MILVIZ

YF-23 Black Widow II

Pilot Handbook

Revised
June 2009

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Revised June 2009.

EULA

Information contained herein is subject to change without notice.

Scope

This manual contains the necessary information for safe and efficient operation of the YF-23A flight test prototype aircraft. These instructions provide a general knowledge of the aircraft and specific normal and emergency operating procedures. Your experience as recognized: therefore, basic flight principles and detailed description and operation of systems common to all other aircraft are avoided. This manual provides the best possible operating instructions under most circumstances, but is not a substitute for sound judgment. Multiple emergencies, adverse weather, terrain, etc. may require modification of the procedure.

Use

This publication is intended for use by an experienced and qualified pilot assigned to the YF-23A. Flight and operating limitations included herein can be supplemented and or supervised by Supplemental Flight and Operating Limitations. Information involving changes to operating procedures will be forwarded to you in operational supplements.

Getting Started

The Northrop YF-23comes in three basic panel sections. The main panel that contains the primary flight displays and avionics, the port side panel that contains the throttle and other controls, and the starboard side panel that contains the flight stick and various system controls.
CHECKLISTS

The flight manual contains itemized procedures with necessary amplifications. The checklist contains itemized procedures without the amplification. Primary line items in the flight manual and checklist are identical. If a formal safety or operational supplement affects your checklist, the affected checklist page will be attached to the supplement.

> Note
> To take full advantage of the advanced lighting effects it is strongly recommended that you turn Light Bloom ON in your Flight Simulator X display menu.

WARNING, CAUTIONS, AND NOTES

Warnings, cautions, and notes are held to an absolute minimum. Everything in this manual could be considered a subject for a note, a caution, or a warning. These definitions apply to warnings, cautions, and notes found throughout the manual.

Use of words Shall, Will, Should, And May

The following definitions apply to use of the words shall, will, should, and may:

Will is used to express a declaration of purpose or simple futurity.
Shall is used to indicate a mandatory requirement.
Should is used to indicate a preferred but not mandatory method of accomplishment.
May is used to indicate an acceptable or suggested means of accomplishment.

Control Systems

COCKPIT LEGEND

See figure 1 below

1. Avionics and primary flight displays. See Avionics and Primary Flight Displays manual for detailed information
2. Backup airspeed indicator
3. APU/EPU Discharge/Test
4. Gear controls
5. Armament controls
6. Landing gear/brakes emergency controls
7. Ground power panel
8. Throttle quadrant
9. Lights and video camera control
10. Trim/spoilers control
11. APU and starter controls
12. VMS controls
13. UHF/VHF controls
14. GPS
15. Backup attitude indicator
16. Engine data readout
17. Cabin altitude indicator
18. Electrical control panel
19. Cabin pressurization controls
20. Flight stick
21. Suit pressure controls
22. Life support connections
23. Oxygen controls
24. Cabin thermal controls
25. Head Up Display (HUD)

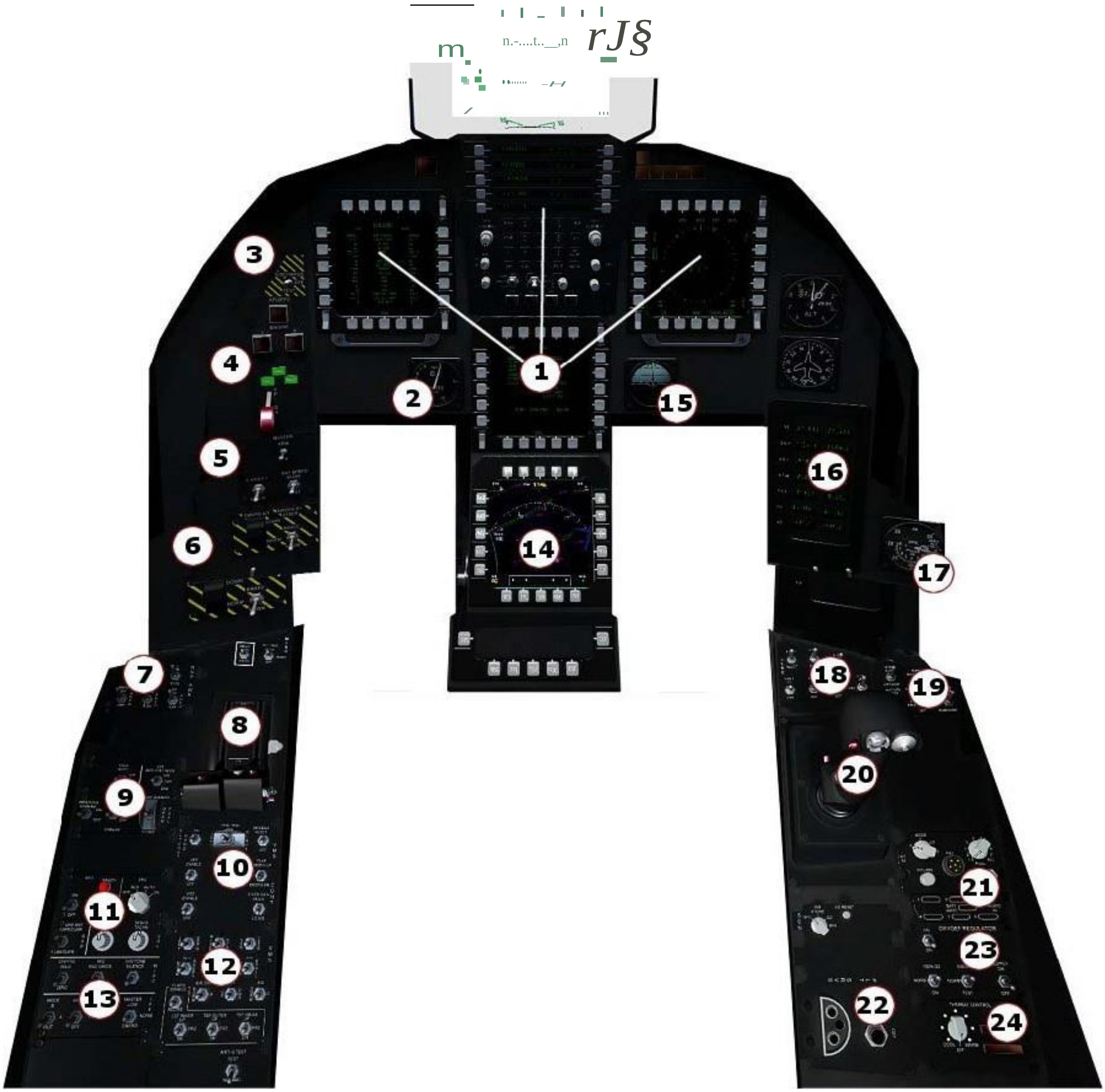


Fig. 1

VMS COMPUTERS

Four redundant VMS computers receive electrical power from VMS dc busses 1 and 2. Two computers are connected to each bus. One transformer rectifier for each bus converts essential ac power to dc power. If a VMS transformer rectifier fails, the essential dc bus powers the VMS bus. If essential ac and dc power is lost in flight, VMS batteries 1 and 2 provide dc power to the respective VMS bus for approximately 2 minutes. VMS 1 and 2 battery switches on the electrical system control panel connect the VMS batteries.

The VMS computers control:

- Flight control movement
- Engine operation
- Boundary layer control door position
- Nosewheel steering
- Antiskid
- Air data
- Flight control related flight test data

VMS computers receive hardwired inputs from the control stick, rudder pedals, throttles, anti-skid panel, brake controls and sensors for weight on wheels, gear position and gear handle position. The computers transmit commands directly for flight control movement, engine boundary layer control door positioning and nosewheel steering. The computers communicate via a VMS data bus with the air data computers, engine control computers, flight control gyros and accelerometers, brakes and standby flight display. The computers communicate via the avionics bus with the fuel system and avionics bus with the armament control system to prohibit door operation or armament firing with hydraulic malfunctions.

Variable gains within the VMS computers limit control deflections depending on airspeed. If total air data failure occurs, the vehicle management computers use the last valid air data. The fixed gain switch provides fixed gains for operations above 350 KCAS or for operation between 350 KCAS and 200 KCAS. A third set of fixed gains for landing is also available. For recovery from out of control situations, the pilot has full control surface deflection capability when the flight control switch is engaged and the paddle switch is pressed and held.

Cockpit Controls

ENGINE DESCRIPTION

The aircraft is powered by two twin-spool YF119-PW 100 afterburning turbofan engines.

The engine control system has two Full Authority Digital Electronic Controls FADEC with dual electronic sensors and control interface. The engines are controlled electrically by hydraulic valves and actuators. Engine electric and hydraulic systems are self-contained engine-driven systems. Backup electrical power is available from aircraft power.

The fan and compressor are aerodynamically linked but mechanically independent. Fan speed N1 and compressor speed N2 indications are provided.

ENGINE CONTROL

Computer interface between the aircraft vehicle management system VMS computers and the engine mounted FADEC provides engine thrust control (Fig.1 No. 8). The interchangeable FADEC operate in a dual active mode and have equal authority over control actuators. Degraded engine modes include idle trip,
Reduced thrust level, partial or total inhibited afterburner, and auto-engine shutdown. The FADEC includes in-flight monitoring of engine performance and post-flight maintenance reporting.

The VMS computers pass Mach and thrust command to the FADEC. The FADEC passes thrust achieved engine performance data to the VMS computers. The VMS computers provide engine performance data via the avionics but to the engine display.

The FADEC adjusts engine speed and pressure to provide stable, stall-free operation throughout the operating envelope. The FADEC controls:

- Main and afterburner fuel flow.
- Main and afterburner ignition.
- Fan and compressor variable vane angles.
- Exhaust nozzle throat and exit area.

The FADEC detects engine stall based on compressor discharge pressure. If a stall is detected, engine ignition is activated, fan speed demand is reduced and pressure ratio demand is reduced. When the stall clears, the engine accelerates to the VMS commanded thrust level.

If engine stall occurs while afterburner is selected, afterburner is terminated. To reselect afterburner after the stall occurs, the throttle must be recycled to military power or below.

If communication between the VMS computers and the FADEC is lost for more than two seconds, the engine trips to mid part power (above flight idle).

LANDING GEAR

The landing gear and gear doors are hydraulically operated and electrically controlled and sequenced. Hydraulic power for extension and retraction is furnished by the utility hydraulic systems. The emergency accumulator provides power for landing gear emergency extension.

Normal gear retraction is approximately 4.5 seconds. Landing gear and doors are retained in the retracted position by mechanical uplocks.

Normal gear extension is approximately 7.0 seconds. Main landing gear is maintained in the extended position by a drag brace held on center by an internal locking actuator. Nose gear is maintained down and locked by an over center drag brace and spring. Gear doors remain open after landing gear extension.

Landing Gear Control Panel

Gear Handle

The landing gear is controlled by a two position wheel shaped handle.

DN	Extends the landing gear
UP	Retracts the landing gear

Gear Handle Warning

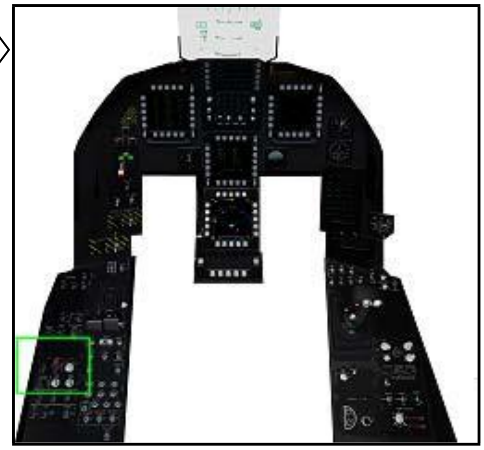
Attempting to retract the landing gear while on the ground will result in a Master Caution warning.

Gear Indicator Lights

The landing gear down indicator lights, labeled NOSE LEFT RIGHT, come on green when the respective landing gear is down and locked.

ENGINE IGNITION

As ignition exciter provides main engine and afterburner ignition in response to FADEC commands.



Spark ignition is supplied to the engine by igniter plugs, two in the main combuster and two in the afterburner section. The FADEC commands main engine ignition during engine start, during engine flameout, deceleration, or if engine stall is detected and afterburner ignition when afterburner is selected until light off is detected.

Fig. 2

1. APU Power switch
2. Power ready indicator
3. Engine crank/combustor control
4. Fuel control

ENGINE STARTING POWER

Power to crank the engines and enable the combuster must be available prior to start. This may be provided in two ways:

1. Starting the Auxiliary Power Unit (APU).
2. Switching on the generator (Fig.1 No. 18) from an engine that is already running.

STARTING THE APU

1. Move the APU start switch (Fig.2 No. 1) to the ON position.
2. Observe the reading on the avionics display (Fig. 3) for APU RPM. Start power is available when 100% APU RPM is achieved

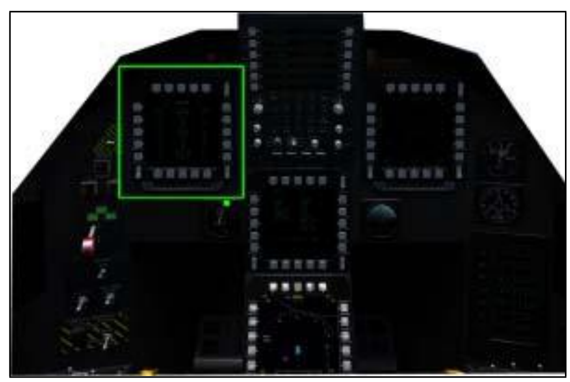


Fig. 3

3. When start power is available the indicator (Fig. 2 No. 2) will illuminate.

When sufficient power is available move the crank/combuster control (Fig. 2 No. 3) to the engine that shall be started, left for port, right for starboard.

THROTTLE QUADRANT

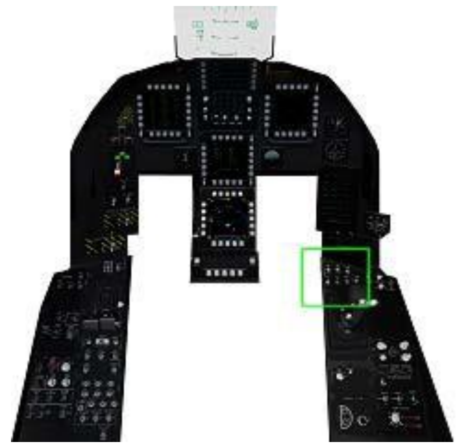
The throttles provide electrical inputs through the VMS to the FADEC. The throttles have detents at military thrust (MIL) and at minimum afterburner. An idle stop precludes inadvertent engine shutdown. When the throttle control is moved the VMS passes engine thrust commands to the engines as a function of throttle position.

ELECTRICAL CONTROLS

Power to the VMS and other aircraft systems shall be facilitated by the electrical panel in Fig. 4. The batteries provide power to the VMS and supporting system. Generator power shall be used to power the avionics and all other systems.

Fig. 4

1. Engine 1 generator toggle
2. Engine 2 generator toggle
3. Battery 1 toggle
4. Battery 2 toggle



LIGHTING CONTROLS

Cabin lights, panel lights, and all exterior navigation lights are controlled from this panel.

1. Cabin lights switch
2. Instrument panel lights
3. Exterior NAV/Anti-collision lights
4. Weapons camera ON/OFF
5. Video exterior camera ON/OFF
6. Slipway override/fuel doors switch

Fig. 5

YAW TRIM/SPOILERS/VMS CONTROLS

Electronic servo controls for yaw trim and spoilers position.

Turn the yaw trim control left or right to add trim to that direction.

VMS mode and power controls are also located in this section.

Fig. 6

1. Flight control override – fly by wire override
2. Yaw trim control L & R
3. VMS/ENG power/bit controller
4. VFT data system OFF/ENABLE
5. Bit mode control for VFT – OFF/CONSTENT
6. Spoilers control
   a. Deployed
   b. 50% deployed
   a. Fully retracted
7. VGS OFF/ENABLE - Allows selection of variable gain sets using MPCD VMS gain
8. Fixed gain switch – LOW/HI

Yaw Control

Deflection of both tail surfaces in the same horizontal direction (e.g. leading edge right) produces aircraft yaw (left). Flaperons compensate for roll caused by the tail surfaces. Flaperons compensate for roll caused by the tail surfaces. Maximum available yaw command is 10 degrees at low subsonic airspeeds decreasing to 2 degrees at supersonic airspeeds. Yaw limiting prevents engine inlet flow distortion. Unless yaw is commanded, flight control laws maintain zero sideslip.

Speedbrakes/Spoilers

Differential deflection of inboard and outboard trailing edge flaperons provides high drag flaps (speedbrakes). Above 3 u G, below 200 KCAC, or above 525 KCAS speedbrakes are unavailable. If speedbrakes were extended when any of these conditions is met, the speedbrakes retract. With the landing gear extended, trailing edge flaperons provide lateral control and flaps.

BRAKE CONTROLS

1. Parking brake ON/OFF
2. Anti-skid control ON/OFF

The anti-skid system is electronically controlled by a three position switch (2). With anti-skid on, hydraulic pressure to the brakes is inhibited until the main wheels spin up to 70 knots after weight is applied to them.

Fig. 7

INTEGRATED COMMUNICATIONS PANEL

1. UHF antenna selector
2. Volume controls
3. Cryptography mode control
4. MIC override
5. Tone silencer
6. IFF mode selector
7. IFF signal light ON/OFF
8. IFF master switch

Fig. 8

VMS TEST PANEL

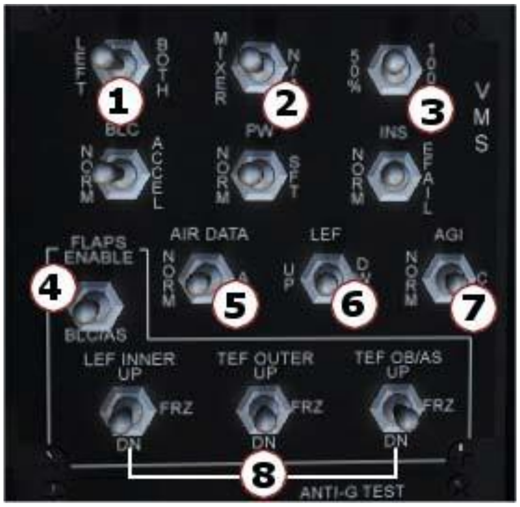


Fig. 9

1. BLC controls LEFT/BOTH selects control doors, NORM/ACCELL controls schedule for opening and closing
2. Flutter/exciter
3. Increased still margin for flutter/exciter
4. Leading edge flaps control
5. Air data selector
6. Leading edge flaps up/down
7. Armament gas ingestion control
8. Flap/BLC switches

FLAPS
Inboard and outboard Flaperons and leading edge flaps extend automatically as required for takeoff, landing and maneuvering. Flap position varies with Mach and AOA.

FUEL CONTROL

The engine fuel system provides pressurized fuel to the engine combustion section and afterburner. Pressurized fuel is also used for engine hydraulic fluid and lubricating oil cooling and electronic component cooling. Access to fuel tank sections is facilitated through the VMS and shall be enabled by moving the fuel selector control (Fig. 2 No. 4). The following positions are available.

1. OFF – all access to fuel is shut off
2. Blend (BLND) – access to all tanks, using even fuel flow
3. AUTO – the VMS controls fuel from all tanks to maintain weight and balance
4. 1 and 2 – Instructs the VMS to use more fuel from the port side (1) or the starboard side (2)

The engine fuel system must have aircraft fuel boost pump pressure to operate properly.

ELECTRICAL CONTROL PANEL

Fig. 10

1. Left (Port) Generator ON/OFF-RESET
2. Right (Starboard) Generator ON/OFF-RESET
3. Auxiliary Generator ON/OFF-RESET – operates off of port engine
4. VMS Battery 1 ON/OFF
5. VMS Battery 2 ON/OFF
6. Emergency Battery ON/OFF
7. Utility Battery Switch ON/OFF

The VMS 1 & 2 batteries power the respective VMS busses when required. On the ground, without AC/APU power the battery switches should not be in the ON position for a prolonged period, as this will deplete the batteries. All batteries recharge when port or starboard generator power is supplied.

ELECTRICAL SYSTEM

The electrical power system consists of two main ac generators, an emergency generator, two pairs of essential transformer-rectifiers, two vehicle management system transformer-rectifiers, a utility battery, an emergency battery, two vehicle management system (VMS) batteries and ac and dc power distribution (bus) systems. External ac power can be applied to power the bus systems on the ground.

Ac Electrical Power

The two main 40kvs ac generators are the primary source of electrical power. The two generators are connected for split bus non-synchronized operation. With both generators operating, each generator supplies power independently to certain aircraft busses. If one generator fails and drops off the line, the remaining generator provides power to essential ac busses, main ac bus 1 and the essential and main dc busses. The main ac 2 bus drops off line during single main generator operation. Current sensors are provided to prevent a fault in one generator system from shutting down both generators. Each generator activates automatically when the respective generator switch is in the position ON and the generator connects to the proper bus when the voltage and frequency are within proscribed limits. A protections system within the generator control unit protects against equipment damage due to under voltage, over voltage, over and under fluctuations and feeder faults. If a malfunction occurs, the generator control unit removes the affected generator from the busses. The respective generator switch must be cycled to RESET and back to ON to bring the generator back on the line after a fault or out of tolerance condition clears. The generator s may be reset as many times as necessary. A generator is removed from the busses by placing the generator switch OFF. Cautions L GEN or R GEN appear on the MPCD if the respective generator is off line.

Generator Switches

The two main generator lever lock switches are labeled L GEN and R GEN respectively.

ON	Generator automatically powers busses when running
OFF	Generator off
RESET	Resets generator

Emergency Generator

If both main generators are off or failed, emergency ac power is supplied by a 15kva generator driven by the emergency power unit (EPU) 1. The emergency generator powers the right and left essential ac busses and all six transformer-rectifiers to supply power to the essential dc busses, the right main dc bus and to the VMS busses 1 and 2. Emergency power unit operation appears on the MPCD. In emergency generator only operation, the left and right main ac busses 1 and 2 and the left main dc bus are not powered. A protection system within the emergency generator control unit protects against equipment damage due to over-voltage or under-frequency. If a malfunction occurs, the emergency generator control unit removes the emergency generator from the busses and gives associated E GEN MALF. The emergency generator switch must be cycled to RESET and back to ON to bring the emergency generator back on line after a fault or out of tolerance condition clears.

Emergency Generator Switch

The lever lock emergency switch has two positions and is labeled EMERG GEN.

ON generator automatically powers essential ac busses when running
RESET resets emergency generator

The aircraft can be configured to operate the EPU with bleed air. Refer to flight user card to select test configuration.

Dc Electrical Power

See Fig. 11.

Six transformer-rectifiers and four batteries are provided. The output of the left transformer-rectifiers 1 and 2 and the right transformer-rectifiers 1 and 2 power the respective left and right essential dc busses. The output of the VMS 1 and 2 transformer-rectifiers power the respective VMS 1 and 2 dc busses.

Either main generator or emergency generator can power all six transformer-rectifiers. Protection is provided so that a short in any transformer-rectifier does not affect another. The caution XFMR RECT on the MPCD indicates one or more transformer-rectifiers have failed. The top level BIT display shows the failed transformer-rectifier. The utility battery can power the utility bus, the essential dc busses and in flight, the VMS 1 bus. In flight the emergency battery can power the essential dc busses and the VMS 2 bus.

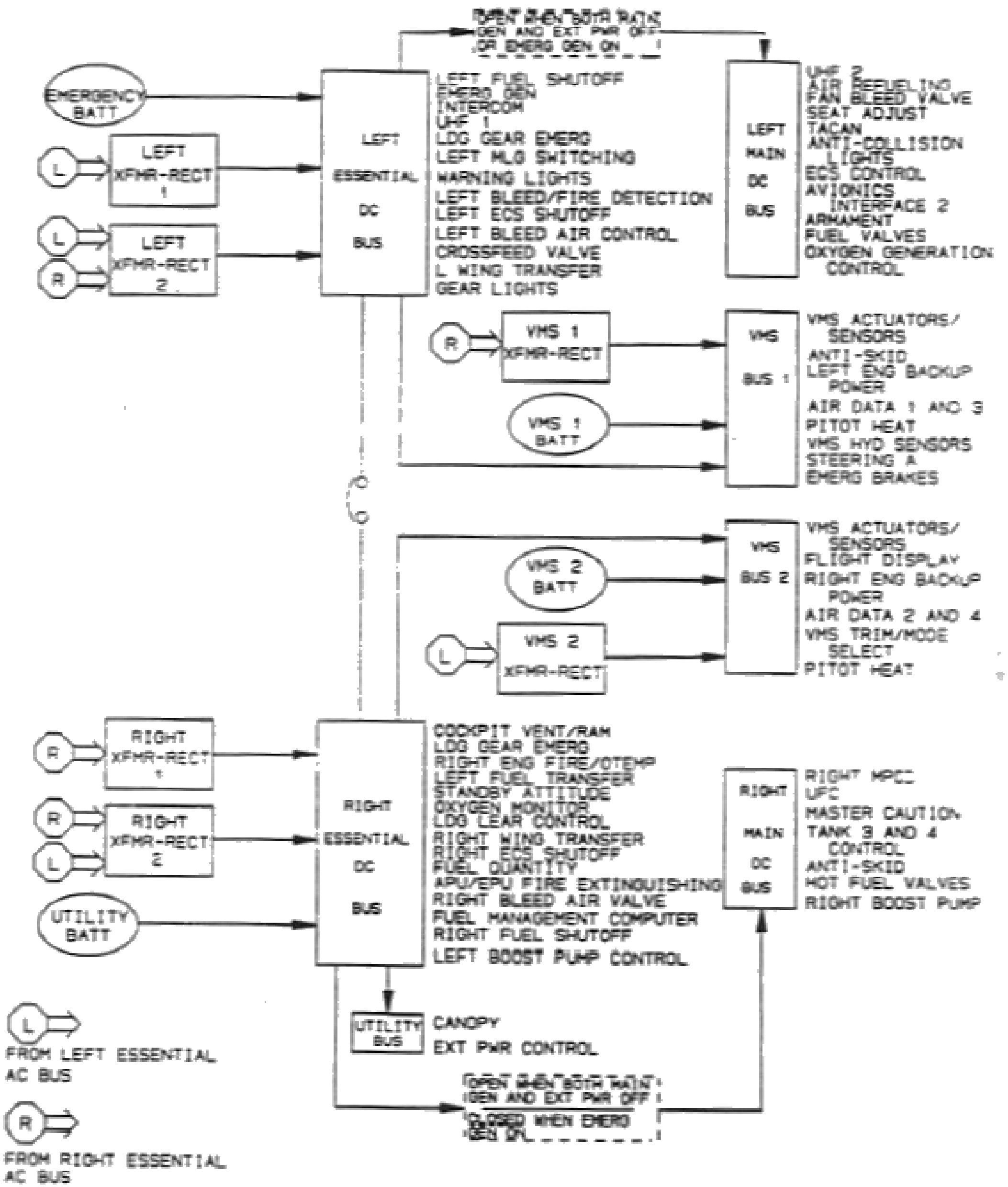
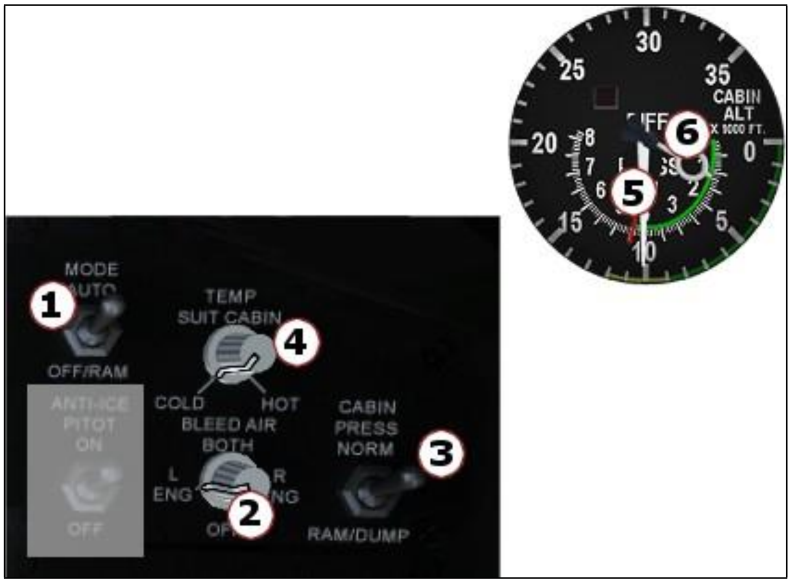


Fig. 11
DC POWER SYSTEM

ENVIRONMENTAL CONTROLS AND INDICATOR



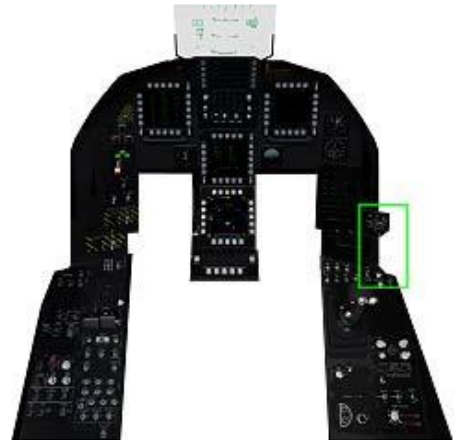


Fig. 12

1. ECS mode switch
2. Bleed air control
3. Cabin pressurization control
4. Suit/cabin temperature control
5. Cockpit altimeter indicator
6. Inside/outside pressure differential indicator

ENVIRONMENTAL CONTROL SYSTEM

The environment control system (ECS) provides conditioned air for:

- Cockpit pressurization and air conditioning
- Windscreen defog
- Canopy seal
- Fuel tank pressurization
- Oxygen generation
- Avionics cooling

The ECS operates with engine, APU or ground cart bleed air. Ram air from the aux ram air scoop or from the engine inlet is the heat sink through the primary heat exchanger

BLEED AIR SYSTEM.

The bleed air ducts from each engine are joined after the primary pressure regulator valve and routed through the secondary pressure regulator valve to the primary heat exchanger. Warm air is routed to the ECS from the primary heat exchanger. Check valves prevent reverse flow.

Bleed Air Control

Bleed air control is on the ECS panel. The control labeled BLEED AIR selects the bleed air source. The control is pulled to provide APU augmented airflow for ECS operation.

OFF	Shuts off bleed air from both engines
R ENG	right engine supplies bleed air
L ENG	left engine supplies bleed air
BOTH	bleed air supplied by both engines

A dual dc powered bleed air leak detection system senses a bleed air leak, displays cautions and automatically closes the appropriate valves. When the leak detectors cool, the cautions rescind and the valves remain closed. The fire detection/extinguishing system tests bleed air leak detection (see Fire Warning and Extinguishing, this section). The test closes the primary pressure regulator valves and turns on the bleed air leak cautions, L(R), BLD LEAK and advisories L(R) BLEED. After the test switch is released, the cautions go out, the primary pressure regulator valves remain closed and the advisories remain on. When the bleed air control is rotated through OFF to BOTH, the primary pressure regulator valves reopen and the advisories go out.

The bleed air leak detection system has three sections. The first is from the primary pressure regulator valve to the secondary pressure regulator valve. If a leak is detected, the caution L BLD LEAK or R BLD LEAK appears depending on the side. The primary pressure regulator valve automatically closes. The second is from the secondary pressure regulator valve to the primary heat exchanger and cautions L BLD LEAK and R BLE LEAK both appear if there is a leak. The secondary pressure regulator valve and both primary pressure regulator valves close. The third section is from the air-conditioning pack to the secondary heat exchanger. A leak turns on both cautions L BLD LEAK and R BLE LEAK and closes the air-conditioning pack flow control valve. The primary and secondary pressure regulator valves remain open and the advisories remain off.

Conditioned Air

Conditioned air provides cockpit air conditioning, pressurization, defog and avionics cooling. Warm bleed air is cooled and dried in the air conditioning pack and ducted to the cockpit and avionics bays. The cockpit flow control valve closes and cockpit airflow stops when the canopy is open. Warm bleed air mixes with conditioned air to maintain temperature. Conditioned air enters the cockpit through louvered inlets in the instrument panel, fixed inlets in each leg well and the defog ducts.

Cockpit Pressurization

Cockpit pressurization is automatic. The cockpit altitude is ambient pressure to 8000 feet MSL. Cockpit altitude remains at 8000 feet to 23,000 feet MSL aircraft altitude. Above 23,000, cockpit pressurization remains at 5psi differential.

Cockpit Altimeter

A cabin pressure altimeter indicates cockpit pressure altitude. The altimeter is marked in 1000 foot increments from 0 to 50,000 feet.

ECS Mode Switch

The three position toggle switch labeled MODE controls the ECS.

AUTO	ECS automatically maintains the selected temperature
MAN	Temperature is manually maintained with the temperature control. The ECX provides maximum airflow to the cockpit and avionic bays
OFF/RAM	ECS is off. Cockpit pressure regulator valve remains closed and cockpit eventually depressurizes. The emergency cockpit/avionics ram air scoop opens. Oxygen generation is off.

Cockpit Altimeter

A cabin pressure altimeter (Fig. 1 No. 17) indicates cockpit pressure altitude. The altimeter is marked in 1,000 foot increments, up to 35,000 feet.

ECS Mode Switch

The three position switch labeled MODE controls the ECS.

AUTO	ECS automatically maintains the selected temperature.
MAN	Temperature is manually controlled with the SUIT/CABIN TEMP control (Fig. 12 No. 4)
OFF/RAM	ECS is off. Cockpit pressure regulator value remains closed and cockpit eventually depressurizes.

Cabin Pressure Switch

The three position toggle switch labeled CABIN PRESS controls cockpit pressurization.

NORM	The cockpit automatically maintains cockpit pressurization to under 9,000 feet.
DUMP	Cockpit pressurization is dumped. Airflow to the cockpit and avionics bays continues. Oxygen generation remains on.
RAM/DUMP	Conditioned airflow stops. Cockpit pressure regulator valve opens and cockpit pressurization is dumped. Emergency cockpit ram air scoop opens. Manual cockpit temperature control is available. Oxygen generation stops.

Temperature Control

The control labeled TEMP adjusts cockpit temperature automatically or manually with the position of the mode switch. Turning the control clockwise from COLD to HOT increases the cockpit temperature from 40 degrees F to 110 degrees F. The inner (raised) knob has no function.

Suit and cabin temperature thermostatic control.

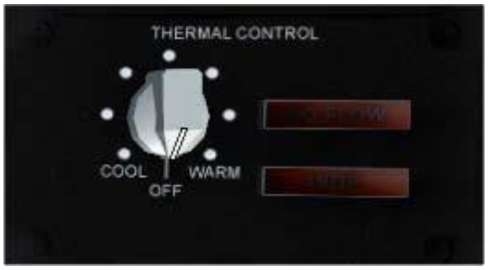


Fig. 13

OXYGEN REGULATOR

Fig. 14

1. Regulator ON/OFF
2. Oxygen power switch
3. Oxygen supply mode selector
4. Oxygen supply switch ON/OFF

UHF SECURE VOICE SYSTEM

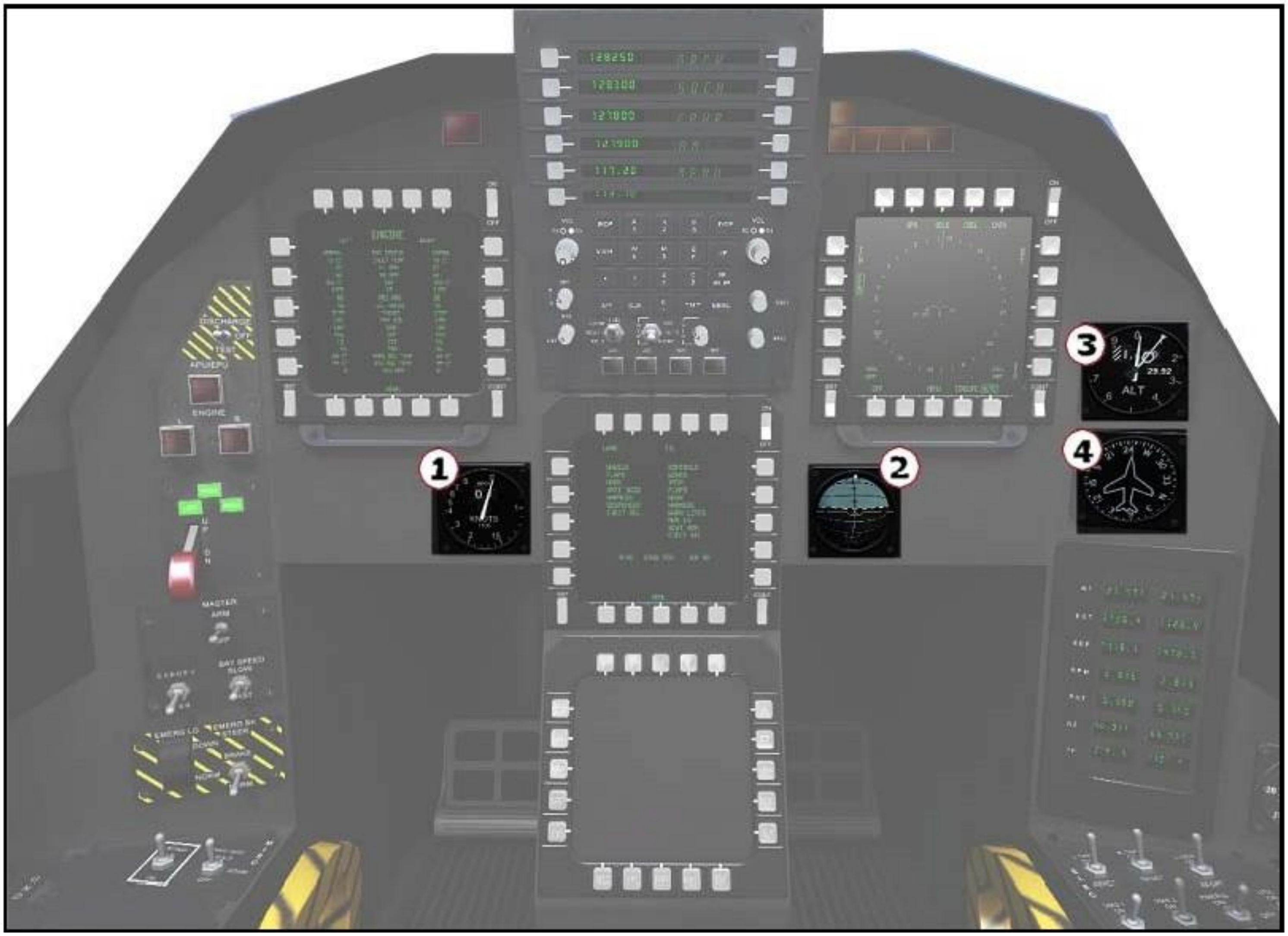
The secure voice system encodes and decodes UHF radio reception and transmission.

1. Mode selector
   a. P – Plain. Transmissions not encrypted
   b. C – Controlled – Encrypted
   c. LD – not used
   d. RV – Not used
2. Fill selector
   e. 1-6 Access to indicated storage registers
   f. Z 1-5 Zeroless registers
   g. Z All Zeroless all 6 registers
3. Volume control
4. Power selector

BACKUP INDICATORS

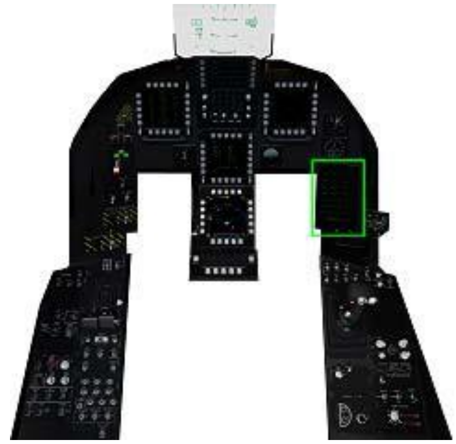
Standard vacuum driven backup instruments are supplied as follows:

Airspeed
Attitude Indicator
Altimeter
Gyro



STANDBY ENGINE INSTRUMENTS

Engine performance indications also appear on the Standby Engine Data Flight Display.



Controls and Displays

Controls and displays provide for monitoring and control of aircraft systems. The controls and displays system consists of Multi-Purpose Color Displays (MPCD), a Head Up Display (HUD), multipurpose display processor, and Upfront Controls (UFC). Data is input through the UFC.

UPFRONT CONTROL

The UFC provides monitoring and control communications, navigation and identification through menus and data displays.

MULTI PURPOSE COLOR DISPLAY (MPCD)

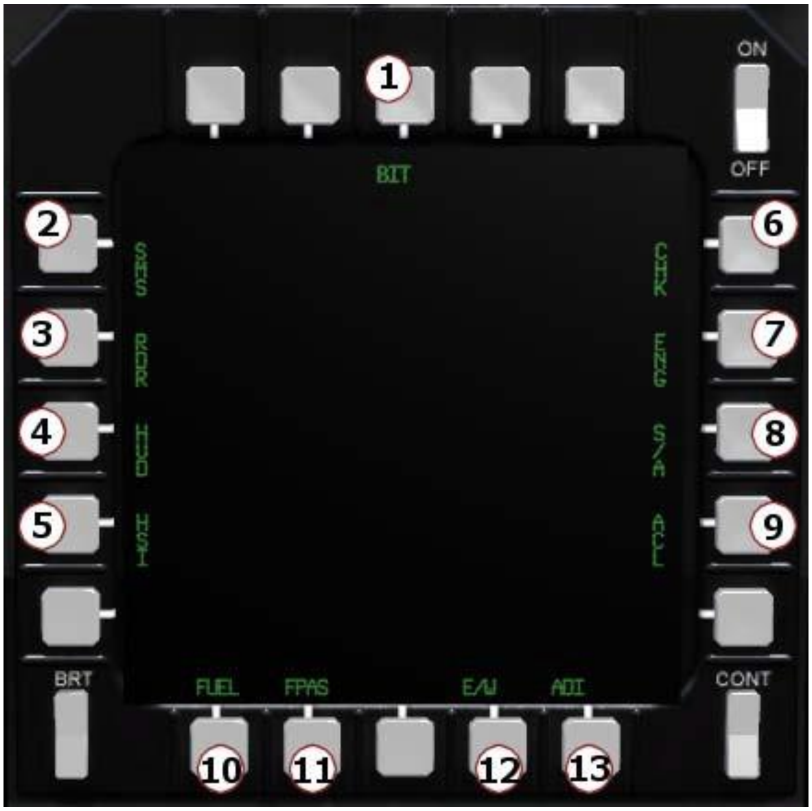
Three Multi Purpose Color Displays (MPCD) provide essential flight and navigation information and permit monitoring and control of systems with a variety of displays and CRTs.

Any display can appear on any of the MPCDs. A program function permits selecting the displays outlined below.

Each CRT is 5 inches square. Buttons around the edge of the display.

The menu display, selected with the menu button, allows you to select which data mode the individual CRT will display

MPCD Menu



1. Built in Test display
2. Stores Management System display
3. Radar display
4. HUD display
5. HSI display
6. Checklist display
7. Engine data display
8. Not operable
9. Autopilot System display
10. Fuel display
11. Fuel Advisory System display

BUILT IN TEST (BIT)

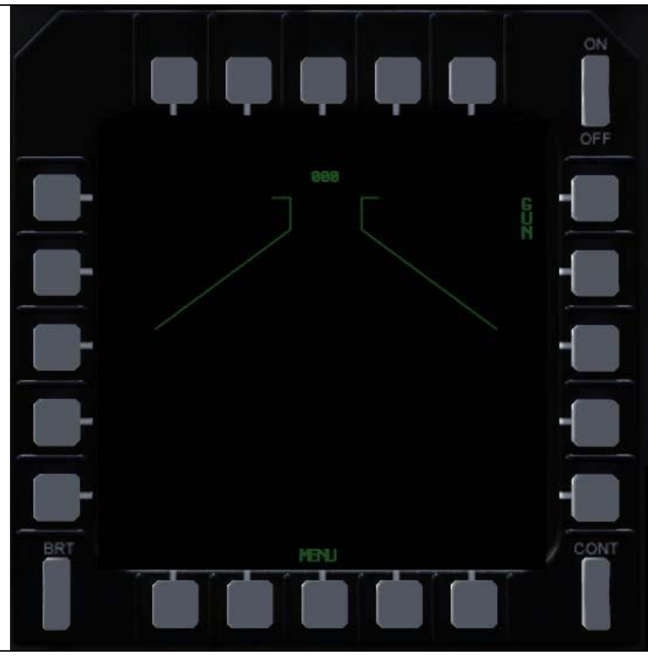
The BIT/status monitoring subsystem provides the aircrew with a simple display of system status. Most information is derived from BIT mechanizations within the avionics sets and from non-avionic built in tests implemented in the computer software for other aircraft subsystems.

1. FCS – Flight Computer Systems failures
2. SENS – Sensor failures
3. STOR – Weapons stores failures
4. ENG – Engine failures
5. AMAD – Fuel and ammo failures
6. DISP – Display Failures
7. MISC – Miscellaneous system failures
8. EW – Electronic Warfare system failures

STORES MANAGEMENT SYSTEM DISPLAY

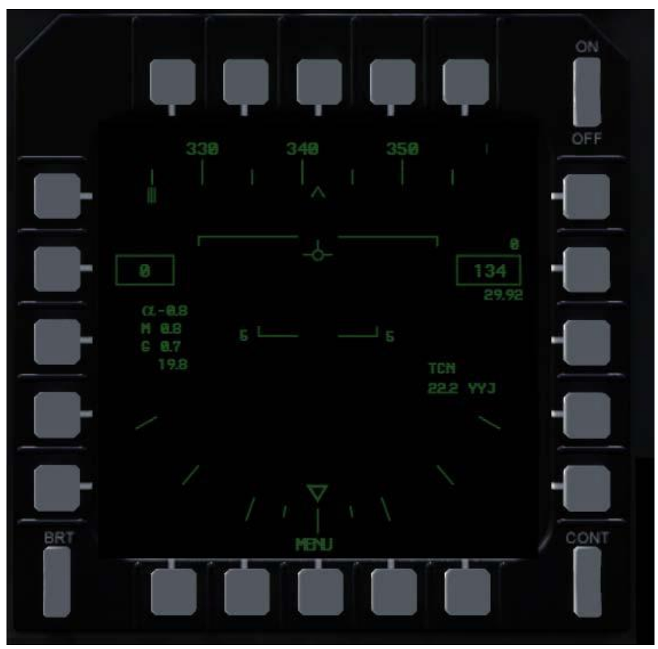
Shows weapons status display.

*Note: Weapons are not modeled at this time.



HUD

Displays the same data as the Head Up Display (HUD).



HSI MODE

Horizontal Situation Indicator (HSI) multi-function display. A compass rose is provided along with several information layers that can be superimposed:

1. TCN - TACAN
2. ILS
3. APT – Airports
4. WPT – Waypoints
5. TIMEUFC – Time in UFC
6. DATA – Current flight plan/GPS data
7. CSEL – Toggles OBS needle
8. SCL – Map scale control
9. SEQ – Waypoint Sequence on/Off toggle
10. AUTO – Automatic waypoint sequencing On/Off

HSI/AUTOPILOT HEADING BUG AND HSI OBS CONTROLS

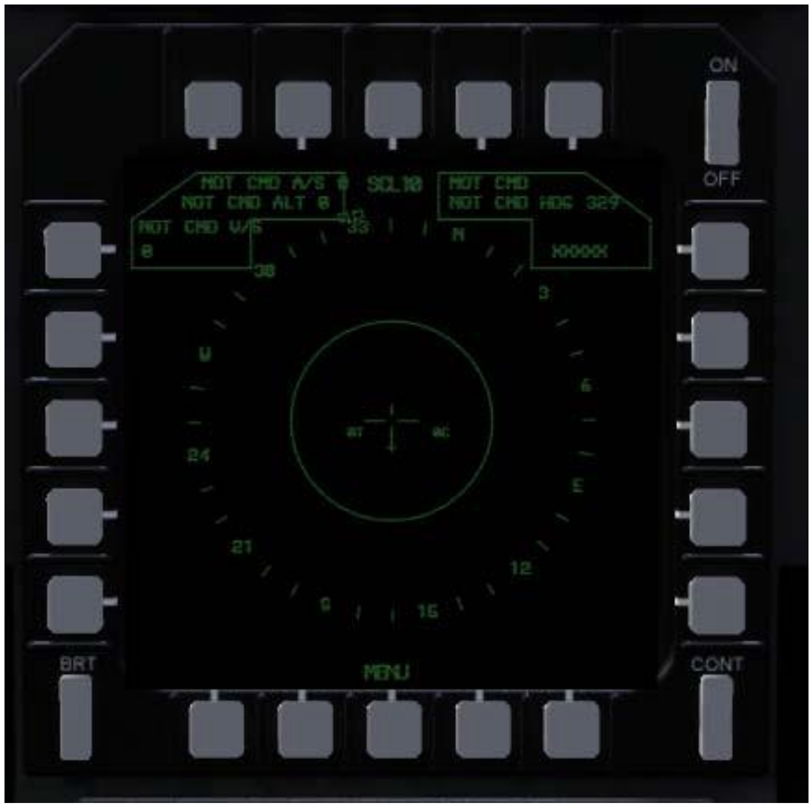
1. Autopilot HDG bug selector
2. HSIOBS selector

CHECKLIST MODE

ENGINE DATA MODE

AUTOPILOT & GPS NAVIGATION

Visualization of the autopilot system in real time with RNAV data on the aircraft is available on the MPCD ACL mode:



Autopilot mode is entered from submenu button AP, each function is enabled or disabled by clicking its button once and features the following settings:

ATTH — Attitude Hold mode

RALT — Radar Altitude Hold Mode. Not implemented

BALT — Barometric Altitude Hold mode. This will set Altitude Hold mode at the CURRENT Altitude. There's no way to manually pre select a different altitude, Altitude mode here will always lock at your current altitude.

HSEL — Heading Select. It will maintain the Heading selected with the HDG selection Bug

CPL — Coupled mode. To change Coupling mode, select either "TCN", "ILS" or "WPT" on the HSI, Note the "CPL TCN" or "CPL ILS" on the airplane symbol. To select a Steering Course towards the station, use the CRS bug, and check the small "CSEL" readout on the HSI. By pressing the "CSEL" button on the HSI, instead, you can toggle on/off the visualization of the CRS indication for the HSI.
To skip a waypoint, use the select waypoint information toggle on the HSI as shown on the following page, when CPL mode is active the aircraft will track to

the waypoint selected, or back to any of the previous listed, you can toggle on/off the CPL to enable and disable the autopilots control over heading without turning of the autopilot.

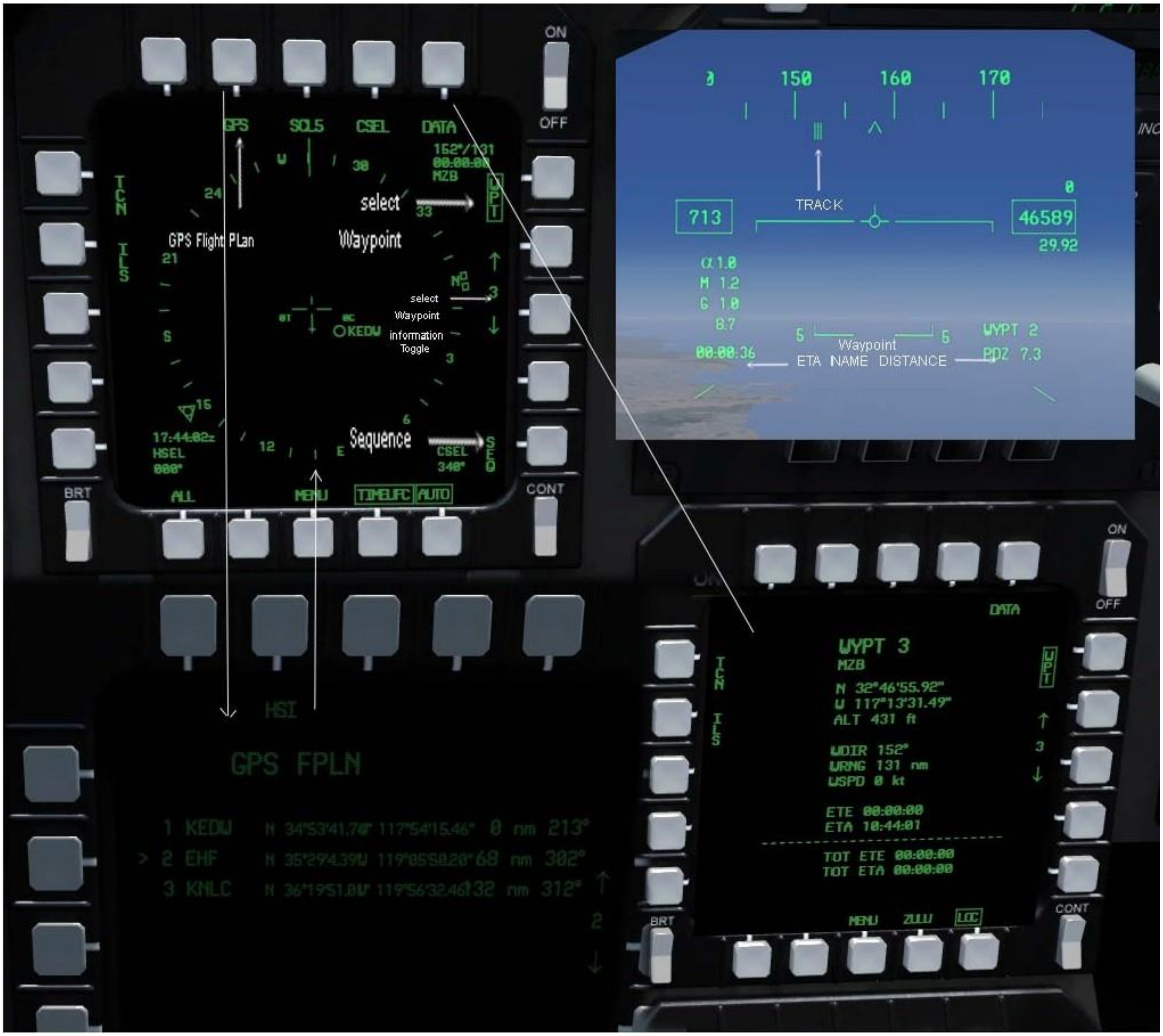
-

FLIGHT PLANNING

It is imperative with this system that you start a flight without a preloaded flight plan, once the aircraft is loaded and fueled you can then import a saved plan or create one using the FSX Flight Planner, information on using it is available in the help menu.

Once in the air turn the Autopilot on, press the A/P button on the Upfront Panel, press BALT to hold the current altitude, and press CPL to automatically follow the route in Waypoint mode on the HSI, the Autopilot will understand we are going to follow a waypoint and, with the SEQ button turned on, the "Coupling" will be to the route, note the HSI showing CPL SEQ. If SEQ was off, and WPT on, the HSI would have shown CPL WPT, meaning it will track a waypoint directly or back course heading by selecting a waypoint with the toggle.

In CPL WPT mode, the Autopilot will fly straight direct to the next waypoint, in CPL SEQ, it will intercept the planned route first and then follow it, with HSEL and using the heading knob adjust the heading bug to the desired coarse it will track a direction, all normal GPS functions are available as described in the help menu.



RADIOS

Com Radio Channel Select - Com 1

1. with the com panel in the default configuration as seen here first click on button GRCV
2. Click function select button 2 as indicated in the drawing
3. Entered desired frequency with decimal, if an error in the entry occurs click CLR and re-enter
4. Click on ENT, indicated with button 4
5. Button 5 is COM 1 frequency swap
6. The numeric pad figures entered are visible in this location as well as the active channel

Com Radio Channel Select - Com 2

1. Com 1 & Com 2 Frequency Swap
2. Click Select Com 2
3. Com 2 Active /Standby Frequency
4. Enter the desired frequency on the keypad and read in the scratchpad
5. Click on ENT to Enter the input Frequency
6 & 7. Rear Dial Com Receive Com 1 & Com 2, Forward Dial On and Volume

SETTING THE VOR AND USING THE HSI TO FOLLOW THE HEADING

Diagram A

1: VOR Submenu Button
2: Enter frequency on keypad and read on numeric display, will read on with Frequency lock
3: with frequency entered on keypad click ENT to activate
4 & 5 NAV 1 select and NAV 1 standby frequency swap, it is possible to use the mouse wheel to set the standby frequency and click button 4 to swap selected standby frequency
6: Audible selection ON/OFF

Diagram B

1: Heading indicator
2: Heading of VOR in degrees Distance to VOR in Miles, VOR Name

Normal Procedures

BEFORE ENTERING COCKPIT

Canopy	FULL OPEN
Canopy indicator	NOT FIRED

A thorough cockpit inspection shall be accomplished before each flight. Switch positions designated as REQUIRED indicate switch control position may vary.

Life Support Equipment

Harness and personal equipment leads	CONNECTED

LEFT CONSOLE

Armament safety override	SAFE
Anti-G switch	NORMAL
Intercom panel	
a. Mode 4 code	AS REQUIRED
b. Mode 4 reply	AS REQUIRED
c. IFF master	NORM
d. Mode 4 crypto	NORMAL
e. Intercom	ON
f. UHF Antenna	AS REQUIRED
VMS Test Panel	
a. Flaps BLC Switches	FRZ
b. Flaps Enable Switch	BLC/AS
c. Air Data	NORM
d. Leading Edge Flaps	AS REQUIRED
e. Armament Gas Ingestion	NORM
f. BLC Accelerate	NORM
g. PW	NORM
h. INS	NORM
I. BLC Select	NORM
VMS Controls	
a. Gain Enable	OFF
b. Fixed Gain	LO A/S
c. VFT	OFF
d. Yaw Trim	OFF
e. VMS/ENG Reset Switch	OFF
APU	OFF
EPU	OFF
Weapons camera	OFF
Video control system switch	OFF
Throttle	CLOSED/OFF

Light Controls

a. Panel Lights Switch	OFF
b. Cabin Lights Switch	OFF
c. Ext Anti-Collision Lights	OFF
Ground Power Switches	AUTO
Brakes	ON
Anti-skid	NORM

INSTRUMENT PANEL

Landing gear emergency extension (EMERG LG)	NORM
Brakes emergency control	NORM
Bay speed switch	SLOW
Master arm	OFF
Landing gear handle	DOWN
Fire extinguisher discharge	OFF
HUD	
a. Brightness knob	OFF
b. Declutter switch	AS DESIRED
c. HUD intensity	DAY

RIGHT CONSOLE

Electrical Panel

a. Generator R and L	ON
b. VMS batteries (2)	ON
c. Utility battery	OFF

Oxygen Regulator

a. Regulator	OFF
b. Oxygen supply	OFF
c. Oxygen switch	NORM
d. Oxygen power	OFF
e. Emergency (EMERG)	NORM

ECS Panel

a. ECS mode	AUTO
b. Temperature control	AS REQUIRED
c. Cabin pressure	RAM/DUMP
d. Anti-ice pitot heat	ON
e. Bleed air control	BOTH

POWER ON

Emergency battery	ON
HUD	ON
Radios(2)	ON
IFF	ON
TACAN	ON
Intercom	CHECK
Interior lights switch	TEST
APU	ON

BEFORE STARING ENGINES

> **WARNING**
> With engines running and without proper ear protection, physical injury and hearing loss can occur. Wear ear plugs in addition to pilot helmet.

Danger Area Fore And Aft	CLEAR
Fire Guard	POSTED
Bleed Air Control	CYCLE OFF, THEN MOVE TO BOTH
Throttles	CYCLE MAX THEN OFF
Right Throttle	IDLE
Engine Crank	R

If the engine has sufficient power and air to start you will hear the engine spool up. Ignition will occur automatically when sufficient engine RPM and EGT is achieved.

Right Engine Indications	CHECK
R Gen	CHECK ON
Left Throttle	IDLE
Engine Crank	L

If the engine has sufficient power and air to start you will hear the engine spool up. Ignition will occur automatically when sufficient engine RPM and EGT is achieved.

Left Engine Indications	CHECK
L Gen	CHECK ON

OXYGEN REGULATOR

Regulator	ON
Supply	ON
Oxygen power	100% THEN NORM

BEFORE TAXI

Both Generators	ON
Right Generator	CYCLE OFF, RESET, THEN ON TO VERIFY THAT THE LEFT GENERATOR ACCEPTS THE ELECTRICAL LOAD. GLASS DISPLAYS WILL GO DARK IF LOAD IS NOT ACCEPTED
Thermal Control	AS REQUIRED
Canopy	AS REQUIRED
Cabin pressure	NORM
VMS Bit	COMPLETE. RESET VMS/ENG AND MOVE BIT SWITCH TO CONSTANT
Anti-G Test	TEST
Vms/Ins	NORM
Spoilers	UP
Yaw Trim	CENTER
Master Arm	ARM
INS selector	STORE
External lights	ON
Crypto	HOLD

TAXI

As the aircraft begins to move, apply brakes to check operation. Check nosewheel steering in both directions. During heavy gross weight operations make all turns at the minimum practical speed.

Brakes	TEST
Nosewheel Steering	CHECK
Flight Indications	CHECK

BEFORE TAKEOFF

Warning and Caution Lights	CHECK OUT
Check Flaps	DOWN
Flight Indications	CHECK
Brakes	ENGAGED

TAKEOFF

Advance throttles and check instrument indications. When ready for takeoff release brakes and advance thrust to MIL or MAX as required. Monitor engine instruments for proper operation.

During takeoff the control stick should remain in neutral position until desired rotation speed. Stop rotation at approx. 10° pitch attitude and allow aircraft to fly off the runway.

Engine L & R	CHECK Brakes RELEASE
Throttles	AS REQUIRED

AFTER TAKEOFF AND CLIMB

Retract landing gear when a positive rate of climb is achieved and verified by outside visual clues. The vertical velocity indicator and altimeter should indicate a climb.

Landing gear	UP
Flaps	UP
Throttles	AS REQUIRED

LEVEL OFF/CRUISE

Monitor aircraft systems operation throughout the flight. Frequently check engine indications, cabin altitude/pressure and fuel quantity

Oxygen	CHECK

DESCENT

Master arm switch	CYCLE ON
Altimeter	RESET TO LOCAL ALTIMETER SETTING
Fuel	CHECK

BEFORE LANDING

Approach and brake speeds	COMPUTE
Landing gear	DOWN
Flaps	DOWN

LANDING

Normal Landing

Fly final approach at 10° angle of attack and 2.5 to 3.5-degree glideslope. Touchdown at 10° AOA and minimum sink rate.

WARNING

Tail strike is possible if touchdown attitude exceeds 12.5° AOA at touchdown!

Cross Wind Landing

Fly final approach with either crab or wing low into the wind but plan to touchdown without crab.

Landing Rollout

Lower nose smoothly to runway without hesitation. After nosewheel touchdown smoothly apply full aft stick for maximum aerodynamic braking. Maintain nosewheel on the runway.

AFTER LANDING

Cockpit pressure	CHECK
Canopy	AS REQUIRED

ENGINE SHUTDOWN

INS selector	OFF
HUD	OFF
External lights	OFF
Crypto	OFF
Video control system	CHECK OFF
Cabin pressure	RAM/DUMP
Canopy	OPEN
Throttle left engine	OFF
Throttle right engine	OFF Fuel
selector	OFF
Engine Shutdown R & L	MONITOR
GEN L & R	RESET/OFF
VMS batteries (2)	OFF
Emergency battery	OFF

Emergency Procedures

EJECTION SEAT

Ejection Preparations
EJECTION INJURIES AND BODY POSITIONING
THESE PROPER BODY POSITIONS MUST BE TAKEN TO PREVENT INJURIES

1. Press head firmly against headrest.
5. Press buttocks firmly against the seat back.
2. Elevate chin slightly (10°).
6. Place thighs flat against seat.
3. Press shoulders and back firmly against seat.
7. Press outside of thighs against side of seat.
4. Hold elbows and arms firmly towards sides.
8. Place heels firmly on deck, toes on rudder pedals.

EJECTION INITIATION
1. Arm ejection seat
2. Pull eject handle

NOTE
In low altitude situations, a one-handed method, using one hand to initiate ejection and the other to maintain the aircraft in the safe operating envelope of the ejection seat, may be required. If firing the seat by this method, particular attention must be paid to maintaining proper body position.

Engine specific information to Pratt Whitney engines is provided under this heading. Source references for this information is Pratt Whitney integration memo N-90012 YF23-A YF119.

AFTERBURNER FAILURE

If an afterburner fails to light or blows out during takeoff (takeoff continued), leave throttle of affected engine in afterburner range. Completion of automatic afterburner recycle is indicated by the caution ENG 1ST if afterburner does not light. The caution ENG 2ND indicates the afterburner use is inhibited.

A low fuel flow and a small nozzle position opening are shown on the MPCD engine display or the standby flight display 1 if the afterburner is not operating.

VMS Engine	RESET
Afterburner	CYCLE THROTTLE TO MIL AND BACK TO AFTERBURNER

DOUBLE GENERATOR FAILURE – TAKEOFF

If a double generator failure occurs on takeoff, abort if possible. The potential for a double engine stall exists when the EPU comes on the line and a fuel spike occurs in each engine. If the takeoff must be continued, MIL power provides the best compromise for takeoff/climb power.

IF altitude and airspeed permit, the best course of action is to immediately reduce power to 5000 pounds per engine fuel flow and re-advance throttle to MIL after EPU is providing ac power.

Throttles	MIL

OUT OF CONTROL RECOVERY

During an out of control condition, the throttle should not be moved. If an engine malfunction does exist (stall, flameout, over-temperature), minimize throttle movement and bring engine performance to within parameters.

ENGINE OIL PRESSURE MALFUNCTION

The caution ENG 1ST is delayed 10-45 seconds for low oil pressure during inverted flight.
If oil pressure is between 5-10 psi, retard throttle affected engine to IDLE and reduce G. If the oil pressure is below 5psi, or above 150psi, the throttle affected engine should be moved to OFF immediately.
Check oil pressure on the MPCD engine display or the standby flight display 1.

Oil Pressure	CHECK

If oil pressure is high-low

Throttle	OFF

If oil pressure is 5-10psi

Throttle	IDLE
VMS/ENG	RESET

ENGINE STALL
If an engine stall occurs, an automatic engine stall recovery is initiated by the FADEC. Stall recovery action includes afterburner termination, firing igniters and rate limited fuel flow. After the stall clears, afterburner must be re-initiated if required.

A non-recoverable engine stall is indicated by increasing EGT with RPM below 60r. and no response to throttle movement. If a non-recoverable stall is indicated, shutdown the affected engine, restart, and leave throttle at idle for the remainder of the flight. If both EGT are high, shut down only one engine at a time to preserve hydraulic system pressure. The engine with the highest EGT should be shut down and restarted first.

DOUBLE ENGINE FLAMEOUT
If both engines flameout, immediately check EGT. If EGT is below normal, simultaneous restarts can be attempted.

Maintain 350-375 KCAS to provide 20% minimum RPM. See ENGINE AIRSTART.

ENGINE AIRSTART

Engine airstart can be accomplished by moving the throttle from OFF to IDLE. Moving the throttle OFF terminates fuel flow and ignition to the engine. Moving the throttle to IDLE activates the FADEC start sequence if engine RPM above 20r.

Optimum engine airstart is 25-50r RPM during engine spool down

If the RPM drops below 17 RPM, start sequence is terminated. If engine drops to 0, the engine could seize. If spool down conditions cannot be met, a windmill crossbleed airstart can be attempted. Airspeed between 350-375 KCAS provides a minimum 200 engine RPM for start. If a crossbleed airstart is required, maintain 200KCAS minimum.

NOZZLE FAILURE
The nozzle position indications are based on the position of the convergent nozzle. If the convergent nozzle fails, the nozzle is hydraulically powered full open and the engine idle trips. VMS/engine reset is required to regain full operation. If the system does not reset, thrust loss at MIL power is minimal.

If the divergent nozzle fails, afterburner operation is inhibited and nozzle position is 58%.

LANDING GEAR SYSTEM

The tricycle landing gear consists of a cantilevered nose gear and semi-levered main gear. The landing gear system includes brakes, antiskid protection and nose wheel steering. With the landing gear up after takeoff, the utility hydraulic system isolation valve closes to isolate circuit B from the landing gear, nose-wheel steering and brakes.

EMERGENCY BRAKING

The emergency brake system is activated by the emergency brake switch. The system uses hydraulic accumulator pressure through independent hydraulic lines to provide braking without antiskid protection. After landing gear emergency extension, the emergency accumulator provides approximately 10 full brake applications and 7 nosewheel steering deflections.

ANTI-SKID SYSTEM

The antiskid system is electrically controlled by a three-position switch. With antiskid on, hydraulic pressure to the brakes is inhibited until main wheels spin up to 70 knots for 3 seconds after weight on main landing gear, if spin up sensor fails.
An anti-spin feature is provided to automatically stop the main wheels from spinning after takeoff when gear retraction is commanded.

Antiskid protection is not available below 35 knots.

Anti-Skid Switch

OFF	No antiskid protection
NORM	Antiskid system selected
HOLD	Brake hold selected

NOSEWHEEL STEERING SYSTEM

Nosewheel steering is electrically controlled by rudder pedal position and hydraulically powered by utility hydraulic circuit B. Nosewheel steering is energized after aircraft power-up by momentarily pressing the nosewheel steering button. Nosewheel steering operates with weight on the nose gear. Steering deflection is 20 degrees.

A maneuvering steering mode is provided for use when taxiing below 15 knots ground speed. Maneuvering mode provides up to 45 degrees maximum steering and is engaged by holding the nosewheel steering button. Use of maximum deflection should be restricted to below five knots ground speed.

After landing, a built-in two second delay is provided before nosewheel steering responds to rudder pedal position.

Nosewheel steering is disengaged by holding the paddle switch pressed, allowing the nosewheel to free caster. The nosewheel steering actuator provides nosewheel shimmy damping with or without nosewheel steering engaged.

Terminology

The following terminology is not commonly used and is described here for reference.

BLC	Boundary Layer Control - refers to a number of methods of controlling the boundary layer of air on the main wing of an aircraft. In doing so, parasitic drag can be greatly reduced and performance likewise increased, while the usable angle of attack can be greatly increased, thereby dramatically improving lift at slow speeds. An aircraft with a boundary layer control system thus has greatly improved performance over a similar plane without such a system, often offering the otherwise contradictory features of STOL performance and high cruising speeds. [3]
ECS	Environmental Control System – Cabin temperature and pressure environment
FADEC	A system consisting of a digital computer, called an "electronic engine control" (EEC) or "electronic control unit" (ECU), and its related accessories that control all aspects of aircraft engine performance. The term "FADEC" is an acronym for either "full authority digital engine control" or "full authority digital electronics control". FADECs have been produced for both piston engines and jet engines, their primary difference due to the different ways of controlling the engines. [1]
IFF	Identify Friend or Foe
MPCD	Multi-Purpose Color Display
STOL	Short Takeoff and Landing
VFT	Virtual Flight Test – A telemetry data recording system
VGS	Variable Gain Switch
VMS	Virtual Memory System, a multi-user, multitasking, virtual memory operating system that runs on DEC's VAX and Alpha lines of minicomputers and workstations. VMS was introduced in 1979 along with the first VAX minicomputer. Like the VAX itself, VMS has undergone many changes over the years. DEC now refers to it as OpenVMS. [2]

[1] – Wikipedia: http://en.wikipedia.org/wiki/FADEC#cite_note-0#cite_note-0
[2] – Webopedia: http://www.webopedia.com/TERM/V/VMS.html
[3] – Wikipedia: http://en.wikipedia.org/wiki/Boundary_layer_control