lower the range.

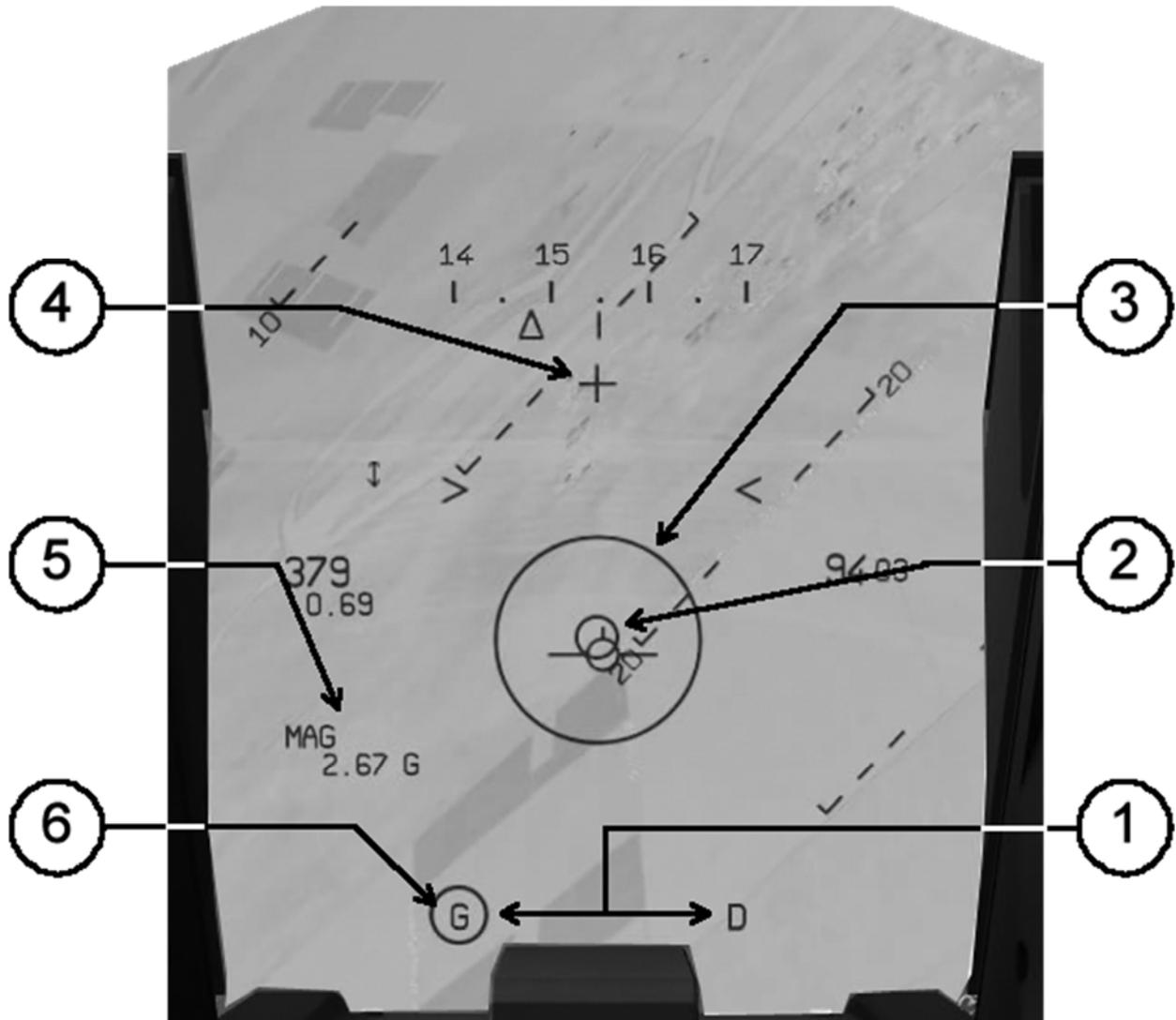
The wingspan markers are helpers to determine target range without the use of radar. When you manage to place a target’s silhouette on the wingspan markers you can calculate a range approximation based on how wide the target is versus the wingspan marker’s width. As you can see, a basic precondition is that you must know the approximate wingspan of your target and to adjust the wingspan marker to that value.

Once you have determined range to target, you place the target at the snake position where a hit is assured.

If you are using radar and your target has radar lock, the wingspan markers are replaced by the radar gun piper. The radar gun piper makes the gunnery easier by indicating the place in the gun snake where a hit is certain. You only have to put your target on the spot in the snake marked by the radar gun piper.

Remember that the closer the target is to the gun cross, the lower the range. If you place a small silhouette near the gun cross you will miss since the actual range is higher. Conversely, if you place a large silhouette near the head of the snake, you will also miss since the range is lower.

## Missiles



### 1. Available missiles

Indicates how many missiles are available. G = Left (Gauche) and D = Right (Droit). The letter disappears when the corresponding missile has been fired.

### 2. Seeker

Represents the missile seeker head. It only appears for Magic II missiles when a target is locked. The seeker will always move towards the selected target position.

### 3. Flight Director Ring

Refer to the Interception Director subtitle for more details.

### 4. Gun cross

Indicates aircraft boresight. It is located at the conjunction of HUD centerline and aircraft's waterline. Only available when Magic IIs are selected. This is the aiming point for the Magic II missiles.

### 5. Attack mode data

Indicates selected weapon (name flashes when the Master arm switch is in the SAFE/OFF position). Aircraft G load and aircraft AOA.

### 6. Selected weapon

Indicates which missile is ready to be fired. By default, the system selects first the left missile and later the right missile, but this order can be changed in the Armament Configuration Panel.

**Note:** When Magic II missiles are selected, both the BA and IAS drop to the center of the HUD. The Heading Scale remains in its position at the top.

## AG

This is the mode used for Air-to-Ground attacks. There are three weapons based sub modes: Guns/Rockets, CCRP and CCIP. For more information about CCRP and CCIP please refer to the Weapons Management chapter.

### Guns/Rockets

This mode is used by both guns and Matra rockets because although they are different weapons, they share the same ballistics characteristics.

#### 1. Ammo count

Displays the current count of 30mm ammunition or 68 mm SNEB rockets.

#### 2. Range to ground

Displays the current slant range to the ground at the point the piper is aiming. For more information, refer to the Weapons Management chapter.

### 3. Radar altitude

Displays current altitude above ground level (AGL). The radar altitude is not automatically displayed and must be manually selected by clicking the appropriate switches in the HUD control panel.

### 4. Gun cross

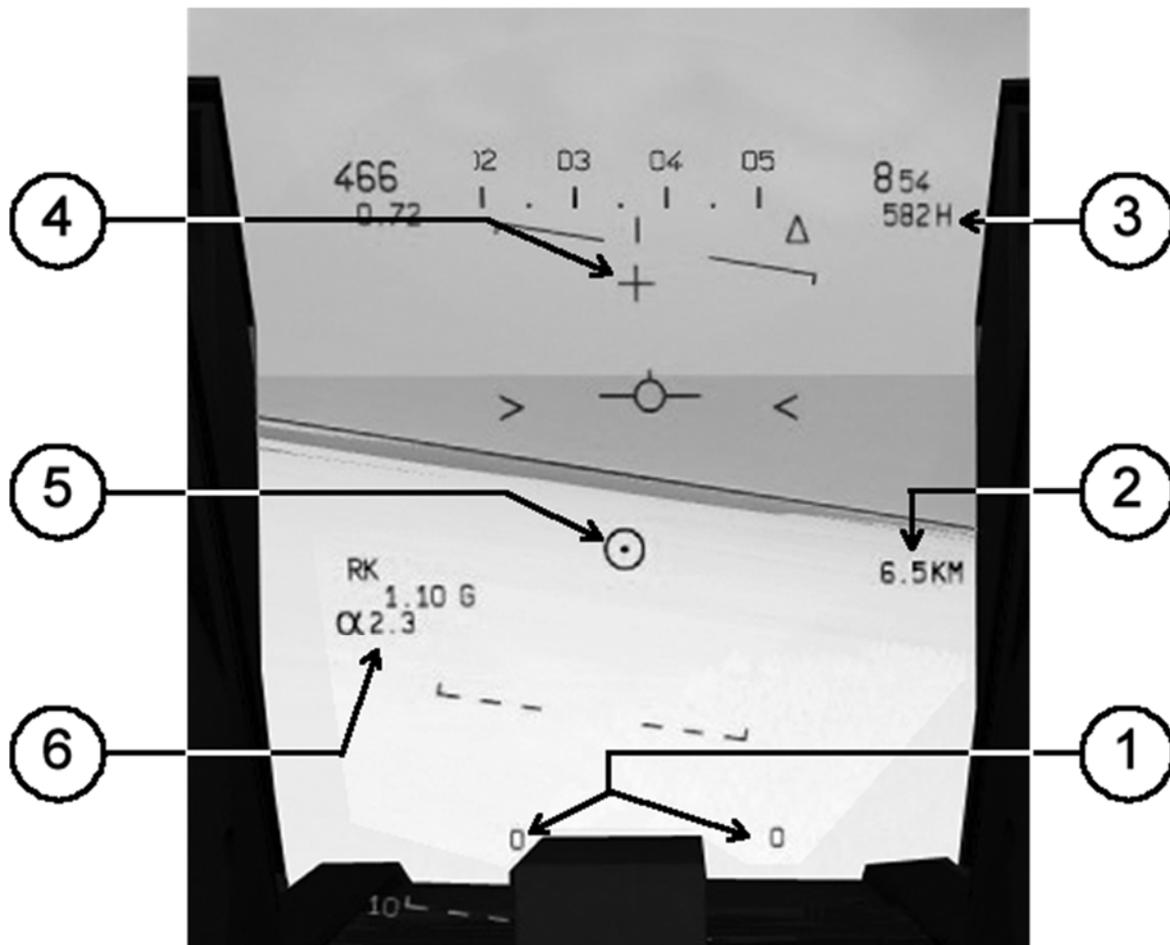
Indicates aircraft boresight. It is located at the conjunction of HUD centerline and aircraft's waterline.

### 5. Gun/Rocket piper

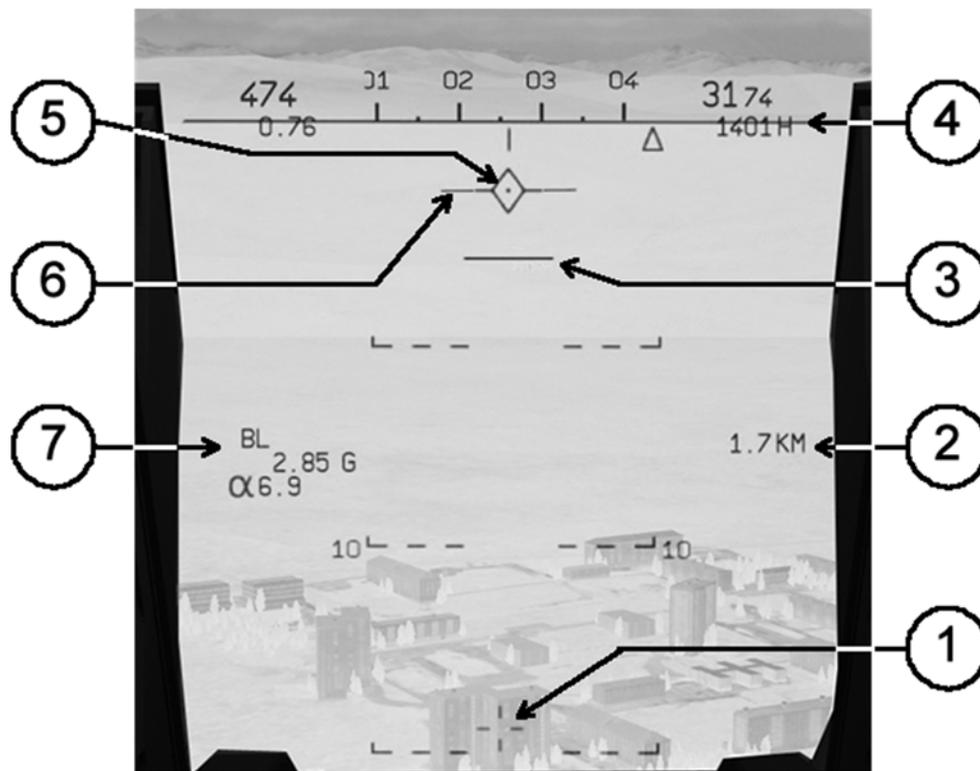
Indicates the point in the ground where the gun shells/SNEB rockets will hit. The aiming point is continuously calculated by the ballistics computer. For more information, refer to the Weapons Management chapter.

### 6. Attack mode data

Indicates selected weapon (name flashes when the Master arm switch is in the SAFE/OFF position). Aircraft G load and aircraft AOA



## CCRP



### 1. Target cross

Shows the selected target position.

### 2. Range to target

Indicates slant range to the target position.

### 3. Release cue

The release cue moves from the target cross towards the CCRP piper. The bomb(s) must be released when the cue is at the center of the piper. The cue is time based and appear when time to target is 15 seconds.

### 4. Radar altitude

Displays current altitude above ground level (AGL). The radar altitude is not automatically displayed and must be manually selected by clicking the appropriate switches in the HUD control panel.

### 5. CCRP piper

It remains at a fixed point and replaces the FPM when in CCRP mode. Before target selection, it is used to select a point in the ground as the target. After target selection, it is used to give the bomb release order.

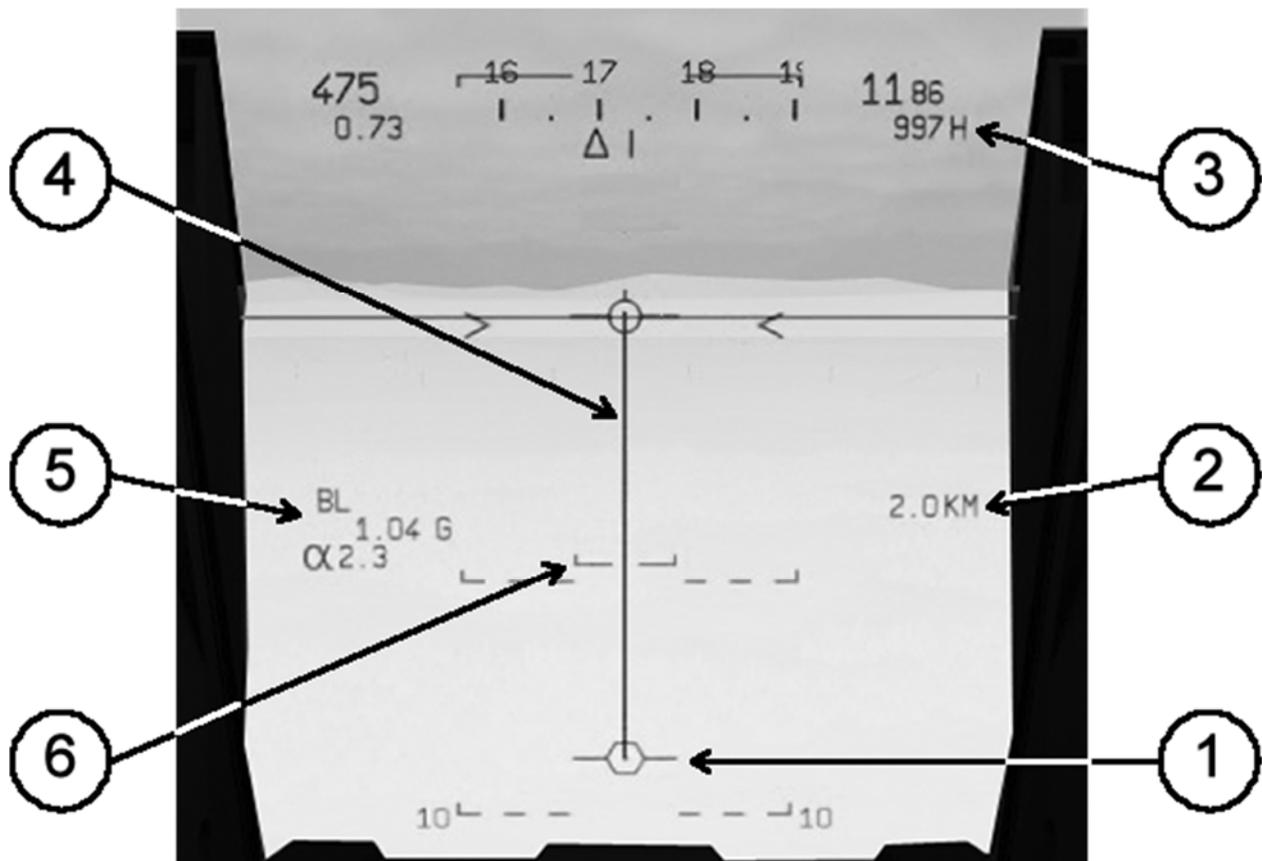
## 6. CCRP steering cues

They appear only after a target point has been selected. They are centered on the CCRP piper and rotate to show deviation from the course to target. The aircraft is flying directly to the target when they are level.

## 7. Attack mode data

Indicates selected weapon (name flashes when the Master arm switch is in the SAFE/OFF position). Aircraft G load and aircraft AOA

### CCIP



### 1. CCIP piper

Aiming point where the bombs will impact.

### 2. Range to ground

Displays the current slant range to the ground at the point the piper is aiming. For more information, refer to the Weapons Management chapter.

### 3. Radar altitude

Displays current altitude above ground level (AGL). The radar altitude is not automatically displayed and must be manually selected by clicking the appropriate switches in the HUD control panel.

### 4. Bomb Fall Line (BFL)

Displays the path that the bombs will follow upon release.

### 5. Attack mode data

Indicates selected weapon (name flashes when the Master arm switch is in the SAFE/OFF position). Aircraft G load and aircraft AOA

### 6. Minimum release altitude cue

Indicates the minimum altitude at which bomb release is safe. It moves from the CCIP piper to the FPM. If the cue reaches the FPM, it is not safe to release the bombs since there is a high probability of taking damage from their detonation. For more information, refer to the Weapons Management chapter.

**Note:** The CCIP piper will only appear if the Radar Altimeter is in the On (M) position.

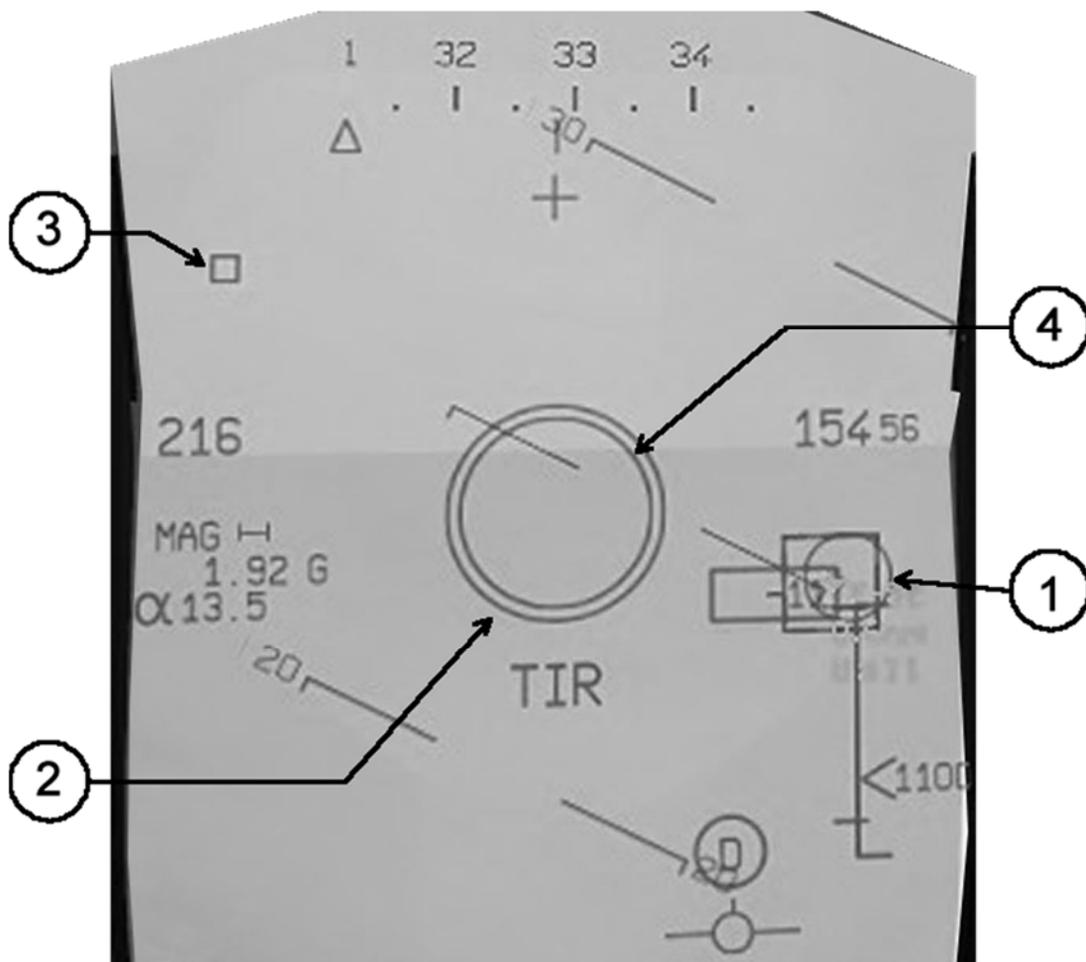
## INTERCEPTION DIRECTOR

The interception director is a special tool available only in Air-to-Air or POL modes. For a more thorough description of POL mode please refer to the Weapons Systems chapter.

The interception director appears only when there is locked radar target regardless of radar mode (TWS or STT). It consists of two elements:

1. **The Flight Director Ring:** Located at the center of the HUD FOV, it indicates the optimal interception zone for the target.
2. **The Interception Flight Director:** It is a small square symbol that represents the point in space towards which the target is flying.

The objective is to maneuver the aircraft so the Interception Flight Director is placed inside the Flight Director Ring. In this way you can be sure that you are flying an optimal interception path towards the target.



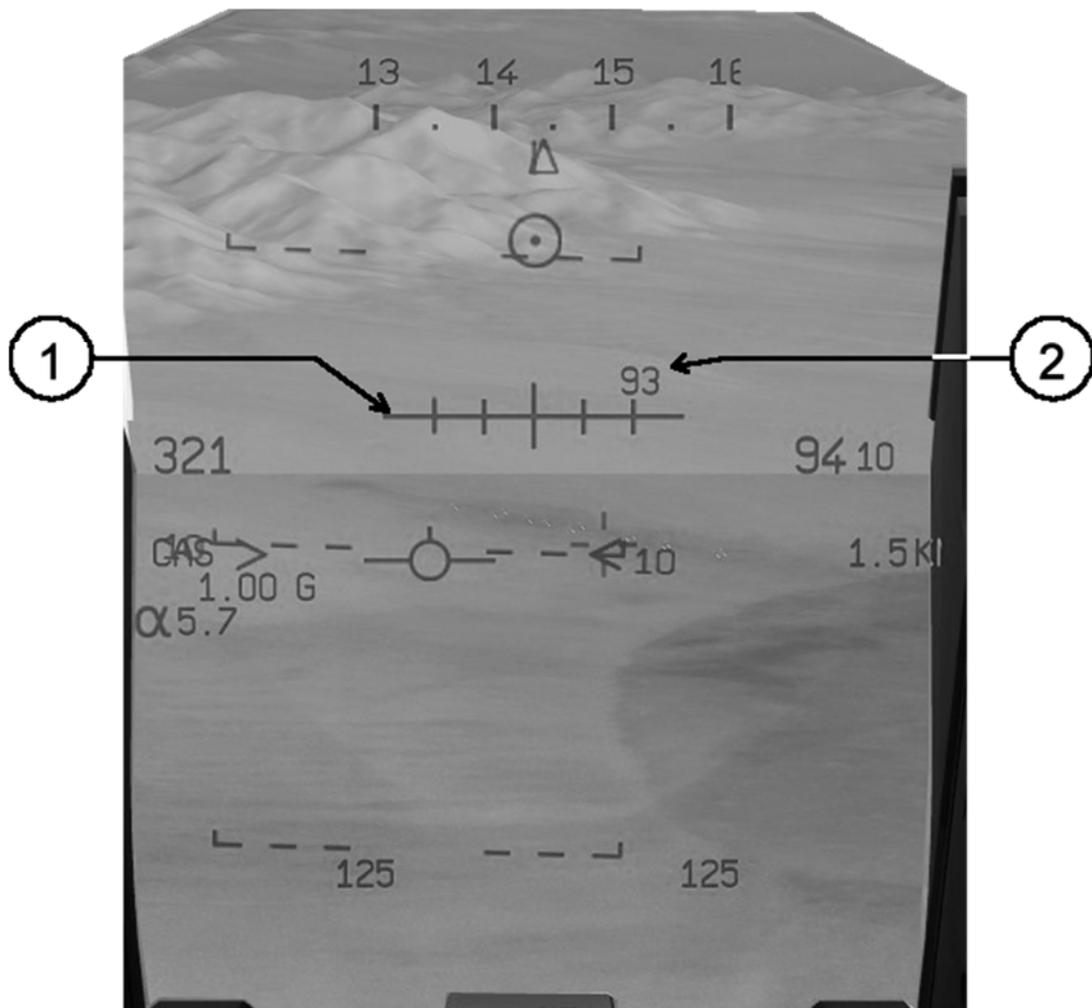
1. **Locked radar target.**
2. **Flight Director Ring.**
3. **Interception Flight Director.** Indicates the point towards where the target is flying
4. **In Range Ring.** Only appears for missiles and indicates that the target is in weapons range.

The Interception Director is not bound to any specific weapon and will appear for all Air-to-Air weapons. There is a special case for Air-to-Air guns, the Interception Director will remain visible as long as the range towards the target is above 1200 meters, in order to prevent clutter in the HUD when the enemy aircraft is within gun range.

**Note:** While the Interception Director will provide you with the best path to close the range with your target, use your own judgment to decide when to fire the selected weapon.

## AUXILIARY GUNSIGHT

The auxiliary gunsight is selected by the pilot. It is available in all modes except Approach. The gunsight is fixed in the horizontal plane but can be moved in the vertical plane to accommodate gun deflection based on ballistic tables for the desired range. The deflection can be modified from 0 to 300 mils.



1. **Auxiliary Gunsight.** To activate it, click on the HAUSSE switch located on the right side of the HUD control panel.
2. **Angle of deflection value.** To modify the deflection click on the HAUSSE knob located on the right side of the HUD control panel, to the right of the HAUSSE switch.

# Chapter 11: Warning System

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## Master Caution Lights

They are located at the Top left of the main instruments panel. Consists of two lights: One Amber for cautions and one Red for warnings.



### When caution occurs:

- Master Caution light: **On**
- Audio warning (see note): **On**
- System specific light on the alarm panel: **On**

### When pilot acknowledges caution (by pressing Master button)

- Master Caution light: **Off**
- Audio warning: **Off**
- System specific light on the alarm panel: **On**

### When caution is no longer valid:

- Master Caution light: **Off**
- Audio warning: **Off**
- System specific light on the alarm panel: **Off**

**Note on audio warning:** No warning will be heard when the caution occurs, but a chime will be heard every 20 seconds until the caution is acknowledged or no longer valid.

### When failure occurs:

- Master Warning light: **On**
- Audio warning (continuous): **On**
- System specific light on the alarm panel: **On**

### When pilot acknowledges failure (by pressing Master button)

- Master Warning light: **Off**
- Audio warning (continuous): **Off**
- System specific light on the alarm panel: **On**

### When failure is no longer valid:

- Master Warning light: **Off**
- Audio warning (continuous): **Off**
- System specific light on the alarm panel: **Off**



## Alarm Lights Panel



The alarm lights panel works in conjunction with the Master Warning and Master Caution lights. Like the Master Warning and Master Caution they are divided in two colors, Amber for Cautions and Red for Warnings.

In this case, each individual light indicates the specific system/subsystem that is affected by the failure/anomalous condition. The light remains on for as long as the caution / warning condition exists.

# Chapter 12: Operational Limitations

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## Engine

Max RPM (including afterburner): 103% rpm

Max Tt7 Temperature (including afterburner): 900°C

## Airframe

# Chapter 13: Aircraft Procedures

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These are the procedures that must be followed before and after a flight. The procedures listed here are a subset of the ones followed by the pilots of the actual aircraft.

## Preflight Checklist

### Left Instruments Panel

Ln	Description	Position
1	FBW/PA Auto test	Off (cover closed)
2	Emergency Afterburner Cutoff	Off (cover closed)
3	Emergency Oil Pump	Off (cover closed)
4	Engine Computer (FADEC)	Norm (cover closed)
5	Fuel Dump	Off (cover closed)
6	Tape recorder	As desired
7	FBW GAIN	Norm
8	Emergency Trim	N
9	Audio volumes panel	Check and set
10	Inflight relight switch	Off
11	Throttle	Stop
12	Radar	Off
13	Pelles (scoops), Souris (incl. Cones), Becs (slats) switches	Auto
14	External lights	Off
15	Brakes circuit switch (SPAD)	On (cover closed)
16	“Emergency fuel” engine mode	Off
17	V/UHF radio	On – Transmitting
18	UHF radio	On – Listening
19	Landing Gear Lever	Down and secured
20	FBW NORM/ULT.SEC Switch	NORM (cover closed)
21	FBW Mode AA/Charges	As required
22	Emergency canopy lever	Towards the rear
23	Parachute lever	Towards the front

### Main Instruments Panel

Ln	Description	Position
1	Master Arm switch	Off
2	Selective Jettison	Off (cover closed)
3	Auxiliary Attitude Indicator	Uncaged
4	FBW NORM/VRILLE switch	Normal
5	HUD and HDD	On
6	Radar altimeter	As desired
7	IFF	Out-3A-C
8	HSI	NAV (Cm or Cv)

9	Fuel Panel	Check – Crossfeed closed
10	BINGO Selector	Insert BINGO value
11	FIRE warning light	Test
12	Caution/Warning Lights	Test

## Right Instruments Panel

Ln	Description	Position
1	Alert Network (QRA) Switch	Off (Down position)
2	Emergency Hydraulic pump	Test then AUTO
3	Sound warning system	Off
4	Canopy sealing	Lever forward (If canopy is closed)
5	VOR/ILS - TACAN	Off
6	Fuel pumps	Off
7	Ignition/vent selector	G or D
8	Fuel Shut-Off Valve Switch	Closed (cover open)
9	Breakers panel	Check
10	INS	Off

## Engine Start

### Before Engine Start

Ln	Description	Position
1	BATT Switch	On
2	TRN Switch	On
3	External power supply (if available)	Connected
4	INS	Align

### Engine Start sequence

Ln	Description	Position
1	Parking Brake	Set
2	Fuel Shut-Off Valve Switch	Open (cover closed)
2	Fuel pumps “D” and “G”	On
3	Ignition/Vent selector	G or D as required.
4	Ignition switch cover (Check that the starting fuel pump is in the “On” position)	Open
5	<b>B.P.</b> warning light	Off
6	Press ignition switch.	
7	When the RPM reach 10% move the throttle towards the Ground IDLE position.	
8	Check RPM and engine temperature.	
9	<b>HUILE</b> <b>T7</b> warning lights	Off

10	<b>BP.G</b>	<b>BP.D</b>	<b>HYD.1</b>	<b>HYD.2</b>	caution lights	Off
11	<b>ALT 1</b>	<b>ALT 2</b>	caution lights			On at 40% RPM and their switches in Off
12	ALT1 and ALT2 switches					On at 40% RPM

## Post-Engine Start Checklist

Ln	Description	Position				
1	INS	NAV (if aligned, otherwise align)				
2	Hydraulic pressure	Check that HYD lights are off				
3	Power supply switches	All On				
4	External power supply (if applicable)	Disconnected				
5	<b>BATT</b>	<b>TRN</b>	<b>ALT 1</b>	<b>ALT 2</b>	caution lights	Off
6	VOR and TACAN	On				
7	Emergency Hydraulic Pump	On.				
8	<b>HYDS</b> warning light	Off				
9	IFF	STBY				
10	HUD	Check configuration				
11	FBW and AP	Test				
12	FBW and AP test lights	Green				
13	All FBW warning lights	Off				
14	Anti-Collision Light	On				
15	Rudder deflection	Check				
16	Flight Controls Surfaces	Check				
17	Airbrakes and Wing slats (Becs)*	Check				

\* To test the wing slats click the BECS switch to OUT. The slats should actuate out. Click the switch back to AUTO. The slats should return to its stowed position.

## TAXIING

### Checklist

Ln	Description	Position
1	Parking Brake	Release
2	<b>PARK</b> caution light	Off
3	Warning Sounds switch	On
4	Caution/Warning Lights panel*	All Off
5	NSW	Activate
6	<b>DIRAV</b> advisory light	On

\* The **CAB** warning light, indicating that the canopy is open, may remain lit at this stage.

You can now increase throttle until the aircraft rolls out. Do not exceed 20 knots ground speed while taxiing.

## TAKE OFF

### Checklist

Ln	Description	Position
1	Canopy	Down and locked
2	<b>CAB</b> warning light	Off
3	Caution/Warning Lights panel	All Off
4	NSW	Secured
5	<b>DIRAV</b> advisory light	Off
6	Full throttle into max afterburner	Check acceleration (Jx) in HUD
7	<b>PC</b> advisory light	On
8	Rotate at 120 Knots	Place horizon on the rotation pitch marker in the HUD.
9	Retract and stow landing gear	Before 260 Knots.

## LANDING

### Checklist

Ln	Description	Position
1	Landing Gear Down	Below 230 knots
2	Landing Gear warning lights	Green
3	Anti-Skid	Check
4	HUD	APP Mode
4	Landing Lights	On
6	AOA final approach	14°
7	Wheel brakes	Below 130 knots*
8	NWS	Below 40 knots

\* Whenever possible, use wheel brakes only when speed is below 100kt, to lessen brakes wear.

## RUNWAY VACATED

### Checklist

<b>Ln</b>	<b>Description</b>	<b>Position</b>
1	Landing Lights	Taxi
2	IFF	Off
3	VOR/ILS	Off
4	TACAN	Off

## **PARKING**

### **Checklist**

<b>Ln</b>	<b>Description</b>	<b>Position</b>
1	External power supply	Connected
2	HUD	Off
3	INS	Off
4	Engine	Stop button
5	When engine has stopped: Fuel pumps G and D	Off
6	Fuel Shut-Off Valve Switch	Closed (cover open)
7	All air conditioning equipment	Off
8	All external lights	Off
9	Radios (V/UHF and UHF)	Off
10	ALT1 and ALT2 switches	Off
11	BATT and TRN switches	Off

# Chapter 14: Navigation

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## The Inertial Navigation System INS

The INS is the heart of the M-2000C navigation system. It allows the aircraft to know its position in the world and to plot a course to a geographical point.

The INS can store the following information:

- 20 navigation waypoints (Latitude, longitude and altitude) and its associated data:
  - Offset waypoint (delta latitude, delta longitude and delta altitude).
  - Runway magnetic heading (QFU).
  - Runway approach glideslope (PD – *Pente Désirée*).
  - Desired arrival time (TD – *Temps Désiré*).
  - Desired arrival track (RD – *Route Désirée*).
- 3 mark points with geographic coordinates along with the mark time.
- The magnetic declination

The INS provides the following information:

- Aircraft geographical position (Latitude and Longitude).
- Horizontal components ( $V_x$ ,  $V_y$ ) of the inertial speed.
- Ground Speed.
- Ground Track.
- Bearing.
- True Heading.
- Magnetic Heading.
- Acceleration components ( $A_x$ ,  $A_y$ ,  $A_z$ ).
- Bearing and distance to a waypoint.
- Track error.
- Magnetic lateral deviation from desired track.
- Track error from desired track.
- Approach glideslope.
- Remaining time to reach waypoint.
- Time difference between remaining time and desired arrival time in order to maintain a constant speed.
- The aircraft load factor.

The INS is composed of two elements:

- The Poste de Commande Navigation PCN (Navigation Control Panel)
- The Poste Sélecteur de Modes PSM (Mode Selector Panel)

The INS controls the information displayed in the following instruments:

- HUD: Aircraft heading, attitude and current waypoint navigation.
- HDD: Aircraft heading, attitude and waypoint position, including bullseye.

- ADI: Aircraft heading, attitude and ILS needles.
- HSI: Aircraft heading, VOR/NAV needles and DME window.
- PCN: See The PCN chapter.

## The PSM

The PSM is the control panel for both the PCN and the INS

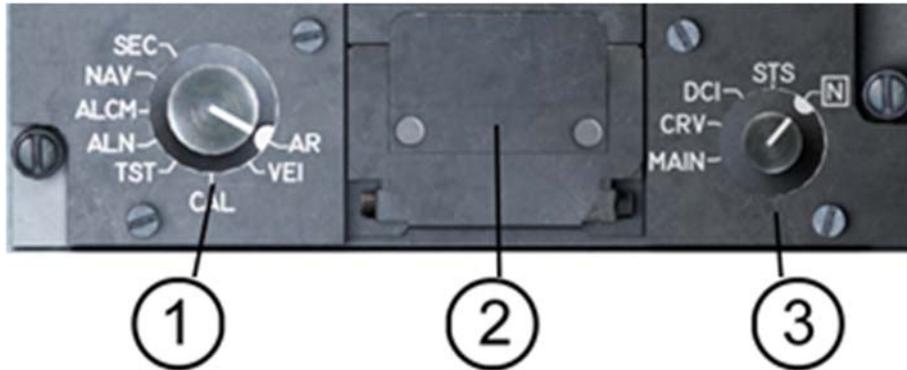


Figure 23 The INS' PSM panel

The PSM is divided in three sections:

1. The INS/PCN Mode Selector:
  - a. **AR** (*Arrêt*): Turns Off both the INS and the PCN
  - b. **VEI** (*Veille*): The gyros remain off but the system is powered and thermal regulation is on. The PCN is available for data entry.
  - c. **CAL** (*Calibration*): Reserved for maintenance.
  - d. **TST** (*Test*): Reserved for maintenance.
  - e. **ALN** (*Alignement normal*): Normal INS alignment procedure (refer to INS alignment).
  - f. **ALCM** (*Alignement sur cap mémorisé*): Memory INS alignment procedure (refer to INS alignment).
  - g. **NAV**: Navigation
  - h. **SEC** (*Secours*): Emergency operation, the INS provides only gyroscopic information (attitude and heading).
2. The Data Cartridge Insertion Module (*Module d'Insertion de Paramètres MIP*)
3. The PCN operational mode:
  - a. **N** (Normal): Default position.
  - b. **STS** (Status): The PCN display the current INS alignment status
  - c. **DCI** (*Données Codées Inertielles*): Inertial Codes Input; To visualize or enter certain parameters into the INS memory.
  - d. **CRV** (*C/R de vol*): Used for maintenance only
  - e. **MAIN** (Maintenance): used for maintenance only

## The PCN

The PCN is responsible for the interface between the pilot and the INS. It has the following functions:

- Visualization of the navigational data in the memory of the INS
- Data input into the memory of the INS
- Visualization of the INS alignment status.
- Control of saved points, register and offset waypoints.



Figure 24 The INS' PCN panel

### 1. LCD Displays

Left window: 6 digits with identification symbols N, S, + and –

Right window: 7 digits with identification symbols E, W; + and –

PREP window: 2 digits indicating the current waypoint for data entry/visualization.

DEST window: 2 digits indicating the current waypoint used for navigation. The data for this waypoint is displayed in the HUD, VTB, HSI and ADI.

## 2. Parameter Selector

Editable Data		
Waypoint	CP/PD	Runway magnetic heading / Desired Glideslope
	ALT	Altitude
	L / G	Latitude / Longitude
RD/TD		Desired track / Desired travel time at waypoint
Offset	$\Delta L / \Delta G$	Offset Latitude / Longitude
Waypoint	$\Delta ALT$	Offset altitude
	$\rho / \theta$	Distance / Bearing to offset waypoint.
DEC		Magnetic declination.

Read Only Data	
DV/FV	Wind direction/speed
TR/VS	Time remaining to waypoint/Ground Speed
D/RLT	Distance / Bearing to waypoint or offset waypoint.

## 3. Function Keys

- **PREP**: Selects the waypoint to be modified.
- **DEST**: Selects the waypoint to be used for Navigation.
- **BAD**: Selects the OFFSET waypoint as destination.
- **REC**: Toggles INS calibration process.
- **MRQ**: Marks a geographical position.
- **VAL**: Used to validate alignment, calibration and mark data.

## 4. Numeric Keypad

Used to enter data into the INS. Consists of:

- 10 numeric keys, from 0 to 9. Including keys to designate North, South, East, West, + and -.
- **EFF** (Effacement) key: Clears the input errors in the system.
- **INS** (Insertion) Key: Enters the data in the system.

## 5. Status Lights

- **PRET** (green): INS is ready.
- **ALN** (yellow): INS is aligning
- **MIP** (yellow): A data cartridge has been inserted.
- **N.DEG** (yellow): The INS needs alignment.
- **SEC** (yellow): The INS is in emergency mode
- **UNI** (red): The INS is damaged.
- **M91, M92, M93**: Indicates mark points being used.

PRET and ALN are only active during the alignment process.

## PCN Utilization

### Waypoint Selection

The PCN uses two waypoint indexes to operate:

- The Preparation (PREP) waypoint, which is the waypoint used for visualization and editing.
- The Destination (DEST) waypoint, which is the waypoint being used for navigation. The DEST waypoint data can only be visualized in the HUD, HDD, ADI and HSI.

To select a PREP waypoint:

1. Click on the PREP button, it will light up.
2. Click on the numeric pad the number of the waypoint you want to visualize and/or modify. The valid PREP waypoint numbers are from 0 to 20. You need to enter both numbers, for numbers below 10 you need to enter the leading 0, e.g.: Waypoint 0 must be entered as 00, 8 as 08, etc.
3. As soon as the second digit has been entered the selected waypoint data will be displayed and the PREP button will go dark.

To select a DEST waypoint:

1. Click on the DEST button, it will light up.
2. Click on the numeric pad the number of the waypoint you want to visualize and/or modify. The valid DEST waypoint numbers are from 1 to 20. You need to enter both numbers, for numbers below 10 you need to enter the leading 0, e.g.: Waypoint 1 must be entered as 01, 8 as 08, etc.
3. As soon as the second digit has been entered the selected waypoint data will be used for navigation and the DEST button will go dark
4. You cannot select waypoint 0 in DEST.
5. You cannot select a waypoint number higher than the number of waypoints in the loaded flight plan.
6. An invalid waypoint number will reset the DEST waypoint to 1.

Additionally, there are the following shortcuts for selecting waypoints:

- If you press PREP twice, without entering a waypoint number, the DEST waypoint number will be copied to PREP.
- If you press DEST twice, without entering a waypoint number, the PREP waypoint number will be copied to DEST. As long as the PREP waypoint number is higher than 00

**Note:** Every time the PSM is placed in VEI, the PREP waypoint automatically changes to 00 and the DEST waypoint changes to 01

## Data Selection

To select the data to be displayed in the PCN you only have to click on the 11 position rotary knob. The data displayed is the following:

For Waypoint 00 (Current aircraft position)

Label	Left Window		Right Window	
	Description	Display	Description	Display
TR/VS	Not Used	Blank	Ground Speed* (Kts)	1990
D/RLT	Not Used	Blank	True Heading* (degs)	359.9
CP/PD	Not Used	+---.-	Not Used	+---.-
ALT	Aircraft Altitude (ft)	±99 999	Aircraft Altitude (m)	±30 480
L/G	Aircraft Latitude (deg)	N/S 90.00.00	Aircraft Longitude (deg)	E/W 180.00.00
RD/TD	Ground Track* (deg)	359.9	INS Chronometer (min, sec)	± 399.59
ΔL/ΔG	Not Used	N/S --.---.--	Not Used	E/W ---.---.--
ΔALT	Not Used	± -- ---	Not Used	± - ---
ρ/θ	Not Used	+ ---.--	Not Used	---.-
DEC	Magnetic Variation (deg)	± 99.9	Not Used	Blank
DV/FV	Wind Direction* (deg)	359.9	Wind Speed* (Kts)	999

For Waypoint 01 to 20

Label	Left Window		Right Window	
	Description	Display	Description	Display
TR/VS	Remaining time* (min, sec)	719.59	Ground Speed* (Kts)	1990
D/RLT	Distance* (NM)	409.60	Bearing* (deg)	359.9
CP/PD	Runway Heading (deg)	+ 359.9	Runway Glideslope (deg)	+ 90.0
ALT	Waypoint Altitude (ft)	± 25 000	Waypoint Altitude (m)	± 7 620
L/G	Waypoint Latitude (deg)	N/S 90.00.00	Waypoint Longitude (deg)	E/W 180.00.00
RD/TD	Selected Bearing (deg)	359.9	Selected Time (min, sec)	± 399.59
ΔL/ΔG	Wp Offset Latitude (Km)	N/S 99 997	Wp Offset Longitude (Km)	E/W 99 997
ΔALT	Wp Offset Altitude (ft)	± 24 999	Wp Offset Altitude (m)	± 7 619
ρ/θ	Wp Offset Distance (NM)	+ 53.99	Wp Offset Bearing (deg)	359.9
DEC	Magnetic Variation (deg)	± 99.9	Not Used	Blank
DV/FV	Wind Direction* (deg)	359.9	Wind Speed* (Kts)	999

## Notes:

- Values with a \* are read only.
- Values with a blue background refer to Waypoint Data
- Values with a green background refer to Offset Waypoint Data
- Waypoint Lat/Lon values are entered in the format: DD:MM.mm where mm are the minutes decimal. Eg: 36° 13.68' N or 115° 02.93' W.

## Data Entry

PREP Waypoint data can be edited only under the following conditions:

- PSM Operational Mode is in N
- PSM Mode is in VEI, ALN, ALCM or NAV
- Waypoint 00 data can only be edited when PSM Mode is in VEI.

There are two types of data that INS use: signed and unsigned.

**Signed data** is all that data that requires that you specify if the value you are about to enter is positive or negative (for mathematical purposes Lat/Lon coordinates North/East are considered positive while South/West are negative). The following are the INS signed data: Waypoint latitude/longitude, waypoint altitude, offset latitude/longitude, offset altitude and magnetic declination.

**Unsigned data** is all the data that is always assumed to have a positive value and thus do not require that you specify its sign: Waypoint runway heading, waypoint runway glideslope, selected bearing, selected time, offset bearing, offset distance.

To edit the data, you must:

1. Select the parameter you want to edit by positioning the parameter knob in the corresponding label.
2. Select either left or right data to edit.
  - a. To select the left data, click on the 1 or 7 keys in the numeric pad.
  - b. To select the right data, click on the 3 or 9 keys in the numeric pad.
3. Both the INS and EFF buttons will light up, indicating that the PCN is in edit mode.
4. The selected window will show a series of dashes, indicating the number of digits to be entered. If the data is signed both signs will be displayed indicating the need to select one.
5. To select a sign, you must click on the associated button: 2 for North, 8 for South, 4 for West and 6 for East. For positive/negative values you must click on 1 (+) or 7 (-) for the left LCD or 3 (+) or 9 (-) for the right LCD.
6. An entry example would be:

You have selected L/G and the right window (G = Longitude), the left window will continue displaying the L data and the right window displays E/W ---.---.--, indicating that you must: Select either E or W and that you must enter 7 digits, including leading zeros.

In this example, if you want to enter 78° 24.03' E then you must:

  - Click on the 6 Key to select E.
  - Enter 0782403 so that all dashes have been replaced by a number

Another example is if you want to enter waypoint altitude in feet, you select the left LCD by clicking on 1 or 7. The right window will keep displaying the current data in meters while the left one displays +/- -----. Select either + or – for values above or below sea level and afterwards you must enter 5 digits including leading zeros. In this example you want to enter 1850 above sea level so you must:

- Click on the 1 Key to select +
- Enter 01850 so that all dashes have been replaced by a number.

Now you are ready for the next step.

7. Click on INS if the information is ready to be entered or EFF if you made an error.
  - If you click on INS, the data you entered is saved.
  - If you click on EFF, all the information entered will be disregarded and the window will show again the dashes.
8. If the data you entered is invalid, it will be discarded and the dashes will appear again.
9. Both INS and EFF buttons will go dark and the selected window will show the new data.
10. Clicking on PREP or changing the parameter knob position will cancel the edit mode.

## **INS Alignment**

The INS requires alignment any time the aircraft has been dark and cold for a long period of time. In the case of DCS, an alignment is required every time you:

- Start from the ramp
- Have requested aircraft repairs from the ground crew
- Has requested a rearm/refuel from the ground crew.

There are two types of alignment: Standard and Memory.

- Standard Alignment takes 8 minutes at the end of which the INS is the most precise.
- Memory Alignment takes 90 seconds and is used when the aircraft has not been moved from the spot where it was parked when the INS was switched off.

For DCS a Standard Alignment is required when:

- You start from the ramp
- You have requested aircraft repairs from the ground crew.

A Memory alignment can be used when:

- You have requested a rearm/refuel from the ground crew.

## **Standard Alignment**

To start a standard alignment, you must:

1. Set the PSM Operational Mode in N

2. Set the PSM Mode in VEI. This will automatically select PREP Waypoint 00
3. Check that the Aircraft position in Latitude, Longitude and Altitude indicated by the PCN are correct. Change them as needed (see Data Entry for more information).
4. Set the PSM Mode knob in ALN when you are satisfied that all aircraft position is correct. Once the PSM is in ALN, the following will happen:
  - a. The ALN yellow light will blink.
  - b. The VAL button will light up.
5. Click on the VAL button to start the alignment process.
  - a. The ALN yellow light will become steady, indicating that the INS is aligning.
  - b. The VAL button will go dark.
6. At this time, you can edit other waypoint data.
7. The alignment process will abort if:
  - a. You click the PSM Mode knob to another position.
  - b. You try to edit the Waypoint 00 data.
8. You can check the alignment process status by clicking the PSM Operational Mode knob to the STS position.
9. The ALN yellow light will turn off when the first coarse alignment (Class 4) has been reached. At the same time the PRET green light will start blinking. At this stage it is safe to abort the alignment process, the INS will remain aligned but its precision will be very low.
10. When the PRET green light has become steady, the alignment process has ended and the INS precision is the highest. You can now put the PSM Mode knob in NAV.

To start a Memory Alignment, you must:

1. Set the PSM Operational Mode in N
2. Set the PSM Mode in VEI. This will automatically select PREP Waypoint 00.
3. Set the PSM Mode in ALCM.
  - a. The ALN yellow light will blink.
  - b. The VAL button will light up.
4. Click on the VAL button to start the alignment process.
  - a. The ALN yellow light will become steady, indicating that the INS is aligning.
  - b. The VAL button will go dark.
5. The alignment process will abort if:
  - a. You click the PSM Mode knob to another position.
  - b. You try to edit the Waypoint 00 data.
6. The ALN yellow light will go dark and the PRET green light will turn on when the alignment process has ended.
7. Now you can put the PSM Mode in NAV.

## **INS Position Update**

The INS is a very accurate instrument that uses a series of gyroscopes to provide the data it needs. Unfortunately, all gyroscopes, no matter how exact and precise are subject to gyro drift because the Earth rotates ( $\omega$ ,  $15^\circ$  per hour), and because of small accumulated errors caused by friction and imperfect balancing of the gyro. Another sort of apparent drift exists in the form of transport wander, where aircraft movement will

essentially add or subtract to the effect of the Earth's rotation upon a gyroscope. The effect of these drift errors is that as time passes by the INS precision starts to suffer. In order to regain navigation precision a procedure called **Position Update** is required to be performed after a certain time.

The M-2000C INS has two methods to provide Position Update for the INS: Waypoint Flyby and Waypoint Radar Ranging. Both methods require the use of a landmark with known position and elevation. This land mark must be set up as one of the waypoints in the flight plan.

### **Waypoint Flyby Position Update**

With this method you have to fly exactly over the selected land mark.

To perform a Waypoint Flyby Position Update, you must:

1. Fly towards the center of the selected landmark, disregarding the INS navigation, cues as soon as you have it in sight.
2. At the exact time when you fly over the landmark, you press the REC button.
3. The PCN will show the following information:
  - a. If the parameter knob is in the  $\Delta L/\Delta G$  position, the difference in latitude and longitude between the aircraft position and the landmark position will be shown. The values will be given in nautical miles.
  - b. If the parameter knob is in any other position, the difference will be shown in polar coordinates. The left LCD display will show distance difference in nautical miles while the right LCD will show the bearing difference.
4. If the difference between aircraft and landmark position is less than 15 nautical miles, the VAL button will turn on.
5. You review the values presented in the PCN and decide whether to accept them or not. If you accept them, then press the VAL button. The accumulated gyro drift will be reset to 0 and the aircraft present position will be corrected. Both REC and VAL buttons will go dark.
6. If the difference between aircraft and landmark positions are more than 15 nautical miles, the VAL button will remain dark and the REC button will start to blink.
7. If you decide to reject the PCN values or if the REC button is blinking, click on the REC button. The INS will not update its position and will continue using the values it already has, including the accumulated drift error.

### **Waypoint Radar Ranging Position Update**

With this method you do not have to fly over the selected landmark. Instead you will use the radar to provide a precise range value between the aircraft and the land mark.

To perform a Waypoint Radar Ranging Position Update, You must:

1. Fly towards the selected landmark, disregarding the INS navigation cues, as soon as you have it in sight.
2. With the PCA in NAV mode, click in the OBL button. The radar will enter TAS mode and a diamond shaped radar cue will appear in the HUD. This cue represents the exact spot where the radar beam is pointing.
3. Maneuver the aircraft until the radar cue and the landmark are aligned.
4. Click on the TAS Ranging keyboard bind.
5. The PCN will show the following information:
  - a. If the parameter knob is in the  $\Delta L/\Delta G$  position, the difference in latitude and longitude between the aircraft position and the landmark position will be shown. The values will be given in nautical miles.
  - b. If the parameter knob is in any other position, the difference will be shown in polar coordinates. The left LCD display will show distance difference in nautical miles while the right LCD will show the bearing difference.
6. If the difference between aircraft and landmark position is less than 15 nautical miles, the VAL button will turn on.
7. You review the values presented in the PCN and decide whether to accept them or not. If you accept them, then press the VAL button. The accumulated gyro drift will be reset to 0 and the aircraft present position will be corrected. Both REC and VAL buttons will go dark.
8. If the difference between aircraft and landmark positions are more than 15 nautical miles, the VAL button will remain dark and the REC button will start to blink.
9. If you decide to reject the PCN values or if the REC button is blinking, click on the REC button. The INS will not update its position and will continue using the values it already has, including the accumulated drift error.
10. The radar returns to its normal operational mode.

Waypoint Radar Ranging Position Update will be cancelled if:

1. You click Master ARM to the ON position.
2. You click the radar to POL mode.
3. You click the PCA to APP mode.
4. You select a weapon.

# Radio Navigation System

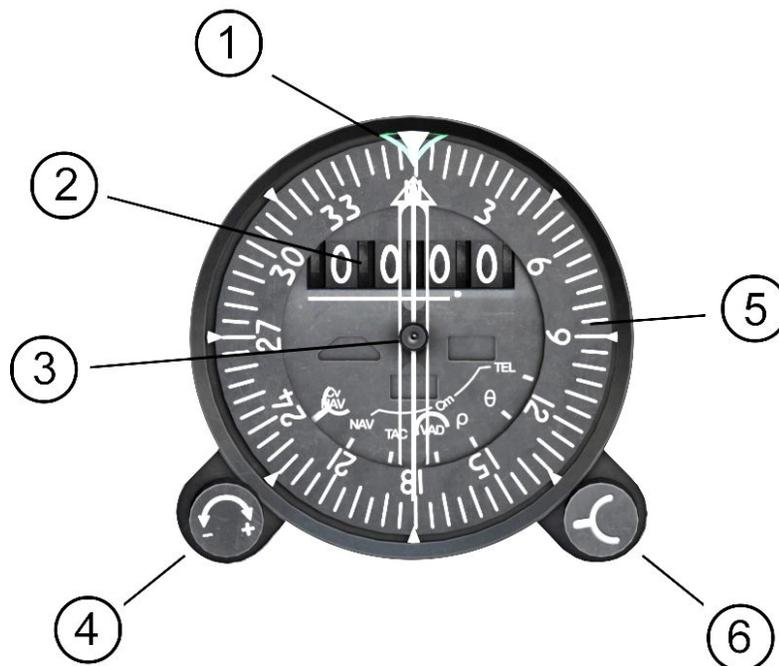
## The Horizontal Situation Indicator HSI

The Horizontal Situation Indicator, commonly called HSI, is an aircraft flight instrument that combines a Heading Indicator with a VOR-ILS indicator.

Unlike standards HSI used in American aircrafts, the M-2000C HSI was designed to require little to no pilot input. It consists of a compass rose to indicate aircraft true or magnetic heading, a selected auto pilot heading indicator, two needles, a four-digit mechanical display, an operational mode indicator and four failure flags.

The only pilot required inputs are: Operational Mode and TACAN Offset values.

The HSI also controls the type of heading that will be used on all navigation instruments: True or Magnetic.



1. Selected AP Course indicator.
2. DME display
3. Needles
  - **Needle 1:** Wide.
  - **Needle 2:** Thin.
4. VAD (TACAN Offset Point) input knob.
5. Compass Rose.

## 6. HSI mode selector

- **Cv NAV**
- **Cm NAV**
- **TAC**
- **VAD**
- **$\rho$**
- **$\theta$**
- **TEL**

### Operational Modes

The HSI has four operational modes: INS/VOR Navigation (NAV), TACAN/VOR Navigation (TAC), TACAN Offset Point/VOR Navigation (VAD) and Ground Controlled Interception (TEL).

- **NAV (main INS/VOR navigation mode):** In this mode, the HSI connects with the INS and displays waypoint navigation information along with bearing to selected VOR/ILS station. This is the only mode that allows to select between true or magnetic headings, through its two sub modes:

**Cv NAV:** In this mode the system uses true heading. Cv stands for *Cap vrai* (French for True heading).

**Cm NAV:** In this mode the system uses magnetic heading. Cm stands for *Cap magnétique* (French for Magnetic heading).

The selection of Cv NAV or Cm NAV also affects the heading indicators in the following instruments: HUD, HDD, ADI.

All other following modes are part of the “Cm” category, i.e. they use only magnetic heading indications.

- **TACAN/VOR Navigation (TAC):** In this mode the HSI connects to the TACAN receiver.
- **TACAN Offset Point/VOR navigation (VAD):** In this mode the HSI calculates and navigates towards a point offset to the current TACAN station. The offset point location is introduced in polar coordinates, distance and magnetic bearing, by using the VAD (TACAN Offset Point) input knob.

This mode has three sub modes:

**VAD:** This is the operational mode. The HSI checks if it a valid TACAN Offset Point exists and calculates distance and bearing from the current aircraft position towards the offset.

**$\rho$  (Rho):** This mode is used to enter the distance in nautical miles from the TACAN station to the offset point.

**θ (Theta):** This mode is used to enter the magnetic bearing from the TACAN station to the offset point.

Please refer to the *TACAN Offset (VAD) Navigation* chapter for more information on this mode.

- **Ground Controlled Interception (TEL):** In this mode the HSI displays interception information: bearing, distance and interception course, towards a target. This mode is used when the aircraft is under Ground Controlled Interception (GCI).

**Note:** Ground Controlled Interception is not simulated in DCS and thus this mode is not operational.

### HSI Information provided

The HSI needles and indicators show navigation information based on the selected mode.

HSI Information							
Mode Indicators	Cv NAV	Cm NAV	TAC	VAD	ρ	θ	TEL
Compass Rose	True Heading	Magnetic Heading					
CAP Flag	Heading Gyros Failure						
Needle 1	Waypoint bearing	TACAN bearing	VAD <sup>1</sup> bearing <sup>4</sup>	VAD <sup>1</sup> magnetic bearing <sup>2</sup>	VAD <sup>1</sup> magnetic bearing <sup>2</sup>	Target Bearing	
Needle 1 Flag	Bearing Failure flag						GCI error <sup>5</sup>
Needle 2	VOR Bearing						Interception Course
Needle 2 Flag	VOR Fail						GCI error <sup>5</sup>
DME	Waypoint distance	TACAN distance	VAD <sup>1</sup> distance <sup>4</sup>	VAD <sup>1</sup> distance <sup>3</sup>	VAD <sup>1</sup> Magnetic Bearing <sup>2</sup>	Target Distance	
DME Flag	Distance Fail						GCI error <sup>5</sup>
Selected Course Indicator	Automatic Pilot Heading						

1: VAD: TACAN Offset Point

2: Magnetic bearing FROM the current TACAN station TO the VAD.

3: Distance FROM the current TACAN station TO the VAD.

4: FROM the aircraft current position TO the VAD.

5: Error in the data link between the ground control and the aircraft.

## TACAN Offset Point (VAD) Navigation

The HSI has a special navigation mode called VAD (*Vecteur Additionel*, French for Additional Vector). The VAD is an offset point calculated from the position of the selected TACAN station. The system uses the Needle 1 (Wide) and DME (numeric) indicators. The Needle 1 and DME flags will be shown if it is not possible to engage the VAD mode.

For the VAD mode to be operational the following conditions must be met:

1. A TACAN station has been selected and the signal must be received.
2. The polar coordinates from the geographical position of the TACAN station to the offset point have been entered into the system.

When all conditions are met the HSI will navigate directly towards the TACAN Offset Point (VAD) from the aircraft position.

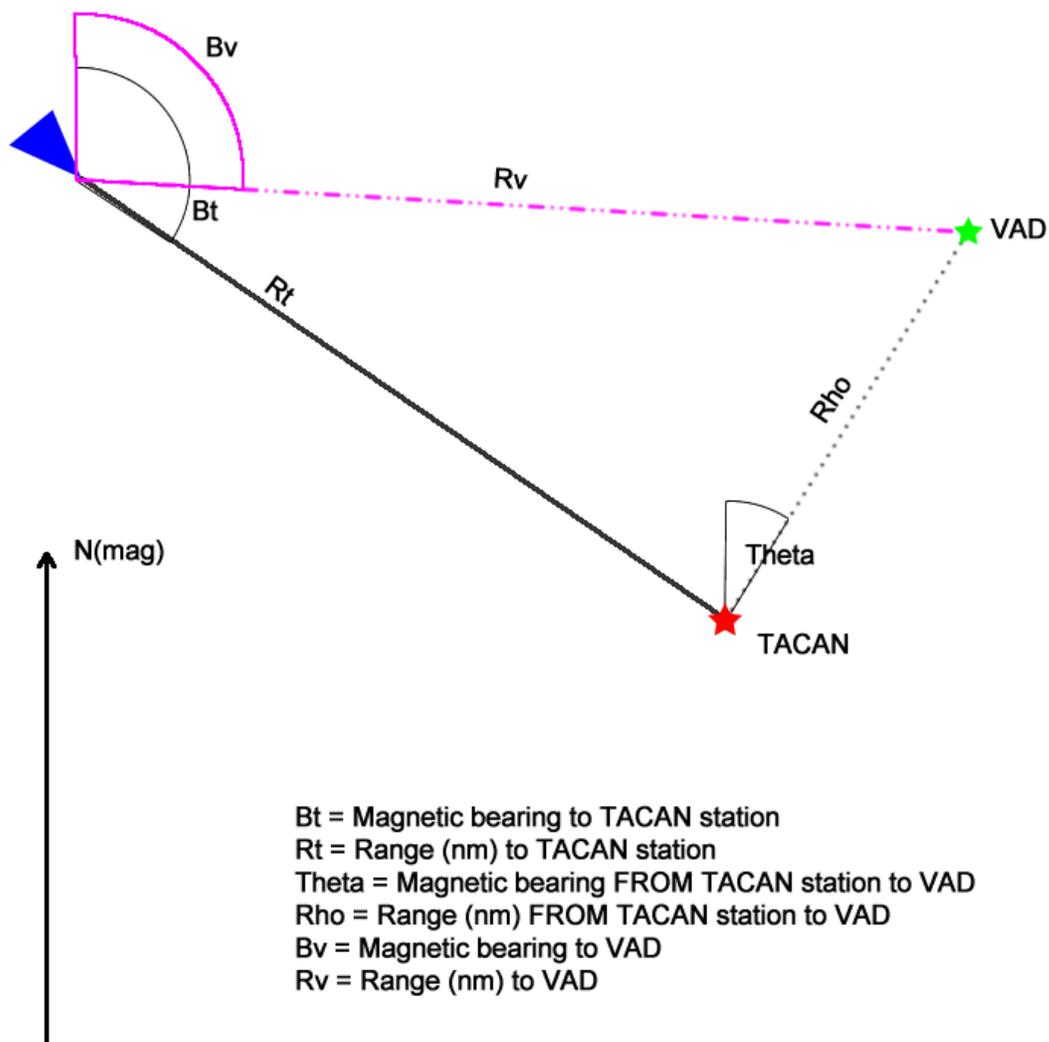


Figure 25 TACAN Offset Point navigation.

### ***How to operate the VAD mode:***

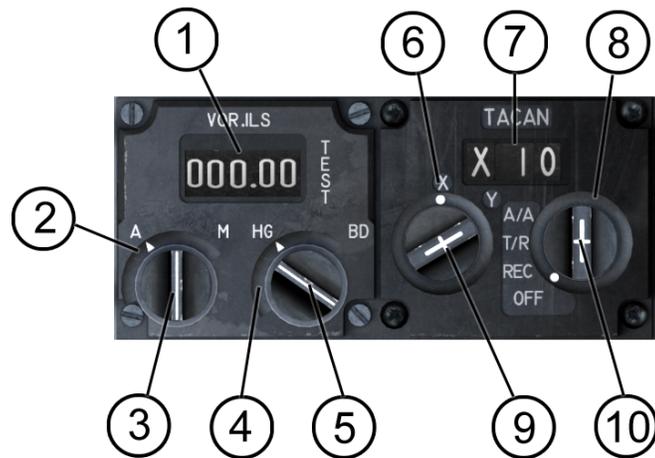
1. Select a TACAN station in the TACAN receiver.
2. Place the HSI in TACAN mode and check that it is receiving a signal from the TACAN station (the DME and Needle 1 flags should not be shown).
3. Place the HSI in  $\theta$  (Theta) mode.
4. Enter the magnetic bearing from the TACAN station to the VAD by rotating the VAD input knob. The Needle 1 indicator will rotate towards the selected value, note that the DME window will also show the corresponding numeric value.
5. Place the HSI in  $\rho$  (Rho) mode.
6. Enter the distance from the TACAN station to the VAD (offset point) by rotating the VAD input knob. The DME indicator will start showing the selected distance. The valid values are from 001.0 to 999.0 nautical miles. The Needle 1 indicator will show the selected  $\theta$  (Theta)
7. Place the HSI in VAD mode. The system will calculate the geographical position of the offset point from the current aircraft position: The Needle 1 indicator will show the magnetic bearing to the VAD and the DME indicator will show the distance in nautical miles (see the graphic).

### **HSI Failure Flags**

The HSI has four failure flags that indicate an error condition in the HSI:

1. **DME Failure:** It shows a bar across the DME indicator, blocking the value shown. If it is visible there is an error in the DME value.
2. **Needle 1 Failure:** It shows an orange tab in the right flag window. If it is visible, then it is not possible to show the bearing to the selected navigation point/station. The Needle 1 indicator will park itself to the  $135^\circ$  position.
3. **Needle 2 Failure:** It shows an orange tab in the left flag window. If it is visible, then it is not possible to show the bearing to the selected VOR/ILS station. The Needle 2 indicator will park itself to the  $225^\circ$  position.
4. **Heading Failure:** It shows an orange tab in the bottom flag window. If it is visible, then it indicates a problem with the heading gyro and thus the heading value shown in the HSI and other heading indicators is not reliable. If shown it is recommended to use the auxiliary heading gyro.

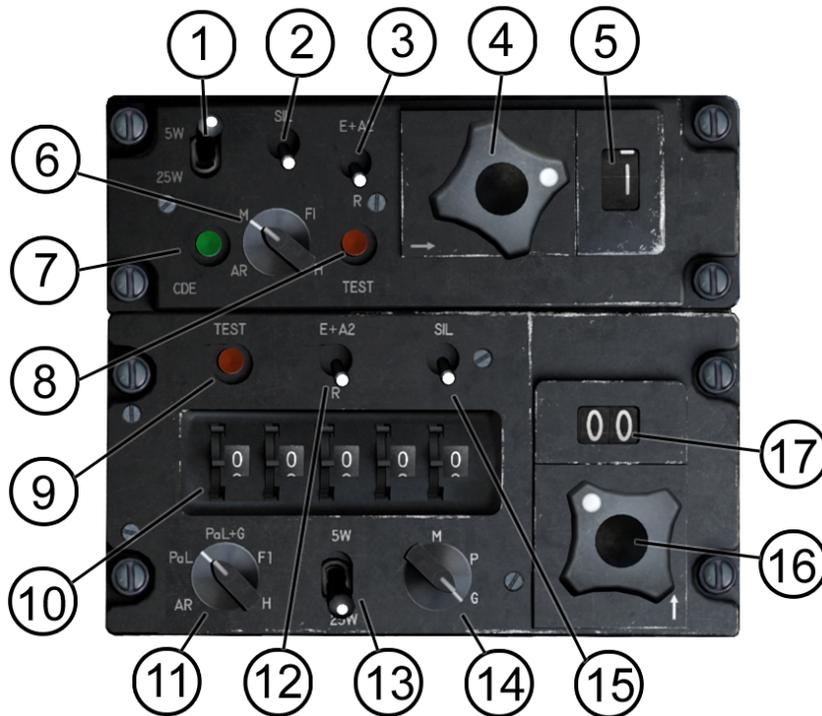
## VOR/ILS and TACAN Receivers



- |                        |                            |
|------------------------|----------------------------|
| 1.) VOR/ILS Indicator  | 4.) TEST L/R Selector      |
| 2.) Power Selector     | 5.) Frequency Selector     |
| 3.) Frequency Selector | 6.) XY TACAN Band Selector |
| 7.) TACAN Indicator    | 8.) TACAN Mode Selector    |
| 9.) Frequency Selector | 10.) Frequency Selector    |

# Chapter 15: Communications

## VHF/UHF Radios



- |   |                                     |
|---|-------------------------------------|
| 1.) UHF Receiver/Transmitter Inverse Selector.    | 2.) UHF SIL/Mute Switch.            |
| 3.) UHF Secure Channel Encryption.                | 4.) UHF Channel Preset Selector.    |
| 5.) UHF Channel Indicator.                        | 6.) UHF Operation Mode Selector.    |
| 7.) UHF Secure Encryption Receive Light           | 8.) UHF Test Button.                |
| 9.) V/UHF Test Button.                            | 10.) V/UHF Frequency Selector.      |
| 11.) V/UHF RX Mode Selector.                      | 12.) V/UHF Channel Encryption.      |
| 13.) V/UHF Receiver/Transmitter Inverse Selector. | 14.) V/UHF TX Modes.                |
| 15.) V/UHF SIL/Mute Switch.                       | 16.) V/UHF Channel Preset Selector. |
| 17.) V/UHF Preset Channel Indicator.              |                                     |

## Volume Control Panel



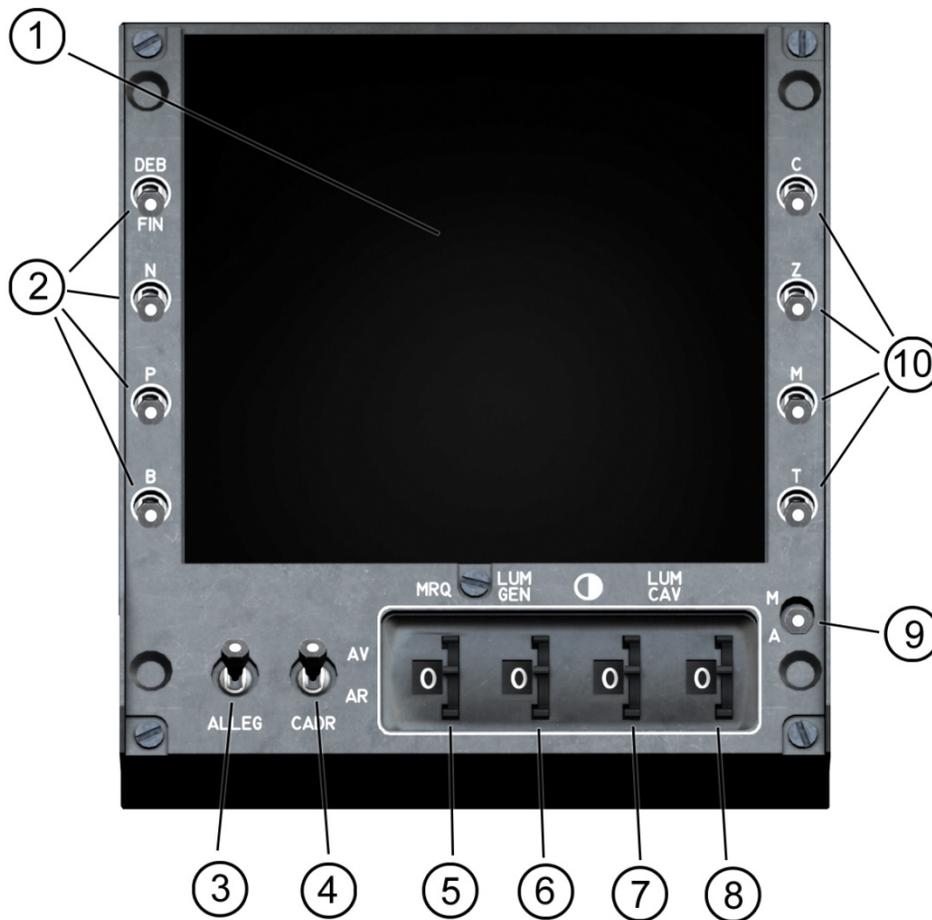
- 1.) COMM Select.
- 3.) TACAN Volume.
- 5.) Approach Volume.
- 7.) UHF Volume.

- 2.) ILS Volume.
- 4.) MAGIC Tone Volume.
- 6.) Marker Volume.
- 8.) V/UHF Volume.

# Chapter 16: Electronic Warfare

## The VTB/HDD

The Visualisation Tête Basse (VTB), which is French for Heads Down Display (HDD), displays radar information along with navigation, target designation and aircraft load out.



1. Display Screen  
Displays the Radar.
2. Parameter Input Select (Left)  
4 switches that allows the left side parameter input for Target Designation.
3. De-Clutter VTB/HDD  
De-Clutters VTB/HDD Symbology .
4. Radar Map Display Select  
Displays the Radar map.

5. MRQ Marker Brightness Adjust  
Adjusts the VTB/HDD's Marker (MRQ)Brightness.
6. Backlight Brightness Adjust  
Adjusts the VTB/HDD's Backlight Brightness.
7. Contrast Adjust  
Adjusts the VTB/HDD's Contrast.
8. Brightness Adjust  
Adjusts the VTB/HDD's Brightness.
9. Power ON/OFF  
Turns On/Off the power of the VTB/HDD.
10. Parameter Input Select (Right)  
4 switches that allows the left side parameter input for Target Designation.

## The RDI Radar

The RDI Radar is a high PRF Doppler multi-mode/single function radar optimized for air-to-air combat. RDI was the first high pulse repetition frequency Doppler radar built in France. RDI is optimized for the air defense mission, therefore it has a single function, though its mode options include:

- Air-to-air search at all altitudes.
- Long-range TWS and missile guidance.
- Automatic short-range STT for missiles and guns.
- Look-down, shoot-down against targets flying as low as 30 meters (98 feet).

RDI is compatible with both the Matra Magic 2 and the Matra Super 530D missiles. Fire control for cannon over ranges of 1000 meters (3280 feet) is provided. Although the RDI is primarily configured for the air defense role it has secondary capabilities to carry out ranging for weapons delivery, low altitude navigation with ground mapping and contour mapping for terrain avoidance.

**Note:** Since DCS lacks AG radar functions both ground mapping and contour mapping are not available.

RDI can provide target range in search mode as opposed to be limited to tracking mode. Three types of scanning are provided for air combat:

- Narrow beam (scanning straight ahead).
- Vertical scanning (optimized for tail chase).

- Helical scanning (covering the HUD field of view).

## RDI radar capabilities and limitations

	Max Ranges*		Lock Type		Doppler
	Search	Lock	TWS	STT	Filter
<b>High PRF</b>	65	50	Yes	Yes	100%
<b>Med PRF (Interleaved)</b>	45	20	Yes	No	50%
<b>Low PRF</b>	25	N/A	No	No	0%

\* All distances are in nautical miles.

For air-to-air combat, RDI provides a 120° cone of coverage, with the antenna sca

For air-to-air combat, the RDI provides a 120° cone of coverage, the antenna scanning at either 50 or 100°/s, with  $\pm 60$ ,  $\pm 30$  or  $\pm 15^\circ$  scan. For air-to-air gun attacks, the 3.5° beam can be locked to the target at up to 19 km (10 nmi) range, with automatic tracking within the head-up display field of view, or in a 'super-search' area, or in a vertical search mode. The system can look up or down, range while searching, track-while-scan, provide continuous tracking, generate aiming signals for air combat and compute attack and firing envelopes. For the strike role it provides real-beam ground-mapping, terrain-avoidance and air-to-ground ranging.

## Close Combat Modes (CCM)

Close Combat Mode is a special mode for air to air engagements. In this mode, the radar will be set at a range of 10 nautical miles and it will lock on the closes contact it can detect.

There are 5 search modes available in CCM:

### Boresight:

Available with all weapons. In boresight mode, the radar is in a fixed position, centered on the aircraft's reference line. It provides a narrow search cone only 3° wide. Basically the radar is converted into a gunnery radar.

### Vertical Scan:

Vertical Scan is available with both AA Guns and Magic missiles selected. It provides a narrow vertical beam that is 4.8° wide and 60° tall. It covers between +50° to -10° centered on the aircraft reference line.

## HUD Scan

HUD Scan is available only when the Super 530D missiles have been selected. The radar covers the entire HUD area, a 20° wide cone.

## Horizontal Scan

This mode is available with all weapons. It has two submodes: Mode 1 and Mode 2, but they work the same: The radar search a 30° Azimuth arc with two bars for a 6° x 60° search cone. Unlike the other modes, it is possible to move the radar antenna in elevation.

Mode 1 uses High PRF, while Mode 2 uses Medium PRF. Medium PRF search mode is only available in Horizontal Scan Mode 2.

## Self Defense equipment

The M-2000C has three different defensive systems that allow the aircraft to survive high threat environments: The SABRE built-in Jamming and deception system, A Serval Radar Warning Receiver (RWR) and the Spirale counter measures dispensing system. Additionally, it has the capability to include a IR launch detection system D<sup>2</sup>M. All these systems are controlled by a single Electronics Counter Measures (ECM) Panel located in the right instruments panel, below the INS Control Panel (PCN).

The ECM panel is divided into two sections: Sensors and Emitters to the left and Decoy dispensers to the right.

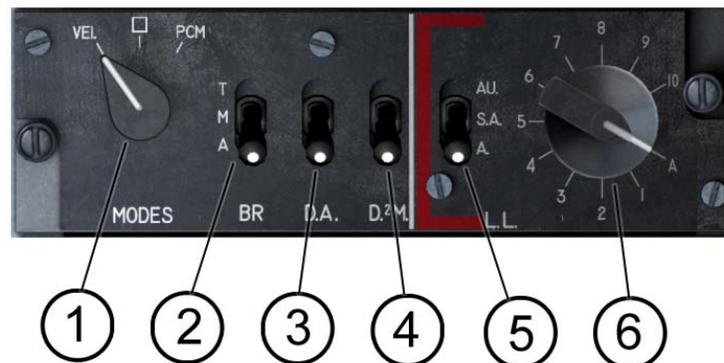
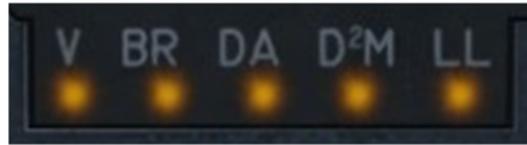


Figure 26 The ECM Panel

1. Jammer operational mode selector switch.
2. Jammer master Switch.
3. Radar Warning Receiver master switch.
4. D<sup>2</sup>M IR launch detector master switch.
5. Decoy dispenser master switch.
6. Decoy dispenser program selector knob.

The working status of all self-defense systems can be checked with the help of the ECM Status Lights bank located below the RWR.



*Figure 27 Self Defense System Status Lights*

From left to right the lights indicate:

- **V:** Jammer standby status.
- **BR:** Jammer operational status.
- **DA:** RWR operational status.
- **D<sup>2</sup>M:** IR SAM Detector operational status.
- **LL:** Decoy dispenser operational status.

The operational status is displayed as follows:

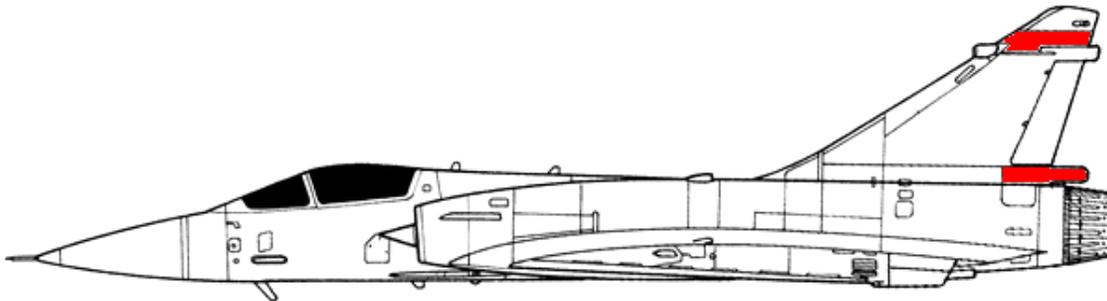
**Light Off:** System is off or not powered.

**Light On:** System is powered and functional.

**Light Blinking:** System is damaged or in self-test.

### **The Sabre Jamming and Deception system**

The M-2000C carries a built-in jamming and deception system. The pod is located at the bottom of the tail-fin and the antennas in a fairing at the top of the same.



*Figure 28 Jammer components location.*

The system is preprogrammed from factory and the pilot has no means to change its working parameters from the cockpit. What methods the system use to jam and spoof enemy radar is classified and no public document exists.

The system has two operational modes: Veille (standby) and PCM (active).

1. **Veille:** In this mode the system is energized but not emitting any signal.

2. **PCM:** In this mode the system is both energized and emitting jamming and deception signals.

**How to operate:**

To operate the jammer the pilot must use two switches (refer to the ECM control panel):

1. **The Jammer Master switch:** This three-position switch controls if the system is On, Off or in Self-test mode.
  - **A:** Jammer is Off.
  - **M:** Jammer is On. Operational status is controlled by the Jammer Operational Mode Switch.
  - **T:** Jammer is in self-test.
2. **The Jammer Operational Mode switch:** This three position switch controls if the system is either in Standby or Active modes.
  - **VEI:** Places the Jammer in standby mode.
  - **[ ]:** This position cedes Jammer operational control to the HOTAS button.
  - **PCM:** This position activates the Jammer

To use the jammer the pilot click place the Jammer Master Switch to the M position. Later he must set the Jammer Operational Mode Switch to the position he desires/requires.

The following table describes the jammer operation depending on switch selection:

Switch Position			Jammer	Status Lights	
BR	MODE	HOTAS		V	BR
A	Any	N/A	Off	Off	Off
M	VEI	N/A	Stby	On	On
	[ ]	Stby	Emit	On	Off
	[ ]	Emit		On	On
	PCM	N/A	Emit	On	On
T	Any	N/A	Stby	Blink	Blink
Malfunction			Off	On	Blink

*Figure 29 Jammer Operation*

**The Radar Warning Receiver RWR**

The RWR is a sensor that detects the radio emissions of radar systems. It provides with both a visual and audio warning when a radar threat is detected. The system is completely passive so there is no danger of discovery when using it.

The RWR system uses four sensors that provide 360° coverage: one located on each wing, looking sideways and two located in the front and rear of the tail fin looking front and back.

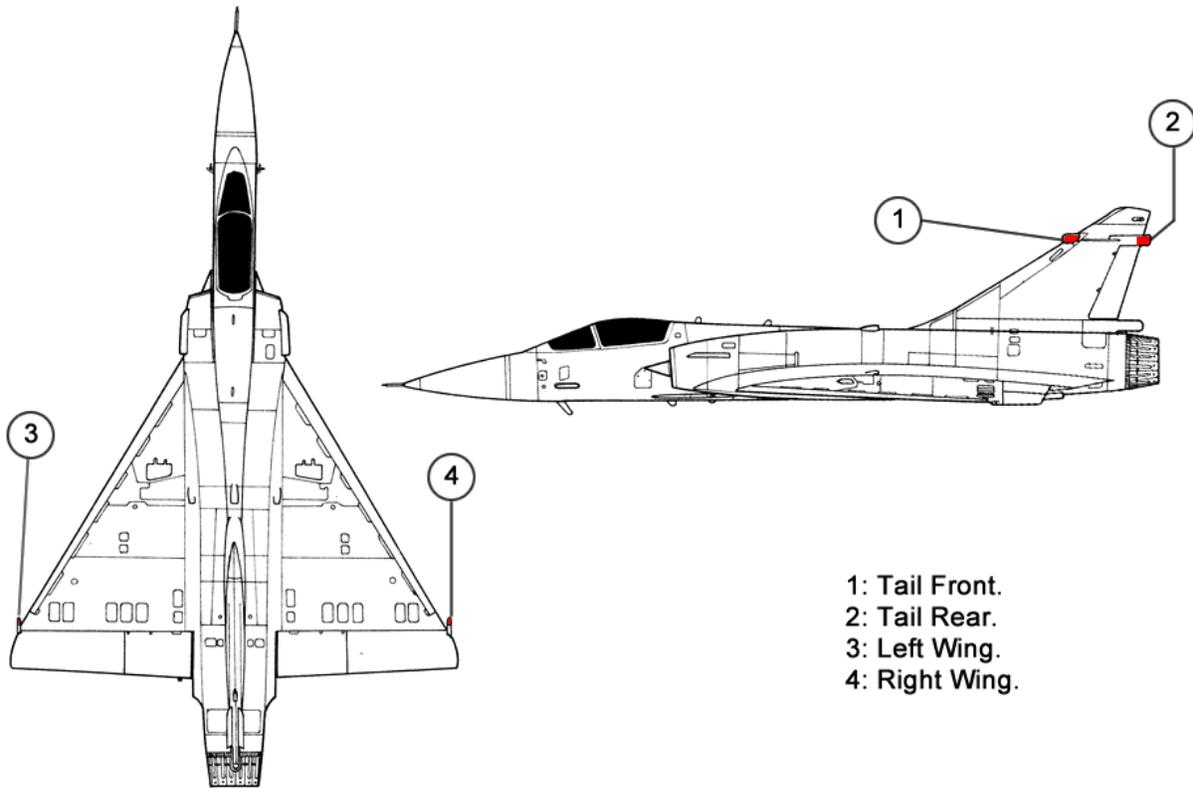


Figure 30 RWR sensors location

The RWR also has a display located to the right of the HUD control panel.

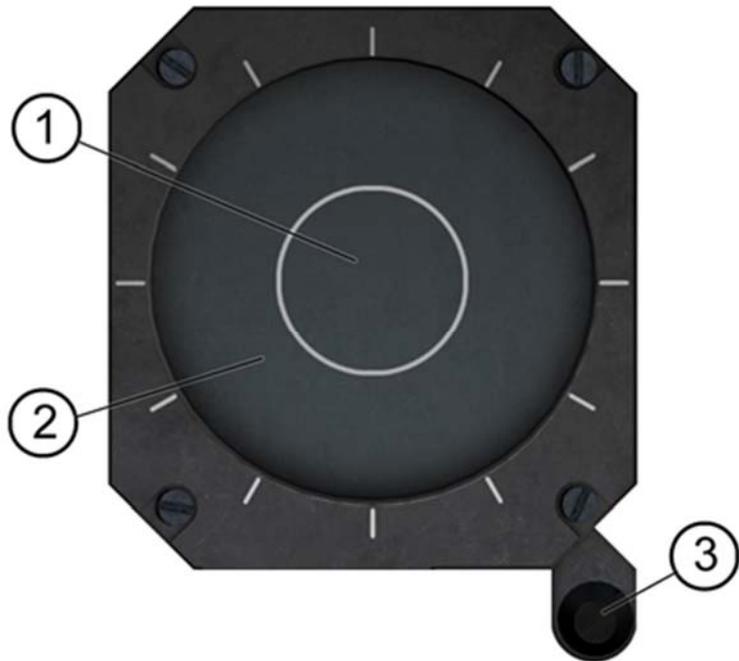


Figure 31 RWR display.

The display has the following components:

1. **The Critical Threat Zone:** All threats displayed inside this zone represent an imminent danger to the safety of the aircraft because they either have a radar lock or the radar is emitting guidance signals to a missile, which is interpreted as a missile launch.

If a missile radar is detected it will be displayed inside this zone, even if it is not guiding towards the aircraft.

2. **The Low Threat Zone:** All threats displayed inside this zone represent a possible danger to the aircraft. The radar signals displayed here are determined to be in search mode. You must decide if they are significant or not.

3. **Brightness Knob:** Controls the display brightness. Not operational.

The RWR cannot determine distance to a threat, all it can do is determine signal strength. The closer the threat is to the RWR center, the stronger the signal. This can be used as an approximation to the distance between the detected radar and the aircraft, but it does not necessarily mean that the threat is close to the aircraft.

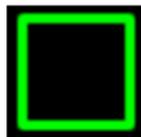
Low threat signals will not cross into the critical threat zone if they are close.

### Symbology:

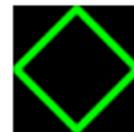
The RWR has an internal library that allows it to identify the category and type of radar. There are three categories: Airborne, ground and missile radars. Each category has its own symbol that identifies it.



**Airborne Radar**



**Ground Radar**



**Missile Radar**

Below the symbol, the RWR will display a three-letter code identifying the type of radar. If the radar cannot be identified it will display the letters UNK.

Airborne Threats		
Aircraft	Code	Notes
MiG 23	M23	
MiG 29	M29	
Su 27	S27	
Su 33	S33	
F-14	F14	
F-15	F15	
F-16	F16	
MiG 25	M25	

Airborne Threats		
Aircraft	Code	Notes
MiG 31	M31	
Tornado F-2	F2	
MiG 27	M23	
Su 24	S24	
Su 30	S30	
F/A-18	F18	
F-111	111	
Su 25	S34	
MiG 25P	M25	
A-50 Mainstay	A50	
E-3	E3	
MiG 29K	29K	
Mirage 2000-5	2KC	
Su 39	S39	
E-2C	E2C	
S-3A	S3	
AV-8B	AV8	
EA-6B	EA6	
F-4E	F4	
F-5E	F5	
MiG 29G	29G	
MiG 29C	29C	
Su 24MR	S24	
F-16A	16A	
F/A-18C	18C	
Tornado IDS	IDS	
F-15E	15E	
M-2000C	2KC	
F-5E	F5E	
Mig-21Bis	M21	
F-86F	F86	Gunnery radar
Mig-15Bis	M15	Gunnery radar
C-101	101	
AH-64D Apache Longbow	64D	

**Note:** These codes are not final and are subject to change.

## Audio Warnings

## **Launch Warnings**

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*To be described in next release*

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## **RWR Self-test**

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*To be described in next release*

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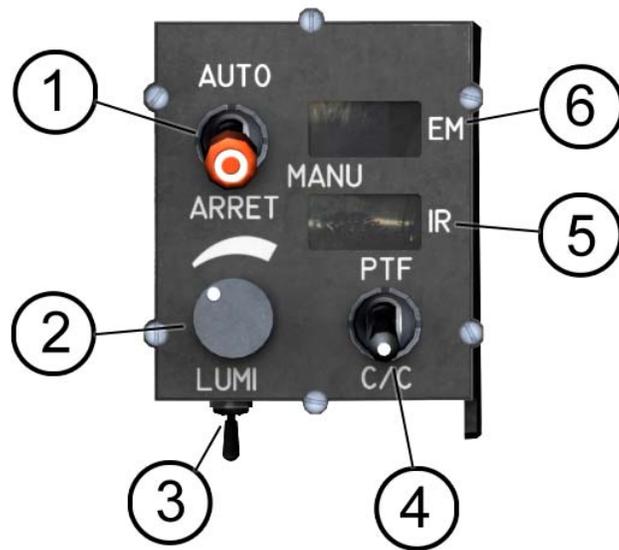
## **Counter Measures Dispensers.**

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*To be described in next release*

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## Éclair Control Panel



- 1.) Power Mode Selection
- 3.) Light Power
- 5.) Flare Counter

- 2.) BRT Adjust
- 4.) Program Selector
- 6.) Chaff Counter

# Chapter 17: Weapons System

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The M-2000C is considered a multirole fighter due to its capability to use both Air-to-Air (AA) and Air-to-Ground (AG) weapons. However, you must be aware that the aircraft was designed as a lightweight interceptor and thus it is heavily specialized towards the air combat role at the expense of AG capabilities, so instead of being a specialized multirole fighter, it should be considered as an Interceptor with secondary Close Air Support (CAS) capabilities.

## Weapons

The M-2000C can load the following weapons:

### Air-to-Air

- R.550 Magic IIs IR guided missiles.
- Matra Super 530Ds Semi Active Radar Homing missiles.

### Air-to-Ground

- Mk-82, 500 pounds unguided low-drag general purpose bomb.
- Mk-82 SE, 500 pounds unguided low-drag retarded general purpose bomb.
- GLB-66, unguided low-drag cluster bomb.
- BAP-100, anti-runway cluster bomb with 18 rocket accelerated penetrators.
- GBU-12, 500 pounds laser guided bomb.
- GBU-16, 1,000 pounds laser guided bomb.
- GBU-24, 2,000 pounds laser guided bomb.
- Matra SNEB rocket pod with 18 68 mm unguided rockets per pod.

Additionally, some export versions were fitted with the following Air-Surface Missiles (ASM):

- AS-37 Martel
- AS-39 Exocet

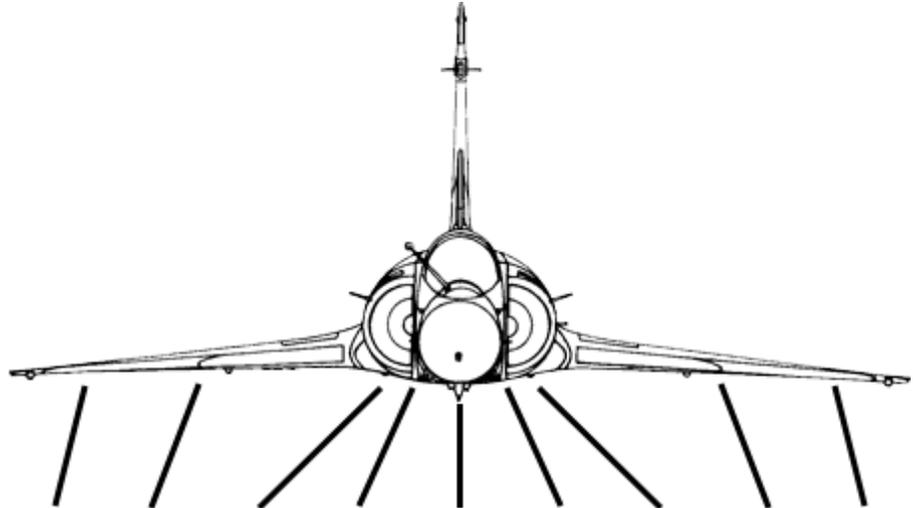
### Internal weapons

2 DEFA 554 30 mm revolver cannons with 125 rounds each.

## Weapons Configuration

The following table shows the allowed weapons configuration:

Table 1 Loadout configuration.



WEAPON	PCA CODE	WING (kg)		FUSELAGE (kg)					WING (kg)	
		RIGHT		FWD	REAR	CENTRAL	REAR	FWD	LEFT	
		300	1800	450	450	1800	450	450	1800	300
		9	8	7	6	5	4	3	2	1
<b>AA Pylons</b>										
R550 Magic 2	MAG	1								1
Super 530D	530		1						1	
<b>AG Pylons</b>										
Mk-82	BL1		1/2*	1	1		1	1	1/2*	
Mk-82SE	BF1		1/2*	1	1		1	1	1/2*	
BLG66 Belouga	BF4		1/2*	1	1	1	1	1	1/2*	
LRF4	RK3	1	1						1	1
BAP 100	BF8					18**				
GBU-12	EF1					1/2*				
GBU-16	EF1					1				
GBU-24	EF1					1				
<b>Fuel Tanks</b>										
RP522	RP					1				
RP541	RP		1						1	

### Notes:

\* 2 bombs can be loaded by using the twin rack RAFAUT AUF2

\*\* This bomb uses the special 30-6-M2 rack.

**Note:** The aircraft ballistic computer can only handle one type of Air-to-Ground weapon. Do not load Air-to-Ground weapons mix (e.g.: rockets and bombs, or Mk-82s and Belougas, etc.) since it is probable that the system will not be able to handle the configuration.

## Open Beta Notes:

In the open beta version, the following weapons are not available and in some cases a temporary substitution is used:

- BLG-66 Belouga, substituted by MK20 Rockeyes.
- BAP-100, not available.
- SNEB 68 mm rocket, substituted by HYDRA 70 rockets.

## Weapons Management

Weapons management is carried out by two panels located in the Main Instruments panel: The Weapons Manager Panel (PCA, French acronym for *Poste de Commande Armement*) and the Weapons Configuration panel (PPA, French acronym for *Poste de Préparation Armement*).

### The PCA

The PCA is located to the left of the radar display. It consists of a panel with one open switch, one guarded switch, and two rows of five LCD displays with buttons below them.

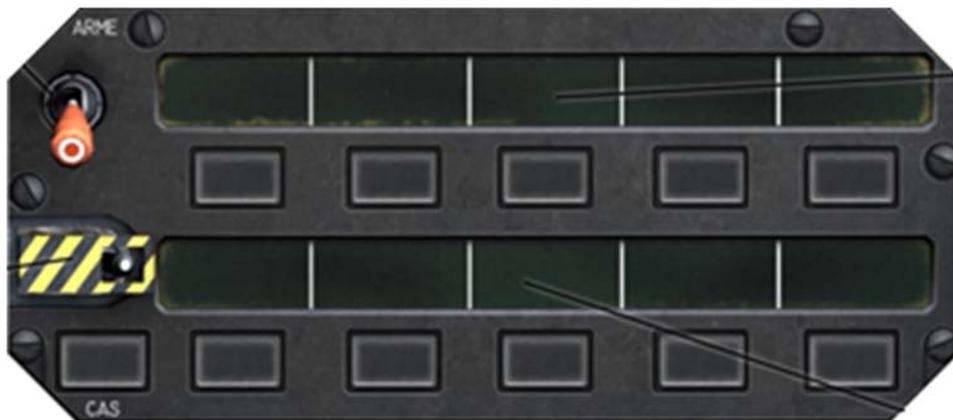


Figure 32 The PCA

The PCA controls the aircraft's Master Modes of operation and is used for all aspects of the aircraft's flight.

The big orange open switch is the Master Arm switch and it changes the aircraft from NAV to Attack mode, either Air-to-Air or Air-to-Ground. Attack modes are weapons based, if you select an Air-to-Air weapon, the system sets itself to Air-to-Air mode and the same works for Air-to-Ground weapons.

The guarded switch is the Selective Jettison consent switch, and it is used to jettison selected weapons from the aircraft.

The two rows of LCD displays with their associated buttons are used to configure aircraft flight parameters and Master Modes. The top row is used to configure the system while the bottom row is used for weapons/stores selection.

### **The PCA Top Row**

The PCA is also used for aircraft system configuration and the options displayed change based on system Master Mode. The associated buttons have a backlit S in the center, that turns on when an option has been selected.

The options displayed in the top row change based on the system Master Mode. Most of the options are exclusive, meaning that selecting one will deselect the previous one.

### **The PCA Bottom Row**

Unlike other systems, the PCA does not display an individual weapon and its position in the aircraft, instead it groups them by type. Since the LCD cannot display the full weapon name a code is assigned to each weapon (please see loadout configuration table for the PCA weapons code), this code is also displayed in the HUD when it is in attack mode. Additionally, the PCA sorts the loaded weapons based on their assigned priorities, basically AA weapons to the left and AG weapons to the right based on type.

Table 2 PCA weapons code display priority.

1	2	3	4	5
MAG	-	-	-	-
-	530	-	-	-
-	BL1/ BF1/BF4	BL1/ BF1/BF4	BL1/ BF1/BF4	BL1/ BF1/BF4
-	RK3	RK3	RK3	RK3
-	RP	RP	RP	RP
-	-	EL1	EL1	EL1
-	-	BF8	BF8	BF8

The associated buttons have two markings: S and P. S stands for selected and P for ready (it is the first letter of the word Prêt).

Weapons selection is done by clicking on the button below the selected code, when a weapon is selected the letter S will light and after an interval of time based on the weapon type, the letter P. When both S and P are lit, the selected weapon is ready for use.

In the bottom row there is an additional button with two markings: K1 and K2, located below the Selective Jettison switch. This button controls the DEFA 553 guns targeting mode: K1 is for air-to-air combat and K2 for air-to-ground attacks.

The bottom row display is static and does not change, but the LCD display will go dark when the associated weapon/store has been expended/jettisoned.

## PCA Modes display

### NAV Master Mode

ARME		TOP		POL		APP		RD		OBL	
OFF											
		S		S		S		S		S	
SEL		MAG		530		RP					
K1	K2	S	P	S	P	S	P	S	P	S	P

This is the default mode and the options displayed are all related to the aircraft navigation.

1. **TOP**: Guidage en Vitesse, Speed guidance. A special navigation mode not available in open beta.

2. **POL**: Police mode. The system provides guidance to a locked target for identification. No weapons are available in this mode, even if the Master Arm switch is in the ON position.
3. **APP**: Approach mode. The system is configured to follow an instruments landing.
4. **RD**: Roue Desirée, desired route. A special navigation mode not available in open beta.
5. **OBL**: Recalage Oblique de la Centrale, Radar based INS calibration. Not available in open beta.

#### Air-to-Air modes

##### 1. Super 530D mode

<b>ARME</b>		<b>RDO</b>		<b>POL</b>		<b>TAF</b>					
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>		<b>MAG</b>		<b>530</b>		<b>RP</b>					
S		S	P	S	P	S	P	S	P	S	P

##### 2. Magic II mode

<b>ARME</b>		<b>RDO</b>				<b>TAF</b>					
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>		<b>MAG</b>		<b>530</b>		<b>RP</b>					
S		S	P	S	P	S	P	S	P	S	P

##### 3. Gun mode

<b>ARME</b>		<b>RDO</b>				<b>TAF</b>		<b>LEN</b>		<b>RAP</b>	
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>		<b>MAG</b>		<b>530</b>		<b>RP</b>					
K1	K2	S	P	S	P	S	P	S	P	S	P

1. **RDO**: Ralliement Designation Poursuite, Target pursuit mode. It is automatically entered when locking a radar contact.
2. **POL**: Police mode.
3. **TAF**: Not known at this time. Not available.
4. **LEN**: Low fire rate (guns only). Set the guns to fire 1,200 rounds per minute.
5. **RAP**: High fire rate (guns only). Set the guns to fire 1,800 rounds per minute.

**Note:** The P symbol is only lit when the missile seeker is tracking a target.

#### Air-to-Ground modes

##### 1. Bombs (all types).

<b>ARME</b>		<b>TAS</b>		<b>RS</b>						<b>PI</b>	
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>		<b>MAG</b>		<b>BL1</b>		<b>RP</b>					
S		S	P	S	P	S	P	S	P	S	P

Free fall bomb in direct attack.

<b>ARME</b>		<b>TAS</b>		<b>RS</b>		<b>ZBI</b>				<b>PI</b>	
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>		<b>MAG</b>		<b>BL1</b>		<b>RP</b>					
S		S	P	S	P	S	P	S	P	S	P

Free fall bomb attack using a designated Initial Point.

##### 2. Rockets

<b>ARME</b>		<b>TAS</b>		<b>RS</b>				<b>EXT</b>		<b>INT</b>	
<b>OFF</b>											
		S		S		S		S		S	
<b>SEL</b>				<b>RK1</b>		<b>RP</b>					
S		S	P	S	P	S	P	S	P	S	P

### 3. Guns

ARME		TAS		RS		LEN		RAP	
OFF									
		S		S		S		S	
SEL		MAG		RK1		RP			
K1	K2	S	P	S	P	S	P	S	P

1. **TAS**: Uses the radar to obtain slant range to ground and calculate impact point.
2. **RS**: Uses the altitude provided by the radar altimeter to calculate slant range to the ground. Less accurate since it cannot take into account changes in terrain level.
3. **PI**: Sets the Initial Point for a bomb run
4. **ZBI**: Used in conjunction with the IP to calculate impact point. This mode depends on the INS.
5. **EXT**: Unknown, probably simultaneous rocket release. Not available in open beta.
6. **INT**: Unknown, probably individual rocket release. Not available in open beta.
7. **LEN**: Low fire rate (guns only). Set the guns to fire 1,200 rounds per minute.
8. **RAP**: High fire rate (guns only). Set the guns to fire 1,800 rounds per minute.

### The PPA

The PPA is located to the right of the radar display and below the HIS. It is used to configure selected weapons options, like bomb fuse type, cooling the Magic II seeker, etc.

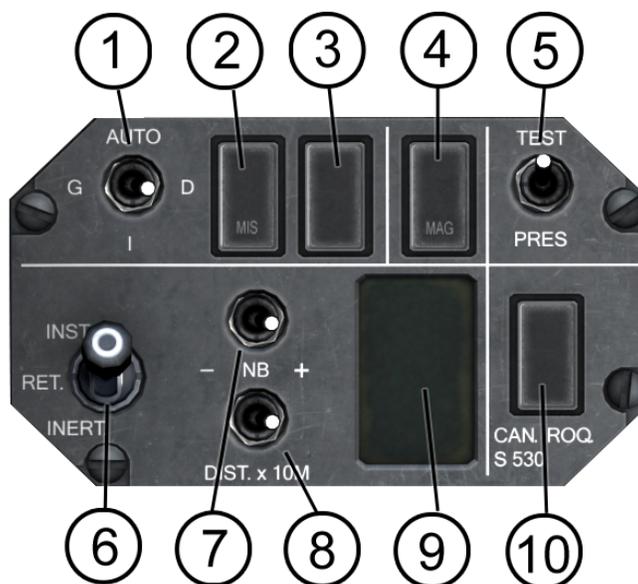


Figure 33 The PPA

The PPA is divided in 5 zones, with each zone dedicated to a weapon type. The zones are from left to right in the top row: S 530D, Magic, Test. In the bottom row they are: Bombs and CAN/ROQ/530.

The PPA has the following elements:

### 1. Missile Pylon Selector (S 530D Zone)

This three position switch is used to control the launch order of the Super 530D missiles. The positions are:

**G:** The first missile to be fired will be the left one.

**AUTO:** The PPA selects the missile that is closest to the locked target. The left missile will be fired when the target is to the left or center of the aircraft. The right missile will be fired when the target is to the right of the aircraft. This is the default position.

**D:** The first missile to be fired will be the right one.

The switch is only active when there are two missiles on board the aircraft. If there is only one, that missile will be fired regardless of switch position

### 2. Super 530D Preparation

This button is used to trigger On or Off all Super 530D missiles Preparation (BIT) and thus allowing/preventing their use. The preparation is triggered by either powering up the aircraft, clicking on the button or by selecting the missile related-mode on the PCA. The missile will take 45 seconds before becoming fully operational.

The preparation is cancelled by clicking again on the button; this is done when OP requires that the aircraft keeps all its weapons safe like during air refueling or long ferry flight with no chance of missile use.

The button has two lights:

**MISS:** Turns one when there are Super 530D missiles aboard the aircraft.

**P:** Short for "Prêt" (Ready). Turns on when the Super 530D are ready to use. Blinking when they are undergoing the preparation process and Dark when the missiles are in safe mode or no missiles are onboard.

### 3. Missile Fire selector

This button is not used in the M-2000C.

### 4. MAGIC II Preparation

This button is used to trigger On or Off all MAGIC II missiles Preparation (BIT & cooling of the seeker) and thus allowing/preventing their use. The preparation is triggered by

either powering up the aircraft, clicking on the button or by selecting the missile related-mode on the PCA or using the HOTAS selector.

Switching the preparation Off is used to save the MAGIC II seeker coolant supply (nitrogen). There is enough supply to keep the seeker heads active for 90 minutes, after that time the seekers become warm rendering the missiles useless. The missile will take 30 seconds before becoming fully operational.

**Note:** Each time the preparation is reactivated (switched On) will shorten the coolant supply by 10 minutes. Plan its use carefully.

The button has two lights:

**MAG:** Turns on when there are MAGIC II missiles aboard the aircraft.

**P:** Short for "Prét" (Ready). Turns on when the MAGIC IIs are ready to use. Blinking when they are undergoing the preparation process and Dark when the missiles are in safe mode or no missiles are onboard.

## 5. System Lights Test/Load out Display

Three position spring loaded switch. The values are:

**TEST:** Test all the PCA and PPA lights.

**OFF:** Default position (unmarked).

**PRES:** Displays in the VTB an aircraft silhouette with the current weapons load.

## 6. Bomb Fusing Selector

Three position switch used to arm the bombs onboard by selecting which fuse to activate. The values are:

**INERT:** Bombs are unarmed/safe. If released with the switch in this position, they will not explode. This is the default position.

**RET.:** Short for Delay. This position arms the bombs' tail fuse thus allowing them to penetrate the target before exploding.

**INST.:** Short for Contact. This position arms the bombs' nose and tail fuses thus allowing them to explode as soon as they hit the target.

RET and INST values are only valid for MK-82, MK-82S and GBU bombs. For Cluster bombs, BAP-100 and RET and INST selects the same fuse.

## 7. Bomb Release Quantity Selector

To increase/decrease the quantity of bombs to be released you have to click on the release quantity switch. A left click will increase the value and a right click will decrease it.

The values are increased/decreased in pairs: 0, 2, 4, 8, 10. For the PPA 0 is equivalent to 1.

## 8. Bomb Release Interval Selector

This switch is used to increase/decrease the distance between each bomb release. A left click will increase the value and a right click will decrease it. The indicated value is in tens of meters, e.g.: 1 = 10 meters, 40 = 400 meters, etc.

This function is only active when multiple bombs are released at the same time.

## 9. Selected Quantity and Interval Display

The top window indicates the quantity of bombs to be released with each trigger action. The bottom window indicates the interval between each individual bomb release, the value is in 10s of meters.

**Note:** Both Selected Quantity and Release interval do not apply to GBU-12, GBU-16, GBU-24 and BAP-100 bombs.

### Bomb release priority

In order to maintain aircraft load balance, the bombs are dropped in matching pairs from the outwards pylons to the internals. The release order is: 2, 8, 4, 6, 3, 7, 5.

## 10. Salvo Firing Selector

This button only applies to the following weapons: Super 530D, DEFA 554 guns and rocket pods. This button is used to select how the weapons will be fired on each trigger press. Functionality differs on weapon type

It has two values:

**TOT:** For Super 530D: It launches both missiles with a two second interval between launch.

For Rockets and DEFA 554 guns: Rocket pods or guns keep firing for as long as the trigger is pressed.

**PAR:** For Super 530D: It launches a single missile.

For Rockets and DEFA 554 guns: Rocket pods or guns fire in burst mode. Rocket burst count can be selected between 1, 3, 6 and 18. The rocket burst count can be selected in the Mission Editor.

## Weapons Utilization

The aircraft weapons can only be used when the Master Arm switch is in the ARMED position. The system will put everything else, like navigation, on standby and will dedicate itself to the selected Master Mode

### DEFA 554

The DEFA 554 30 mm autocannons need to be armed before they are available. To electrically arm them, click on the GUN ARM switch located above the FBW GAIN switch.



*Figure 34 Gun Arm switch in SAFE and ARMED positions*

### Magic II

The R.550 Magic II is a fire and forget IR guided missile. It does not need the radar to seek and intercept a target. To use it you only need to click on the MAG button in the PCA or click on the HOTAS button,

A low buzz-like sound will be heard while the seeker is searching. The buzz will be replaced by a louder tone when the seeker has locked on a target. In the HUD, the seeker symbol will move towards the position of the locked target.

If the target is also locked on radar, a smaller circle will appear inside the seeker search area circle indicating that the target is in the NO ESCAPE zone.

A no shoot cross will appear when the G-load is too high to fire the missile.

## Super 530D

The Matra Super530D is a semi-active homing radar missile, also known as a beam rider. To successfully use this missile, you need two conditions:

- A locked radar target
- To always keep the target in your screen during the flight time the missile needs to intercept it.

Note: The Super 530D is not a fire and forget missile. You need to keep the aircraft in a easily predicted flight path until the missile either intercepts or misses, which will put you in a disadvantage for the entire missile flight time.

To select the Super 530D, click on the 530 button in the PCA.

## Trigger Delay for Missiles

As a security measure there is a time delay between the moment the trigger is pressed to the instant the missile is launched. The delay varies depending on weapon and mode:

- For Magic II missiles there is 0.5 seconds firing delay.
- For Super 530D missiles the delay changes as follows:
  - If the radar is in STT mode, the delay is 0.8 seconds.
  - If the radar is in TWS mode, the delay will be 1 second.
  - If the PPA Salvo Firing Selector is in TOT mode, there will be a 2 seconds delay between each missile launch.

If the trigger is released before the delay timer runs out, no missile will be fired.

## Bombing Procedures

There are two modes to release bombs:

- **CCRP, or Continuously Computed Release Point.** In this mode the pilot selects a point in the ground as the target and the ballistic computer calculates the specific time when the bombs should be released in order to hit the target.
- **CCIP, or Continuously Computed Impact Point.** In this mode, the ballistic computer displays in the HUD the point at which the bombs would hit the ground based on aircraft altitude, speed and pitch. To hit a target, you have to place the impact point over the target and release the bombs.

In the M-2000C, the bomb release mode is determined by the bomb type. MK-82s, GBU-12, GBU-16 and GBU-24 all use CCRP. MK-82SE, BGL-66 and BAP-100, all use CCIP.

Both methods require the same ingredient: target ground elevation. There are three ways to get this value: By radar ranging, calculating it from the aircraft altitude above ground and from the INS system.

- **Radar ranging:** To obtain radar ranging data, you need to click on the TAS button. The radar screen will go dark and the words TAS will appear in the upper right corner. This is the most precise method.
- **Altitude above ground:** To obtain altitude above ground you need to activate the radar altimeter. Then you must click on the RS button in the PCA. The system will use the same ground elevation below the aircraft as the target elevation. This method will fail if the ground continuously changes elevation.
- **INS calculation:** In this mode you need to first select an initial point and the INS will calculate the ground elevation based on the flight plan it has in memory. This mode is not yet available.

It is recommended that both TAS and RS are selected in the PCA. This way if there is a problem with the radar ranging data, the system will fall back to the radar altimeter.

### CCRP Procedure

To do a CCRP bomb run the following procedure must be followed. (For symbols description please refer to the HUD chapter).

1. Minimum altitude should be 2000 feet AGL.
2. Fly in a slight dive towards your target. It shouldn't be more than 15°.
3. Place the CCRP piper over your target
4. Click on the AG DESIGNATE button (refer to HOTAS title in Chapter 1).
5. Pull up and resume level flight.
6. The target cross will remain over the target.
7. Fly towards the target.
8. When you are 15 seconds from the release point, the release cue will appear.
9. Press the trigger as soon as you see the release cue. **Keep the trigger pressed while the cue is visible.**
10. The bombs will be released automatically when the cue cross the CCRP piper.
11. The system will clear the target designation as soon as the bombs have been released.

## **CCIP Procedure**

To do a CCIP bomb run the following procedure must be followed. (For symbols description please refer to the HUD chapter).

1. Upon activating the CCIP, raise the seat so your downwards view is better
2. Minimum altitude should be 1500 feet AGL. 3000 AGL feet is better, especially if you are going to do a high dive.
3. Minimum indicated airspeed should be 400 KIAS.
4. The CCIP piper will appear at the bottom of the HUD.
5. When nearing your target, fly in a dive. The steeper the dive the better. 20° to 25° dives are very precise.
6. Check the safe altitude cue position.
7. Press the trigger to release the bombs when the CCIP piper is over your target
8. Pull up.
9. DO NOT release the bombs if the safe altitude cue intersects the FPM or is above it.

## **Bombing Safety Limits**

The aircraft has two bomb safety limits that will prevent a bomb release when it is unsafe:

- a. No bomb will be released if the g load of the aircraft is below 0.4g. This limit prevents that the bomb fly back into the aircraft.
- b. No bomb will be released if the pylon safety is engaged. The pylon safeties are based on air speed. If there is not enough speed over the wings, the safeties will engage and the bombs will not be released.

## **Stores Jettison**

There are two ways to jettison the stores loaded in the aircraft: Selective Jettison and Emergency Jettison.

### **Selective Jettison**

With selective jettison you can release a specific store type without affecting all the others, like jettisoning external fuel tanks.

1. Click the Selective Jettison switch cover to the open position.
2. Click the Selective Jettison switch to the left position.
3. Select the store to be jettisoned in the PCA.
4. Click the Master Arm switch to the ARMED position
5. Pull the trigger.
6. Click the Master Arm switch to the OFF position
7. Click the Selective Jettison switch to the right position
8. Click the Selective Jettison switch cover to the closed position.

### **Emergency Jettison**

With emergency jettison all the stores in the aircraft will be released except for the Magic II missiles. The emergency release includes the Super 530Ds if they are loaded.

# Revision Changes

1. HOTAS Buttons Keyboard Configuration.
2. HSI Chapter updated. Operational modes explained.