
# DCS GUIDE
# F-5E3 TIGER II

LAST UPDATED: 11/03/2022

By Chuck

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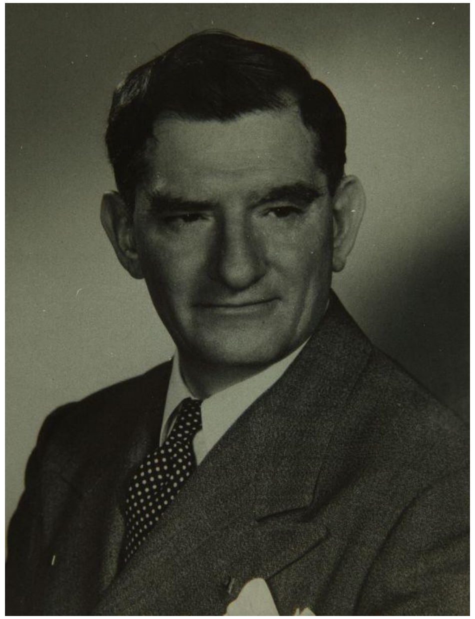
Special thanks to Paul "Goldwolf" Whittingham for creating the guide icons.

The **F-5E Tiger II** is a supersonic light fighter aircraft designed by Northrop Corporation. There are two main models in the family of the “F-5”; the original F-5A and F-5B “Freedom Fighter” variants and the extensively updated F-5E and F-5F “Tiger II” variants. The design team wrapped a small, highly aerodynamic fighter around two compact and high-thrust General Electric J85 engines, focusing on performance and a low cost of maintenance. Smaller and simpler than contemporaries such as the McDonnell Douglas F-4 Phantom II, the F-5 cost less to procure and operate, making it a popular export aircraft. Though primarily designed for a day air superiority role, the aircraft is also a capable ground-attack platform.

In the late 1950s, the Air Force required supersonic fighters capable of carrying out ground attacks with conventional (non-nuclear) weapons. The key goal was to combine high combat performance with easy mastering, low cost of maintenance and versatility. It became clear that a mass-produced fighter had to be cheap, simple and low-maintenance aircraft. In 1953 the American Northrop Corporation started designing of a light fighter with a delta wing and bottom-mounted intake. Edgar Schmued, the designer of the famous P-51 Mustang and F-86 Sabre, who had been working at Northrop Corporation since 1950, participated in new fighter concept development. However, in 1955 the project was canceled for a number of reasons. The project continued as a privately funded program and from this the F-5 eventually emerged.

*Edgar O. Schmued*
*(1899-1985)*

Using a pair of J85 engines as the baseline, the Northrop team began considering a series of prospective designs. Among the earliest concepts was the N-156TX of March 1955. This mounted the engines in pods, one under each wing about mid-span. The fuselage was quite slim compared to the final design, with a crew of two under a narrow cockpit canopy. Chief engineer Welko Gasich convinced Schmued that the engines must be located within the fuselage for maximum performance. This led to the January 1956 PD-2812 version which began to look a lot like the final product, although this version had a long-span low-mounted elevator with notable anhedral. March 1956's PD-2832 moved to a more conventional elevator and had a strongly swept vertical stabilizer. The design underwent several further versions over the next year which experimented with different nose designs and continued to lengthen the fuselage. The final design, PD-2879D, emerged in December 1956.

Gasich also introduced the concept of "life cycle cost" into fighter design, which provided the foundation for the F-5's low operating cost and long service life. A Northrop design study stated "The application of advanced technology was used to provide maximum force effectiveness at minimum cost. This became the Northrop philosophy in the development of the T-38 and F-5 lightweight trainer and fighter aircraft."

The N-156T was quickly selected by the United States Air Force as a replacement for the T-33 in July 1956. On 12 June 1959, the first prototype aircraft, which was subsequently designated as YT-38 Talon, performed its first flight. Development of the N-156F continued at a lower priority as a private venture by Northrop; on 25 February 1958, an order for three prototypes was issued for a prospective low-cost fighter that could be supplied under the Military Assistance Program for distribution to less-developed nations.

The first N-156F flew at Edwards Air Force Base on 30 July 1959, exceeding the speed of sound on its first flight. Although testing of the N-156F was successful, demonstrating unprecedented reliability and proving superior in the ground-attack role to the USAF's existing North American F-100 Super Sabres, official interest in the Northrop type waned, and by 1960 it looked as if the program was a failure. Interest revived in 1961 when the United States Army tested it for reconnaissance and close air support.


In 1962, the Kennedy Administration revived the requirement for a low-cost export fighter, selecting the N-156F as winner of the F-X competition on 23 April 1962, subsequently becoming the "F-5A", and was ordered into production in October that year. It was named under the 1962 United States Tri-Service aircraft designation system, which included a reset of the fighter number series. Northrop manufactured a total of 624 F-5As, including three YF-5A prototypes, before production ended in 1972. A further 200 F-5B two-seat trainer aircraft, lacking nose-mounted cannons but otherwise combat-capable, and 86 RF-5A reconnaissance aircraft, fitted with four-camera noses, were also built. In addition, Canadair built 240 first-generation F-5s under license (CF-5), CASA in Spain built 70 more aircraft under license as well (SF-5).

In 1970, Northrop won the International Fighter Aircraft (IFA) competition to replace the F-5A, with better air-to-air performance against aircraft like the Soviet MiG-21. The resultant aircraft, initially known as F-5A-21, subsequently became the F-5E. It had more powerful (5,000 lbf) General Electric J85-21 engines, and had a lengthened and enlarged fuselage, accommodating more fuel. Its wings were fitted with enlarged leading edge extensions, giving an increased wing area and improved maneuverability. The aircraft's avionics were more sophisticated, crucially including a radar (initially the Emerson Electric AN/APQ-153) (the F-5A and B had no radar). It retained the gun armament of two M39 20 mm cannons, one on either side of the nose of the F-5A. Various specific avionics fits could be accommodated at a customer's request, including an inertial navigation system, TACAN and ECM equipment. Additionally the two position nose landing gear from the Canadian CF-5 was incorporated to reduce takeoff distance.

The first F-5E flew on 11 August 1972. A two-seat combat-capable trainer, the F-5F, was offered, first flying on 25 September 1974, at Edwards Air Force Base, with a new nose, that was three feet longer, which, unlike the F-5B that did not mount a gun, allowed it to retain a single M39 cannon, albeit with a reduced ammunition capacity. The two-seater was equipped with the Emerson AN/APQ-157 radar, which is a derivative of the AN/APQ-153 radar, with dual control and display systems to accommodate the two-men crew, and the radar has the same range of AN/APQ-153, around 10 nm. On 6 April 1973, the 425th TFS at Williams Air Force Base, Arizona, received the first F-5E Tiger II.

The F-5E experienced numerous upgrades in its service life, with the most significant one being adopting a new planar array radar, Emerson AN/APQ-159 with a range of 20 nm to replace the original AN/APQ-153. Similar radar upgrades were also proposed for F-5F, with the derivative of AN/APQ-159, the AN/APQ-167, to replace the AN/APQ-157, but that was cancelled. The latest radar upgrade included the Emerson AN/APG-69, which was the successor of AN/APQ-159, incorporating mapping capability. However, most nations chose not to upgrade for financial reasons, and the radar saw very little service in USAF aggressor squadrons and Swiss Air Force.

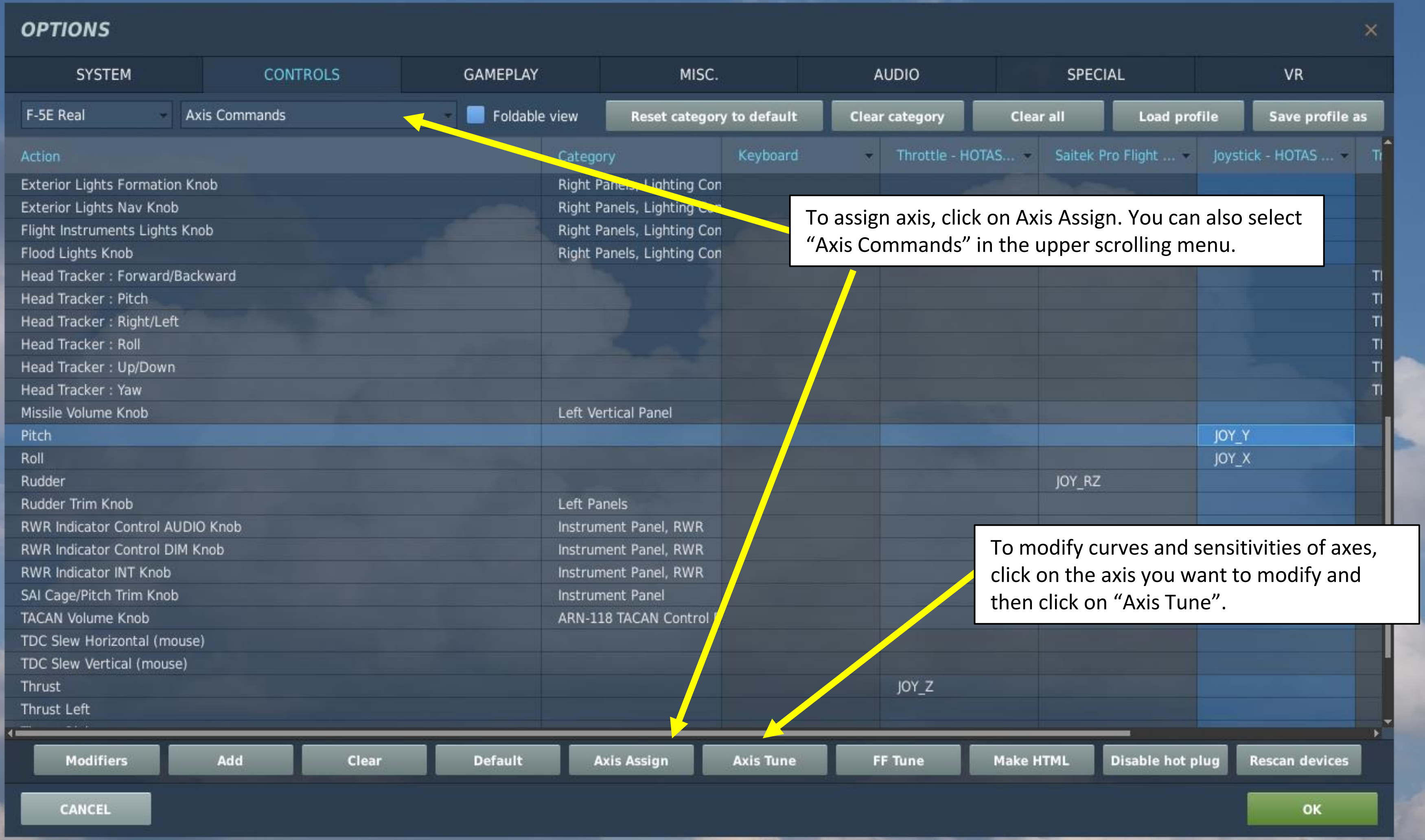

Primarily used by American allies, the F-5 remains in US service to support training exercises. Many of you might be familiar with the infamous "MiG-28" in the movie Top Gun, which was in fact a F-5 aircraft acting as an adversary trainer in Red Flag exercises.

Overall, the Tiger II is an extremely pleasant aircraft to fly. To some, it may seem like an outdated jet, but it has appreciable ground strike capabilities. It has no IFF (Identify-Friend-or-Foe) interrogation capabilities and most target acquisition must be done visually. However, the radar installed on the Tiger II gives a well-trained pilot great situational awareness in comparison to its nemesis: the MiG-21.  It is a robust, powerful little jet that has a well laid-out cockpit that makes it very easy to find panels and specific switches. Once you have a couple of flight hours under your belt, you will understand why this jet was such a resounding success in the export market. It is the perfect happy medium for a country that wants to protect its airspace but doesn`t have the financial means to buy top-of-the-line F-15s.

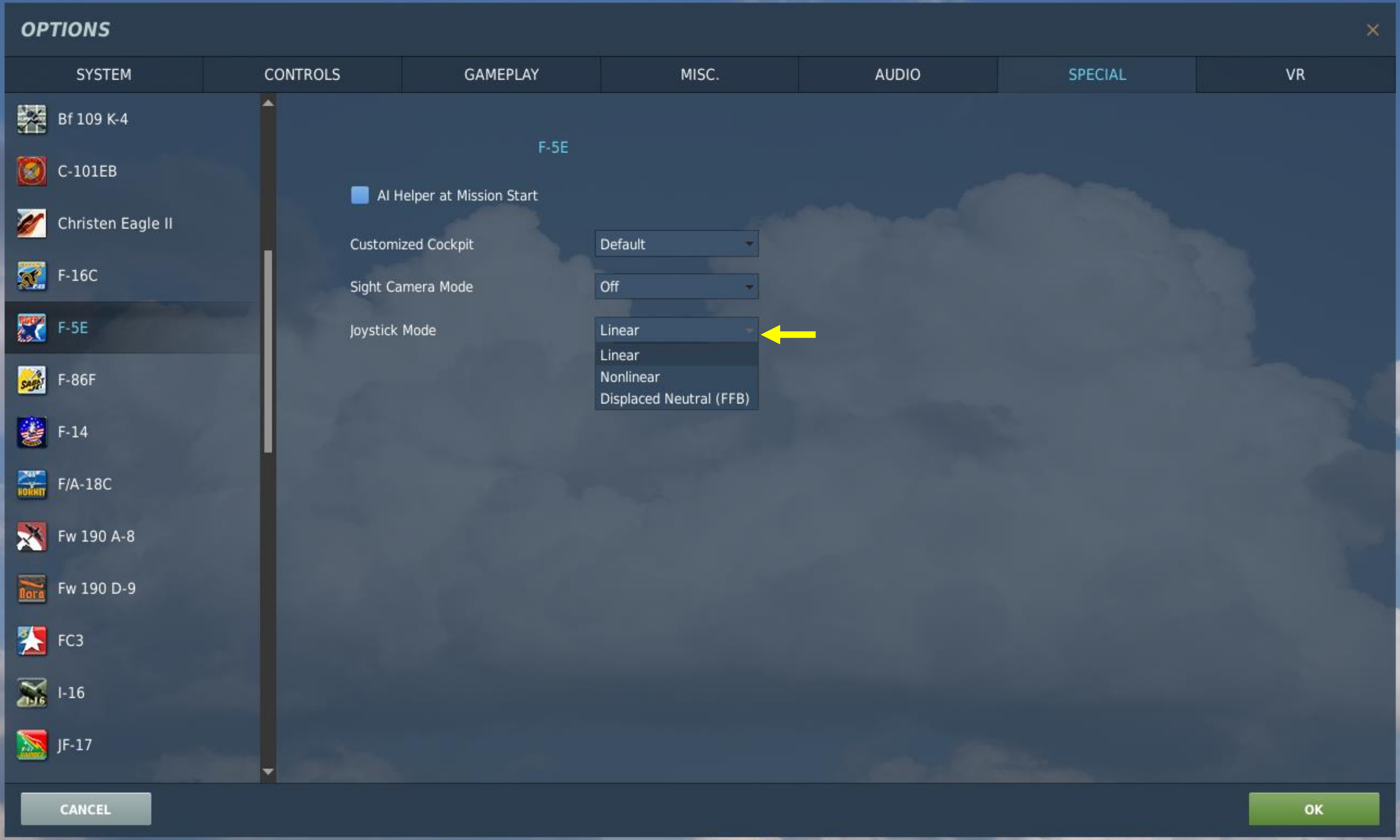
# WHAT YOU NEED MAPPED


+ TOE BRAKES (MAPPED ON PEDALS)

Note: In your controls, make sure you check your "Trim" controls since the default version of the game has your trim hat set to changing your view rather than trim the aircraft. Since most of you are probably equipped with a TRACKIR already, I suggest you make sure the Trim Hat Switch is set up properly.

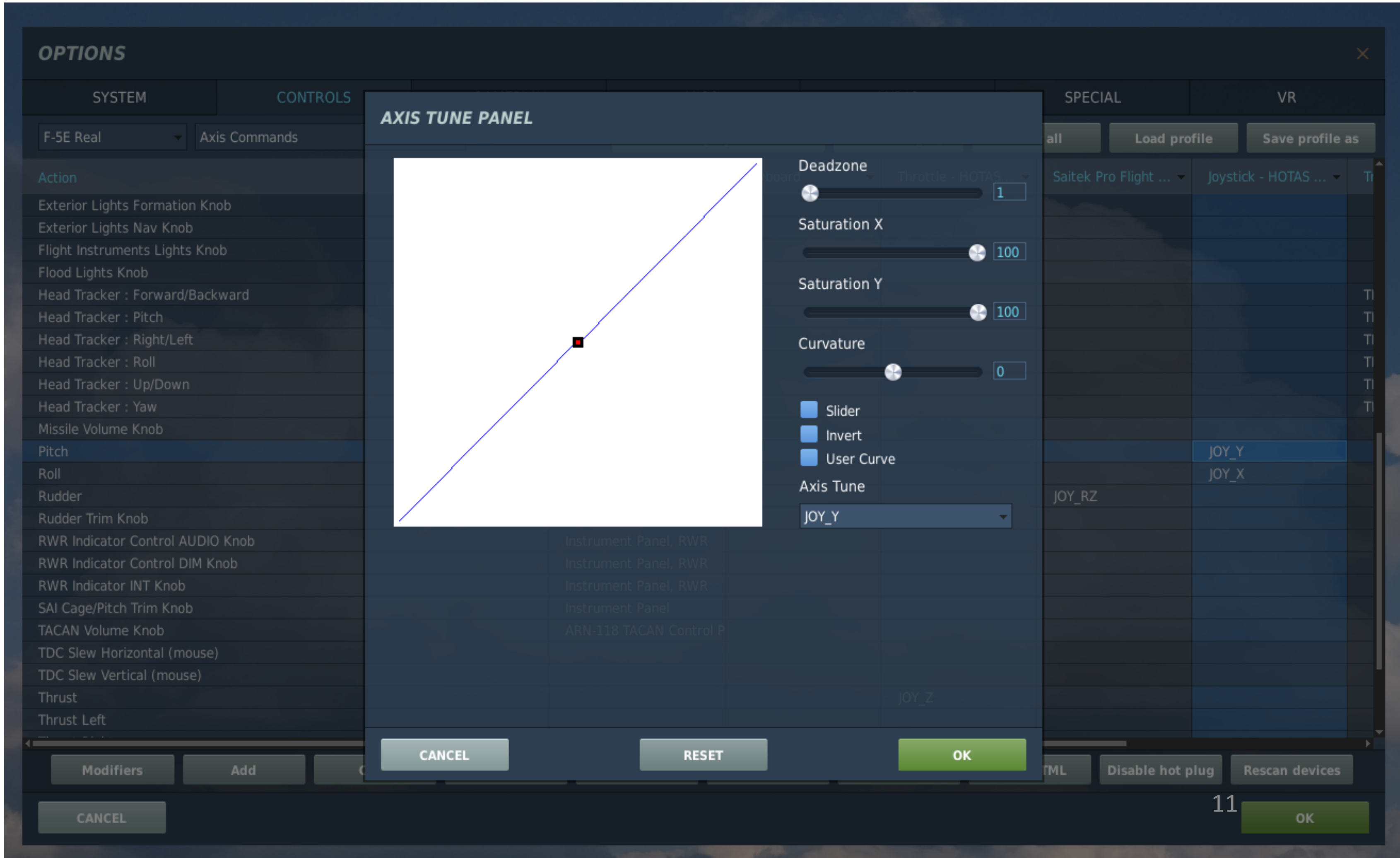


In the “Special Options” tab, I suggest you set your Joystick Mode to Linear.



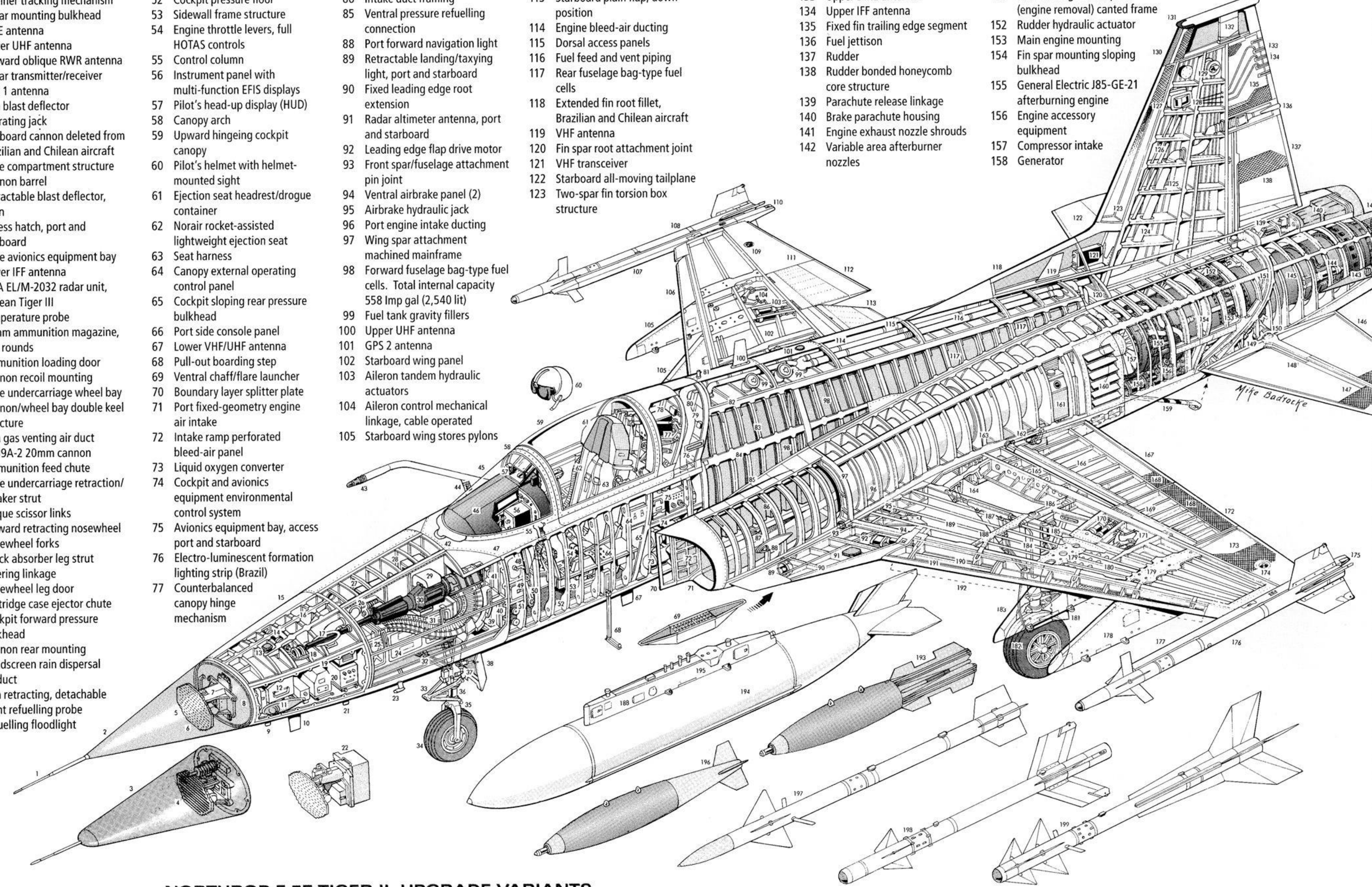
Bind the following axes:

- PITCH (DEADZONE AT 1, SATURATION X AT 100, SATURATION Y AT 100, CURVATURE AT 0)
- ROLL (DEADZONE AT 1, SATURATION X AT 100, SATURATION Y AT 100, CURVATURE AT 0)
- RUDDER (DEADZONE AT 0, SATURATION X AT 100, SATURATION Y AT 100, CURVATURE AT 0)
- THRUST – CONTROLS ENGINE RPM
- WHEEL BRAKE LEFT / RIGHT
- AN/APQ-159 Radar TDC Button – Azimuth
- AN/APQ-159 Radar TDC Button – Range




FLAPS
DRAG CHUTE
LG DOWN
LOAD LOCK
NO FILM
LIGHT
OFF
ALT
EXTERNAL STORES
SELECT JETTISON
ENGINE START
BOOST PUMPS
AUTO BALANCE
CABIN TEMP
CANOPY JETTISON

1 Pitot head
2 Glass-fibre radome
3 Reprofiled radome, Swiss/Austrian and Singaporean aircraft
4 AN/APQ-159 radar unit
5 Radar scanner
6 Galileo Avionica (FIAR) Grifo (Brazil) and Grifo-F (Singaporean F-5S)
7 Scanner tracking mechanism
8 Radar mounting bulkhead
9 DME antenna
10 Lower UHF antenna
11 Forward oblique RWR antenna
12 Radar transmitter/receiver
13 GPS 1 antenna
14 Gun blast deflector operating jack
15 Starboard cannon deleted from Brazilian and Chilean aircraft
16 Nose compartment structure
17 Cannon barrel
18 Retractable blast deflector, open
19 Access hatch, port and starboard
20 Nose avionics equipment bay
21 Lower IFF antenna
22 ELTA EL/M-2032 radar unit, Chilean Tiger III
23 Temperature probe
24 20mm ammunition magazine, 280 rounds
25 Ammunition loading door
26 Cannon recoil mounting
27 Nose undercarriage wheel bay
28 Cannon/wheel bay double keel structure
29 Gun gas venting air duct
30 M-39A-2 20mm cannon
31 Ammunition feed chute
32 Nose undercarriage retraction/breaker strut
33 Torque scissor links
34 Forward retracting nosewheel
35 Nosewheel forks
36 Shock absorber leg strut
37 Steering linkage
38 Nosewheel leg door
39 Cartridge case ejector chute
40 Cockpit forward pressure bulkhead
41 Cannon rear mounting
42 Windscreen rain dispersal air duct
43 Non retracting, detachable flight refuelling probe
44 Refuelling floodlight
45 One piece frameless windscreen panel
46 Instrument panel shroud
47 Hinged windscreen coaming panel, instrument access
48 Position of incidence vane on starboard side
49 Canopy emergency release
50 Rudder pedals
51 Static port
52 Cockpit pressure floor
53 Sidewall frame structure
54 Engine throttle levers, full HOTAS controls
55 Control column
56 Instrument panel with multi-function EFIS displays
57 Pilot's head-up display (HUD)
58 Canopy arch
59 Upward hingeing cockpit canopy
60 Pilot's helmet with helmet-mounted sight
61 Ejection seat headrest/drogue container
62 Norair rocket-assisted lightweight ejection seat
63 Seat harness
64 Canopy external operating control panel
65 Cockpit sloping rear pressure bulkhead
66 Port side console panel
67 Lower VHF/UHF antenna
68 Pull-out boarding step
69 Ventral chaff/flare launcher
70 Boundary layer splitter plate
71 Port fixed-geometry engine air intake
72 Intake ramp perforated bleed-air panel
73 Liquid oxygen converter
74 Cockpit and avionics equipment environmental control system
75 Avionics equipment bay, access port and starboard
76 Electro-luminescent formation lighting strip (Brazil)
77 Counterbalanced canopy hinge mechanism
78 RWR analyser and VTR recorder
79 Engine bleed-air duct to ECS system
80 Canopy sloping rear bulkhead
81 AS-2038/UPN antenna (Brazil)
82 Fuselage upper main longeron
83 Close-pitched fuselage frame structure
84 Cockpit section longeron
85 Boundary layer spill duct
86 Intake duct framing
85 Ventral pressure refuelling connection
88 Port forward navigation light
89 Retractable landing/taxying light, port and starboard
90 Fixed leading edge root extension
91 Radar altimeter antenna, port and starboard
92 Leading edge flap drive motor
93 Front spar/fuselage attachment pin joint
94 Ventral airbrake panel (2)
95 Airbrake hydraulic jack
96 Port engine intake ducting
97 Wing spar attachment machined mainframe
98 Forward fuselage bag-type fuel cells. Total internal capacity 558 Imp gal (2,540 lit)
99 Fuel tank gravity fillers
100 Upper UHF antenna
101 GPS 2 antenna
102 Starboard wing panel
103 Aileron tandem hydraulic actuators
104 Aileron control mechanical linkage, cable operated
105 Starboard wing stores pylons
106 Leading edge manoeuvring flap, down position
107 Wing tip missile carrier/launch rail
108 Starboard missile installation
109 Position light
110 Starboard aft navigation light repeater
111 Fixed trailing edge segment
112 Starboard inset aileron
113 Starboard plain flap, down position
114 Engine bleed-air ducting
115 Dorsal access panels
116 Fuel feed and vent piping
117 Rear fuselage bag-type fuel cells
118 Extended fin root fillet, Brazilian and Chilean aircraft
119 VHF antenna
120 Fin spar root attachment joint
121 VHF transceiver
122 Starboard all-moving tailplane
123 Two-spar fin torsion box structure
124 Fuel system venting duct
125 Fin rib structure
126 Cable ducts
127 Leading edge honeycomb core structure
128 Anti-collision light
129 Tail position light
130 Fin tip antenna fairing
131 VOR localiser antenna
132 Upper UHF antenna
133 Upper DME antenna
134 Upper IFF antenna
135 Fixed fin trailing edge segment
136 Fuel jettison
137 Rudder
138 Rudder bonded honeycomb core structure
139 Parachute release linkage
140 Brake parachute housing
141 Engine exhaust nozzle shrouds
142 Variable area afterburner nozzles
143 Rear RWR antenna
144 Afterburner nozzle fueldraulic control actuator
145 Afterburner duct
146 Port all-moving tailplane
147 Tailplane bonded honeycomb core structure
148 Machined tailplane spar
149 Tailplane pivot mounting
150 Tailplane hydraulic actuator
151 Rear fuselage break point (engine removal) canted frame
152 Rudder hydraulic actuator
153 Main engine mounting
154 Fin spar mounting sloping bulkhead
155 General Electric J85-GE-21 afterburning engine
156 Engine accessory equipment
157 Compressor intake
158 Generator
159 Runway emergency arrester hook, lowered
160 Pilot controlled auxiliary intake doors, open for take-off and approach
161 Hydraulic reservoir, port and starboard, dual system
162 Flap drive motor
163 Rear spar attachment machined fuselage mainframe
164 Main undercarriage wheel bay
165 Flap shroud panel
166 Flap rib structure
167 Port plain flap
168 Trailing edge bonded honeycomb panels
169 Aileron rib structure
170 Port aileron tandem hydraulic actuator
171 Control cable linkage
172 Port aileron
173 Fixed trailing edge segment
174 Port position light
175 Port aft navigation light repeater
176 AIM-9L Sidewinder air-to-air missile
177 Wing tip missile carrier/launch rail
178 Port outboard stores pylon
179 Pylon attachment hardpoints
180 Outer wing panel spar structure




181 Mainwheel leg door
182 Port mainwheel
183 Inboard 'wet' stores pylon
184 Main undercarriage shock absorber leg strut
185 Hydraulic retraction jack
186 Mainwheel leg pivot mounting
187 Side lock and breaker strut
188 Main undercarriage mounting rib
189 Wing panel multi-spar structure
190 Leading edge flap rib structure
191 Port leading edge manoeuvring flap
192 Leading edge flap down position
193 500lb (454kg) retarded bomb
194 Centreline external fuel tank, capacity 230 Imp gal (1,041 lit)
195 Centreline pylon, 3,000lb (1,360kg) capacity
196 500lb (454kg) HE bomb
197 Rafael Derby intermediate-range air-to-air missile (Chile)
198 Rafael Python 3 close-range air-to-air missile (Brazil and Singapore)
199 Rafael Python 4 close-range air-to-air missile (Chile)

NORTHROP F-5E TIGER II, UPGRADE VARIANTS

**Tip**: Pilot body can be toggled ON/OFF with “RSHIFT+P”

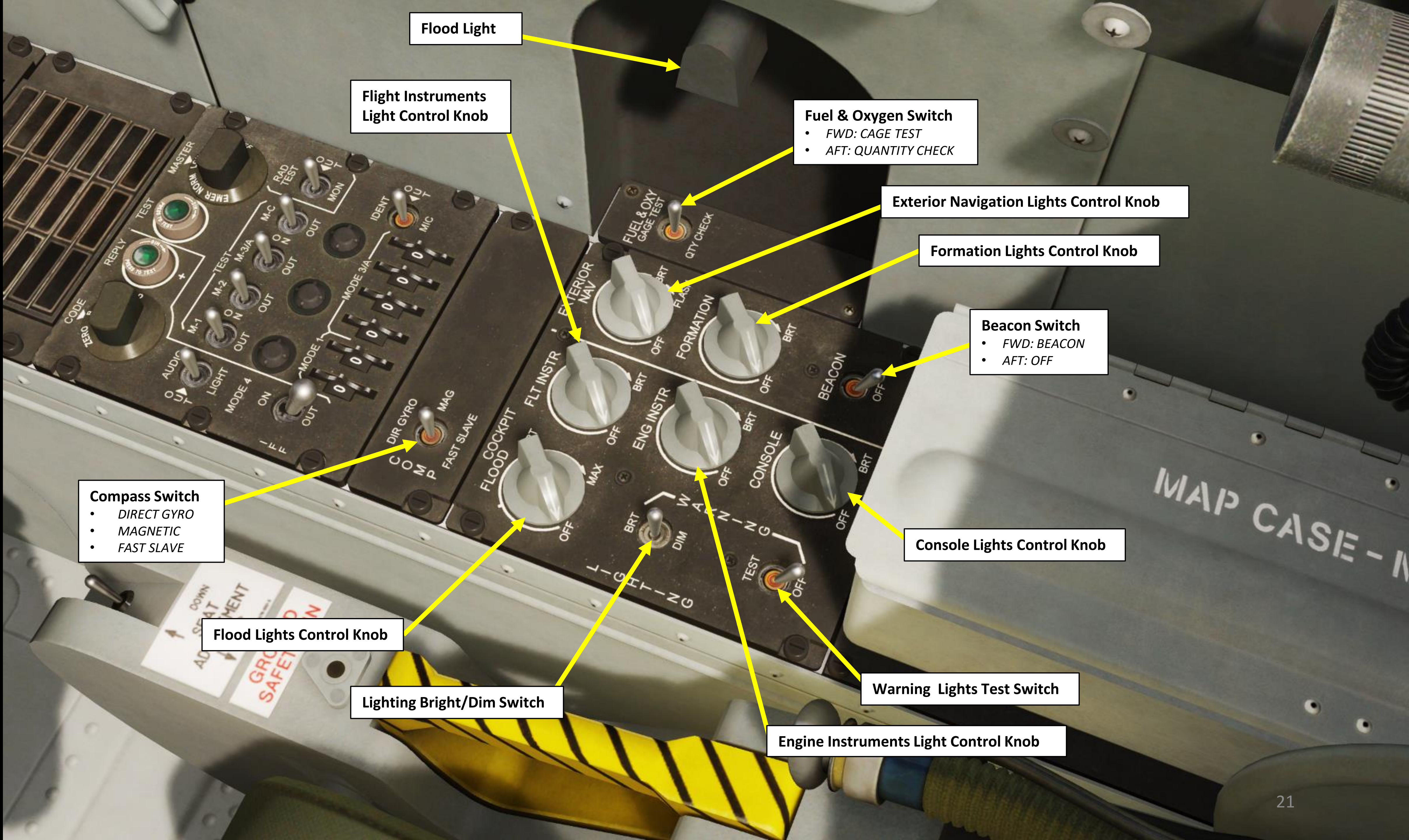

NO FILM
CHUTE
AUX INTAKE DOORS
CLOSE
CABIN PRESS
CABIN TEMP
PYLONS
BOOST PUMPS
CROSSFEED
AUTO BALANCE
ANTI-ICE
CANOPY JETTISON
NORTHROP

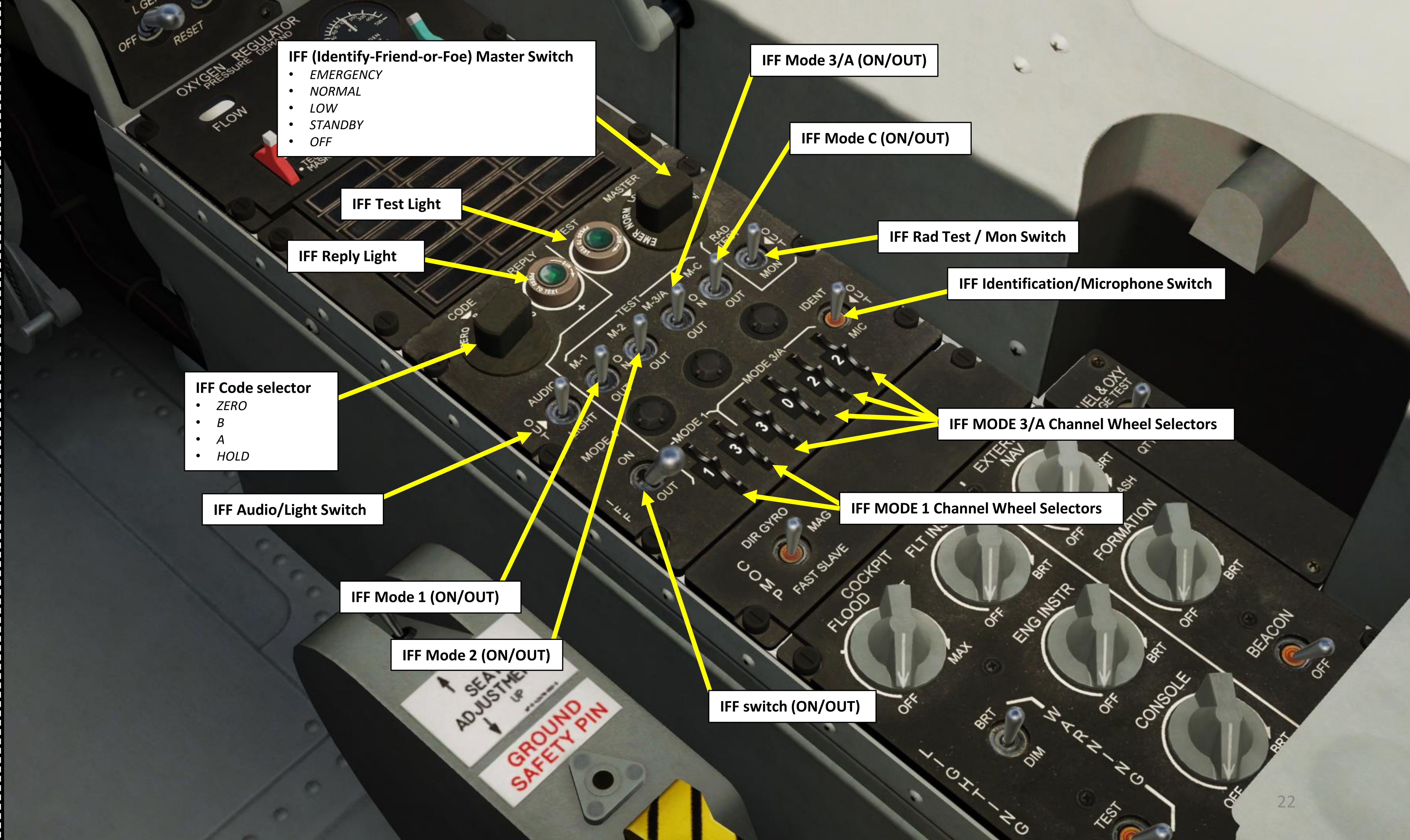

MAP CASE - NO STEP
AUTO BALANCE
GROUND SAFETY PIN
SEAT ADJUSTMENT
FLOW


Seat Adjustment Switch
FWD: Seat DOWN
AFT: Seat UP
Ejection Seat Handle
Oxygen Tube
Shoulder Harness Adjustment Lever
FWD: Locked
AFT: Auto
Ejection Seat Handle
SEAT ADJUSTMENT
GROUND SAFETY PIN
LOCK
SHOULDER HARNESS
AUTO


Canopy Breaker Tool
• Used to shatter canopy glass
Utility Light
Map Case
• Click to Open Kneeboard
MAP CASE - NO STEP


Circuit Breakers
MAP CASE- NO STEP
FORMATION
BEACON
CONSOLE
NAV
EXTERIOR
ENG INSTR
FLASH
BRT
OFF
TEST


Flood Light
Flight Instruments Light Control Knob
Fuel & Oxygen Switch
• FWD: CAGE TEST
• AFT: QUANTITY CHECK
Exterior Navigation Lights Control Knob
Formation Lights Control Knob
Beacon Switch
• FWD: BEACON
• AFT: OFF
Compass Switch
• DIRECT GYRO
• MAGNETIC
• FAST SLAVE
Console Lights Control Knob
Flood Lights Control Knob
Warning Lights Test Switch
Lighting Bright/Dim Switch
Engine Instruments Light Control Knob
MAP CASE -

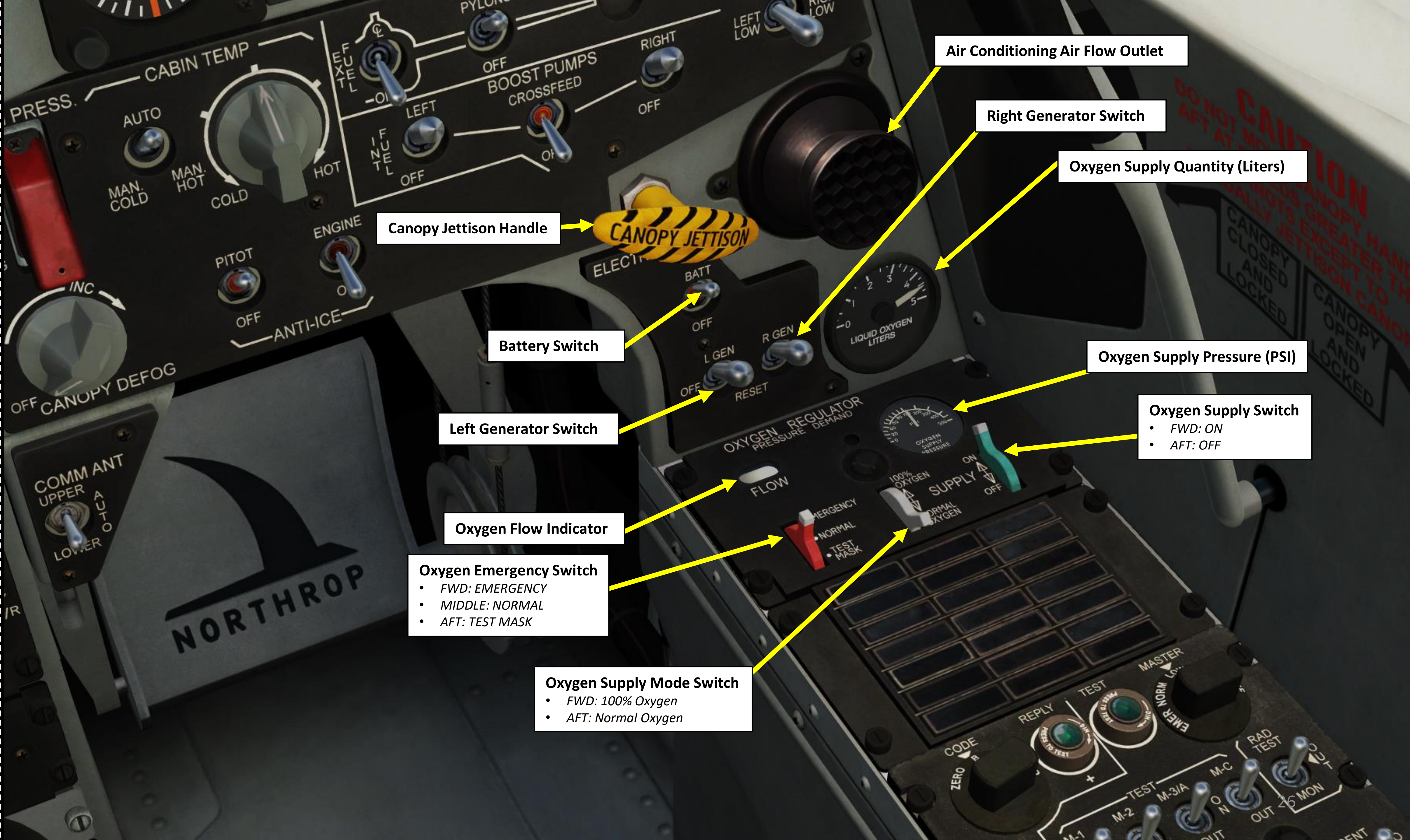

IFF (Identify-Friend-or-Foe) Master Switch
• EMERGENCY
• NORMAL
• LOW
• STANDBY
• OFF
IFF Mode 3/A (ON/OUT)
IFF Mode C (ON/OUT)
IFF Test Light
IFF Reply Light
IFF Rad Test / Mon Switch
IFF Identification/Microphone Switch
IFF Code selector
• ZERO
• B
• A
• HOLD
IFF MODE 3/A Channel Wheel Selectors
IFF Audio/Light Switch
IFF MODE 1 Channel Wheel Selectors
IFF Mode 1 (ON/OUT)
IFF Mode 2 (ON/OUT)
IFF switch (ON/OUT)

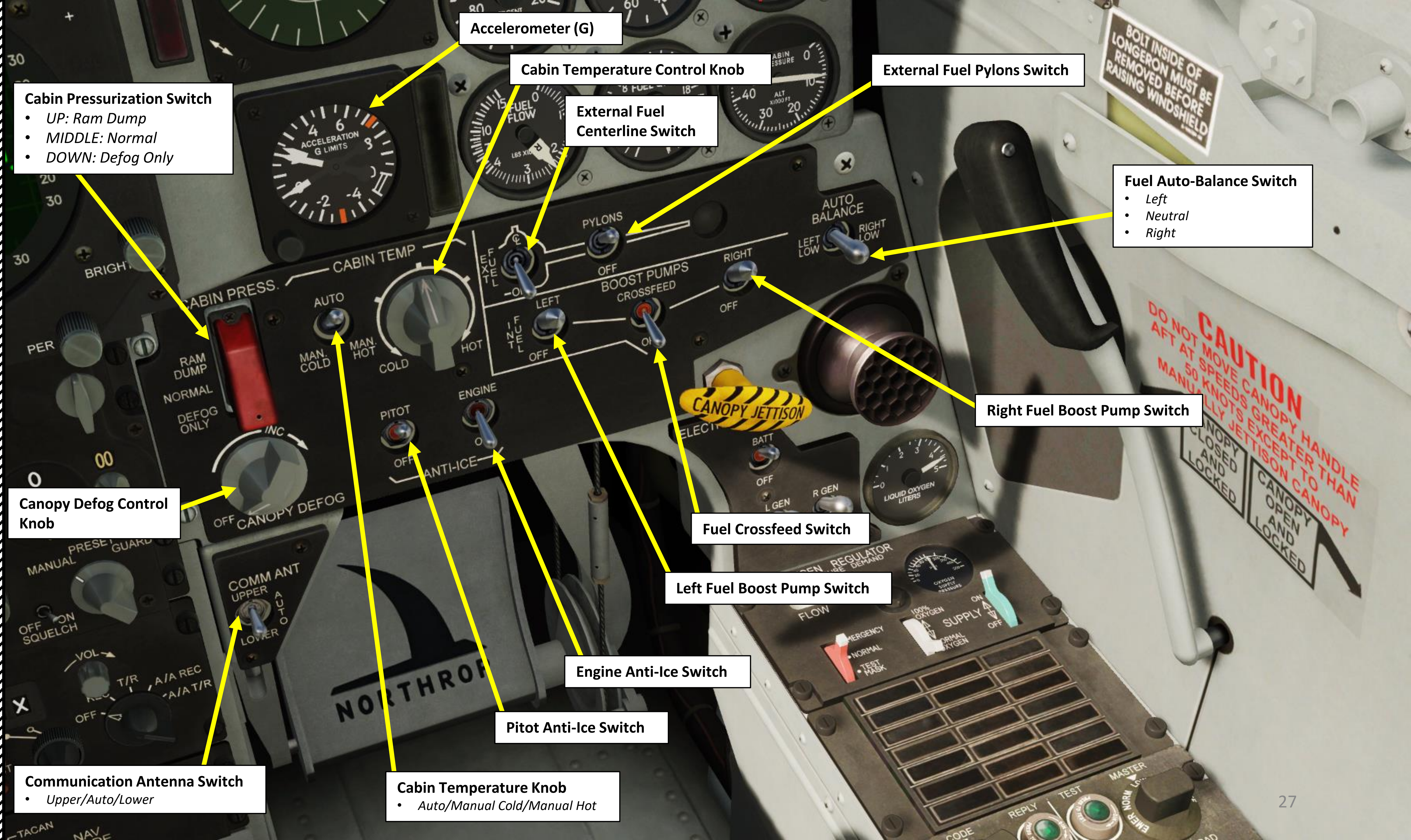
# Caution/Warning Panel

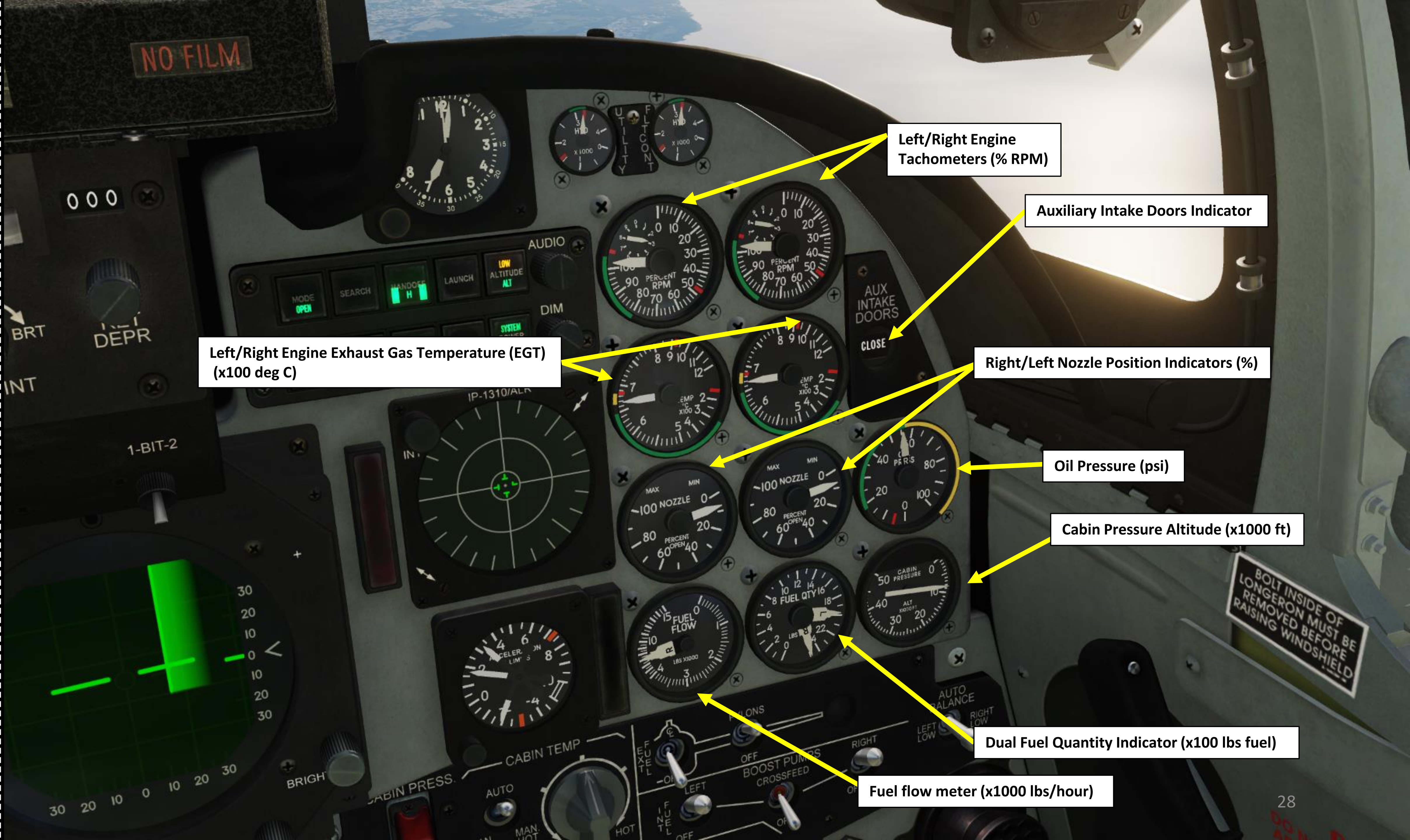
| | | |
|---|---|---|
| **L GENERATOR**<br>Left generator failed or OFF | **CANOPY**<br>Canopy unlocked | **R GENERATOR**<br>Right generator failed or OFF |
| **UTILITY HYD**<br>Utility Hydraulic Pressure under 1500 psi or hydraulic fluid overheat | **SPARE**<br>Not implemented in this F-5 variant | **FLIGHT HYD**<br>Flight Control Hydraulic Pressure under 1500 psi or hydraulic fluid overheat |
| **EXT TANKS EMPTY**<br>Fuel transfer from external tanks complete | **IFF**<br>Not implemented in this F-5 variant | **OXYGEN**<br>Oxygen level below 0.5 L or low oxy pressure |
| **L FUEL LOW**<br>Left engine fuel level below 400 lbs | **ENGINE ANTI-ICE ON**<br>Engine Anti-Ice system is on | **R FUEL LOW**<br>Right engine fuel level below 400 lbs |
| **L FUEL PRESS**<br>Left fuel boost pump pressure below 66.5 psi | **INS**<br>Not implemented in this F-5 variant | **R FUEL PRESS**<br>Right fuel boost pump pressure below 66.5 psi |
| **AOA/FLAPS**<br>Auto-flap system failure | **AIR DATA COMPUTER**<br>CADC or Pitot-static system failure | **DIR GYRO**<br>Not implemented in this F-5 variant |
| **SPARE**<br>Not implemented in this F-5 variant | **DC OVERLOAD**<br>DC System failure | **SPARE**<br>Not implemented in this F-5 variant |


Canopy Control Lever
AUX INTAKE DOORS
CLOSE
BOLT INSIDE OF LONGERON MUST BE REMOVED BEFORE RAISING WINDSHIELD
CAUTION
CANOPY CLOSED AND LOCKED
CANOPY OPEN AND LOCKED
CANOPY JETTISON
CABIN TEMP
BOOST PUMPS
CROSSFEED
PYLONS
AUTO BALANCE


LIGHT
OFF
NO FILM
LOAD
LOCK
J-3088
FLAPS
AUTO
DRAG CHUTE
HOOK
PUSH
ALT
HDG
CRS
MODE
RET INT
DEPR
PNL LT
PITCH
CURSOR
BRIGHT
AUDIO
DIM
AUX INTAKE DOORS
CLOSE
DOWN LOCK OVERRIDE
LG DWN
SILENCE
LG DOWN
BOMBS ARM
NOSE
TAIL
INTERVAL
GUNS MSL & CAMR
CAMR ONLY
EXTERNAL STORES
SAFE
BOMB
RKT/DISP
RIPL
EMER ALL JETT
PUSH
SELECT JETTISON
SELECT POSITION
OFF
PYLONS
MISSILE VOLUME
ARMT POSITION SELECT
ENGINE START
LEFT
RIGHT
LDG & TAXI LIGHT
ARMT LIGHT CONTROL
VIDEO
CHAN
CABIN PRESS.
CABIN TEMP
RAM DUMP
NORMAL
DEFOG ONLY
AUTO
MAN COLD
MAN HOT
COLD
HOT
CANOPY DEFOG
PITOT
ENGINE
ANTI-ICE
BOOST PUMPS
CROSSFEED
AUTO BALANCE
LEFT LOW
RIGHT LOW
COMM ANT
UPPER
LOWER
CANOPY JETTISON
BATT
L GEN
R GEN
RESET
TACAN
6 3 X
UHF
MAIN
BOTH
ADF
VOL
MANUAL
PRESET
GUARD
TONE
SQUELCH
A/A REC
A/A T/R
T/R


Air Conditioning Air Flow Outlet
Right Generator Switch
Oxygen Supply Quantity (Liters)
Canopy Jettison Handle
Battery Switch
Oxygen Supply Pressure (PSI)
Oxygen Supply Switch
• FWD: ON
• AFT: OFF
Left Generator Switch
Oxygen Flow Indicator
Oxygen Emergency Switch
• FWD: EMERGENCY
• MIDDLE: NORMAL
• AFT: TEST MASK
Oxygen Supply Mode Switch
• FWD: 100% Oxygen
• AFT: Normal Oxygen


Accelerometer (G)
Cabin Temperature Control Knob
External Fuel Pylons Switch
Cabin Pressurization Switch
• UP: Ram Dump
• MIDDLE: Normal
• DOWN: Defog Only
External Fuel Centerline Switch
Fuel Auto-Balance Switch
• Left
• Neutral
• Right
Right Fuel Boost Pump Switch
Canopy Defog Control Knob
Fuel Crossfeed Switch
Left Fuel Boost Pump Switch
Engine Anti-Ice Switch
Pitot Anti-Ice Switch
Communication Antenna Switch
• Upper/Auto/Lower
Cabin Temperature Knob
• Auto/Manual Cold/Manual Hot


Left/Right Engine Tachometers (% RPM)
Auxiliary Intake Doors Indicator
Left/Right Engine Exhaust Gas Temperature (EGT) (x100 deg C)
Right/Left Nozzle Position Indicators (%)
Oil Pressure (psi)
Cabin Pressure Altitude (x1000 ft)
Dual Fuel Quantity Indicator (x100 lbs fuel)
Fuel flow meter (x1000 lbs/hour)
NO FILM
AUX INTAKE DOORS
CLOSE
AUDIO
DIM
CABIN TEMP
BOOST PUMPS
CROSSFEED
AUTO BALANCE
BOLT INSIDE OF LONGERON MUST BE REMOVED BEFORE RAISING WINDSHIELD


Magnetic Compass
Magnetic Compass Light Switch


Utility Hydraulic System Pressure Gauge (x1000 psi)
Flight Controls Hydraulic Pressure Gauge (x1000 psi)
Clock
LOAD
LOCK
NO FILM
MODE
RET INT
AUDIO
DIM
IP-1310/ALR
AUX INTAKE DOORS
CLOSE
PNL LT
1-BIT-2
PITCH

RWS (Radar Warning System) Buttons (from Left to Right)

- RWS (Radar Warning System) Mode Button (Priority/Open)
- RWS Search Button
- RWS Handoff Button (not functional)
- RWS Launch Button
- RWS Altitude Button (Low Alt/ Alt)

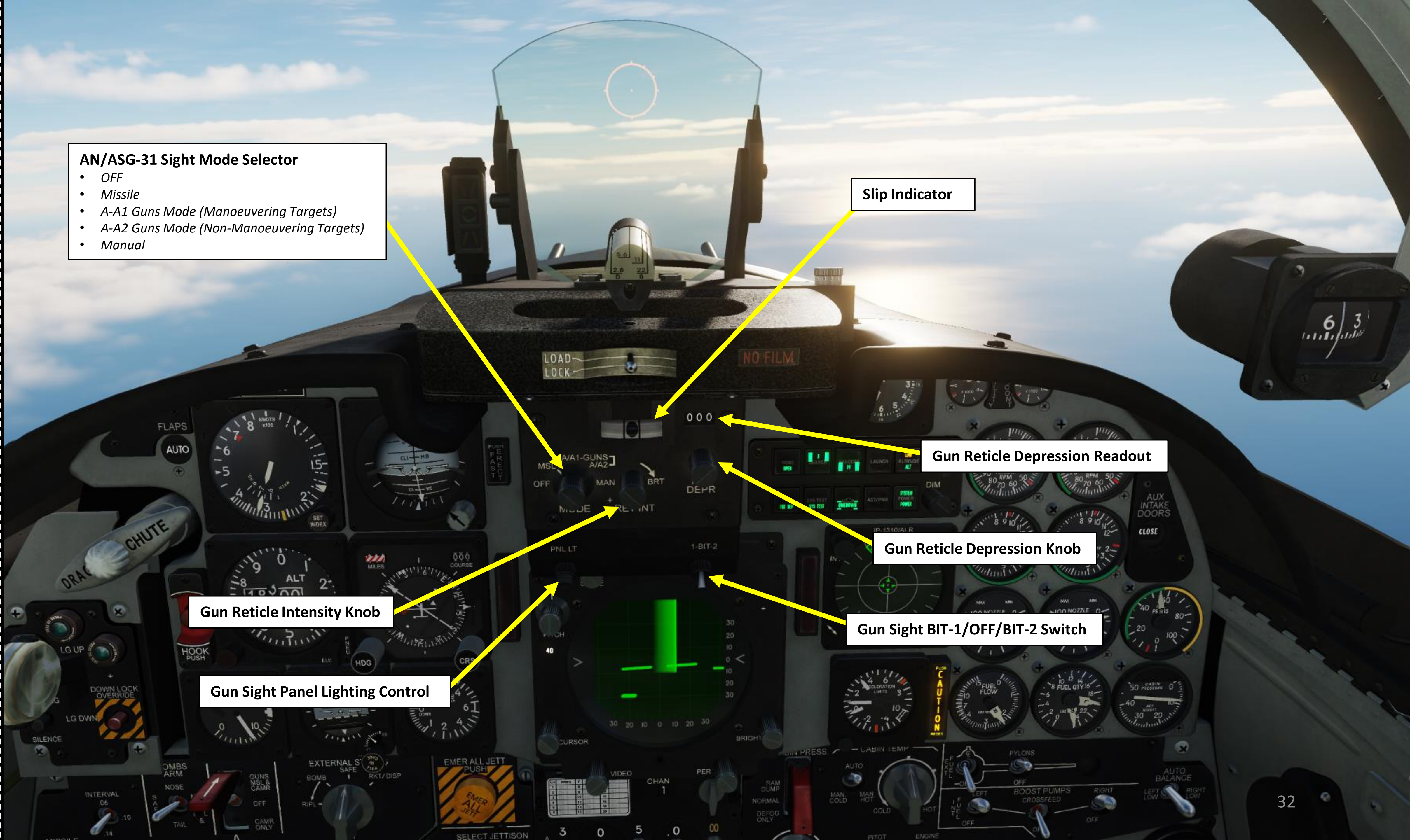
RWS Panel Audio Control

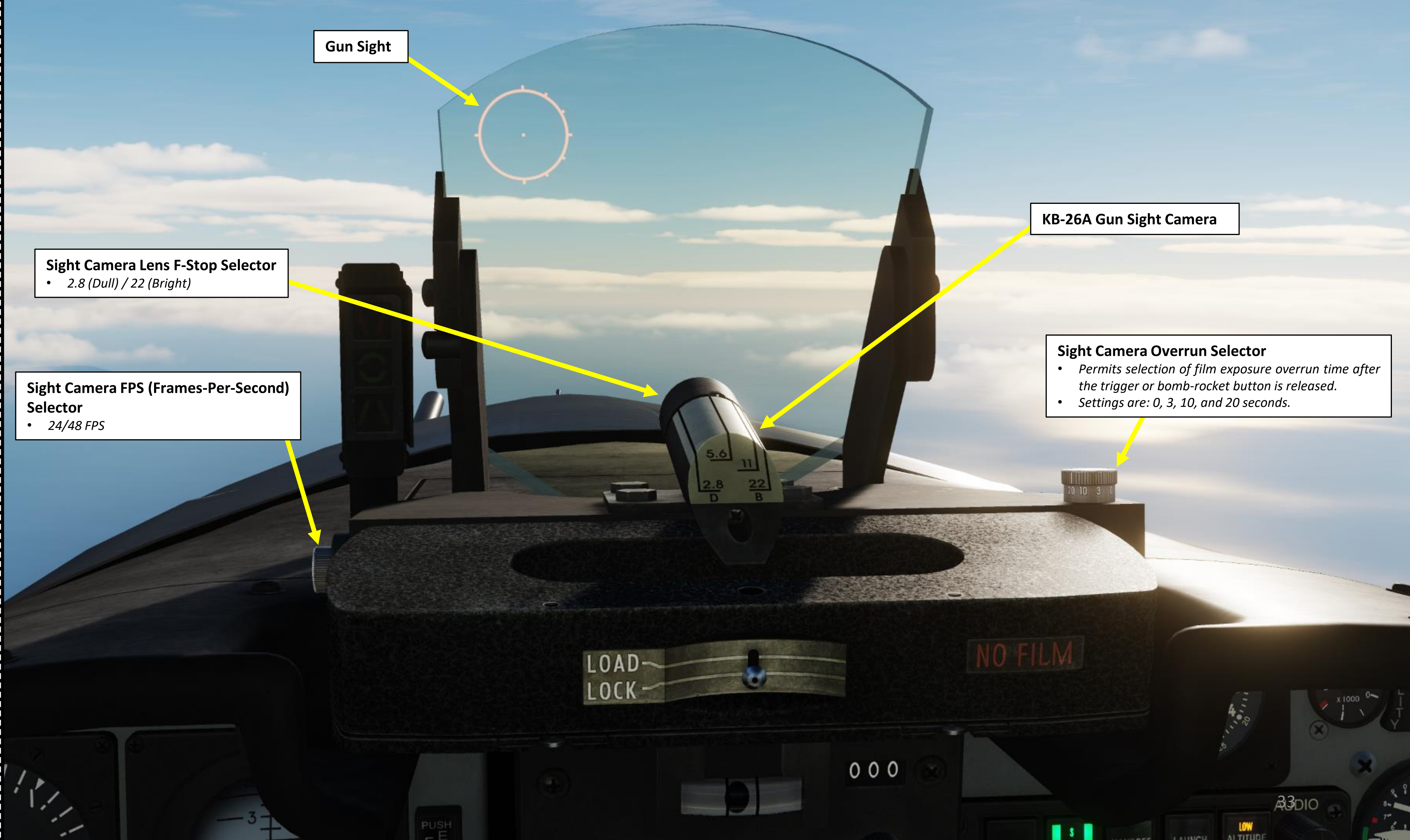
RWS Panel Lighting Dimmer Control

IP-1310/ALR RWS (Radar Warning System)

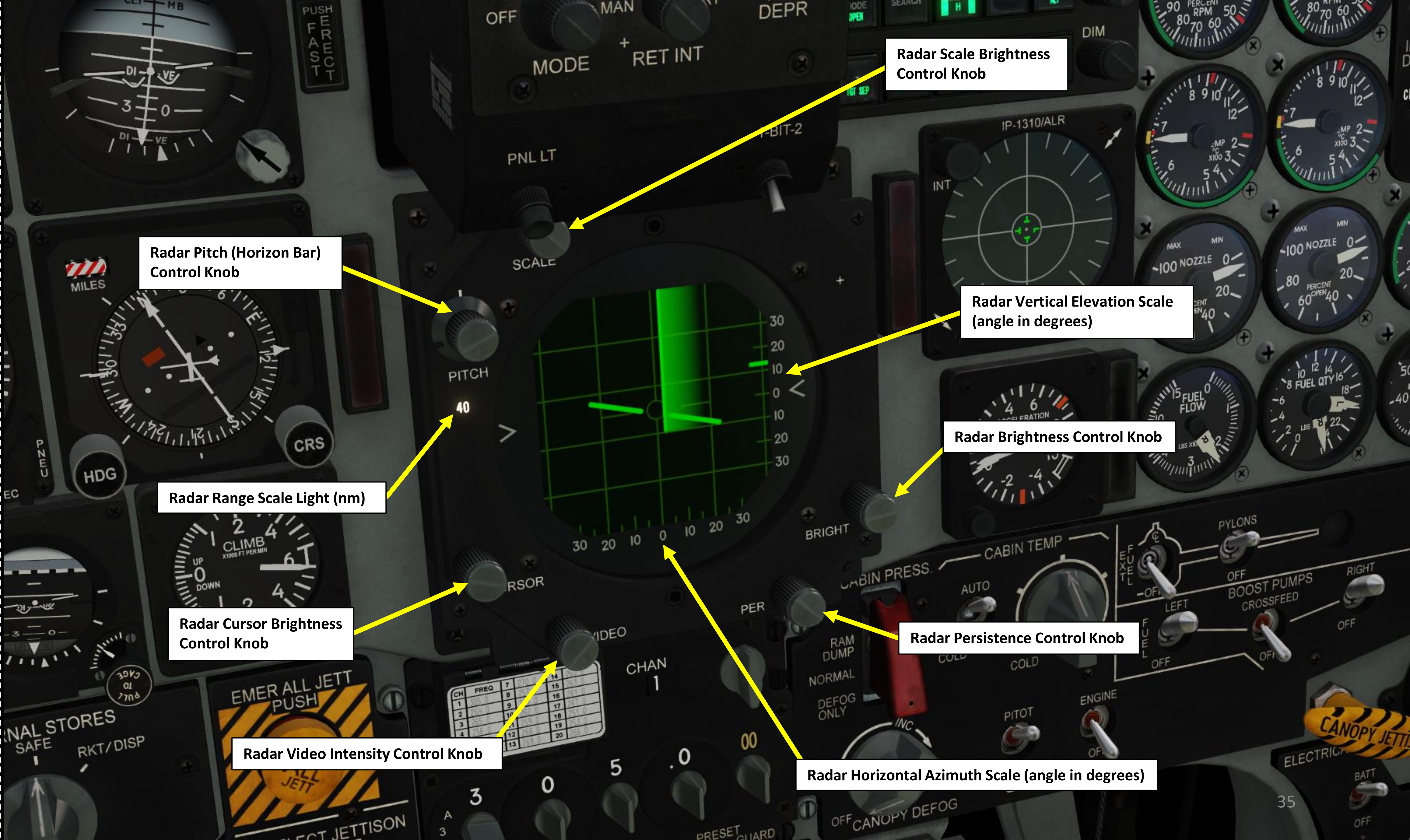
RWS (Radar Warning System) Buttons (from Left to Right)

- RWS T (Threat Priority) Button
- RWS System Test Button
- RWS Unknown Ship Button
- RWS ACT/PWR Button
- RWS Power Button

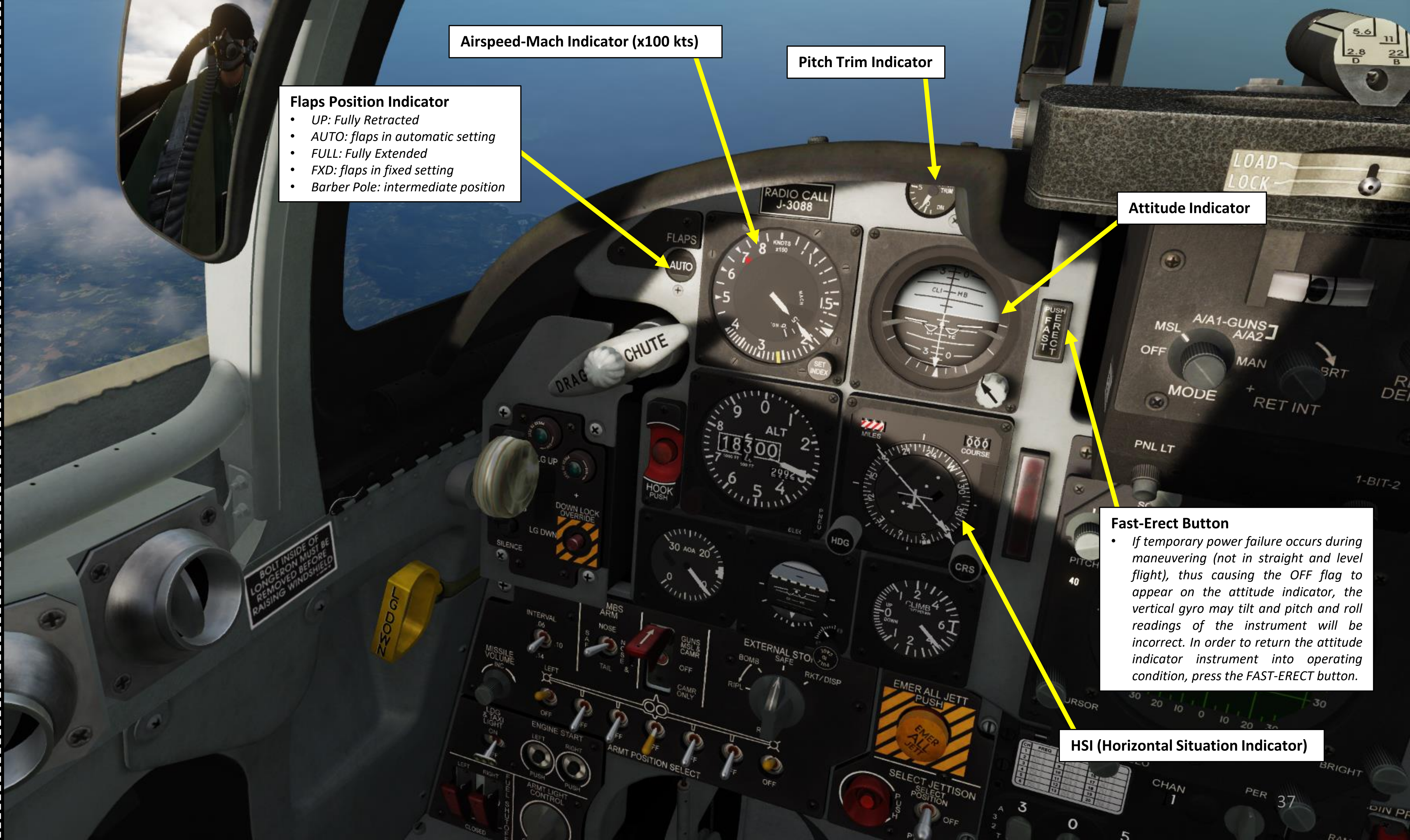

AN/ASG-31 Sight Mode Selector
• OFF
• Missile
• A-A1 Guns Mode (Manoeuvering Targets)
• A-A2 Guns Mode (Non-Manoeuvering Targets)
• Manual
Slip Indicator
Gun Reticle Depression Readout
Gun Reticle Depression Knob
Gun Reticle Intensity Knob
Gun Sight BIT-1/OFF/BIT-2 Switch
Gun Sight Panel Lighting Control


Gun Sight
KB-26A Gun Sight Camera
Sight Camera Lens F-Stop Selector
• 2.8 (Dull) / 22 (Bright)
Sight Camera FPS (Frames-Per-Second) Selector
• 24/48 FPS
Sight Camera Overrun Selector
• Permits selection of film exposure overrun time after the trigger or bomb-rocket button is released.
• Settings are: 0, 3, 10, and 20 seconds.
5.6
11
2.8
D
22
B
20 10 3
LOAD
LOCK
NO FILM

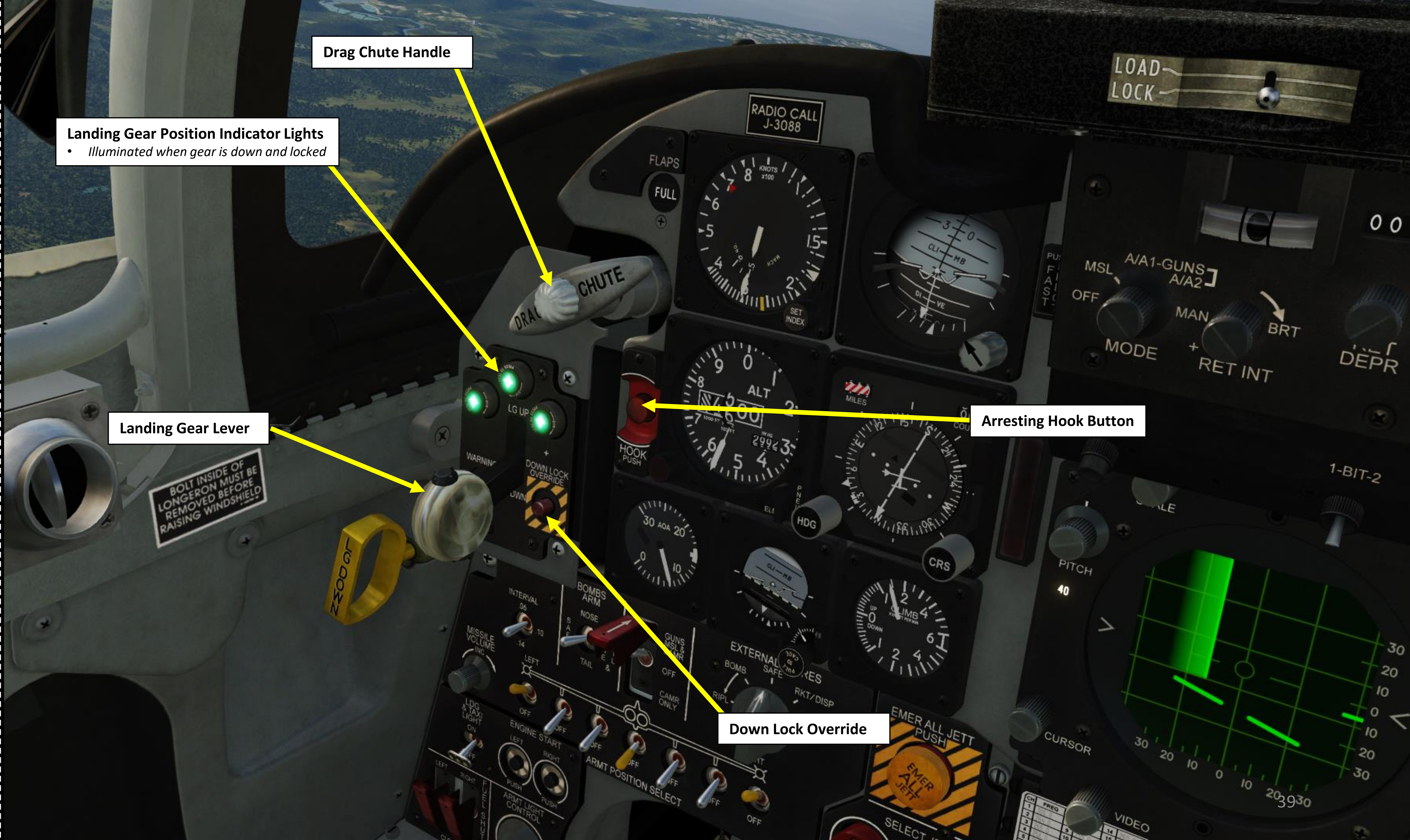

AoA (Angle of Attack) Indexer
• Green = Good airspeed
• Yellow = Too Fast
• Red = Too Slow


Radar Scale Brightness Control Knob
Radar Pitch (Horizon Bar) Control Knob
Radar Vertical Elevation Scale (angle in degrees)
Radar Brightness Control Knob
Radar Range Scale Light (nm)
Radar Cursor Brightness Control Knob
Radar Persistence Control Knob
Radar Video Intensity Control Knob
Radar Horizontal Azimuth Scale (angle in degrees)

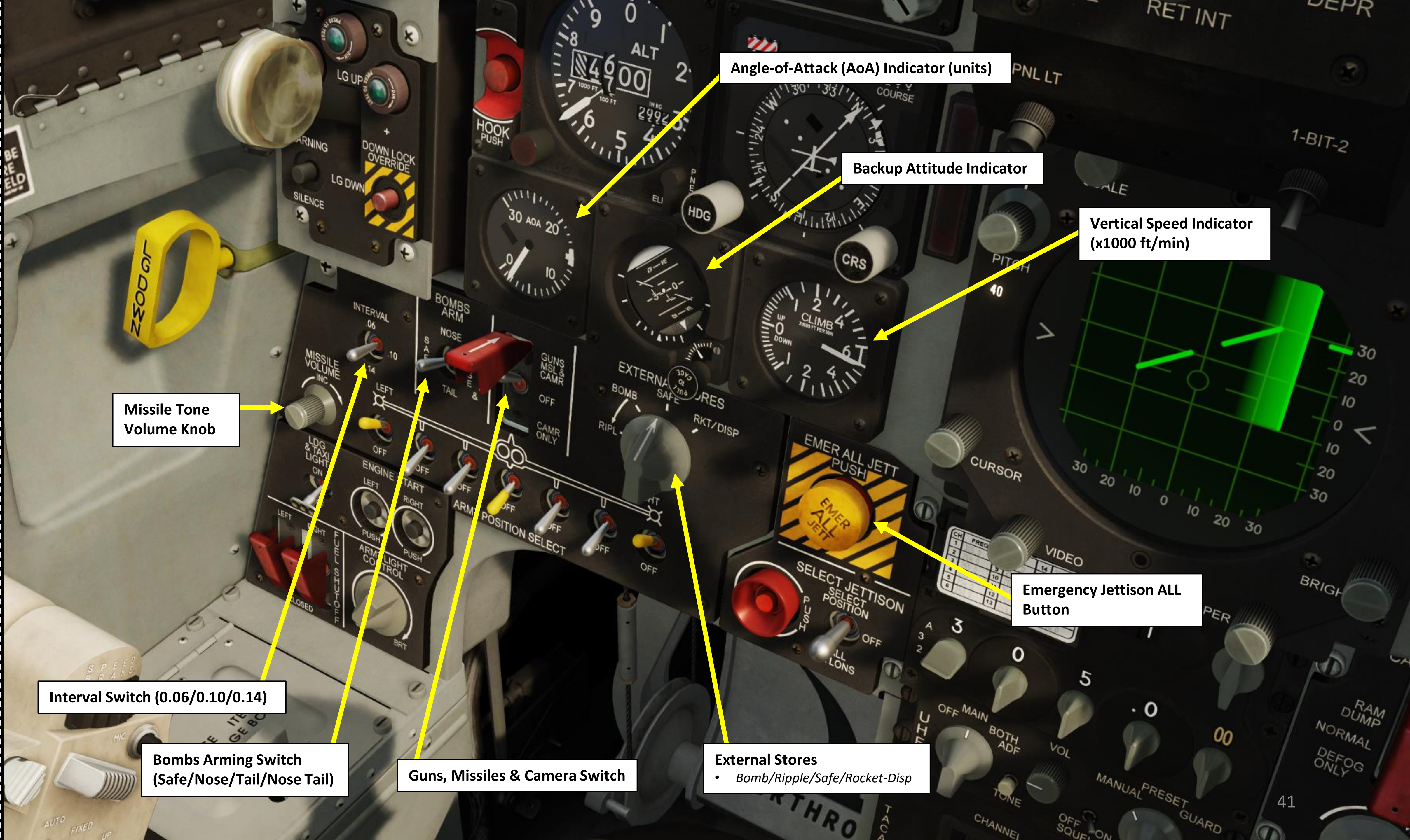

Left Engine Fire Light
Right Engine Fire Light
Master Caution Indicator/Button (Push-to-Reset)

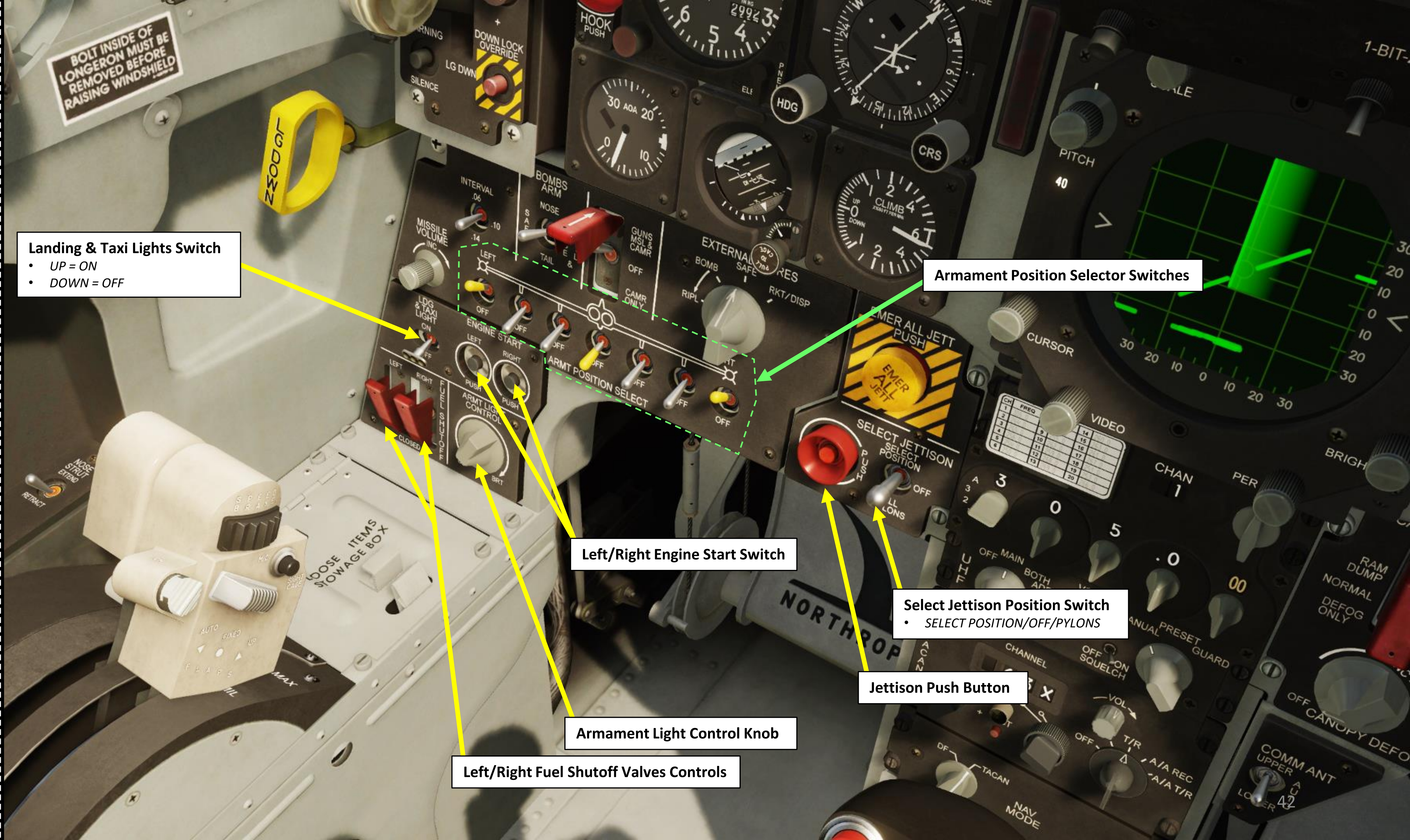

Airspeed-Mach Indicator (x100 kts)
Pitch Trim Indicator
Flaps Position Indicator
• UP: Fully Retracted
• AUTO: flaps in automatic setting
• FULL: Fully Extended
• FXD: flaps in fixed setting
• Barber Pole: intermediate position
Attitude Indicator
Fast-Erect Button
• If temporary power failure occurs during maneuvering (not in straight and level flight), thus causing the OFF flag to appear on the attitude indicator, the vertical gyro may tilt and pitch and roll readings of the instrument will be incorrect. In order to return the attitude indicator instrument into operating condition, press the FAST-ERECT button.
HSI (Horizontal Situation Indicator)
RADIO CALL J-3088
FLAPS
AUTO
DRAG CHUTE
HOOK PUSH
ALT
HDG
CRS
COURSE
LG DOWN
EXTERNAL STORES
EMER ALL JETT PUSH
SELECT JETTISON
ARMT POSITION SELECT
ENGINE START
MISSILE VOLUME
INTERVAL
DOWN LOCK OVERRIDE
BOLT INSIDE OF LONGERON MUST BE REMOVED BEFORE RAISING WINDSHIELD
LOAD LOCK
MODE
RET INT
PNL LT

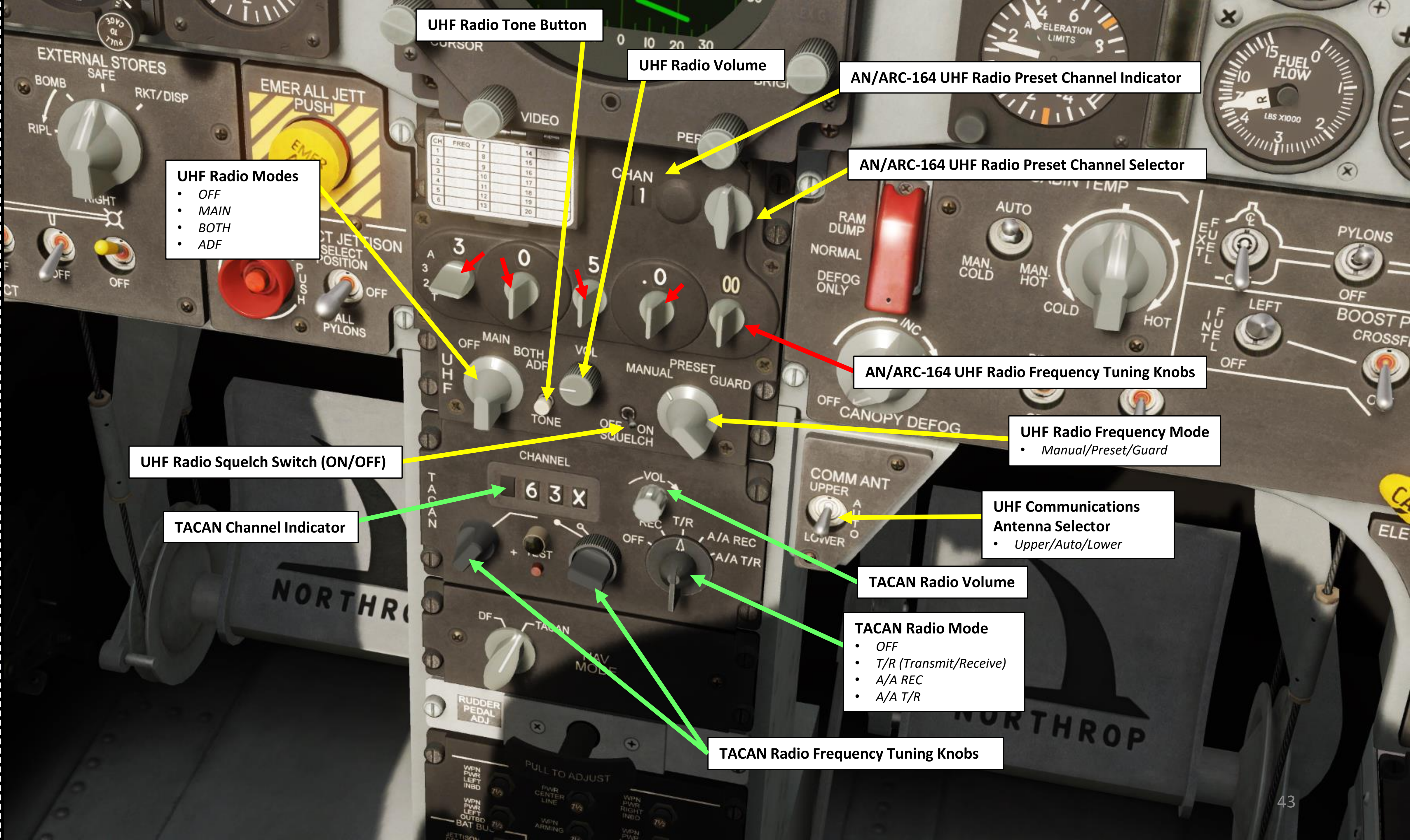

Altimeter Barometric Pressure Setting Indicator (in Hg)
Altitude Indicator (ft)
Altimeter Barometric Pressure Setting Knob
Altimeter Mode Switch
Three-position switch, springloaded to return to NEUTRAL.
• ELECTRIC – Corrected altitude (computed by central air data computer (CADC)
• PNEUMATIC – Altitude pressure (spring-loaded in neutral position)

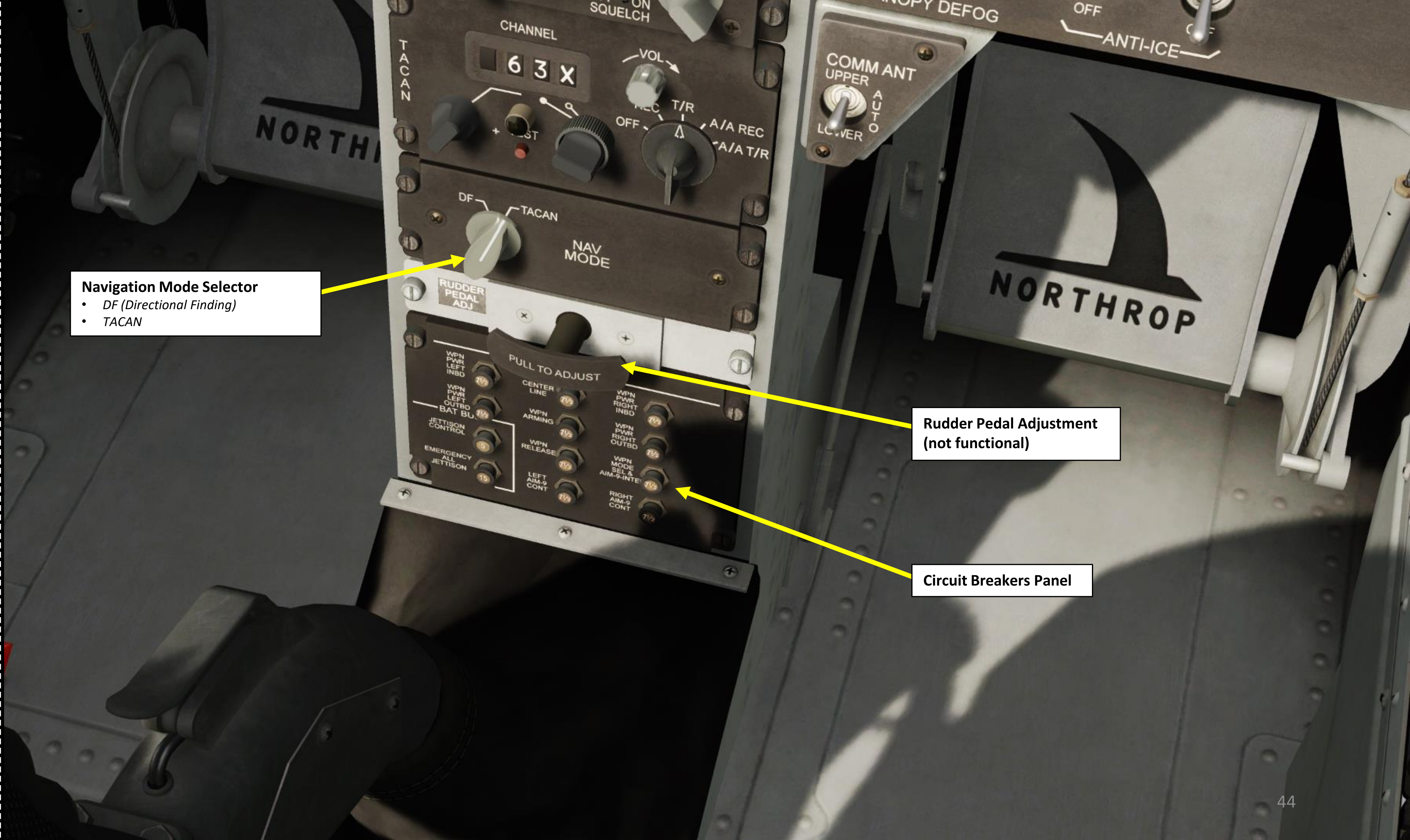

Drag Chute Handle
Landing Gear Position Indicator Lights
• Illuminated when gear is down and locked
Landing Gear Lever
Arresting Hook Button
Down Lock Override
DRAG CHUTE
RADIO CALL J-3088
FLAPS
FULL
LOAD
LOCK
LG UP
WARNING
DOWN LOCK OVERRIDE
HOOK PUSH
LG DOWN
BOLT INSIDE OF LONGERON MUST BE REMOVED BEFORE RAISING WINDSHIELD
EMER ALL JETT PUSH
ARMT POSITION SELECT
ENGINE START
EXTERNAL STORES
HDG
CRS
PITCH
CURSOR
VIDEO
MODE
RET INT
DEPR


Emergency Landing Gear Lever
Landing Gear/Flaps
Warning Silence Button
BOLT INSIDE OF LONGERON MUST BE REMOVED BEFORE RAISING WINDSHIELD
RADIO CALL J-3088
LOAD
LOCK
FLAPS
CHUTE
HOOK PUSH
ALT
HDG
CRS
COURSE
MODE
PNL LT
PITCH
CURSOR
EMER ALL JETT PUSH
ARMT POSITION SELECT
ENGINE START


Angle-of-Attack (AoA) Indicator (units)
Backup Attitude Indicator
Vertical Speed Indicator (x1000 ft/min)
Missile Tone Volume Knob
Emergency Jettison ALL Button
Interval Switch (0.06/0.10/0.14)
Bombs Arming Switch (Safe/Nose/Tail/Nose Tail)
Guns, Missiles & Camera Switch
External Stores
• Bomb/Ripple/Safe/Rocket-Disp


Landing & Taxi Lights Switch
• UP = ON
• DOWN = OFF
Armament Position Selector Switches
Left/Right Engine Start Switch
Select Jettison Position Switch
• SELECT POSITION/OFF/PYLONS
Jettison Push Button
Armament Light Control Knob
Left/Right Fuel Shutoff Valves Controls

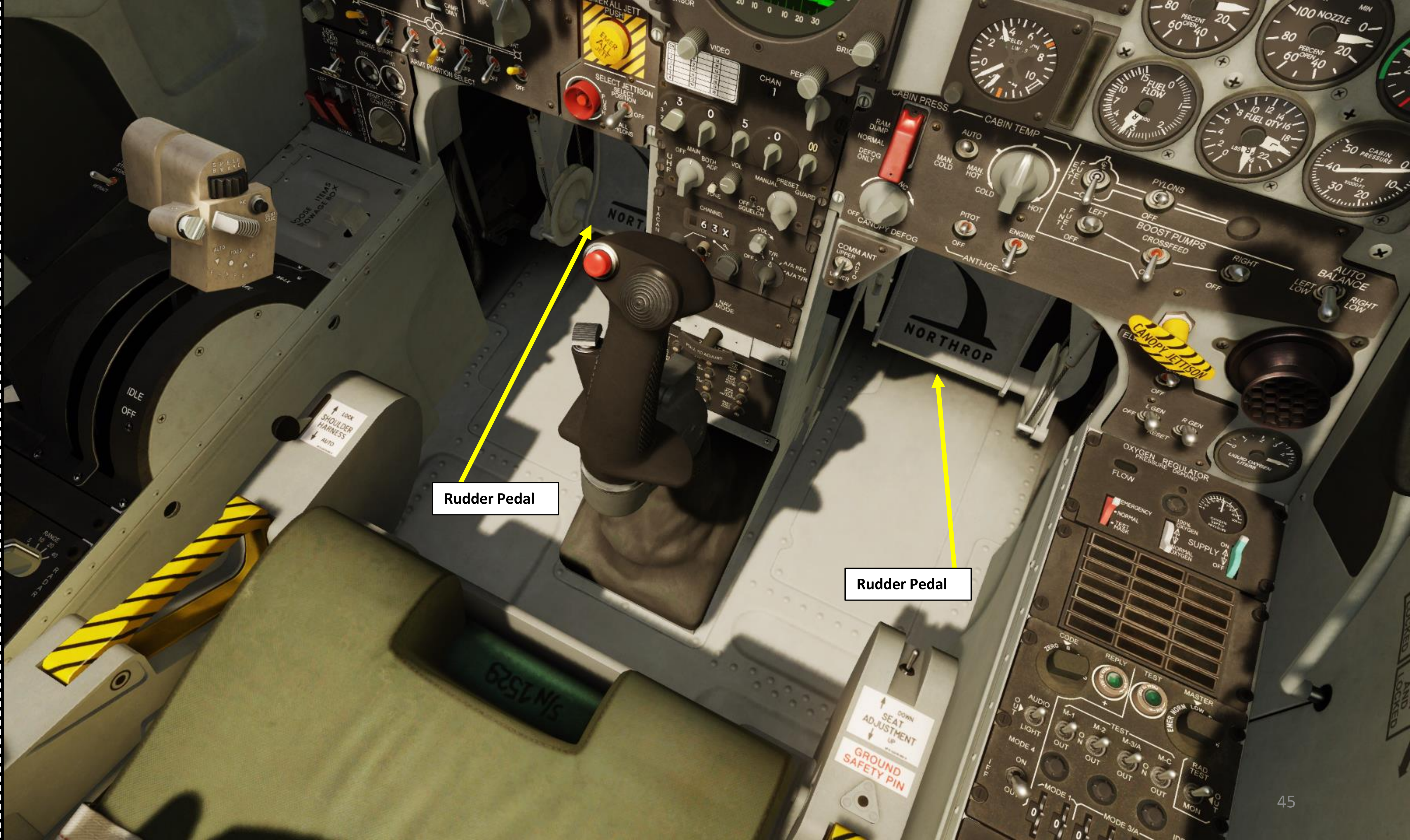

UHF Radio Tone Button
UHF Radio Volume
AN/ARC-164 UHF Radio Preset Channel Indicator
AN/ARC-164 UHF Radio Preset Channel Selector
UHF Radio Modes
• OFF
• MAIN
• BOTH
• ADF
AN/ARC-164 UHF Radio Frequency Tuning Knobs
UHF Radio Frequency Mode
• Manual/Preset/Guard
UHF Radio Squelch Switch (ON/OFF)
TACAN Channel Indicator
UHF Communications Antenna Selector
• Upper/Auto/Lower
TACAN Radio Volume
TACAN Radio Mode
• OFF
• T/R (Transmit/Receive)
• A/A REC
• A/A T/R
TACAN Radio Frequency Tuning Knobs

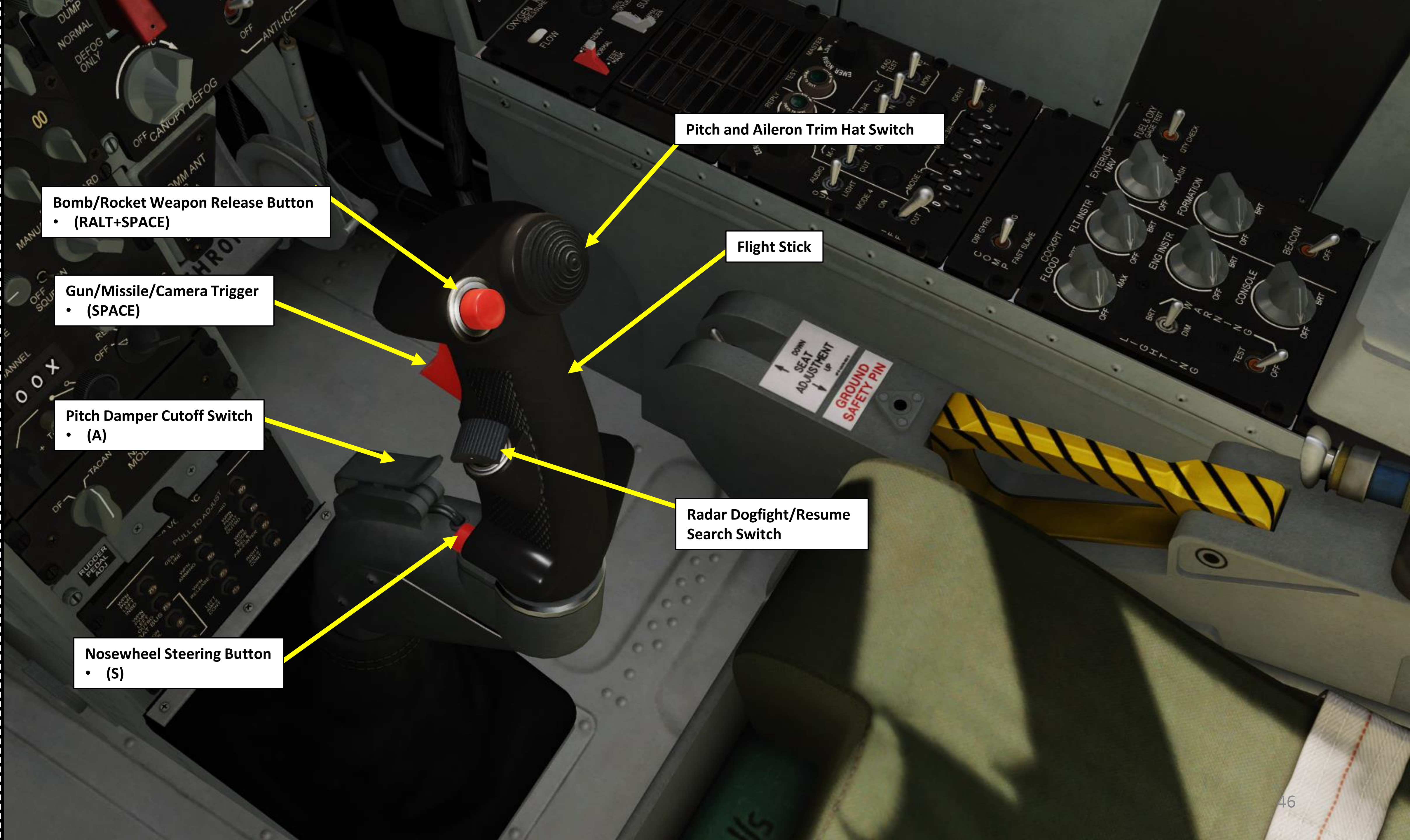



**Navigation Mode Selector**
- *DF (Directional Finding)*
- *TACAN*

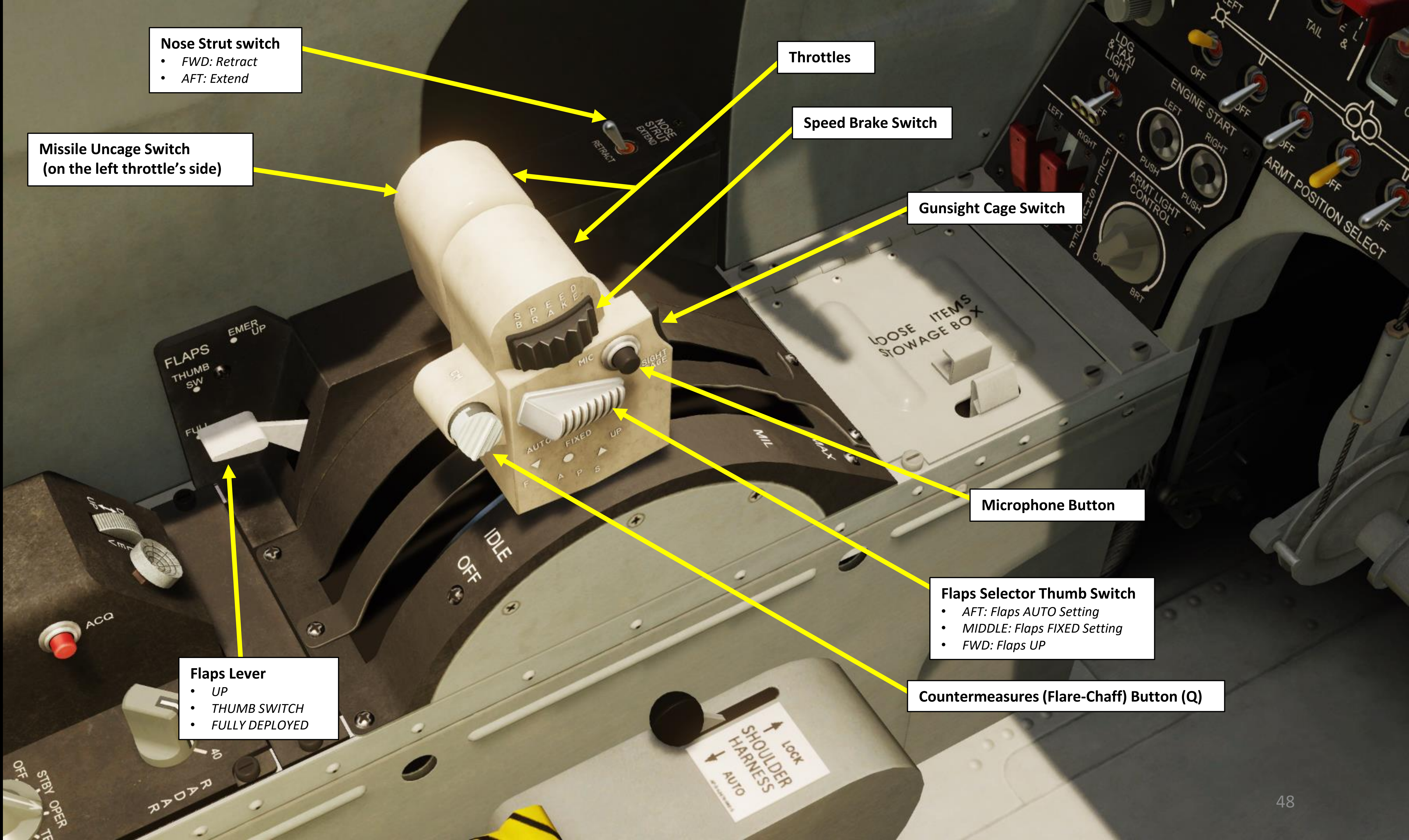
**Rudder Pedal Adjustment (not functional)**

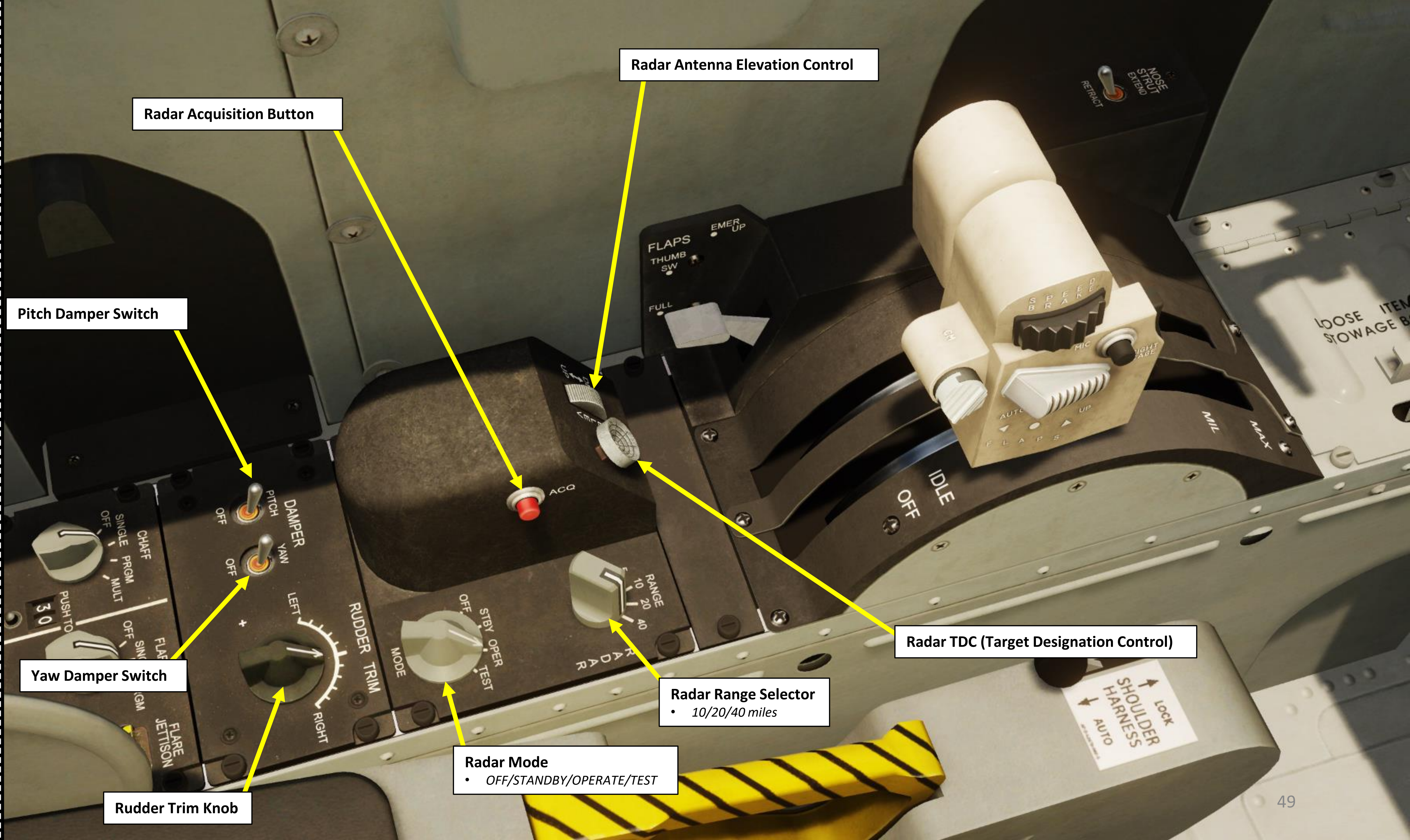
**Circuit Breakers Panel**

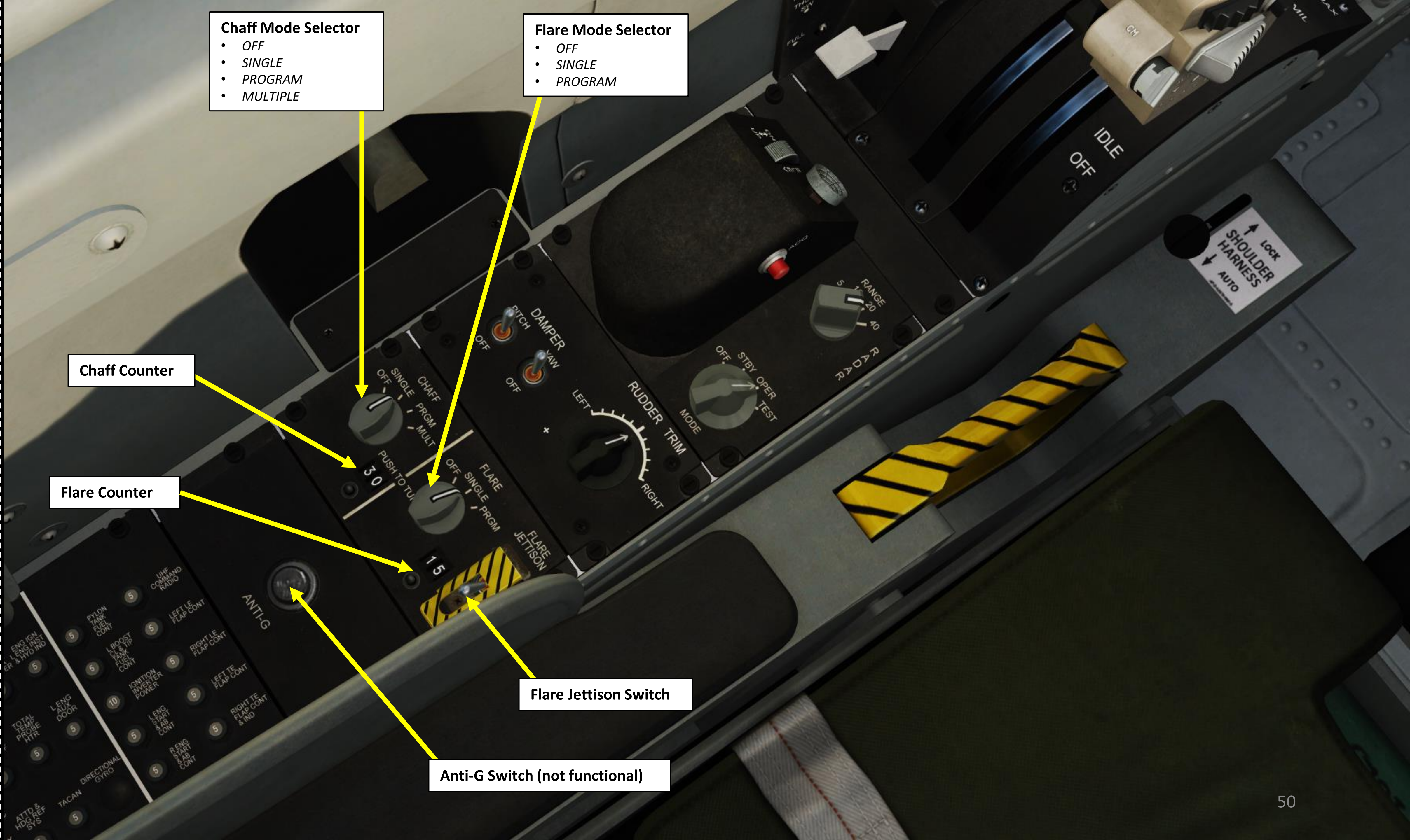

Rudder Pedal
Rudder Pedal

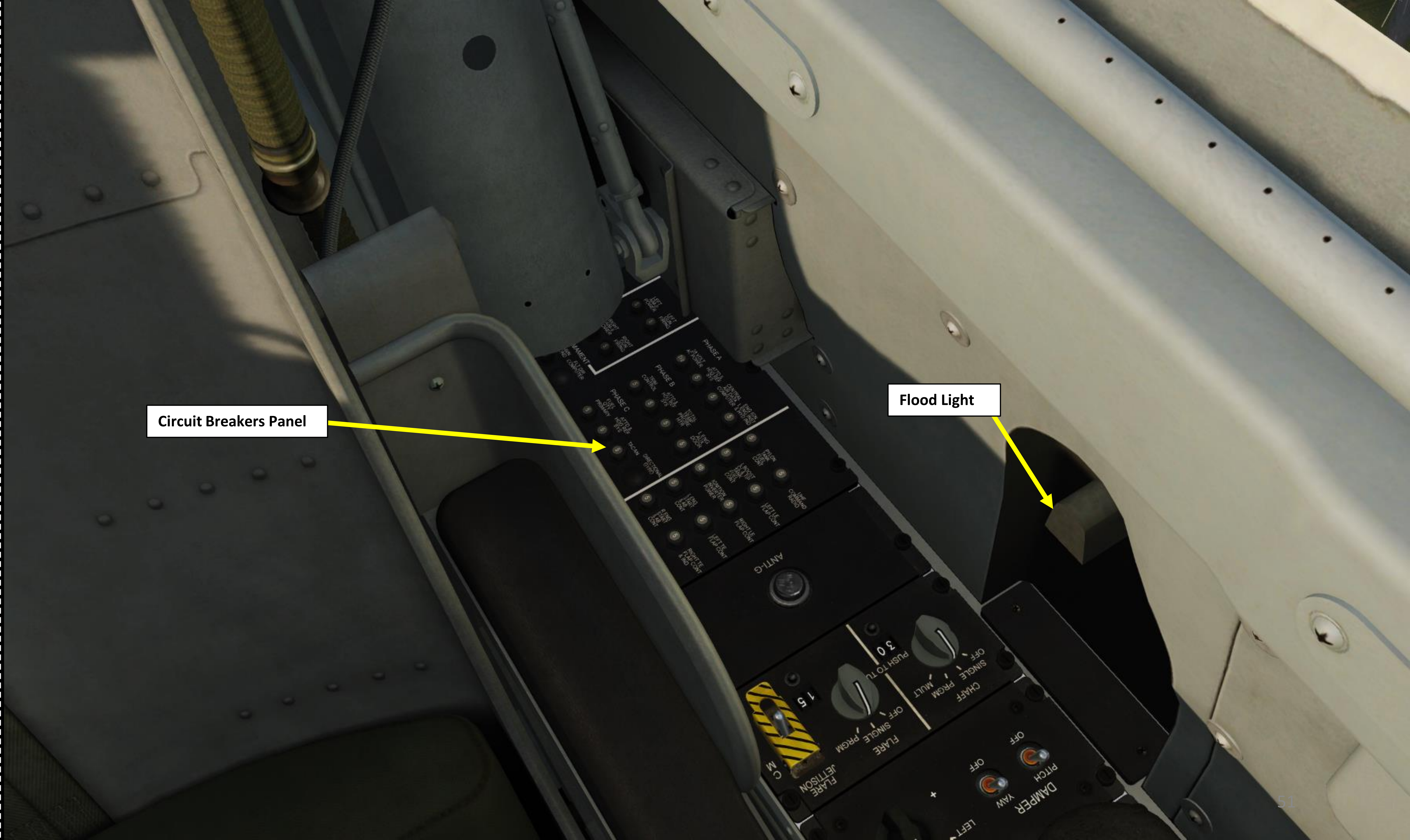

Pitch and Aileron Trim Hat Switch
Bomb/Rocket Weapon Release Button
• (RALT+SPACE)
Flight Stick
Gun/Missile/Camera Trigger
• (SPACE)
Pitch Damper Cutoff Switch
• (A)
Radar Dogfight/Resume Search Switch
Nosewheel Steering Button
• (S)


Air Conditioning Air Flow Outlet
Air Conditioning Air Flow Outlet


Nose Strut switch
• FWD: Retract
• AFT: Extend
Missile Uncage Switch
(on the left throttle's side)
Throttles
Speed Brake Switch
Gunsight Cage Switch
Microphone Button
Flaps Selector Thumb Switch
• AFT: Flaps AUTO Setting
• MIDDLE: Flaps FIXED Setting
• FWD: Flaps UP
Countermeasures (Flare-Chaff) Button (Q)
Flaps Lever
• UP
• THUMB SWITCH
• FULLY DEPLOYED
NOSE STRUT EXTEND
RETRACT
FLAPS
EMER UP
THUMB SW
SPEED BRAKE
MIC
AUTO
FIXED
UP
MIL
MAX
IDLE
OFF
LOOSE ITEMS STOWAGE BOX
ENGINE START
ARMT POSITION SELECT
ARMT LIGHT CONTROL
LDG & TAXI LIGHT
ACQ
SHOULDER HARNESS
LOCK
AUTO
RADAR


Radar Antenna Elevation Control
Radar Acquisition Button
Pitch Damper Switch
Yaw Damper Switch
Rudder Trim Knob
Radar Mode
• OFF/STANDBY/OPERATE/TEST
Radar Range Selector
• 10/20/40 miles
Radar TDC (Target Designation Control)
FLAPS
ACQ
DAMPER
PITCH
YAW
RUDDER TRIM
LEFT
RIGHT
MODE
RANGE
RADAR
IDLE
OFF
MIL
MAX
SHOULDER HARNESS
LOCK
AUTO


Chaff Mode Selector
- OFF
- SINGLE
- PROGRAM
- MULTIPLE
Flare Mode Selector
- OFF
- SINGLE
- PROGRAM
Chaff Counter
Flare Counter
Flare Jettison Switch
Anti-G Switch (not functional)

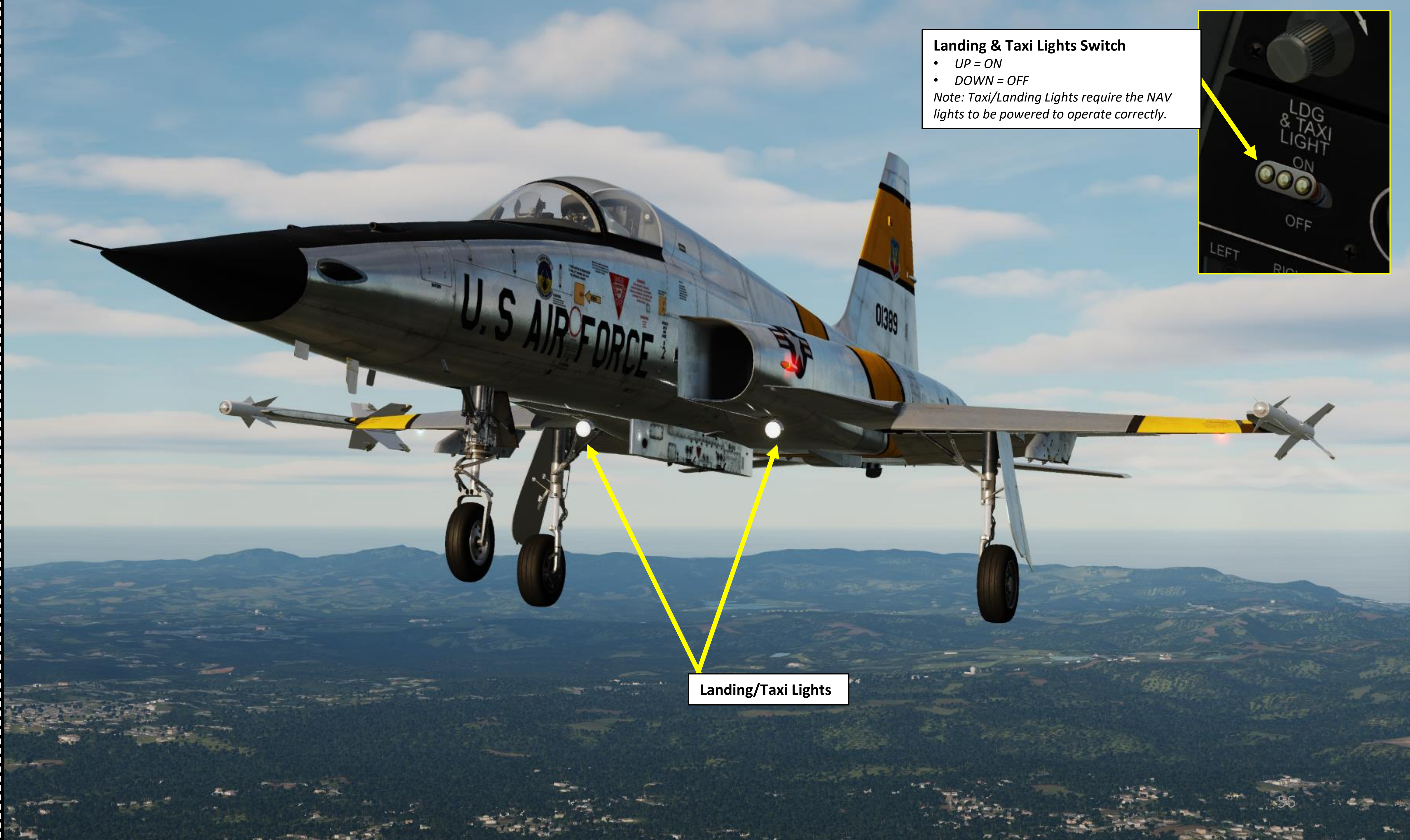

Circuit Breakers Panel
Flood Light
ANTI-G
FLARE JETTISON
FLARE
CHAFF
PUSH TO TEST
DAMPER
PITCH
YAW


FLAPS
AUTO
CHUTE
EMER ALL JETT
PUSH
AUX INTAKE DOORS
COCKPIT FLOOD
FLT INSTR
EXTERIOR NAV
FUEL & OXY GAGE TEST

**Auxiliary Intake Doors**

- *Auxiliary (aux) intake doors on each side of the fuselage above the wing trailing edge provide additional air to the engines for added thrust during takeoff and low-speed flight (low dynamic pressure). The doors are automatically controlled by a signal from the central air data computer (CADC). An aux intake doors indicator on the instrument panel provides an indication of closed, intermediate, or open position of the doors.*

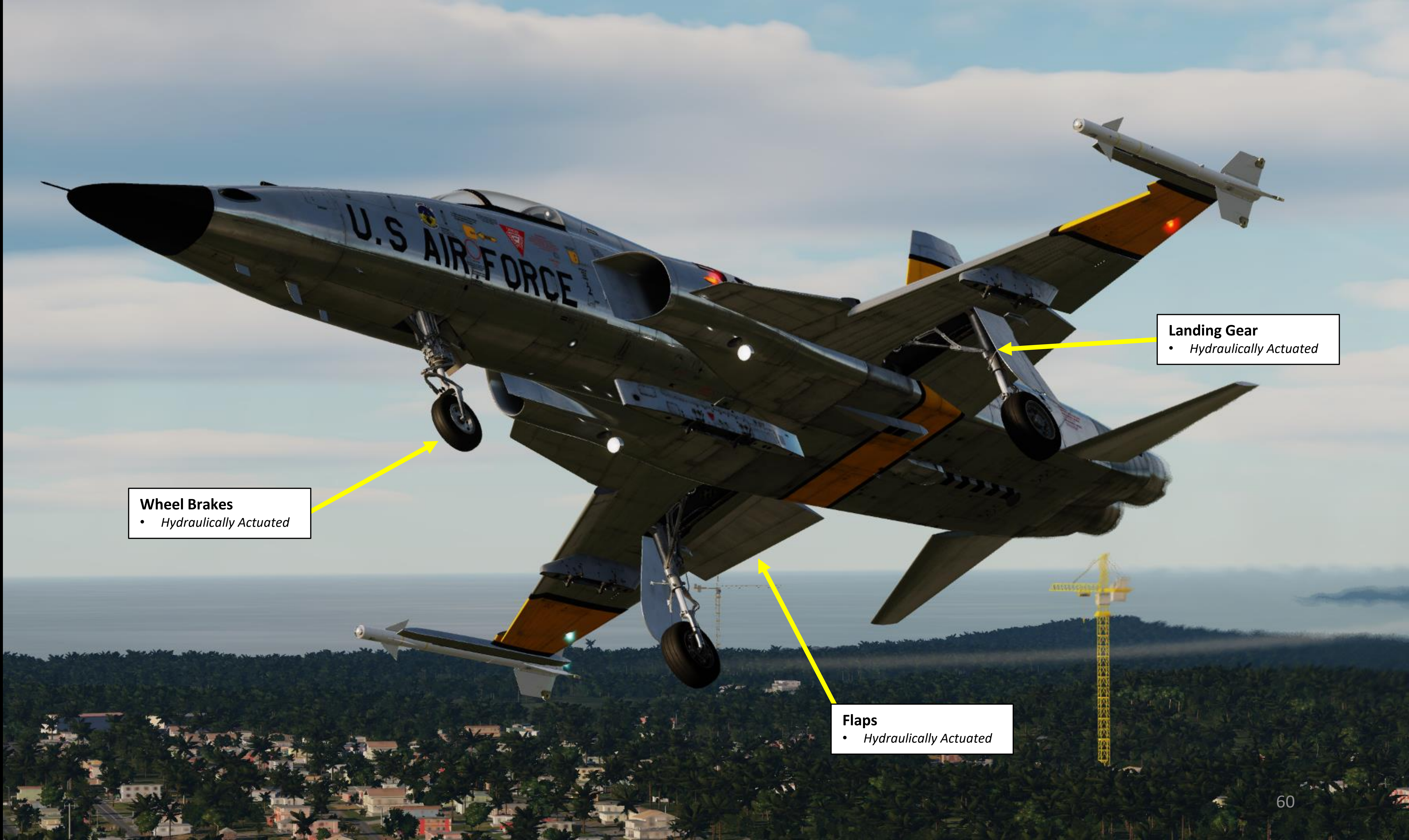

COCKPIT FLOOD
OFF
MAX
FLT INSTR
OFF
BRT
EXTERIOR NAV
OFF
FLASH
QTY CHECK
ENG INSTR
OFF
BRT
FORMATION
OFF
BRT
LIGHTING
BRT
DIM
WARNING
TEST
CONSOLE
OFF
BRT
OFF
Exterior Navigation (Position) Lights Control Knob
Formation Lights Control Knob
Beacon Switch
Tail Position Light
Rotating Beacon Light
Formation Light
Primary Position Light
Auxiliary Position Light
Auxiliary Position Light
Formation Light
01389


Landing & Taxi Lights Switch
• UP = ON
• DOWN = OFF
Note: Taxi/Landing Lights require the NAV lights to be powered to operate correctly.
Landing/Taxi Lights
U.S AIR FORCE
01389
LDG & TAXI LIGHT
ON
OFF
LEFT


Fuselage Lights (White)
U.S. AIR FORCE


**Gun Deflector Door**
- *Deflects gun smoke away from engine intakes*
- *Opens when gun trigger is held in the first stage*


U.S AIR FORCE
Gun Cartridge Ejector Chute
• Opens when gun trigger is held in the first stage


Landing Gear
• Hydraulically Actuated
Wheel Brakes
• Hydraulically Actuated
Flaps
• Hydraulically Actuated


01389
U.S AIR FORCE
Speed Brakes
• Hydraulically Actuated


Rudder
Aileron
Elevator


TACAN Receiver Antenna
UHF/IFF Antenna
UHF/ADF Antenna
U.S AIR FORCE


UHF Antenna
TACAN Receiver Antenna
IFF Antenna
01389


Drag Chute

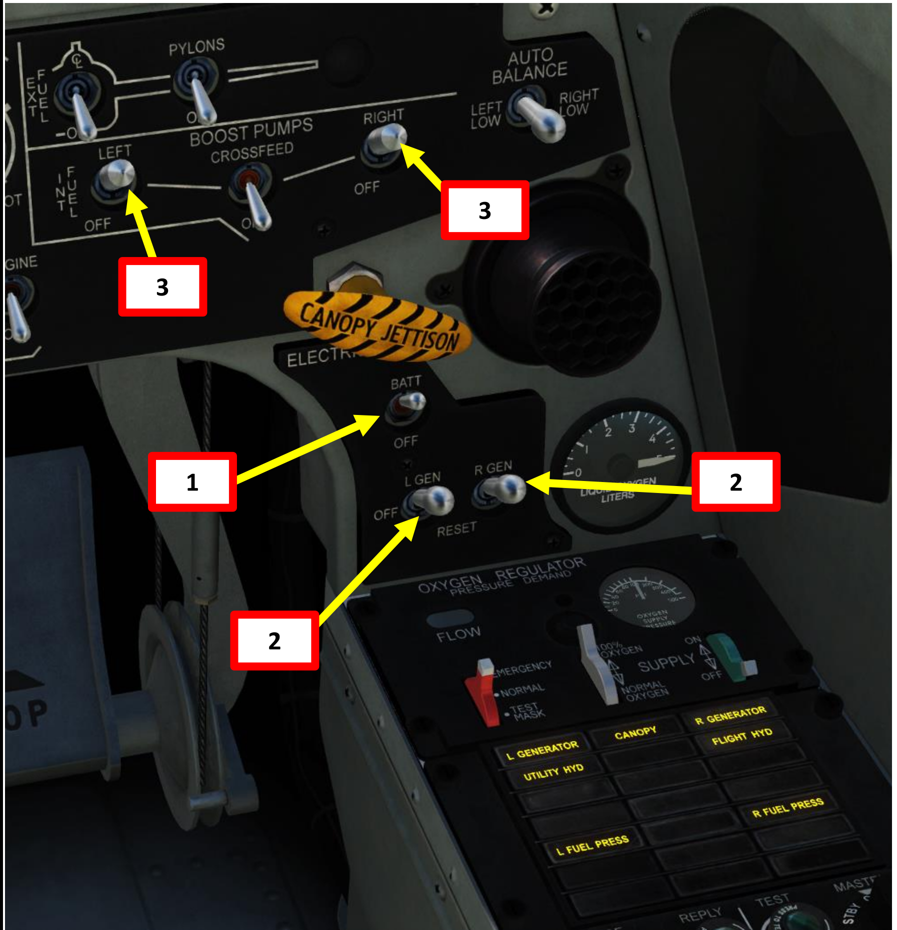

**Arrestor Hook**

- *The arresting hook system is an emergency system consisting of a retracted hook under the fuselage aft section and a button to electrically release and extend the hook for runway arrestment.*
- *The arresting hook is extended by pushing the Arresting Hook button. The hook engagement speed is 160 KIAS, and the Hook extends only if landing gear is down.*
- *Once deployed, the hook cannot be retracted.*


01389
U.S AIR FORCE

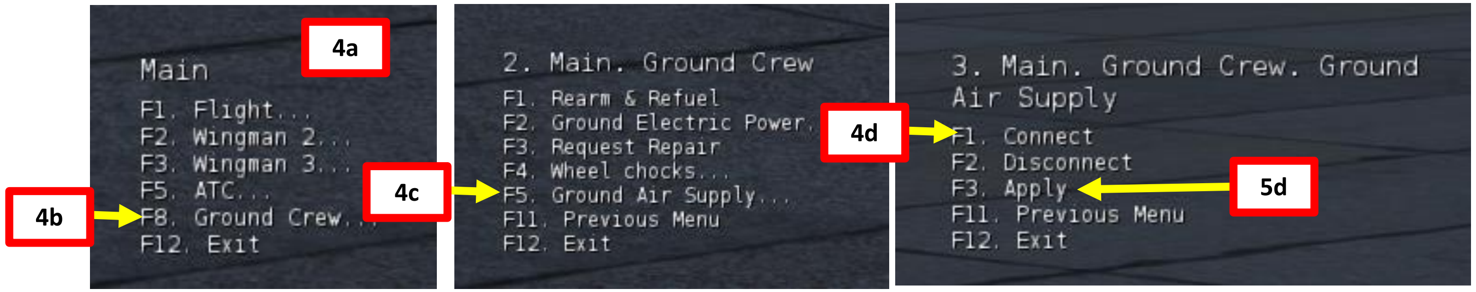
# ENGINE START

1. Set Battery Switch – ON (UP)
2. Set Left and Right Generator Switches – ON (UP)
3. Set Left and Right Booster Pump Switches – ON (UP)




# ENGINE START

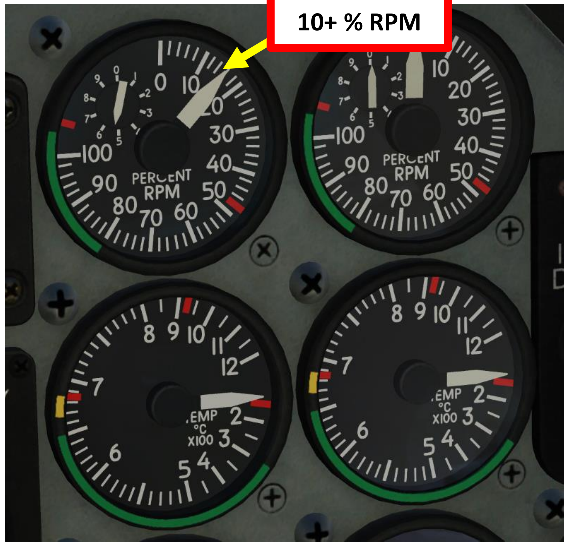
4. Contact ground crew to connect compressed air supply unit:
   a) Press “\” to open radio menu
   b) Press “F8” to select ground crew
   c) Press “F5” to select Ground air supply
   d) Press “F1” to connect air supply unit
5. Contact ground crew to request air supply pressure to drive the left engine starter (motoring).
   a) Press “\” to open radio menu
   b) Press “F8” to select ground crew
   c) Press “F5” to select Ground air supply
   d) Press “F3” to supply air (*apply*)

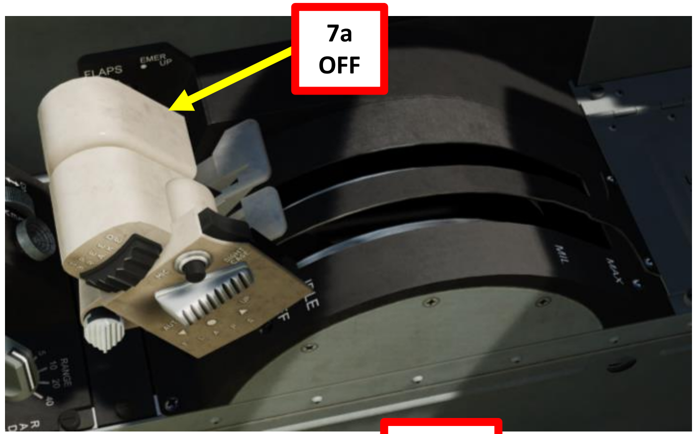


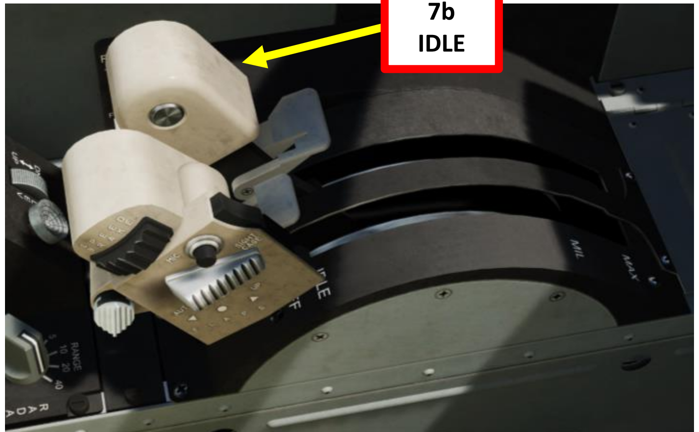

**Left Engine RPM Increases (driven by air pressure supply)**

# ENGINE START

6. Once left engine RPM has reached at least 10 %, push the LEFT ENGINE START button.
7. Set left engine throttle to IDLE by pressing "RALT+HOME". Fuel will then be introduced into the combustion chamber and engine lightoff sequence will proceed with the igniters.
    - Control: **Throttle (LEFT) – IDLE**
8. Within 35 seconds, left engine will stabilize to the following parameters:
    a) IDLE RPM (49-52 %)
    b) EGT (Exhaust Gas Temperature) no less than 140 deg C
    c) Nozzle position 60 to 79%
    d) Fuel flow rate about 400 pph
    e) Oil pressure between 5 and 20 psi
    f) UTILITY hydraulic pressure between 2800 and 3200 psi

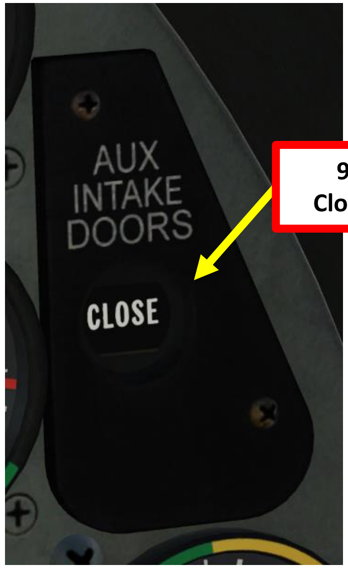




# ENGINE START

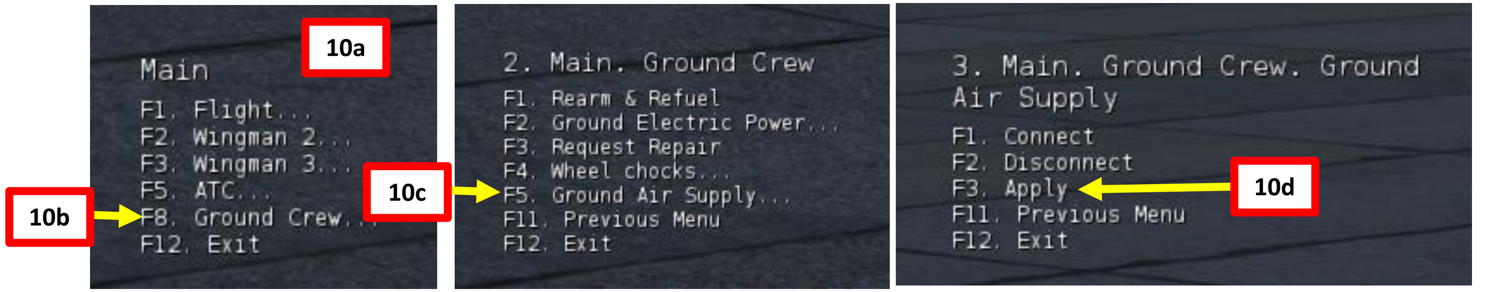
9. When left engine is stabilized to IDLE, the engine-driven hydraulic pump will automatically open up the left engine auxiliary intake door. Confirm that the auxiliary intake door position indicator changes to BARBER POLE. This indicates that the left intake door is open, but that the right intake door is closed.

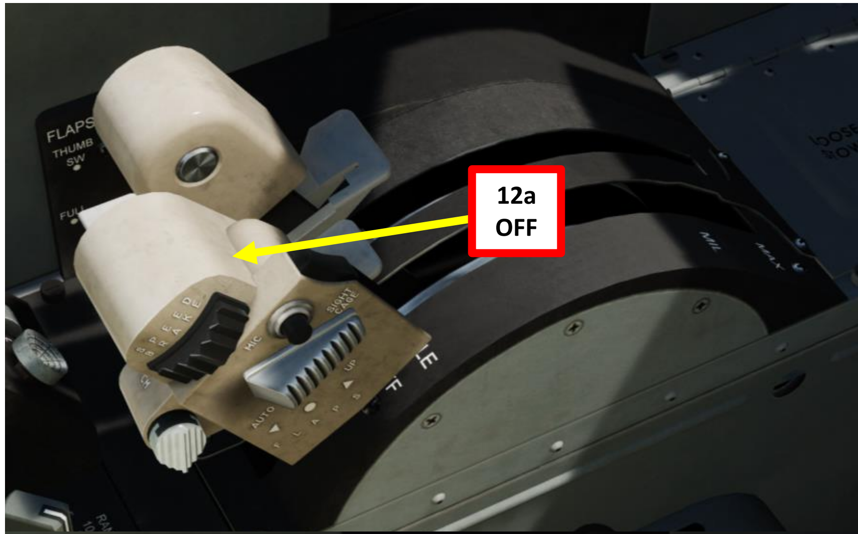




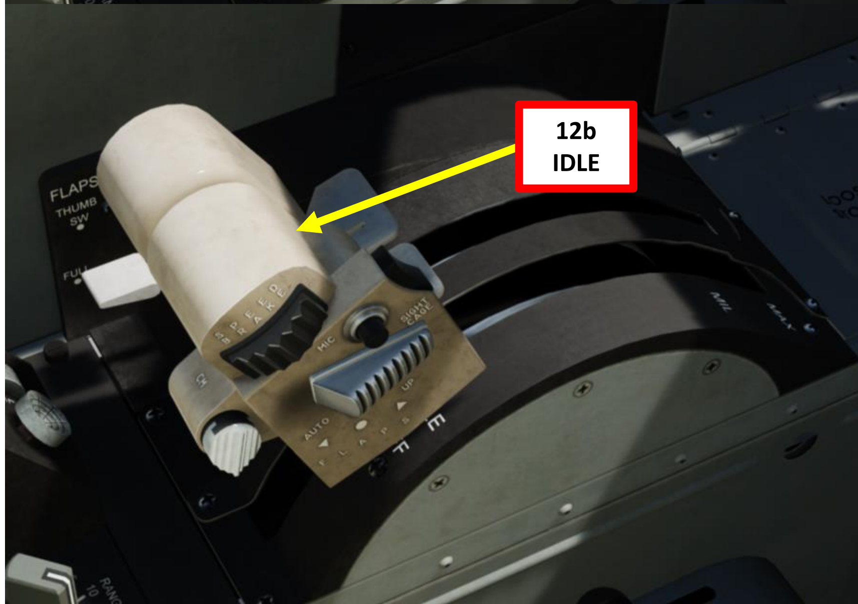
# ENGINE START

10. Contact ground crew to request air supply pressure to drive the right engine starter (motoring).
    a) Press “\” to open radio menu
    b) Press “F8” to select ground crew
    c) Press “F5” to select Ground air supply
    d) Press “F3” to supply air (*apply*)
11. Once right engine RPM has reached at least 10 %, push the RIGHT ENGINE START button.
12. Set right engine throttle to IDLE by pressing “RCTRL+HOME”. Fuel will then be introduced into the combustion chamber and engine lightoff sequence will proceed with the igniters.
    - Control: **Throttle (RIGHT) – IDLE**



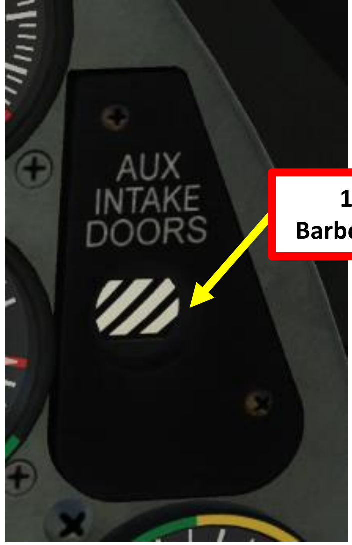





# ENGINE START

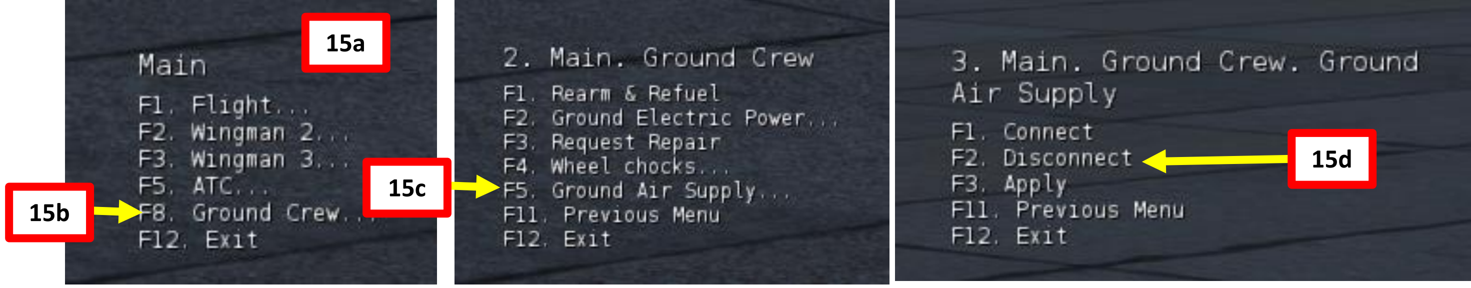
13. Within 35 seconds, right engine will stabilize to the following parameters:
    a) IDLE RPM (49-52 %)
    b) EGT (Exhaust Gas Temperature) no less than 140 deg C
    c) Nozzle position 60 to 79%
    d) Fuel flow rate about 400 pph
    e) Oil pressure between 5 and 20 psi
    f) FLTCONT (Flight Controls) hydraulic pressure between 2800 and 3200 psi
14. When right engine is stabilized to IDLE, the engine-driven hydraulic pump will automatically open up the right engine auxiliary intake door. Confirm that the auxiliary intake door position indicator changes to OPEN. This indicates that both the left and right intake doors are open.

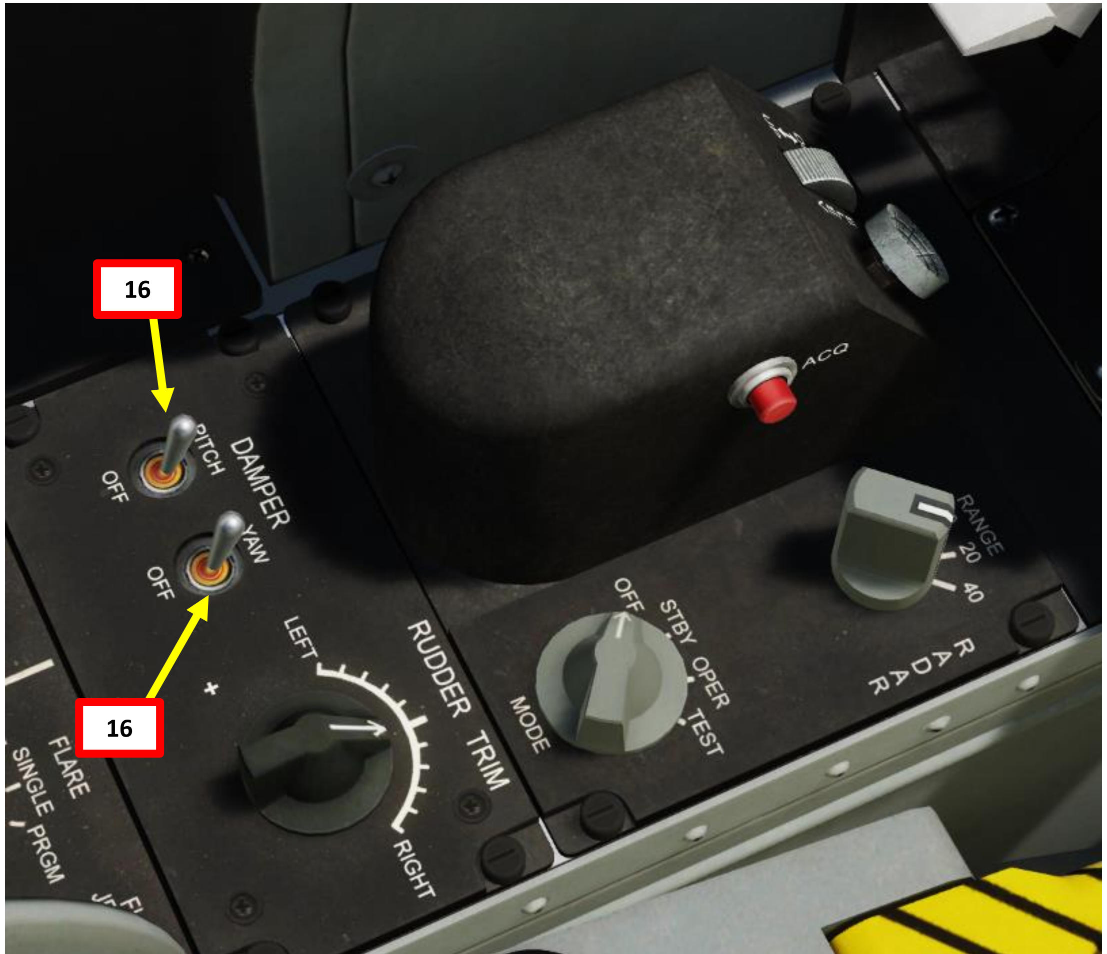




# POST-START

15. Disconnect compressed air supply unit:
    a) Press “\” to open radio menu
    b) Press “F8” to select ground crew
    c) Press “F5” to select Ground air supply
    d) Press “F2” to disconnect air supply unit
16. Set Yaw and Pitch Damper Switches – ON (FWD).
17. Set OXYGEN SUPPLY switch – ON (FWD).
18. Confirm that Oxygen Regulator Flow Indicator is active; the indicator should keep alternating between white and black.



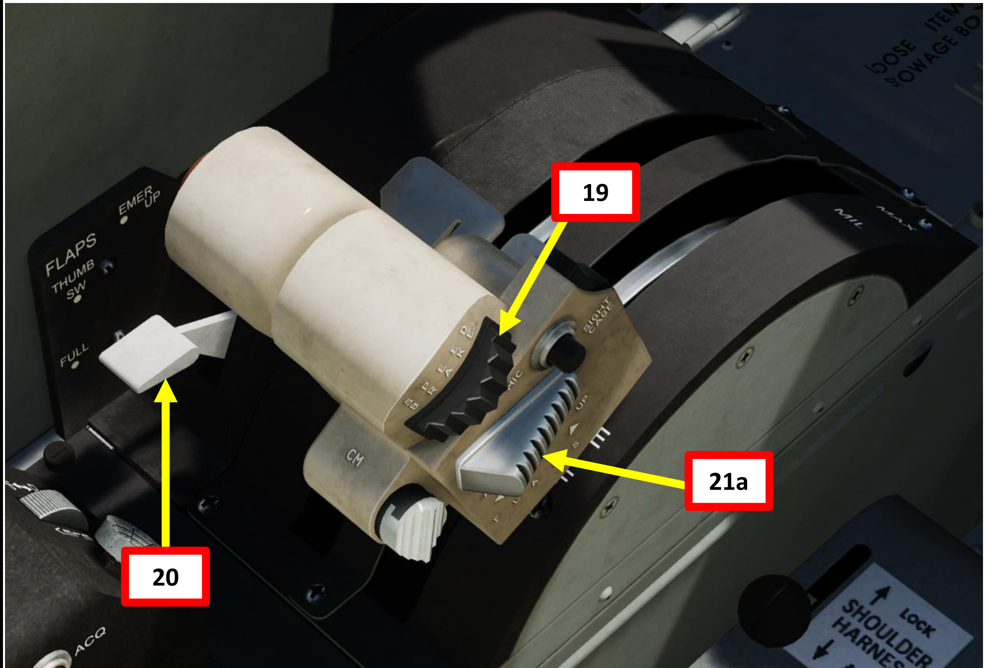

# POST-START

19. Retract airbrakes by setting airbrake thumb switch FWD
20. Set Flap Mode Switch – THUMB SWITCH (MIDDLE POSITION)
21. Set Flap Thumb Switch – AFT (AUTO)
22. Set Elevator Pitch Trim for Takeoff using elevator trimmer switch on your stick. It will vary with your takeoff configuration. Aileron and Rudder Trim can be left to 0 deg.


**Takeoff Pitch Trim Setting**

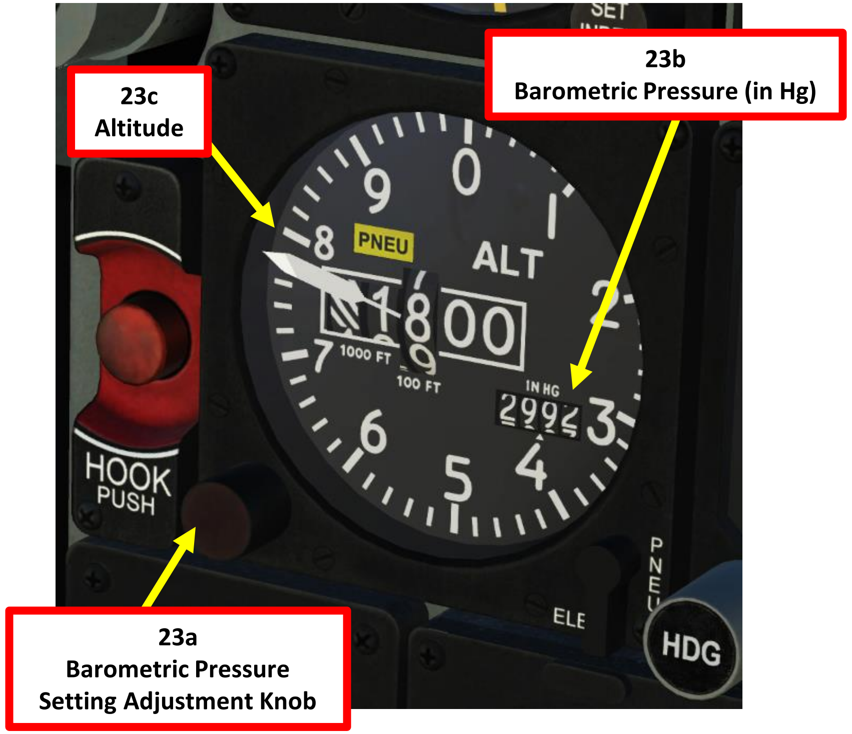
- No gun ammo & no stores: 6
- Drop tanks + gun ammo + missiles: 7
- Drop tanks + gun ammo + missiles + bombs + rockets: 8
- Gun ammo + missiles + bombs + rockets + containers: 9

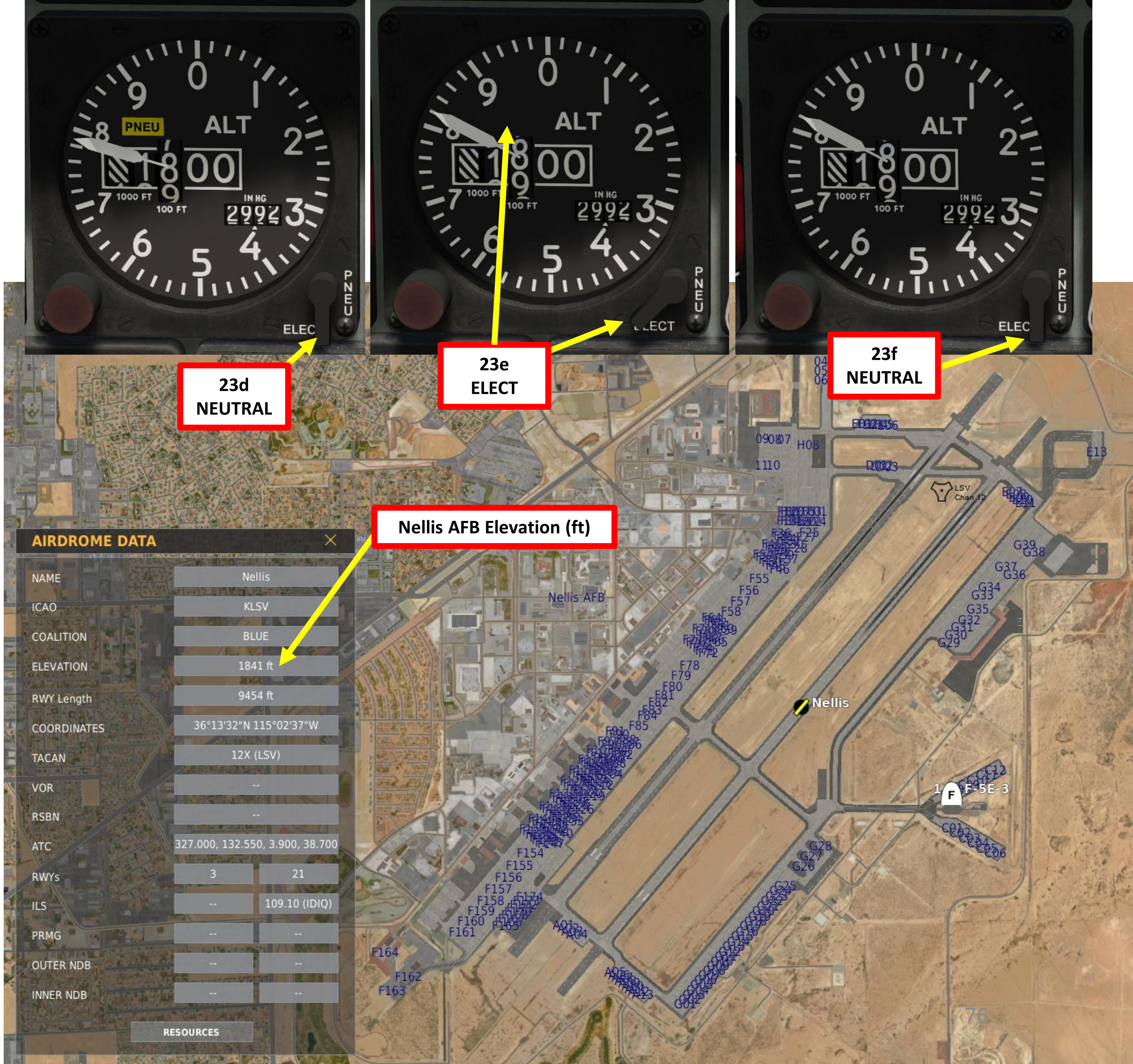


# POST-START

23. Set altimeter barometric pressure setting. After, set momentarily the Altimeter Mode Switch to ELECTRIC, then release it. When released, the Altimeter Mode Switch is springloaded to return to NEUTRAL. This will remove the "PNEU" flag on the altimeter.
    - If airfield elevation data is available, you can adjust the barometric pressure knob to make the altimeter reading match the airfield elevation (which would be 1840 ft in our case since we takeoff from Nellis AFB). However, you will have to keep in mind that your altitude reading will be AMSL (Above Mean Sea Level), not from the ground. This is important to remember when being directed by the ATC (Air Traffic Controller).
    - Alternatively, you can set the barometric pressure knob to make the altimeter reading match "0". In that case, the altitude reading will be AGL (Above Ground Level), not from sea level.

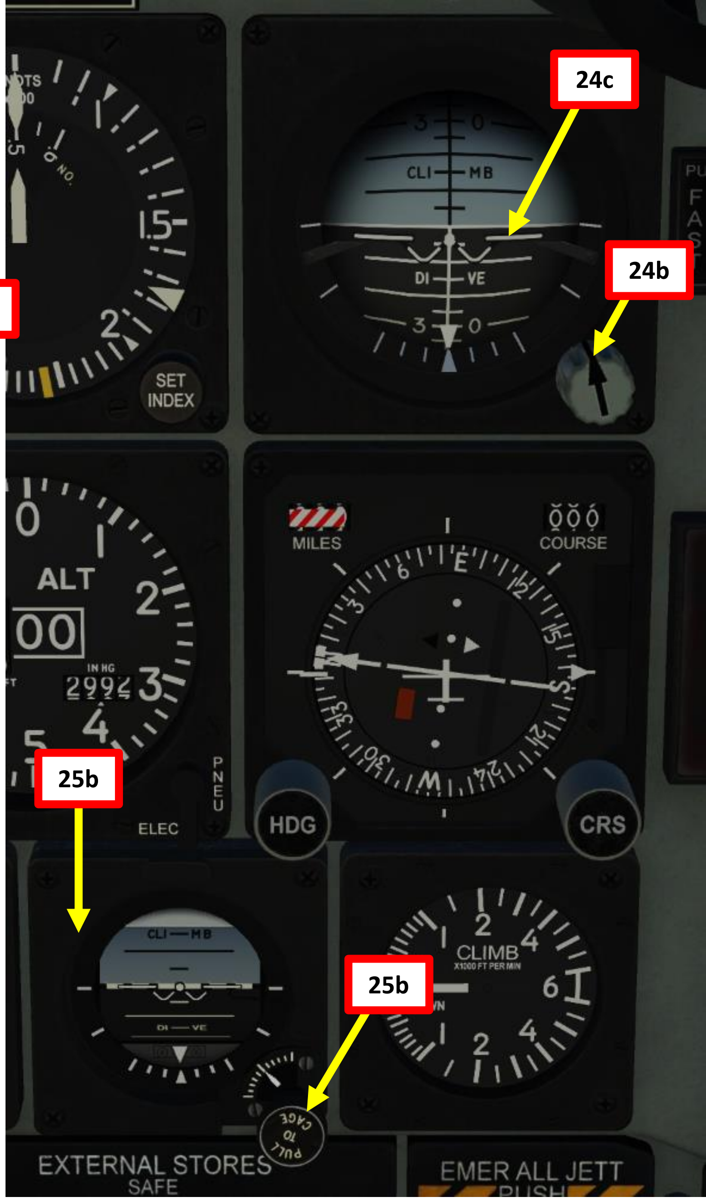


# POST-START

24. Set Primary Attitude Indicator pitch trim to -3 deg as shown by rotating its pitch trim knob.
25. Set Standby Attitude Indicator pitch trim to -3 deg as shown by rotating the PULL TO CAGE knob.
26. Press the RWS (Radar Warning System) POWER Button.
27. Press the RWS (Radar Warning System) SEARCH Button.



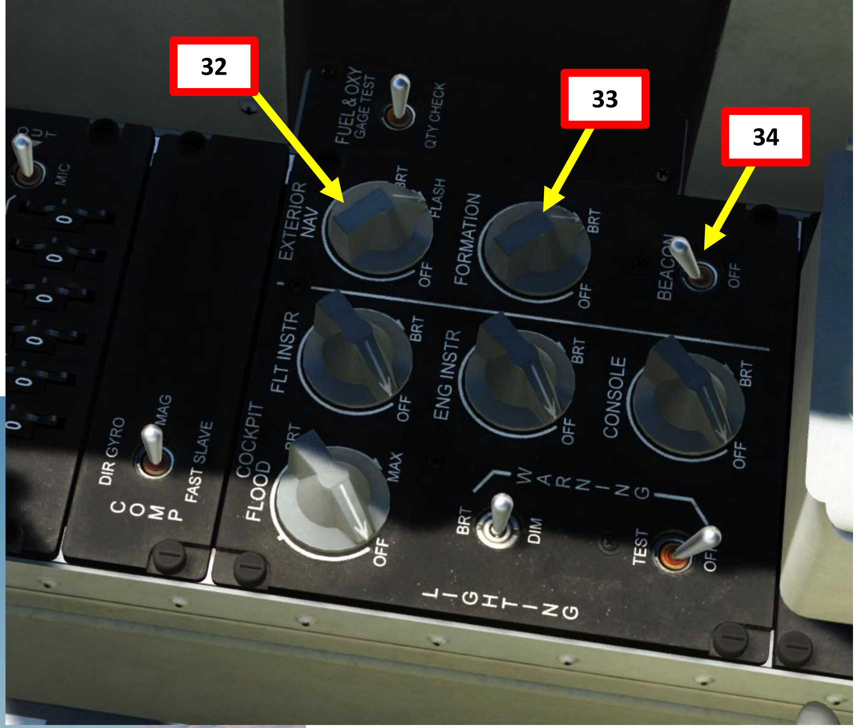


# POST-START

28. The right fuel tank has about 580 lbs more fuel than the left fuel tank for a fully fueled aircraft without drop tanks. Depending on your fuel state during flight, it is important to have a balanced fuel state.
    - Set AUTO-BALANCE switch to LEFT LOW. AUTO-BALANCE switch will automatically revert to MIDDLE position once fuel configuration is balanced.
29. Set PITOT HEAT Switch – ON (UP)
30. Set ENGINE ANTI-ICE Switch – As Required depending on weather conditions.
31. Press Master Caution button to extinguish the CAUTION light.

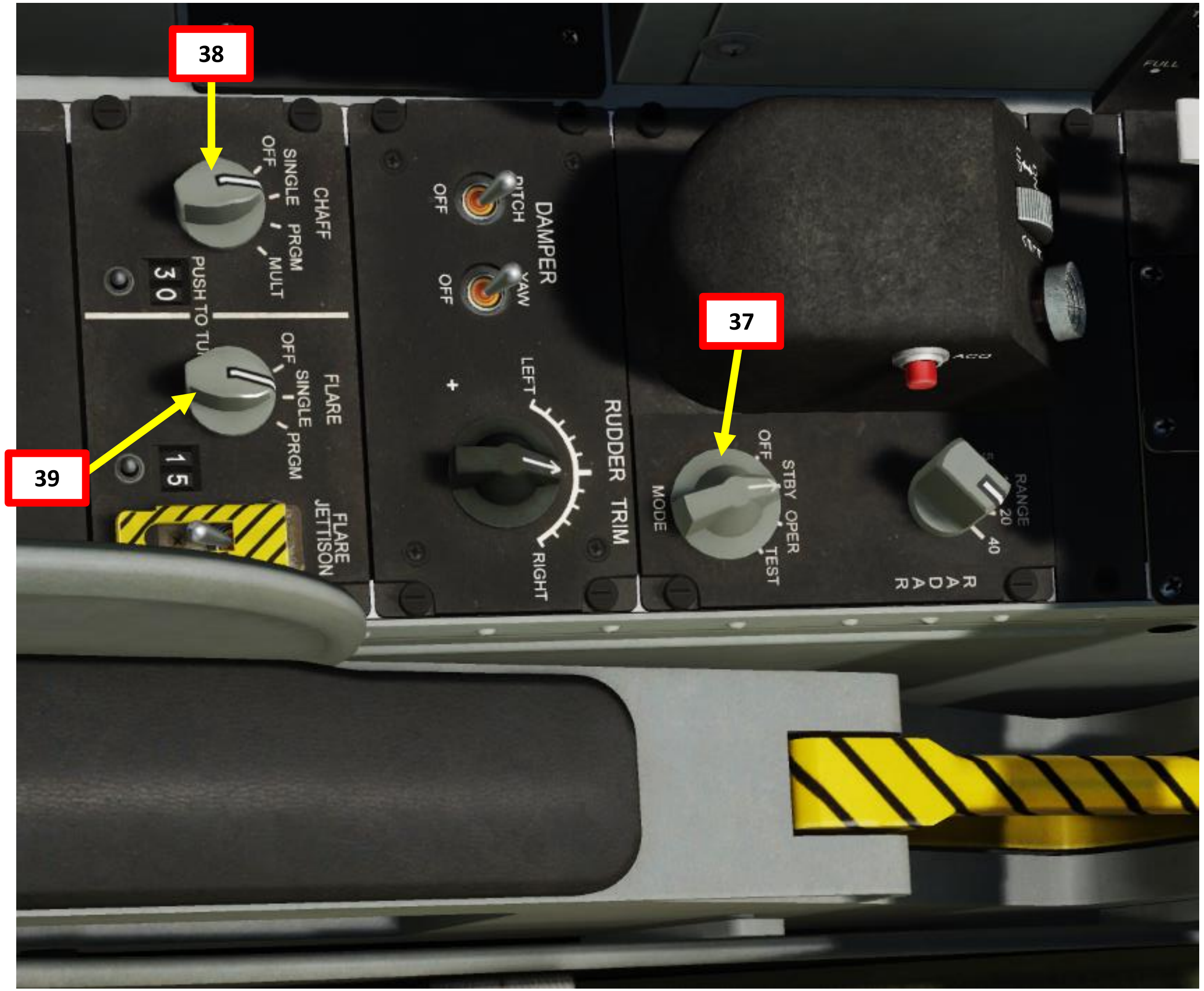

# POST-START

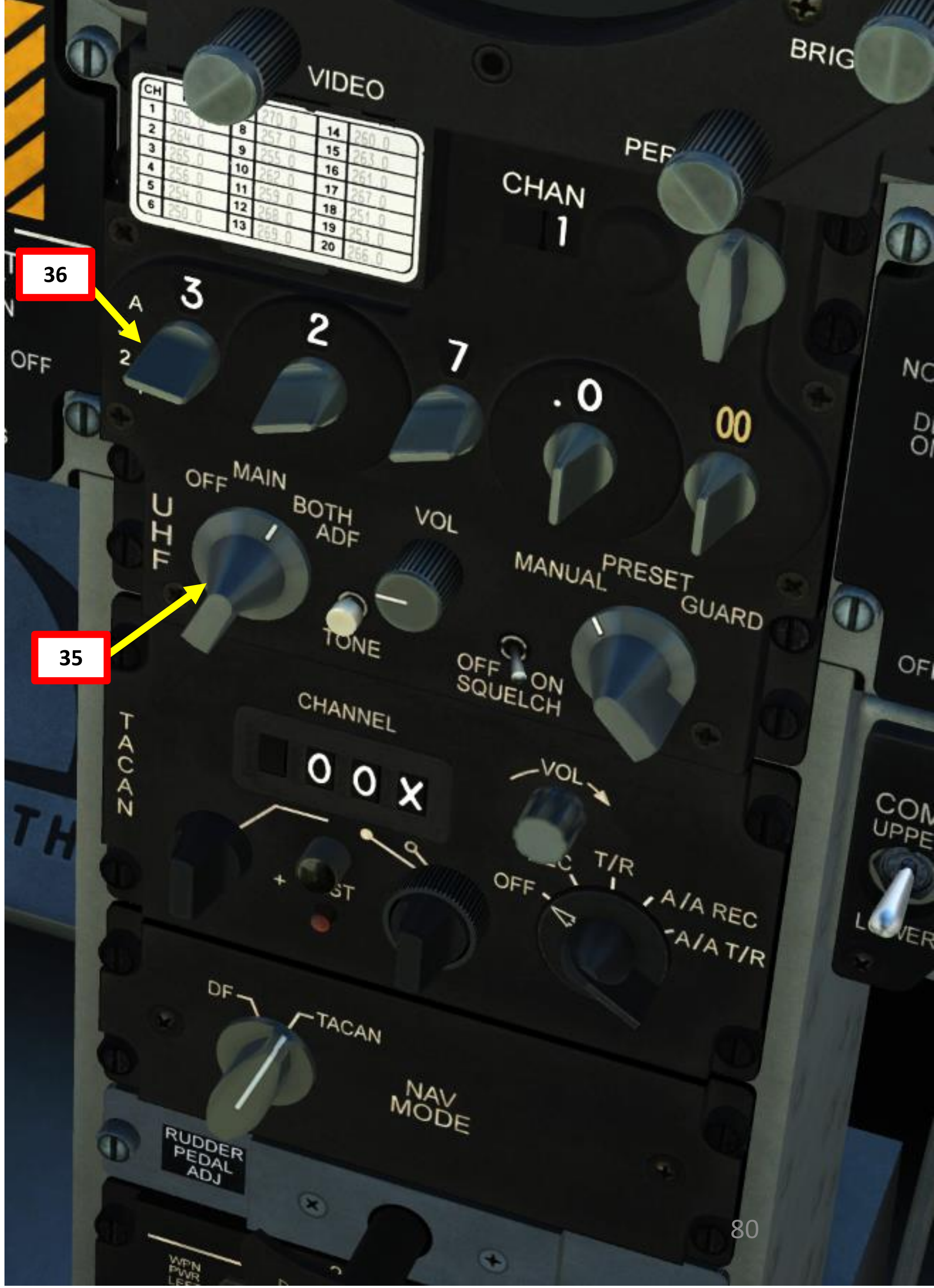
32. Set Exterior Navigation Lights Control Knob – BRT.
33. Set Formation Lights Control Knob – BRT.
34. Set Beacon Switch – FWD (ON).




# POST-START

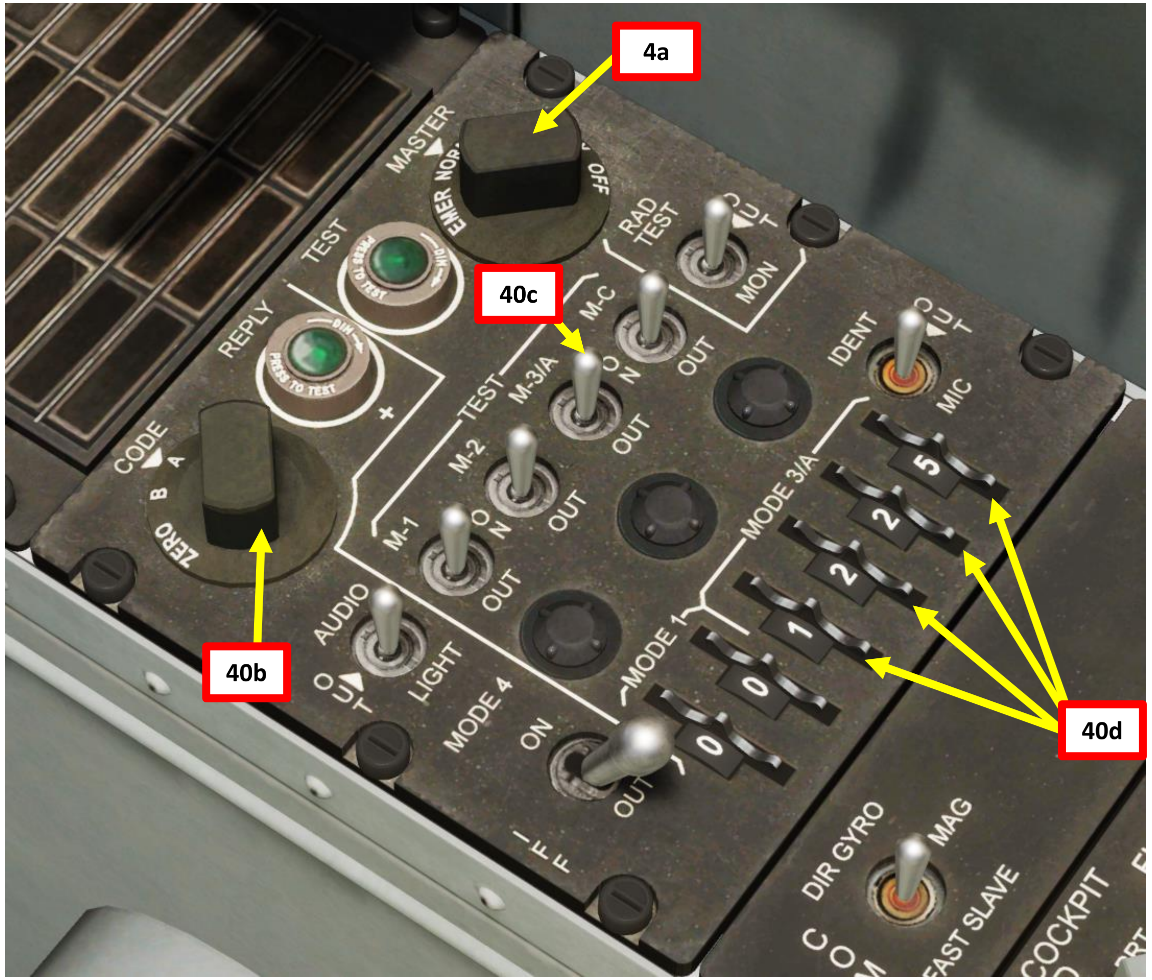
35. Set UHF Radio Mode Selector – BOTH (ON).
36. Set UHF Radio Frequency – As Required.
37. Set radar MODE switch to STBY (Standby).
    - **Caution**: Radar will proceed to a warm-up phase. Radar can overheat after more than 10 minutes spent on the ground. Make sure you are taking off in less than 10 minutes or **simply set the radar MODE switch to OFF** and set it back to STBY before takeoff (recommended).
38. Set Chaff Selector – Single
39. Set Flare Selector – Single



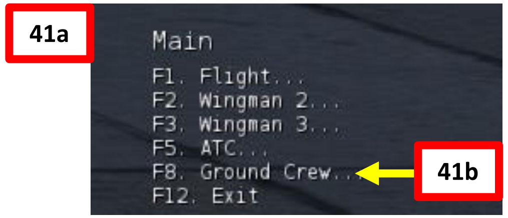
# POST-START

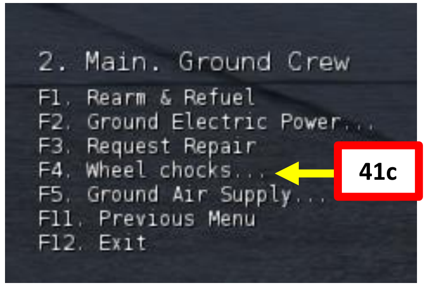
40. Set your IFF (Identify-Friend-or-Foe) Transponder Code – As required by mission briefing. As an example, if we need a IFF Transponder set to Mode 3/A Code 1225:
    a) Set IFF Master Switch to NORMAL
    b) Set IFF Code Selector to A
    c) Set IFF Mode 3/A Switch – MIDDLE (ON)
    d) Set IFF MODE 3/A Channel Wheel Selectors to "1225".

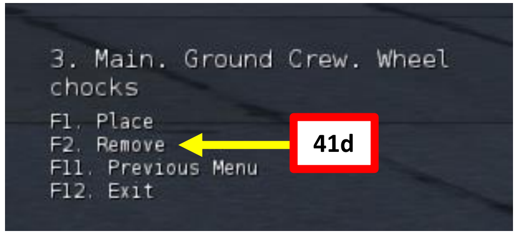


# POST-START

41. Remove Wheel Chocks by pressing:
    a) "/"
    b) "F8 – GROUND CREW"
    c) "F4 – WHEEL CHOCKS"
    d) "F2 – REMOVE"



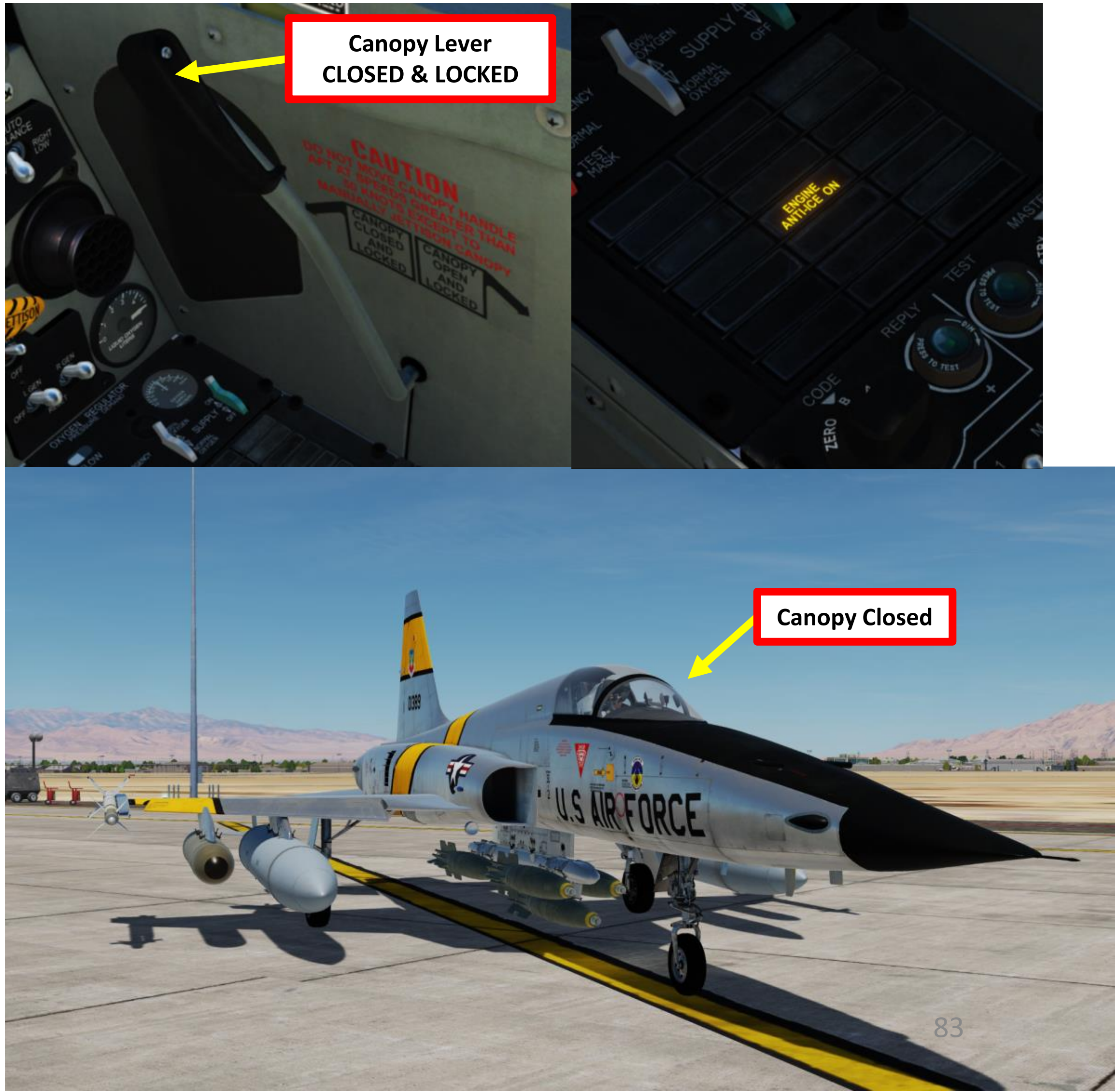





# POST-START

42. Close and Lock Canopy (Lever FWD).

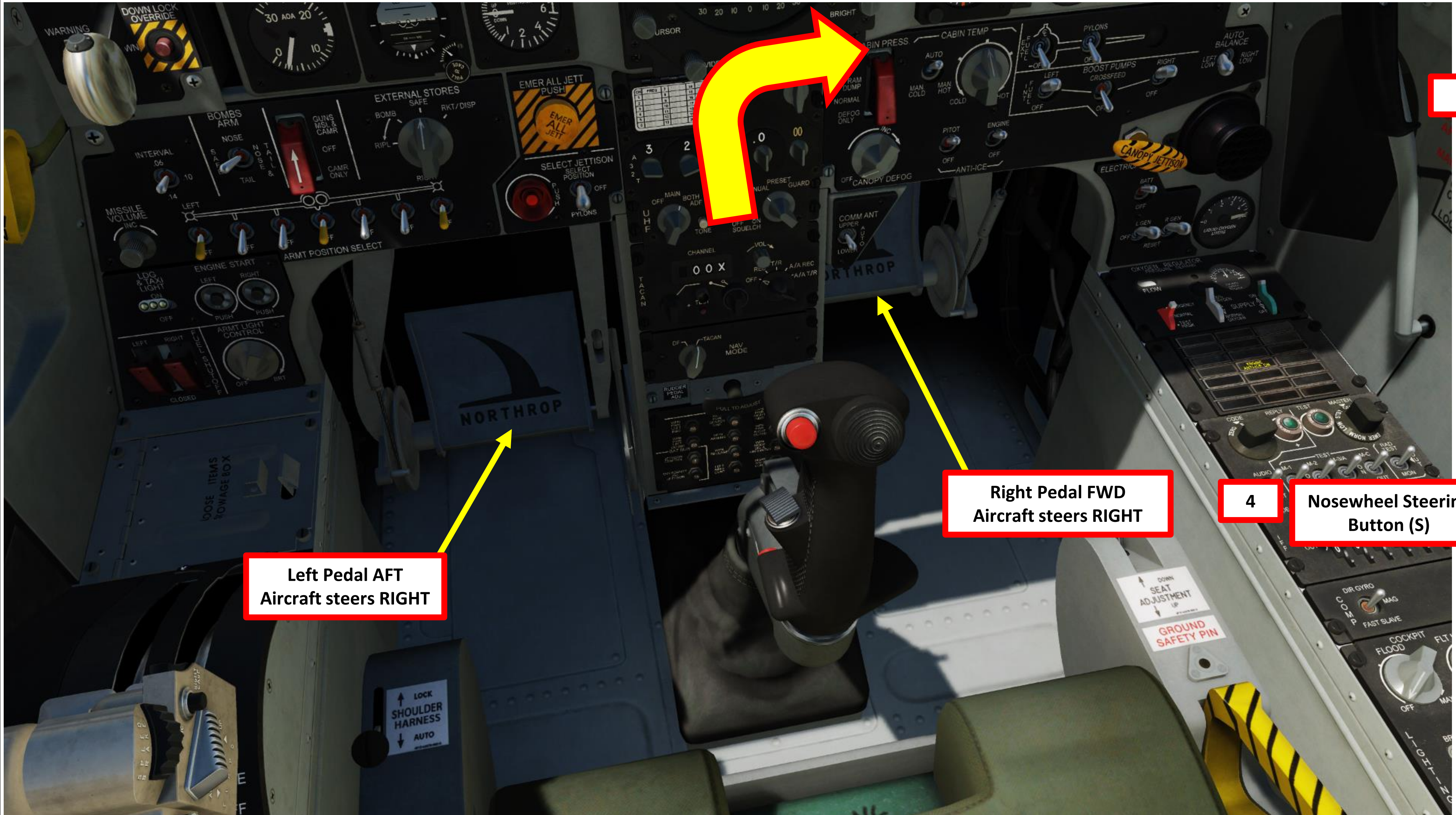



# POST-START

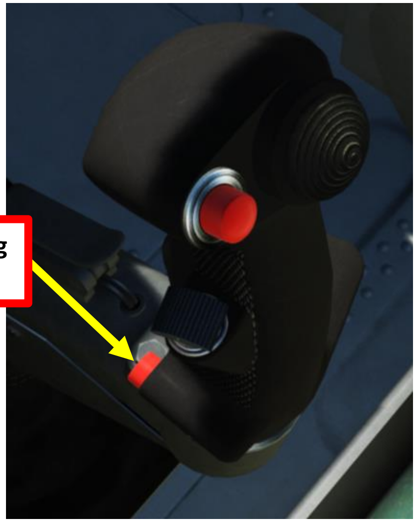
43. You are now ready to taxi. Request clearance to the tower, then proceed to the runway.

# TAXI

1. Set Landing & Taxi Lights Switch – ON (UP)
2. Verify that wheel chocks have been removed.
3. Taxi the aircraft by throttling up to 65-70 % RPM.
4. Steer the aircraft by **holding** the Nose Wheel Steering button ("S" key binding) as you turn using the rudder pedals. Steering direction is kept by the nosewheel steering mechanism and can be adjusted by deflecting respective pedal.
5. Brakes are operated by conventional toe-type brake pedals.







# TAXI

6. Taxiing speed is controlled by means of the throttles and main wheel toe brakes so as to avoid aircraft roll-over during its steering. Keep throttles at approximately 55-60 % RPM during taxiing, which should give you a speed of 10-15 kts on the ground.

# TAKEOFF

1. Once takeoff clearance has been obtained from the Tower, line up on the runway.
2. Set Landing & Taxi Lights Switch – OFF (DOWN)
3. Consult takeoff performance table below to obtain your rotation speed. For a configuration of about 24,000 lbs, our rotation speed will be about **190 kts**.
4. Check that takeoff elevator pitch trim is set as per the Takeoff Trim Setting table below.


**Takeoff Pitch Trim Setting**

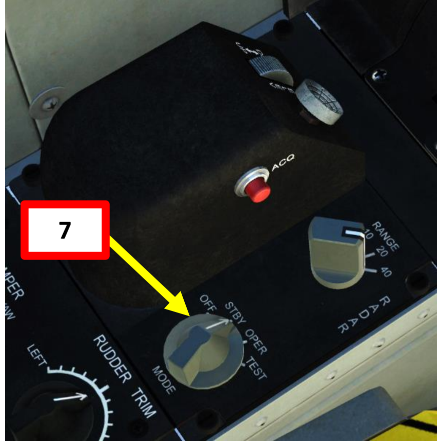
- **No gun ammo & no stores: 6**
- **Drop tanks + gun ammo + missiles: 7**
- **Drop tanks + gun ammo + missiles + bombs + rockets: 8**
- **Gun ammo + missiles + bombs + rockets + containers: 9**


## Takeoff Performance Table

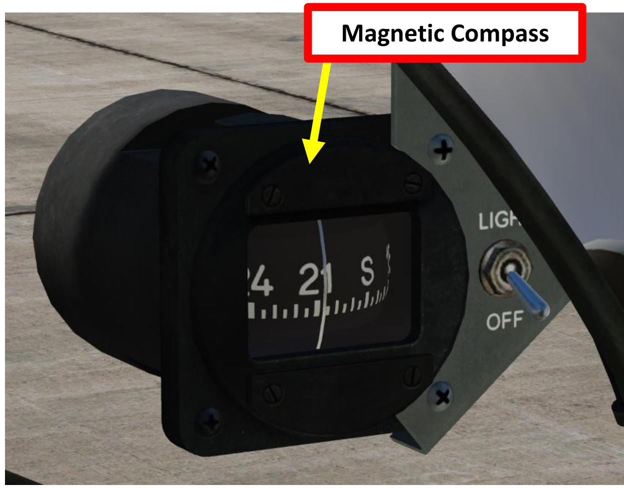
| Takeoff weight (lbs) | Stores, ammo | Center-of-Gravity Position<br>% MAC (Mean Aerodynamic Chord) | Liftoff Speed (kts) |
|---|---|---|---|
| 15,000 | None | 18 to 17 | 143 to 145 |
| 15,500 to 16,000 | Gun ammo + Missiles | 14 to 13 | 153 to 155 |
| 17,000 to 18,000 | Central fuel tank + gun ammo + missiles | 12 to 11 | 164 to 168 |
| 19,000 | 3xFuel Tanks 150 + gun ammo + missiles | 15 to 14 | 166 to 168 |
| 19,000 to 21,000 | Bombs + rockets + Central fuel tank + gun ammo + missiles | 15 to 14 | 168 to 175 |
| 22,000 | 3xFuel tanks 275 + gun ammo + missiles | 15 to 13 | 178 to 180 |
| 23,000 and more | Bombs + rockets + gun ammo + missiles | 15 to 14 | 185 to 190 |

# TAKEOFF

5. Ensure you align yourself with the runway and advance a couple of yards to keep your nose wheel straight and aligned.
6. Check that Magnetic Compass and HSI (Horizontal Situation Indicator) both display the correct runway heading, which should be approximately 210 in our case.
7. Set Radar MODE switch to STBY (Standby).

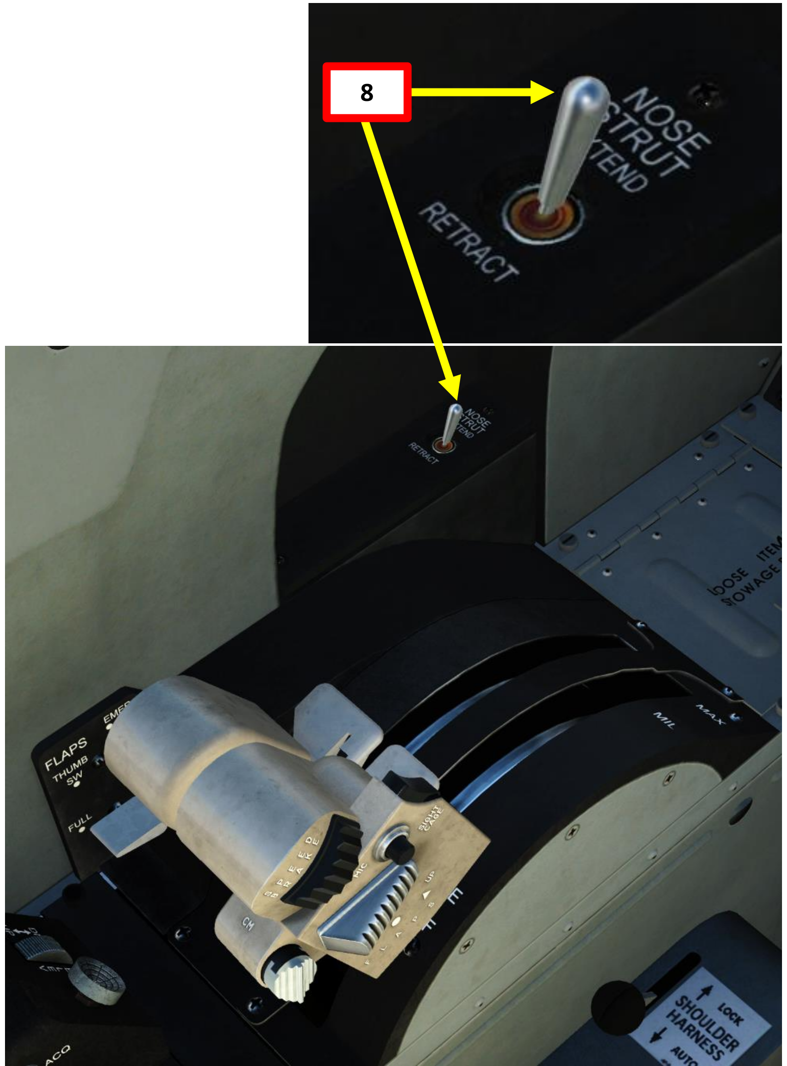







# TAKEOFF

8. Set NOSE STRUT switch to EXTEND to gain an additional 3 units of Angle of Attack, minimizing the runway length required for takeoff.
9. Set flaps to AUTO and ensure airbrakes are retracted.





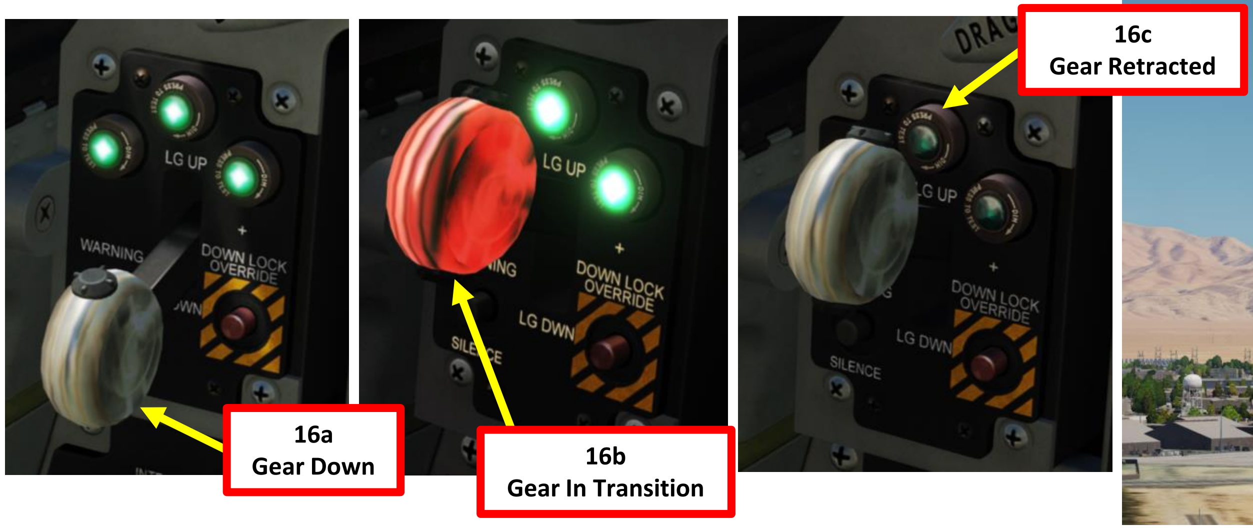
# TAKEOFF

10. Center the rudder pedals.
11. Hold down brakes, increase throttle to 95 % RPM.
12. Release brakes and start rolling.
13. As the aircraft gains speed, set throttle fully forward to engage afterburners.
14. Rotate at the required rotation speed obtained from the takeoff performance (190 kts for a 24,000 lbs takeoff weight configuration) by gently pulling the stick aft.
15. Upon liftoff, ensure positive climb rate is achieved by maintaining angle of attack so that airspeed and altitude keep increasing.



# TAKEOFF

16. When a positive rate of climb is achieved, raise Landing Gear Lever.






# TAKEOFF

17. Throttle back to MIL (Military) Power detent, then adjust power and aircraft attitude to maintain a climb speed of 300 kts minimum.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# NORMAL 360-DEGREE LANDING APPROACH

1. Start approach 3 nm from airport @ 1500 ft and 300 kts
2. Start reverse landing course @ 1500 ft and 300 kts
3. Set flap thumb switch to AUTO
4. Extend landing gear
5. Ensure green lights indicate landing is on downlock
6. Decelerate to 165 kts while maintaining 1500 ft. Use speed brakes if necessary.
7. Carry out turning to the landing course @ 1500 ft and 165 kts
8. Descend at a rate of 1000 ft/min and slow down to a final approach speed of 145 kts.

## APPROACH SPEED FORMULA:

$V_{APPROACH}$ = 145 + 5 (if gun ammo remaining) + (fuel qty remaining – 1000)/200

Example for approach with 3000 lbs remaining with gun ammo

$V_{APP}$ = 145 + 5 + (3000 - 1000)/200 = 160 kts

Example for approach with 600 lbs remaining without gun ammo

$V_{APP}$ = 145 + 0 + (600 - 1000)/200 = 143 kts



Landing Pattern

# NORMAL 360-DEGREE LANDING APPROACH

9. On final, decrease vertical speed to 400 ft/min.

# NORMAL 360-DEGREE LANDING APPROACH

10. Trim aircraft pitch to set a ON SPEED Angle of Attack. Use the AoA Indexer as a reference (green doughnut = On Speed) and the AoA Indicator (units), which should be at the 3 o'clock position.


AoA (Angle of Attack) Indicator (units)


AoA (Angle of Attack) Indexer Table

| | | | |
|---|---|---|---|
|  |  |  | Slow |
|  |  |  | Slightly slow |
|  |  |  | On-speed |
|  |  |  | Slightly fast |

# NORMAL 360-DEGREE LANDING APPROACH

11. Flare at 20 ft by gently pulling the stick aft and touchdown at 135 kts.

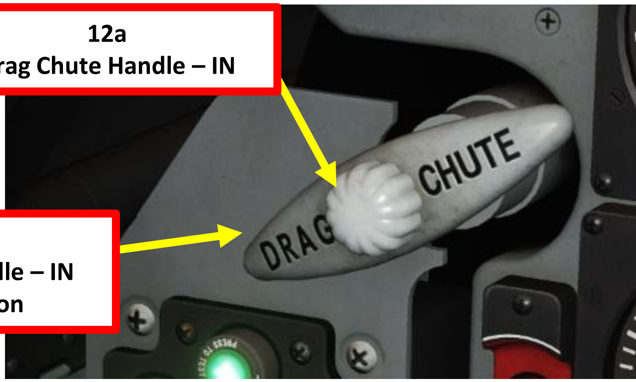
# NORMAL 360-DEGREE LANDING APPROACH

12. Slowly lower the nose wheel and deploy drag chute by pulling the drag chute handle (shortcut: “P” binding).

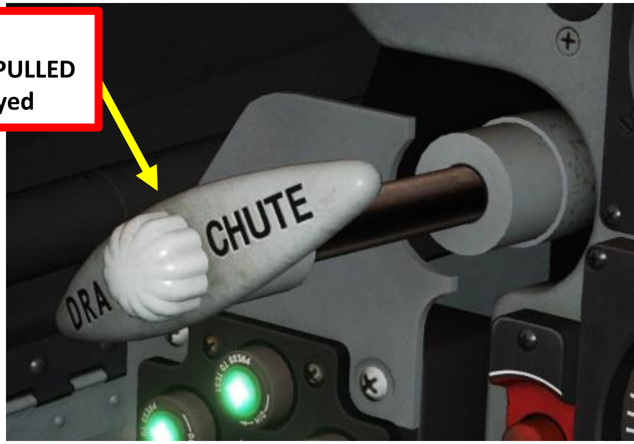
**12b**
**Drag Chute Handle – PULLED**
**Drag Chute Deployed**


**12a**
**Drag Chute Handle – IN**

**12d**
**Drag Chute Handle – IN**
**Reset Position**




**12b**
**Drag Chute Handle – PULLED**
**Drag Chute Deployed**




**12c**
**Drag Chute Handle – TURNED & PULLED**
**Drag Chute Released**

# NORMAL 360-DEGREE LANDING APPROACH

13. Tap your toe brakes until you come to a full stop.
14. Taxi back to the parking area.

# AERODYNAMICS

The F-5’s flight qualities are very good for a plane of this time. It’s a high-performance multipurpose tactical fighter with a primary mission of air superiority. It is equipped with wing leading and trailing edge flaps, which provide increased lift and improved maneuvering performance. However, during acceleration flaps are retracted in order to reduce drag and to provide better acceleration. At high Mach numbers, particularly at 0.9-0.95 for clean aircraft or near limiting Mach numbers for aircraft with stores, pitch control sensitivity increases.

At the airspeeds above 360 KIAS the airplane is able to reach structural limiting normal load while below 360 KIAS attainable g's are limited by the stall AOA. For the F-5E-3 with shark-nose forebody and increased-area LEX wing stall occurs at approximately 27-28 units AOA and is accompanied by the wing-rock or by the wing-drop depending on flight conditions and configuration. At lower airspeeds airplane maneuvering performance rapidly degrades so it is recommended not to let the airspeed fall below 300 KIAS while maneuvering. This requirement can be neglected during maximum range gliding, landing approaches and when performing tactical maneuvers which involve flying at low airspeeds/high AOA.

# PROHIBITED MANOEUVERS

- Inverted spins
- Exceeding 28 units AOA, read on corresponding gauge, during maneuvering.
- Exceeding 20 units AOA with centerline store installed or with asymmetrically installed stores (regardless of flap position)
- Multiple barrel rolls
- Exceeding negative 2 G with speed brake extended
- 360-degree full deflection aileron rolls at load factors greater than 5 g without pylon stores or 1 g with pylon stores.
- Abrupt full deflection of rudder with empty 275-gallon centerline external tank
- Abrupt full deflection of rudder with empty 150-gallon centerline external tank at airspeeds above 400 KIAS
- Sharp full deflection of rudder or full roll stick input with outboard external load

# FLIGHT LIMITATIONS

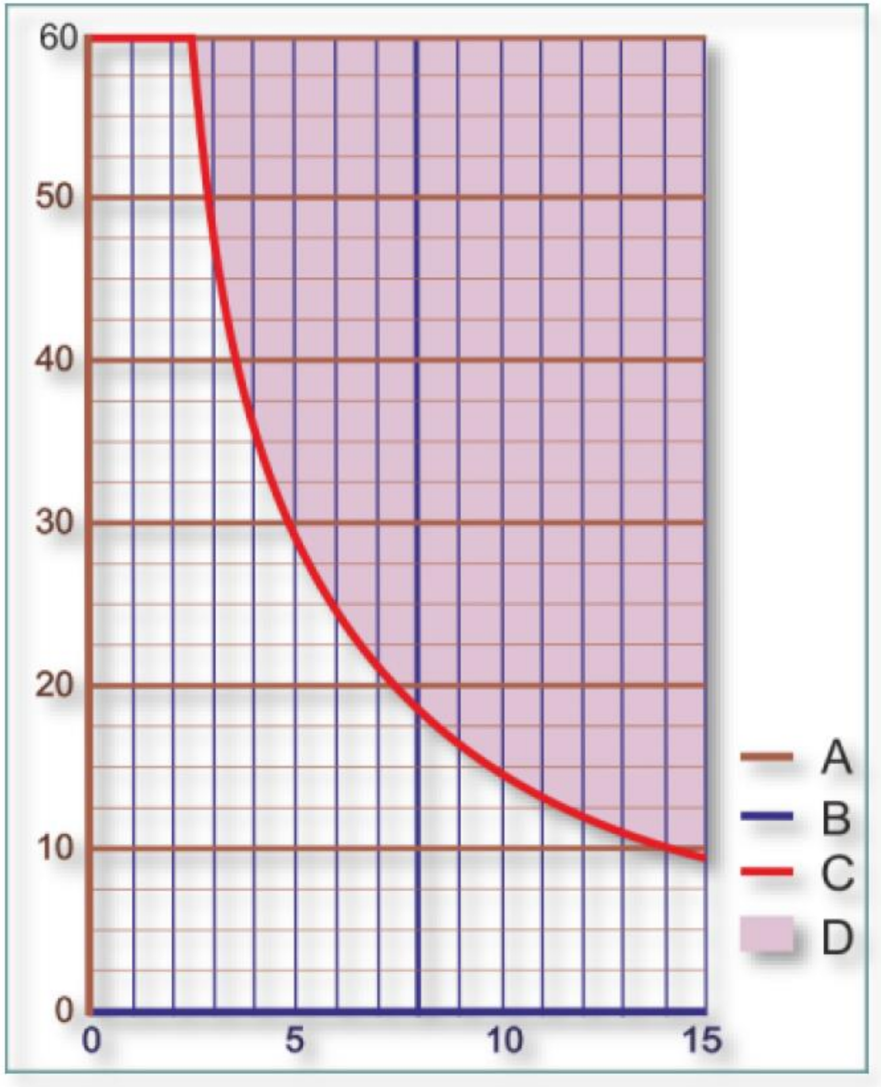
| Aircraft Flight Limits | | |
|---|---|---|
| Maximum taxiing speed with open canopy | 50 KIAS | Strength of the canopy hinges in open position |
| Maximum Drag chute deployment speed | 180 KIAS | Strength of Drag Chute release mechanism.<br>Drag Chute is deployed after nosewheel lowering. |
| Maximum landing gear extension speed | 260 KIAS | Strength of landing gear door hinges. |
| Maximum landing light retraction speed | 300 KIAS | Retraction force of the light retraction mechanism |
| Maximum nosewheel steering engagement speed | 65 KIAS | Taxiing safety (possibility of flipping over the airplane) |
| Maximum crosswind component during landing | • 20 kts (10 m/s) with drag chute<br>• 35 kts (18 m/s) without drag chute | Yaw stability during roll. Possibility of veering off the runway. |
| Recommended descent rates on the glide path before landing | • Airplane has less than 3700 pounds of fuel: 600 feet per minute (400 feet per minute at crosswind)<br>• Airplane has more than 3700 pounds of fuel: 360 feet per minute (300 feet per minute at crosswind) | Main landing gear strength.<br>Decrease in descent rate due to increased weight is conditioned by increased translational speed, required for maintaining specified angle of attack during landing approach. |
| Maximum takeoff run ground speed | 230 KIAS | Wheel tires strength. |
| Maximum airspeed without pylons (with missiles on wingtip launchers) | 710 KIAS or Mach 2.0 | Mach 2.0 can be achieved during descending |
| Maximum G without pylons (with missiles on wingtip launchers) | +7.3 G / -3,0 G | |
| Maximum speed with one centerline external tank | 650 KIAS or Mach 1.4 | |
| Maximum speed with load on inboard (or outboard) pylons and centerline external tank | 600 KIAS or Mach 1.2 | |
| Maximum speed with three external tanks (150- gallon tanks on wing pylons) | 560 KIAS or Mach 1.2 | |
| Maximum speed with wing weapon stores and centerline external tank | 520 KIAS or Mach 0.85 | |
| Maximum G with stores | +6.5 G / -2.0 G | |
| Maximum speed with armament on outboard pylons and external tanks (275 gallons) on inboard pylons.<br>Note: If external tanks are empty, the same limitations are applicable, as those that apply | 450 KIAS or Mach 0.8 | |
| Maximum G with loaded external weapon stores and inboard external tanks (275 gallons). | +4 G / -1.5 G | |

# FLIGHT LIMITATIONS

## Fuel System Limitations

| | | |
|---|---|---|
| Less than 650 pounds of fuel in either system | Avoid steep descending at high engine RPM<br>At high fuel flow rates (more than 6000 pph) CROSSFEEDING should be off | Can result in engine flameout due to low remaining fuel level |
| Boost pumps are off (inoperative) | Avoid fuel flow rates above 9800 pph at altitudes above 25,000 feet | Can result in engine flameout |
| Sustained 0-G flight | Avoid such flight conditions at high engine RPM | Can result in engine flameout |
| Negative-G | See negative G engine flameout region chart. | Exceeding the operation time limitations can result in engine flameout |

## Negative G Engine Flameout Region




A: Allowable time in negative G (sec)
B: Indicated fuel flow, per engine (x1000 lbs/hour)
C: Engine oil system limit (sec)
D: Engine Flameout Area

# FLAPS

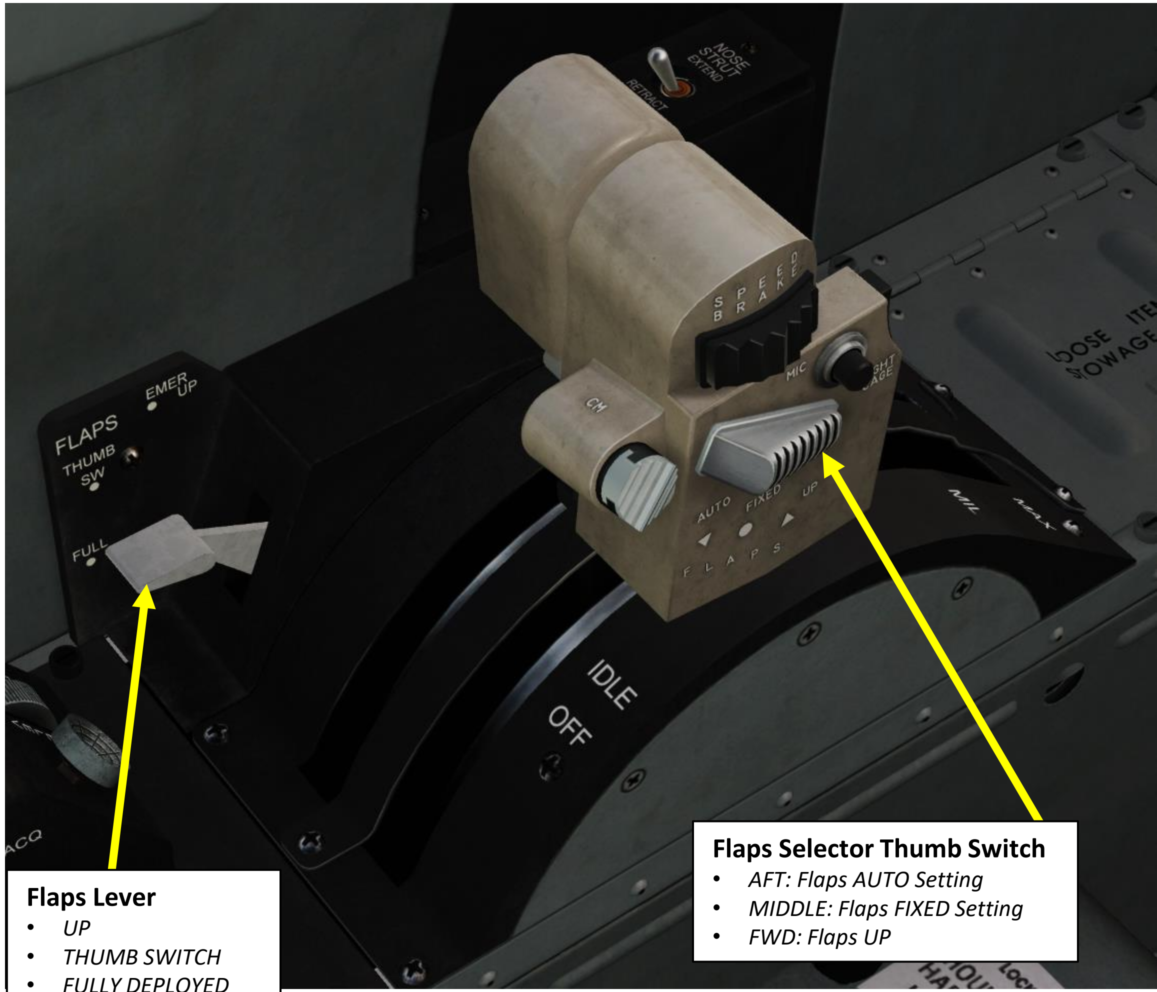
The F-5 is equipped with an automatic flaps system. The left and right leading edge flaps and the left and right trailing edge flaps are mechanically interconnected to prevent their asynchronous operation, and mechanically interconnected to the horizontal tail to maintain pitch trim during flaps operation.

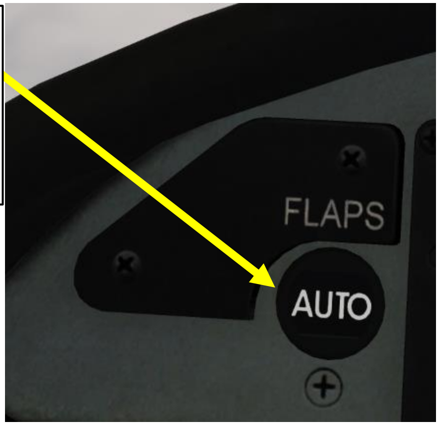
# FLAPS

The flap system has the following control modes:

- **FULL**: Flaps fully extended
- **EMERGENCY UP**:  Flaps fully retracted
- **THUMB SWITCH**: Control of flaps is done with thumb switch instead. The THUMB SWITCH on the throttle has three sub-modes:
    - **AUTO**: Flaps operate automatically based on your Angle of Attack (AOA) and the signals from the CADC (Central Air Data Computer).
        - With AUTO selected, flaps are automatically positioned depending on AOA and/or signals from the CADC. The flaps can be positioned to 0°/0°, 12°/8°, 18°/16° or 24°/20°. Above 550 KIAS or Mach 0.95, the CADC prevents extension of the flaps regardless of AOA and an audible warning signal will sound if the flaps remain extended approaching this speed.
    - **FIXED**: Flaps in fixed position, ensuring minimum fuel consumption. In fixed flaps setting, flaps are automatically positioned by the CADC:
        - 12°/8° position – when flying at altitudes below 32,000 feet above sea level
        - 0°/8° position – when climbing through 32,000 feet (±2000 feet)
        - 12°/8° position – when descending through 28000 feet (±2000 feet)
        - 0°/0° position – when approaching 550 KIAS or Mach 0.95, regardless of altitude.
    - **UP**: Flaps fully retracted, ensuring maximum flying range.

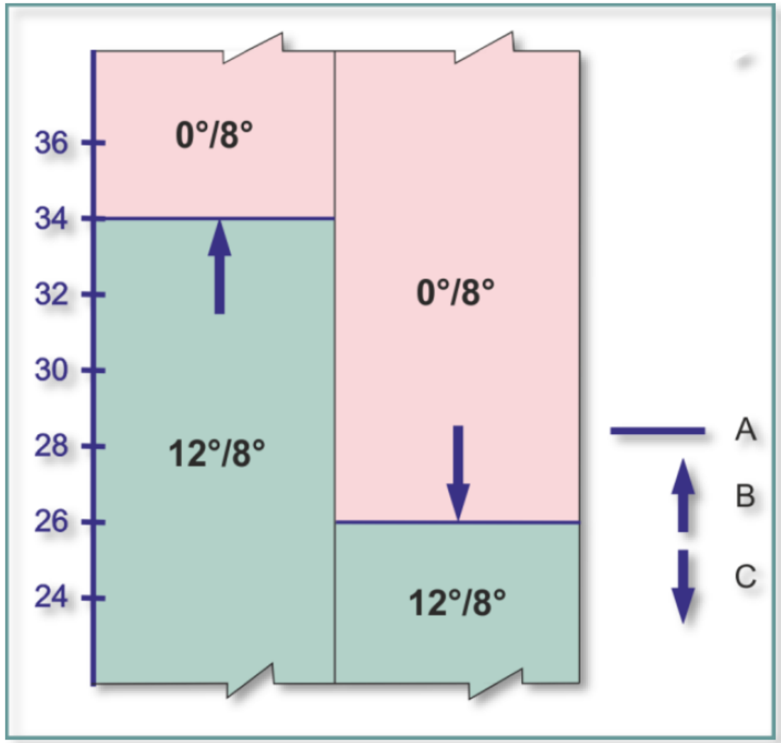
I usually recommend to set the flaps lever to THUMB SWITCH and the thumb switch to AUTO mode. It is much more efficient to let the flaps control themselves automatically and reduces your workload significantly.



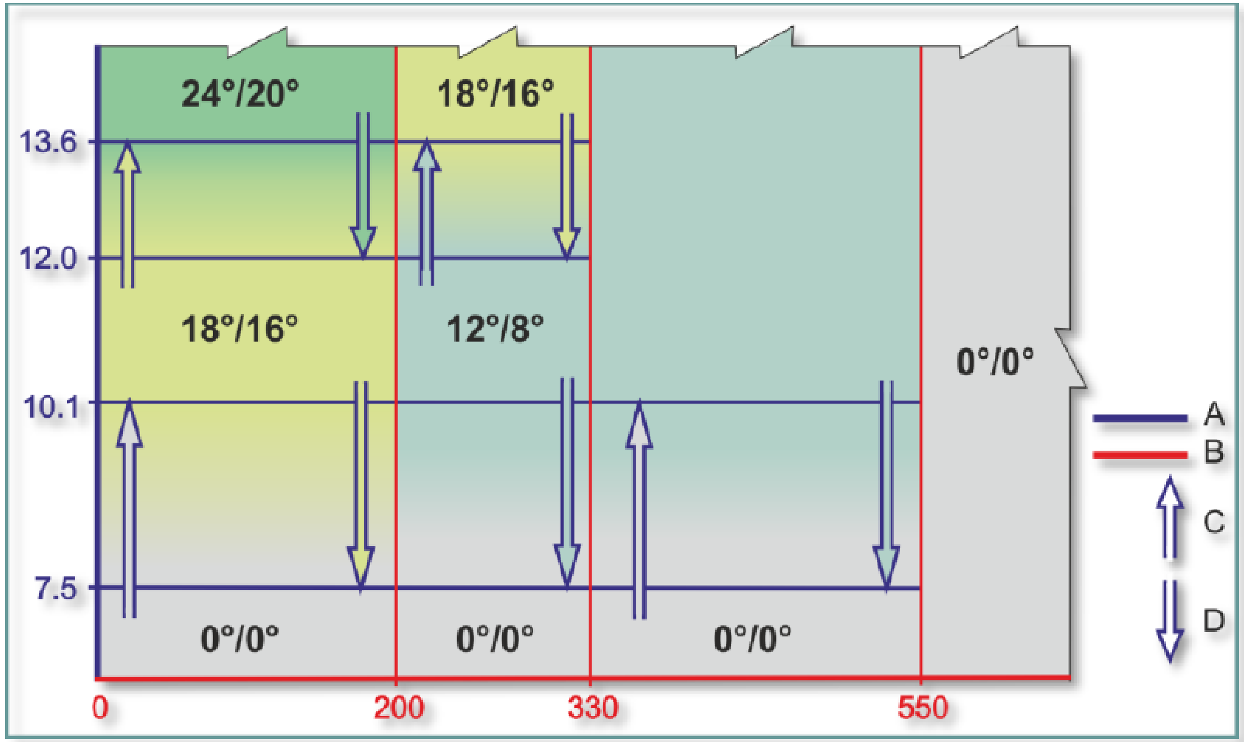
# FLAPS

Here is an overview of flap shift scheduling in “Fixed” and “Auto” modes.




Fixed Flap Shift Schedule

A: Altitude (x1000 ft)
B; Flap Position during Climbing (deg)
C: Flap Position during descending (deg)




Auto Flap Shift Schedule

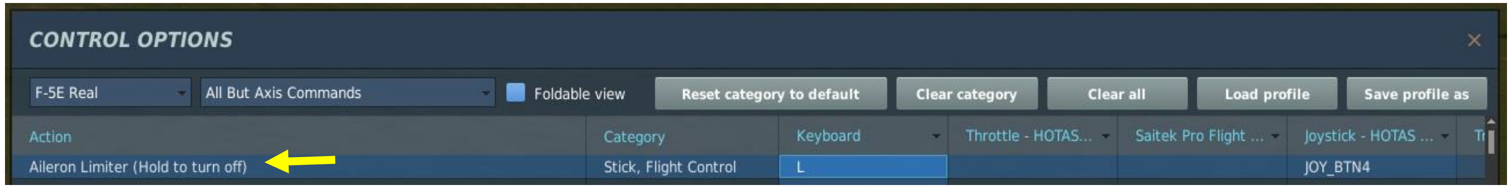
A: Indicated Angle-of-Attack (units)
B: Indicated Airspeed (KIAS)
C: Increasing Angle-of-Attack
D: Decreasing Angle-of-Attack

# AILERON DEFLECTION LIMITER

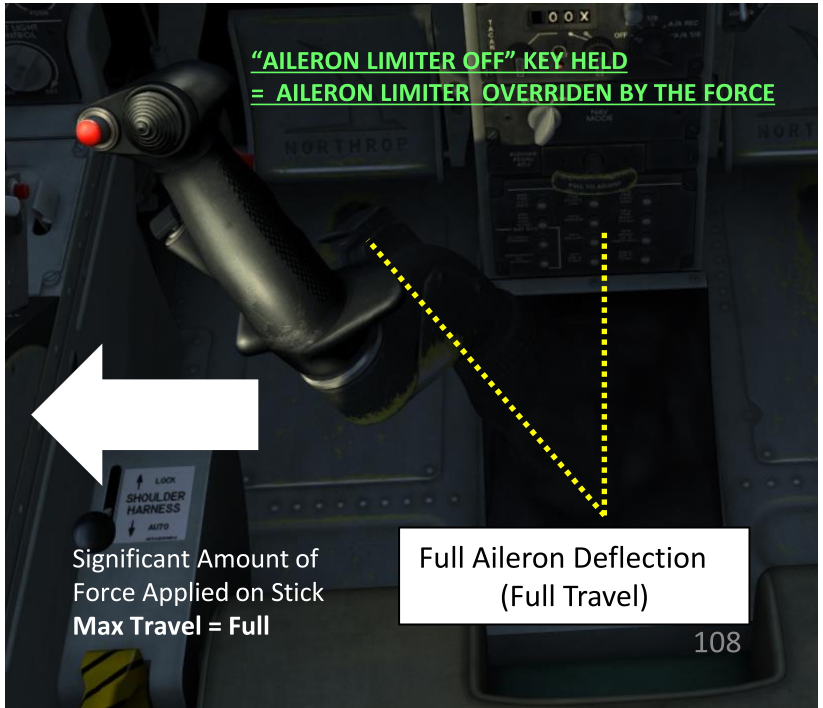
An aileron limiter, which is mechanically positioned by retraction of the landing gear, provides a spring stop which limits the aileron to one-half travel (as shown on image B). To obtain full aileron travel, additional stick force must be applied to override the aileron spring stop. The aileron limiter is disengaged when the landing gear is in the extended position, allowing full aileron travel.

In other words, an aileron limiter will mechanically limit your stick movement in order to protect the aircraft against G-overload in normal manoeuvering conditions. This will limit your roll rate. The limiter can be overridden if you apply if you force a little more on the stick; this will allow you to have a much faster roll rate. In real life, the limiter's primary function is used for stall recovery, emergencies and violent manoeuvers that could be necessary during a dogfight.

Most users equipped with a force-feedback stick will immediately notice the difference in the force needed to move the stick from neutral to half-travel and the force needed to move the stick from half-travel to full-travel. However, the majority of users do have a standard non-force-feedback stick. In order to simulate this behaviour, Belsimtek implemented a control that will allow full aileron travel: AILERON LIMITER (HOLD TO TURN OFF), mapped to the "L" key. Simply hold this key and you will "virtually" apply enough strength on the stick to override the aileron limiter and perform full stick (aileron) deflection, allowing you to have a much greater roll rate.



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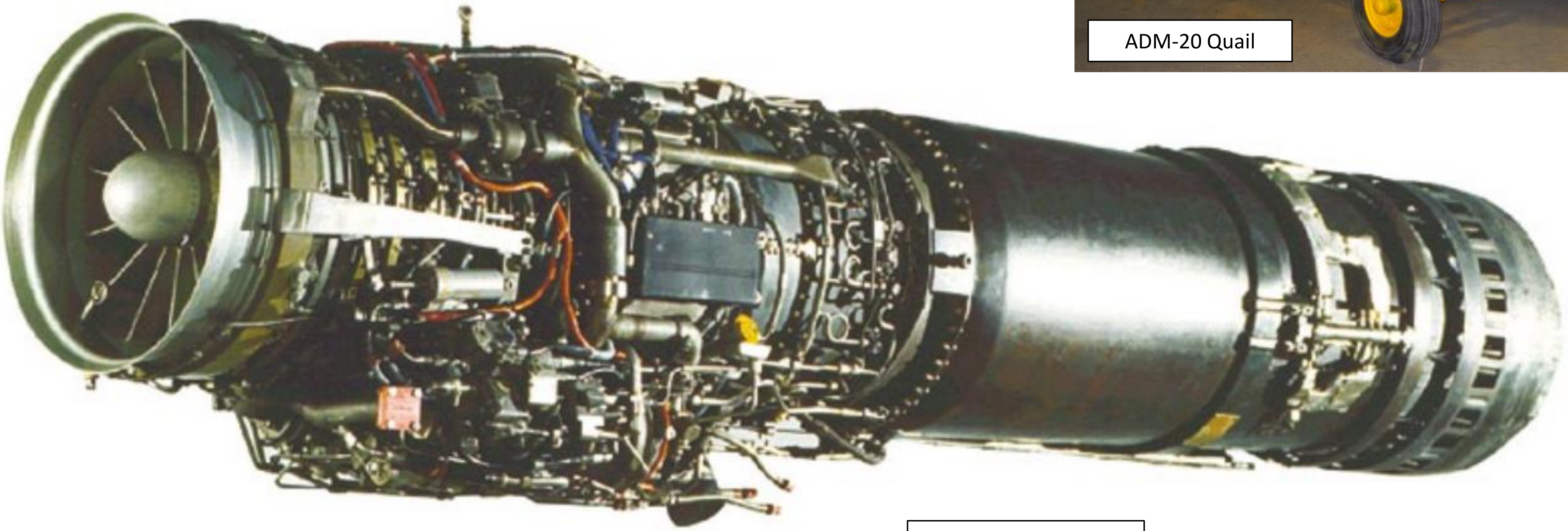
# GENERAL ELECTRIC J-85-GE-21 ENGINE

The F-5 is powered by two **J85-GE-21 turbojet engines**, which were designed and manufactured by General Electric Company USA. The J-85 is a compact, high performance, lightweight turbojet engine comprising a nine-stage axial-flow compressor coupled directly to a two-stage turbine and an afterburner with a variable area exhaust nozzle.

The J85 was originally designed to power a large decoy missile, the McDonnell ADM-20 Quail. The Quail was designed to be released from a B-52 Stratofortress in-flight and fly for long distances in formation with the launch aircraft, multiplying the number of targets facing the SA-2 surface-to-air missile operators on the ground. This mission demanded a small engine that could nevertheless provide enough power to keep up with the jet bomber. Like the similar Armstrong Siddeley Viper being built in England, the engine on a Quail drone had no need to last for extended periods of time, so therefore could be built of low-quality materials.

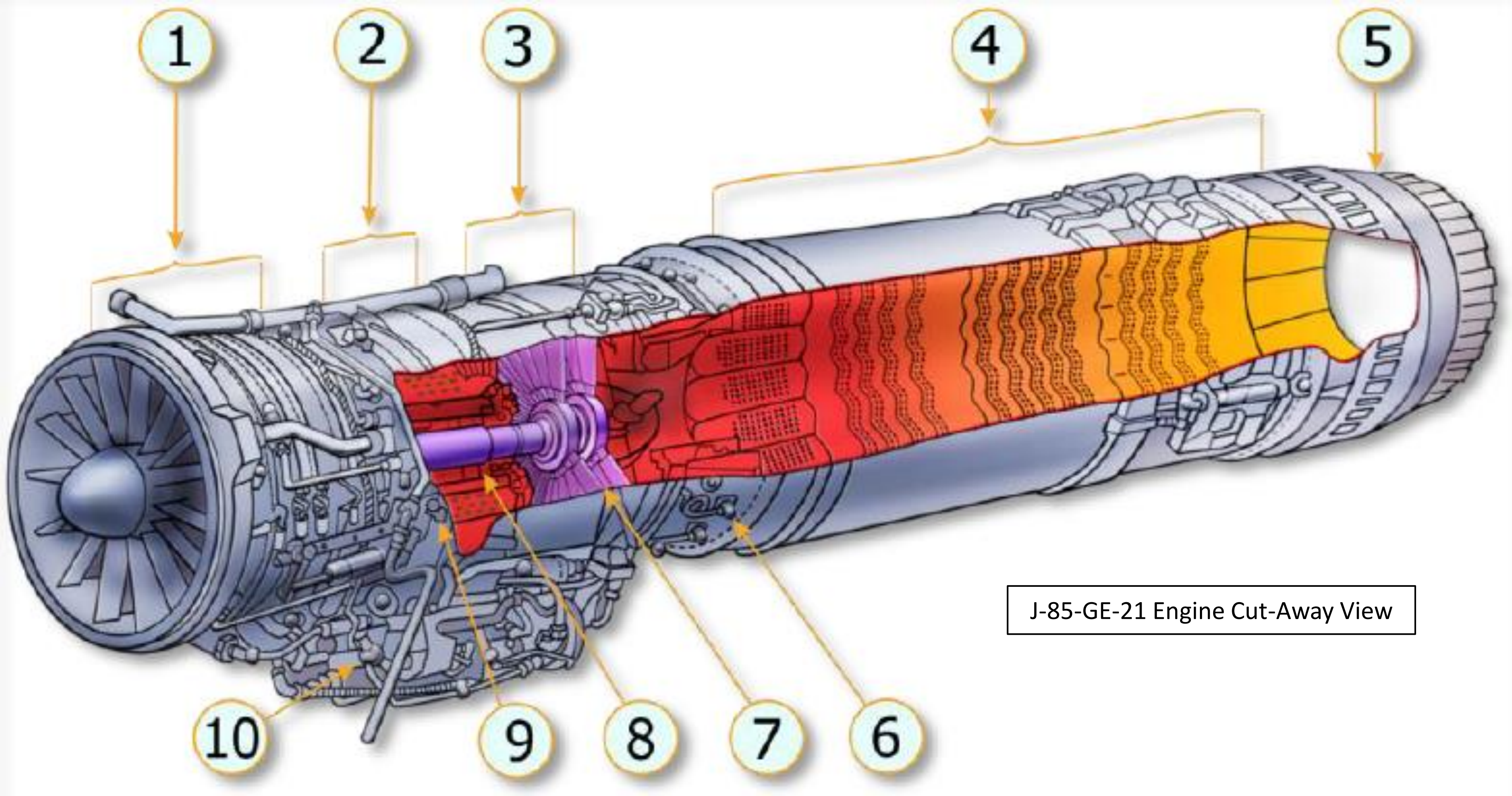

ADM-20 Quail


J-85-GE-21 Engine

# GENERAL ELECTRIC J-85-GE-21 ENGINE

Air enters into a compressor through air inlet ducts located on the both sides of the fuselage. The nine-stage compressor is equipped with variable stator vanes that reduce the possibility of a compressor stall. This has a significant effect on simulation of the idle power and engine starting. Inlet guide vanes are heated by hot air to prevent their icing. In addition, compressed hot air bled from the compressor provides heating of the fuselage nose (with the radar antenna) and canopy windshield. Cooled compressor bleed air provides pressurization to the anti-G suit and external fuel tanks.

The compressor is coupled directly with a two-stage turbine. Exhaust gases from the combustor section passes through the turbine and drives the engine rotor, afterwards, the hot gases are dumped into a variable exhaust nozzle. Each engine is equipped with an accessory gearbox that operates a hydraulic pump and an AC generator. Automatic gearbox shift occurs in the 68% to 72% engine rpm range.



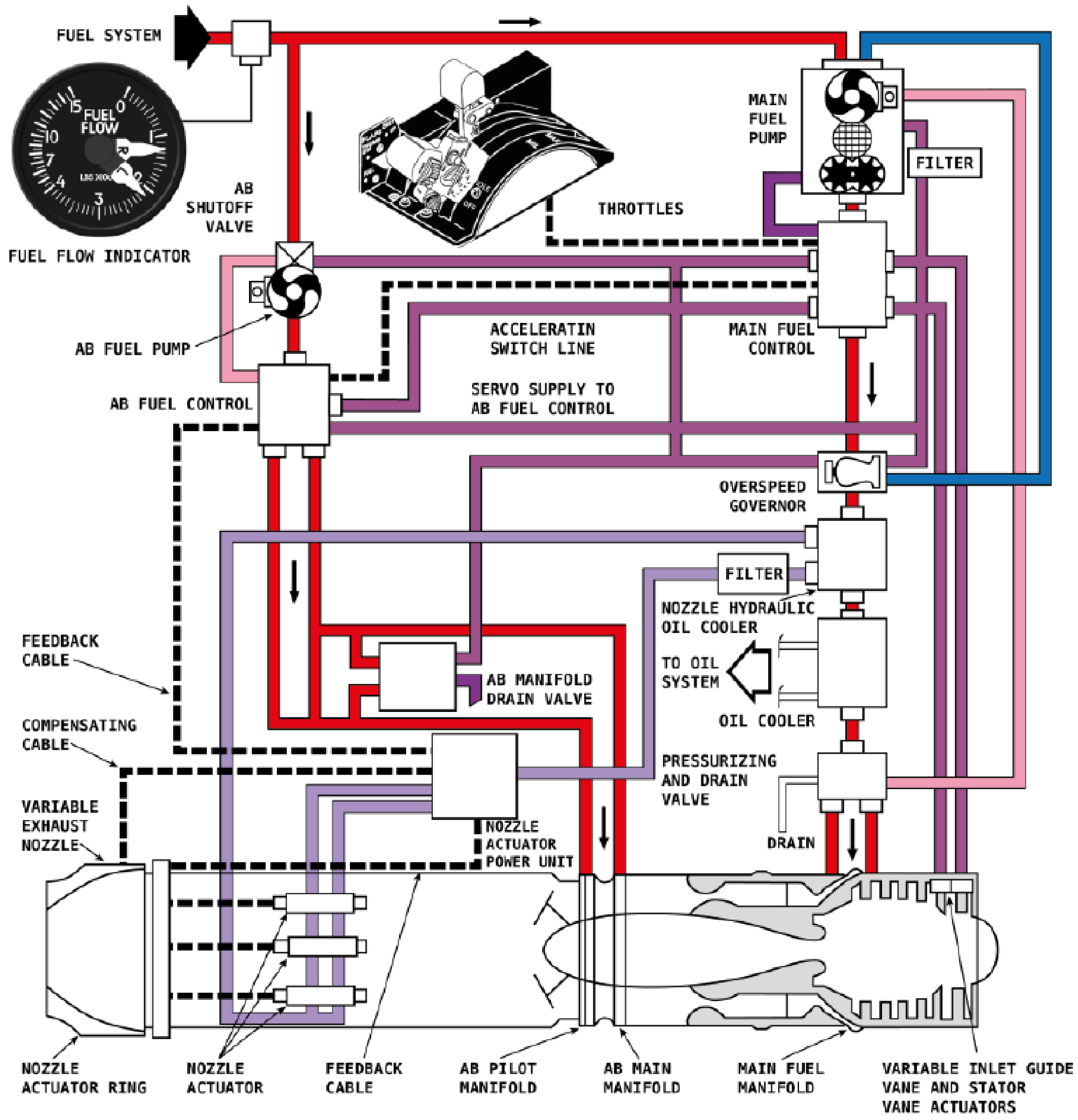

J-85-GE-21 Engine Cut-Away View

1. Compressor Section
2. Combustor Section
3. Turbine Section
4. Afterburner Section
5. Variable Exhaust Nozzle
6. Afterburner Main Fuel Manifold
7. Turbine
8. Rotor
9. Fuel Nozzles
10. Engine Accessory Gearbox

# ENGINE SYSTEM OVERVIEW

- FUEL FLOW
- FUEL PRESSURE
- FUEL FLOW TRANSMITTER
- FUEL BOOST PUMP PRESSURE
- ELECTRICAL ACTUATION
- HYDRAULIC ACTUATION
- MECHANICAL ACTUATION
- OVERSPEED GOVERNOR BYPASS PRESSURE

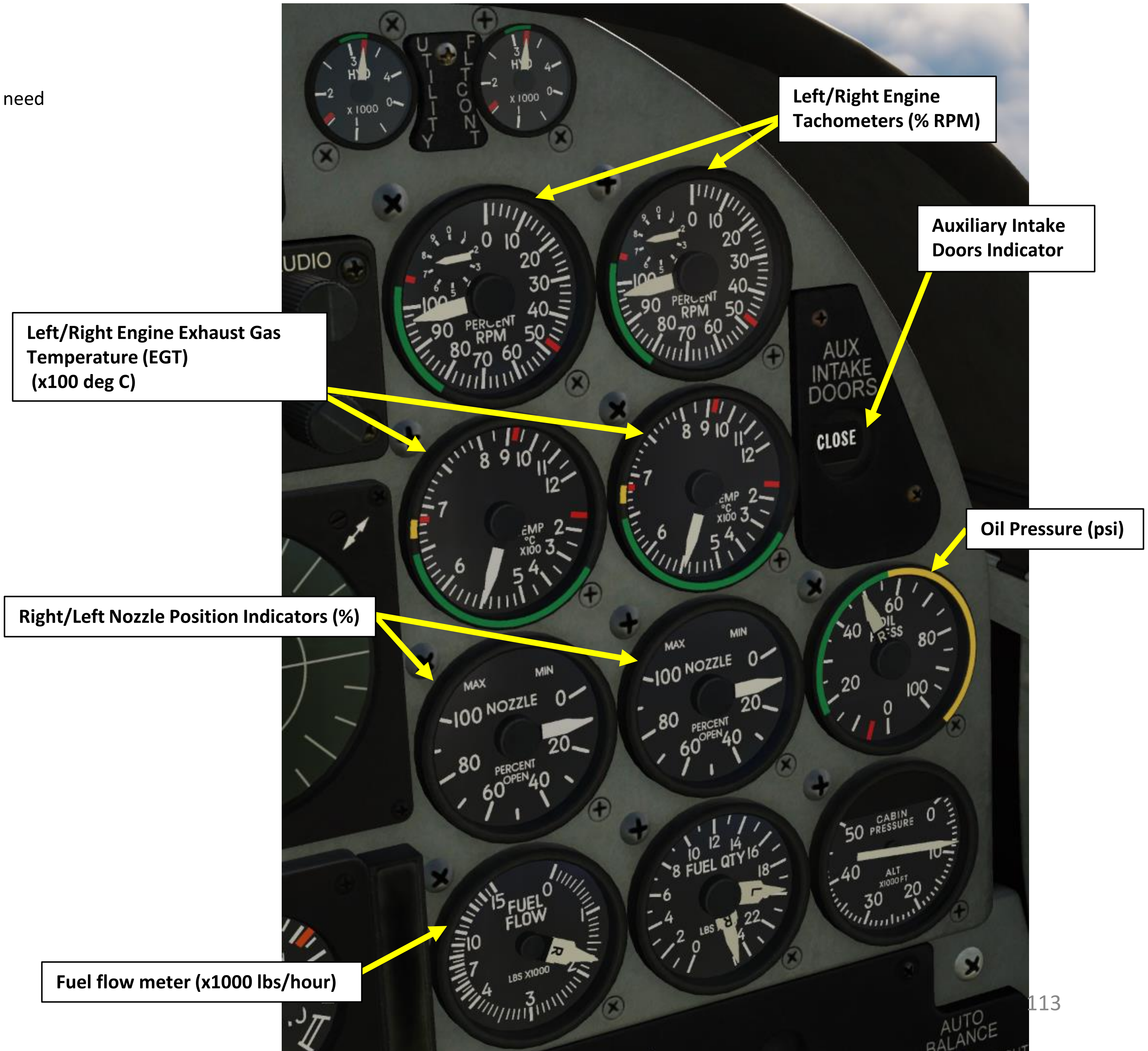
## *Engine Fuel Control System*



# ENGINE PARAMETERS

Here is an overview of the different engine parameters you need to monitor:

- Tachometers: Engine RPM in %
- Exhaust Gas Temperature (EGT) in deg C
- Nozzle Position Indicators (in %)
- Fuel Flow Meter (lbs per hour)
- Engine Oil Pressure (psi)
- Auxiliary Intake Doors Status



# ENGINE CONTROLS

**Main Engine Controls:**

Engines are controlled with the throttles. Engine power detents are:

- **OFF**: Engines are shut down
- **IDLE**: Engines are at minimum idle power
- **MIL** (Military Power): static thrust at military (MIL) power is 3250 pounds (1475 kgf)
- **MAX** (Maximum Afterburner Power): static thrust at MAX power is 4650 pounds (2110 kgf)

**T5 (EGT) Amplifier Control System**

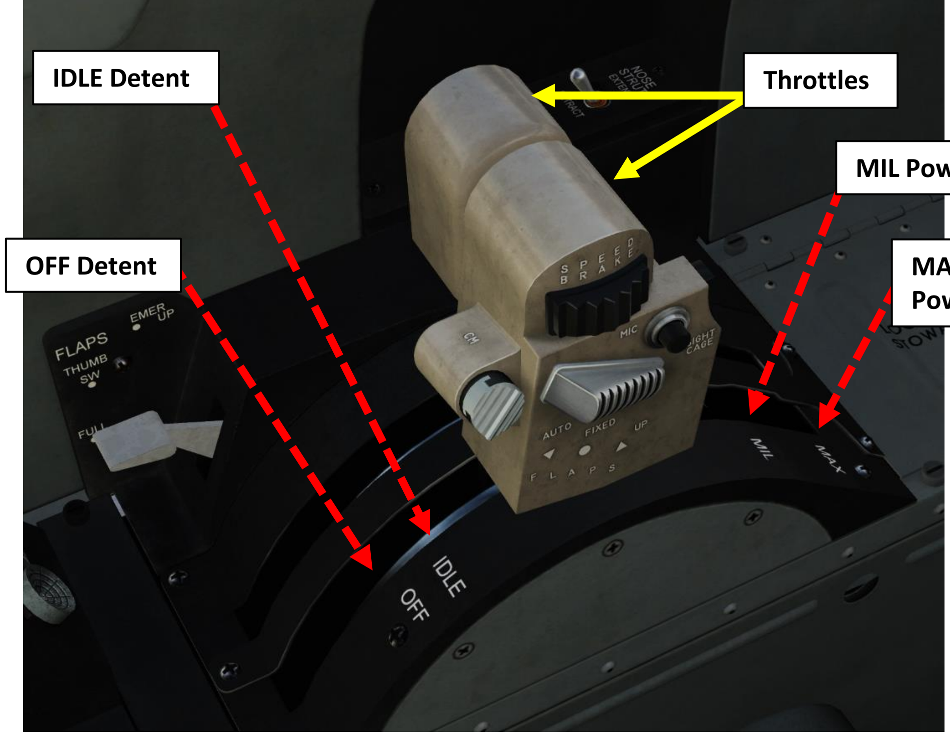
This system maintains a preset turbine discharge EGT (Exhaust Gas Temperature) during MAX (Afterburner) and MIL power operation. If EGT is higher than the preset temperature, the amplifier causes the nozzle to open; if lower, the nozzle closes. A T2 (Engine Inlet Temperature) sensor is linked with the main fuel control and affects increase/decrease in fuel flow at MIL/MAX power (from military to maximum/afterburner power). As airspeed increases, T2 temperature increases and MIL/MAX RPM increases. When inlet temperature (T2) decreases, as in a sustained climb, MIL/MAX RPM also decreases. With T2 temperature of -43°C and below, MIL/MAX RPM may be as low as 90%.

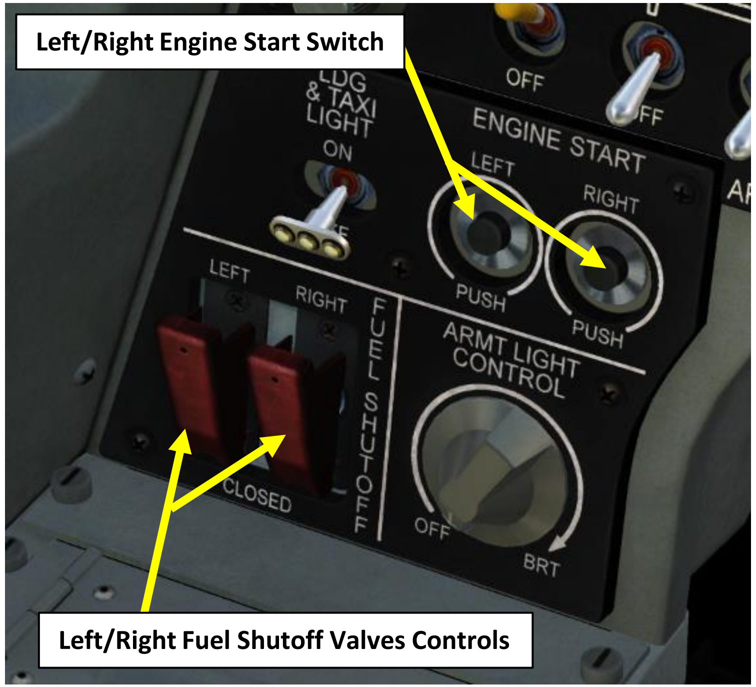
**Overspeed Governor:**

- A hydromechanical overspeed governor is provided to limit engine speed to a maximum steady state of about 106% rpm if the main fuel control fails.

**Engine Anti-Ice System:**

- The Engine Anti-Ice switch set to ON (UP) turns on hot bleed air supply to the engine inlet guide vanes. Enabling engine anti-ice slightly reduces engine thrust; only use it if necessary when the outdoor temperature is below 4 deg C and humidity is high.

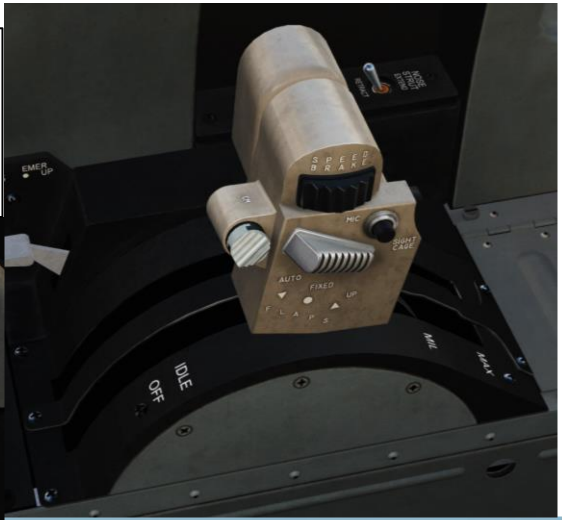



# ENGINE NOZZLE OPERATION SCHEDULE

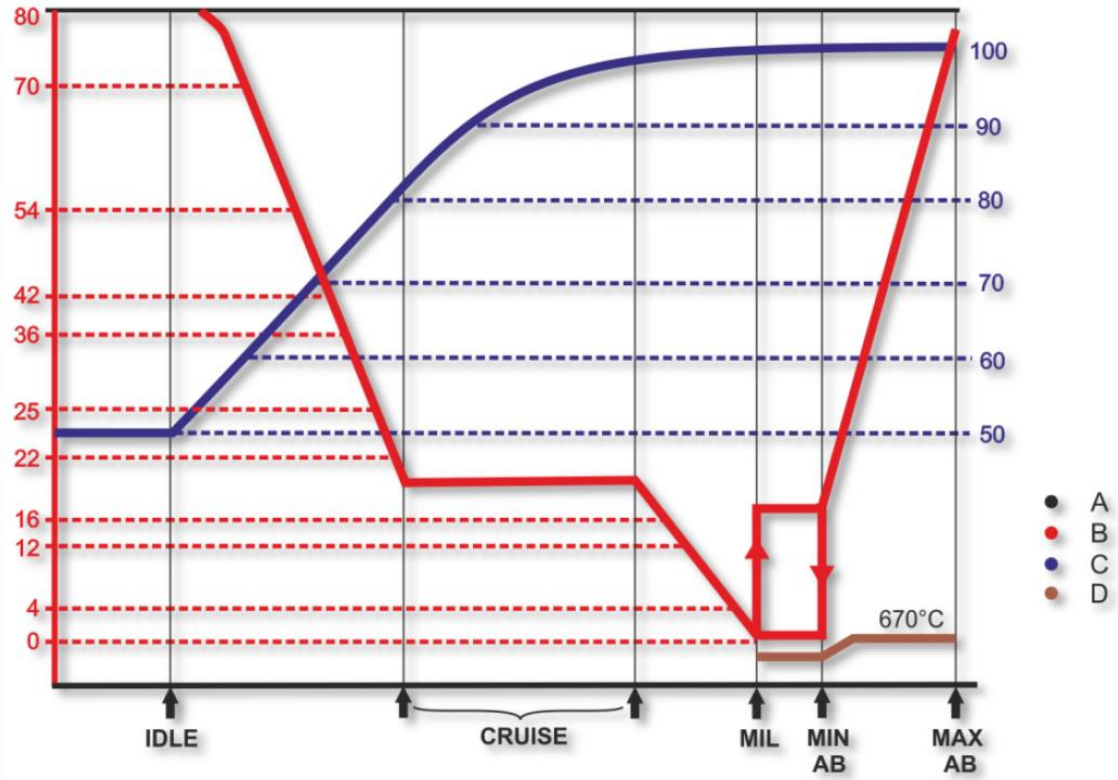
A variable exhaust nozzle control system maintains EGT (Exhaust Gas Temperature) within allowable limits in MIL and MAX (afterburner) power ranges. The system is automatic and provides required thrust throughout the operating power range from IDLE to MAX.

When throttles are advanced into the MAX (afterburner) power range, the automatic control system maintains constant EGT (T5) at 670 ± 5 deg C by varying the diameter of the nozzle. Thus, exhaust nozzle position varies depending on throttle position and EGT (T5).

**Example:**
*Nozzle 10 % Open*
*Throttle between CRUISE and MIL ranges*
*90 % Engine RPM*
*EGT (T5) 550 deg C*


**Nozzle Operation Schedule**




A. Throttle Position
B. Nozzle Position in percent of fully open position (100 %)
C. Engine RPM (%)
D. T5 / EGT (Exhaust Gas Temperature)

# ENGINE AUXILIARY INTAKE DOORS

Auxiliary (AUX) intake doors on each side of the fuselage above the wing trailing edge provide additional air to the engines for added thrust during takeoff and low-speed flight (low dynamic pressure).

The doors are automatically controlled by a signal from the central air data computer (CADC). An AUX INTAKE DOORS indicator on the instrument panel provides an indication of closed, intermediate, or open position of the doors.

During engine start, the auxiliary intake doors open after each individual generator comes online at around 48 % RPM. After takeoff, the doors close at approximately Mach 0.4 (255 ± 10 KIAS). During descent and landing pattern entry, the doors open at approximately Mach 0.375 (235 ± 5 KIAS).

Upon loss of AC power, the doors move to the closed position as the doors are spring-loaded closed and actuated open.

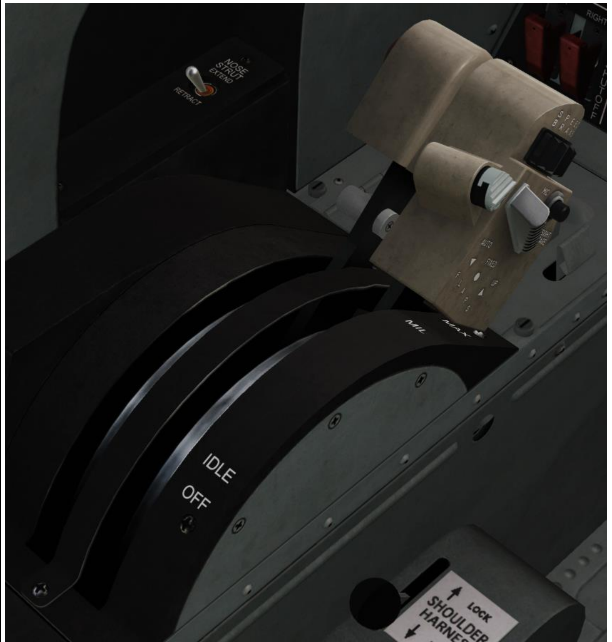
- If the doors fail in the closed position during takeoff roll, a thrust loss of approximately 7 percent and a corresponding increase in takeoff ground run should be expected.
- If the doors fail in the open position in flight at over Mach 0.4, an increase in fuel consumption of up to 10 percent may occur depending on flight conditions.
- If the auxiliary intake doors fail in the closed position during deceleration below Mach 0.375, the most probable effect is upon landing pattern entry and the subsequent pattern, approach, and landing. With this condition, the approximate thrust loss of 7 percent should be kept in mind for possible go-around or missed approach power requirements


**Auxiliary Intake Doors Indicator**

- ***CLOSE*** *– Both intake doors fully closed.*
- ***OPEN*** *– Both intake doors fully open.*
- ***Barber Pole****:*
  - *Intake doors in intermediate position;*
  - *One intake door open, the other intake door closed;*
  - *DC power is not available*


# AFTERBURNERS

Afterburner operation is initiated by advancing throttle beyond MIL mark. There is no proper indicator to show whether the afterburners are engaged or not. Afterburner lightoff should occur within approximately 5 seconds. Take note that sometimes you may not always know if the afterburner engaged correctly. A good visual cue is to check the nozzle position indicator: close to fully open means that the afterburner is engaged.




# ENGINE LIMITS

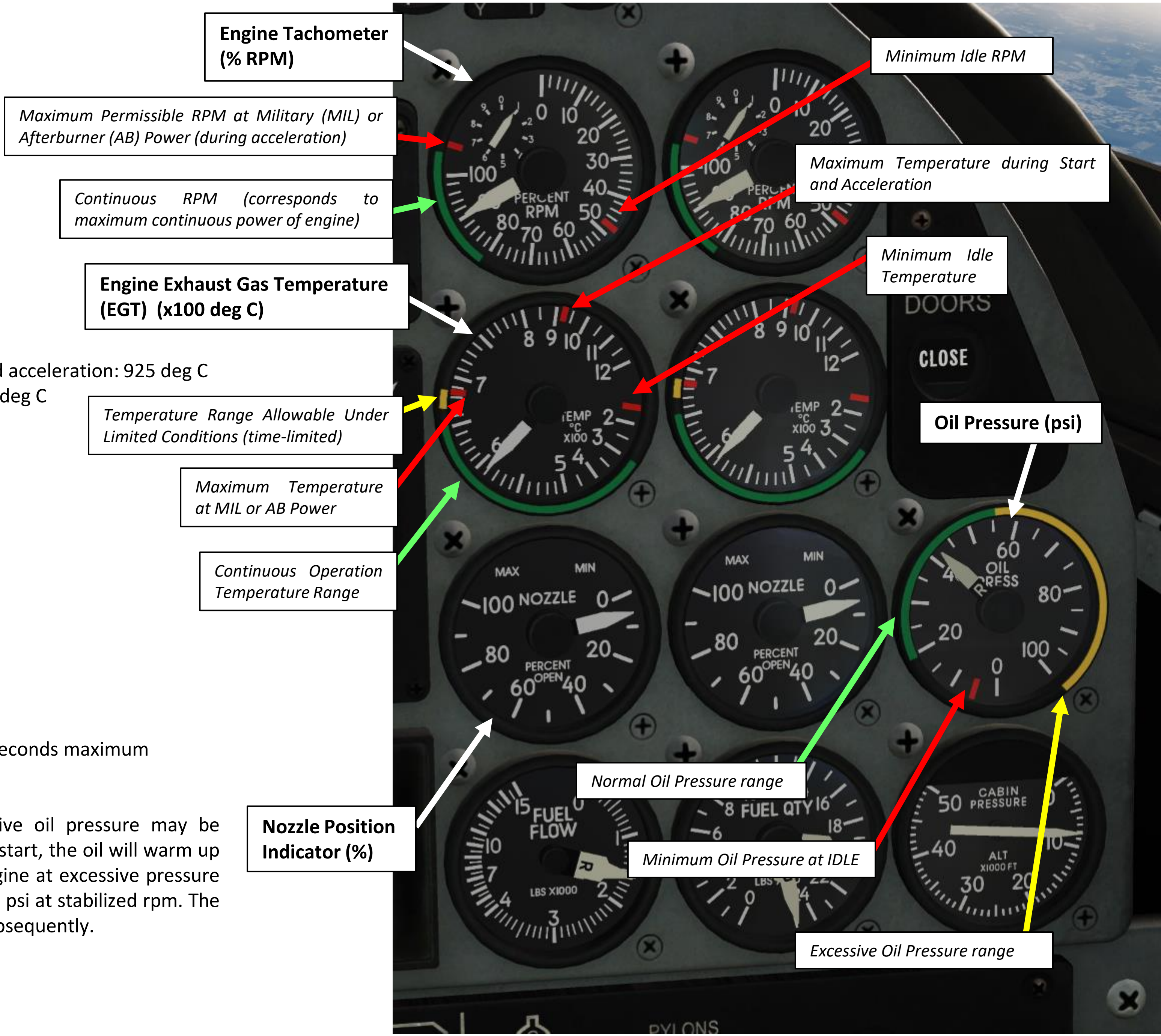
**Engine RPM Limits**
- IDLE: 49 – 52 % RPM
- Continuous Mode: 80 – 103 % RPM
- Maximum allowable exceeding of engine RPM: 107 % RPM
- MIL (Military): 90 – 103 % RPM
- MAX (Afterburner): 90 – 103 % RPM
- RPM Fluctuations +/- 1 % RPM at all modes

**Exhaust Gas Temperature (T5) Limits**
- Minimum: 140 deg C
- Stable Continuous Operation: 325 – 650 deg C
- Maximum: 685 deg C
- Maximum allowable exceeding of temperature during start-up and acceleration: 925 deg C
- Allowable temperature range at afterburner operation: 675 – 685 deg C
- Normal Temperature Fluctuation: +/- 7.5 deg C

**Engine Nozzle Position Limits**
- IDLE 70 – 80 %
- MIL: 0 – 16 %
- MAX: 50 – 80 %
- Normal fluctuation: +/- 3 %

**Engine Oil Pressure Limits**
- Minimum: 5 psi
- Normal operating range at all power mods: 20 – 55 psi
- Allowable excessive pressure at MIL and MAX mods: 55 to 100 psi
- Normal fluctuations: +/- 2 psi
- Allowable oil pressure drop to 0 psi while engine is operating: 60 seconds maximum

Additional notes on oil pressure:
- When starting the engine in cold weather conditions, excessive oil pressure may be observed (the colder the oil the higher its viscosity). After engine start, the oil will warm up and its pressure should fall below 55 psi. Do not operate the engine at excessive pressure for more than 6 minutes. The oil pressure may fluctuate within 10 psi at stabilized rpm. The oil pressure may drop to 0 psi during maneuvering and recover subsequently.



# COMPRESSOR STALLS & ENGINE SURGE

Compressor stalls may occur when you move the throttle too quickly. You will notice a sudden loss in engine RPM. The J85 turbojet engine is slow to respond to throttle input, so it should be treated gently. In case of compressor stall, pull back the throttle to IDLE and slowly throttle up. Major compressor failure may result in an engine flameout.

A **compressor stall** is a local disruption of the airflow in the compressor of a gas turbine or turbocharger. A stall that results in the complete disruption of the airflow through the compressor is referred to as a **compressor surge**. The severity of the phenomenon ranges from a momentary power drop barely registered by the engine instruments to a complete loss of compression in case of a surge, requiring adjustments in the fuel flow to recover normal operation.

Compressor stall was a common problem on early jet engines with simple aerodynamics and manual or mechanical fuel control units, but has been virtually eliminated by better design and the use of hydromechanical and electronic control systems such as Full Authority Digital Engine Control (FADEC). Modern compressors are carefully designed and controlled to avoid or limit stall within an engine's operating range.

The compressor stall sensitivity of an engine is increased by foreign object damage, high angles of attack at low airspeeds and high altitudes, abrupt yaw impulses at low airspeeds (below approximately 150 KIAS), temperature distortion, engine anti-ice system in operation, and ice formation on the engine inlet ducts or inlet guide vanes. Compressor stalls can also be caused by component malfunctions; engine rigged out of limits; throttle bursts to MIL or MAX power at high altitude and low airspeed; hot gas ingestion from other aircraft or during gun firing at high altitudes and negative g conditions; and maneuvering flight with landing gear down at altitudes above 30,000 feet.

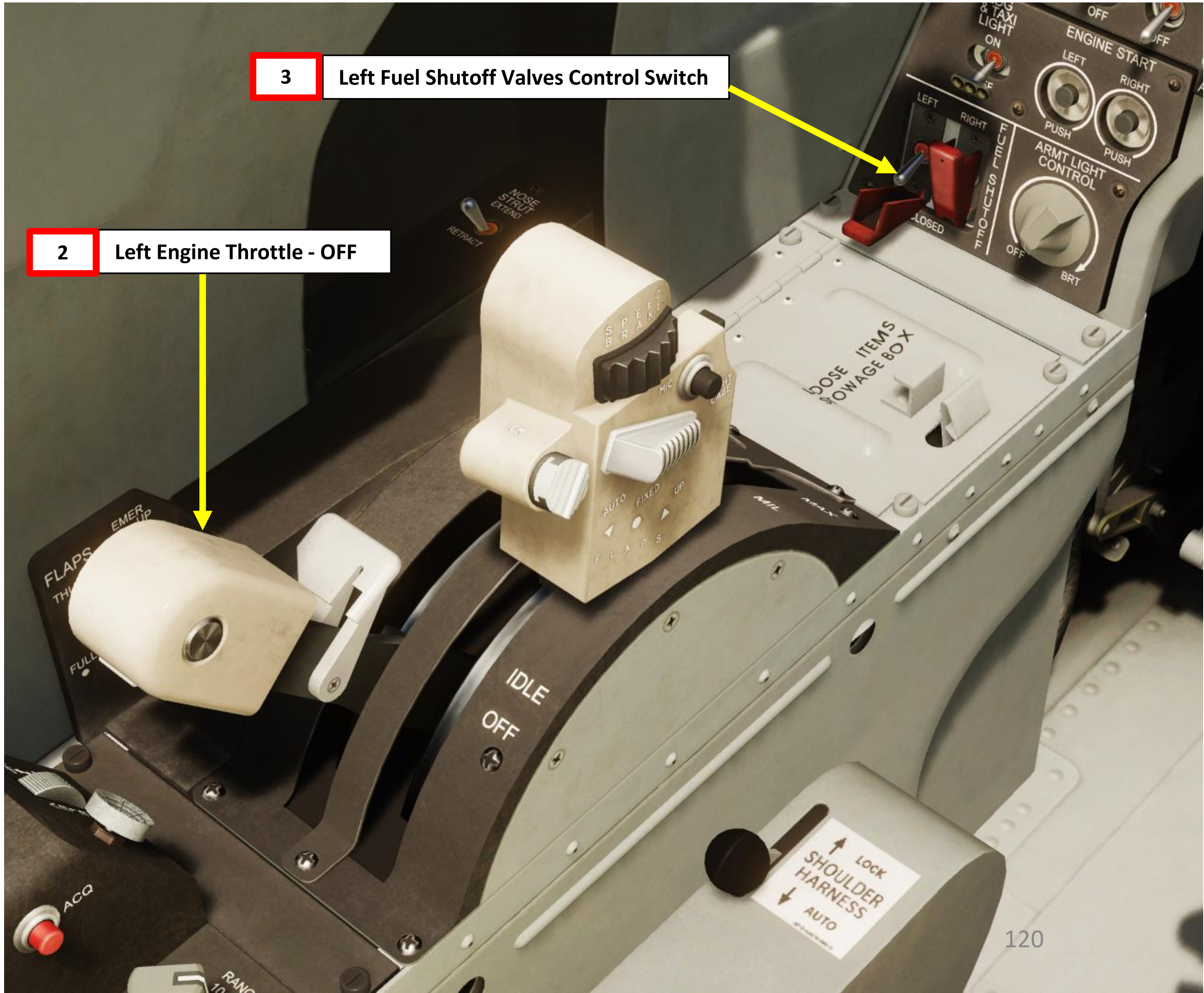
The nine-stage compressor of the J-85 engine has variable inlet guide vanes and variable stators to reduce (but not necessarily nullify) the risk of compressor stall. Operation is automatic as a function of engine RPM and inlet temperature. A P3 compressor dump system activates for approximately 16 seconds to reduce the possibility of compressor stall when a throttle is burst to MAX (afterburner) range at intermediate or high altitudes.

Keep in mind that compressor stall still can be caused by combination of adverse conditions.

# ENGINE FIRE

If an engine fire is detected, the FIRE light of the affected engine will illuminate. The F-5E is not equipped with proper fire extinguishers, so the best you can do to try to kill the fire is to shut the engine down and cutoff the fuel supply.

1. Fire detected in left engine
2. Set affected engine throttle – OFF
    - RALT+END for left engine
    - RCTRL+END for right engine
3. Set Fuel Shutoff Valve Control Switch of affected engine – SHUTOFF/CLOSED (DOWN)

# ENGINE FAILURE

## SINGLE ENGINE FAILURE

- In case of an unrecoverable single engine failure, you fly the F-5 pretty much the same way as you would fly with two engines since both engines are located close to the airframe centerline.
- Remember to auto-balance the fuel (crossfeed only if both systems are less than 400 lbs apart)
- Consider jettisoning your stores since you may not maintain altitude when extending the landing gear and flaps for landing.

If a single engine failure occurs, here is a quick checklist to run through:

1. Good engine – Set thrust as required
2. Stores – Jettison if required
3. Landing Gear – UP
4. Speed Brake – IN
5. Flaps – Set as Required
6. Identify Dead Engine – Dead Foot, Dead Engine (Check against instruments)
7. Verify Dead Engine – Affected throttle to IDLE, then to OFF
8. Perform Fuel Balancing – As Required
9. Attempt an engine airstart/relight if the engine failure is not due to damage or fire.

## DUAL ENGINE FAILURE

In case both engines are dead:

1. Convert airspeed to altitude (20 deg nose up maximum)
2. Maintain an airspeed of 250 KIAS
3. Set both throttles to MAX.

The Air Combat Tutorial Library (Requiem) has a great video on engine failures:
https://youtu.be/0t6ySqwdHuI

**Recommended Single-Engine Climb Speeds**

| Landing Gear | Flaps Setting | Airspeed (KIAS) |
|---|---|---|
| DOWN | Automatic | 210 |
| UP | Automatic | 230 |
| UP | UP (Retracted) | 290 |

**Notes:**
If you have an engine failure and need to climb, these are the airspeeds you should fly at in order to climb safely. Under normal conditions:

- Minimum single engine speed is 190 KIAS
- Maximum thrust gives a minimum of 300 ft/min climb rate

# ENGINE RELIGHT PROCEDURE

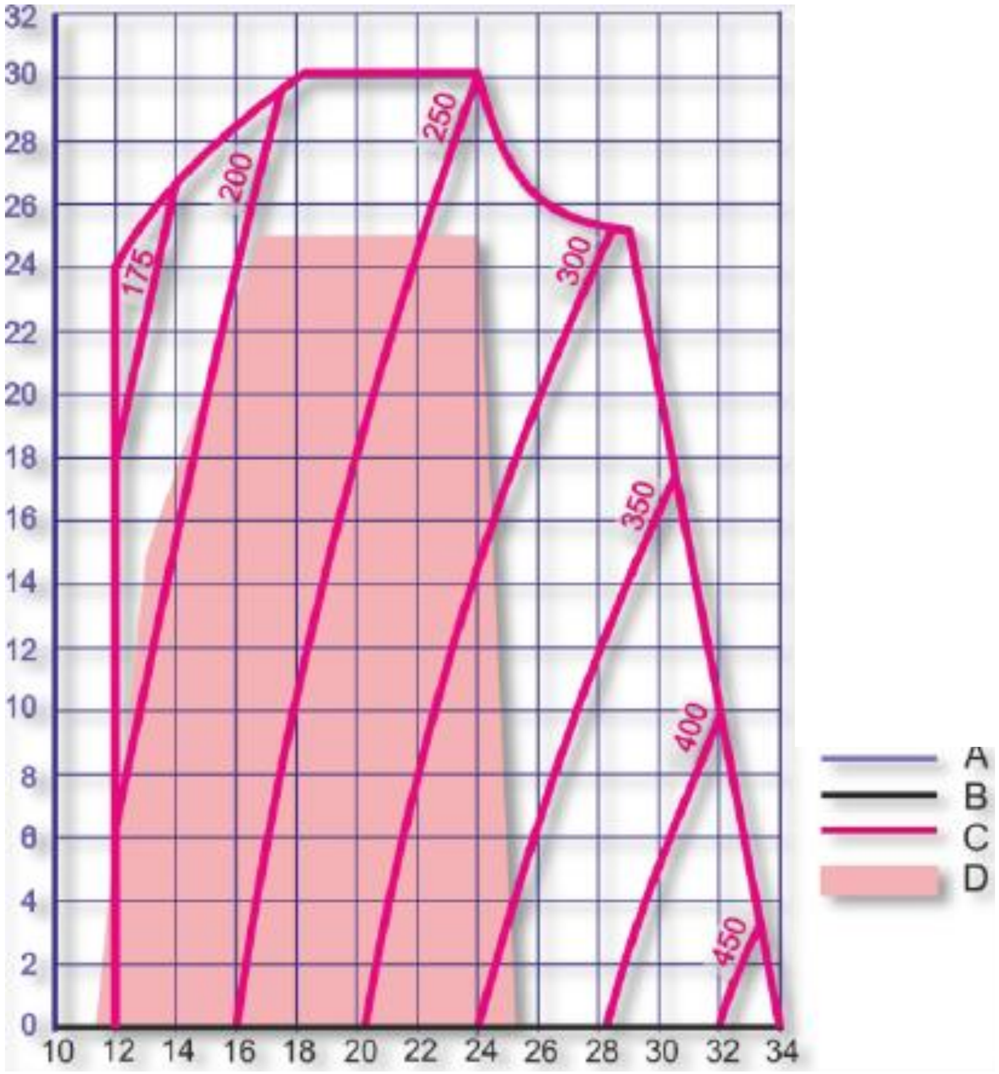
In case of engine flameout (due to a partial compressor stall or other conditions listed previously), you may be able to restart your engine if the engine didn't seize completely. if the aircraft airspeed is sufficient to provide enough airflow to drive the compressor blades even without combustion, we can perform a "windmilling engine start", which basically uses the ram air going through the engine intake to drive the compressor blades.

**<u>If both engines flamed out, always try to start the left engine first (utility hydraulic system is powered by the left engine hydraulic pump).</u>**

Use the Airspeed Curve chart to determine if you are within a safe setting to restart your engine (ideally, you want to be in the red area).

1. According to the graph, if we are flying at 20,000 ft and are flying at 150 kts, we will not have enough airflow to restart it through windmilling.
2. Find desirable airspeed and altitude on the graph and dive to reach the proper airspeed/altitude setting. We can dive to 18,000 ft and gain additional airspeed and reach 250 kts, which will allow us to generate 20 % RPM through windmilling, which puts us in the stable airstart area on the graph.

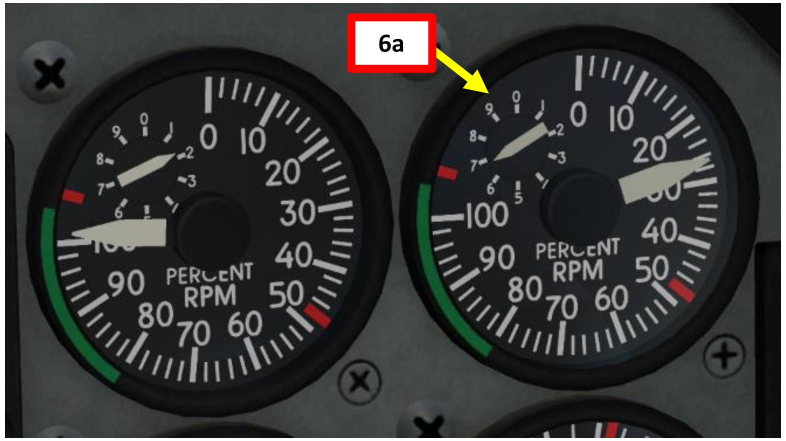
**Engine Windmill Speed**
**Pressure Altitude / Airspeed Curve**



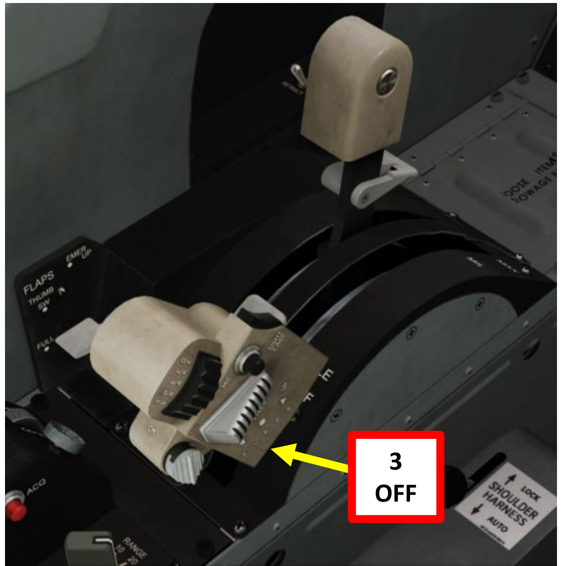

A. Pressure Altitude – 1000 ft
B. Engine Windmill Speed (% RPM)
C. Airspeed (KIAS)
D. Stable Airstart Area

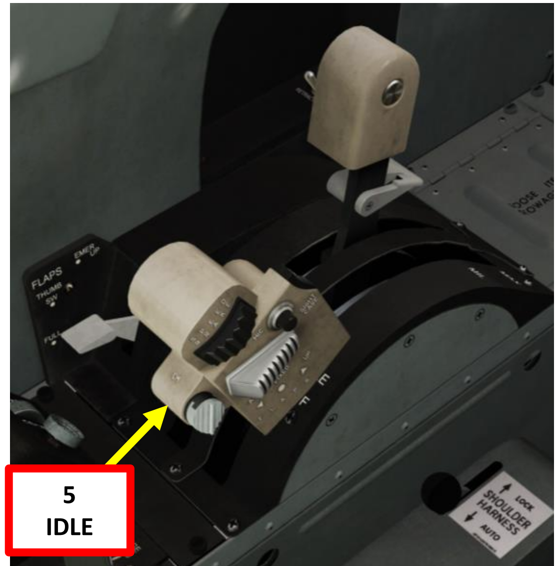
# ENGINE RELIGHT PROCEDURE

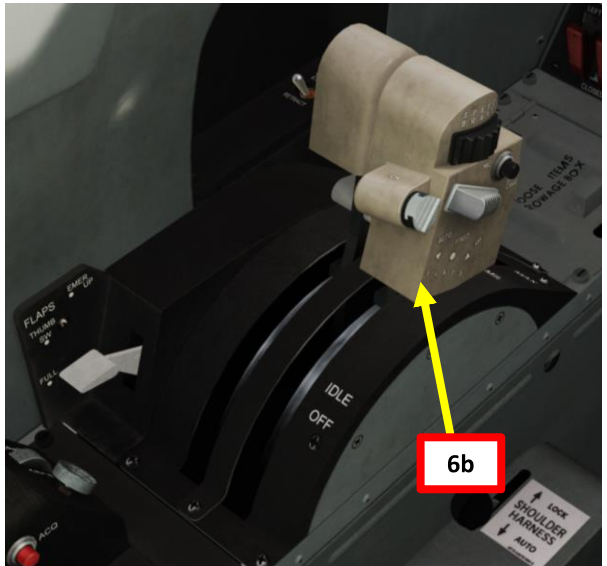
3. Once airspeed/altitude conditions are respected and enough RPM is generated on the engine, retard the throttle of the flamed out engine and set it to OFF (**RALT+END for Left throttle, RCTRL+END for Right throttle**).
4. Press and hold the ENGINE START button of the flamed out engine.
5. Set throttle of the flamed out engine to IDLE (**RALT+HOME for Left throttle, RCTRL+HOME for Right throttle**).
6. Ignition of the flamed out engine should be performed within 25 seconds. Once RPM increases, gradually throttle up.



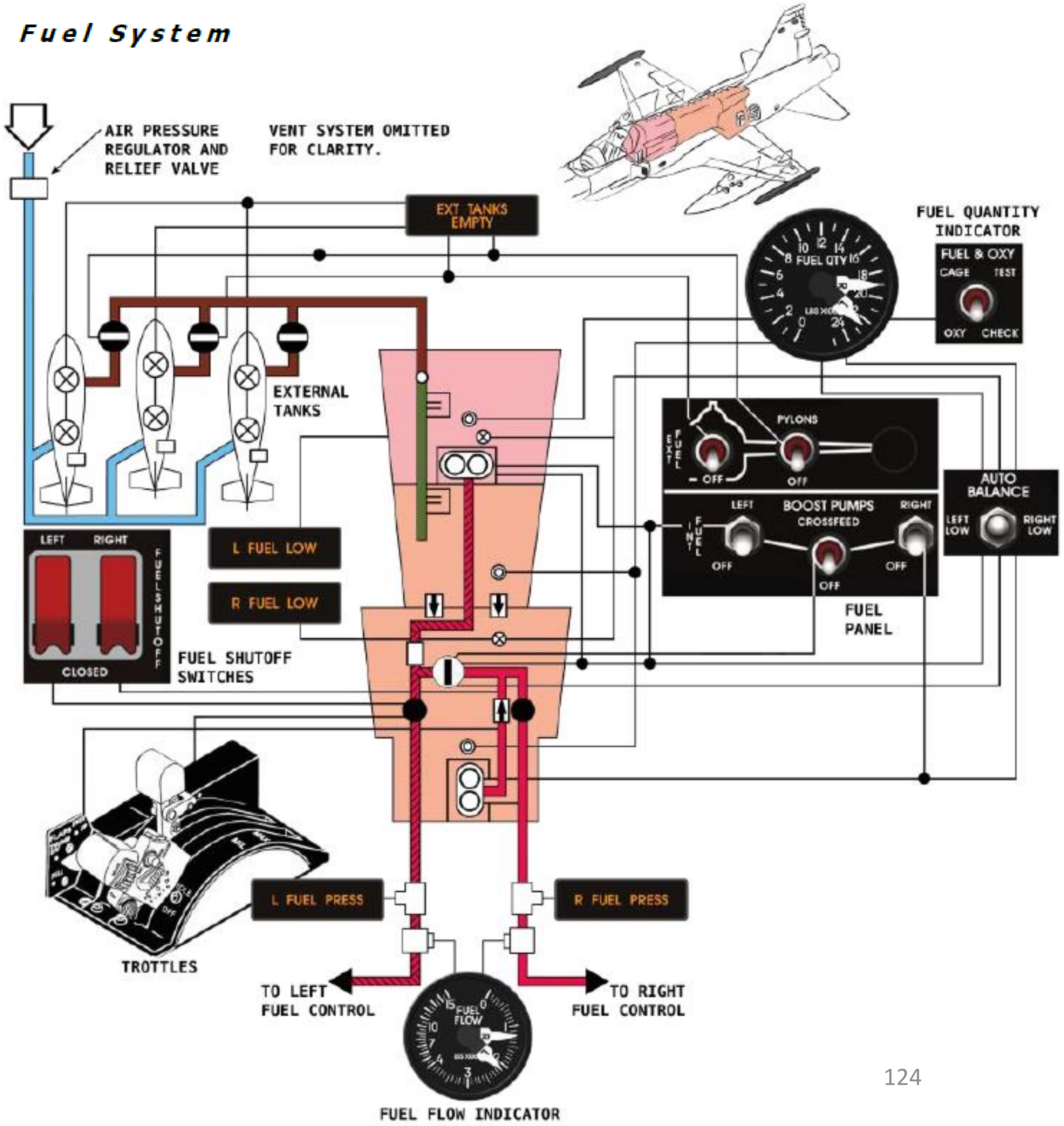



# FUEL SYSTEM OVERVIEW

- LEFT FUEL SUPPLY
- RIGHT FUEL SUPPLY
- EXTERNAL FUEL SUPPLY
- SINGL-POINT FUELING LINE
- SINGL-POINT MANIFOLD
- FUEL FLOAT SWITCH
- TANK PRESSURE RELIEF VALVE
- FUEL QUANTITY PROBE
- ENGINE BLEED AIR
- BOOST PUMP
- ELECTRICAL ACTUATION
- FUEL SHUTOFF VALVE
- FUEL CONTROL VALVE
- CHECK VALVE
- FUEL FLOW TRANSMITTER
- CROSSFEED VALVE
- LEFT SYSTEM
- RIGHT SYSTEM
- FUEL PRESSURE SWITCH



# FUEL TANKS

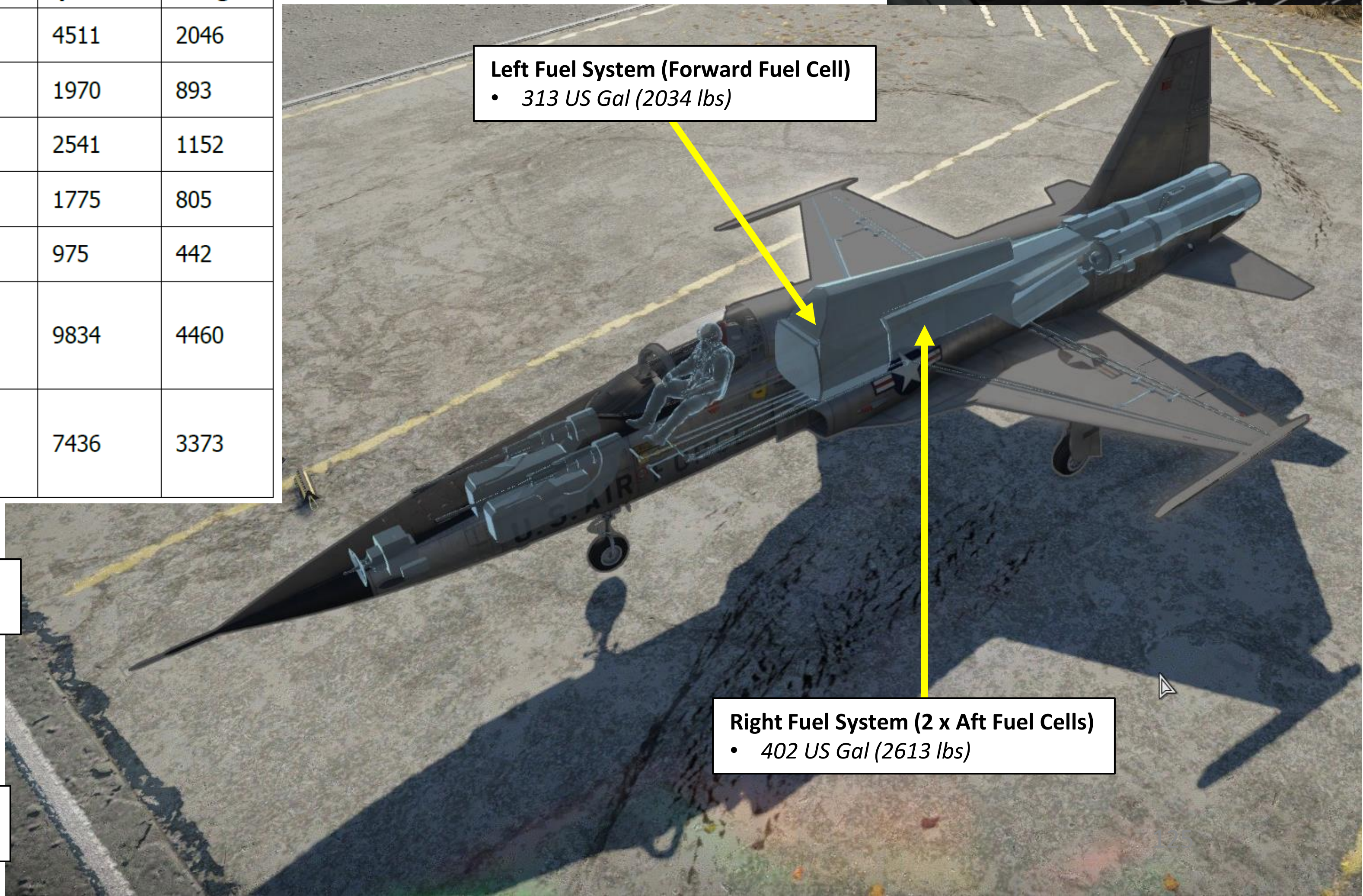
The fuel tank system of the F-5E consists of two internal tanks, consisting of the left system (forward cell) and the right system (two aft cells). Up to three external fuel tanks can be installed (either 150 US gal or 275 US gal). The fuel quantity indicators only display fuel for the internal fuel tanks.

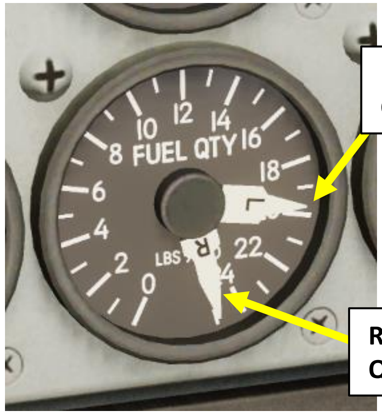
- Total Internal Fuel Quantity: 715 US Gal (4647 lbs)
- Maximum Fuel Quantity: 1171 US Gal (7611 lbs)

| FUEL | FULLY SERVICED | | | USABLE | | |
|---|---|---|---|---|---|---|
| | gallons | pounds | kg | gallons | pounds | kg |
| Both systems (total) | 715 | 4647 | 2107 | 694 | 4511 | 2046 |
| Left system (forward cell) | 313 | 2034 | 922 | 303 | 1970 | 893 |
| Right system (2 aft cells) | 402 | 2613 | 1185 | 391 | 2541 | 1152 |
| 275-gallon external tank | 275 | 1788 | 811 | 273 | 1775 | 805 |
| 150-gallon external tank | 152 | 988 | 448 | 150 | 975 | 442 |
| Maximum fuel quantity with 3 external tanks, 275 gallons each | 1540 | 10010 | 4540 | 1513 | 9834 | 4460 |
| Maximum fuel quantity with 3 external tanks, 150 gallons each | 1171 | 7611 | 3452 | 1144 | 7436 | 3373 |

**L/R FUEL LOW Lights**

- *Illuminates when fuel remaining in left/right fuel system is below approximately 350 to 400 lbs or aircraft is placed in negative-G condition for 10 seconds or longer.*

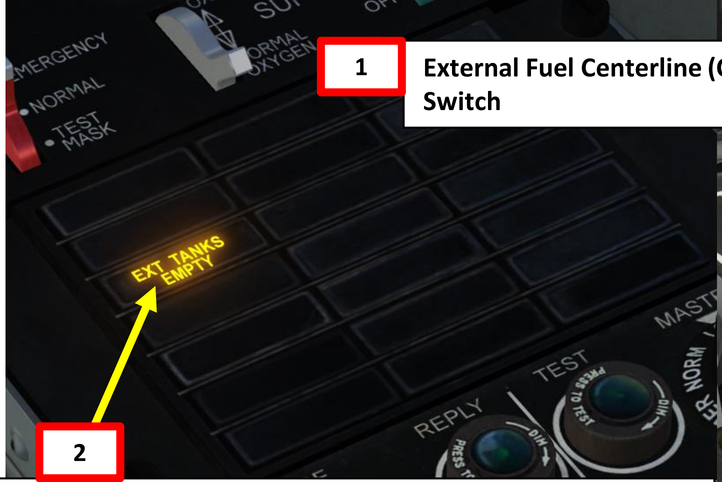



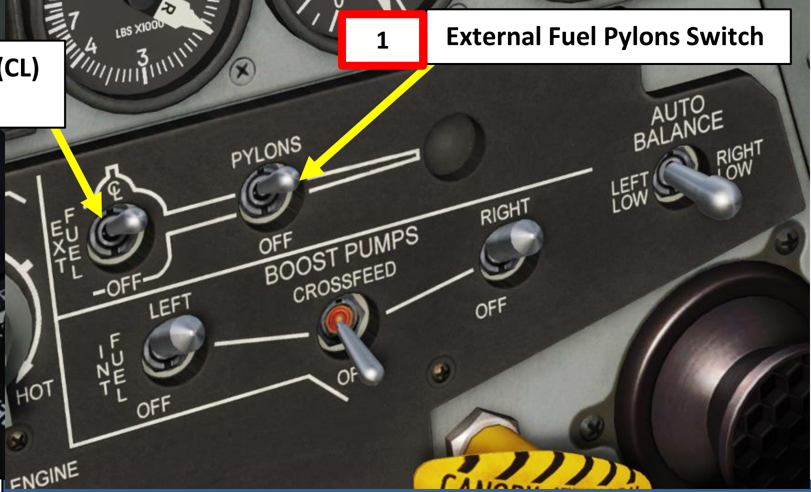



# EXTERNAL FUEL TANKS OPERATION

**To use external fuel tanks:**

1. Set EXT FUEL Transfer switches – ON (UP).
    - EXT FUEL CL is for the centerline external fuel tank
    - PYLONS is for the external fuel tanks installed under the wing pylons
2. Once EXT TANKS EMPTY light illuminates, the fuel in the external tanks has been successfully transferred to the internal fuel tanks in the fuselage. Set EXT FUEL Transfer switches – OFF (DOWN).




**EXT TANKS EMPTY Light**

- *Illuminates when external fuel tanks are empty. Placing the EXT FUEL Transfer switch(es) OFF extinguishes this light. If carrying only one inboard (wing pylon) fuel tank, the light does not illuminate when external transfer is complete.*

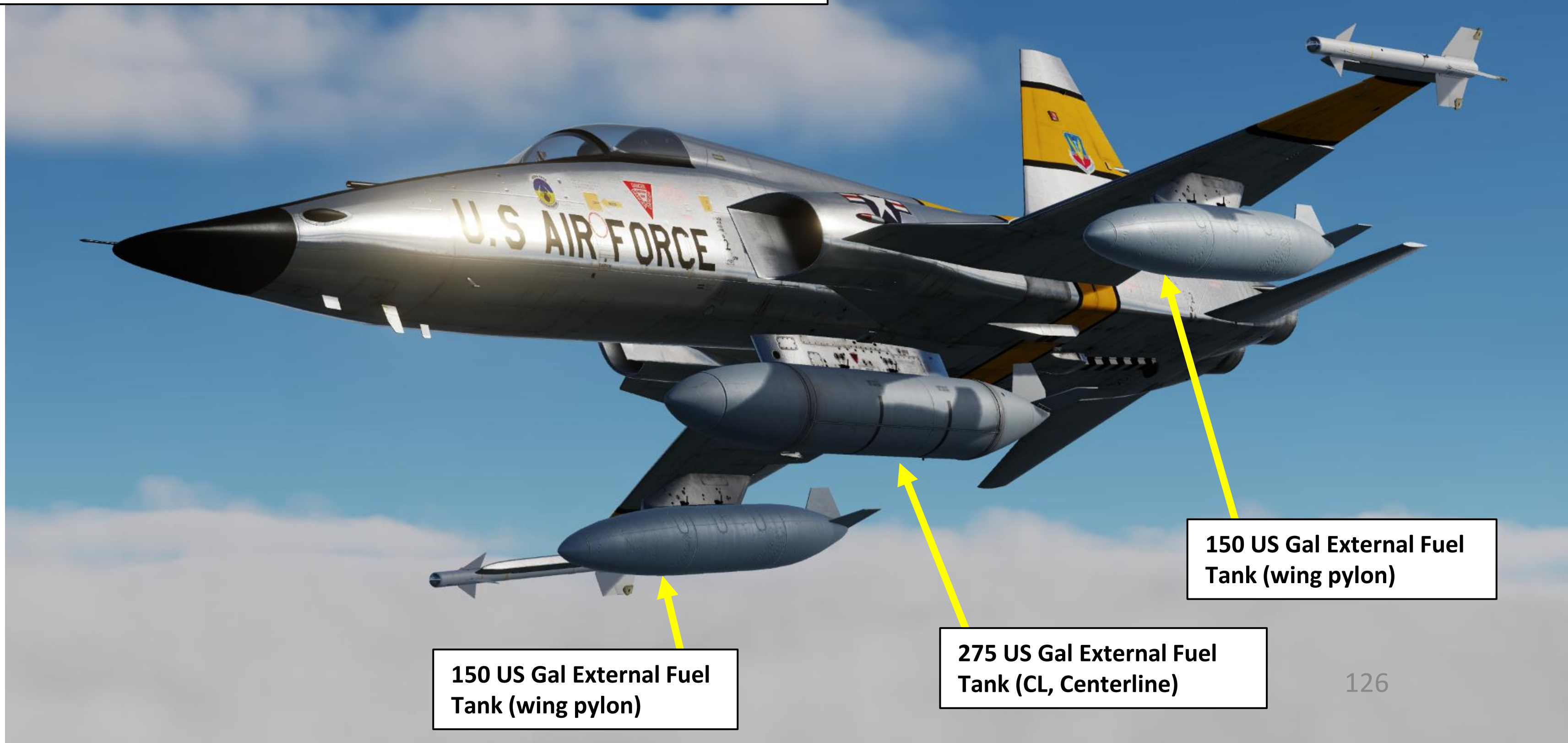
**External Fuel Tank Sequencing**

When external tanks are carried, use inboard wing pylon tanks first, centerline tank next, and internal fuel last.

During ground operation, it is not recommended to transfer fuel from external tanks when fuel quantity in the left fuel system is 1700 pounds or more, or in the right system is 2300 pounds or more.

When inboard tanks are empty (indicated when EXT TANKS EMPTY caution light comes on), check fuel quantity indicator for a decrease in quantity to assure that inboard tanks are empty. To transfer centerline tank fuel, turn off PYLONS fuel transfer switch and turn on CL fuel transfer switch.

Failure to turn off the fuel transfer switch when inboard tanks are empty prevents EXT TANKS EMPTY light from indicating when the centerline tank is empty because the EXT TANKS EMPTY light will be permanently on.



# EXTERNAL FUEL TANKS JETTISON

**METHOD 1: Emergency Jettison**

If you only have external fuel tanks equipped on your pylons, the quickest way to jettison external fuel tanks is to press the EMERGENCY ALL JETTISON button after flipping the protective cover.

**Emergency Jettison ALL Button Protective Cover**


**Emergency Jettison ALL Button**


# EXTERNAL FUEL TANKS JETTISON

**METHOD 2: Selective Jettison – ALL PYLONS**

1. Set Select Jettison Position Switch – PYLONS (DOWN)
2. Press Jettison Push Button.
3. Once stores jettison is complete, set Select Jettison Position Switch – OFF (MIDDLE)

Actuation of the button jettisons wing and centerline stores and also actuates the pylon jettison circuits. If pylons are jettisoned with stores, the stores jettison from the pylons first followed by the pylons approximately 1 second later.


# EXTERNAL FUEL TANKS JETTISON

**METHOD 3: Selective Jettison – SELECT POSITION**

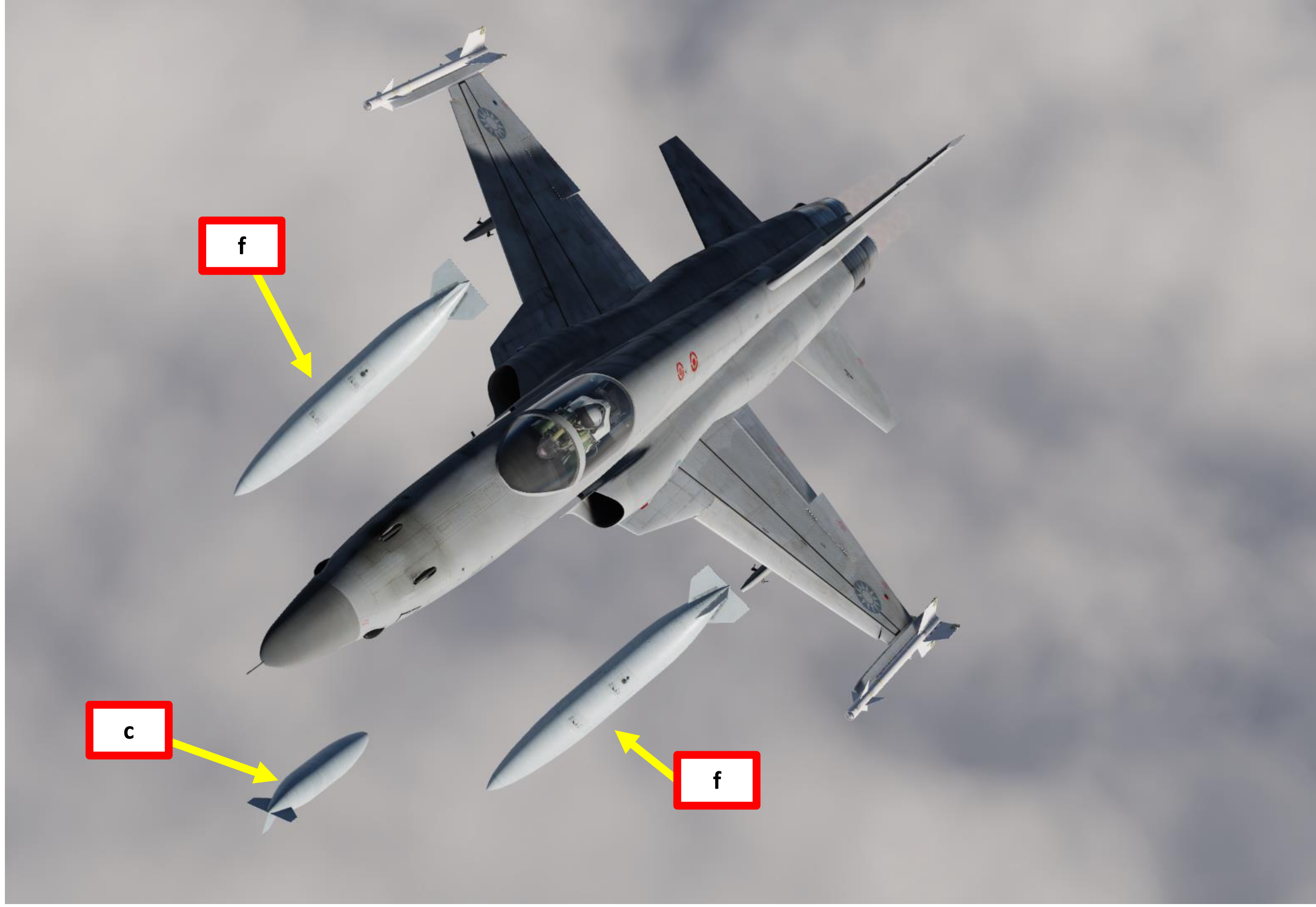
The centerline store, any wing store, or paired wing store (both outboard or both inboard) may be jettisoned individually as selected by the armament position selector switches. Only one release or paired release (both outboard or both inboard pylons) occurs for each actuation of SELECT JETTISON button. After selected store is jettisoned, it must be selected OFF before the next store can be jettisoned. For example, in order to jettison the outboard stores, the armament position selector switches of the centerline and inboard stores must be set in OFF position.

Sequencing logic provides the following store release priority:

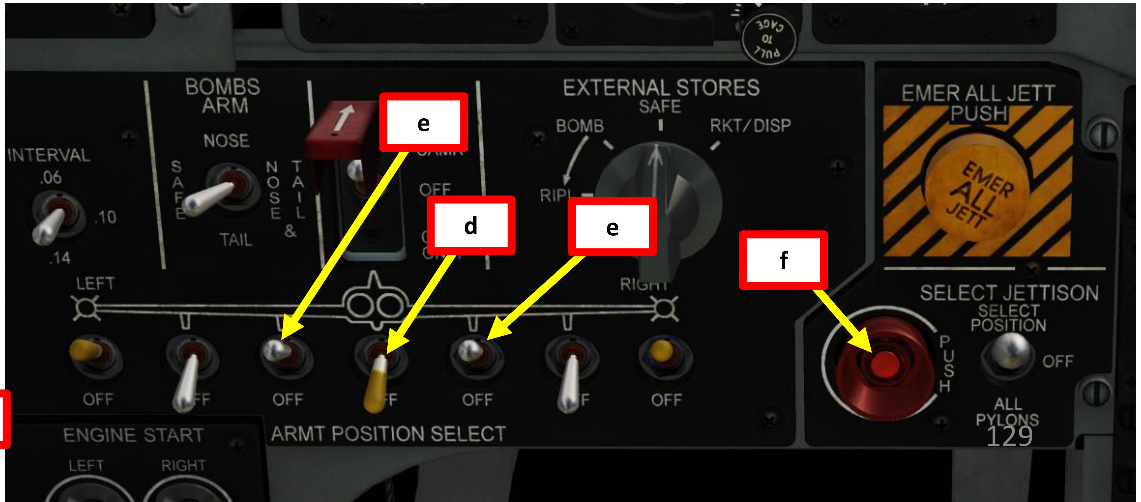
1. Centerline
2. Inboard
3. Outboard
4. Wingtip missiles emergency launch.

If you want to jettison all fuel tanks using this method:

a) Set Select Jettison Position Switch – SELECT POSITION (UP)
b) Set Centerline Armament Position Selector Switch – ON (UP)
c) Press Jettison Push Button
d) Set Centerline Armament Position Selector Switch – OFF (DOWN)
e) Set Inboard Wing Pylon Armament Position Selector Switches – ON (UP)
f) Press Jettison Push Button
g) Set Select Jettison Position Switch – OFF (MIDDLE)







# FUEL BALANCING

**Fuel balancing** in flight is required because there is a difference in fuel capacity between fuel cells of the right and left engines. The engines may use fuel at different rates (for example, when left and right throttles are at different positions). Therefore, if fuel quantity in the cells is not controlled, the center of gravity may change, thus affecting flight dynamics.

## FUEL AUTO-BALANCE

Auto-balance operation is initiated by pulling the AUTO BALANCE switch out of detent and positioning it to the left or right low position corresponding to the internal system with the lower fuel quantity. The switch is held in the selected position by a holding solenoid. Selecting either of the positions opens the CROSSFEED valve (the CROSSFEED switch shall be placed in DOWN/OFF position) and permits feeding both engines from the fuel system with the higher fuel quantity.

As an example, in the case of substantial difference in fuel quantities (more than 200 pounds, the left engine has less fuel), place AUTO BALANCE switch to the left low position. The CROSSFEED valve opens, rotation of the left boost pump reverses and permits fuel feeding from the right fuel system to both engines.

Auto-balance operation ceases when:

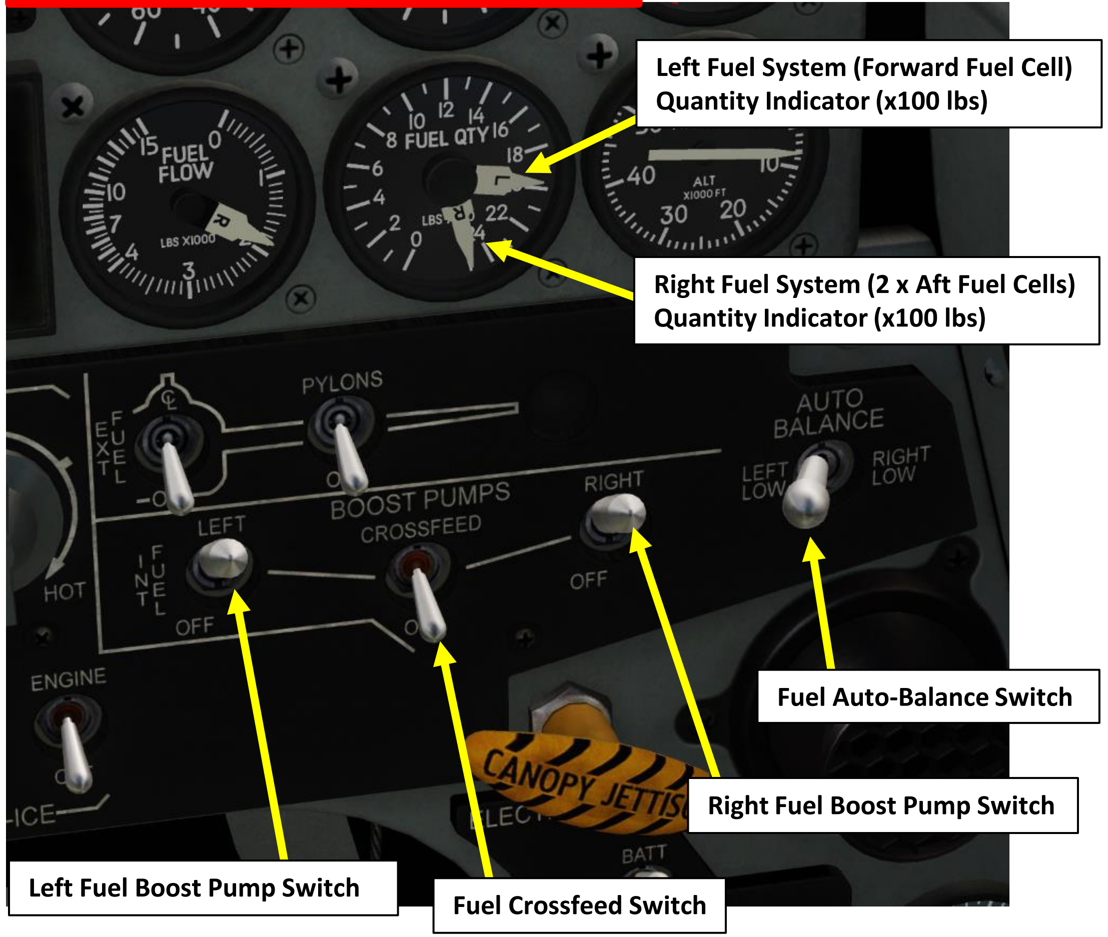
- Difference between left and right fuel quantity indicator pointers is within 50 to 125 pounds;
- The low level float switch in the system supplying fuel to both engines closes for longer than 10 seconds;
- CROSSFEED switch is activated (placed in the UP/ON position).

When auto-balance operation ceases, the holding solenoid is deenergized, allowing the AUTO BALANCE switch to return to the center position, the CROSSFEED valve closes (unless the CROSSFEED switch has been positioned to UP/ON), the low system boost pump resumes normal operation.

Notes:

- Balancing kicks in after external tanks fuel is depleted and engines start using fuel from internal tanks.
- Middle and aft internal tanks have 560 pounds more fuel than forward, therefore AUTO BALANCE should be activated after external tanks fuel is depleted, and right engine fuel usage is maintained;
- Auto-balance is operational with one running engine, provided that AC power is available and both boost pumps are operating.

Example: Auto-Balancing
LEFT fuel system has less fuel than RIGHT fuel system



# FUEL BALANCING

## FUEL MANUAL BALANCE

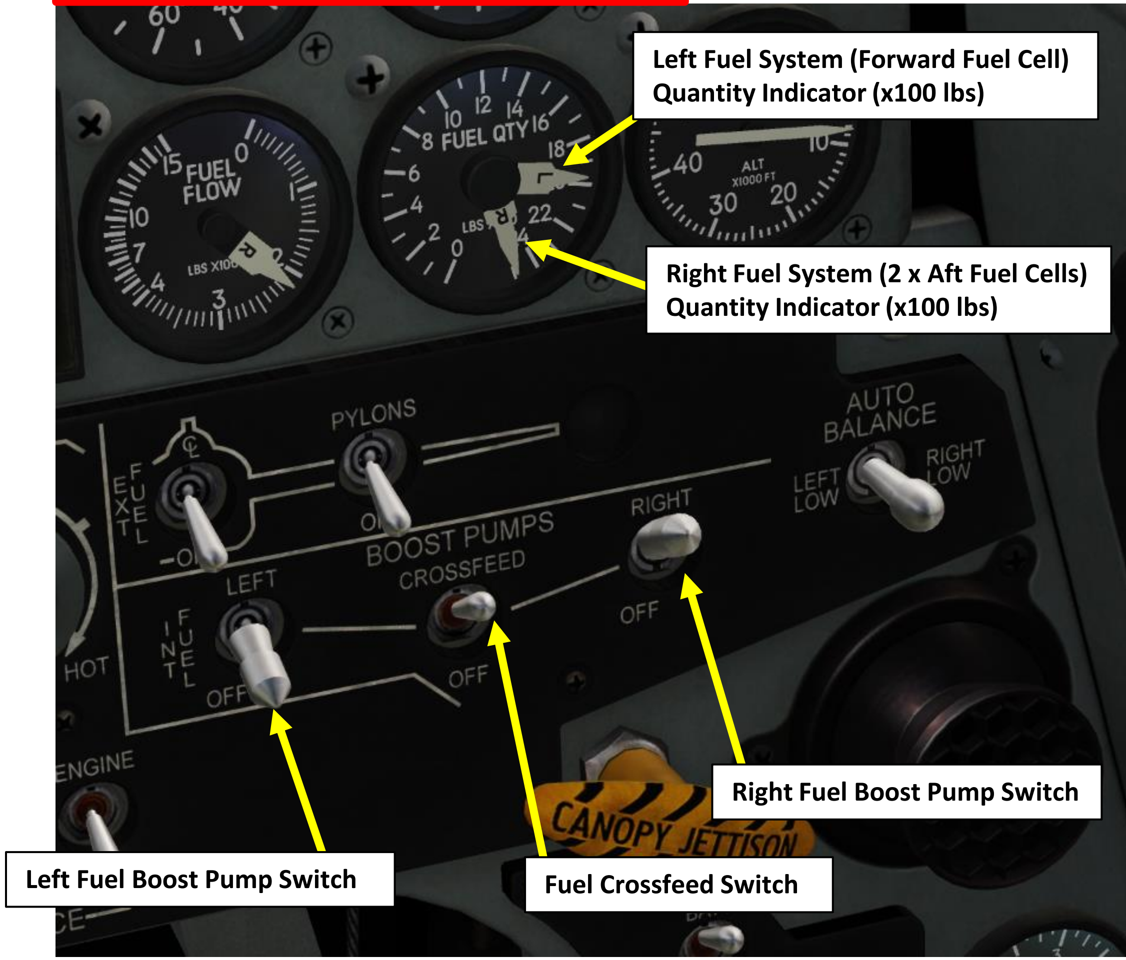
Manual fuel balancing (crossfeed) is accomplished by following this procedure:

1. Turn the CROSSFEED switch UP/ON to open the fuel crossfeed valve
2. Set BOOST PUMP switch DOWN/OFF of the system with the lower fuel quantity.
3. Set the inoperative BOOST PUMP switch UP/ON as soon as the difference in fuel quantity between the left and right engine is within 100 pounds.
4. After the pump has operated for a minimum of 2 minutes, set the CROSSFEED switch DOWN/OFF.

Important Notes:

- Failure to fulfill the above procedure (boost pump deactivation) will lead to fuel being used only from one fuel system, causing aircraft unbalance.
- Failure to fulfill the 2-minutes requirement before placing the CROSSFEED switch in OFF position may lead to air getting inside fuel system whose boost pump was off, possibly resulting in engine shutdown.

**Example: Manual Balancing**
**LEFT fuel system has less fuel than RIGHT fuel system**



# LOW FUEL OPERATION

If an internal fuel system has less than 650 pounds of fuel, the quantity of fuel falls below the fuel boost pump upper inlet and the boost pump output is reduced by approximately 40%.

During fuel crossfeed operation, if the engines are operated at power settings requiring a fuel flow of 6000 pounds per engine per hour or greater, the low pressure light may come on and engine RPM fluctuations may occur because of insufficient fuel pressure.

If both fuel systems below approximately 400 pounds, fuel auto-balance operation is not available. Do not attempt to use the CROSSFEED valve, because if the fuel supply in one system is depleted or one of the boost pumps fail, air may be supplied to the fuel line causing dual engine flameout. There is no cockpit indication of boost pump failure.

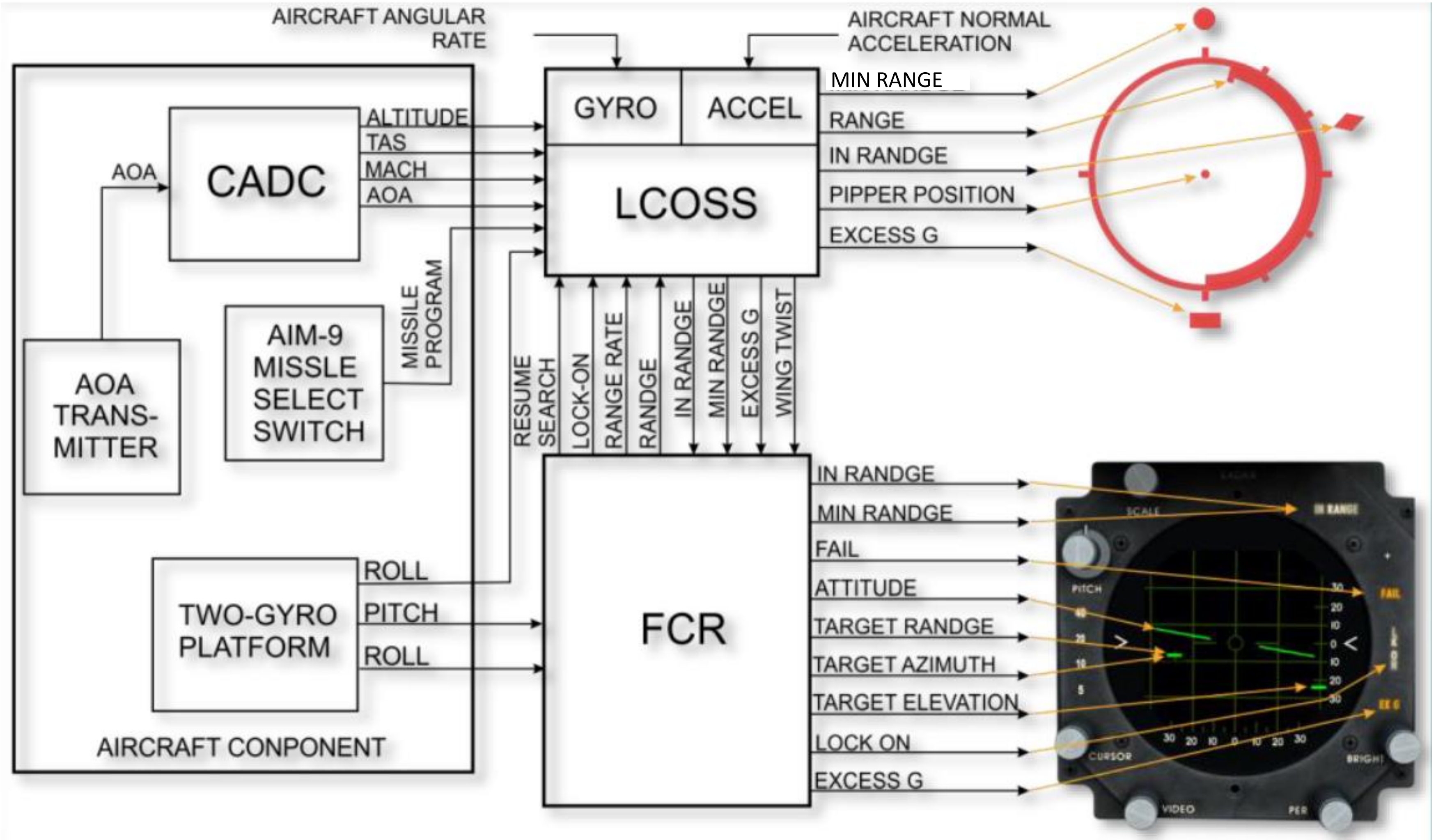

LOAD
LOCK
FLAPS
AUTO
MSL
A/A1-GUNS
A/A2
OFF
MAN
BRT
MODE
RET INT
DEPR
AUX
INTAKE
DOORS
CLOSE
IP-1310/ALR
ALT
MILES
COURSE
PITCH
HOOK
PUSH
AOA
CLIMB
FUEL
FLOW
FUEL QTY
CURSOR
BRIGHT
VIDEO
CHAN
PER
EXTERNAL STORES
SAFE
BOMB
RKT/DISP
GUNS
EMER ALL JETT
PUSH
CABIN PRESS.
CABIN TEMP
AUTO
MAN.
COLD
MAN.
HOT
RAM
DUMP
NORMAL
PYLONS
BOOST PUMPS
CROSSFEED
LEFT
RIGHT
AUTO
BALANCE
LEFT
LOW
RIGHT
LOW
LIGHT
OFF

# FIRE CONTROL SYSTEM

The fire control system assists aiming process and provides the pilot with indications and commands required for weapon employment. The fire control system consists of:

- **AN/APQ-159(V)-3 fire control radar (FCR)**
- **AN/ASG-31 lead computing optical sight system (LCOSS)**

The AN/APQ-159(V)-3 and AN/ASG-31 may operate jointly or separately during air-to-air attacks. During air-to-ground attacks, only AN/ASG–31 is used. IR seeking missiles and guns are used for air-to-air attacks. Bombs, rockets, and guns are used for air-to-ground attacks. Flares are used for night illumination of ground locations.



# AN/APQ-159(V)-3 RADAR INTRODUCTION

The Emerson Electric AN/APQ-159 was an I band/J band radar designed to upgrade Emerson's older AN/APQ-153 used in the Northrop F-5. It offered roughly double the range, increased off-boresight tracking angles, and considerably improved reliability. The AN/APQ-159(V)-3 radar for the F-5E3 we have provides for air target search, lock-on, and tracking for head-on and stern attacks in open airspace.

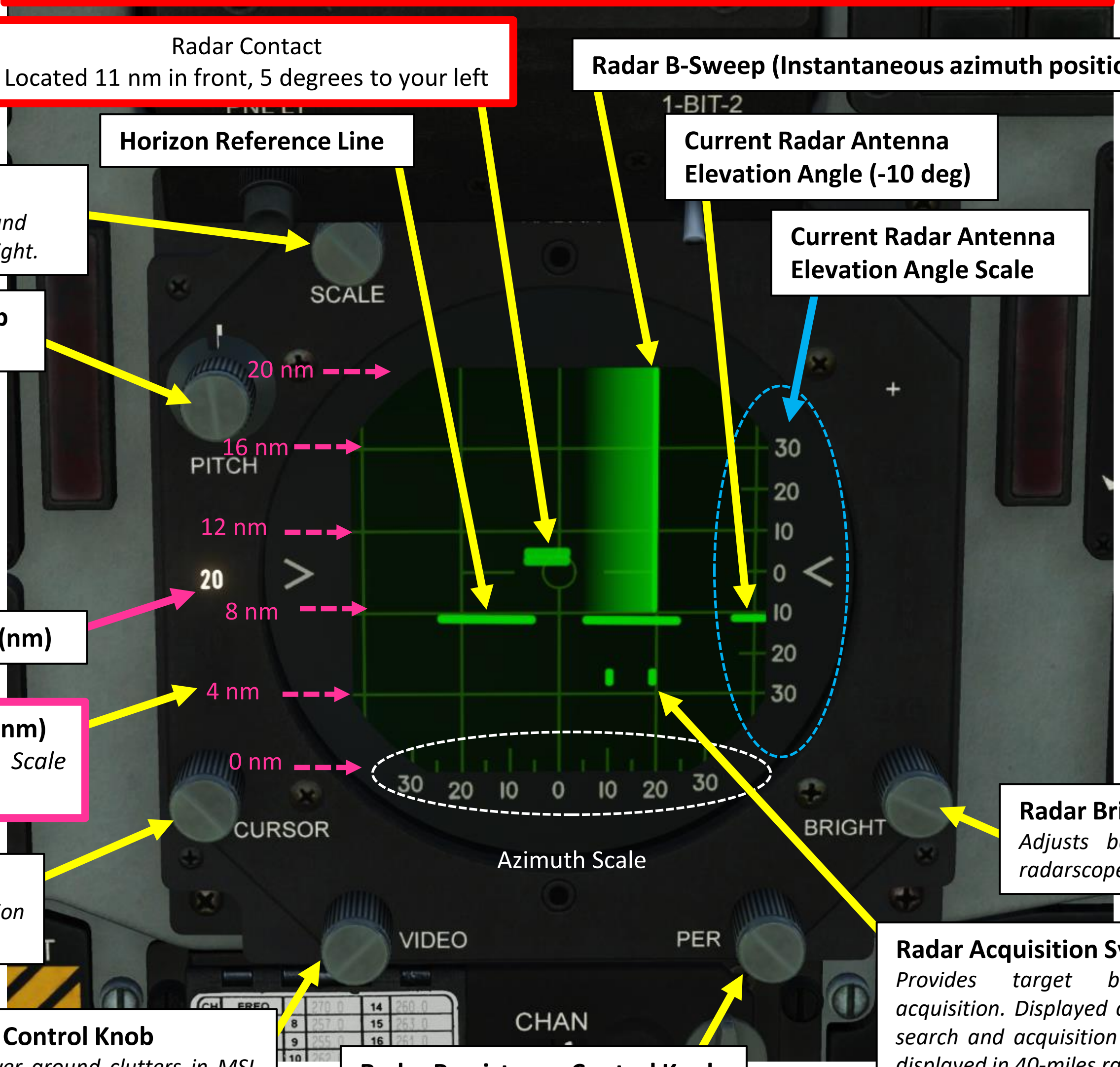
Like the earlier APQ-153, the APQ-159 was a purely air-to-air radar system. It had four primary modes of operation, two search modes with different ranges using a simple B-Scope display, a C-Scope gunnery display with ranging and automatic lock-on ("dogfight mode"), and a similar mode used with the AIM-9 Sidewinder that calculated the missile's engagement envelope and provided cues to the pilot to fly into the envelope. The radar offered no air-to-ground modes at all, nor was it capable of firing the AIM-7 Sparrow in spite of its BVR (Beyond Visual Range) capability.

The APQ-159's primary upgrade was the addition of a new planar phased array antenna, replacing the -153's parabolic dish. This made the antenna smaller front-to-back which allowed it to be pointed to higher angles within the nose. It also greatly reduced the sidelobes, which improved gain and allowed the range to be greatly increased from the -153's roughly 10 nautical miles (19 km) to the -159's 20 nautical miles (37 km).

# RADAR DISPLAY

The radar search pattern is a two-bar antenna scan depending on the radar operating range. The (vertical) radar range grid scale varies if you change the radar range with the Radar Range Scale Control. The uppermost horizontal line on the range scale is the maximal range. The other lines simply divide this distance in fifths of this distance.

## Radar Display in Search Mode




Radar Contact
Located 11 nm in front, 5 degrees to your left

**Radar B-Sweep (Instantaneous azimuth position of radar antenna)**

**Horizon Reference Line**

**Current Radar Antenna Elevation Angle (-10 deg)**

**Current Radar Antenna Elevation Angle Scale**

**Radar Scale Brightness Control Knob**
*Adjusts brightness of azimuth and range grid lines, azimuth and elevation scales, and missile steering circle from off to full bright.*

**Radar Pitch (Horizon Bar) Control Knob**
*Adjusts horizon bar 20 degrees up or down.*

**Radar Range Scale Light (nm)**

**Horizontal Lines Radar Range Grid (nm)**
*Uppermost line is the Radar Range Scale indicated by the Range Scale Light*

**Radar Cursor Brightness Control Knob**
*Adjusts brightness of horizon bar, elevation cursor, acquisition symbol and aim symbol on radarscope from off to full bright.*

**Radar Video Intensity Control Knob**
*Adjusts video intensity over ground clutters in MSL mode. Inoperative in DM, DG, and GUN mode*

**Radar Persistence Control Knob**
*Adjusts time the video remains on radarscope.*

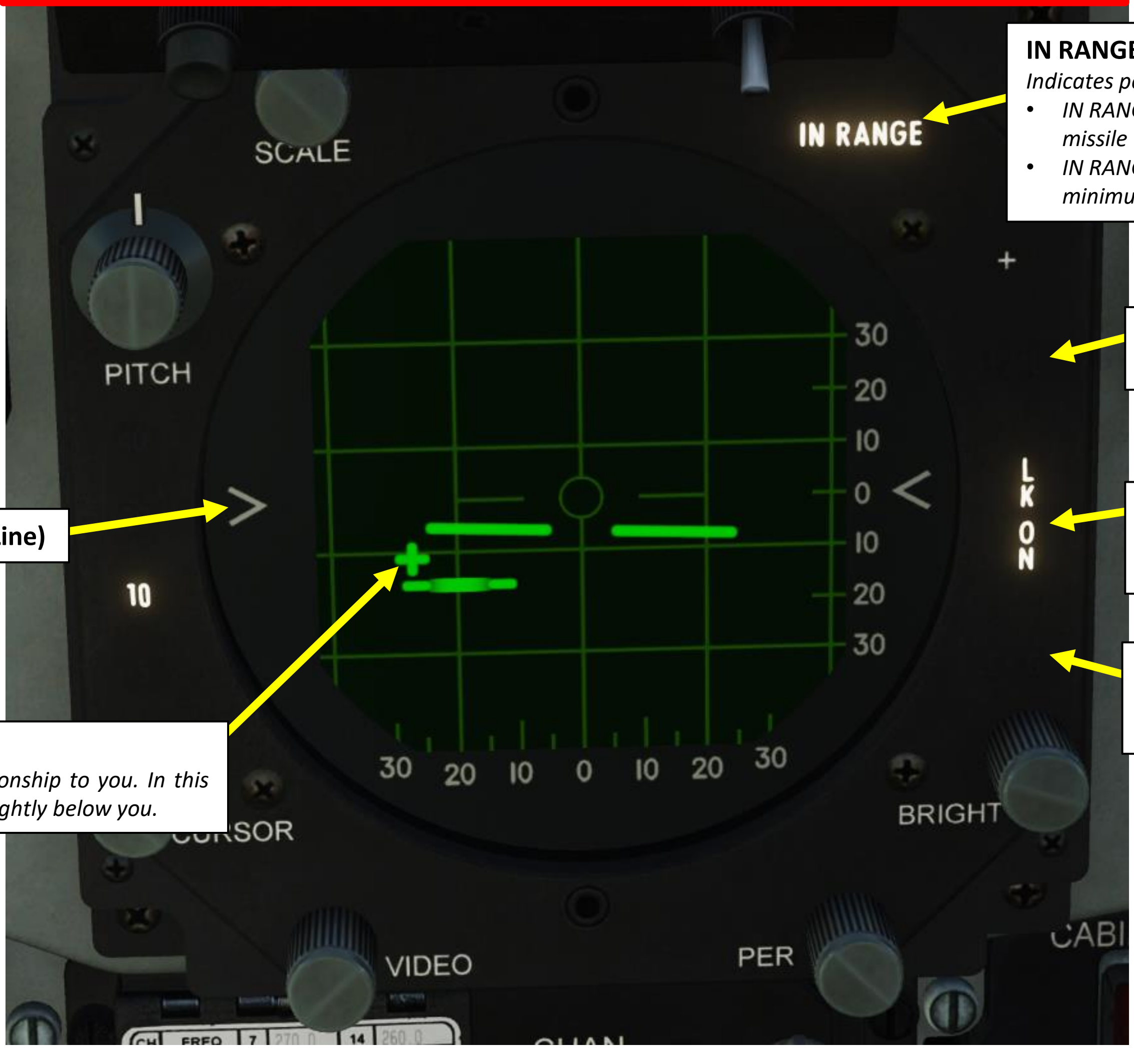
**Radar Brightness Control Knob**
*Adjusts background brightness of radarscope from off to full bright.*

**Radar Acquisition Symbol**
*Provides target bracketing and acquisition. Displayed on radarscope in search and acquisition phases, but not displayed in 40-miles range.*

# RADAR DISPLAY

In Lock-On/Tracking Mode (radar lock) mode, the radar displays a weapon aiming symbol that provides information about the locked target's altitude and azimuth relative to you.

## Radar Display in Lock-On/Tracking Mode




**IN RANGE Light**
*Indicates permissible range.*
- *IN RANGE is steady on: Target in range for missile launch or gun attack.*
- *IN RANGE is flashing: Target range is less than minimum range for missile launch or gun attack*

**FAIL Light**
*Illumination indicates radar failure.*

**LK ON Light**
*Illuminates when radar is locked on and during range-tracking target.*

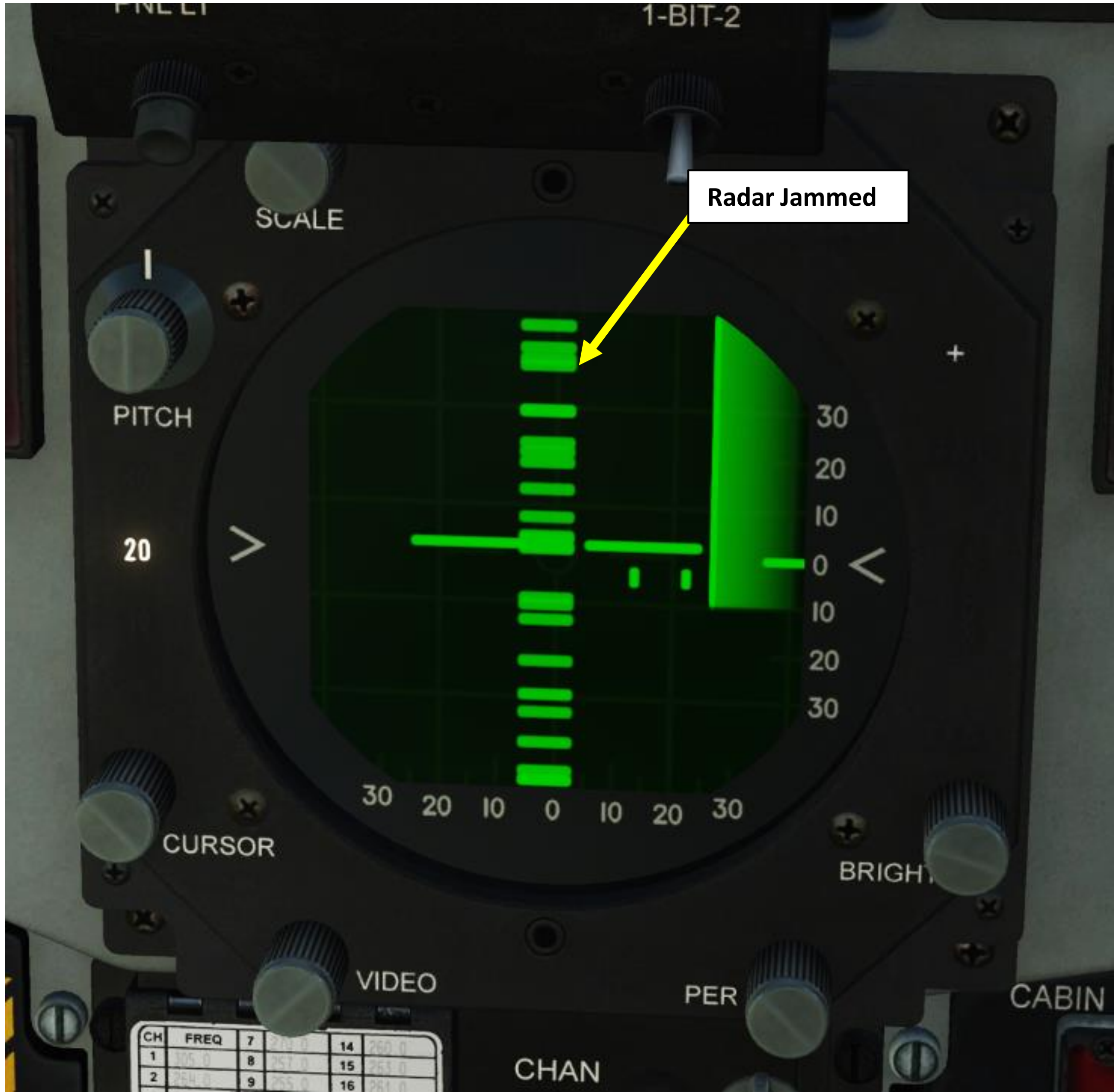
**EX G Light**
*Indicates excessive G condition for successful missile guidance.*

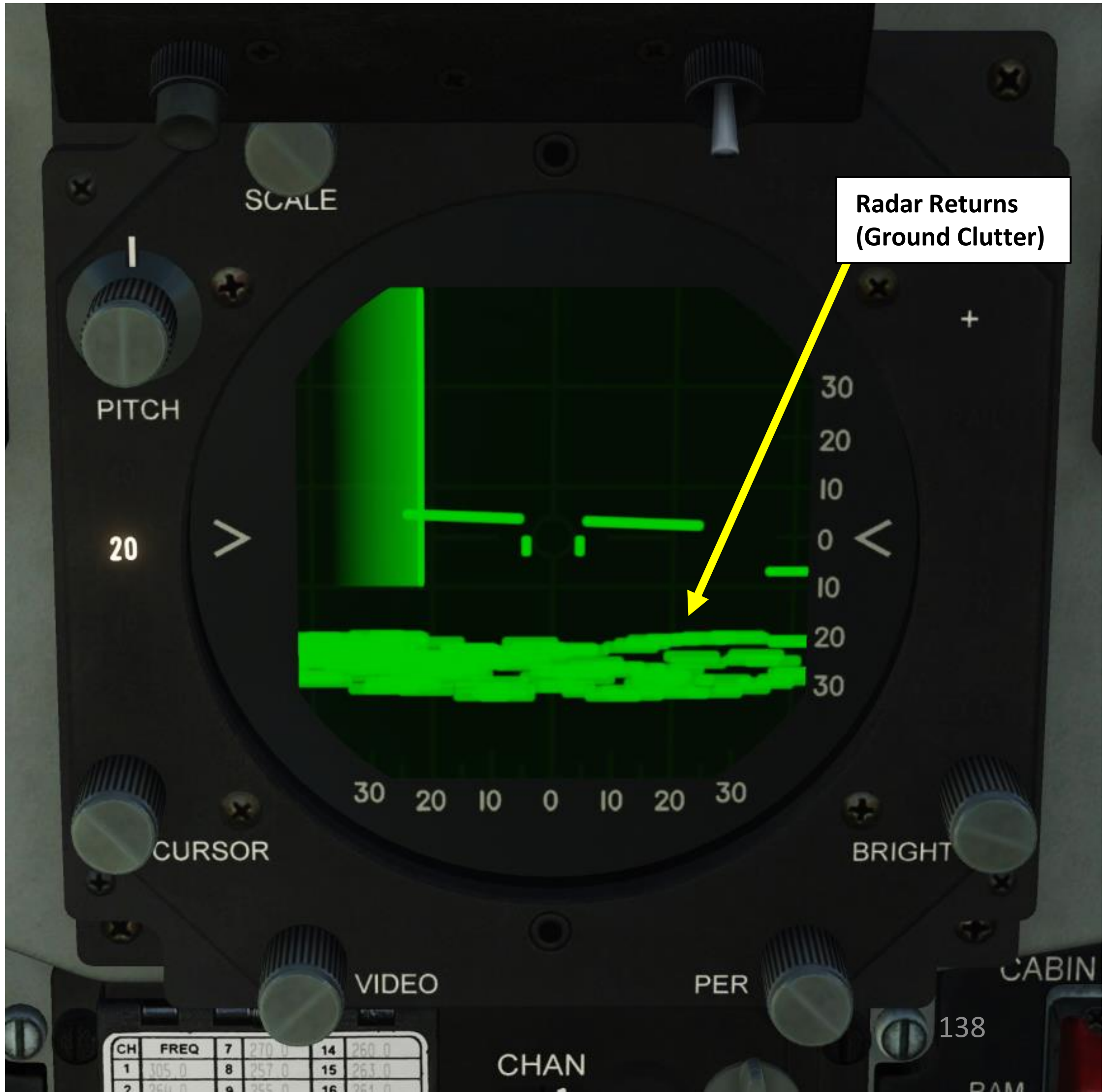
**ARL (Armament Reference Line)**

**Weapon Aiming Symbol**
*Indicates position of target in relationship to you. In this example, the target is to your left, slightly below you.*

# RADAR DISPLAY

The radar can become hard to read due to radar jamming signals or ground clutter.



# RADAR PERFORMANCE

The radar elevation angle can be controlled by tilting the radar antenna. However, your radar scanning cone only covers a definite azimuth and elevation angle as shown below. Distances and angles are not to scale. In search mode, the radar performs a 2-bar scan.

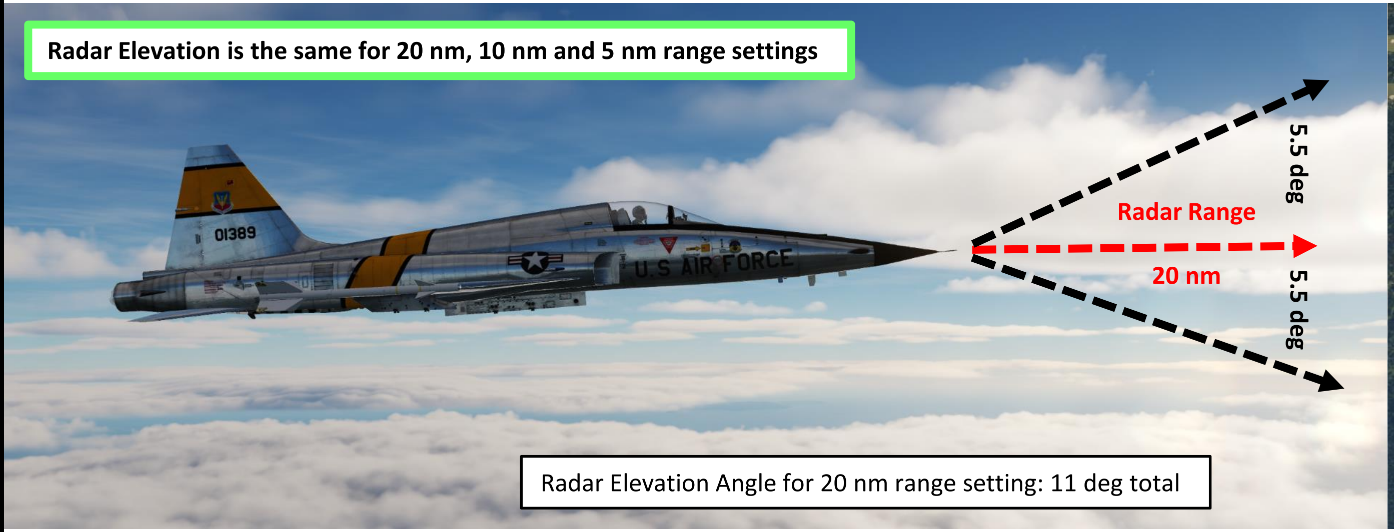
## HOW TO FIND TARGET ALTITUDE IN RELATIONSHIP TO YOU

Difference of Height (hundreds of ft) = Elevation Angle (deg) x Range (nm)

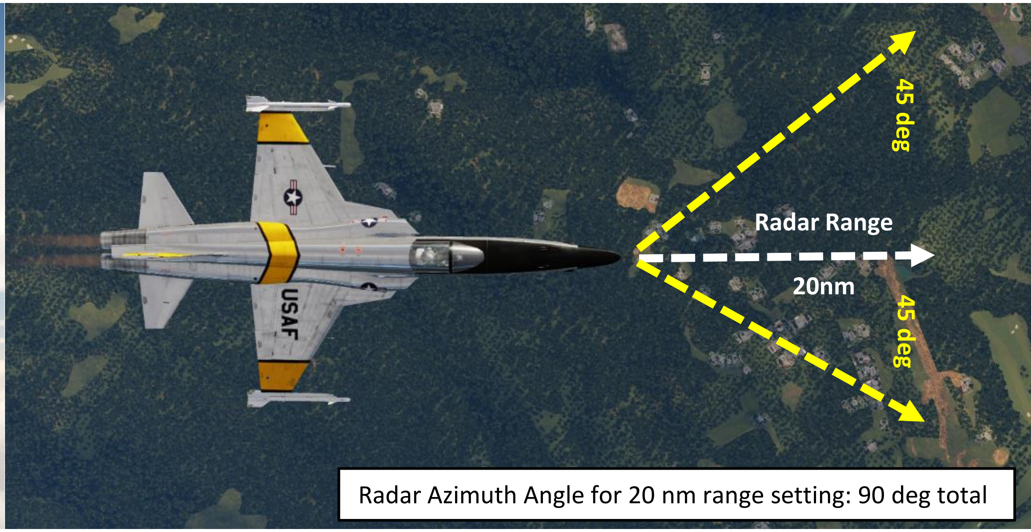
Example: Target Range at 10 nm, spotted at 5 deg UP

H = 5 deg x 10 nm = 50 x 100 ft = Target is 5000 ft above you

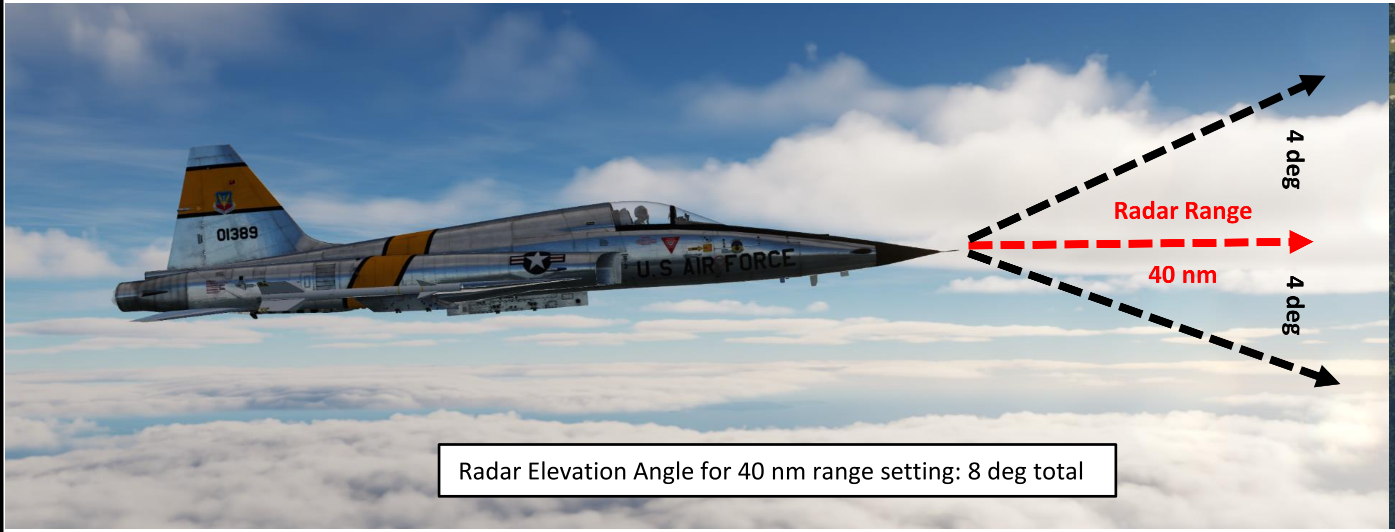
**Radar Elevation is the same for 20 nm, 10 nm and 5 nm range settings**



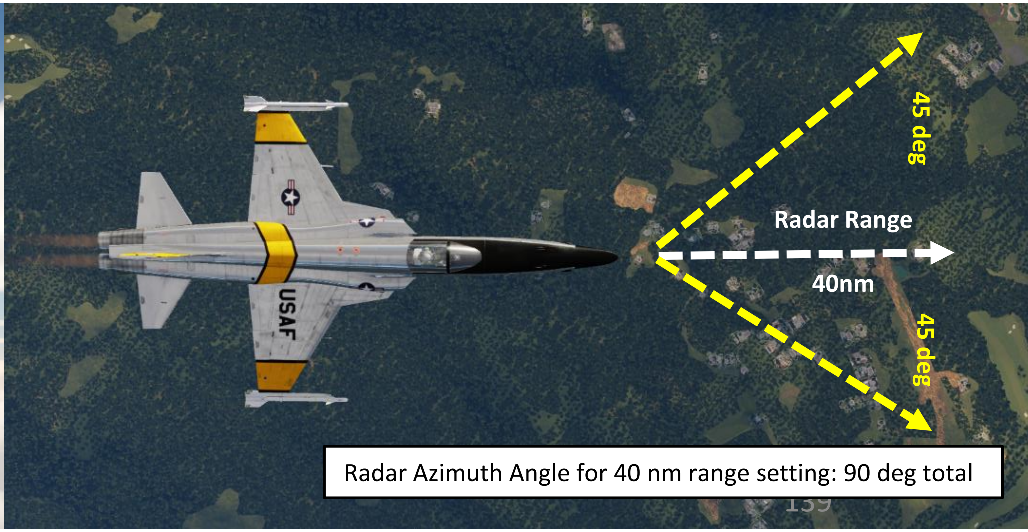

Radar Elevation Angle for 20 nm range setting: 11 deg total




Radar Azimuth Angle for 20 nm range setting: 90 deg total



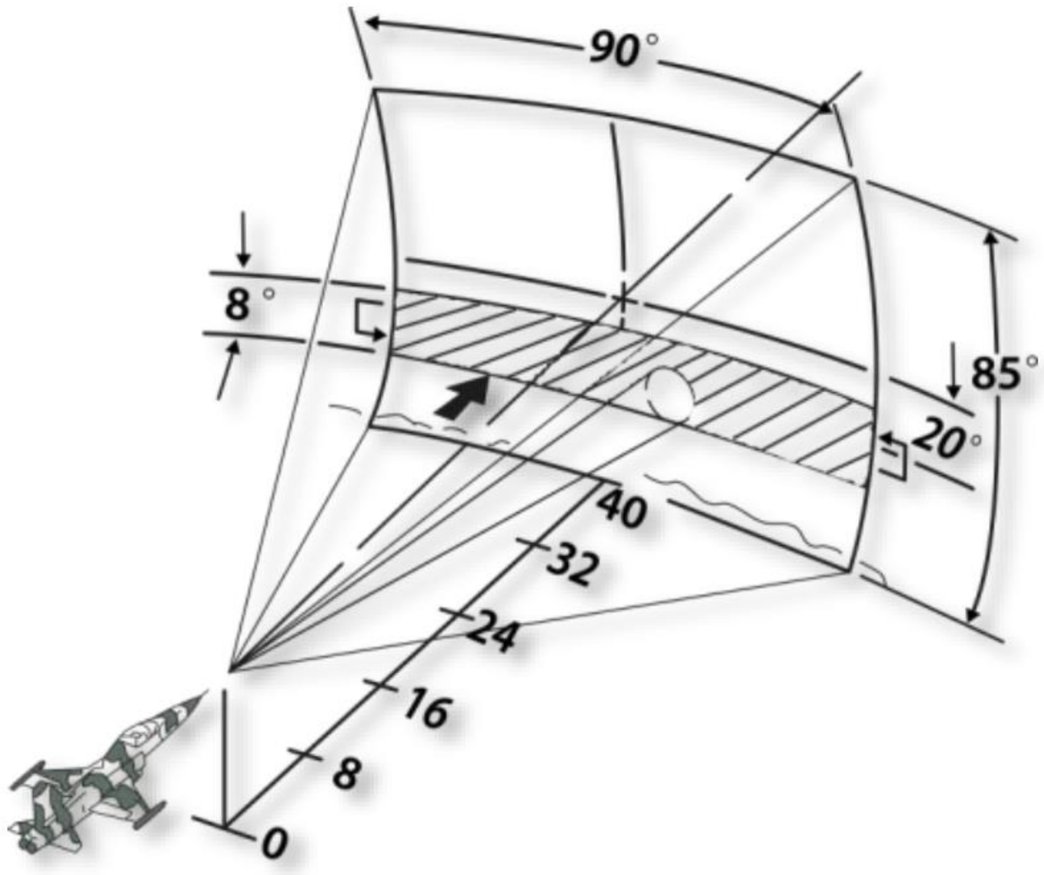

Radar Elevation Angle for 40 nm range setting: 8 deg total



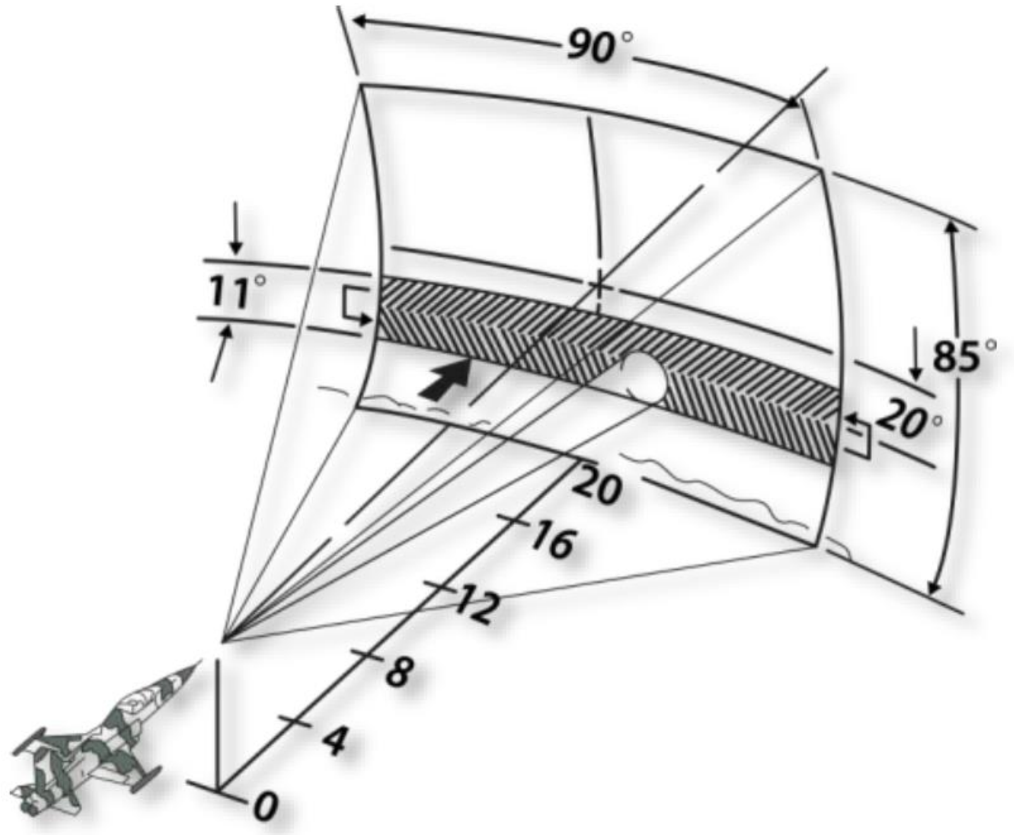

Radar Azimuth Angle for 40 nm range setting: 90 deg total

# RADAR PERFORMANCE

**40-mile Range Setting**
Antenna scan covers 90° in azimuth and 4 deg below and above antenna centerline.




**20, 10 and 5-mile Range Settings**
Antenna scan covers 90° in azimuth and 5.5 deg below and above antenna centerline.



# RADAR CONTROLS

**Dogfight/Resume Search Switch**

- ***FWD (DM MODE):*** *Selects DM mode and deactivates normal release system. After DM mode selection, antenna aligns to 0 degrees azimuth and on ARL. Range gate slews from 500 to 30,000 feet to lock on the first target encountered.*
- ***CENTER-PRESS (RESUME SEARCH):***
  - *In MSL mode – initiates search phase or breaks lock if radar was locked on.*
  - *In DM and DG modes – rejects selected dogfight mode, breaks lock if radar was locked on, and initiates search phase.*
  - *In GUNS mode – initiates search phase and breaks lock if radar was locked on.*
- ***AFT (DG MODE):*** *Selects DG mode and deactivates normal release system. After DG mode selection, antenna aligns to 0 degrees azimuth and 4.7 degrees below armament reference line (ARL). Range gate slews from 500 to 5600 feet to lock on the first target encountered.*

**Radar Mode Selector**

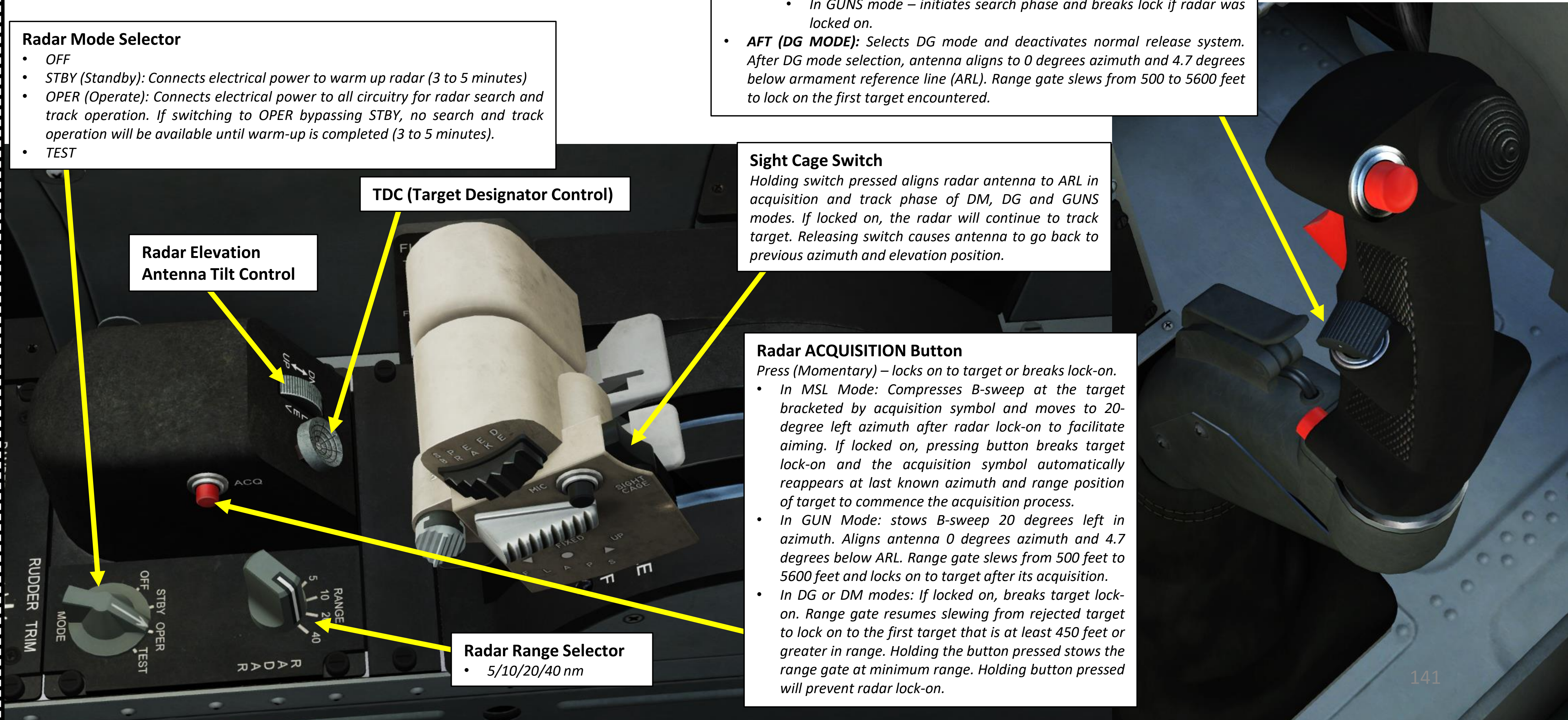
- *OFF*
- *STBY (Standby): Connects electrical power to warm up radar (3 to 5 minutes)*
- *OPER (Operate): Connects electrical power to all circuitry for radar search and track operation. If switching to OPER bypassing STBY, no search and track operation will be available until warm-up is completed (3 to 5 minutes).*
- *TEST*

**Sight Cage Switch**

*Holding switch pressed aligns radar antenna to ARL in acquisition and track phase of DM, DG and GUNS modes. If locked on, the radar will continue to track target. Releasing switch causes antenna to go back to previous azimuth and elevation position.*

**TDC (Target Designator Control)**

**Radar Elevation Antenna Tilt Control**




**Radar ACQUISITION Button**

*Press (Momentary) – locks on to target or breaks lock-on.*

- *In MSL Mode: Compresses B-sweep at the target bracketed by acquisition symbol and moves to 20-degree left azimuth after radar lock-on to facilitate aiming. If locked on, pressing button breaks target lock-on and the acquisition symbol automatically reappears at last known azimuth and range position of target to commence the acquisition process.*
- *In GUN Mode: stows B-sweep 20 degrees left in azimuth. Aligns antenna 0 degrees azimuth and 4.7 degrees below ARL. Range gate slews from 500 feet to 5600 feet and locks on to target after its acquisition.*
- *In DG or DM modes: If locked on, breaks target lock-on. Range gate resumes slewing from rejected target to lock on to the first target that is at least 450 feet or greater in range. Holding the button pressed stows the range gate at minimum range. Holding button pressed will prevent radar lock-on.*

**Radar Range Selector**

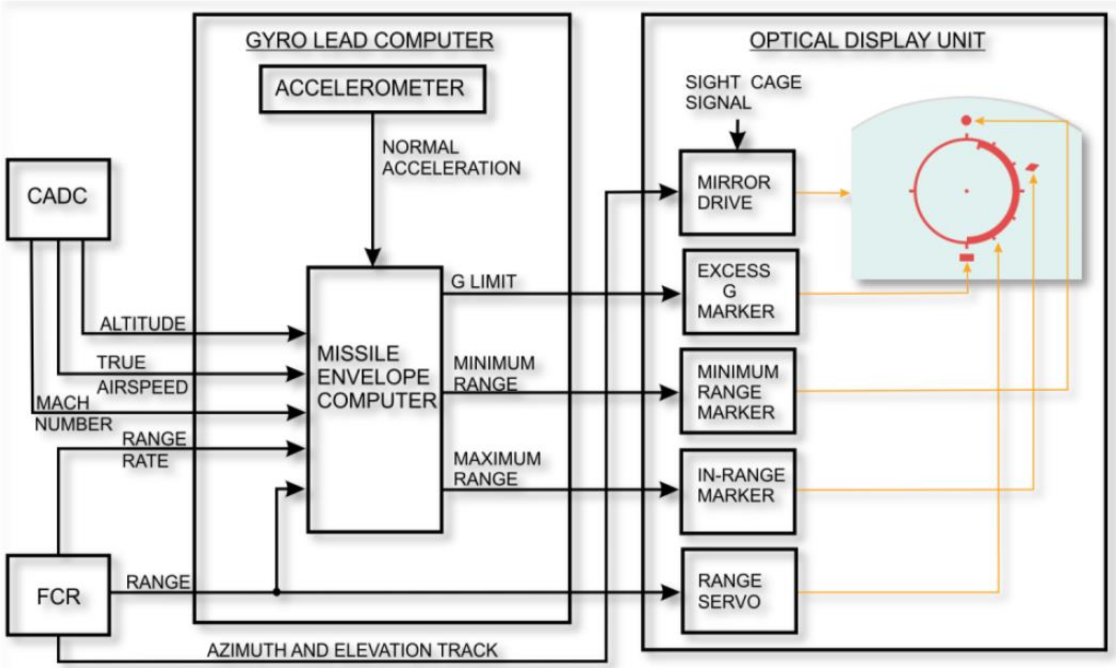
- *5/10/20/40 nm*

# AN/ASG-31 LCOSS (LEAD COMPUTING OPTICAL SIGHT SYSTEM)

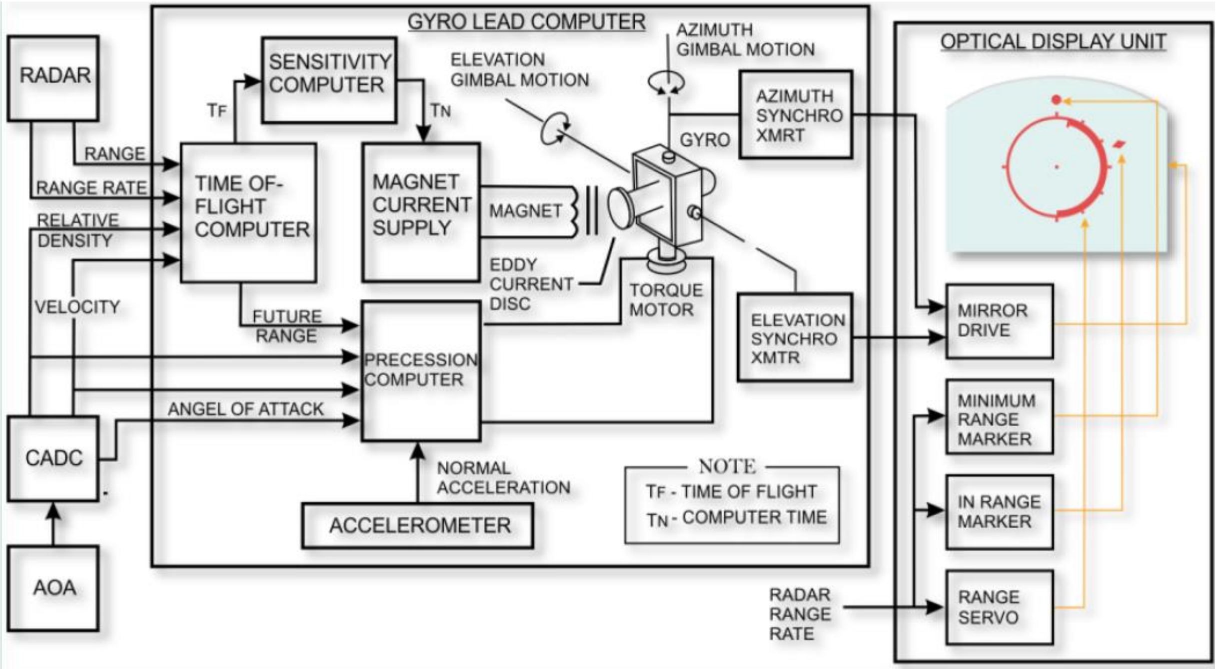
The AN/ASG–31 system aids aiming during air-to-air firing of the AIM–9 missiles and guns, air-to-ground guns firing, and air-to-ground delivery of bombs and rockets. The system computes and displays launch envelope for AIM-9 missile on the radar indicator and on the sight reticle as well as lead for air-to-air gun firing on optical sight in MSL, DM, DG, and A/A1 or A/A2 modes.

The AN/ASG-31 system consists of the GLC (Gyro Lead Computer) and the ODU (Optical Display Unit) .The AN/ASG-31 may be used in conjunction with the AN/APQ-159 or separately during air-to-air attacks. When only the AN/ASG–31 is used for air-to-air attacks, the reticle does not display range bar, range indexes, in-range, minimum-range, and excess-g markers. In this case, distance to a target can be estimated by comparing visible target size with reticle circle diameter.

**AN/ASG-31 and AN/APQ-159 Joint Operation in Missile Mode**




**AN/ASG-31 and AN/APQ-159 Joint Operation in Gun Mode**



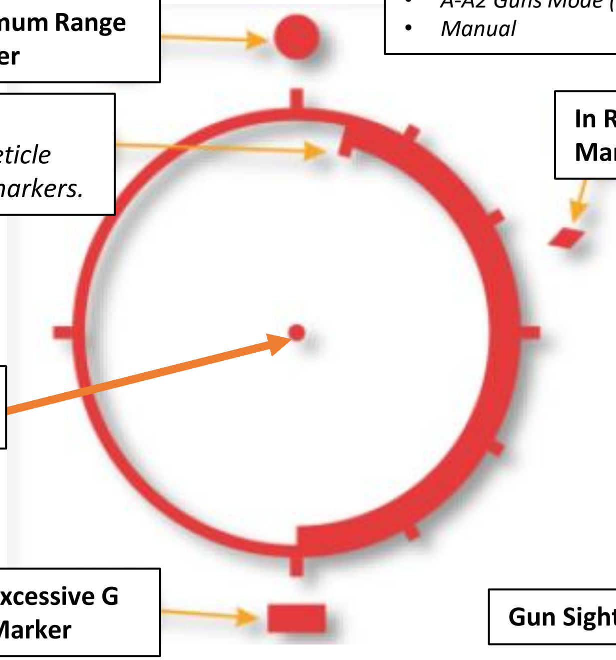
# AN/ASG-31 LCOSS (LEAD COMPUTING OPTICAL SIGHT SYSTEM)

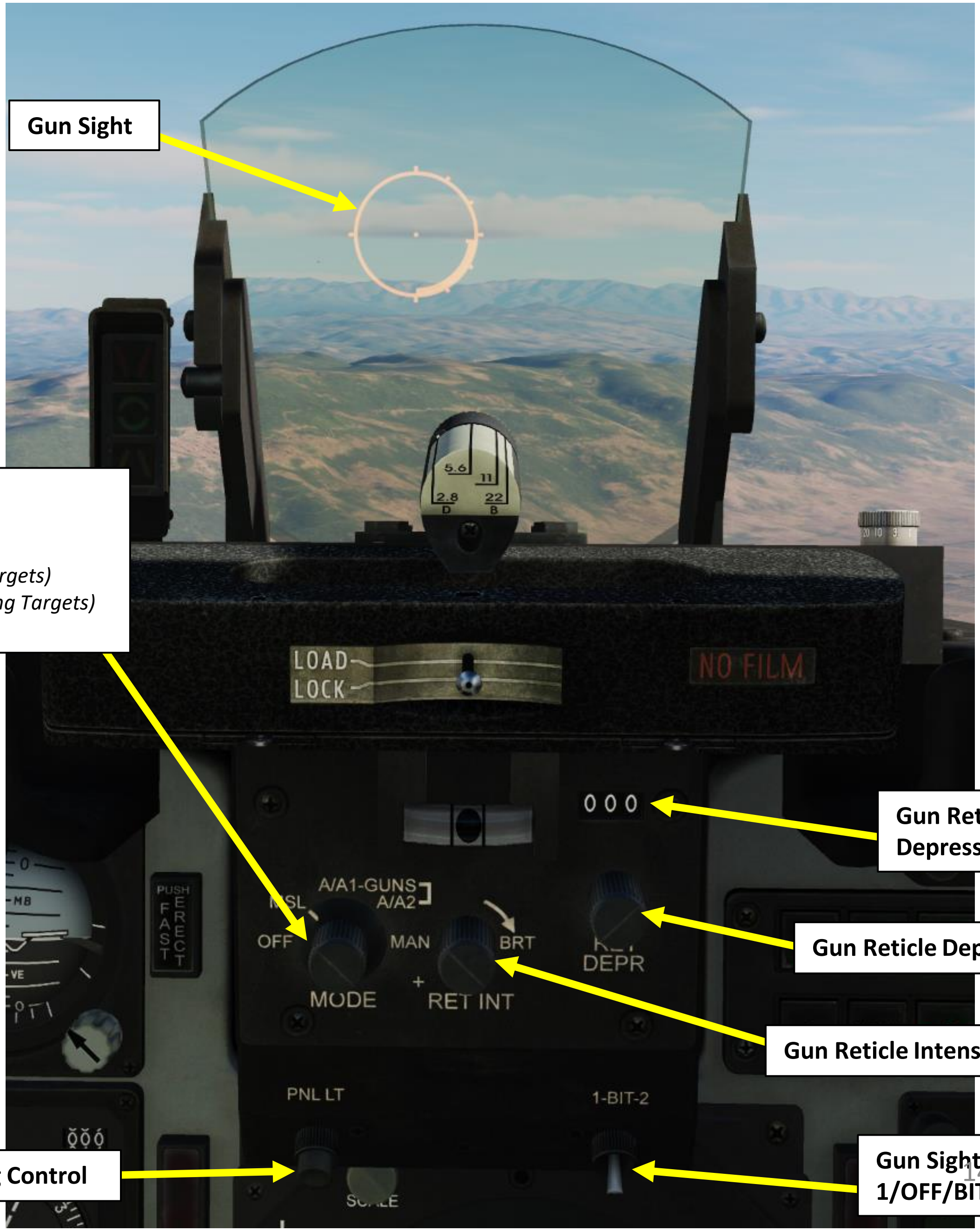
After radar locks-on to the target, aiming markers appear on the gun sight circle.

The range bar extends from the 6-o'clock position on the inner right side of the circle toward the 12-o'clock position, depending on the target range. Each range index indicates 1000 feet in gun modes and 10,000 feet in missile mode. The range indexes are located on the outer right side of the circle.

When the leading edge of the range bar is at the 6-o'clock position, range to the target is 60,000 feet in missile mode and 6000 feet in gun modes.

Decrease in target range causes the bar to move towards 12 o'clock position, and when the target range is within the permissible launch envelope, an in-range marker appears. The in-range marker disappears when the target is beyond launch envelope.



# RADAR OPERATING MODES

## Radar Modes Overview

**Missile (MSL)** mode provides target search, acquisition, lock-on, and tracking when firing AIM-9 missiles. The mode is used in long-range missile combats at distances up to 40 miles and requires the TDC to slew the radar acquisition symbol on the target. To lock, the Radar ACQUISITION button is pressed.

- MSL mode is selected by setting the AN/ASG-31 Sight Mode Selector to MSL, then setting the Dogfight/Resume Search Switch to CENTER-PRESS.

**Dogfight Missile (DM)** mode provides target search, acquisition, lock-on, and tracking when firing AIM-9 missiles. The mode is used in short-range missile combats at distances closer than 20 nm. It is recommended to perform target search and acquisition in 20-mile range before selecting DM mode.

- DM mode is selected by setting the Dogfight/Resume Search Switch FWD

**Dogfight Gun (DG)** mode provides target search, acquisition, and lock-on during guns firing. The mode is used in short-range combats against maneuvering targets with different angular rates. It is recommended to perform target search and acquisition in 10-mile range before selecting DG mode. After mode selection, if the target is within the range of 500 to 5600 feet, the radar automatically locks on to the target.

- DG mode is selected by setting the Dogfight/Resume Search Switch AFT

**A/A1 Guns Mode** is similar to Dogfight Gun (DG).

- A/A1 mode is selected by setting the AN/ASG-31 Sight Mode Selector to A/A1 and pressing the ACQ button to initiate lock-on to the target.

**A/A2 Guns Mode** mode provides target search, acquisition, and lock-on during gun firing. The mode is primarily used in short-range air-to-air combats against unaccelerated constant rate maneuvering target. It is recommended to perform target search and acquisition in 10-mile range before selecting A/A2 mode. After mode selection, if the target is within the range of 500 to 5600 feet, the radar automatically locks on to the target. In this mode, the sight system calculates the lead angle.

- A/A2 mode is selected by setting AN/ASG-31 Sight Mode Selector to A/A2 and pressing the ACQ button to initiate lock-on to the target.

All radar lock-on modes are exited using the Dogfight/Resume Search Switch CENTER-PRESS.

**AN/ASG-31 Sight Mode Selector**

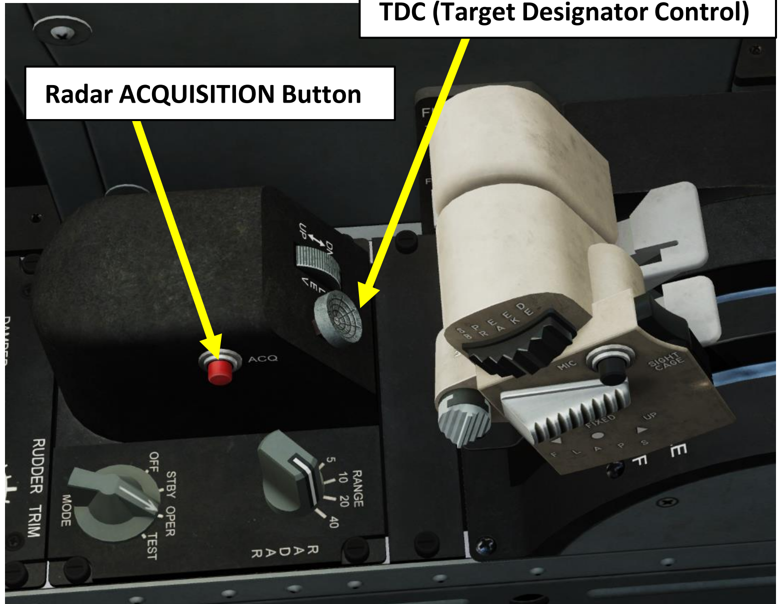
- *OFF*
- *MSL (Missile)*
- *A-A1 Guns Mode (Manoeuvering Targets)*
- *A-A2 Guns Mode (Non-Manoeuvering Targets)*
- *Manual*


**Dogfight/Resume Search Switch**

- *FWD (DM MODE)*
- *CENTER-PRESS (RESUME SEARCH)*
- *AFT (DG MODE)*

**TDC (Target Designator Control)**

**Radar ACQUISITION Button**

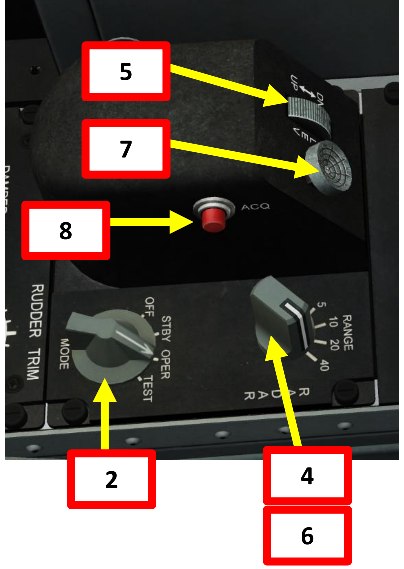



# RADAR OPERATING MODES

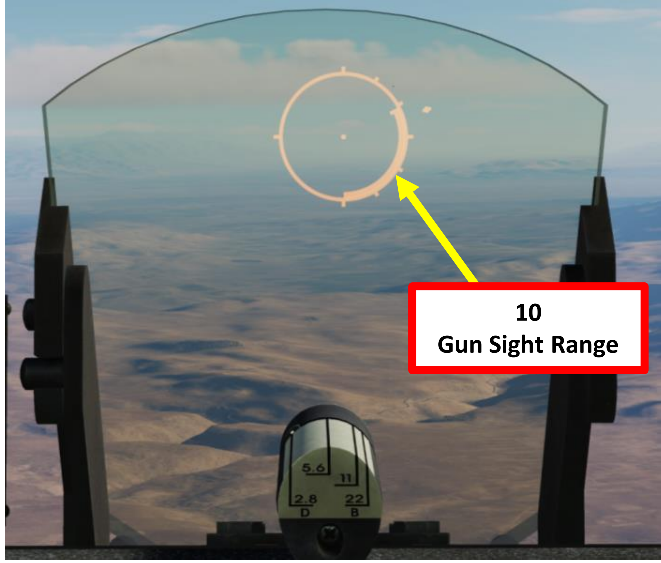
## Missile (MSL) Mode

MSL mode provides target search, acquisition, lock-on, and tracking when firing AIM-9 missiles. The mode is used in long-range missile combats at distances up to 40 miles.

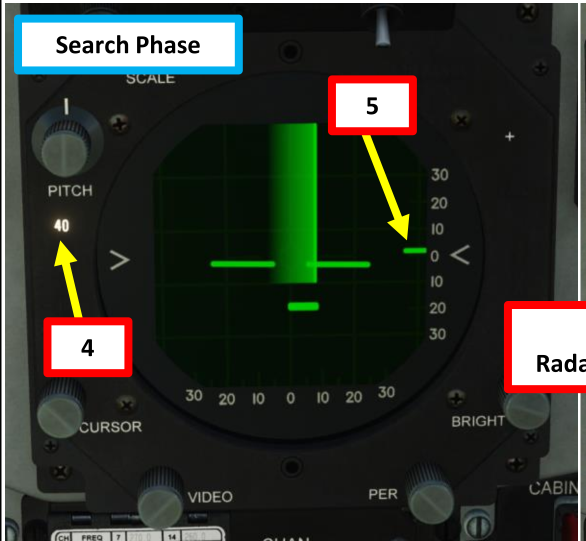
1. Set AN/ASG-31 Sight Mode Selector to MSL
2. Make sure Radar Mode selector is set to OPER
3. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
4. Set the radar range to 40 nm.
5. Tilt the radar antenna vertically as required.
6. Detect target on the radar, then set radar range to 20 nm.
7. Slew Acquisition symbol (ACQ) over the radar contact using the TDC (Target Designator Control).
8. Press ACQ button to spotlight target and attempt a radar lock. Range scale automatically changes to 10 nm. Antenna starts scanning ±5 degrees in azimuth and ±1.5 degrees in elevation.
9. After radar lock-on to the target, antenna conically scans about the target with 12 deg span. Radar display shows target range gate and weapon aiming symbol.
10. After radar lock-on to the target, aiming markers appear on the gun sight circle.
11. You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).

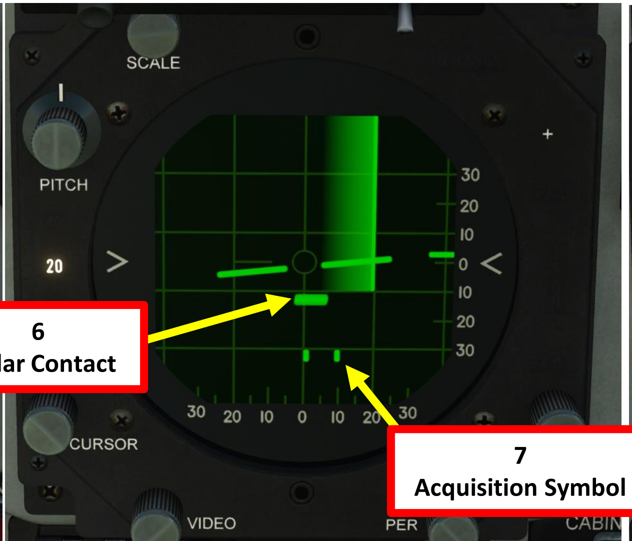


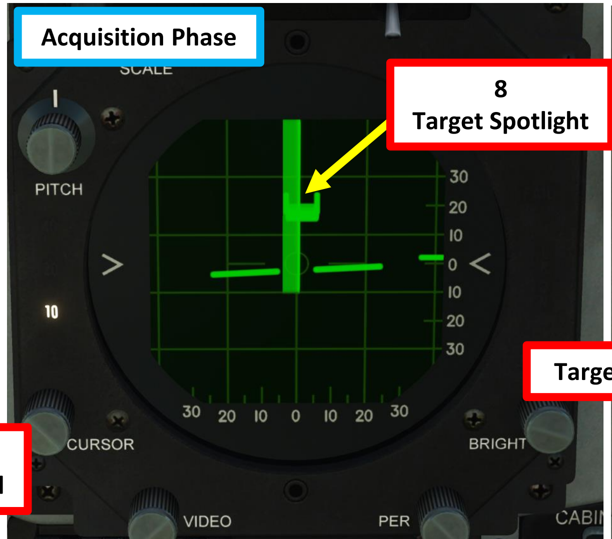


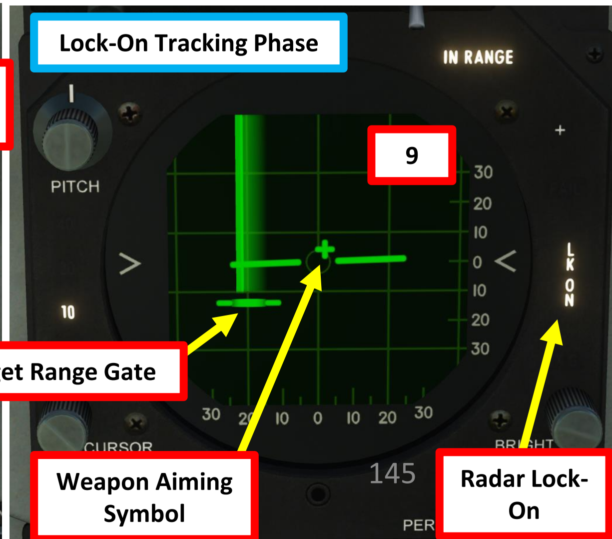






# RADAR OPERATING MODES

## Missile (MSL) Mode

The maximum acquisition range ($R_A$) and lock-on range ($R_{LO}$) in MSL mode depend on target flight altitude, aircraft type, and direction relative to the fighter. In the tables below, the fighter used as a reference is the F-4 Phantom II and the bomber used as a reference is a B-52.

**Acquisition and Lock-On Range at Head-On Attack**

| Target type | Altitude (feet) | $R_A$ (miles) | $R_{LO}$ (miles) |
|---|---|---|---|
| Bomber | >5000 | ≈40 | ≈10 |
| Fighter | >5000 | ≈16.6 | ≈10 |
| Bomber | <5000 | ≈24 | ≈10 |
| Fighter | <5000 | ≈10 | ≈8.5 |

**Acquisition and Lock-On Range at Stern Attack**

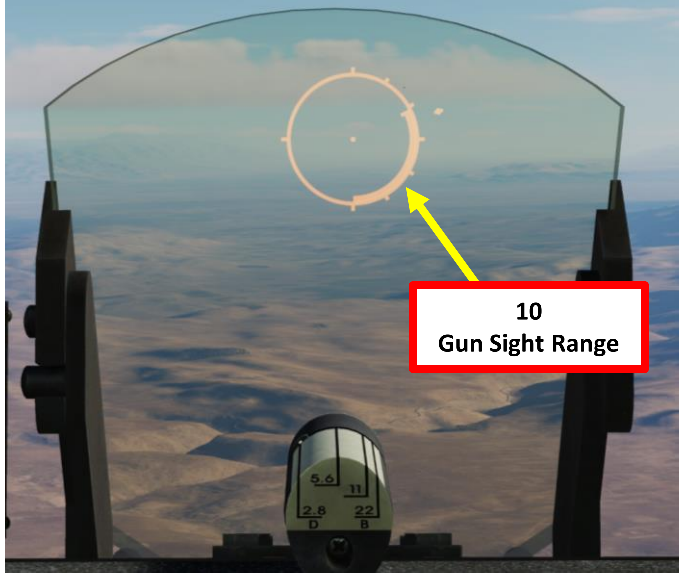
| Target type | Altitude (feet) | $R_A$ (miles) | $R_{LO}$ (miles) |
|---|---|---|---|
| Bomber | >5000 | ≈13 | ≈10 |
| Fighter | >5000 | ≈5.5 | ≈5 |
| Bomber | <5000 | ≈8 | ≈6.8 |
| Fighter | <5000 | ≈5 | ≈4.5 |

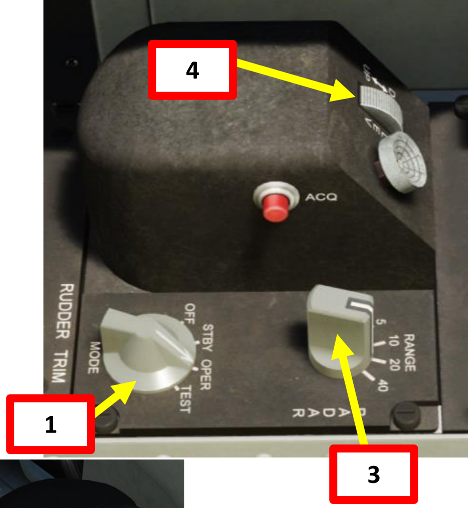
# RADAR OPERATING MODES

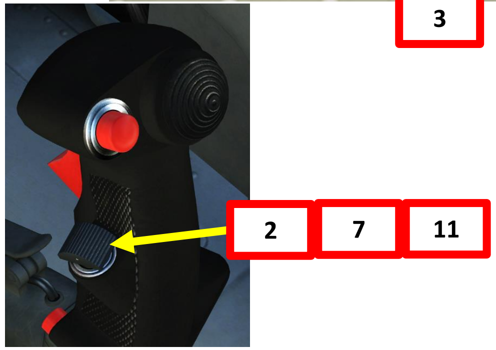
## Dogfight Missile (DM) Mode

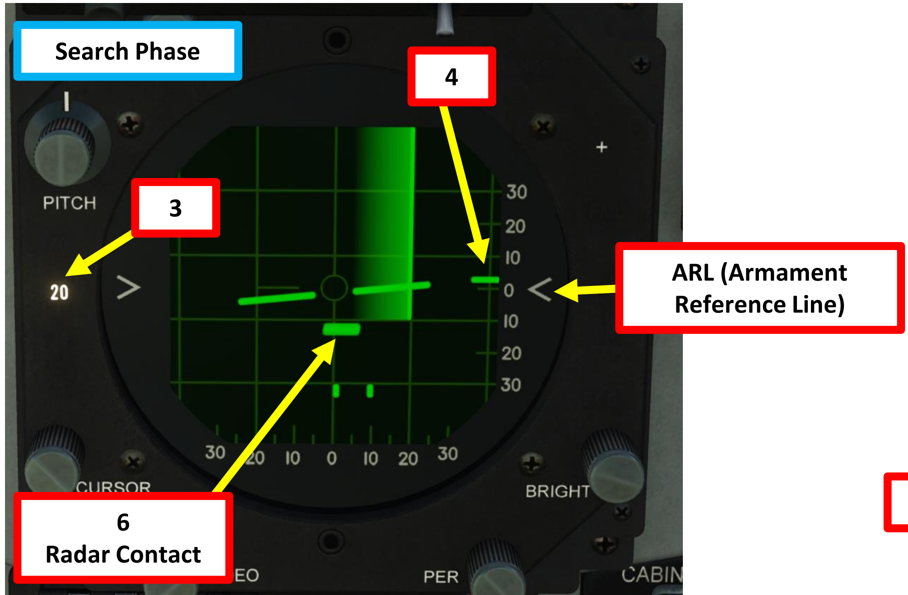
Dogfight Missile (DM) mode provides target search, acquisition, lock-on, and tracking when firing AIM-9 missiles. The mode is used in short-range missile combats at distances closer than 20 nm. It is recommended to perform target search and acquisition in 20-mile range before selecting DM mode.

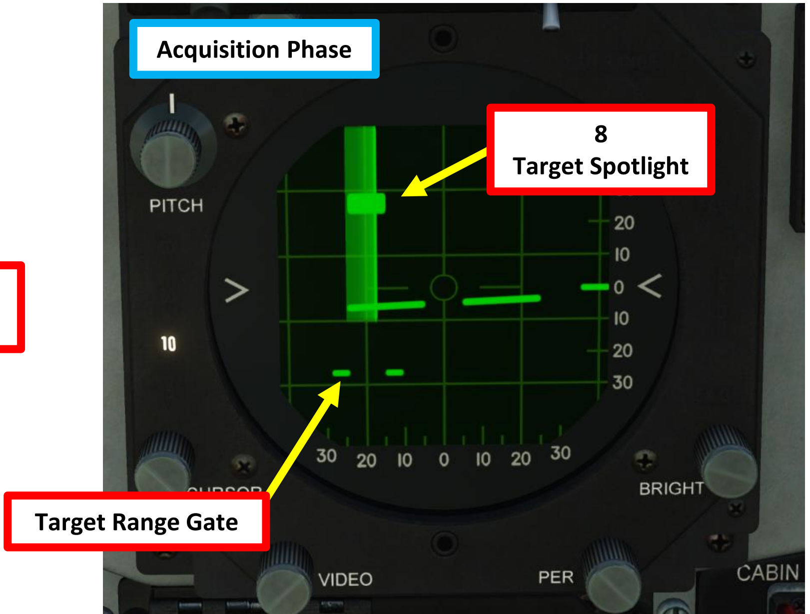
1. Make sure Radar Mode selector is set to OPER
2. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
3. Set the radar range as required.
4. Tilt the radar antenna vertically as required.
5. Detect target on the radar, then get to a distance of 20 nm or less.
6. Maneuver aircraft to center target on 0 deg azimuth and elevation.
7. Initiate DM (Dogfight Missile) Mode by setting the Dogfight/Resume Search Switch to FWD.
8. After DM mode selection, the radar antenna aligns to 0° azimuth and on ARL (Armament Reference Line) and range scale changes to 10 miles. If the target is within the range of 500 to 30,000 feet, the radar automatically locks on to the first target encountered.
9. After radar lock-on to the target, radar display shows target range gate and weapon aiming symbol.
10. After radar lock-on to the target, aiming markers appear on the gun sight circle.
11. You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).



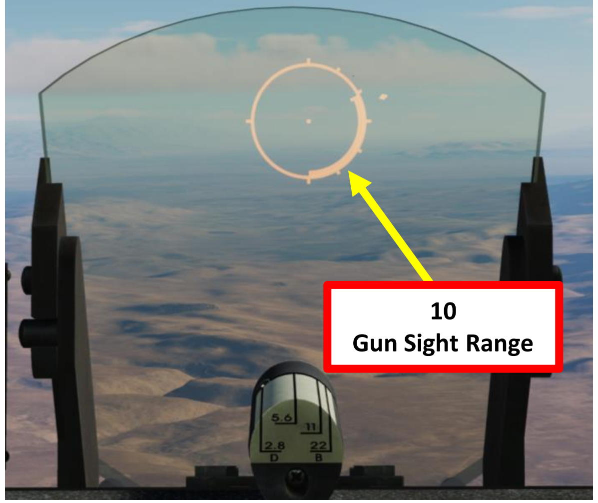



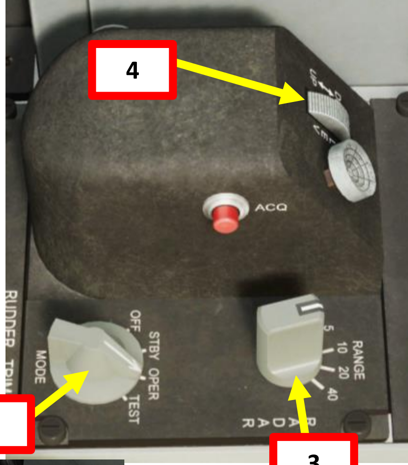

# RADAR OPERATING MODES

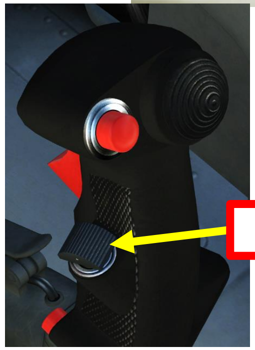
## Dogfight Gun (DG) Mode

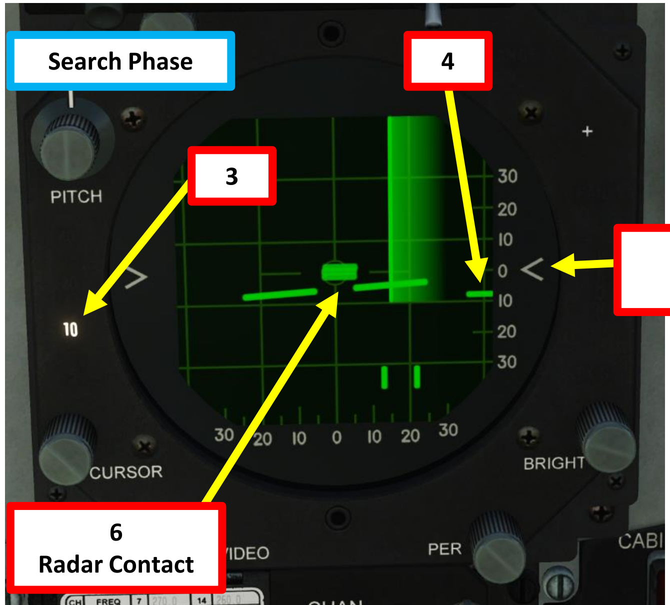
Dogfight Gun (DG) mode provides target search, acquisition, and lock-on during guns firing. The mode is used in short-range combats against maneuvering targets with different angular rates. It is recommended to perform target search and acquisition in 10-mile range before selecting DG mode. After mode selection, if the target is within the range of 500 to 5600 feet, the radar automatically locks on to the target.

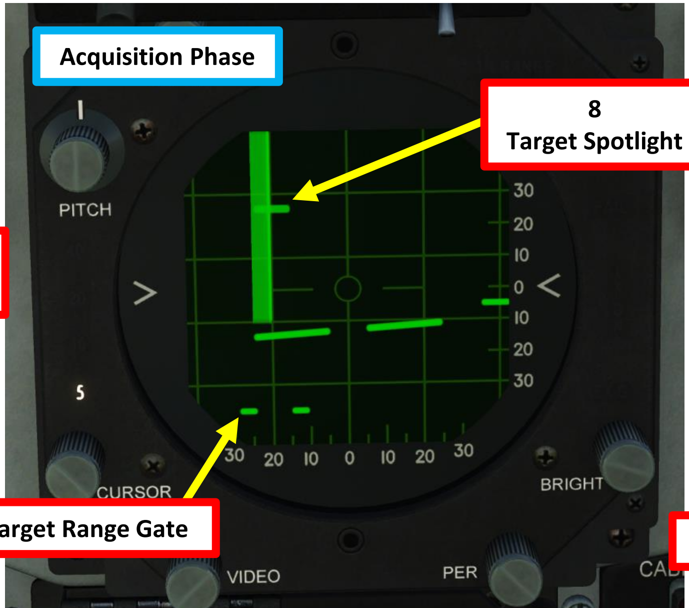
1. Make sure Radar Mode selector is set to OPER
2. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
3. Set the radar range as required.
4. Tilt the radar antenna vertically as required.
5. Detect target on the radar, then get to a distance of 10 nm or less.
6. Maneuver aircraft to center target on 0 deg azimuth and elevation.
7. Initiate DG (Dogfight Gun) Mode by setting the Dogfight/Resume Search Switch to AFT.
8. After DG mode selection, the radar antenna aligns to 0° azimuth and 4.7 deg below ARL (Armament Reference Line) and range scale changes to 5 miles. If the target is within the range of 500 to 5,600 feet, the radar automatically locks on to the first target encountered.
9. After radar lock-on to the target, radar display shows target range gate.
10. After radar lock-on to the target, aiming markers appear on the gun sight circle with ranging information.
11. You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).

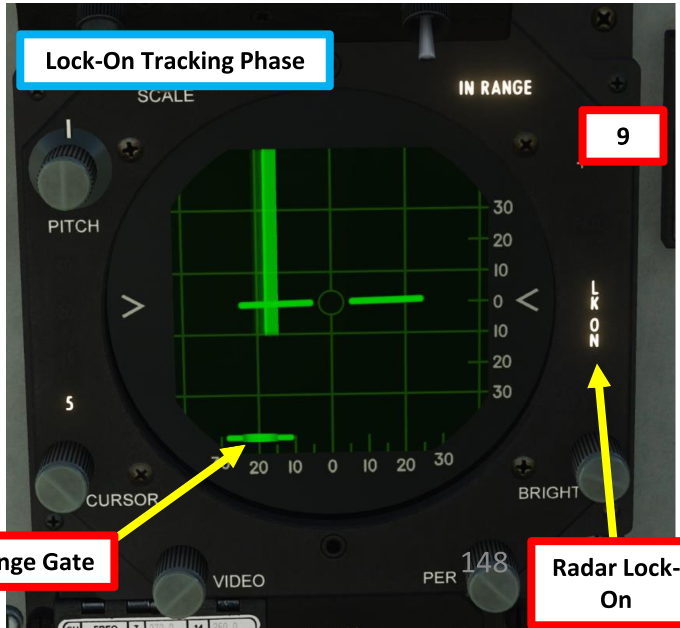


# NOTES ABOUT RADAR

For DCS players used to modern jets, there are a few important points to clarify with the radar of the F-5.

- The radar does not actually guide your AIM-9 missiles: Sidewinders track infrared signatures and do not require any radar guidance. The radar provides you with an estimate for the target range, but no proper missile guidance capability.
- The radar should be used as a tool to improve your situational awareness, but keep in mind to look outside. The radar's capabilities are quite limiting in close range dogfights.
- The radar is not able to differentiate between friendly or enemy contacts. Make sure you properly identify your target visually before firing anything.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# SECTION STRUCTURE


- **1 - Introduction**
  - 1.1 – Weapons Overview
  - 1.2 – My Weapons Control Setup
- **2 – Air-to-Ground Weapons**
  - 2.1 – Unguided Bombs (MK-82 High Drag Snake Eyes)
  - 2.2 – GBU-12 Paveway II Laser-Guided Bombs
  - 2.3 – Hydra 70 (2.75 in) Rockets
  - 2.4 – M-39A3 20 mm Guns (Air-to-Ground)
- **3 – Air-to-Air Weapons**
  - 3.1 – AIM-9 Sidewinder Missile
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    - 3.1.2 – DM (Dogfight Missile) Mode
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  - 4.2 – Emergency Stores Jettison

# 1 – Introduction
## 1.1 – Weapons Overview

### AIR-TO-AIR MISSILES

| NAME | DESCRIPTION |
|---|---|
| AIM-9B | Short range IR guided missile |
| AIM-9P | Short range IR guided missile, upgrade to the AIM-9B |
| AIM-9P5 | Short range IR guided missile, upgrade to the AIM-9P |

### GUNS

| NAME | DESCRIPTION |
|---|---|
| M-39A3 | 20 mm cannons (280 rounds per cannon x 2 cannons). The gun fires at 1500 to 1700 rounds per minute. |

### ROCKETS

| NAME | DESCRIPTION |
|---|---|
| Hydra 70 (LAU-3 Pod) | 19 x 70 mm (2.75 in) unguided FFAR (Folding-Fin Aerial Rockets) |
| Hydra 70 (LAU-68 Pod) | 7 x 70 mm (2.75 in) unguided FFAR (Folding-Fin Aerial Rockets) |

### BOMBS (UNGUIDED)

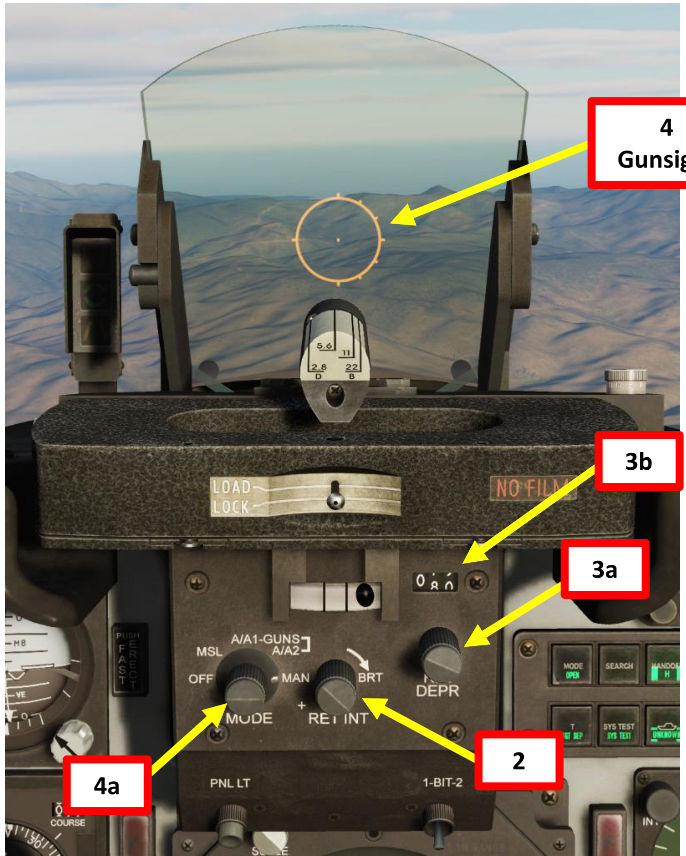
| NAME | DESCRIPTION |
|---|---|
| BDU-33 | 25 lbs Practice bombs |
| BDU-50HD | 500 lbs Inert High-Drag Practice Bomb |
| BDU-50LD | 500 lbs Inert Low-Drag Practice Bomb |
| BDU-50LGB | 500 lbs Laser-Guided Inert Low-Drag Practice Bomb |
| CBU-52B | 220 x High Explosive / Fragmentation Cluster Bomblets |
| GBU-12 | 500 lbs Laser-Guided Bomb |
| M117 | 750 lbs Low-Drag General-Purpose Bomb |
| Mk-82 | 500 lbs Low-Drag General-Purpose Bomb |
| MK-82 Snakeye | 500 lbs High-Drag General-Purpose Bomb |
| MK-83 | 1000 lbs Low-Drag General-Purpose Bomb |
| Mk-84 | 2000 lbs Low-Drag General-Purpose Bomb |
| SUU-25 x 8 LUU-2 | Target Marker Flares |

# 1 – Introduction
## 1.2 – My Weapons Control Setup

# 2.1 – Unguided Bombs
## MK-82 Snake Eye High-Drag Bombs

# 2.1 – Unguided Bombs
# MK-82 Snake Eye High-Drag Bombs

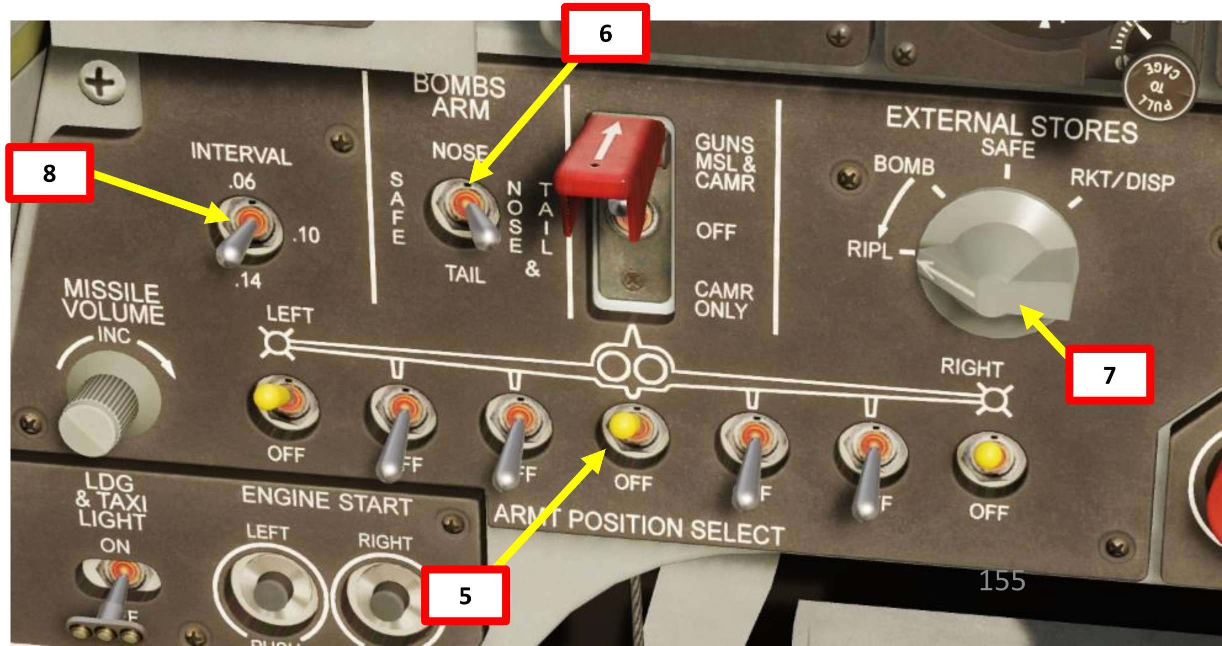
1. Determine target altitude using the F10 map (in our case 0 ft). Add target elevation to your dive bombing table altitude parameters.
    - In this example, we will perform a 30 deg dive from 6000 ft with a dive initiation speed of 350 kts. The release altitude will be 2000 ft and the release speed of 440 to 450 KIAS.
2. Set gunsight reticle brightness – as required.
3. Set gunsight depression to approx. 79 mils DOWN using the DEPR knob
4. Set gunsight mode to MANUAL
5. Power on armament pylons with the bombs you want to drop.
6. Arm bomb fuses (NOSE & TAIL recommended)
7. Select external store release (BOMB for single bomb release or RIPL for ripple bomb release)
8. If RIPL selected, set desired bomb release interval (0.06, 0.10 or 0.14 seconds).




**1** **Dive Bombing Table**

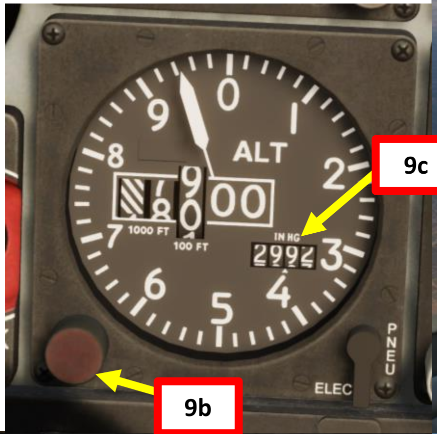
| Parameter | Dive Angles (degrees) | |
|---|---|---|
| | 20 | 30 |
| Dive initiation altitude (ft AGL) | 5000 | 6000 |
| Dive initiation speed (kts) | 350 | 350 |
| Release altitude (ft AGL) | 1500 | 2000 |
| Release speed (kts) | 380 to 400 | 440 to 450 |
| Reticle Depression (mils) | 80 | 79 |

Bombing is very difficult in the F-5 since you need to enter very precise input parameters. The ones I recommend are those who work most of the time, but if you want to bomb very precisely, I suggest that you consult this bombing chart from the F-5E Weapon Delivery Manual from the 476th Virtual Fighter Group:
http://www.476vfightergroup.com/downloads.php?do=file&id=446

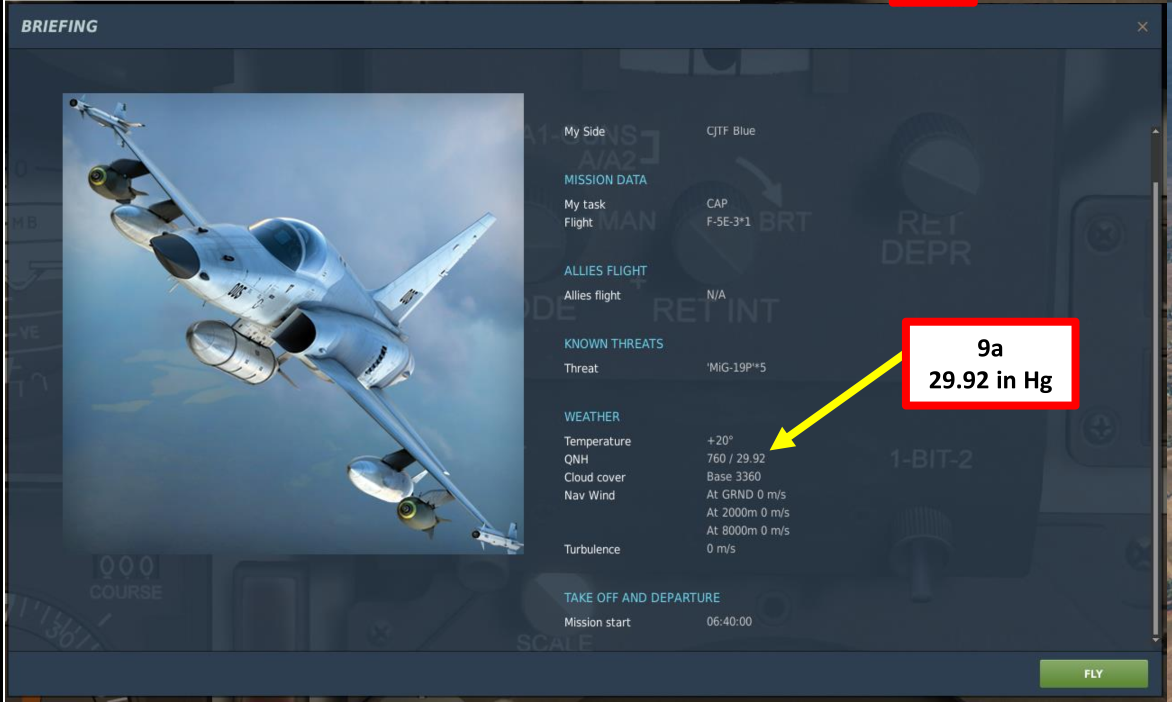


# 2.1 – Unguided Bombs
# MK-82 Snake Eye High-Drag Bombs

9. Consult mission briefing and set the barometric pressure setting to the QNH pressure reference to sea level. It is important to set it correctly since barometric altitude is the only way we have to estimate the release altitude since the F-5E does not have a radar altimeter nor a radar that provides air-to-ground ranging information.
10. Approach the target and maintain it to your aircraft's 10 o'clock position. Fly at least 6000 ft above the target at 350 kts or faster.

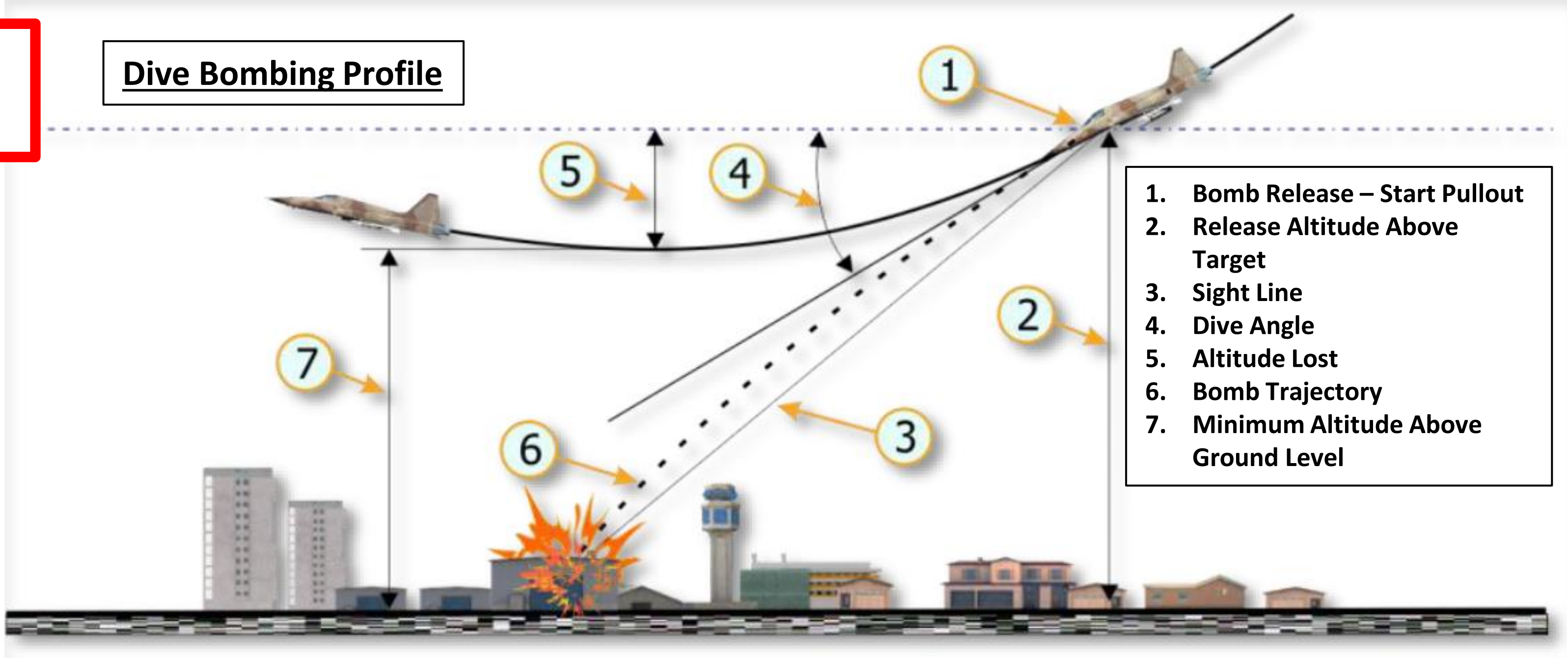


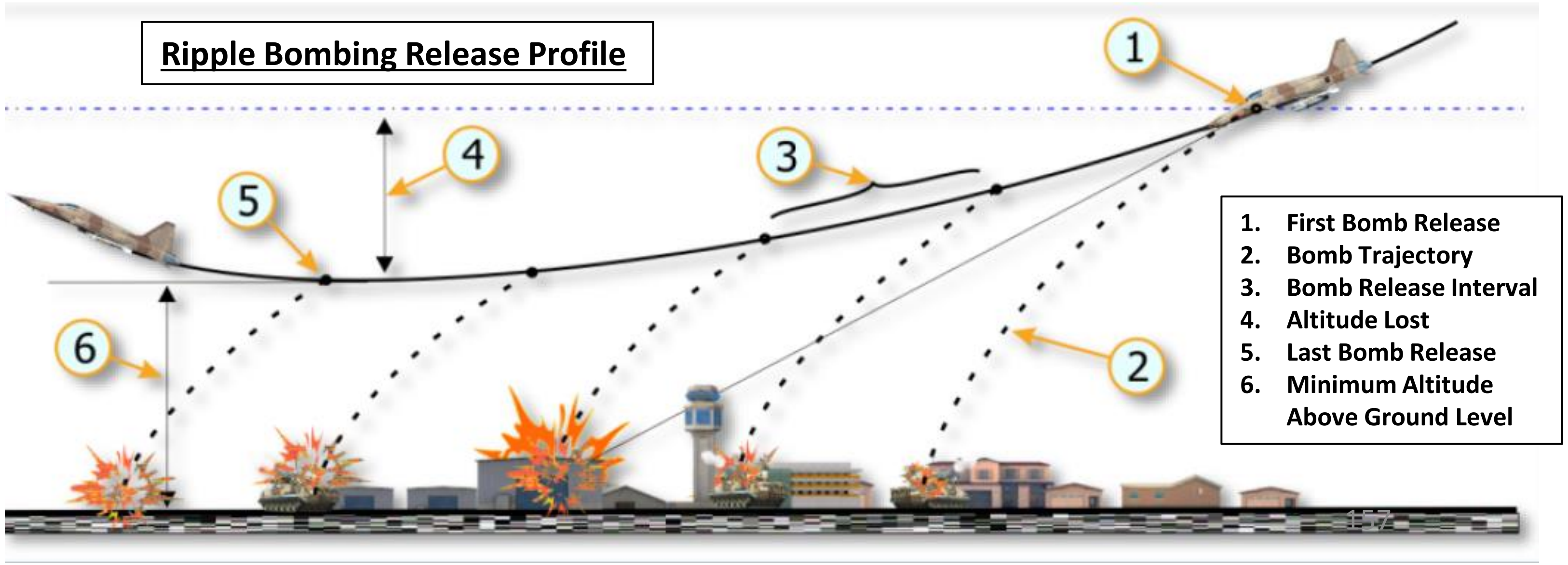





# 2.1 – Unguided Bombs
# MK-82 Snake Eye High-Drag Bombs

11. For a 30 deg bomb run dive, roll in on the target while throttling back to IDLE. Dive should be initiated from 6000 ft at 350 kts.
12. Use your altimeter, speed indicator and attitude indicator to fly with correct bombing parameters. For a 30 deg dive, maintain airspeed between 440 and 450 kts.



# 2.1 – Unguided Bombs
# MK-82 Snake Eye High-Drag Bombs

13. Keep gunsight pipper slightly below target as you dive.
14. Align target with gunsight pipper before bomb release (2000 ft above ground level).
15. Release bombs 2000 ft above ground level by holding the WEAPON RELEASE BUTTON (RAlt+Space).
16. After bomb release, recover from the dive with a 4 G pull up. This pull up must happen within 2 seconds after weapon release or the blast radius may damage your aircraft.

15

13
Gunsight Pipper
(Below Target)

14
Gunsight Pipper
(On Target)

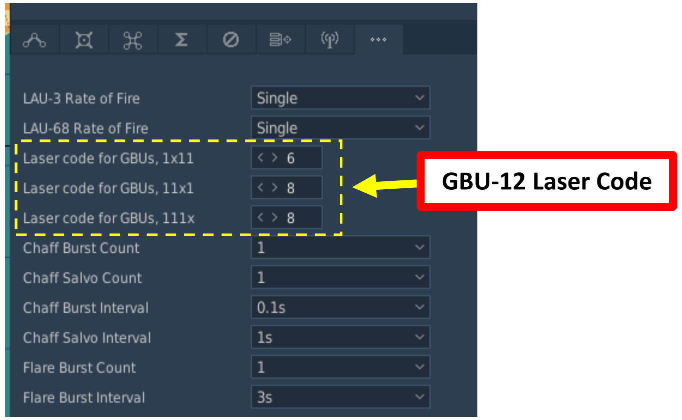
## 2.1 – Unguided Bombs
## MK-82 Snake Eye High-Drag Bombs

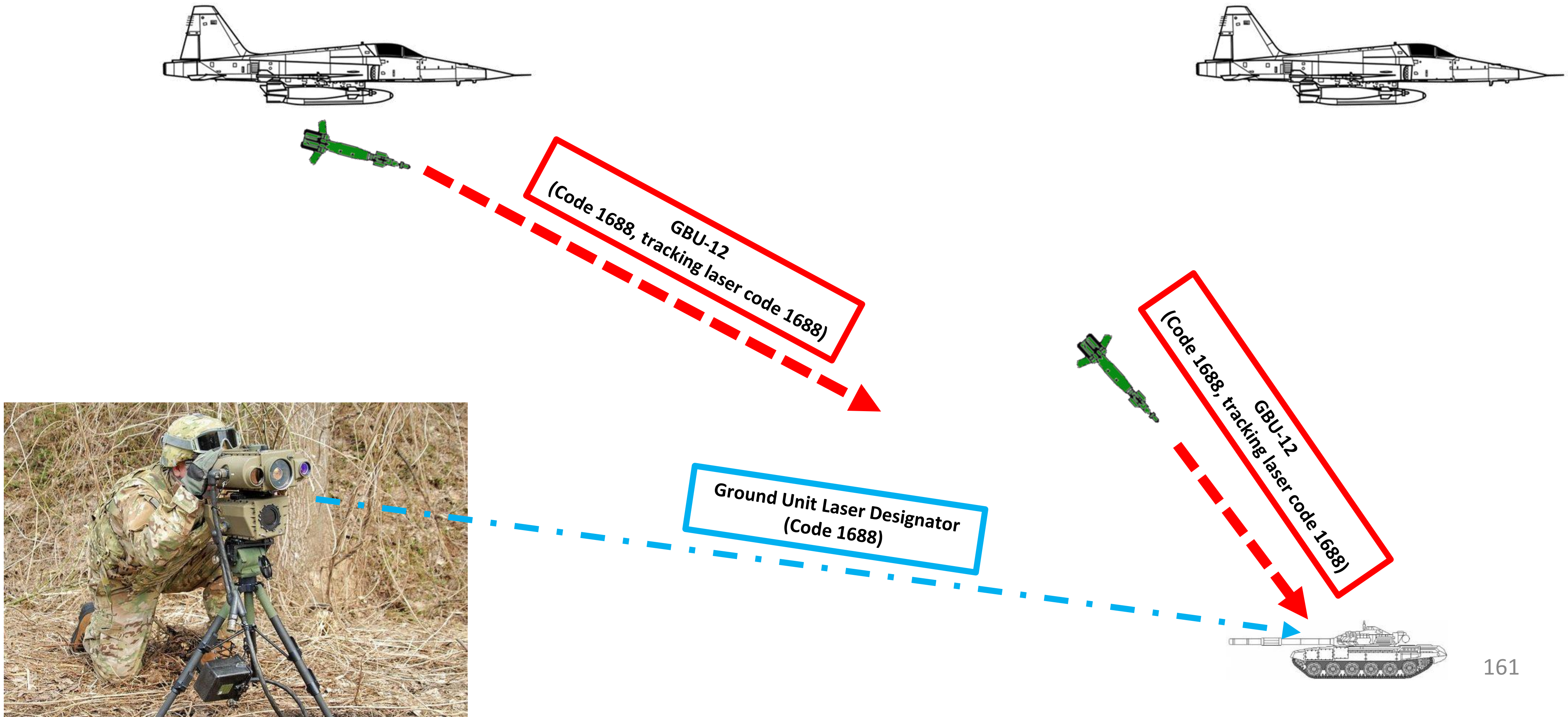
# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

The GBU-12 Paveway II is the laser-guided version of the Mk-82 unguided, general purpose bomb. The GBU-12 guides using the same principles as the GBU-10, the only difference being the bomb the LGB is based on. The seeker head on each laser guided bomb is set to track only a specific laser pulse rate frequency (PRF) code. These are manually set by the weapons load crew during ground operations (via Mission Editor) and may not be set from the cockpit during flight.

Contrary to modern multirole jets with targeting pods capable of designating and lasing a target by itself, the F-5E must rely on a ground unit (or a friendly aircraft equipped with a targeting pod with its own laser designator) to lase the target. The laser code of the GBU-12 must be the same as the laser code of the laser designator.

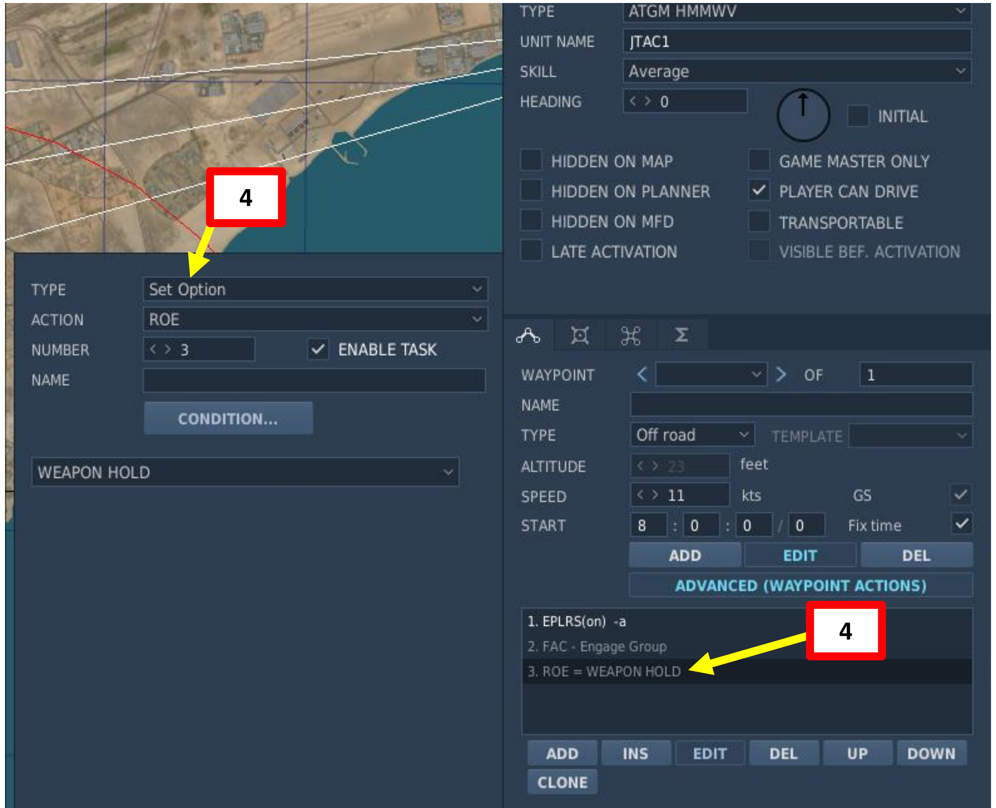


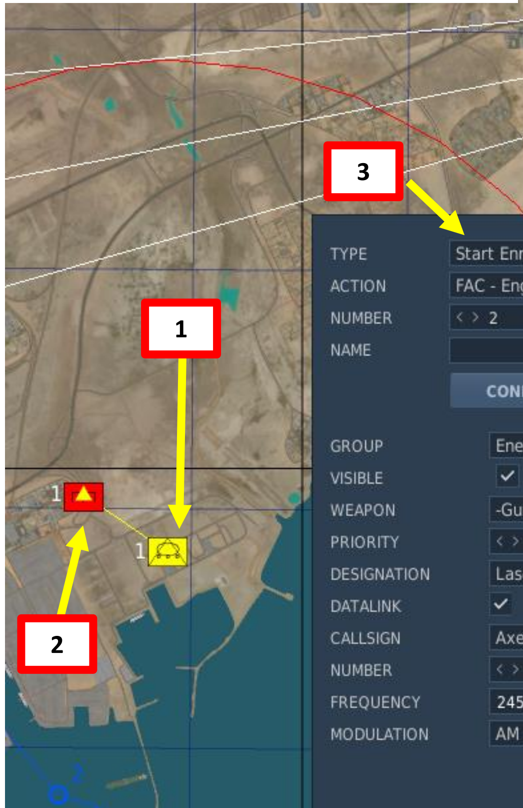



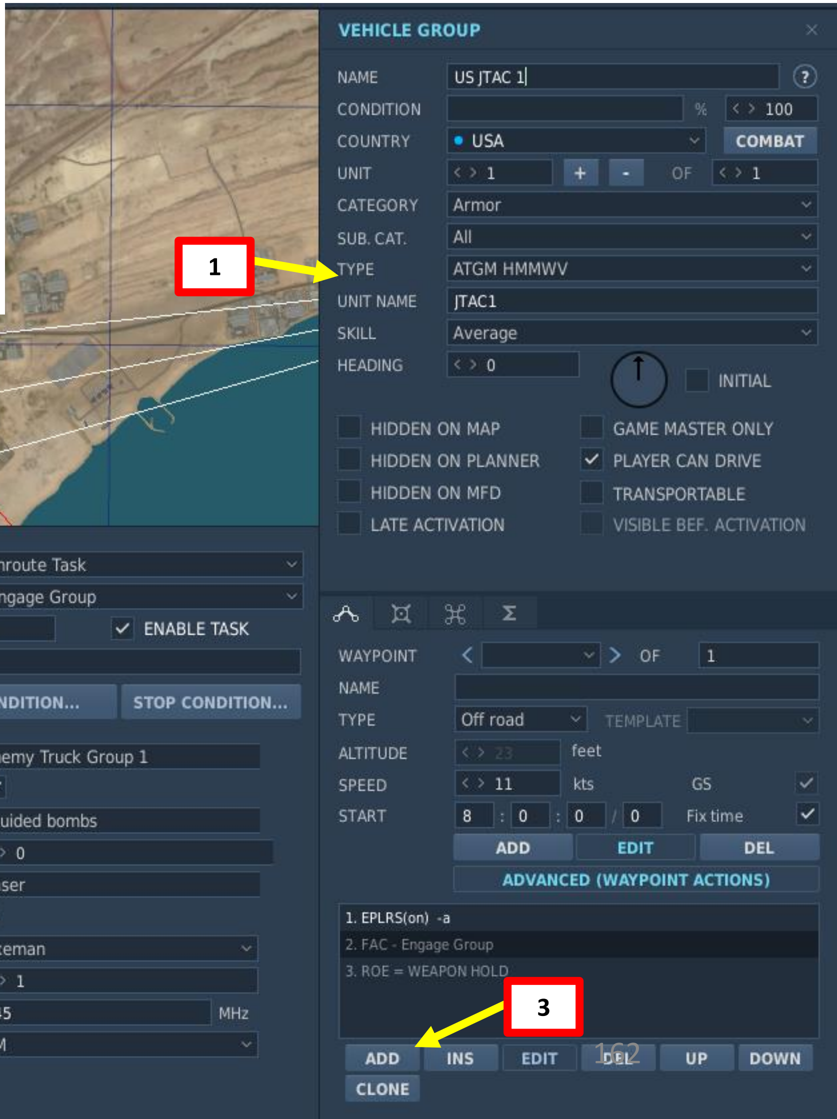
# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

## A – Creation of a JTAC (Joint Terminal Attack Controller) to lase a target for you

1. In the mission editor, insert a friendly "ATGM M1045 HMMWV TOW" unit. He will be your JTAC.
2. Make sure that you have enemy units placed in the map and that you have given them a name (example: "ENEMY UNITS")
3. Select your JTAC unit, click "ADD", and select TYPE "START ENROUTE TASK" and ACTION "FAC – ENGAGE GROUP".
   a) GROUP = "ENEMY UNITS" (the group we just created)
   b) VISIBLE = CHECKED
   c) WEAPON = GUIDED BOMBS
   d) DESIGNATION = LASER
   e) CALLSIGN = AXEMAN (or whatever you prefer)
   f) FREQUENCY = 245 MHz (this will be the radio frequency you will use to contact the JTAC)
   g) MODULATION = AM
4. Select your JTAC unit, click "ADD" again and select TYPE = "SET OPTION" and ACTION "ROE". Set to WEAPON HOLD.
5. You can also set the unit to INVISIBLE and IMMORTAL.



# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

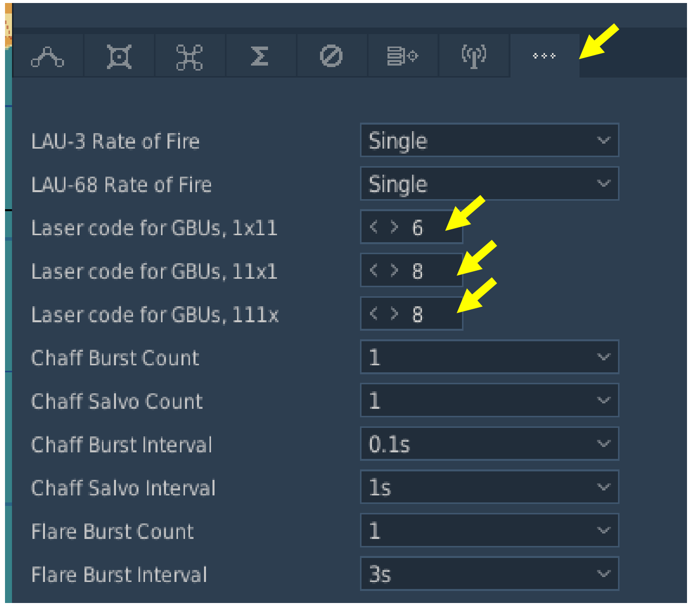
## B – Setting GBU-12 Laser Code

If you are flying in multiplayer and do not know your GBU-12 code, you can open the WEAPON Kneeboard page by pressing "RSHIFT+K". This will show you the laser code set on your GBU-12 laser-guided bomb.

Laser-guided bomb laser codes can be modified on ground by using the following commands:

- **RSHIFT** + **RALT** + **9** : Changes Laser Code (Hundreds)
- **RSHIFT** + **RALT** + **0** : Changes Laser Code (Ones)
- **RSHIFT** + **RALT**+ **-** : Changes Laser Code (Tens)

Take note that setting the bomb laser code should be done when the engine is shut down.

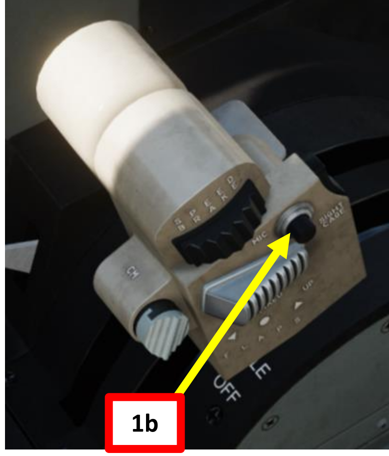




# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

## C – Contacting a JTAC (Joint Terminal Attack Controller) to request target lasing

1. Set JTAC frequency to 245.00 MHz on the UHF radio.
2. Press "RALT+\" (UHF Radio Microphone Push-to-Talk Button) to communicate and select JTAC – AXEMAN (F4) in radio menu.
3. Select "CHECK-IN 15 MIN" (F1)
4. You will contact the JTAC and give him your altitude and ordnance available, plus your time available on station.
5. JTAC will answer "Type 2 in effect" and ask you when you are ready to receive a 9-liner.
6. Select "READY TO COPY" (F1) to receive 9-liner.
7. The JTAC will give you the 9-liner and ask you when you are ready for remarks.
8. Select "READY TO COPY REMARKS" (F1)
9. JTAC will give you remarks.
10. Select "9-LINE READBACK" to repeat the information you have been given and confirm it with the JTAC.
11. JTAC will confirm your readback and request you to tell him when you are inbound.
12. Select "IP INBOUND" (F1), the JTAC will tell you to CONTINUE or ABORT.
13. Select "LASER ON" to request the JTAC to lase targets.
14. Once targets are lased, you may now go on your bomb run.


**2**
UHF Radio AN/ARC-164
Main
F1. Flight...
F2. Wingman 2...
F3. Wingman 3...
F4. JTAC - Axeman11...
F5. ATC...
F8. Ground Crew...
F12. Exit

**3**
UHF Radio AN/ARC-164
2. Main. JTAC - Axeman11
F1. Check-in 15 min
F2. Check-in 30 min
F3. Check-in 45 min
F4. Check-in 60 min
F11. Previous Menu
F12. Exit

**4**
PLAYER: Axeman 1-1, this is Enfield 1-1, 1 x F-5E-3
DQ1696 at 7000
I have: GBU-12, bombs, 300 x gun
Play time is 0 + 15
Available for tasking. What do you have for us?

**5**
JTAC (Axeman11): Enfield 1-1, this is Axeman 1-1, type 2 in effect. Advise when ready for 9-line

**6**
UHF Radio AN/ARC-164
Axeman11. JTAC. Ready for 9-line
F1. Ready to copy
F2. Check out
F11. Parent Menu
F12. Exit

**7**
JTAC (Axeman11): line is as follows
1, 2, 3 N/A
[4. Elevation: ]23 feet MSL
[5. Target: ]truck
[6. Coordinates: ]DQ086998
[7. ]Marked by laser, 1688
[8. Friendlies: ]southeast 450 meters, troops in contact
[9. ]Egress west
JTAC (Axeman11): advise when ready for remarks and further talk-on

**8**
UHF Radio AN/ARC-164
Axeman11. JTAC. Ready for remarks
F1. Ready to copy remarks
F2. Unable to comply
F3. Check out
F11. Parent Menu
F12. Exit

**9**
JTAC (Axeman11): use GBU-12

**10**
UHF Radio AN/ARC-164
Axeman11. JTAC. 9-line readback
F1. 9-line readback
F2. Unable to comply
F3. Check out
F11. Parent Menu
F12. Exit

**11**
PLAYER: 23, DQ086998
JTAC (Axeman11): readback correct
JTAC (Axeman11): report IP INBOUND

**12**
UHF Radio AN/ARC-164
Axeman11. JTAC. Ready for action
F1. IP INBOUND
F2. Repeat brief
F3. What is my target?
F4. Contact
F6. Unable to comply
F7. Check out
F11. Parent Menu
F12. Exit

PLAYER: Enfield 1-1, IP INBOUND
JTAC (Axeman11): Enfield 1-1, CONTINUE

**13**
UHF Radio AN/ARC-164
Axeman11. JTAC. TEN SECONDS TO LASER
F1. LASER ON
F2. TEN SECONDS
F3. Repeat brief
F4. What is my target?
F5. Contact
F7. Unable to comply
F8. Check out
F11. Parent Menu
F12. Exit

**14**
PLAYER: Enfield 1-1, LASER ON
JTAC (Axeman11): LASER ON RESPOND
JTAC (Axeman11): LASING

# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

**C – Contacting a JTAC (Joint Terminal Attack Controller) to request target lasing**

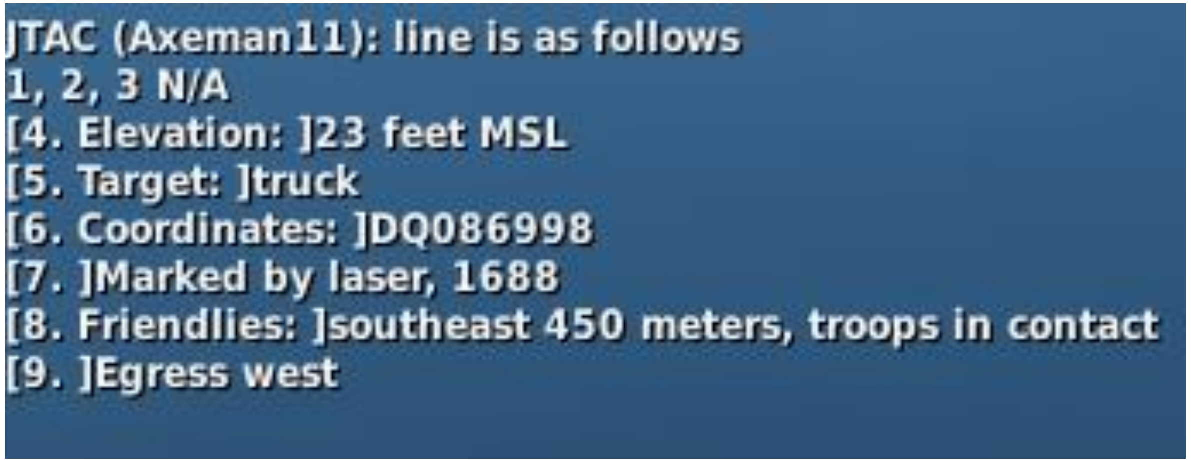
What is a CAS (Close Air Support) 9-liner and why is it important? The goal of a 9-liner is to provide you as much information as concisely as possible.

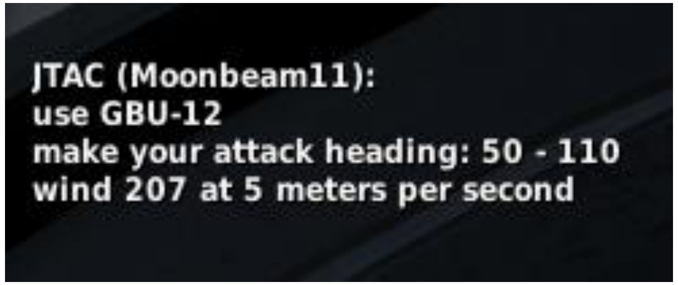
**9-Liner**

**Line 1**: IP/BP – Initial Point/Battle Position (N/A in our case)
**Line 2**: Heading from the IP to the Target (N/A in our case)
**Line 3**: Distance from the IP/BP to target (N/A in our case)
**Line 4**: Target elevation – 23 feet over Mean Sea Level (MSL)
**Line 5**: Target description: Truck.
**Line 6**: Target location: Grid coordinates of target
**Line 7**: Target Mark Type: Marked by laser on laser code 1688
**Line 8**: Location of Friendlies: JTAC located 140 meters North of Target
**Line 9**: Egress semi-cardinal direction when departing from target: West

**Remarks**

Remarks generally include information about troops in contact or danger close, SEAD support in effect, hazards, weather or other threats. In our case, the JTAC wants us to use GBU-12s .



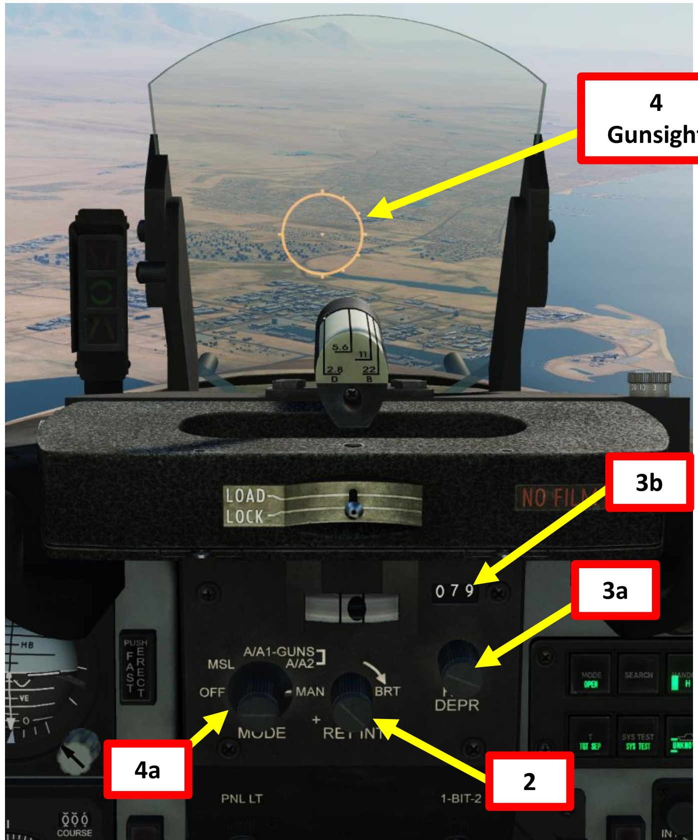



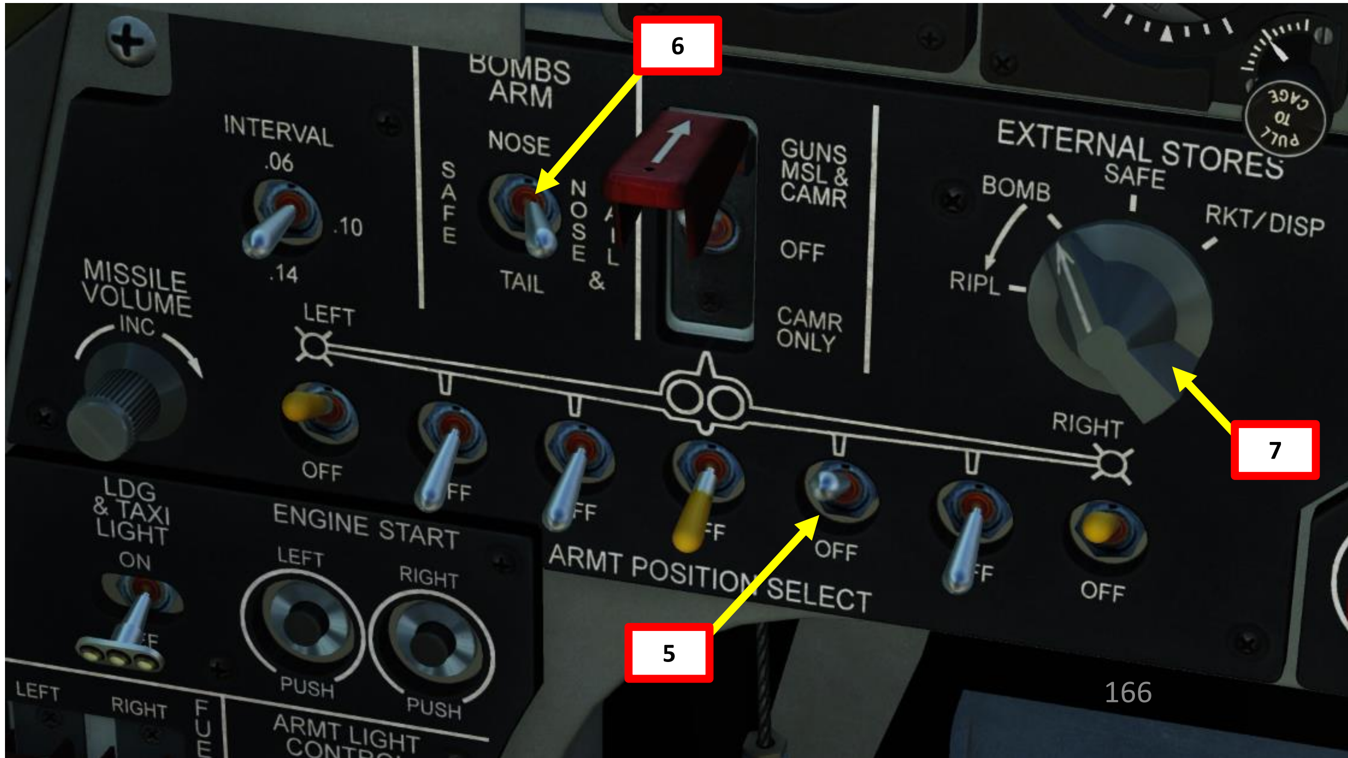
# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

**D – Perform Attack**

1. Determine target altitude using the F10 map (in our case 0 ft). Add target elevation to your dive bombing table altitude parameters.
    - In this example, we will perform a 30 deg dive from 6000 ft with a dive initiation speed of 350 kts. The release altitude will be 2000 ft and the release speed of 440 to 450 KIAS.
2. Set gunsight reticle brightness – as required.
3. Set gunsight depression to approx. 79 mils DOWN using the DEPR knob
4. Set gunsight mode to MANUAL
5. Power on armament pylons with the bombs you want to drop.
6. Arm bomb fuses (NOSE & TAIL recommended)
7. Select external store release (BOMB for single bomb release)

| 1 Dive Bombing Table | | |
|---|---|---|
| **Parameter** | **Dive Angles (degrees)** | |
| | **20** | **30** |
| Dive initiation altitude (ft AGL) | 5000 | 6000 |
| Dive initiation speed (kts) | 350 | 350 |
| Release altitude (ft AGL) | 1500 | 2000 |
| Release speed (kts) | 380 to 400 | 440 to 450 |
| Reticle Depression (mils) | 80 | 79 |

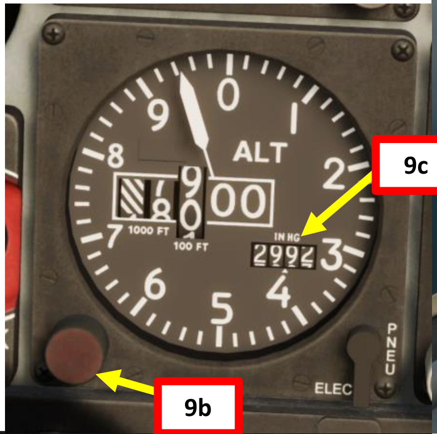


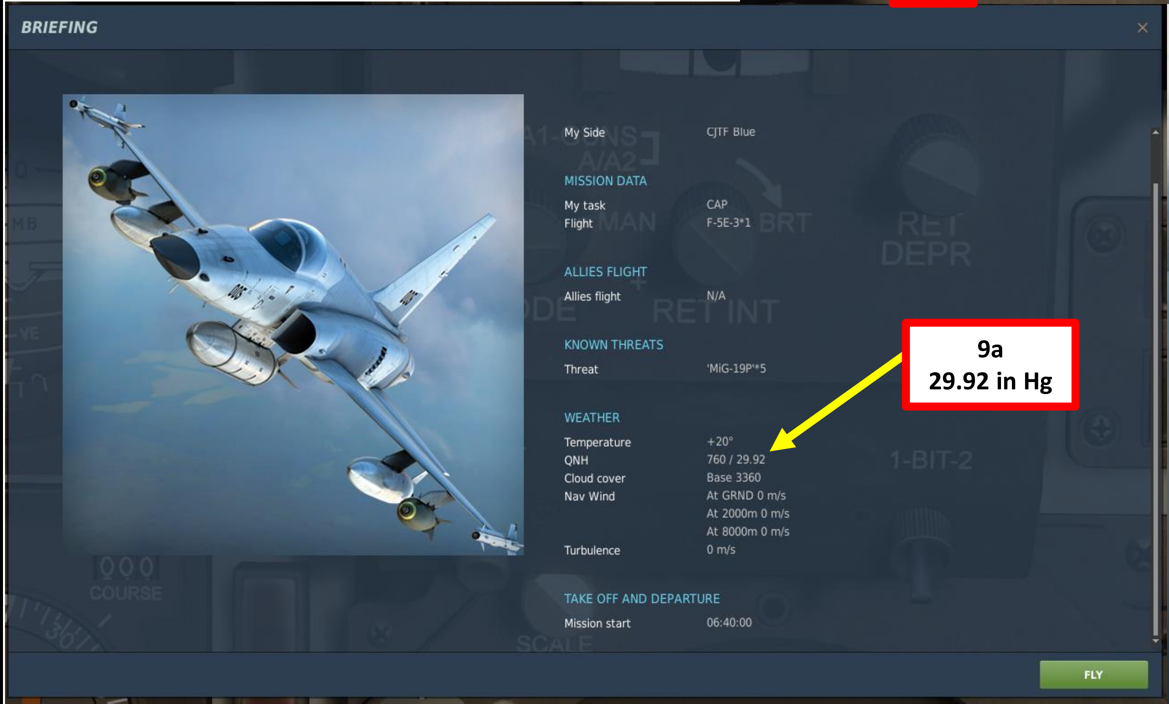
# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

## D – Perform Attack

9. Consult mission briefing and set the barometric pressure setting to the QNH pressure reference to sea level. It is important to set it correctly since barometric altitude is the only way we have to estimate the release altitude since the F-5E does not have a radar altimeter nor a radar that provides air-to-ground ranging information.
10. Approach the target and maintain it to your aircraft's 10 o'clock position. Fly at least 6000 ft above the target at 350 kts or faster.



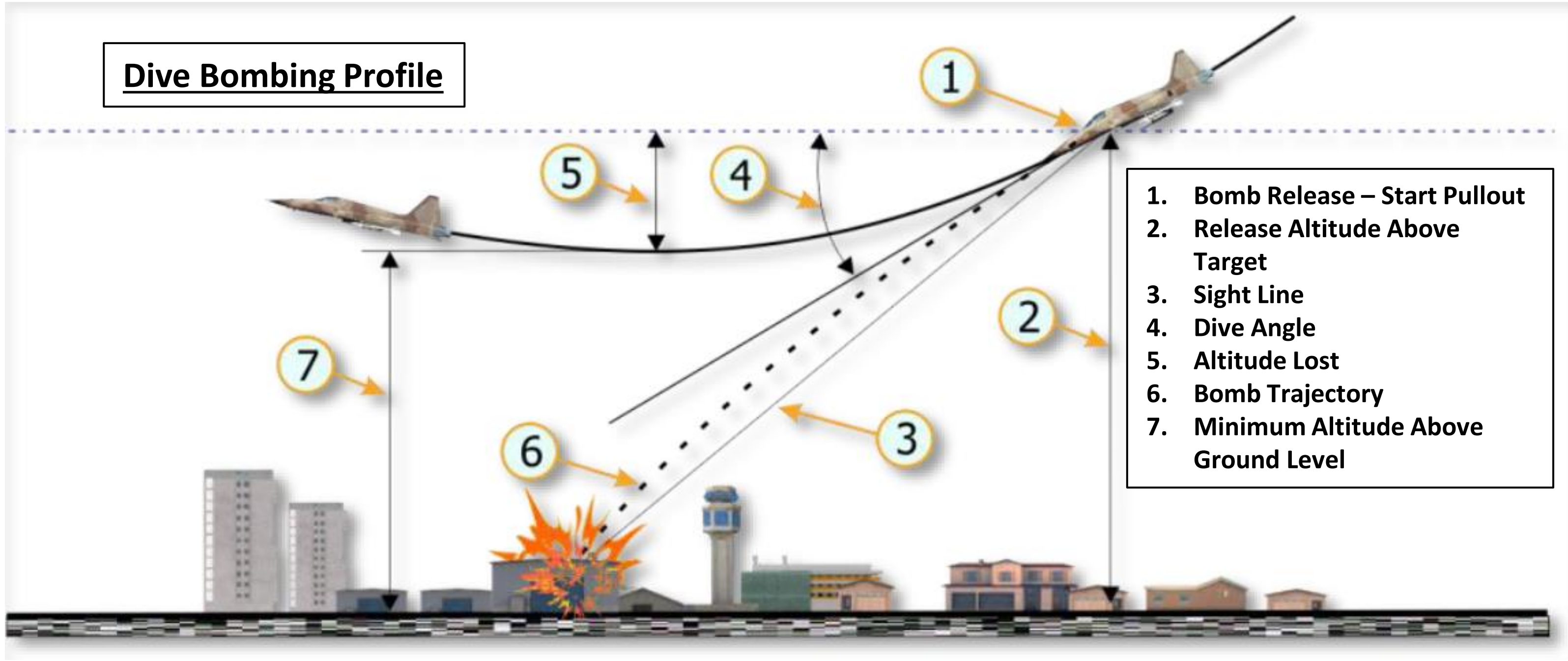





# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

**D – Perform Attack**

11. For a 30 deg bomb run dive, roll in on the target while throttling back to IDLE. Dive should be initiated from 6000 ft at 350 kts.
12. Use your altimeter, speed indicator and attitude indicator to fly with correct bombing parameters. For a 30 deg dive, maintain airspeed between 440 and 450 kts.



# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

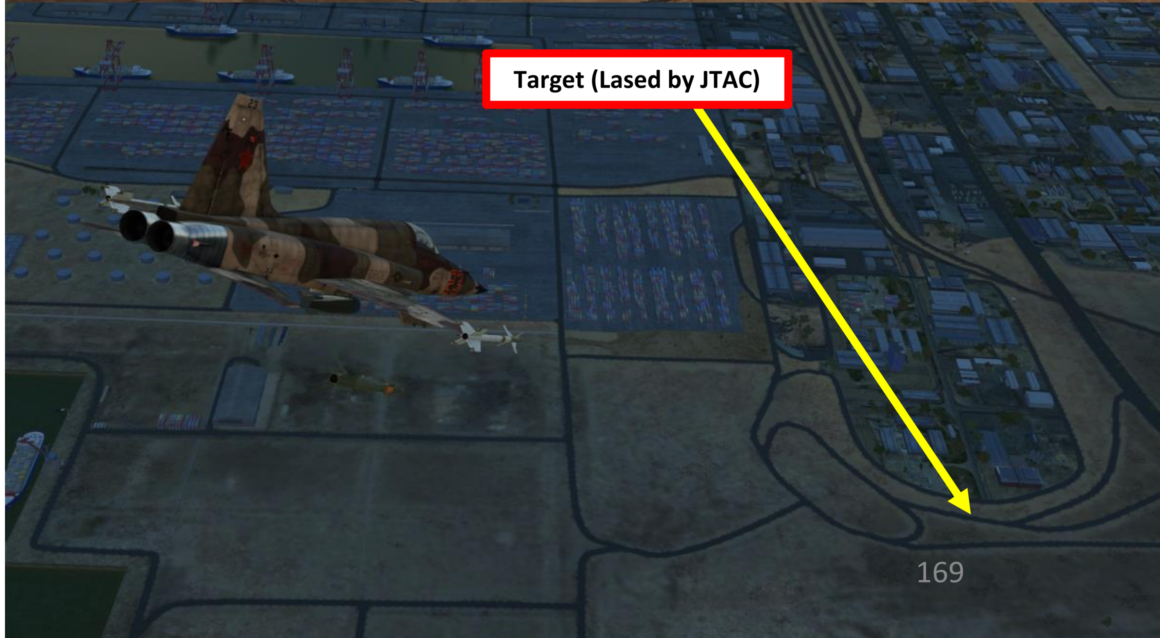
**D – Perform Attack**

13. Keep gunsight pipper slightly below target as you dive.
14. Align target with gunsight pipper before bomb release (2000 ft above ground level).
15. Release bombs 2000 ft above ground level by holding the WEAPON RELEASE BUTTON (RAlt+Space).
16. Once GBU-12 is falling, it will track the laser of the JTAC designating the target until impact.
17. After bomb release, recover from the dive with a 4 G pull up. This pull up must happen within 2 seconds after weapon release or the blast radius may damage your aircraft.

15

13
Gunsight Pipper
(Below Target)


14
Gunsight Pipper
(On Target)

# 2.2 – Laser-Guided Bombs GBU-12 PAVEWAY II

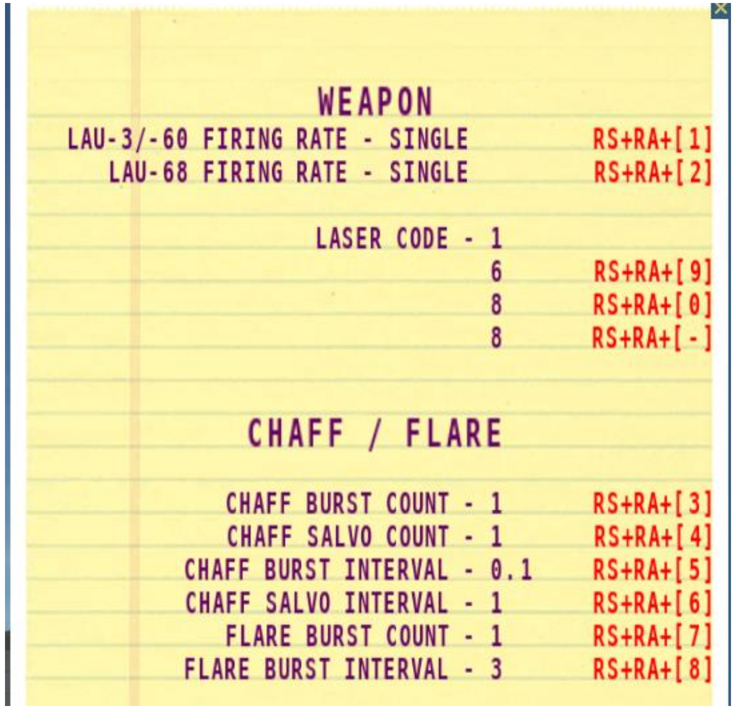
**D – Perform Attack**

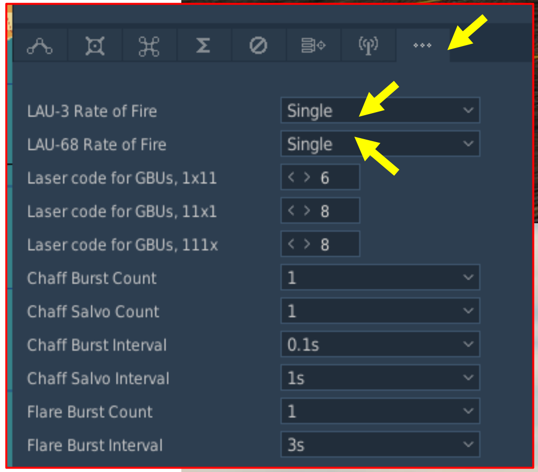
# 2.3 – Rockets
## Hydra 70 (2.75 in) Rockets

# 2.3 – Rockets
## Hydra 70 (2.75 in) Rockets

Rocket pods firing rate can be set either via the Mission Editor or by using the kneeboard (RSHIFT+K) while aircraft is shutdown on the ground.

- RSHIFT+RALT+1 toggles between the LAU-3 or LAU-60 rocket pod firing rates:
  - Single
  - Ripple (17 ms, 20 ms or 60 ms)
- RSHIFT+RALT+2 toggles between the LAU-68 rocket pod firing rates:
  - Single
  - Ripple (60 ms)



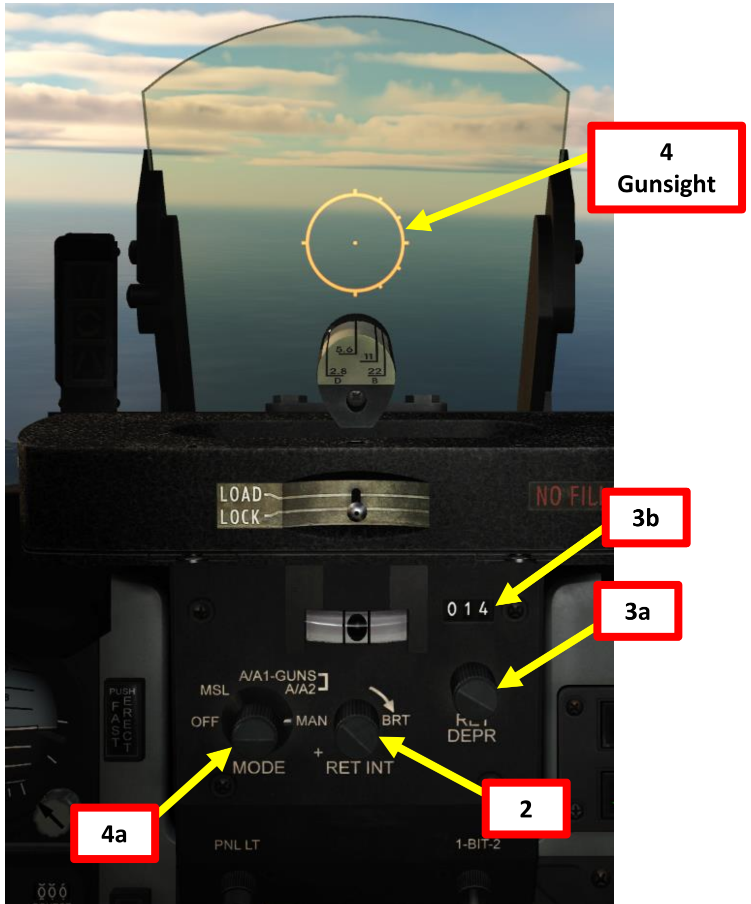


# 2.3 – Rockets
# Hydra 70 (2.75 in) Rockets

1. Determine target altitude using the F10 map (in our case 0 ft). Add target elevation to your rocket table altitude parameters.
   - In this example, we will perform a 20 deg dive from 5000 ft with a dive initiation speed of 350 kts. The firing altitude will be 1500 ft and the speed at moment of firing of 400 KIAS.
2. Set gunsight reticle brightness – as required.
3. Set gunsight depression to approx. 14 mils DOWN using the DEPR knob for a rocket run done with a 20 deg dive angle
4. Set gunsight mode to MANUAL
5. Power on armament pylons with the rocket pods you want to use.
6. Select external store release (RKT/DISP)

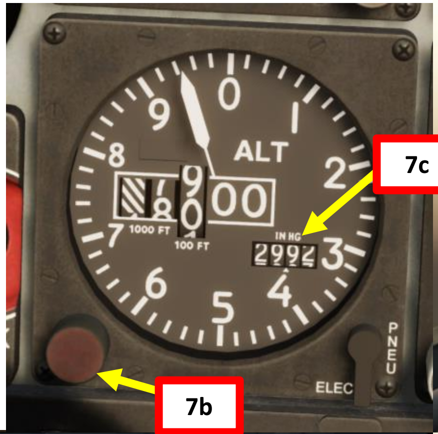
**1 Rocket Table**

| Parameter | Dive Angles (degrees) | |
|---|---|---|
| | 20 | 30 |
| Dive initiation altitude (ft AGL) | 5000 | 6000 |
| Dive initiation speed (kts) | 350 to 370 | 350 |
| Firing altitude (ft AGL) | 1500 | 2000 |
| Speed at Moment of Firing (kts) | 400 | 400 |
| Reticle Depression (mils) | 14 | 10 |

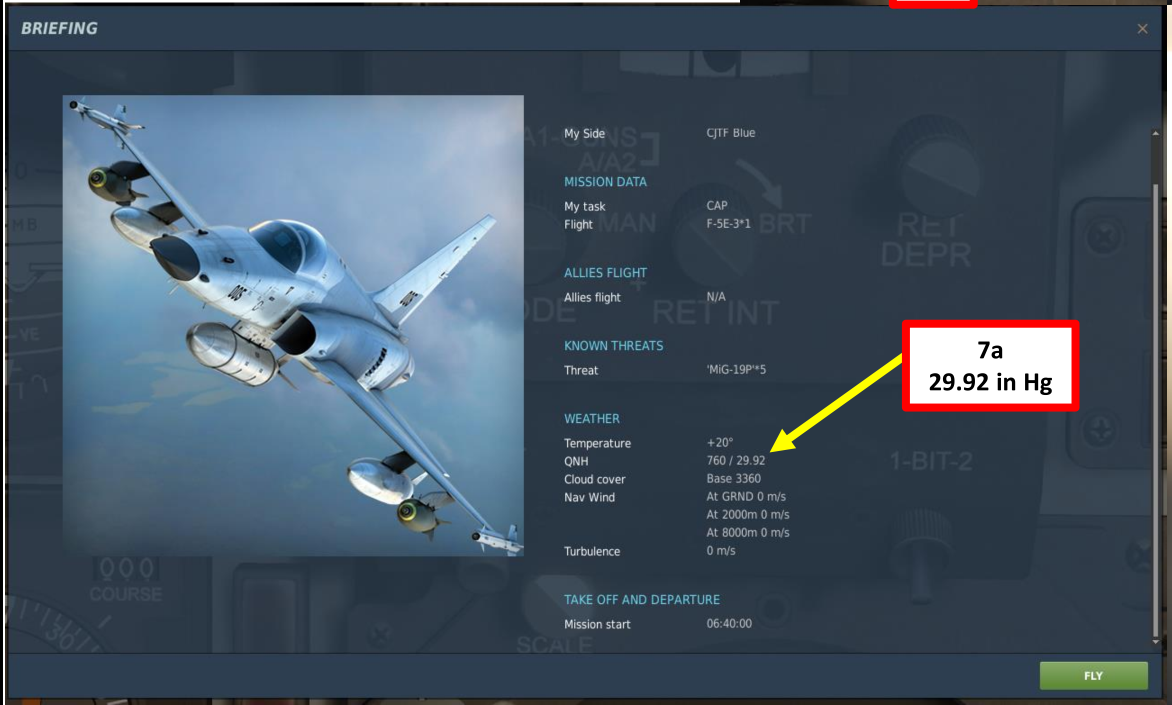



# 2.3 – Rockets
# Hydra 70 (2.75 in) Rockets

7. Consult mission briefing and set the barometric pressure setting to the QNH pressure reference to sea level. It is important to set it correctly since barometric altitude is the only way we have to estimate the release altitude since the F-5E does not have a radar altimeter nor a radar that provides air-to-ground ranging information.
8. Approach the target and maintain it to your aircraft's 10 o'clock position. Fly at least 5000 ft above the target at 350 kts or faster.








# 2.3 – Rockets
# Hydra 70 (2.75 in) Rockets

9. For a 20 deg attack run dive, roll in on the target while throttling back to IDLE. Dive should be initiated from 5000 ft at 350 kts.
10. Use your altimeter, speed indicator and attitude indicator to fly with correct attack profile parameters. For a 20 deg dive, maintain airspeed at 400 kts.
11. Keep gunsight pipper slightly below target as you dive.
12. Align target with gunsight pipper before rocket launch (1500 ft above ground level).
13. Launch rockets 1500 ft above ground level by holding the WEAPON RELEASE BUTTON (RAlt+Space).
14. After rocket run, recover from the dive with a 4 G pull up. This pull up must happen within 2 seconds after weapon release or the blast radius may damage your aircraft.

13

11
Gunsight Pipper
(Below Target)

12
Gunsight Pipper
(On Target)


# 2.3 – Rockets
## Hydra 70 (2.75 in) Rockets

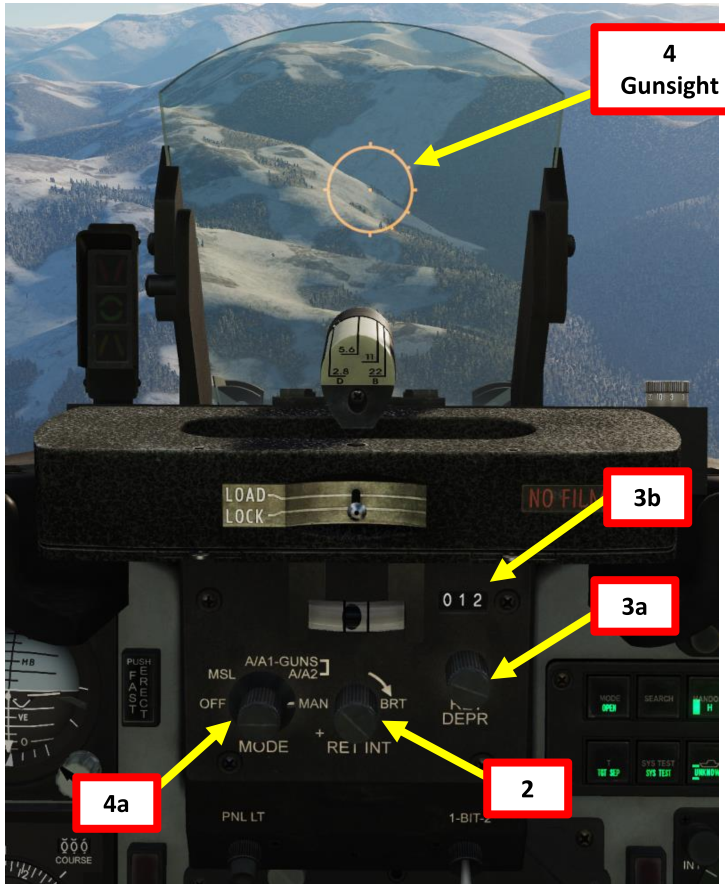
# 2.4 – M-39A3 20 mm Guns (Air-to-Ground)

# 2.4 – M-39A3 20 mm Guns (Air-to-Ground)

1. Determine target altitude using the F10 map (in our case 0 ft). Add target elevation to your gun attack table altitude parameters.
    - In this example, we will perform a 20 deg dive from 5000 ft with a dive initiation speed of 350 kts. The firing altitude will be 2000 ft and the speed at the moment of firing of 400 KIAS.
2. Set gunsight reticle brightness – as required.
3. Set gunsight depression to approx. 12 mils DOWN using the DEPR knob for a gun attack run done with a 20 deg dive angle
4. Set gunsight mode to MANUAL
5. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).

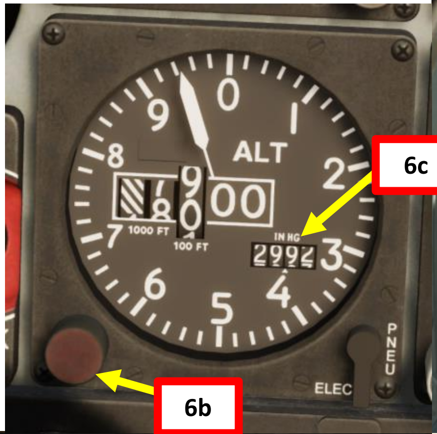
**1 – Air-to-Ground Gun Attack Table**

| Parameter | Dive Angles (degrees) | |
|---|---|---|
| | 20 | 30 |
| Dive initiation altitude (ft AGL) | 5000 | 6000 |
| Dive initiation speed (kts) | 350 to 370 | 350 to 370 |
| Firing altitude (ft AGL) | 2000 | 3000 |
| Speed at Moment of Firing (kts) | 400 | 400 |
| Reticle Depression (mils) | 12 | 8 |

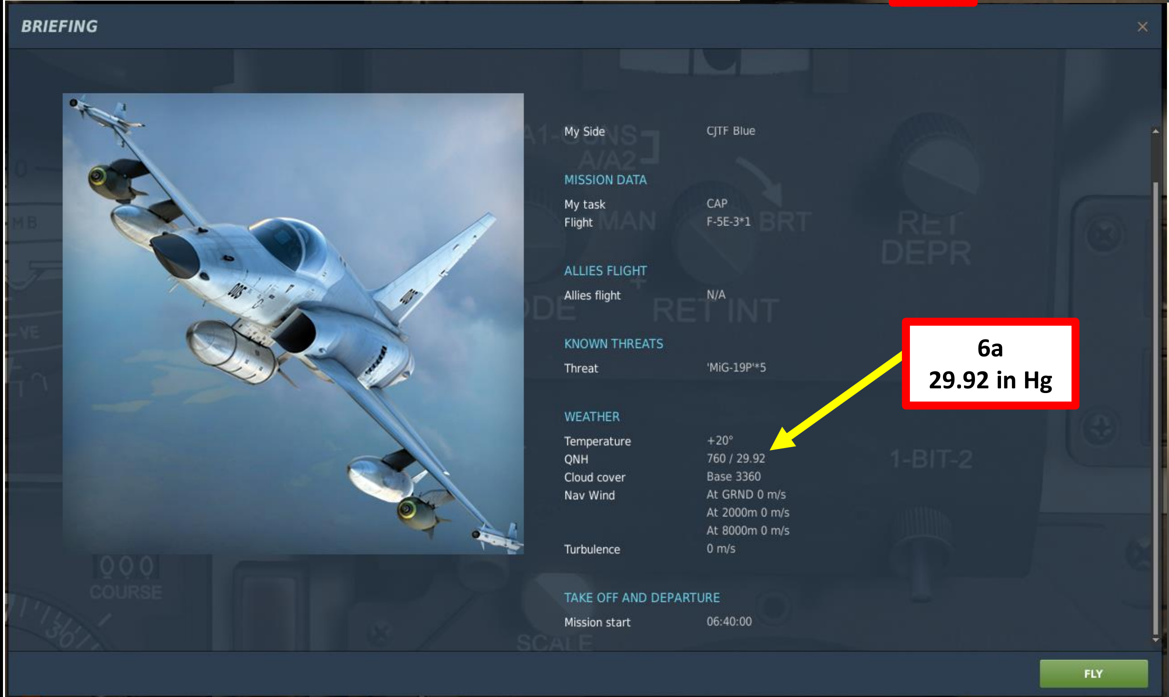



# 2.4 – M-39A3 20 mm Guns (Air-to-Ground)

6. Consult mission briefing and set the barometric pressure setting to the QNH pressure reference to sea level. It is important to set it correctly since barometric altitude is the only way we have to estimate the release altitude since the F-5E does not have a radar altimeter nor a radar that provides air-to-ground ranging information.
7. Approach the target and maintain it to your aircraft's 10 o'clock position. Fly at least 5000 ft above the target at 350 kts or faster.

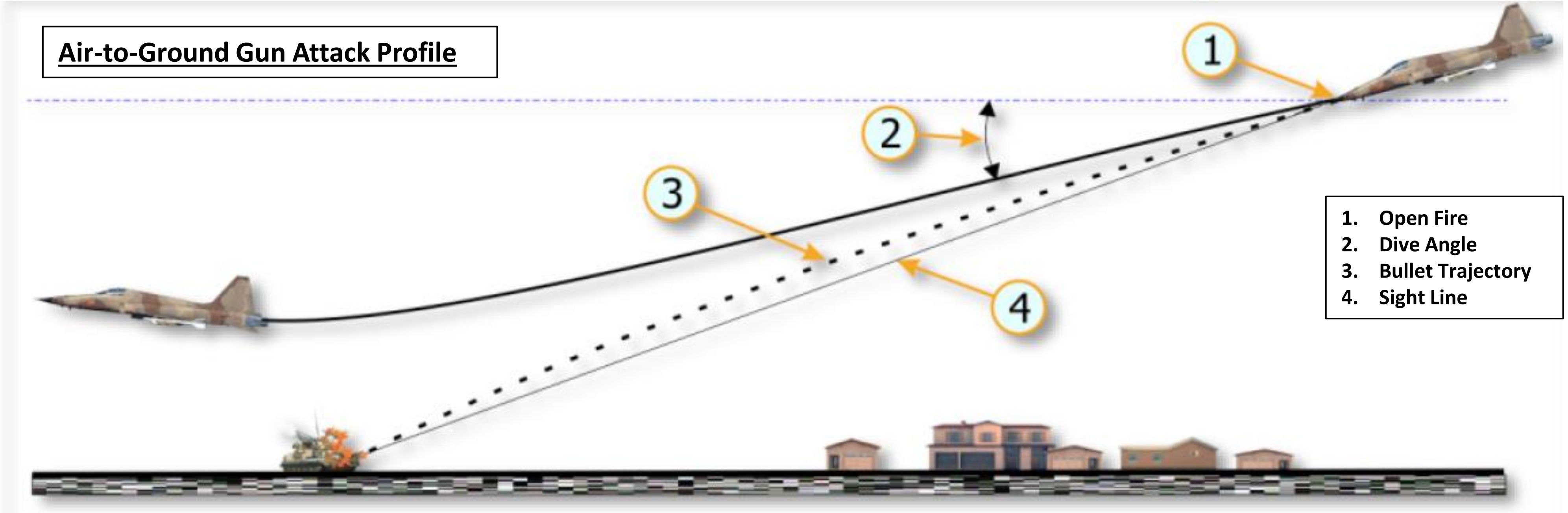






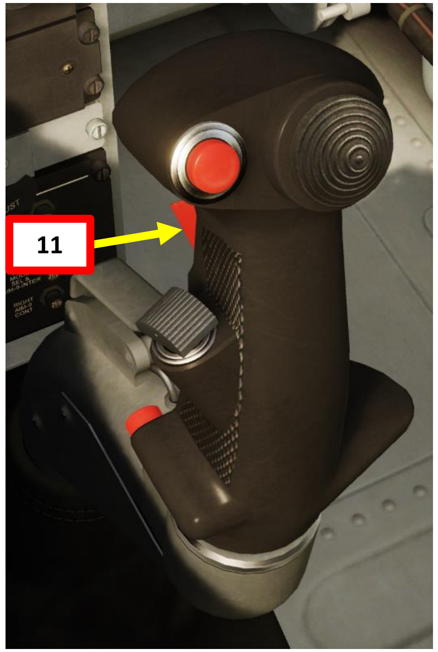

# 2.4 – M-39A3 20 mm Guns (Air-to-Ground)

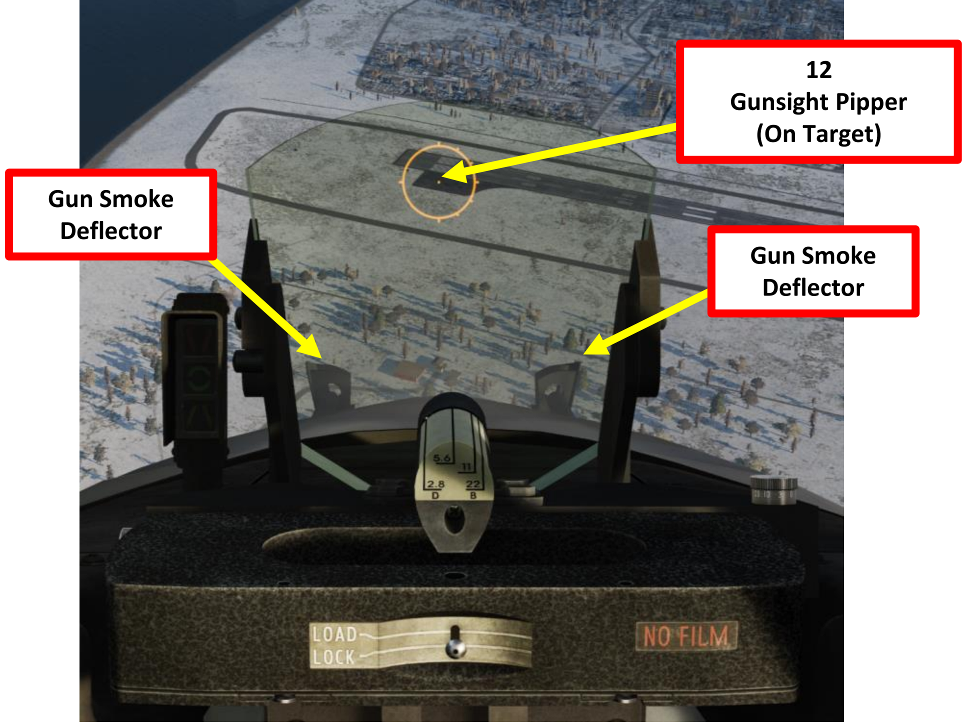
8. For a 20 deg attack run dive, roll in on the target while throttling back to IDLE. Dive should be initiated from 5000 ft at 350 kts.
9. Use your altimeter, speed indicator and attitude indicator to fly with correct attack profile parameters. For a 20 deg dive, maintain airspeed around 400 kts.



# 2.4 – M-39A3 20 mm Guns (Air-to-Ground)

10. Align target with gunsight pipper before firing guns (2000 ft above ground level).
11. Fire guns when reaching 2000 ft above ground level.
    a) Squeeze the first-stage trigger to deploy the gun smoke deflectors (“T” binding),
    b) Squeeze the second-stage trigger to fire the guns (“SPACEBAR” binding).
12. After gun run, recover from the dive with a 4 G pull up.

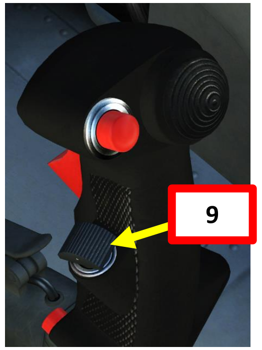


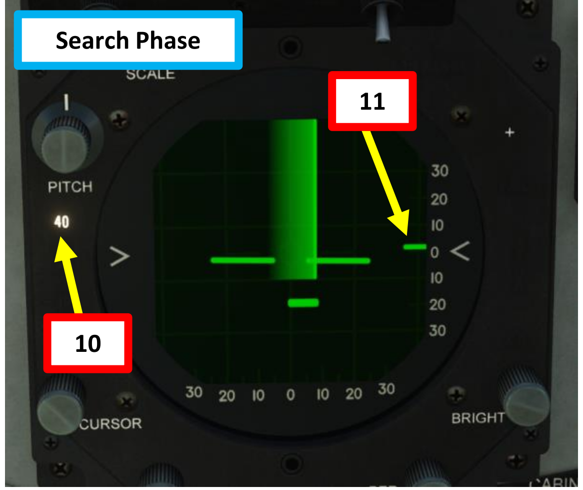

# 3.1 – AIM-9 Sidewinder IR Missile

# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.1 – MSL (Missile) Mode

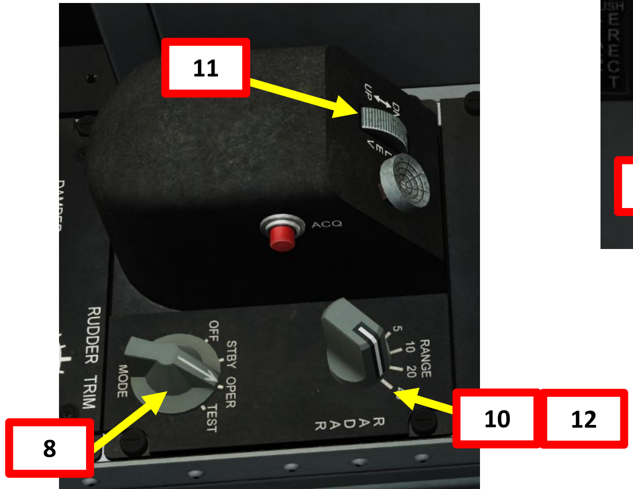
*Note: In this tutorial, a radar lock is performed in order to have ranging information to evaluate the distance to the target. However, keep in mind that a radar lock is not required at all to use the AIM-9P since the missile tracks heat signatures; the radar has no capability to guide the Sidewinder missile.*



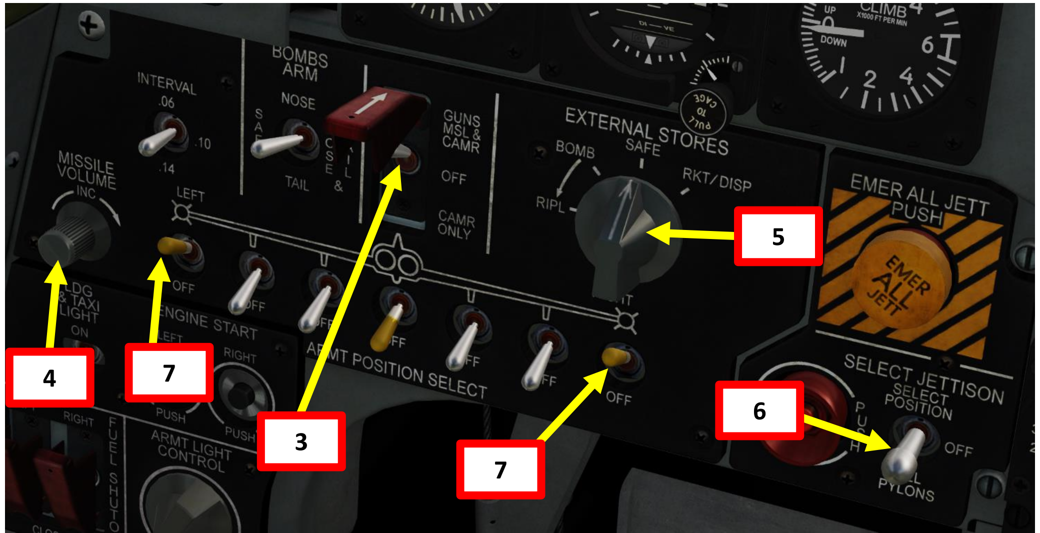

1. Set gunsight reticle brightness – as required.
2. Set AN/ASG-31 Sight Mode Selector to MSL
3. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).
4. Set Missile Volume Knob – As Required
5. Set External Stores Selector – SAFE
6. Set Select Jettison Position Switch – OFF (MIDDLE)
7. Power on armament wingtip pylons with the missiles (leftmost and rightmost switches UP).
8. Make sure Radar Mode selector is set to OPER
9. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
10. Set the radar range to 40 nm.
11. Tilt the radar antenna vertically as required.
12. Detect target on the radar, then set radar range to 20 nm.





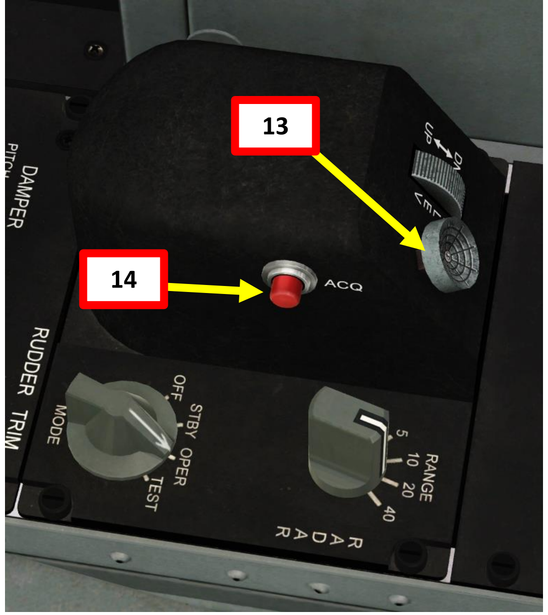


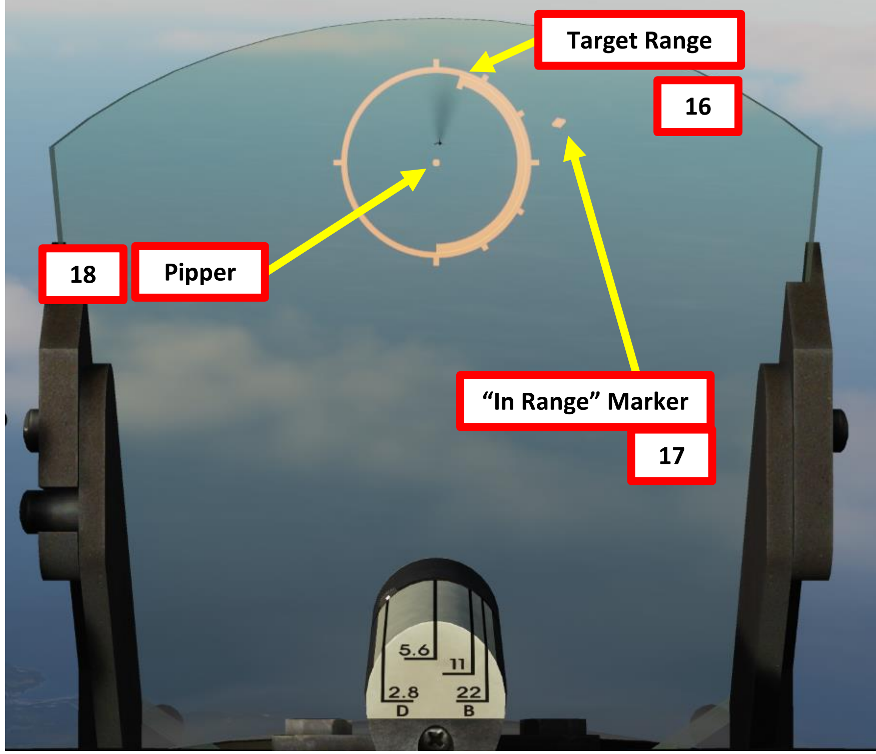


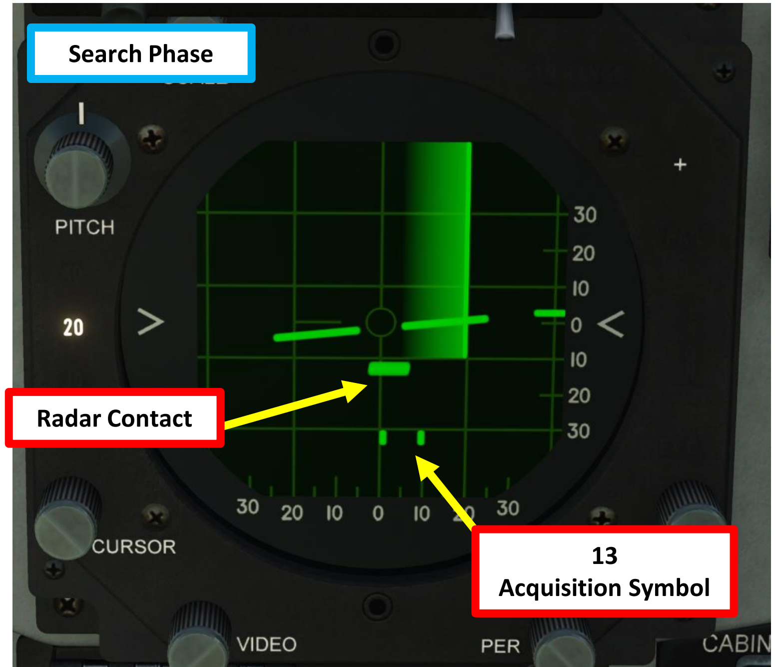


# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.1 – MSL (Missile) Mode

13. Slew Acquisition symbol (ACQ) over the radar contact using the TDC (Target Designator Control).
14. Press ACQ button to spotlight target and attempt a radar lock. Range scale automatically changes to 10 nm. Antenna starts scanning ±5 degrees in azimuth and ±1.5 degrees in elevation.
15. After radar lock-on to the target, antenna conically scans about the target with 12 deg span. Radar display shows target range gate and weapon aiming symbol.
16. After radar lock-on to the target, aiming markers appear on the gun sight circle.
    - Note: You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
17. A red dot ("in-range marker") will appear next to the gunsight reticle when you are in range to fire the missile.
18. Place the reticle in the approximate location of the target.





# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.1 – MSL (Missile) Mode

19. Continue target approach until missile heat seeker locks on to the target's heat signature. The growling sound of the seeker will change from a low-pitch growl to a high-pitch sound.
20. By default, the missile seeker head is caged, which means it can track targets mainly in its boresight direction. This may not be practical against manoeuvering targets like fighters.
21. **<u>Press and hold</u>** Missile Uncage switch (RSHIFT+M) after seeker lock-on to facilitate maneuvering to advantageous attack position. The benefit of uncaging the seeker is that you do not have to keep the target directly in the relatively small position where the caged/boresighted seeker can "see" it. The most common use is to allow you to pull some lead on the target before firing, which reduces the amount of manoeuvring the missile has to do upon launch, allowing it to use that energy to increase the probability of kill (PK).
    - When missile is uncaged and the seeker tracks a heat signature, the high-pitch sound volume will slightly increase.
22. Fire missile by holding the WEAPON RELEASE BUTTON (RAlt+Space).

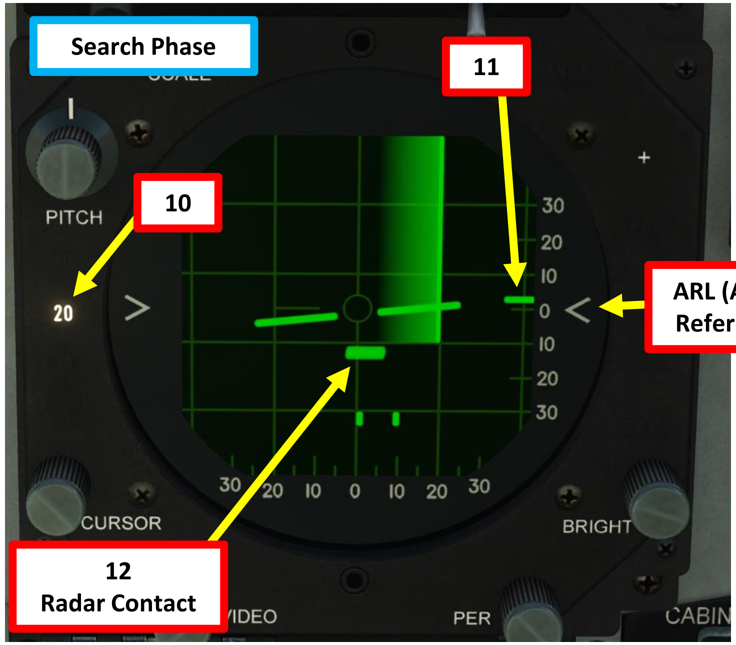
**Missile Uncage Switch (on the left throttle's side)**



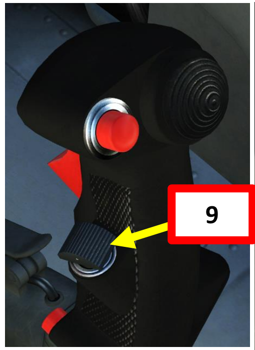
# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.2 – DM (Dogfight Missile) Mode

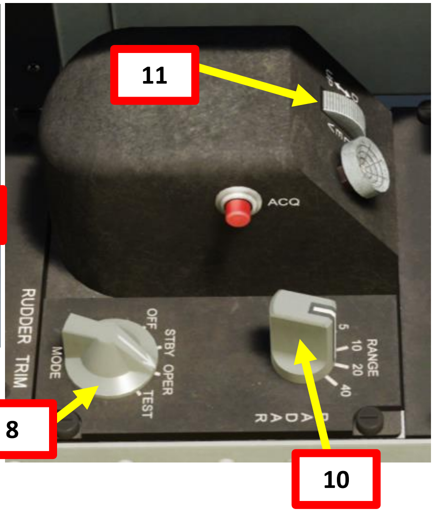
*Note: In this tutorial, a radar lock is performed in order to have ranging information to evaluate the distance to the target. However, keep in mind that a radar lock is not required at all to use the AIM-9P since the missile tracks heat signatures; the radar has no capability to guide the Sidewinder missile.*

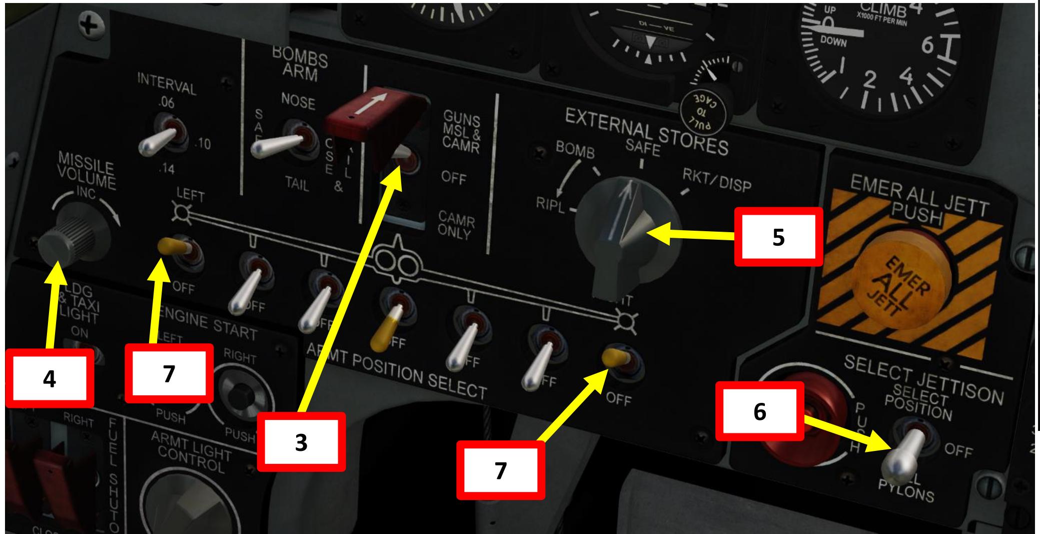
1. Set gunsight reticle brightness – as required.
2. Set AN/ASG-31 Sight Mode Selector to MSL
3. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).
4. Set Missile Volume Knob – As Required
5. Set External Stores Selector – SAFE
6. Set Select Jettison Position Switch – OFF (MIDDLE)
7. Power on armament wingtip pylons with the missiles (leftmost and rightmost switches UP).
8. Make sure Radar Mode selector is set to OPER
9. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
10. Set the radar range as required.
11. Tilt the radar antenna vertically as required.
12. Detect target on the radar, then get to a distance of 20 nm or less.
13. Maneuver aircraft to center target on 0 deg azimuth and elevation.





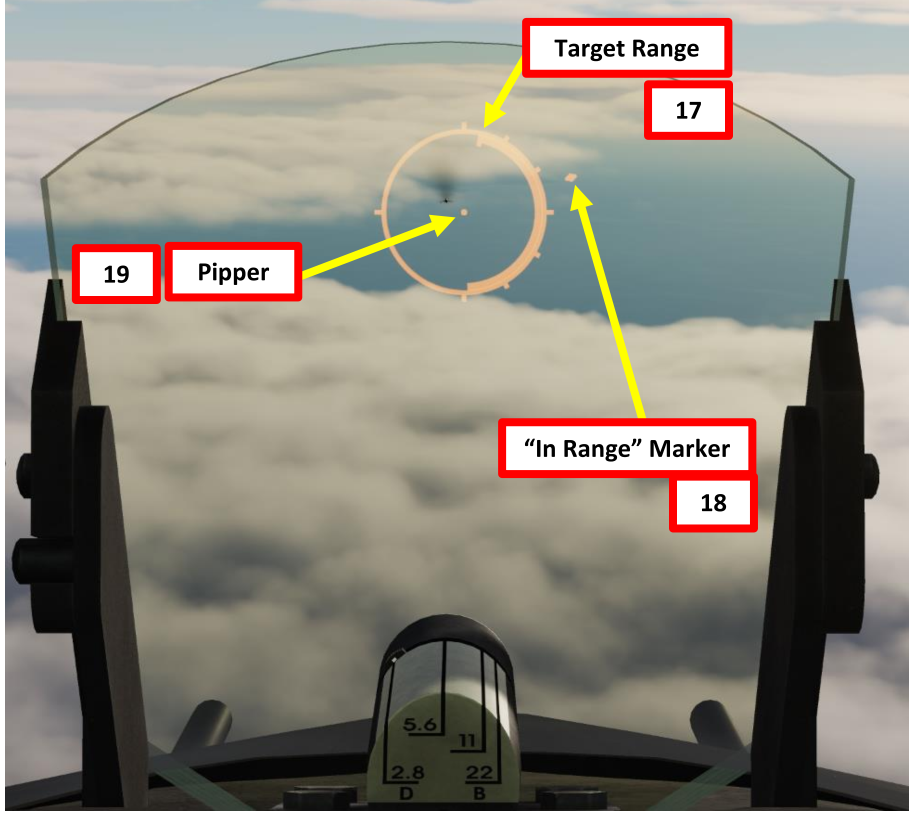


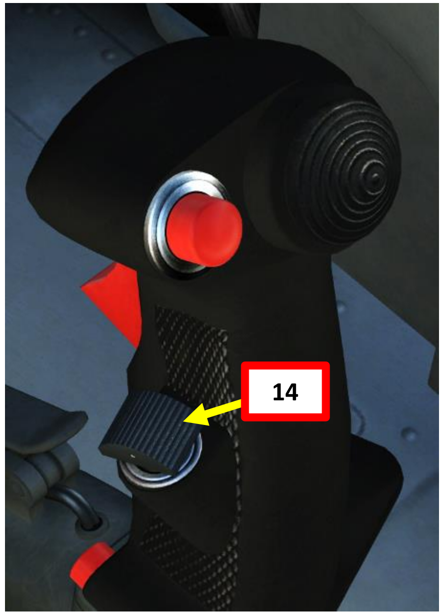



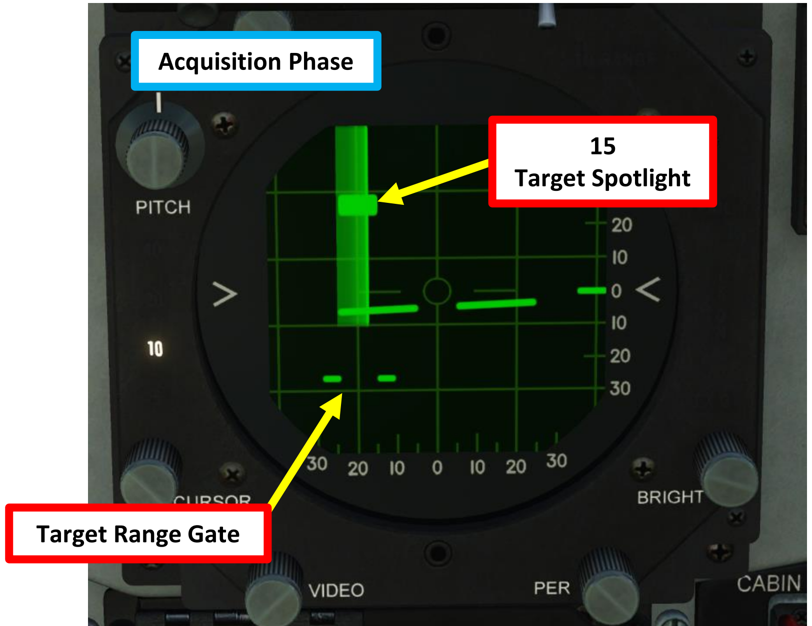



# 3.1 – AIM-9 Sidewinder IR Missile
# 3.1.2 – DM (Dogfight Missile) Mode

14. Initiate DM (Dogfight Missile) Mode by setting the Dogfight/Resume Search Switch to FWD.
15. After DM mode selection, the radar antenna aligns to 0° azimuth and on ARL (Armament Reference Line) and range scale changes to 10 miles. If the target is within the range of 500 to 30,000 feet, the radar automatically locks on to the first target encountered.
16. After radar lock-on to the target, radar display shows target range gate and weapon aiming symbol.
17. After radar lock-on to the target, aiming markers appear on the gun sight circle.
    - Note: You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
18. A red dot ("in-range marker") will appear next to the gunsight reticle when you are in range to fire the missile.
19. Place the reticle in the approximate location of the target.




# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.2 – DM (Dogfight Missile) Mode

20. Continue target approach until missile heat seeker locks on to the target's heat signature. The growling sound of the seeker will change from a low-pitch growl to a high-pitch sound.
21. By default, the missile seeker head is caged, which means it can track targets mainly in its boresight direction. This may not be practical against manoeuvering targets like fighters.
22. **<u>Press and hold</u>** Missile Uncage switch (RSHIFT+M) after seeker lock-on to facilitate maneuvering to advantageous attack position. The benefit of uncaging the seeker is that you do not have to keep the target directly in the relatively small position where the caged/boresighted seeker can "see" it. The most common use is to allow you to pull some lead on the target before firing, which reduces the amount of manoeuvring the missile has to do upon launch, allowing it to use that energy to increase the probability of kill (PK).
    - When missile is uncaged and the seeker tracks a heat signature, the high-pitch sound volume will slightly increase.
23. Fire missile by holding the WEAPON RELEASE BUTTON (RAlt+Space).

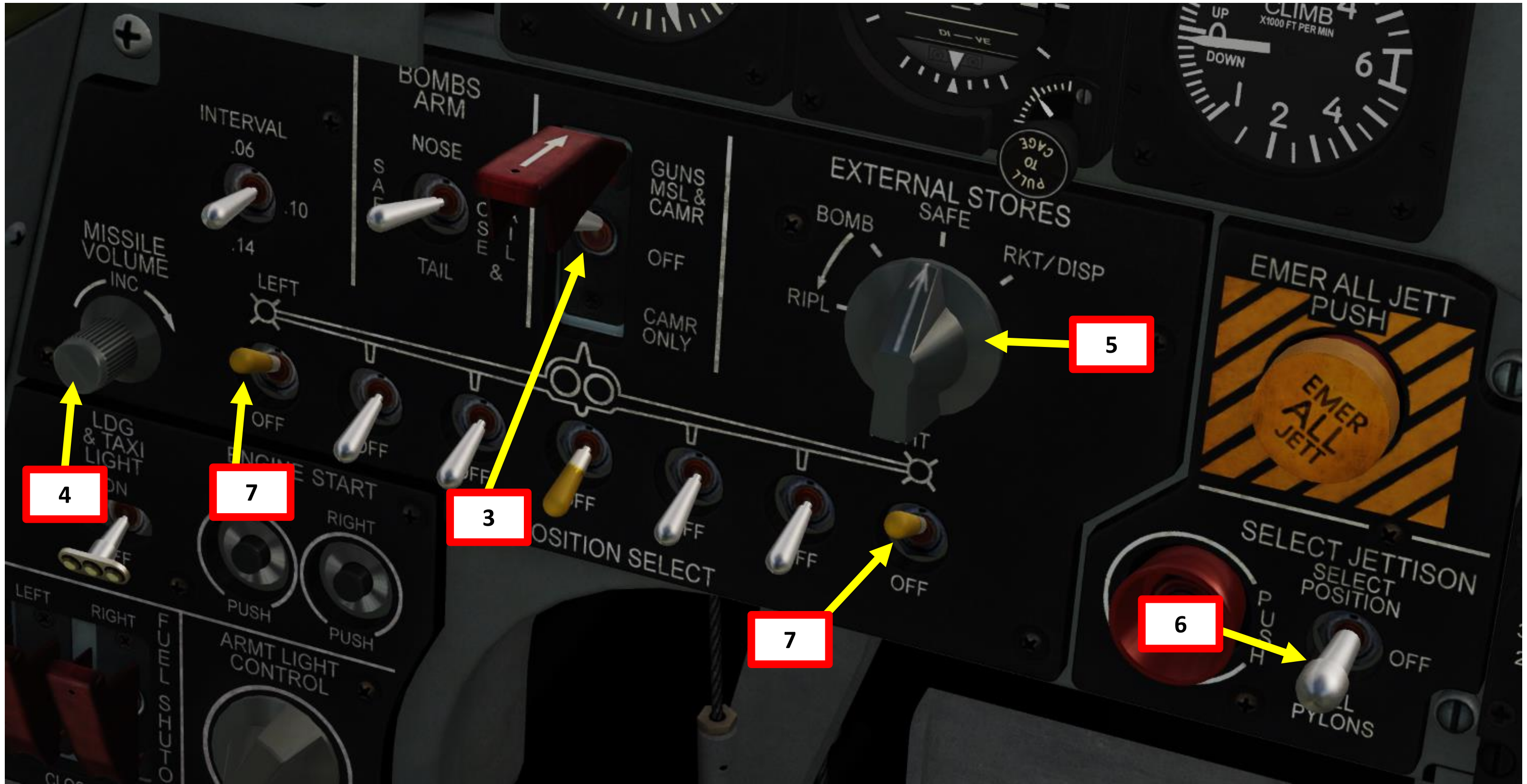
Missile Uncage Switch (on the left throttle's side)

22




# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.3 – Without Radar

1. Set gunsight reticle brightness – as required.
2. Set AN/ASG-31 Sight Mode Selector to MSL
3. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).
4. Set Missile Volume Knob – As Required
5. Set External Stores Selector – SAFE
6. Set Select Jettison Position Switch – OFF (MIDDLE)
7. Power on armament wingtip pylons with the missiles (leftmost and rightmost switches UP).




# 3.1 – AIM-9 Sidewinder IR Missile
## 3.1.3 – Without Radar

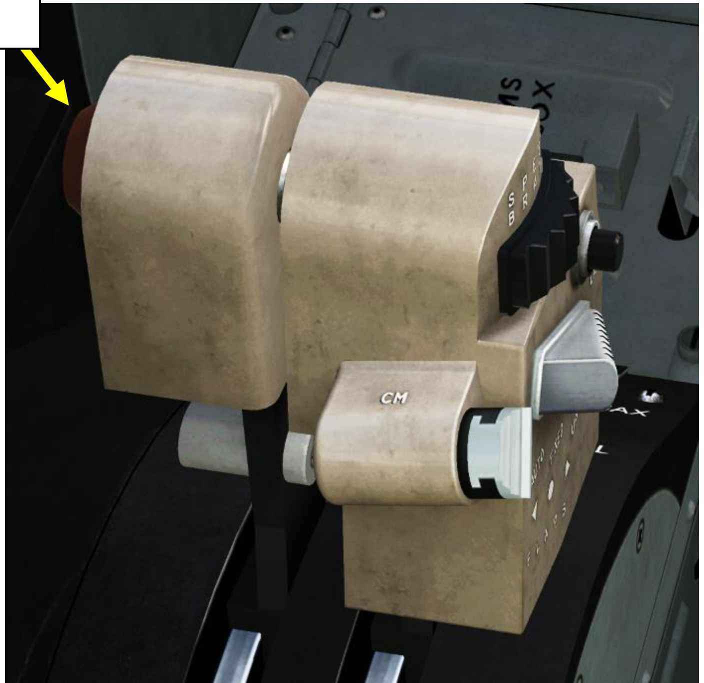
8. Maneuver the aircraft to take attack position at target range of 5000 to 7000 ft and align reticle pipper with target. Launch range is to be determined by comparison of visible target size with reticle diameter.
9. Continue target approach until missile heat seeker locks on to the target's heat signature. The growling sound of the seeker will change from a low-pitch growl to a high-pitch sound.
10. By default, the missile seeker head is caged, which means it can track targets mainly in its boresight direction. This may not be practical against manoeuvering targets like fighters.
11. **<u>Press and hold</u>** Missile Uncage switch (RSHIFT+M) after seeker lock-on to facilitate maneuvering to advantageous attack position. The benefit of uncaging the seeker is that you do not have to keep the target directly in the relatively small position where the caged/boresighted seeker can "see" it. The most common use is to allow you to pull some lead on the target before firing, which reduces the amount of manoeuvring the missile has to do upon launch, allowing it to use that energy to increase the probability of kill (PK).
    - When missile is uncaged and the seeker tracks a heat signature, the high-pitch sound volume will slightly increase.
12. Fire missile by holding the WEAPON RELEASE BUTTON (RAlt+Space).




# 3.1 – AIM-9 Sidewinder IR Missile
# 3.1.4 – To Cage or Not To Cage

Here is an interesting article from the 1982 USAF Fighter Weapons Newsletter that explains the benefits of caging or uncaging the AIM-9P missile prior to firing the missile.

**Missile Uncage Switch (on the left throttle's side)**




## AIM-9P
### To Cage or Not to Cage

By
Captain CHARLES C. DEANO
4484 FWS
Eglin AFB, FL 32542

At the end of the war, they're not going to ask, "How..." just, "How many?" This may be true, but right now there is a lot of controversy in the F-4 community about "how" to employ the AIM-9P (caged or uncaged). The purpose of this article is to present the pros and cons of uncaging the seeker prior to firing the missile.

Obviously, the biggest advantage of uncaging the seeker head is to enable the pilot to confirm that the seeker head is tracking the target prior to committing the missile; right? Maybe, but this is easier said than done. The first problem we encounter is the pilot's difficulty in recognizing the difference between the aural tone generated when the seeker is tracking the target (null position) and when it's not. The difference is very subtle, and until you have experimented with captive AIM-9s enough to insure that you can tell the difference in the heat of battle, you are better off firing with the missile caged and a good tone in your headset; if so, then there is no need for you to read the rest of this article. It would be nice if we had a visual cue on the HUD that showed the pilot where the missile seeker is looking when uncaged, but I'm afraid you'll have to wait until MPC hands you the keys to an F-15 or F-16 with AIM-9Ls before you have that luxury.

The next advantage of uncaging is the ability to acquire the target, uncage the missile, and then transition from pure pursuit to lead pursuit, thereby reducing the maneuvering required by the missile after launch. This technique improved the $P_K$ of the AIM-9E, but the improved guidance and maneuverability of the AIM-9P makes this unnecessary for most "typical" dogfight FOX-2 launch parameters.

While uncaging and pulling lead may be unnecessary in a medium altitude "turn-and-burn" engagement, low altitude (below 300 ft) employment is another story. Since the missile has no way of sensing ground proximity, by uncaging the seeker head and pulling lead slightly above the target, you can improve the probability that the missile will not impact the ground prior to target intercept. This will help compensate for missile drop during the short period immediately after launch when the missile is ballistic. The amount of missile drop is dependent on launch Mach number and pitch angle, and the pilot must weigh the potential benefit gained by this maneuver against the possibility that the seeker will break lock due to the increased background noise encountered when your background turns from blue to brown. Remember that if the target is maneuvering to a lower altitude during the shot, the proportional navigation system will compute an intercept trajectory that might result in missile contact with the ground (hopefully followed shortly by target contact with the ground).

A few other disadvantages of uncaging deserve mention:

a. The switchology involved in uncaging the AIM-9 in the F-4 slightly complicates the employment of the missile (remember the KISS principle). While this can be overcome with training, how many times have you tried to disconnect from the boom with the pickle button? If the answer is once or more, ask yourself if you can be sure that a similar switch error may not occur in the heat of battle, and weigh the probability of that switch error costing you a shot versus what you expect to gain by uncaging.

b. The time delay required to perform seeker uncaging prior to launch may eliminate any advantage gained. Uncaging the seeker should not be employed at high aspect angles with the fighter closing rapidly on the target. The best technique in this situation is to fire quickly with a good tone, thus minimizing the chance of launching inside min-range.

c. In the F-4, when you depress the AAR button with the Master Arm on, you uncage all AIM-9 seekers. If the IR source is not in the missile FOV when you uncage, or your thumb slips off of the AAR button prior to trigger squeeze, it may take up to several seconds for the seeker to recage. You may get an intermittent tone while the seeker is recaging, but the chances of your recapturing the tone, either by hitting the AAR button again or squeezing the trigger, are not good. The bottom line is if you press the AAR button and then release it, count to four before you consider yourself in the FOX-2 business.

To sum it all up, AIM-9P missile engagement capability is only slightly improved by uncaging the seeker and leading the target at trigger squeeze. This is due to the high maneuverability of the AIM-9P and the resultant capability to turn rapidly to a collision trajectory. A small lead angle in the vertical direction at very low altitude can provide an advantage under some conditions; however, missile firing experiences have shown that the extra uncaging procedures and tone confusion cause more aborted/bad launches than the minor advantages gained. The biggest single cause of failure of the AIM-9P is missile launch without a valid tone. Being a null seeker, once uncaged the missile will go to perfect track and the tone level will drop dramatically. To avoid confusion it is recommended that the pilot concentrate on being within the heart of the envelope, obtain a valid tone, and fire the AIM-9P uncaged.

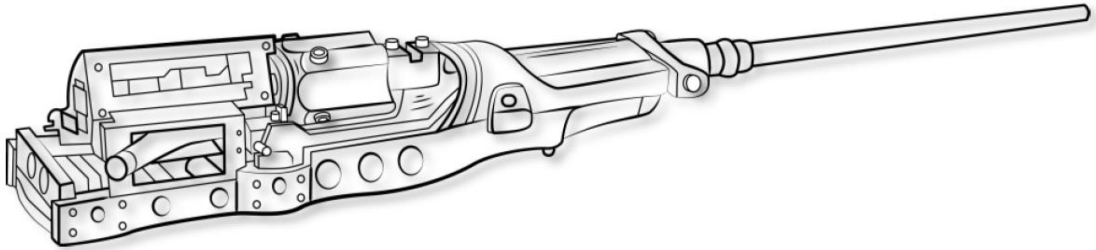
Captain Charles C. Deano
Eglin AFB, FL 32542

# 3.2 – M-39A3 20 mm Guns

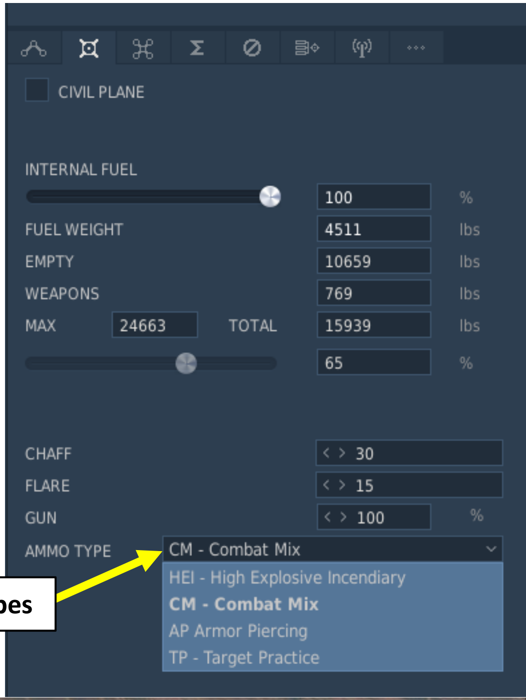
# 3.2 – M-39A3 20 mm Guns
## 3.2.1 – Introduction

The F-5E has two M-39A3 20 mm guns mounted in the upper forward section of the fuselage. The gun fires at 1500 to 1700 rounds per minute. Each gun has capacity of 280 rounds. The guns have a purging system for removing explosive gases and to prevent ingestion of these gases into the engines. During firing, the gun purge doors open and purge system is activated.

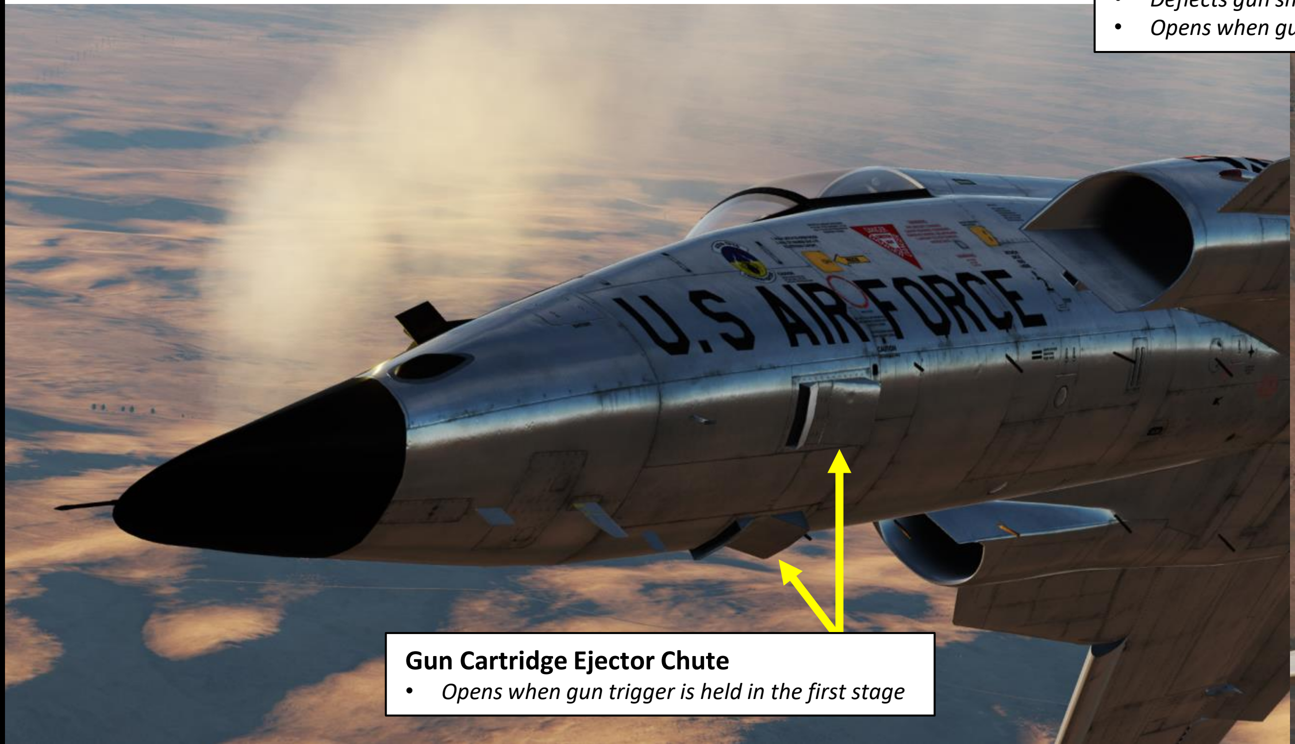
The type of gun ammunition equipped can be set via the Mission Editor or the Ground Crew menu.



**M-39A3 20 mm Cannon**




**Gun Ammo Types**




**Gun Cartridge Ejector Chute**
- *Opens when gun trigger is held in the first stage*


**Gun Deflector Doors**
- *Deflects gun smoke away from engine intakes*
- *Opens when gun trigger is held in the first stage*

# 3.2 – M-39A3 20 mm Guns
## 3.2.1 – Introduction

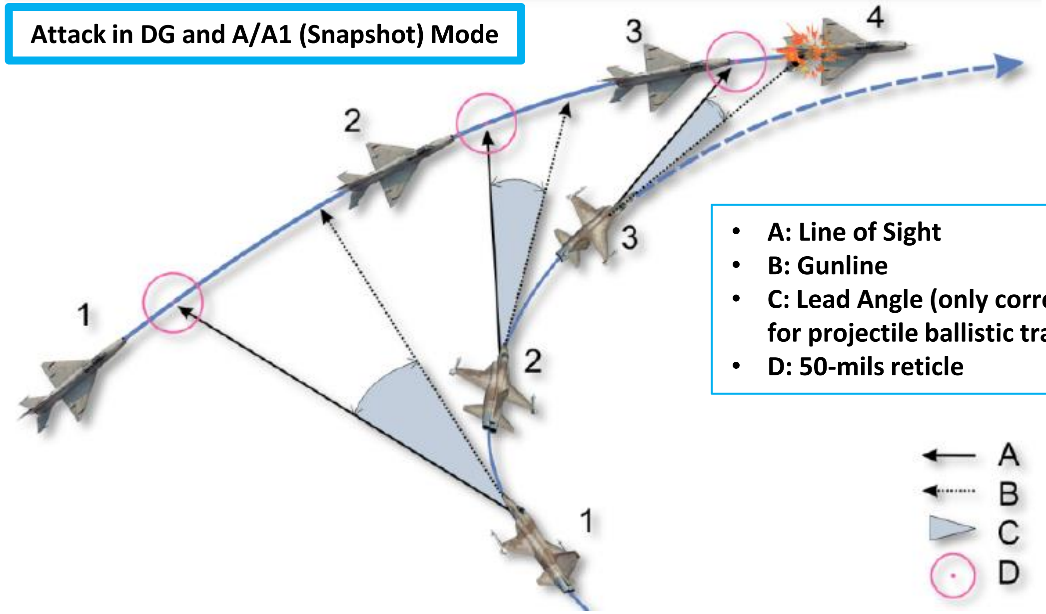
The guns can be used in two primary modes. You can either select A/A1 or A/A2 guns mode based on the target you are engaging. For fighters like the MiG-21, I recommend A/A1 mode. For bombers or fighter-bomber aircraft like the Su-24, I recommend the A/A2 mode.

- **A/A1 (Snapshot) Guns Mode**: Primarily used in short-range air-to-air combats against maneuvering targets with different angular rates and requires you to lead the gunsight pipper ahead of the target. A/A1 mode is automatically selected if Dogfight/Resume Search Switch is set to AFT (DG, Dogfight Gun Mode) or with the AN/ASG-31 Sight Mode Selector being set to A/A1 GUNS.
- **A/A2 (LCOS, Lead Computing Optical Sight) Guns Mode**: Primarily used in short-range air-to-air combats against unaccelerated constant rate maneuvering target and requires you to place the gunsight pipper directly on the target without having to lead ahead of the target. A/A1 mode is selected with the AN/ASG-31 Sight Mode Selector being set to A/A2 GUNS.


**AN/ASG-31 Sight Mode Selector**

**Dogfight/Resume Search Switch**
- *FWD (DM MODE)*
- *CENTER-PRESS (RESUME SEARCH)*
- *AFT (DG MODE)*

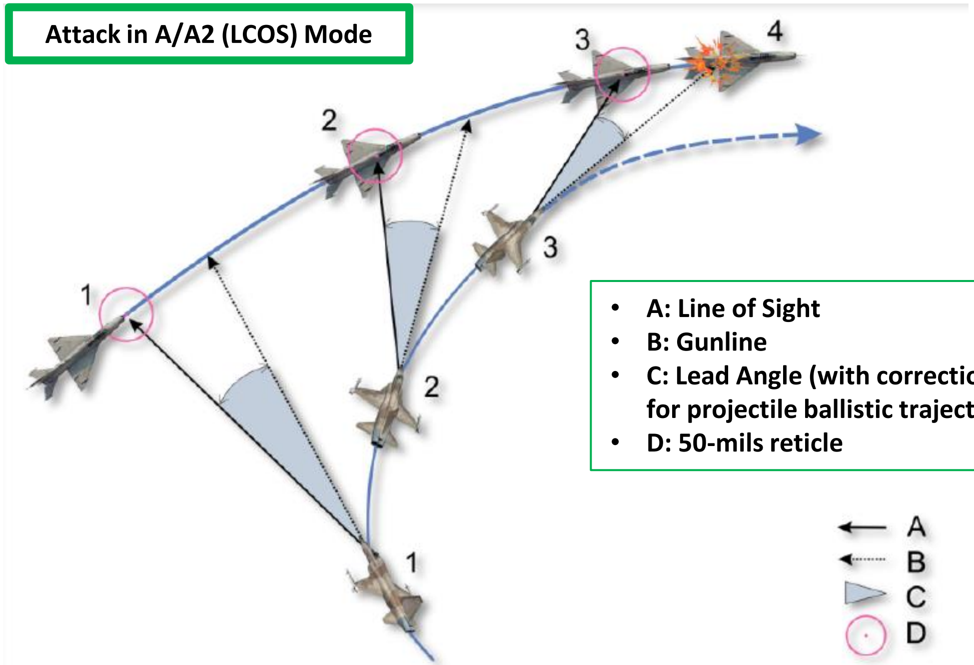
**Attack in DG and A/A1 (Snapshot) Mode**




- **A: Line of Sight**
- **B: Gunline**
- **C: Lead Angle (only correction for projectile ballistic trajectory)**
- **D: 50-mils reticle**

- **1: Attacker and target positions at attack initiation**
- **2: Attacker and target positions at aiming**
- **3: Attacker and target positions at firing**
- **4: Target impact**

**Attack in A/A2 (LCOS) Mode**



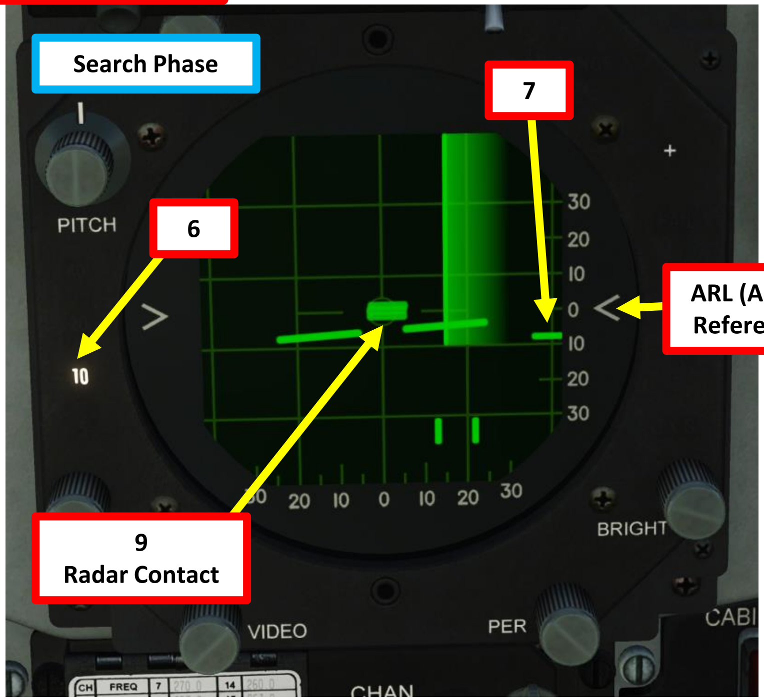

- **A: Line of Sight**
- **B: Gunline**
- **C: Lead Angle (with correction for projectile ballistic trajectory)**
- **D: 50-mils reticle**

- **1: Attacker and target positions at attack initiation**
- **2: Attacker and target positions at aiming**
- **3: Attacker and target positions at firing**
- **4: Target impact**

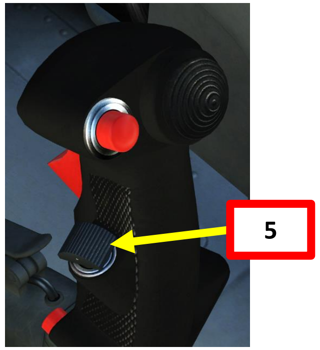
# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.2 – DG (Dogfight Gun) & A/A1 (Snapshot) Mode

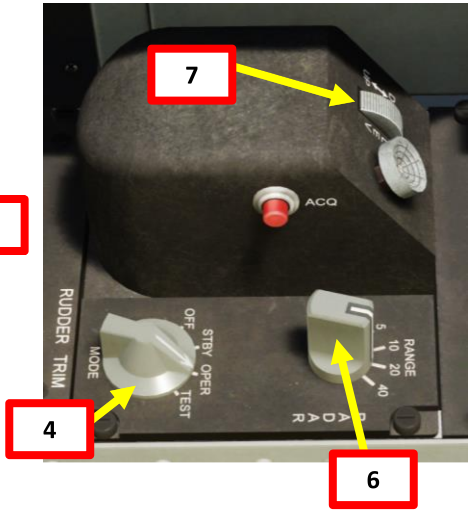
DG & A/A1 Modes are best used against manoeuvering targets like fighter jets.

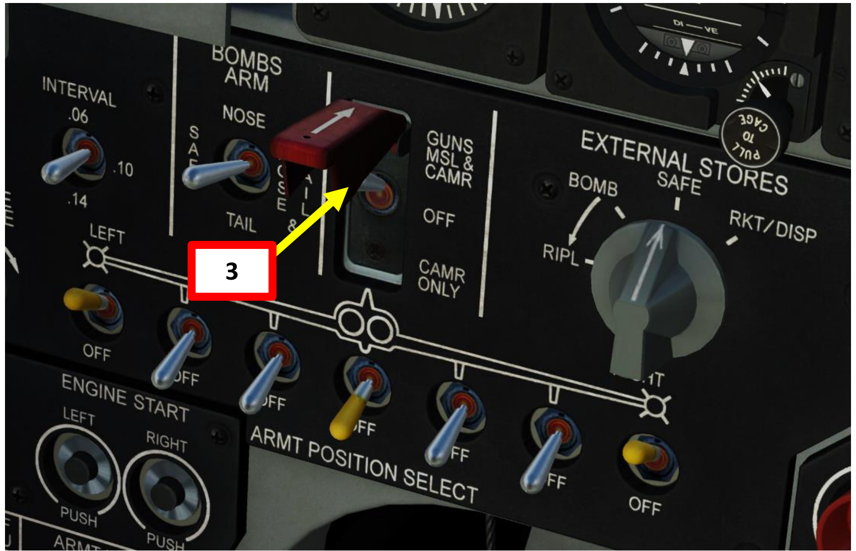
1. Set gunsight reticle brightness – as required.
2. Set AN/ASG-31 Sight Mode Selector to A/A1.
    - Alternatively, you can also set the Sight Mode Selector to MSL. The Dogfight Gun Mode (activated by setting the Dogfight/Resume Search Switch to AFT) overrides any selected mode and the sight will work as if in A/A1.
3. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).
4. Make sure Radar Mode selector is set to OPER
5. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
6. Set the radar range as required.
7. Tilt the radar antenna vertically as required.
8. Detect target on the radar, then get to a distance of 10 nm or less.
9. Maneuver aircraft to center target on 0 deg azimuth and elevation.





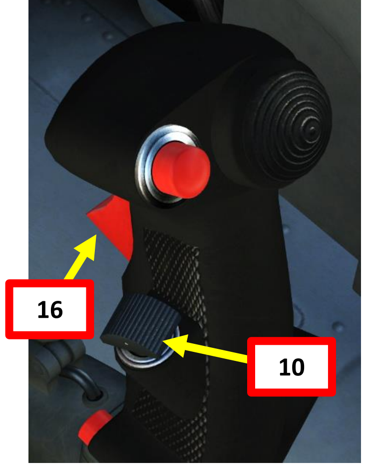


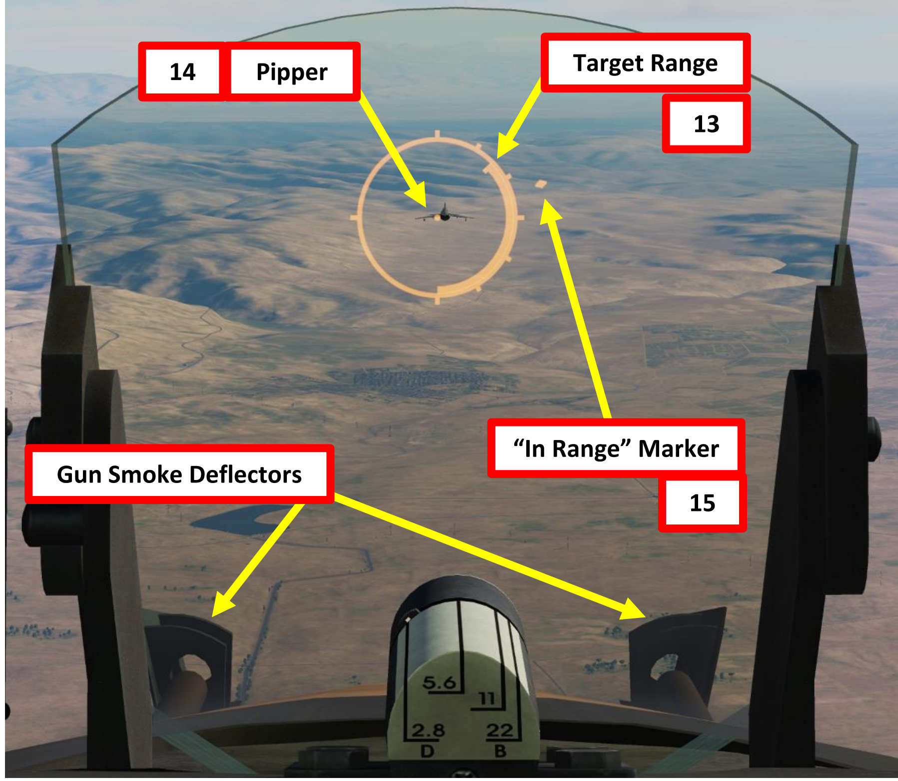



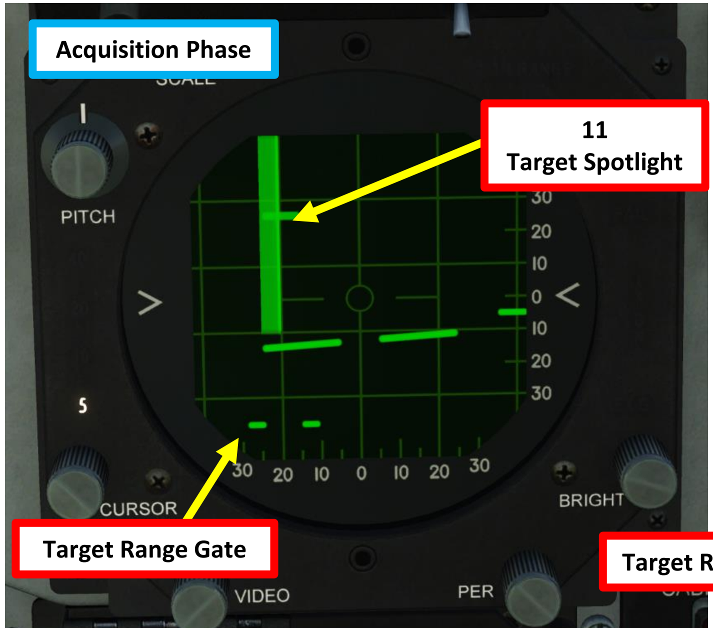



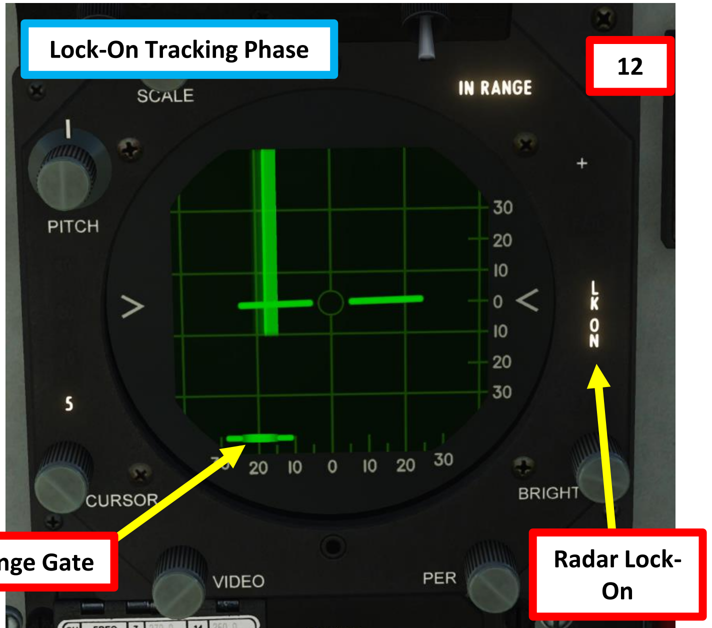
# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.2 – DG (Dogfight Gun) & A/A1 (Snapshot) Mode

10. Initiate DG (Dogfight Gun) Mode by setting the Dogfight/Resume Search Switch to AFT.
11. After DG mode selection, the radar antenna aligns to 0° azimuth and 4.7 deg below ARL (Armament Reference Line) and range scale changes to 5 miles. If the target is within the range of 500 to 5,600 feet, the radar automatically locks on to the first target encountered.
12. After radar lock-on to the target, radar display shows target range gate.
13. After radar lock-on to the target, aiming markers appear on the gun sight circle with ranging information.
    - Note: You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
14. Place the reticle pipper slightly forward of the target based on lead angle. The effective range of the guns is 2700 ft to 1000 ft. Consider projectile flight time for 2700-ft range is approximately 1 second, 0.7 seconds for 2000 ft, and 0.3 seconds for 1000 ft.
15. A red dot ("in-range marker") will appear next to the gunsight reticle when you are in range to fire the guns.
16. To fire the guns:
    a) Squeeze the first-stage trigger to deploy the gun smoke deflectors ("T" binding),
    b) Squeeze the second-stage trigger to fire the guns ("SPACEBAR" binding).

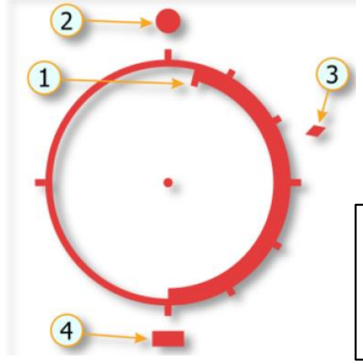


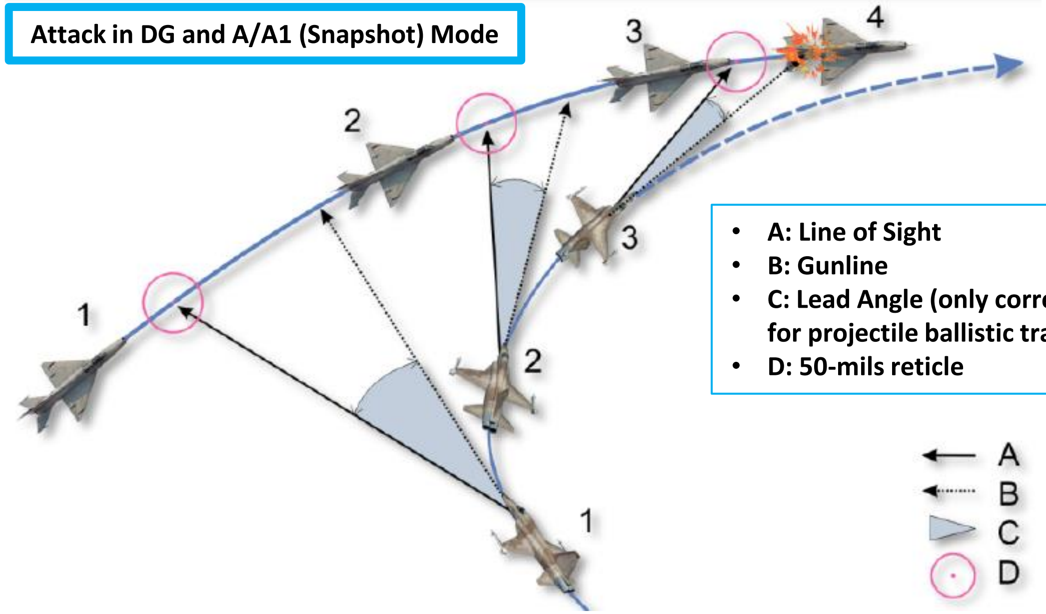



# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.2 – DG (Dogfight Gun) & A/A1 (Snapshot) Mode




1. Range Bar
2. Minimum Range Bar
3. In Range Marker
4. Excess-G Marker

**Attack in DG and A/A1 (Snapshot) Mode**



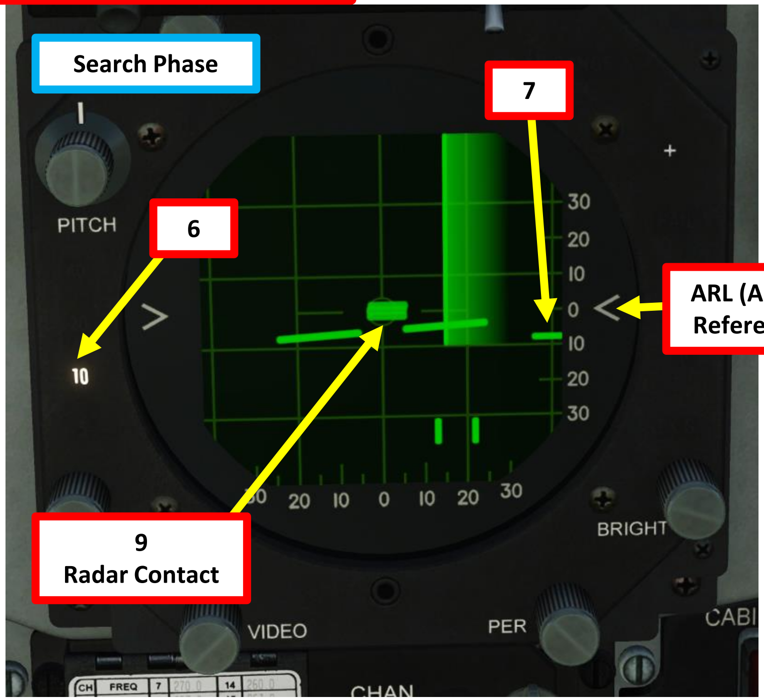

- A: Line of Sight
- B: Gunline
- C: Lead Angle (only correction for projectile ballistic trajectory)
- D: 50-mils reticle

- 1: Attacker and target positions at attack initiation
- 2: Attacker and target positions at aiming
- 3: Attacker and target positions at firing
- 4: Target impact

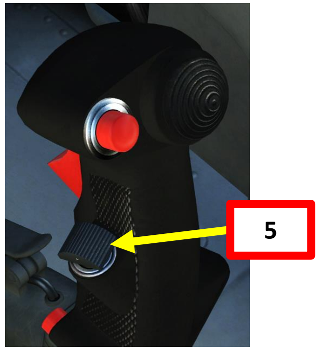
# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.3 – A/A2 (LCOS, Lead Computing Optical Sight) Mode

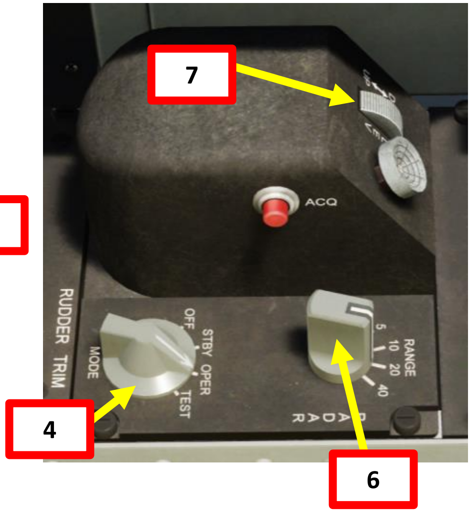
A/A2 Mode is best used against non-manoeuvering targets like bombers.

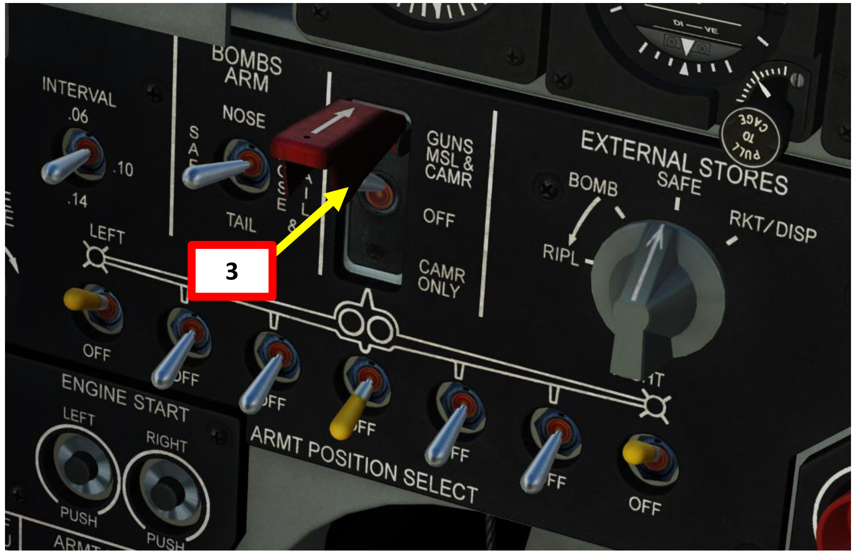
1. Set gunsight reticle brightness – as required.
2. Set AN/ASG-31 Sight Mode Selector to A/A2
3. On armament panel, flip safety cover and set Weapon Arming Switch to GUNS MSL & CAMR (UP).
4. Make sure Radar Mode selector is set to OPER
5. Initiate Search Mode by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
6. Set the radar range as required.
7. Tilt the radar antenna vertically as required.
8. Detect target on the radar, then get to a distance of 10 nm or less.
9. Maneuver aircraft to center target on 0 deg azimuth and elevation.





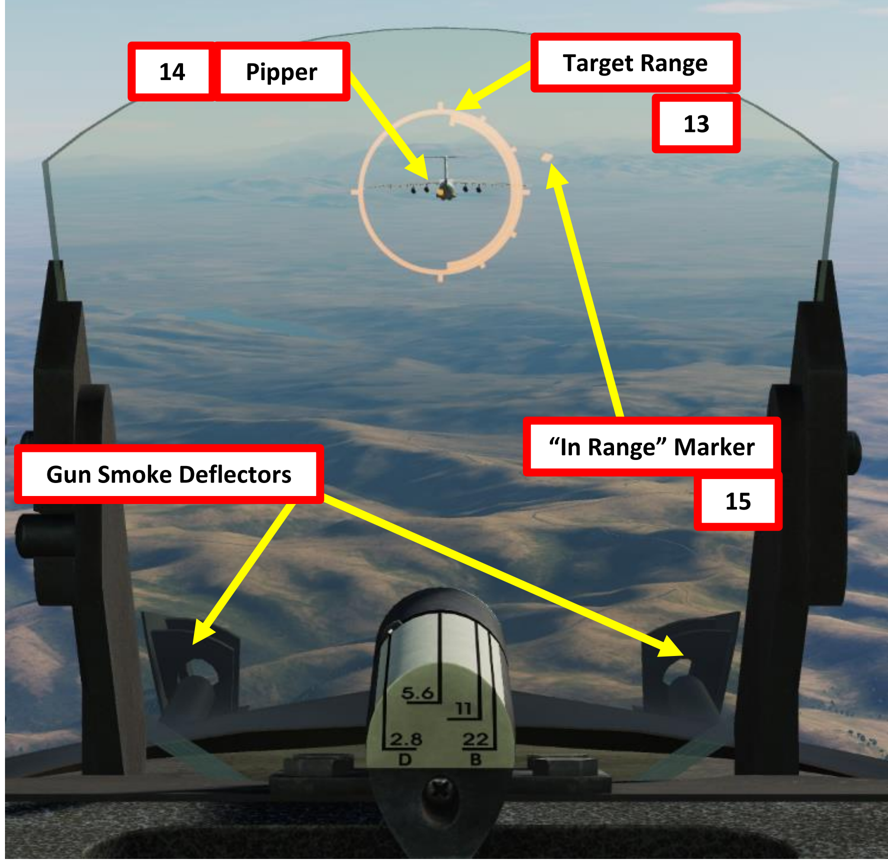


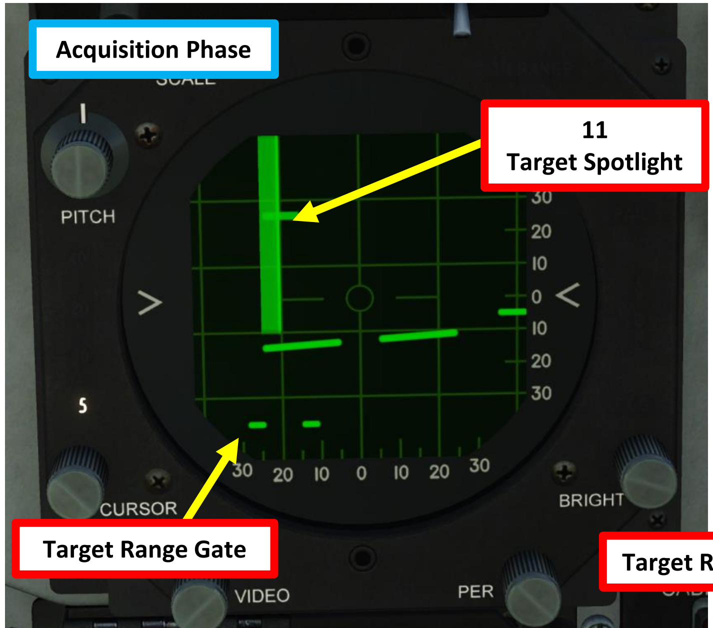



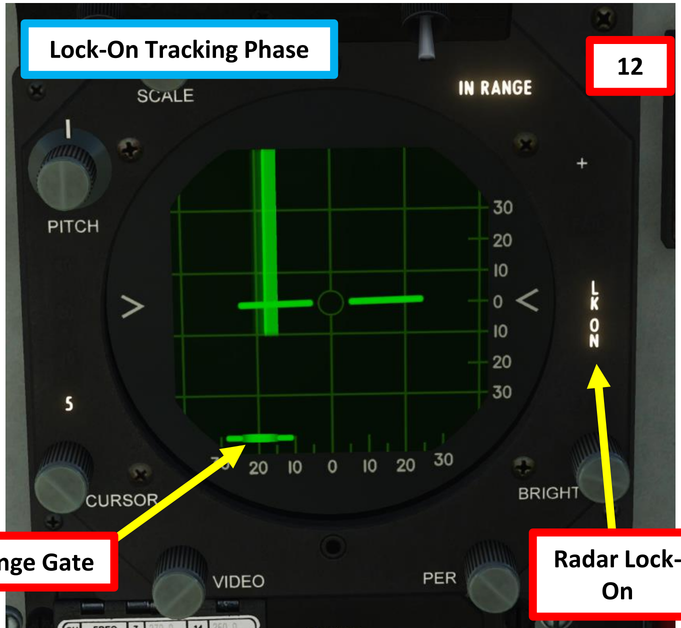



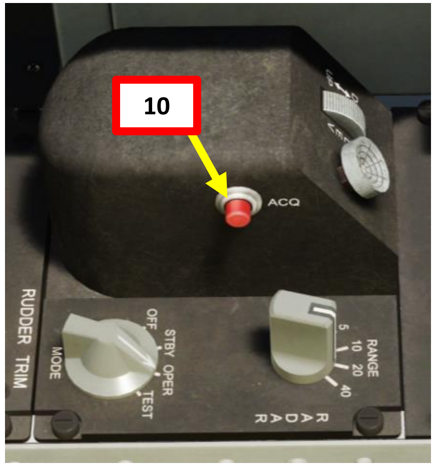
# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.3 – A/A2 (LCOS, Lead Computing Optical Sight) Mode

10. Initiate A/A2 Mode by pressing the ACQ button ("ENTER" binding).
11. After A/A2 mode selection, if the target is within the range of 500 to 5600 feet, the radar automatically locks on to the target. In this mode, the sight system calculates the lead angle, which means you can aim the pipper on the target rather than in front of it.
12. After radar lock-on to the target, radar display shows target range gate.
13. After radar lock-on to the target, aiming markers appear on the gun sight circle with ranging information.
    - Note: You can unlock the target by setting the Dogfight/Resume Search Switch to DEPRESS (CENTER).
14. Place the reticle pipper on the target. The effective range of the guns is 2700 ft to 1000 ft.
15. A red dot ("in-range marker") will appear next to the gunsight reticle when you are in range to fire the guns.
16. To fire the guns:
    a) Squeeze the first-stage trigger to deploy the gun smoke deflectors ("T" binding),
    b) Squeeze the second-stage trigger to fire the guns ("SPACEBAR" binding).

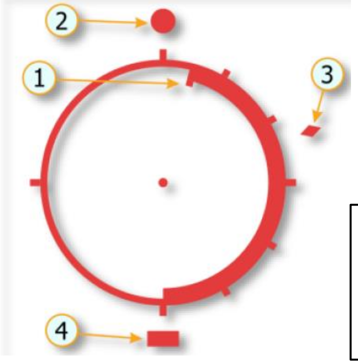



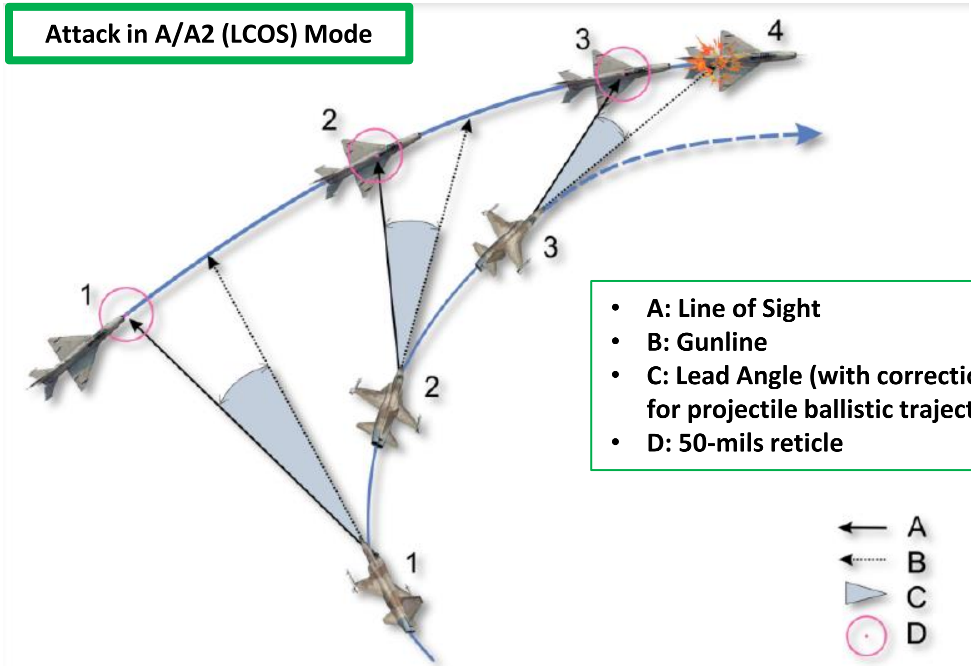



# 3.2 – M-39A3 20 mm Guns (Air-to-Air)
## 3.2.3 – A/A2 (LCOS, Lead Computing Optical Sight) Mode




1. Range Bar
2. Minimum Range Bar
3. In Range Marker
4. Excess-G Marker

**Attack in A/A2 (LCOS) Mode**




- A: Line of Sight
- B: Gunline
- C: Lead Angle (with correction for projectile ballistic trajectory)
- D: 50-mils reticle

- 1: Attacker and target positions at attack initiation
- 2: Attacker and target positions at aiming
- 3: Attacker and target positions at firing
- 4: Target impact


# 4 – Ordnance Jettison
## 4.1 – Selective Ordnance Jettison

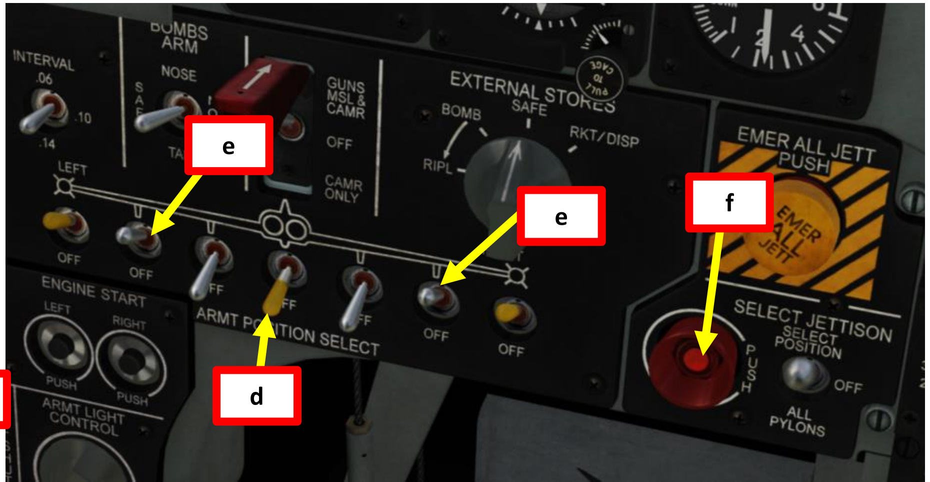
**Selective Jettison – SELECT POSITION Functionality**

The centerline store, any wing store, or paired wing store (both outboard or both inboard) may be jettisoned individually as selected by the armament position selector switches. Only one release or paired release (both outboard or both inboard pylons) occurs for each actuation of SELECT JETTISON button. After selected store is jettisoned, it must be selected OFF before the next store can be jettisoned. For example, in order to jettison the outboard stores, the armament position selector switches of the centerline and inboard stores must be set in OFF position.

Let’s jettison the central pylon and outer wing pylons using this method:

a) Set Select Jettison Position Switch – SELECT POSITION (UP)
b) Set Centerline Armament Position Selector Switch – ON (UP)
c) Press Jettison Push Button. The Centerline pylon will drop.
   - Note: Even if wingtip missile switches are ON, they have a lower priority than the centerline pylon and will therefore not drop.
d) Set Centerline Armament Position Selector Switch – OFF (DOWN)
e) Set Outboard Wing Pylon Armament Position Selector Switches – ON (UP)
f) Press Jettison Push Button. Outboard pylons will drop.
   - Note: Even if wingtip missile switches are ON, they have a lower priority than the outboard pylons and will therefore not drop.
g) Set Select Jettison Position Switch – OFF (MIDDLE)


**Sequencing logic provides the following store release priority:**
1. Centerline
2. Inboard
3. Outboard
4. Wingtip missiles emergency launch

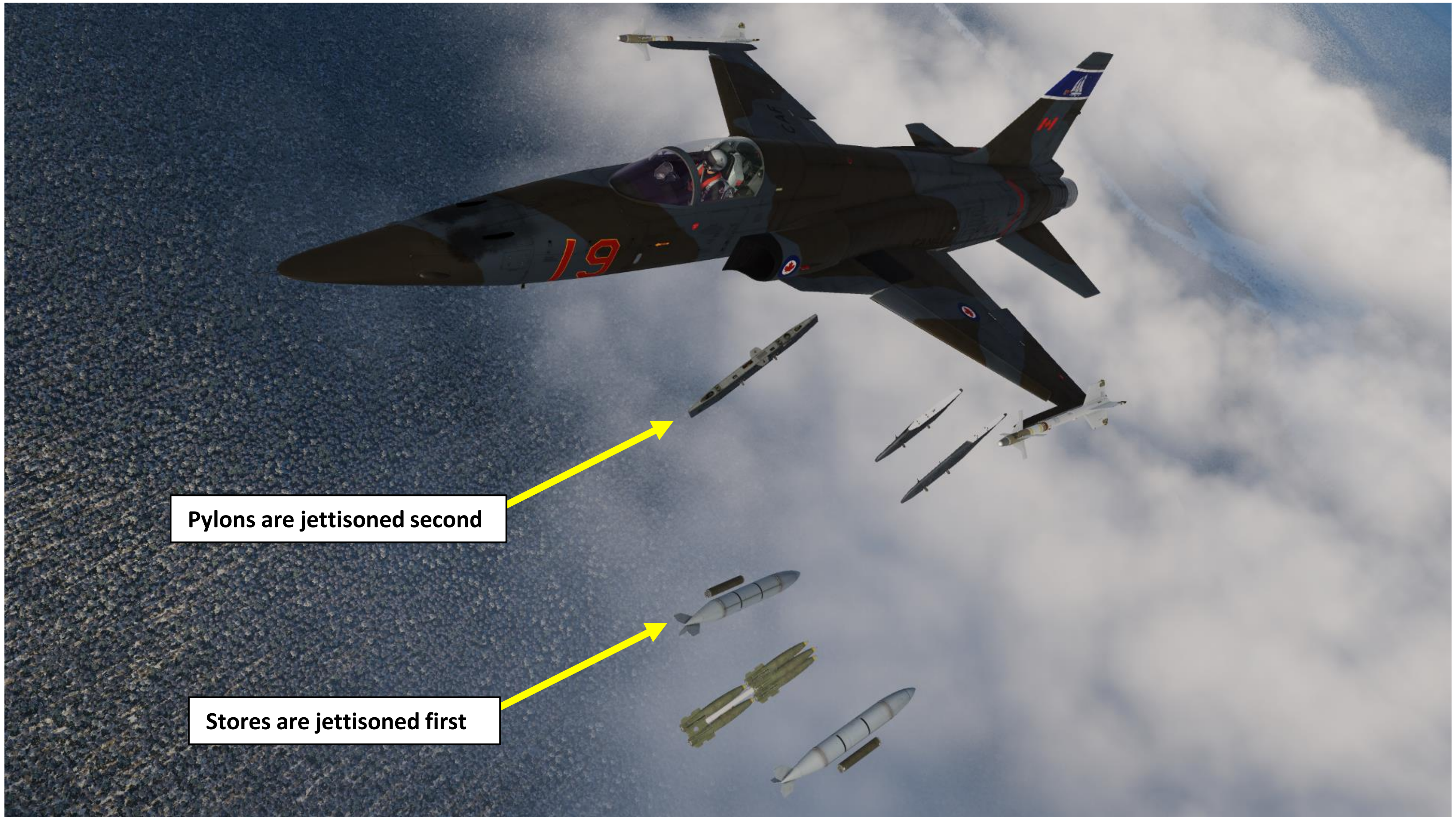



# 4 – Ordnance Jettison
## 4.1 – Selective Ordnance Jettison

**Selective Jettison – ALL PYLONS Functionality**

1. Set Select Jettison Position Switch – PYLONS (DOWN)
2. Press Jettison Push Button
3. Once stores jettison is complete, set Select Jettison Position Switch – OFF (MIDDLE)

Actuation of the button jettisons wing and centerline stores and also actuates the pylon jettison circuits. If pylons are jettisoned with stores, the stores jettison from the pylons first followed by the pylons approximately 1 second later.

# 4 – Ordnance Jettison
## 4.2 – Emergency Stores Jettison

The EMERGENCY ALL JETTISON button is used when you want to quickly dump all your stores (with the exception of the AIM-9 wingtip pylons). When pushed, the button connects the power supply to electrically salvo-jettison stores from all pylons, bypassing all armament control selections.

Note: before pressing the EMERGENCY ALL JETTISON button, you need to click on the yellow safety cover to remove it.

**Emergency Jettison ALL Button Protective Cover**

**Emergency Jettison ALL Button**



USAF
U.S. AIR FORCE

# COUNTERMEASURES – INTRODUCTION

Countermeasures are very simple to use. You have two countermeasure types at your disposal: flares and chaff. We will explore together what is used against what, and how.

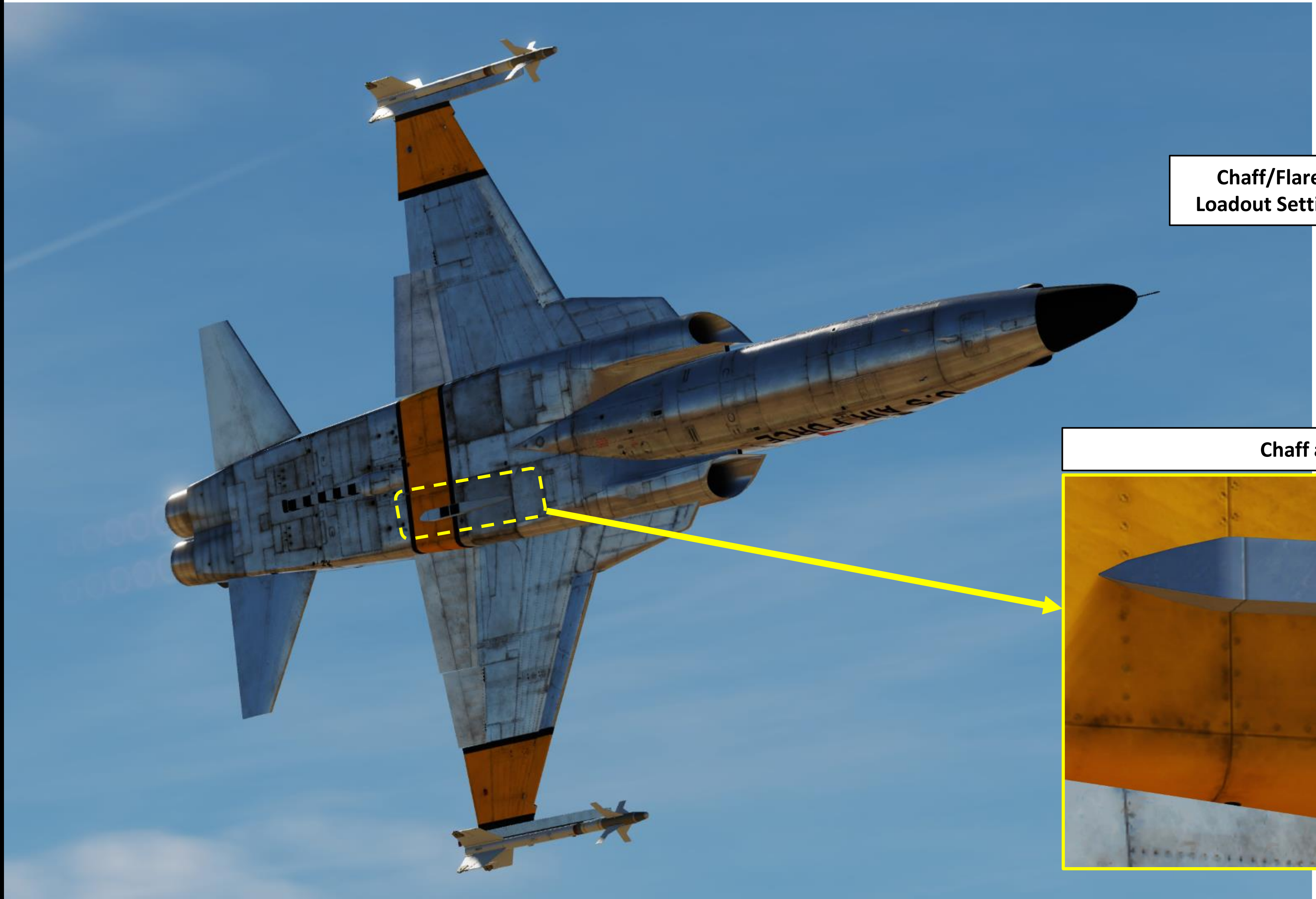
Missiles can generally track you using 2 things: radar signature (radar waves are sent on you and you reflect them, which is called a “radar signature”) and heat signature (like the exhaust of your engines). Countermeasures will only be effective against the kind of weapon it was meant to counter; a heat-seeking missile will not care if you deploy electronic countermeasures against it since it tracks heat, not radar signatures. This is why it is important to know what is attacking you in order to counter it properly. This is what the RWS (Radar Warning System) is for: to help you know what is firing at you so you can take the adequate action to counter it.

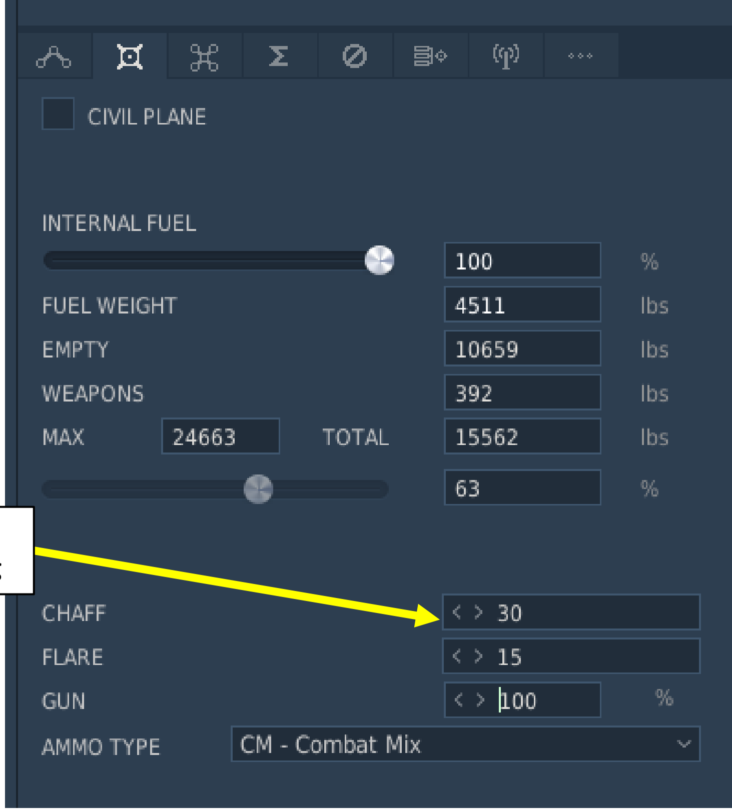
**Flares** are used against missiles that track heat (infrared or IR) signatures. Instead of going for the heat signature generated by your engines, a missile will go for a hotter heat source like flares.

**Chaff** is a form of “passive” jamming. Passive (reflected) jamming is when a deceptive object or device reflects radar waves. Chaff is simply a bundle of small pieces of metal foil with reflective coating, which creates clusters of radar signatures that prevent a radar to get a solid lock on the aircraft itself.

# AN/ALE-40 CHAFF & FLARE DISPENSER SYSTEM

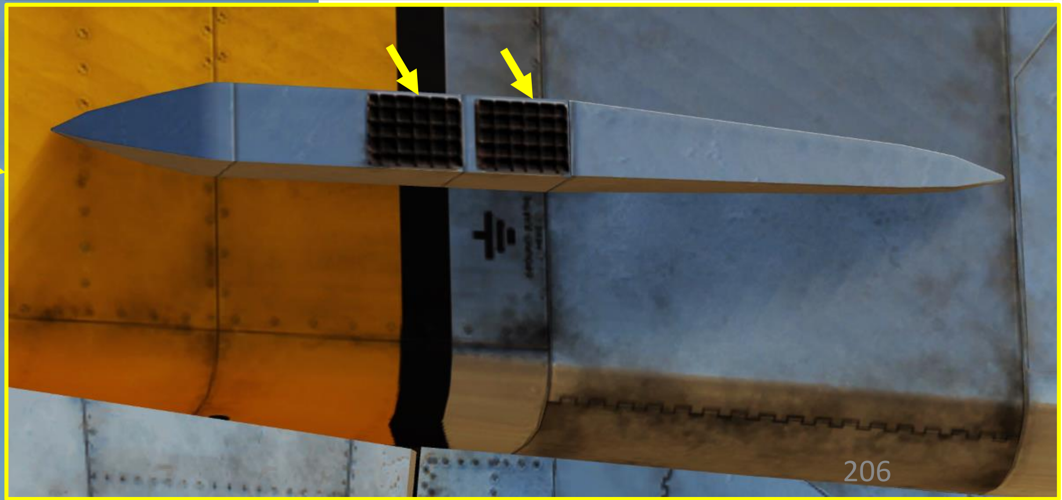
The AN/ALE-40 system provides the capability of dispensing flare or chaff payloads as a means of defense against hostile radar or IR missile attack. You can load up to 60 chaff cartridges or up to 30 flare cartridges. You can also equip a combination of 30 chaff and 15 flares. The chaff/flare loadout can be set via the Mission Editor or from the Ground Crew Menu.






Chaff/Flare Loadout Setting

Chaff and Flare Dispensers (30 chaff + 15 flares)



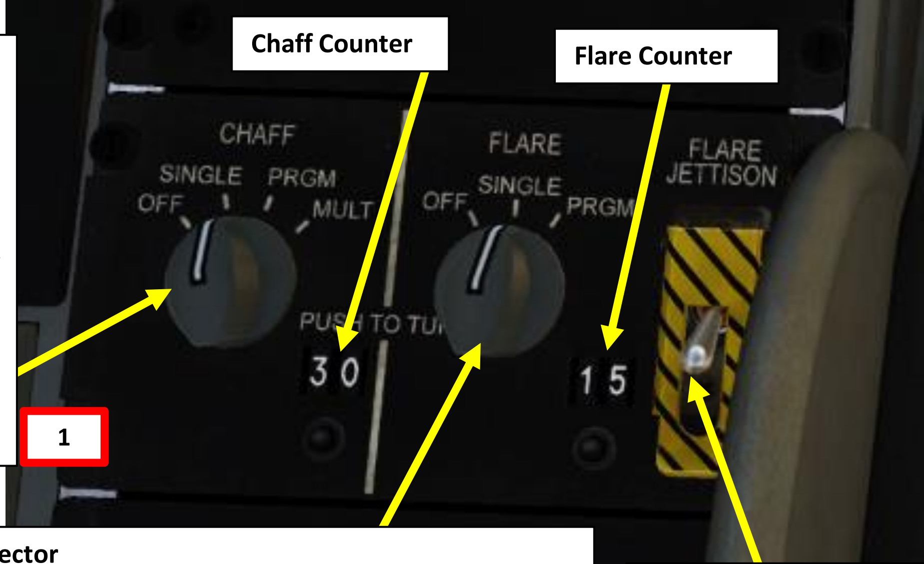
# CHAFF & FLARE DISPENSING

**Single Mode**

1. Select the CHAFF mode selector and set it to SINGLE.
2. Select the FLARE mode selector and set it to SINGLE.
3. Press the Countermeasures Flare-Chaff Button on your throttle ("Q") to dispense flares and chaff.

**Chaff Mode Selector**

- ***OFF***
- ***SINGLE***: *single chaff is dispensed when flare-chaff button is pressed.*
- ***PROGRAM***: *chaffs are dispensed according to preset program when flare-chaff button is pressed. Program settings are set by the ground crew:*
  - *0.1, 0.2, 0.3, or 0.4-second interval between chaff bursts*
  - *1, 2, 3, 4, 5, or 8-second interval between salvo*
  - *1, 2, 3, 4, 6, 8 chaff bursts at an interval*
  - *1, 2, 4, 8, salvos in a program or till the end of chaffs.*
- ***MULTIPLE***: *dispenses 1, 2, 3, 4, 6, or 8 flares when flare-chaff is pressed. (set by ground crew)*




Chaff Counter

Flare Counter

1

2

Flare Jettison Switch

**Flare Mode Selector**

- ***OFF***
- ***SINGLE***: *a single flare is dispensed when flare-chaff button is pressed.*
- ***PROGRAM***: *flares are dispensed according to preset program when flare-chaff button is pressed. Program settings are set by the ground crew:*
  - *3, 4, 6, 8 or 10-second interval*
  - *1, 2, 4, 8 flares per salvo or till the end of chaffs.*


3

**Countermeasures (Flare-Chaff) Button (Q)**

# CHAFF & FLARE DISPENSING

## PRGM (Program) Mode

1. The Chaff/Flare program is set when the aircraft is on the ground.
2. Select the CHAFF mode selector and set it to PRGM.
3. Select the FLARE mode selector and set it to PRGM.
4. Press the Countermeasures Flare-Chaff Button on your throttle (“Q”) to dispense flares and chaff.

**Chaff Mode Selector**

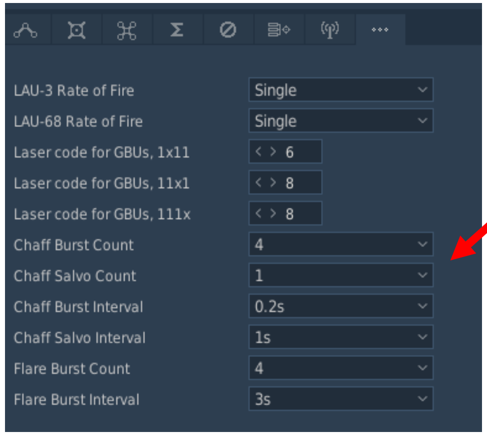
- ***OFF***
- ***SINGLE****: single chaff is dispensed when flare-chaff button is pressed.*
- ***PROGRAM****: chaffs are dispensed according to preset program when flare-chaff button is pressed. Program settings are set by the ground crew:*
  - *0.1, 0.2, 0.3, or 0.4-second interval between chaff bursts*
  - *1, 2, 3, 4, 5, or 8-second interval between salvo*
  - *1, 2, 3, 4, 6, 8 chaff bursts at an interval*
  - *1, 2, 4, 8, salvos in a program or till the end of chaffs.*
- ***MULTIPLE****: dispenses 1, 2, 3, 4, 6, or 8 flares when flare-chaff is pressed. (set by ground crew)*


**3**

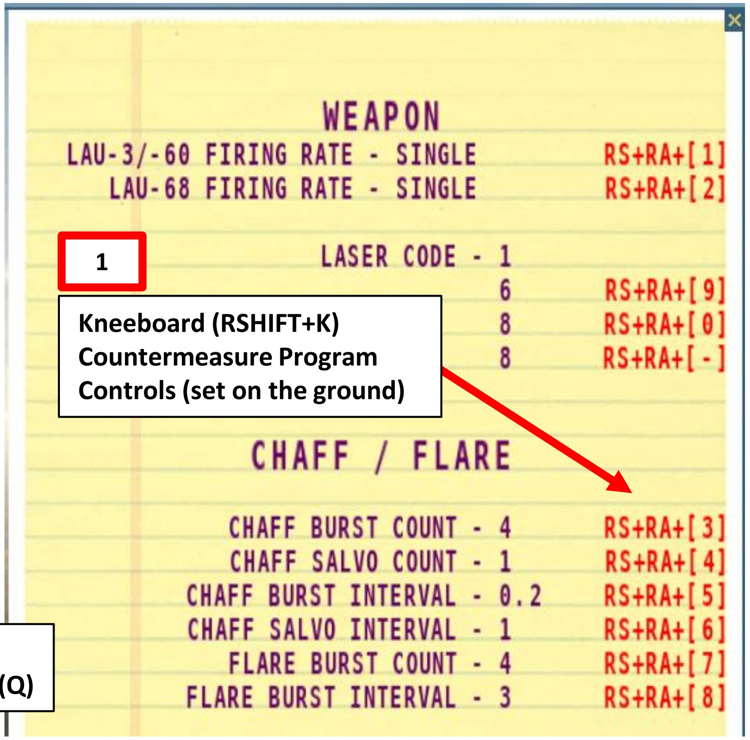
**Flare Mode Selector**

- ***OFF***
- ***SINGLE****: a single flare is dispensed when flare-chaff button is pressed.*
- ***PROGRAM****: flares are dispensed according to preset program when flare-chaff button is pressed. Program settings are set by the ground crew:*
  - *3, 4, 6, 8 or 10-second interval*
  - *1, 2, 4, 8 flares per salvo or till the end of chaffs.*

**Flare Jettison Switch**




**Mission Editor Countermeasure Program Controls (set on the ground)**



WEAPON

| | | |
|---|---|---|
| LAU-3/-60 FIRING RATE - SINGLE | | RS+RA+[1] |
| LAU-68 FIRING RATE - SINGLE | | RS+RA+[2] |
| LASER CODE - | 1 | |
| | 6 | RS+RA+[9] |
| | 8 | RS+RA+[0] |
| | 8 | RS+RA+[-] |

CHAFF / FLARE

| | | |
|---|---|---|
| CHAFF BURST COUNT - | 4 | RS+RA+[3] |
| CHAFF SALVO COUNT - | 1 | RS+RA+[4] |
| CHAFF BURST INTERVAL - | 0.2 | RS+RA+[5] |
| CHAFF SALVO INTERVAL - | 1 | RS+RA+[6] |
| FLARE BURST COUNT - | 4 | RS+RA+[7] |
| FLARE BURST INTERVAL - | 3 | RS+RA+[8] |

**1**

**Kneeboard (RSHIFT+K) Countermeasure Program Controls (set on the ground)**


**4**

**Countermeasures (Flare-Chaff) Button (Q)**

# AN/ALR-87 RWS (RADAR WARNING SYSTEM)

The RWS (Radar Warning System) is basically a top-down view of your aircraft. The aircraft in the upper quadrants are to your front while the aircraft on the lower quadrants are to your rear.

**To power the RWS:**
1. Pess the POWER button.
2. Activate Search Mode by pressing on the SEARCH button.

Positions of emitter and launch symbols on the indicator do not necessarily correspond to the actual distance from the hostile emitter to the aircraft.

Distance from the emitter symbol to the indicator center corresponds to the emitter signal power. Generally, the closer the symbol is to the indicator center, the closer the emitter is to the aircraft. In addition to visual indications, the system produces audio warning signals depending on the operation mode of the detected emitter (search, tracking, and launch).

The RWS generates warning tones in order to warn pilot acoustically. The loudness of the audio warning tones can be adjusted by means of the AUDIO knob.
There are two types of audio warning signals:
- New emitter sound
- Missile launch sound

The new emitter sound consists of two equal tones within 1 second that are used for various emitter classes:
- 750 Hz – Emitter of ground/air guided weapon systems.
- 1500 Hz – Search radars and unknowns.
- 1744 Hz – Aircraft onboard radars.

The missile launch sound consists of seven tones within 1.5 seconds with a frequency of 1000 Hz.

# AN/ALR-87 RWS (RADAR WARNING SYSTEM)

**RWS (Radar Warning System) Mode Button**
*Reverses display of the azimuth indicator to illustrate a maximum of 16 emitter symbols or to restrict the illustration to a maximum of 6 emitter symbols with maximum threat priority.*
- *Initial state: OPEN – Illustration of a maximum 16 emitter symbols.*
- *Alternative state: PRIORITY – Restriction to illustration to a maximum of 6 emitter symbols.*

- *Lower display field: OPEN – lights up if initial state was selected.*
- *Upper display field:*
  - *PRIORITY – lights up if alternative state was selected and if no more than 6 emitters are present.*
  - *PRIORITY – blinks if alternative state was selected and more than 6 emitters are present.*

*Note: Selection between 16 and 6 emitter symbols is made by repeatedly pressing the MODE button.*

**RWS Search Button**
*Switches over display of the azimuth indicator for optional non-display/display of the emitter symbols of defined radar systems*
- *Initial state: Only fire control radars are displayed.*
- *Alternative state: Emitter symbols of defined radar systems are displayed.*

- *Upper display field:*
  - *S – dark when only fire control radars are displayed.*
  - *S – lights up when emitter symbols of defined radar systems are displayed.*

**RWS Handoff Button (not simulated)**

**RWS Launch Button (not simulated)**

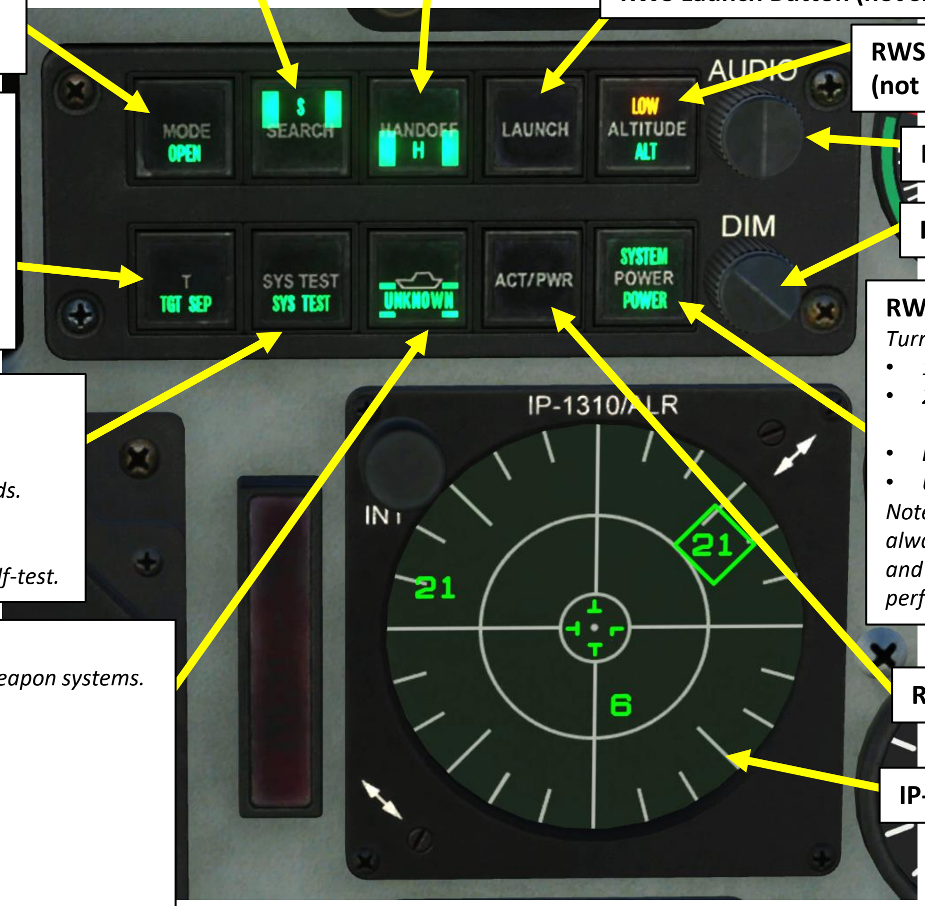
**RWS Altitude Button (Low Alt/ Alt) (not simulated)**

**RWS Panel Audio Control**

**RWS Panel Lighting Dimmer Control**

**RWS T (Threat Priority) Button**
*Separates symbols that cover each other on the azimuth indicator; the symbol with the highest threat priority remains in the right place.*
- *Initial state: No symbol separation.*
- *Special state: Symbol separation effective.*

- *Lower display field: TGT SEP – always lights up.*
- *Upper display field: TGT SEP – lights up if symbol separation is effective.*




**RWS System Test Button**
*Triggers system self-test.*
- *Initial state: RWS operational use.*
- *Special state: self-test runs, duration about 10 seconds.*

- *Lower display field: SYS TEST – always lights up.*
- *Upper display field: ON – lights up in the course of self-test.*

**RWS Power Button**
*Turns on and off the radar warning system.*
- *1st selection state: RWS turned off.*
- *2nd selection state: RWS turned on.*

- *Lower display field: POWER*
- *Upper display field: SYSTEM*

*Note: the lower and upper displays SYSTEM + POWER always light up if radar warning system is turned on and power supply present. A 50-second self-test is performed automatically after turn-on.*

**RWS Unknown Ship Button**
*Reverses display for optional illustration/non-illustration of emitter symbols of unknown weapon systems.*
- *Normal state: Unknown emitters are illustrated with symbol U.*
- *Alternative state: Unknown emitters are not illustrated.*

- *Lower display field: UNKNOWN – always lights up.*
- *Upper display field:*
  - *U – dark if initial state selected.*
  - *U – lights up if alternate state selected and no unknowns present.*
  - *U – blinks if alternate state selected and unknowns present.*

**RWS ACT/PWR Button**

**IP-1310/ALR RWS (Radar Warning System)**

# AN/ALR-87 RWS (RADAR WARNING SYSTEM)

Here is a summary of the RWS symbology.

Each symbol on the RWS has three states:

- Symbol without circle: someone's radar is looking for you but has no lock.
- Symbol with circle: someone's radar has a lock on you.
- Symbol with flashing circle: a radar-guided weapon has been fired and is heading straight to you.

**Note 1**: The symbol with a diamond represents the biggest threat to you. Keep in mind that the RWS cannot distinguish between friendly or enemy contacts or missile launches.

**Note 2**: If the RWS is unable to identify emitters, the U symbol appears on the indicator.


| Symbol | Identification |
|---|---|
| **Ground-to-Air Radars** | |
| A | Gepard and ZSU-23-4 Shilka self-propelled antiaircraft guns |
| S6 | 2S6 Tunguska self-propelled antiaircraft gun |
| 3 | S-125 Neva (SA-3) surface-to-air missile system |
| 6 | Kub (SA-6) surface-to-air missile system |
| 8 | Osa (SA-8) surface-to-air missile system |
| 10 | Acquisition radar of S-300 (SA-10) surface-to-air missile system |
| CS | Low-altitude acquisition radar (Clam Shell) of S-300 (SA-10) surface-to-air missile system |
| BB | Acquisition radar (Big Bird) of S-300 (SA-10) surface-to-air missile system |
| 11 | Acquisition radar of Buk (SA-11/17) self-propelled, medium-range surface-to-air missile systems |
| SD | Search radar (Snow Drift) of Buk (SA-11/17) self-propelled, medium-range surface-to-air missile systems |
| 13 | Strela-10 (SA-13) surface-to-air missile system |
| DE | Search radar of Sborka mobile reconnaissance and command center (Dog Ear) |
| 15 | Tor (SA-15) surface-to-air missile system |
| RO | Roland surface-to-air missile system |
| PA | Patriot surface-to-air missile system |
| HA | Hawk surface-to-air missile system |
| S | Ground-based early warning systems |
| **Air-to-air radars** | |
| E3 | E-3A airborne early warning and control aircraft |
| E2 | E-2C airborne early warning and control aircraft |
| 50 | A-50U airborne early warning and control aircraft |
| 21 | MiG-21 |
| 23 | MiG-23ML |
| 25 | MiG-25PD |
| 29 | MiG-29, Su-27, and Su-33 |
| 31 | MiG-31 |
| 30 | Su-30 |
| 34 | Su-34 |
| M2 | Mirage 2000-5 |
| F4 | F-4 |
| F5 | F-5 |
| 14 | F-14 |
| 15 | F-15 |
| 16 | F-16 |
| 18 | F/A-18 |

# AN/ALR-87 RWS (RADAR WARNING SYSTEM)

# IFF (IDENTIFY-FRIEND-OR-FOE) INTRODUCTION

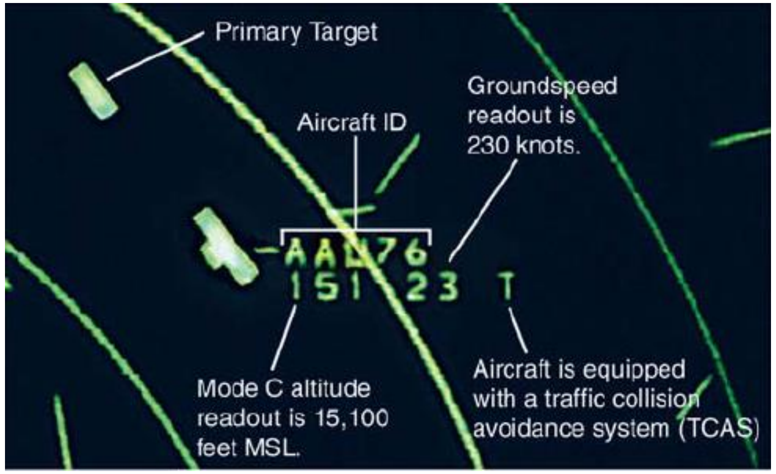
An IFF (Identify-Friend-or-Foe) system usually consists of an **INTERROGATOR** component and a **TRANSPONDER** component.

The **interrogator** component broadcasts an interrogation signal with a specific "code" (pulse frequency).

A **transponder** equipped on another aircraft will receive the interrogation signal and broadcast a reply signal with its own "code" (pulse frequency) as well. The information sent from this reply signal will vary based on the transponder mode selected.

Your own aircraft transponder will then see if the interrogation code and reply codes match, which in some cases can be used to determine whether the other aircraft is a friendly contact. The nature of the information determined will vary based on the transponder mode.

Take note that **the F-5E-3 has no interrogator**, therefore you cannot send interrogation signals to other aircraft to see whether they are friendly or not. However, you do have a transponder, which is very important. If you set an incorrect transponder code, friendly contacts may not be able to identify you as a friendly, which can be a big problem.



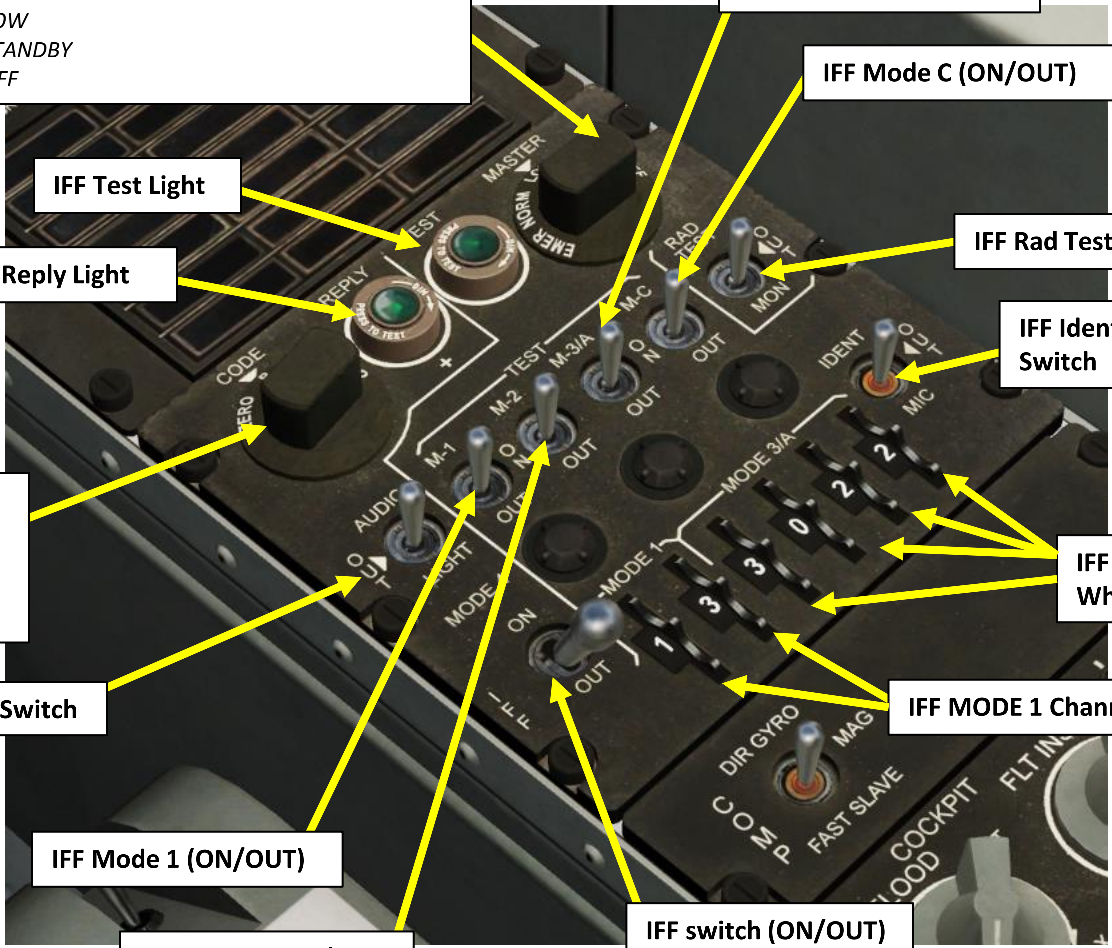

# IFF MODES

In its simplest form, a IFF "Mode" or interrogation type is generally determined by pulse spacing between two or more interrogation pulses. Various modes exist from Mode 1 to 5 for military use, to Mode A, C, and Mode S for civilian use. The takeaway from this table should be:

- **Mode 4 is the preferred mode in a combat** scenario because it is highly secure (encrypted). Encrypted interrogation codes cannot be detected by an enemy transponder, and your transponder will not broadcast a reply signal to the other team.
- **Mode 4 invalid/lack of reply cannot guarantee that an aircraft is hostile**, but a **valid reply is a guarantee of a friendly contact** (within DCS)
- **Modes 1, 2, and 3 are not secure to use** since any other aircraft from the opposing team could find what your Interrogator code is and set his transponder to it, fooling you into thinking he is a friendly contact. These modes also easily give away your position since every time your transponder broadcasts an answer, this signal can be intercepted by an enemy transponder, which can send your position to other enemy fighters via datalink.

| Military Interrogation Mode | Civilian Interrogation Mode | Description |
|---|---|---|
| 1 | | Provides 2-digit 5-bit mission code |
| 2 | | Provides 4-digit octal unit code (set on ground for fighters, can be changed in flight by transport aircraft) |
| 3 | A | Provides a 4-digit octal identification code for the aircraft, set in the cockpit but assigned by the air traffic controller. Mode 3/A is often combined with Mode C to provide altitude information as well. |
| | C | Provides the aircraft's pressure altitude and is usually combined with Mode 3/A to provide a combination of a 4-digit octal code and altitude as Mode 3 A/C, often referred to as Mode A and C |
| 4 | | Provides a 3-pulse reply, delay is based on the encrypted challenge |
| 5 | | Provides a cryptographically secured version of Mode S and ADS-B GPS position |
| S | | Mode S (Select) is designed to help avoiding overinterrogation of the transponder (having many radars in busy areas) and to allow automatic collision avoidance. Mode S transponders are compatible with Mode A and Mode C Secondary Surveillance Radar (SSR) systems. This is the type of transponder that is used for TCAS or ACAS II (Airborne Collision Avoidance System) functions |

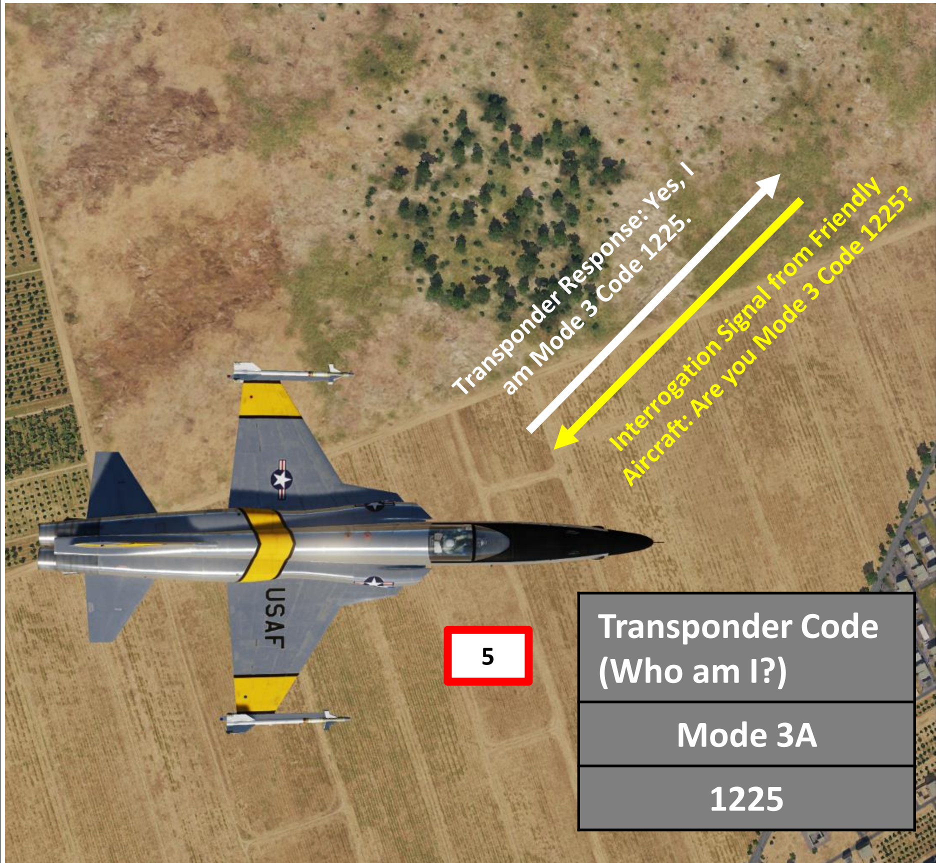
# AN/APX-72 IFF TRANSPONDER COMPONENTS

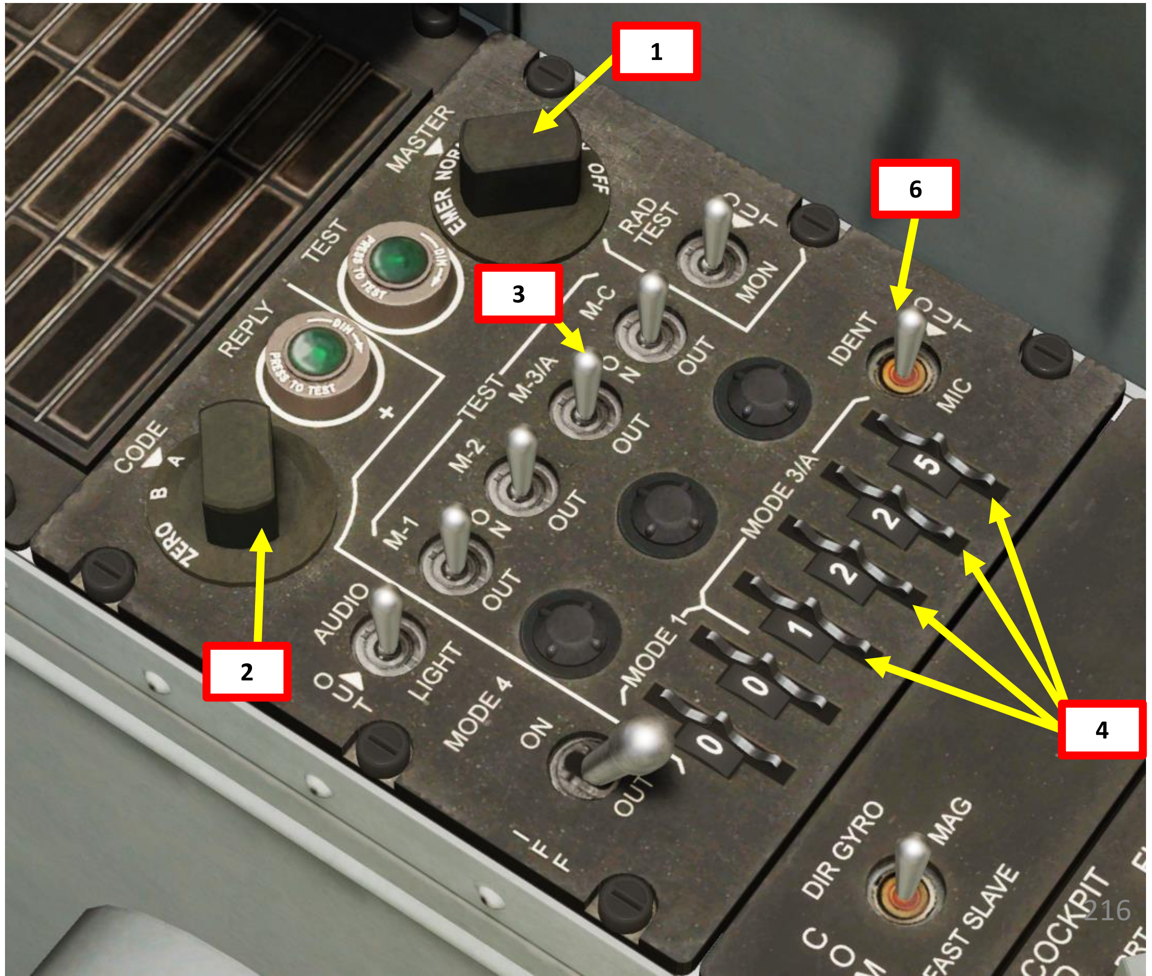


# SETTING UP THE AN/APX-72 IFF TRANSPONDER

As an example, let's say that the mission briefing needs us to set the IFF transponder to **Mode 3A with a code of 1225**.

1. Set IFF Master Switch to NORMAL
2. Set IFF Code Selector to A
3. Set IFF Mode 3/A Switch – MIDDLE (ON)
4. Set IFF MODE 3/A Channel Wheel Selectors to "1225".
5. If you are interrogated with mode 3A with a code set to 1225, the transponder will then send a response signal (reply) to the interrogator with the transponder code you entered previously.
6. If the tower wants to know your position, they are likely to send you a specific IFF mode and code, then ask you to "*Identify*". This requires you to press the IFF Identification/Microphone Switch to IDENT (FWD), which will allow the tower to know where you are from your transponder's identification signal/transmission.



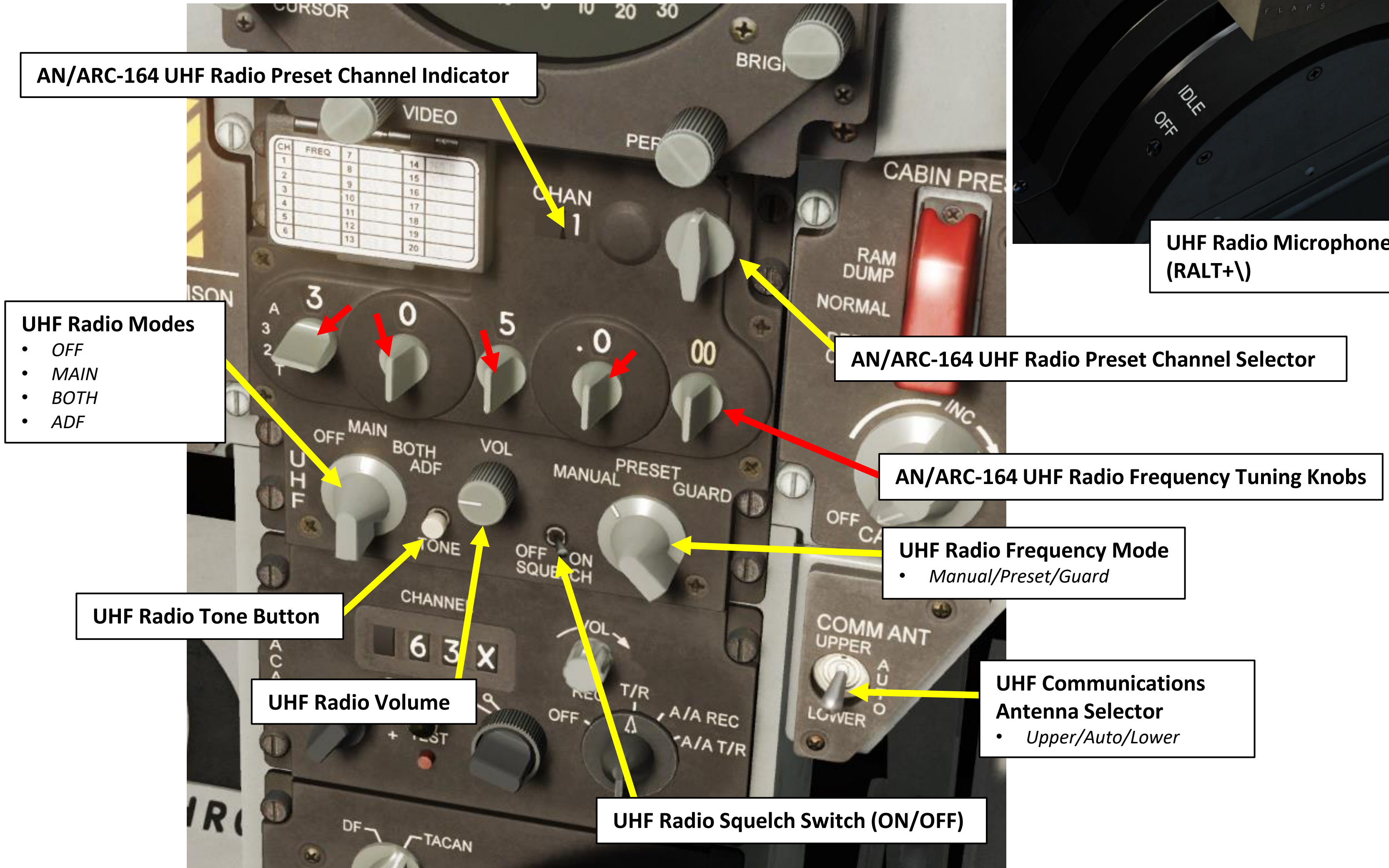



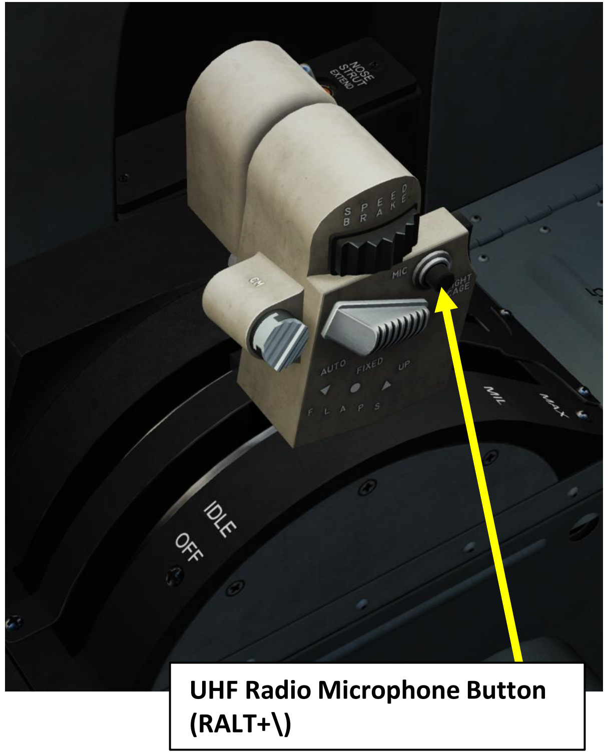
# RADIO SYSTEM OVERVIEW

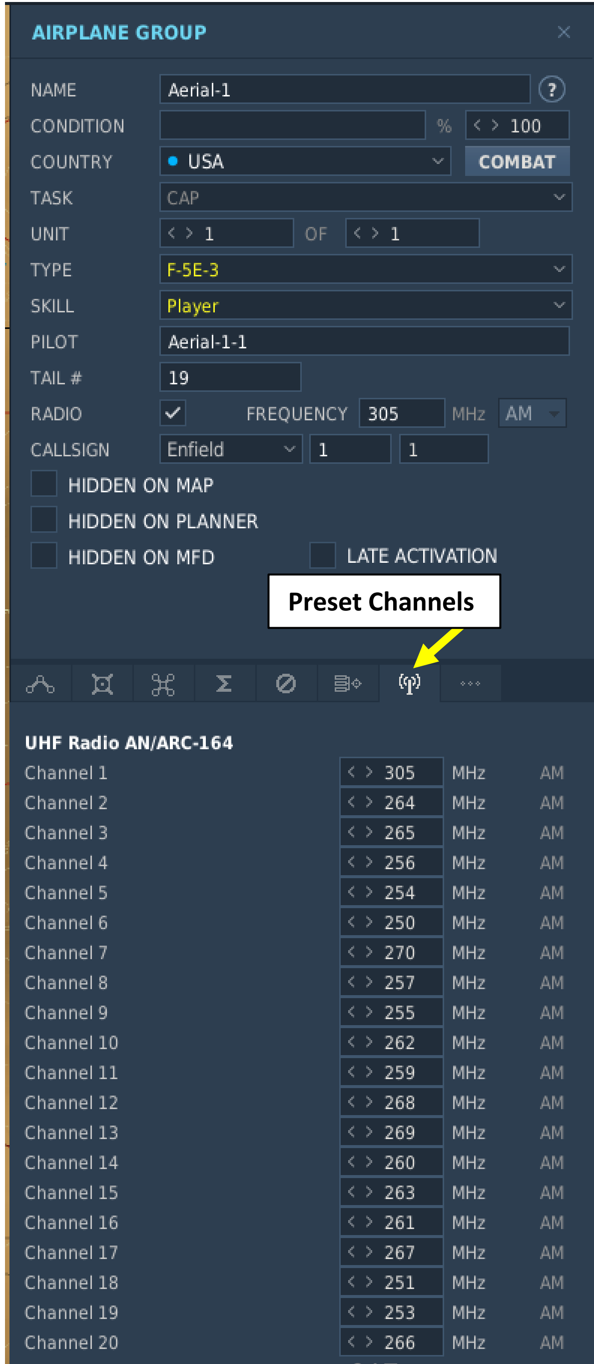
The AN/ARC-164 UHF radio set is used for wingmen, support flights, air traffic controllers. Its frequencies are set between 225.000 and 399.975 MHz.

There are 20 preset radio channels, which are set via the Mission Editor. You can also manually enter a frequency using the UHF Radio Frequency Mode selector.

Radio transmission is performed with the UHF Radio Microphone Button (RALT+\) on the throttle.



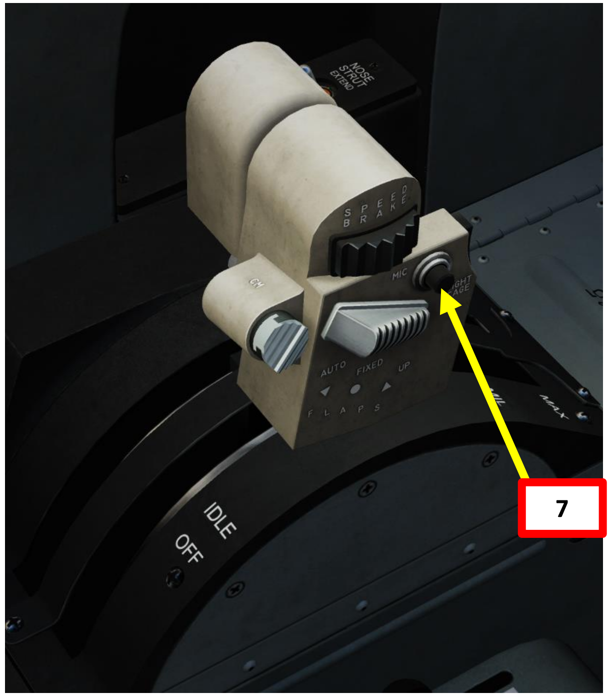



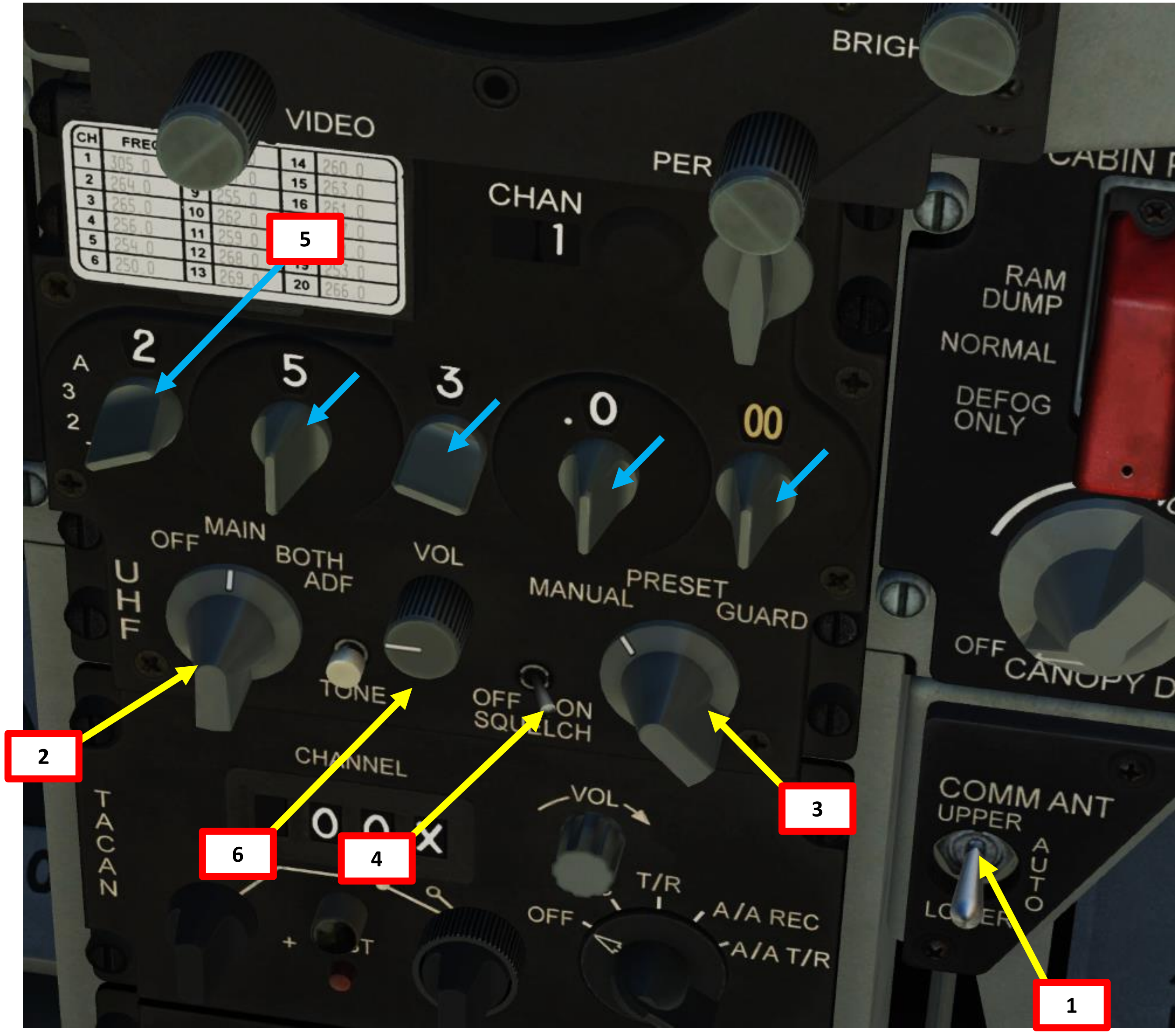



# AN/ARC-164 UHF RADIO TUTORIAL (MANUAL CHANNEL)

In this example, we want to transmit on a specific (manual) frequency of 253.000 MHz.

1. Set Communications Antenna Selector – AUTO (MIDDLE)
2. Set UHF Radio Mode Selector - MAIN
3. Set UHF Radio Frequency Mode Selector – MANUAL
4. Set UHF Radio Squelch Switch – ON
5. Set UHF Radio Frequency to 253.000 MHz
6. Adjust UHF Radio Volume – As Required
7. Transmit using the UHF Radio Microphone (RAlt+\).

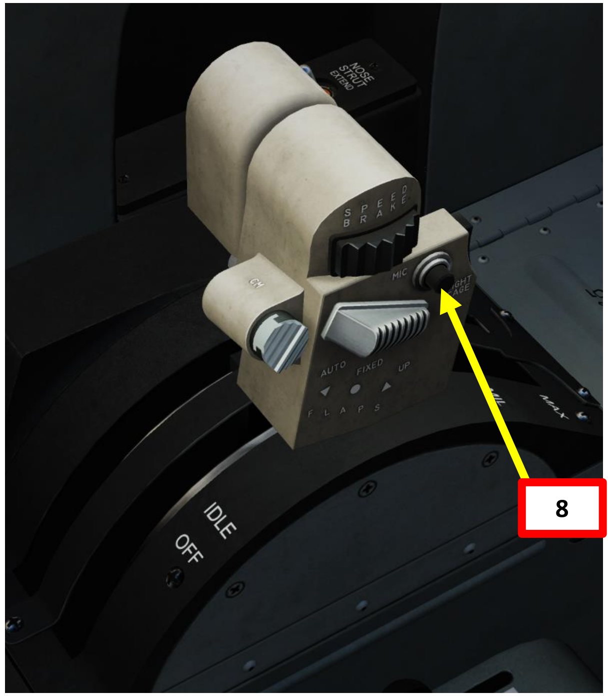


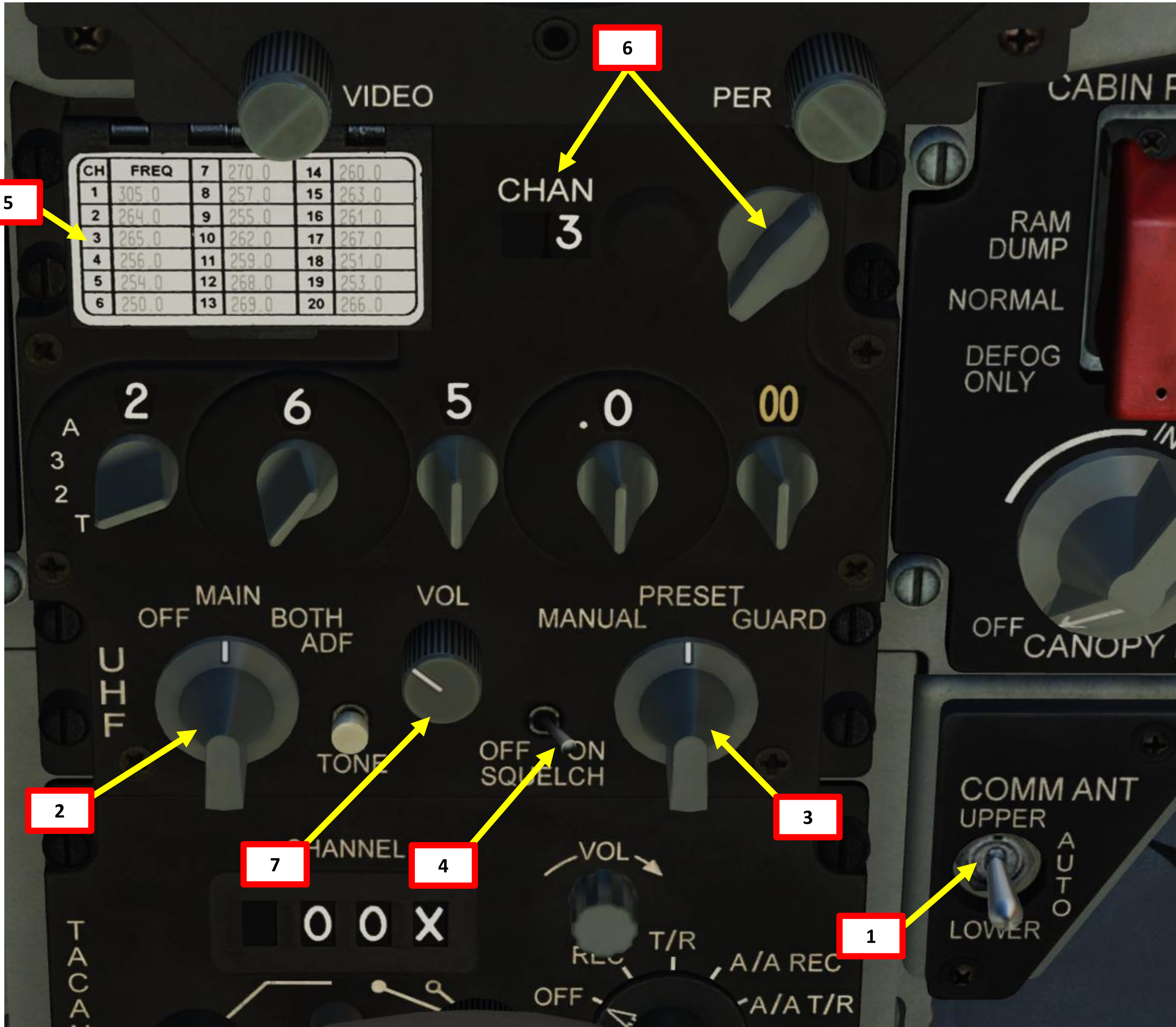



# AN/ARC-164 UHF RADIO TUTORIAL (PRESET CHANNEL)

In this example, we want to transmit on the preset radio channel No. 3, which is set to 265.000 MHz.

1. Set Communications Antenna Selector – AUTO (MIDDLE)
2. Set UHF Radio Mode Selector - MAIN
3. Set UHF Radio Frequency Mode Selector – PRESET
4. Set UHF Radio Squelch Switch – ON
5. Check on the preset frequency placard to see if preset channel matches the desired frequency (No. 3 is preset to 265.000 MHz).
6. Set UHF Radio Preset Channel Selector to “3”, the desired radio channel.
7. Adjust UHF Radio Volume – As Required
8. Transmit using the UHF Radio Microphone (RAlt+\).

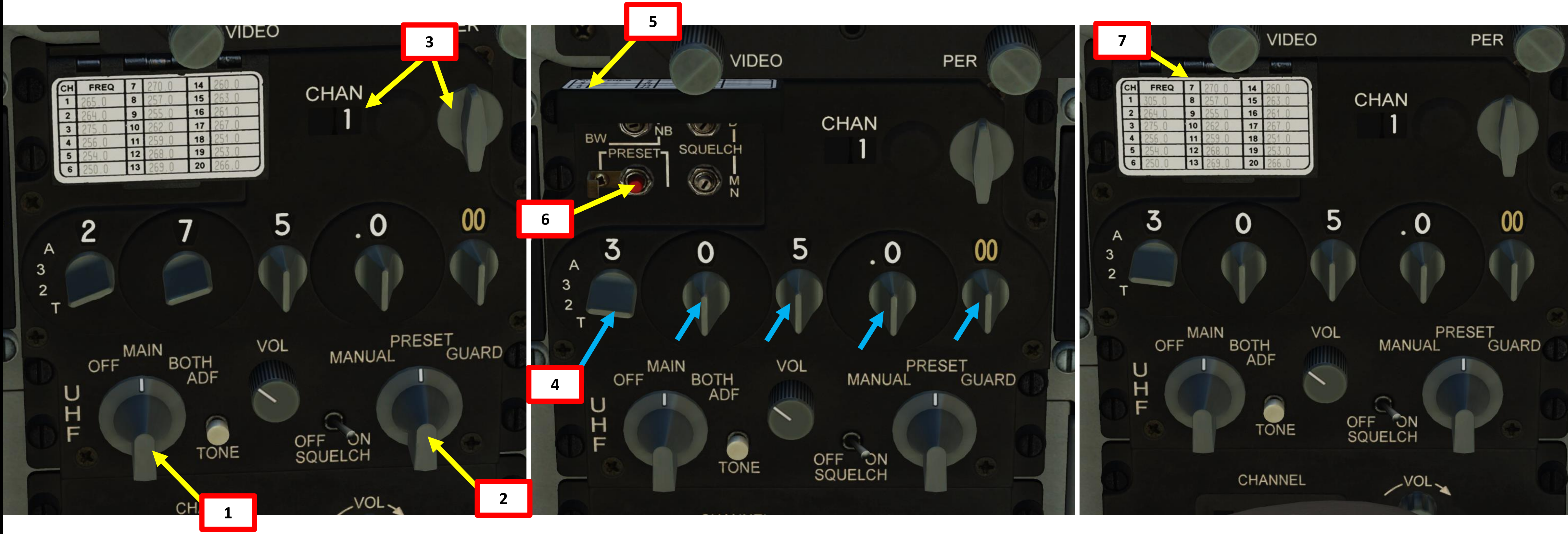


# AN/ARC-164 UHF RADIO TUTORIAL (MODIFYING A PRESET CHANNEL)

It is possible to change the frequency memorized in a preset channel. As an example, Preset Channel No. 1 is set to 265.000 MHz, and we would like to change Channel No. 1 to 305.000 MHz instead.

1. Set UHF Radio Mode Selector - MAIN
2. Set UHF Radio Frequency Mode Selector – PRESET
3. Set UHF Radio Preset Channel Selector to “1”, the desired radio channel we want to edit.
4. Set UHF Radio Frequency to 305.000 MHz
5. Flip the hinged access door of the preset frequency placard.
6. Press on the PRESET red button.
7. Close the hinged access door of the preset frequency placard.
8. Radio Channel No. 1 will then be preset to frequency 305.000 MHz.



# NAVIGATION EQUIPMENT OVERVIEW

Navigation is an extensive subject. You can check chapter 15 of FAA manual for more details on navigation.

**LINK:** https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/18_phak_ch16.pdf

"NDB" is what we call a non-directional beacon. It transmits radio waves on a certain frequency on long distances. These waves are read by an ADF (automatic direction finder). NDBs are typically used for radio navigation.

"VOR" is what we call a VHF Omnidirectional Range system. It transmits radio waves on a certain frequency. These waves are read by a VOR receiver. VOR systems, just like NDBs, can be used for radio navigation.

NDB and VOR are used just like lighthouses were used to guide ships. This way, air corridors and airways are created to help control an increasingly crowded sky.

TACAN is a Tactical Air Navigation System used by the military. TACAN beacons can be placed on ground stations, airfields or even aircraft themselves like tankers. The TACAN station equipment on the ground has two parts, one provides bearing and the other one distance. A VOR station on the ground only provides bearing. There are also DME stations on the ground to provide distance. A VOR onboard equipment can receive the distance signal from the TACAN "distance part" of the equipment on ground. And, of course, a VOR onboard equipment can receive also the distance signal from a DME (Distance Measuring Equipment) station.

The **AN/ARA-50 UHF/ADF radio** (ADF: Automatic Direction Finder) system tracks NDB stations. The AN/ARC-164 UHF radio has an interface with AN/ARA-50 UHF/ADF radio and provides direction-finding capability, i.e. taking relative bearing to tuned ground-based ADF beacons or airborne UHF radios. For direction-finding, the function selector must be in ADF position.

The **AN/ARC(N)-118** system tracks TACAN stations. The TACAN system is used to quickly determine coordinates of a specific place, usually, it is an aerodrome. The TACAN provides the pilot with bearing and distance to a selected TACAN ground station. The TACAN system is often used to quickly get navigational data of friendly aerodromes. Moreover, some aircraft are capable of transmitting signals of a TACAN beacon.

# NAVIGATION EQUIPMENT OVERVIEW

The F-5 does not come with fancy avionics: most of your navigation has to be done visually. In order to know your heading, you have the Magnetic Compass and the HSI (Horizontal Situation Indicator) at your disposal.

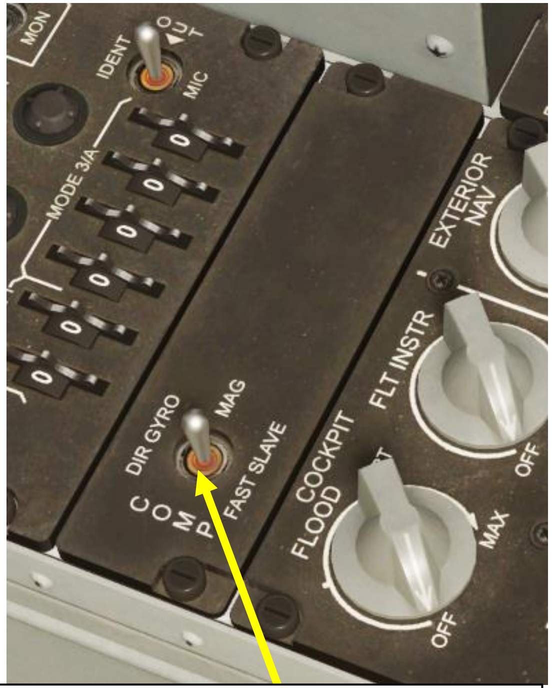
The HSI is used to track TACAN beacons. The TACAN is a Tactical Air Navigation System used by the military. You can also use the UHF/ADF (Automatic Direction Finder) radio, which provides direction-finding capability but no range unlike the TACAN.


**Fast-Erect Button**

- *If temporary power failure occurs during maneuvering (not in straight and level flight), thus causing the OFF flag to appear on the attitude indicator, the vertical gyro may tilt and pitch and roll readings of the instrument will be incorrect. This way, the gyros may accumulate drift error over time. In order to return the attitude indicator instrument into operating condition, press the FAST-ERECT button.*

**Magnetic Compass**

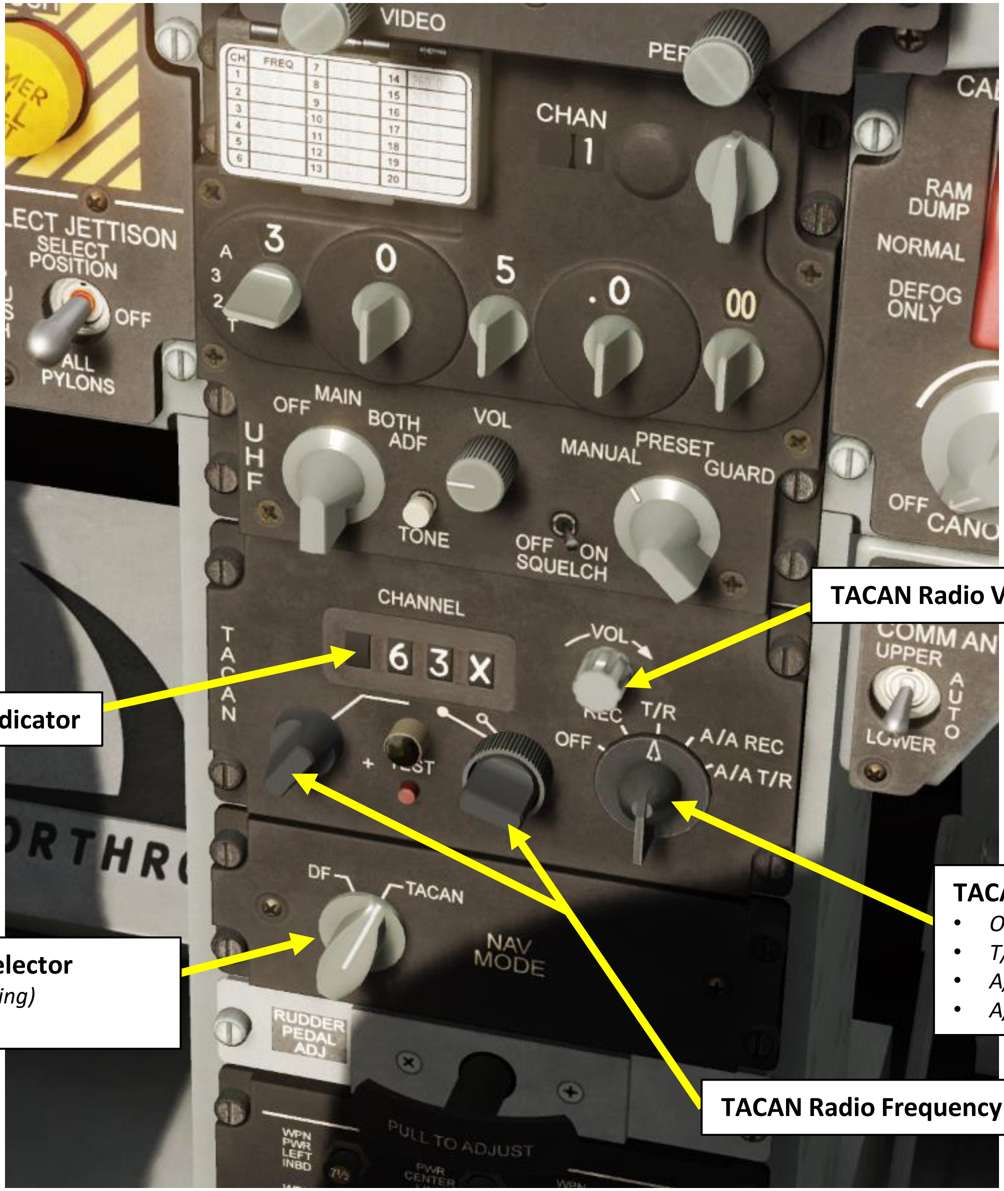
**HSI (Horizontal Situation Indicator)**




**Compass Switch**

- *DIRECT GYRO: Compass card maintains orientation to the last magnetic north azimuth. Magnetic sensing is not available and heading displayed is based solely on directional stability.*
- *MAGNETIC: Normal operation mode. Switching from DIR GYRO to MAG automatically fast slaves the compass card to indicate the correct magnetic heading. The card will remain oriented to magnetic North.*
- *FAST SLAVE: Momentarily placing compass switch at FAST SLAVE erects the compass card to magnetic north within 25 seconds.*
- *Note: the aircraft should be maintained in straight and level, unaccelerated flight for at least 30 seconds whenever using FAST SLAVE, or returning to MAG from DIR GYRO, or after AC power interruption. Wait 2 minutes between consecutive fast slave cycle attempts.*

# NAVIGATION EQUIPMENT OVERVIEW



**TACAN Radio Volume**

**TACAN Channel Indicator**

**TACAN Radio Mode**
- *OFF*
- *T/R (Transmit/Receive)*
- *A/A REC*
- *A/A T/R*

**Navigation Mode Selector**
- *DF (Directional Finding)*
- *TACAN*

**TACAN Radio Frequency Tuning Knobs**

# MAGNETIC DEVIATION

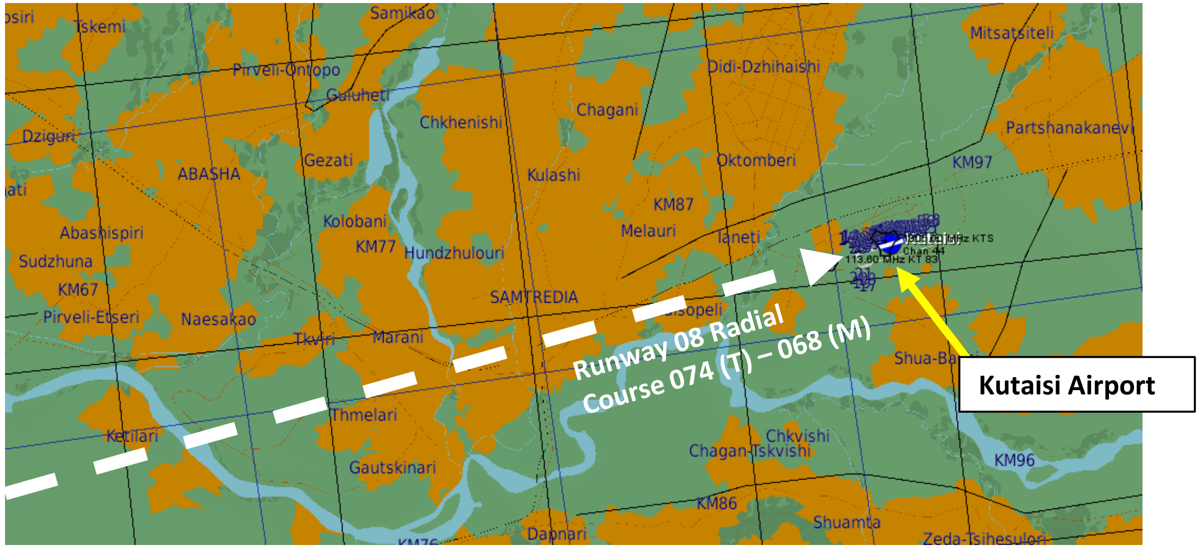
The direction in which a compass needle points is known as magnetic north. In general, this is not exactly the direction of the North Magnetic Pole (or of any other consistent location). Instead, the compass aligns itself to the local geomagnetic field, which varies in a complex manner over the Earth's surface, as well as over time. The local angular difference between magnetic north and true north is called the magnetic declination. Most **map coordinate** systems are based on **true north**, and magnetic declination is often shown on map legends so that the direction of true north can be determined from north as indicated by a compass.This is the reason why in DCS, the course to a runway needs to be "adjusted" to take into account this magnetic declination of the magnetic North pole (which is actually modelled in the sim, which is pretty neat).

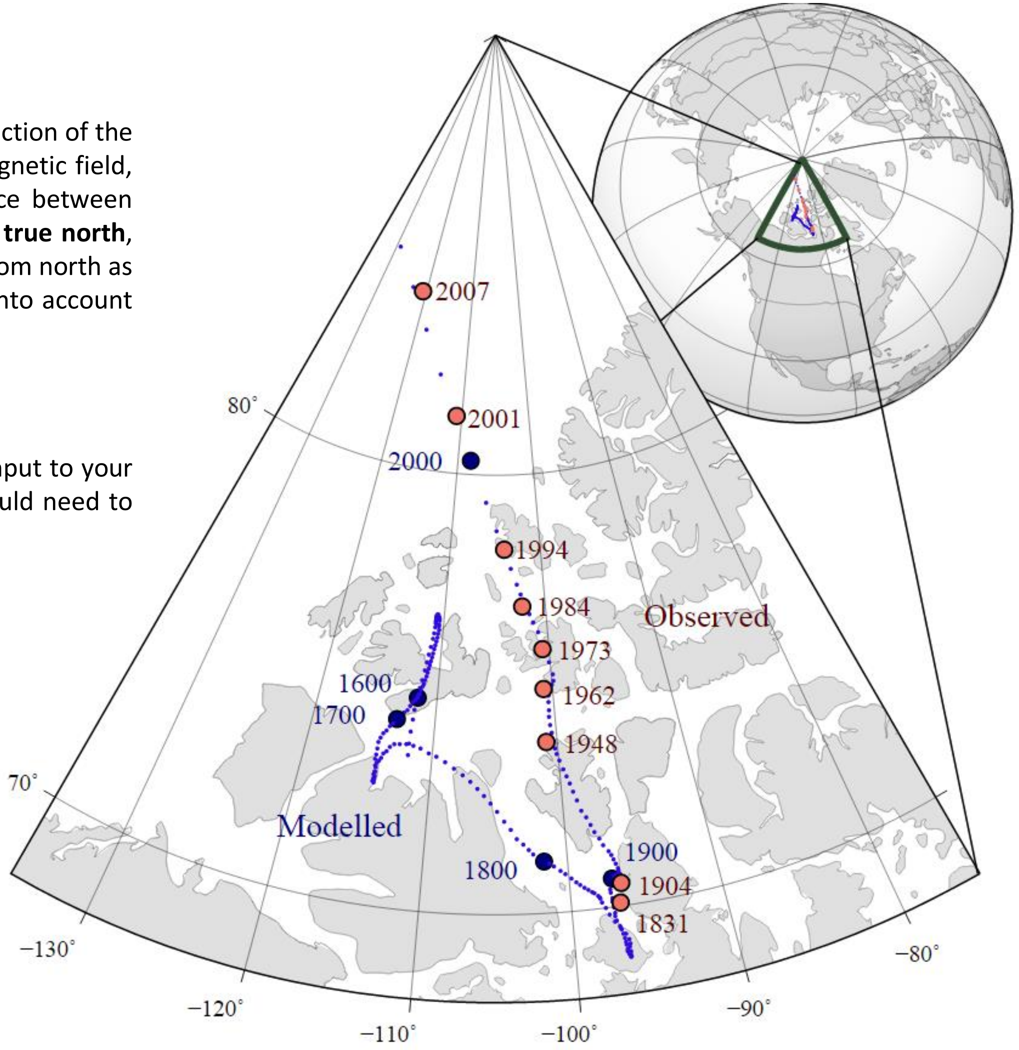
**True Heading = Magnetic Heading + Magnetic Deviation**

As an example, if the runway heading that you read on the F10 map in Kutaisi is 074 (True Heading), then the input to your magnetic compass course should be 074 subtracted with the Magnetic Deviation (+6 degrees), or 068. You would need to enter a course of 068 (M) on the HSI.

<u>**Magnetic Declination:**</u>

- **+6.4 deg for Caucasus**
- **+14.2 deg for Nevada**
- **+1.3 deg for Persian Gulf**
- **-5 deg for Normandy**
- **+0.2 deg for the English Channel**
- **+5.2 deg for Syria**
- **+0.9 deg for Marianas**



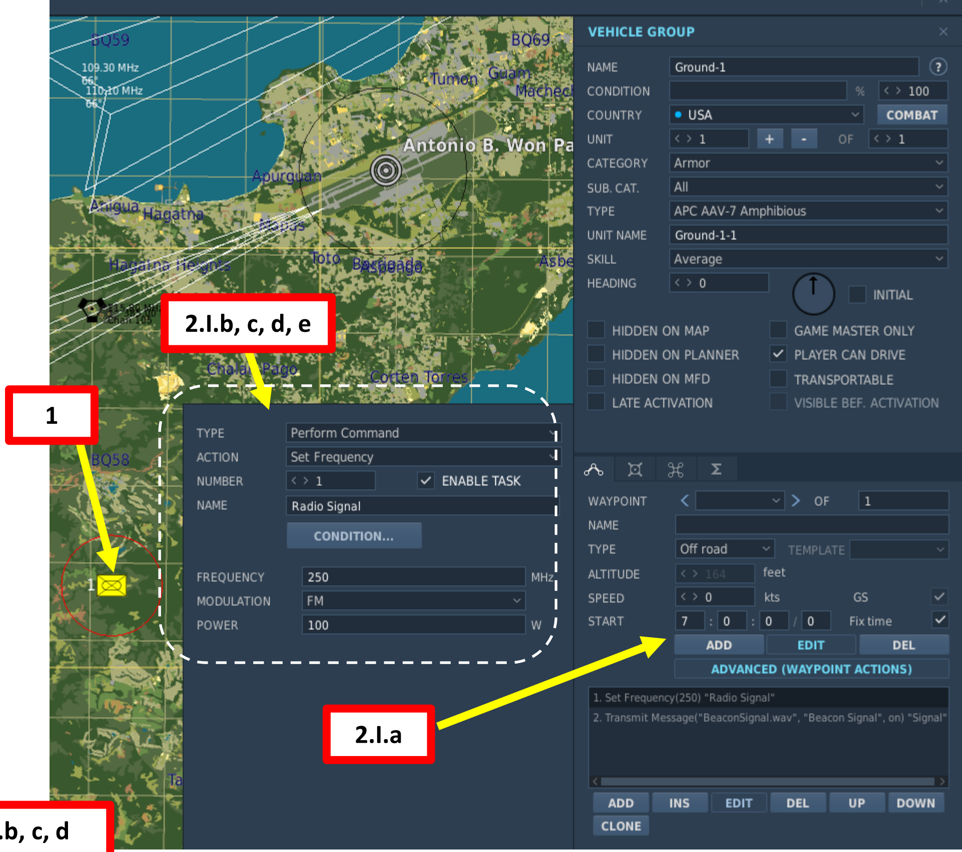



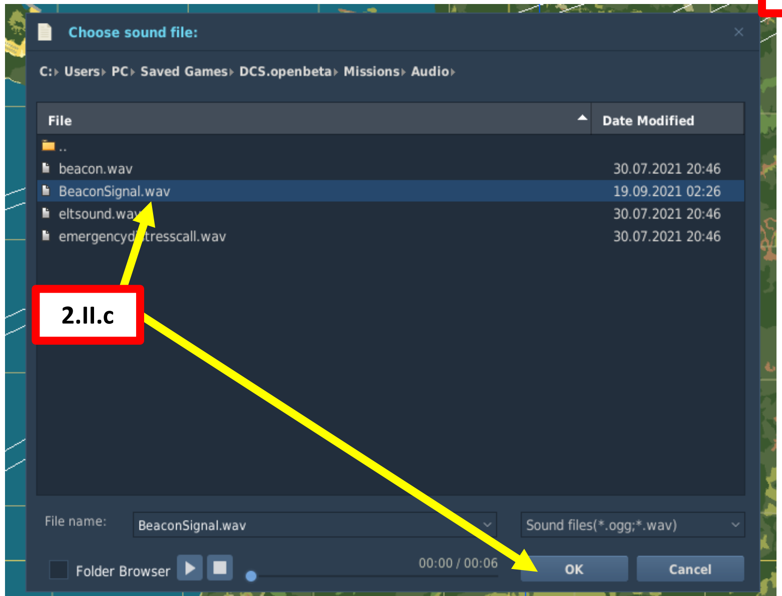

The movement of Earth's north magnetic pole across the Canadian arctic, 1831–2007.

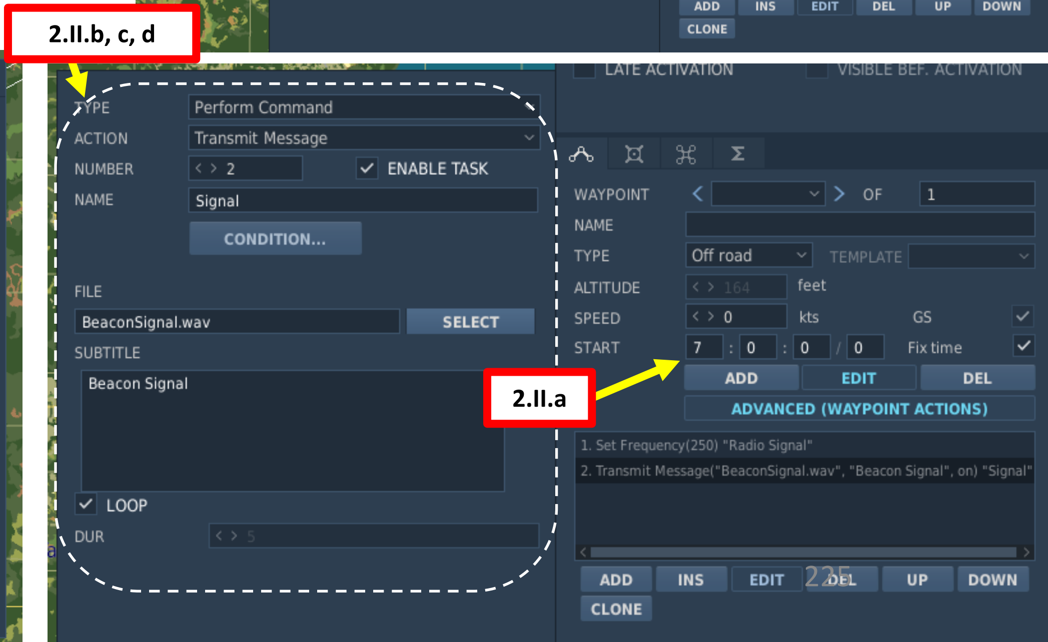
# ADF (AUTOMATIC DIRECTION FINDER) TUTORIAL

Note: most Non-Directional Beacons in DCS are set in the KHz frequency range, while the F-5 can only track frequencies in the MHz range. Therefore, a way to use ADF is to have a ground unit transmitting a radio signal on the MHz frequency range. This can be done with the Mission Editor.
We will first need to set up a mission with a unit that transmits a radio signal on a **UHF FM frequency of 250 MHz**.

1. Create Unit that will transmit the radio signal
2. In ADVANCED (WAYPOINT ACTIONS) of Waypoint 0
   - I. Click on ADD
     - a) Select Type - PERFORM COMMAND
     - b) Select ACTION – SET FREQUENCY
     - c) Set Frequency to a valid frequency (250 MHz)
     - d) Select FM Band
     - e) Select Power (i.e. 100 W)
   - II. Click on ADD
     - a) Select Type - PERFORM COMMAND
     - b) Select ACTION – TRANSMIT MESSAGE
     - c) Select a valid .wav or .ogg audio file with the distress call. Add subtitles if desired.
     - d) Select LOOP



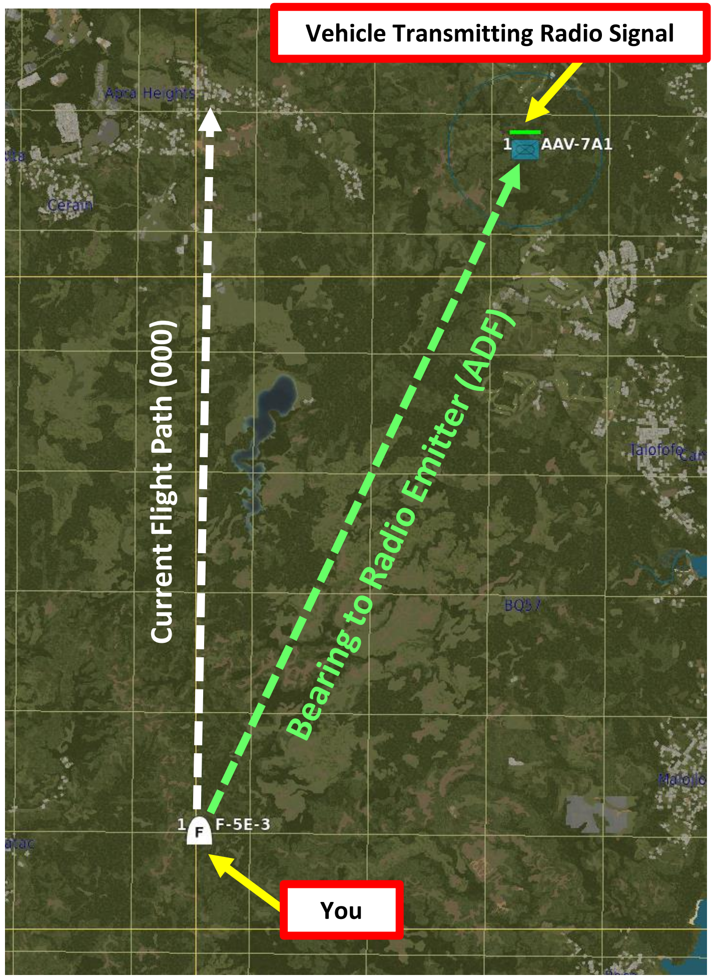



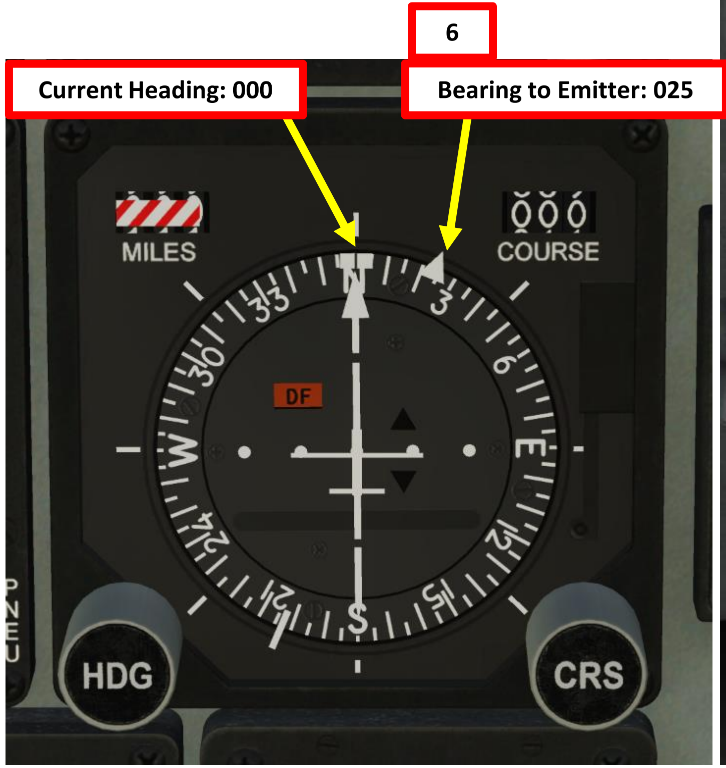



# ADF (AUTOMATIC DIRECTION FINDER) TUTORIAL

Here is a how to home on a radio emitter:

1. Read mission briefing to determine on what UHF frequency the vehicle will transmit. In our case, the beacon is located in a vehicle transmitting on a frequency of 250.000 MHz.
2. Set UHF Radio Mode to ADF (Automatic Direction Finder).
3. Set UHF Frequency Mode to MANUAL ,
4. Set UHF frequency to 250.000 MHz.
5. Set Navigation Mode Selector to DF (Direction Finder).
6. Fly towards the direction indicated by the small white triangle on the HIS (Horizontal Situation Indicator).



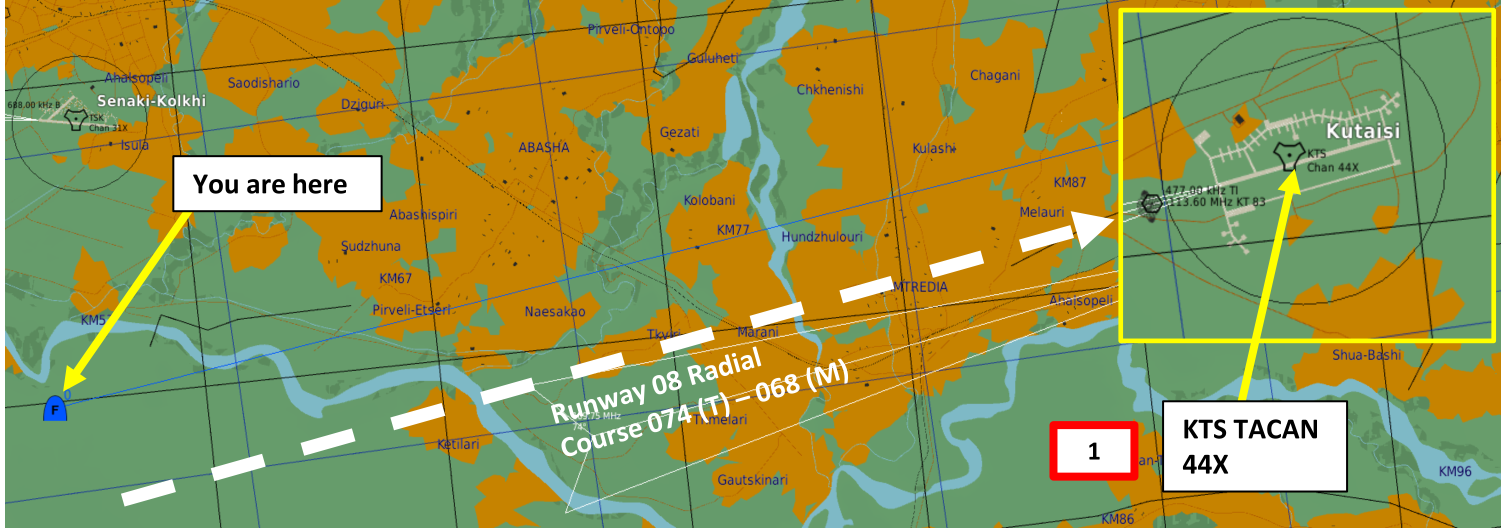




# ADF (AUTOMATIC DIRECTION FINDER) TUTORIAL

# TACAN TUTORIAL

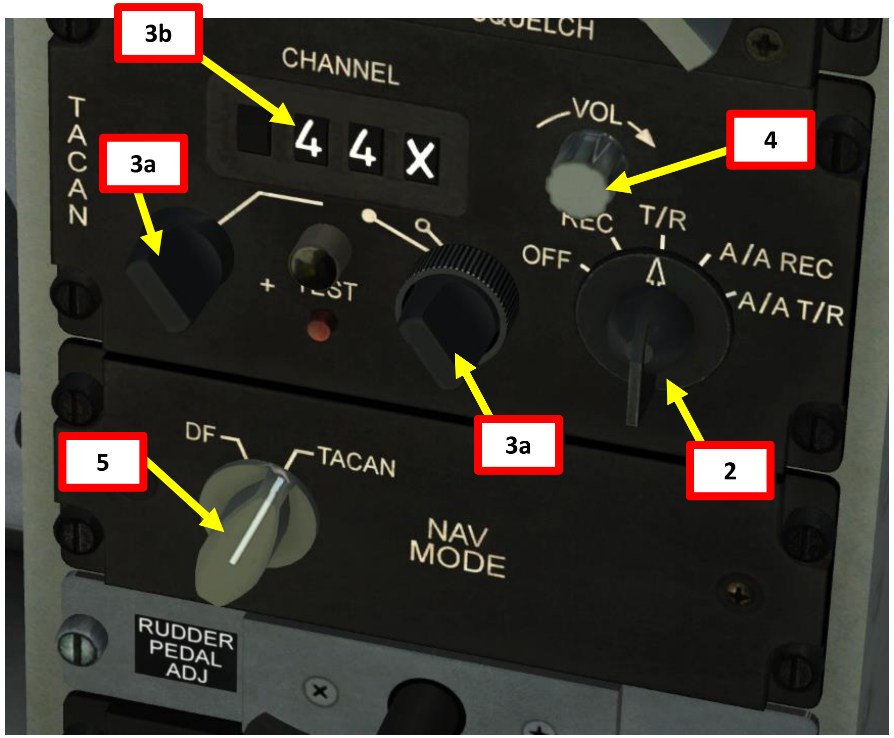
TACAN (Tactical Air Navigation) stations are navigation aids typically used by the military and provide you directional and distance guidance. TACAN beacons can be installed on airdromes, air refueling tankers or even aircraft carriers.

1. We will track Kutaisi's TACAN 44X.
2. Set TACAN Mode to Transmit/Receive (T/R).
3. Set TACAN frequency to 44X. (Scroll mousewheel on left and right knobs to set 44 and right click on right knob to set X).
4. Adjust TACAN volume – As Required.
5. Set NAVIGATION MODE to TACAN.
6. On HSI (Horizontal Situation Indicator), set course to 068 using the CRS knob.



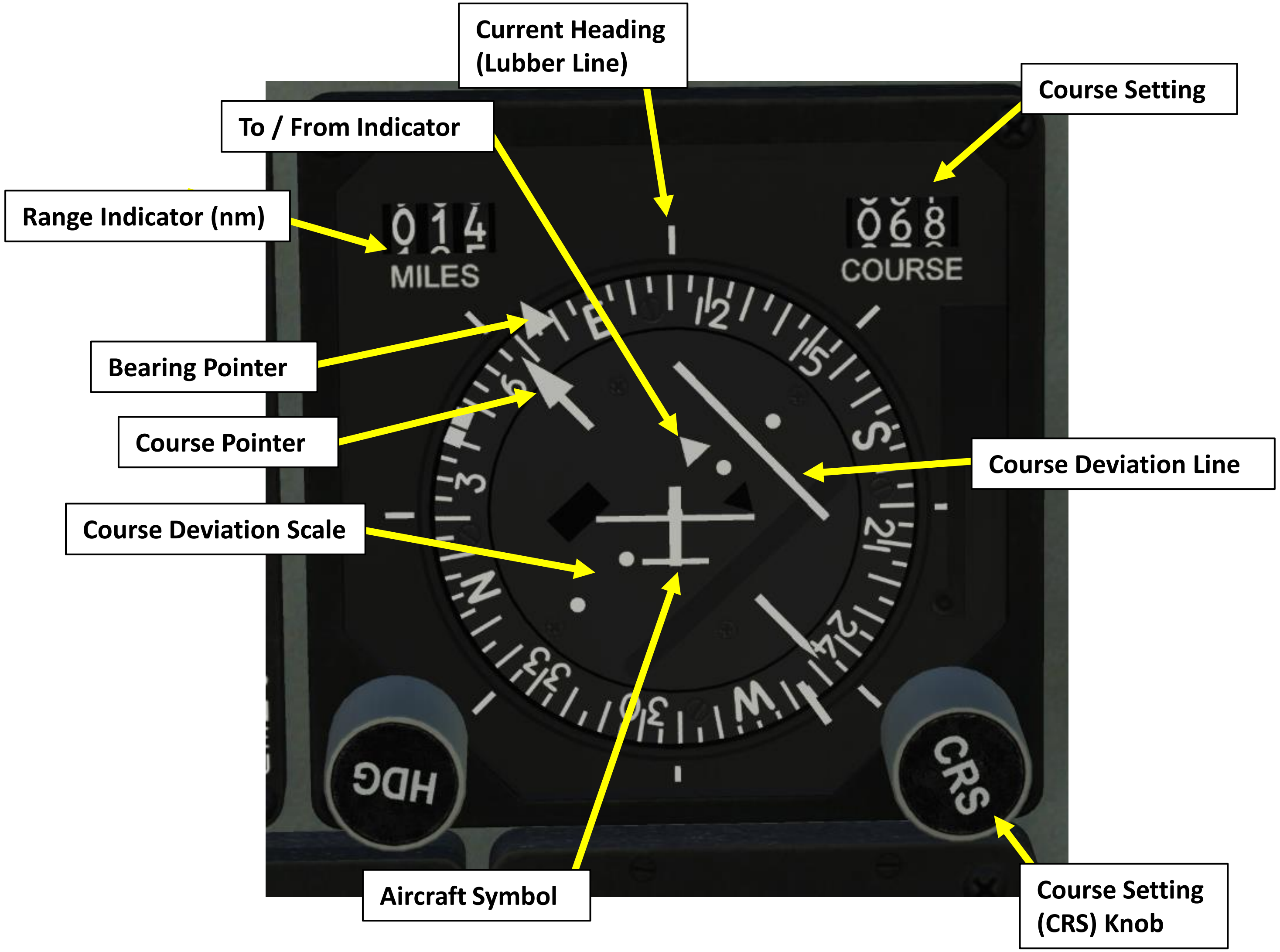

TACAN OPERATION MODES:

- REC: Your TACAN operates in receive mode only and provides bearing, course deviation, and station identification.
- T/R: The TACAN acts in a transceiver mode (send and receive) and provides bearing, range, deviation and station identification. This will be your most common selection.
- A/A REC: TACAN operates in Air-to-Air mode and can only receive bearing, course deviation and station identification for a TACAN-equipped aircraft.
- A/A T/R: TACAN operates in Air-to-Air transceiver mode and provides bearing, range, deviation, and station identification with a TACAN-equipped aircraft.

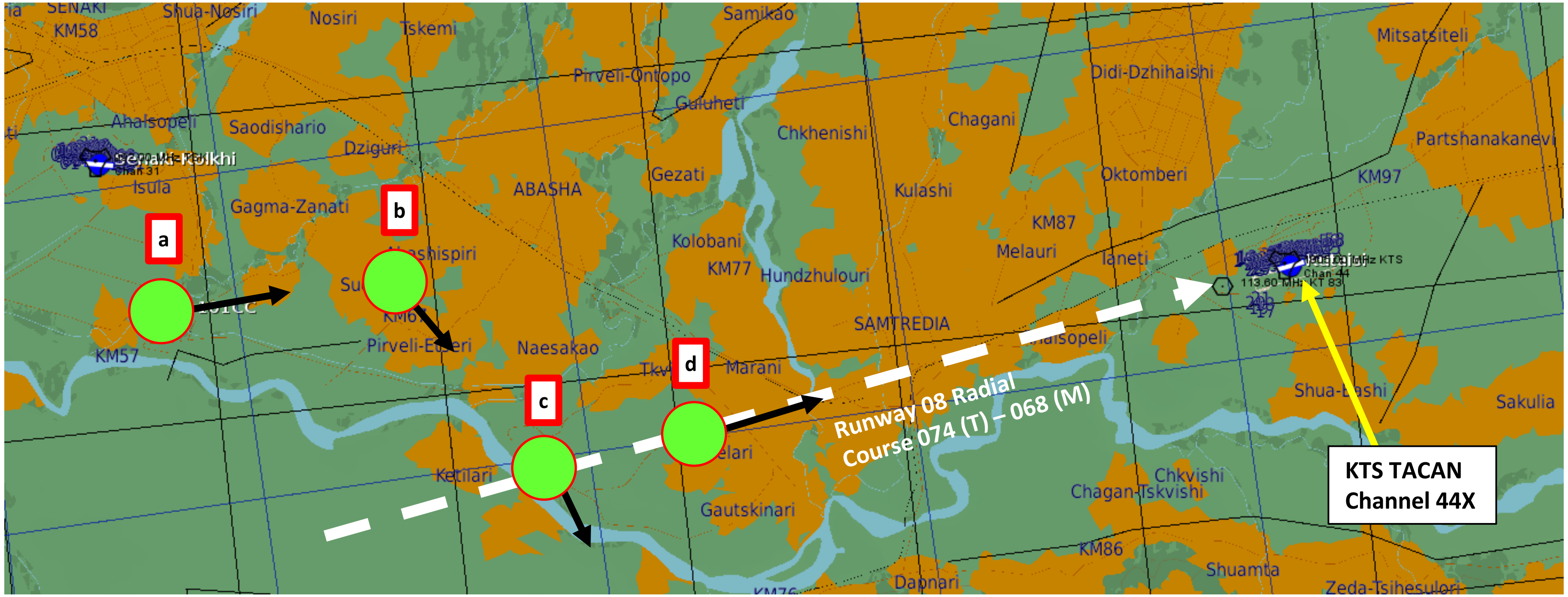



# TACAN TUTORIAL

7. Steer the aircraft towards the TACAN CDI (Course Deviation Indicator) Reference Line. As you approach the radial, the line deviation with the centerline of the HSI will gradually diminish.
8. The direction of the TACAN beacon will be displayed by the Bearing Pointer.
9. CDI (Course Deviation Indicator) will indicate how far off the TACAN radial course (068) you are.
10. The To / From Indicator (White Triangle) will indicate whether you are heading towards the radial or away from it.
11. When CDI Reference line is centered, this means you are on the 068 radial.
12. Then, turn towards the TACAN Bearing Pointer (or Course Pointer) to follow the radial to the runway.



# TACAN TUTORIAL

# TACAN TUTORIAL

# AIR COMBAT

Since you will most likely be facing the MiG-21 in combat, here are a couple of tips.

The MiG-21 is all about energy and acceleration using hit and run tactics, while the F-5 has excellent agility that makes it surprisingly dangerous in the turning fight.

The main advantage of the F-5 is that it can detect the MiG-21 more easily with its radar. This allows you to plan your ambushes carefully. The MiG-21 is a superb climber, so don't try to follow it in a climb. The F-5's roll rate can be very useful in scissor fights: use this to your advantage.

Here is a very instructive video by WAT on the art of fighting in the MiG-21, which shows the strengths and weaknesses of the F-5 as well.
https://www.youtube.com/watch?v=Ibrvzon1ByA

## MiG-21

- Faster Acceleration
- Great energy fighter
- Faster but has a 1300 KIAS Speed limit before compressor stall occurs
- Radar Guided missiles and Rear Aspect R-60 Fox-2's (Infrared-guided missiles)
- Less Situation Awareness since radar is a little more primitive than the F-5E's
- More important workload
- Has IFF (Can identify Friend or Foe with the Radar)
- Smaller Roll Rate than the F-5

## F-5E

- Simpler to use and operate
- Better Canopy view for Situation Awareness
- All-aspect Aim-9P5 Fox 2's (Infrared-guided missiles)
- No Radar-guided Missiles
- Has a slightly better turn rate than the MiG-21
- Better Radar than the MiG-21, but cannot identify friend from foe (no IFF)
- Can carry a lot of Air-to-Ground ordnance

More MiG-21 videos by Hadwell, one of the best MiG pilots in multiplayer

https://www.youtube.com/watch?v=zXO-CdKUIRk

https://www.youtube.com/watch?v=OPh24YChcQw

https://www.youtube.com/watch?v=W0fHJUzb2E8

https://www.youtube.com/watch?v=8gH5cR7-x_Y

# RESOURCES

**Belsimtek's F-5E3 Manual**
https://www.digitalcombatsimulator.com/en/downloads/documentation/f5_flight_manual_en/

**Full flight manual of the F-5E**
http://www.476vfightergroup.com/downloads.php?do=file&id=445

**476th Virtual Fighter Group Database**
http://www.476vfightergroup.com/downloads.php

**F-5E Weapon Delivery Manual from the 476th Virtual Fighter Group**
http://www.476vfightergroup.com/downloads.php?do=file&id=446

**476th Virtual Fighter Group Youtube Channel**
https://www.youtube.com/user/476vFG/videos

**The Air Combat Tutorial Library – DCS F-5E Tiger (Youtube Playlist)**
https://www.youtube.com/playlist?list=PLnyigzFtHeNoVFUIFFkc8Zvzvr2ZN3Qme

**Tricker - DCS F-5 Tutorials (Youtube Playlist)**
https://www.youtube.com/playlist?list=PL4a4myRJ63XvP8RFEKD2KREP0GAiZDBWI

**Bunyap Sims Test Flight Series – F-5E Tiger II**
https://www.youtube.com/playlist?list=PLoiMNu5jyFzTWpTVFFz9wls4woqHzRloY

**WinchesterDelta's F-5E Tiger II Tutorial**
https://www.youtube.com/watch?v=h_AOkCka1dg

**Northrop F-5 Freedom Fighter Documentary**
https://www.youtube.com/watch?v=AvDfs6s4tbA

# THANK YOU TO ALL MY PATRONS

Creating these guides is no easy task, and I would like to take the time to properly thank every single one of my Patreon supporters. The following people have donated a very generous amount to help me keep supporting existing guides and work on new projects as well:

- MasterGraves
- ChazFlyz
- RaptorDad86
- Shakespeare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