Section I

PREFACE

FOREWORD

Thank you for downloading the F111 for MSFS 2020. This is the second major project developed by a young team, who set a very challenging task of reconstructing the iconic F-111 E. We do believe 10 months of development have not been lost labor, and this remarkable aircraft will bring you many hours of enjoyment in the virtual skies of MSFS 2020.

F111 is an utterly complex aircraft, and implementation of each system and function would take a lot of time. Therefore, some systems were not included in the initial release and will be released as they are ready in nearest product updates. Already implemented gauges and systems were elaborated very carefully based on actual functionality, and almost all were implemented exactly as described in the original F-111 Pilot's Manual. Despite its sobriquet "Aardvark" F111 is one of the most beautiful military aircraft, so a lot of effort was made to elaborate the visual part of both the interior and exterior of the plane.

Versions

This manual applies to PRODUCT VERSION 0.2.x

Copyright Information

Credits and Acknowledgements

I would like to gratefully acknowledge the development team for their superb work and dedication to this project. Many of you wondered if we would ever get it done, so the day has come.

Features

- Big, powerful, fast, extremely high-altitude & hedgehopping, all-weather, multi-purpose F-111 was designed to be the best.
- Fly high and fast: above 50,000 feet and 2.5 Mach
- Try full power of two Pratt & Whitney TF30 engines with realistic controls and monitoring systems.
- Flight model is based on actual performance characteristics at diverse altitudes and speeds taking into account wing swing angle and overall configuration of aircraft.

Cockpit Systems and Gauges are made with ultimate realism according to the original F111 Pilot's Manual:

1. Fuel Supply System
2. Electrical Power Supply System
3. Landing Gear, Tail Bumper, Nose Wheel Steering and Arresting Hook Systems
4. Wing Sweep, Wing Flaps and Slats, Aerodynamic Deceleration and Flight Control Systems.
5. The full functional Autopilot with more than 24 different modes of flight.
6. Maximum Safe Mach Assembly
7. Warning, Caution and Indicator Lamps
8. Lighting System.
9. Communication Equipment
10. Navigation system

11. Lead Computing Optical Sight
12. Fire Extinguishing System

- Very detailed model of Exterior and Virtual Cockpit with full 3D gauges and many animated parts:

1. Wing Flex animation taking into account loading and sweep angle
2. Realistic Flaps, Slats, Spoilers and Wing Sweep animations with interdependency and payload limitations
3. Refuel Receptacle, Arresting Hook, Gear, Weapons Bay Doors
4. Different variants of payloads
5. End many more…

Custom FX for the ultimate in realism are taken far beyond what is available by default:

1. Afterburner effect
2. High angle of attack and stall vortex effects
3. Sonic boom effect
4. Dump & Burn effect
5. And much more…

Future plans

1. TFR – terrain following radar
2. Aerial refueling
3. Weapon system with droppable objects
4. Bombing navigation system.

HISTORY

The F-111 is one of the greatest aircrafts ever designed. It is mostly known for its swing-wings and “dump & burn” fire show. First drafted in the early 1960s by General Dynamics, the F-111 Aardvark, despite its weird animal choice for a name, was a widely used strategic bomber at its time. The aircraft took its first flight on December 21, 1964 and was brought into the in July 1967. The purpose of the F-111 was to create an airplane that could serve as a long-range interceptor for the U.S. Navy as well as a top-notch strike fighter bomber for the Air Force’s use. However, the aircraft only proved useful for the Air Force because after the plane was assembled and ready to be put onto a carrier, it was deemed too heavy to be used. Despite this, the Air Force put good use to the F-111, but not until its common engine inlet, drag, and various structural failure problems were corrected. Once the F-111E came to the surface, the plane was top notch with very powerful engines, terrain following radar, and laser-guided weapons. All of the previous conflicts were fixed, and the Aardvark became a highly useful aircraft for many years.

CUSTOM KEY MAPPINGS

WING-SWEEP is controlled by
"ADF2 VOLUME" hotkeys at RADIO section *(don't ask why)*
"INCREASE ADF2 VOLUME" **-** increasing wings sweep angle
"DECREASE ADF2 VOLUME"**-** decreasing wings sweep angle

These controls can be set via the normal axis/keys/button menu assignment (see figure above).

CAUTION

Wings-sweep, Flaps, Slats and Spoilers controls are interconnected. In some cases, their controls can be mutually exclusive. In order to avoid logical conflicts of Wing-sweep and surfaces controls it is strongly recommended following:

1. **DO NOT to use an external AXIS for FLAPS and SPOILERS controls**
2. **USE gradual extends FLAPS key binding instead of FULL UP / FULL DOWN hotkeys**

IMPORTANT NOTES:

- When flaps are out of the retracted position, the wings are forced fully swept forward
- When flaps are out of the retracted position, the wings-sweep cannot be beyond 26 degrees position
- Spoilers (Spoilerons) are not operative when wings-sweep is beyond 26 degrees position.

AUTOPILOT

"AUTOPILOT MASTER ON/OFF" toggles autopilot stabilization mode.

Note, modes of autopilot are specific and can be set only by switches in Virtual Cockpit.

AIRBRAKE

"SPOILERS TOGGLE" toggles airbrake (main gear hatch).

PAYLOAD JETTISON

"Smoke ON" toggles payload jettison trigger
In a real aircraft, the pilot uses a trigger on the joystick to release the payload. To activate the jettison function in the simulator, assign the corresponding hotkey to "Smoke ON" in the control options menu.

NOSE WHEEL STEERING

"NOSE WHEEL STEERING" toggles NWS function

Important Flying Tips

Aircraft weight

Total fuel weigh is 61781.4 pounds
Weight of the aircraft with internal and external fuel tanks fully filed is 108.353 pounds, which is exceeding takeoff and landing weight.
Maximum gross weight:

- Taxi and takeoff 91.500
- In-flight 100.000
- Landing 80.000

Recommended fuel quantity settings:
Refer to aircraft weight and fuel supply system sections for more detail.

Sweep wings and external stores

Sweep wings control is extremely important. For normal takeoff the aircraft should be in take-off configuration with wings in 16 degree positions, Flaps and Slats extended, take off trim is set.

In case of using external stores, the wing sweep handle lockout controls should be set according to the aircraft configuration. This system prevents the wing sweep handle from being moved aft past the marked positions. This is the wing sweep angles past which certain weapons on the inboard pivot pylons would strike the fuselage.

Refer to Wing Sweep System and Aircraft Performance sections for more detail.

Maximum Rated Speed

The maximum speed can be reached in certain conditions: Weight about 50000 pounds, Altitude 50,000 feet or higher, Wing swing position 50 degrees or greater.

During supersonic flight in all altitudes, the Total Temperature indicator (aircraft forward surface temperature) should be constantly monitored in order to prevent the aircraft overheating.

Refer to Aircraft Performance, Total Temperature indication and Maximum Safe Mach Assembly sections for more detail.

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General Arrangement Diagram

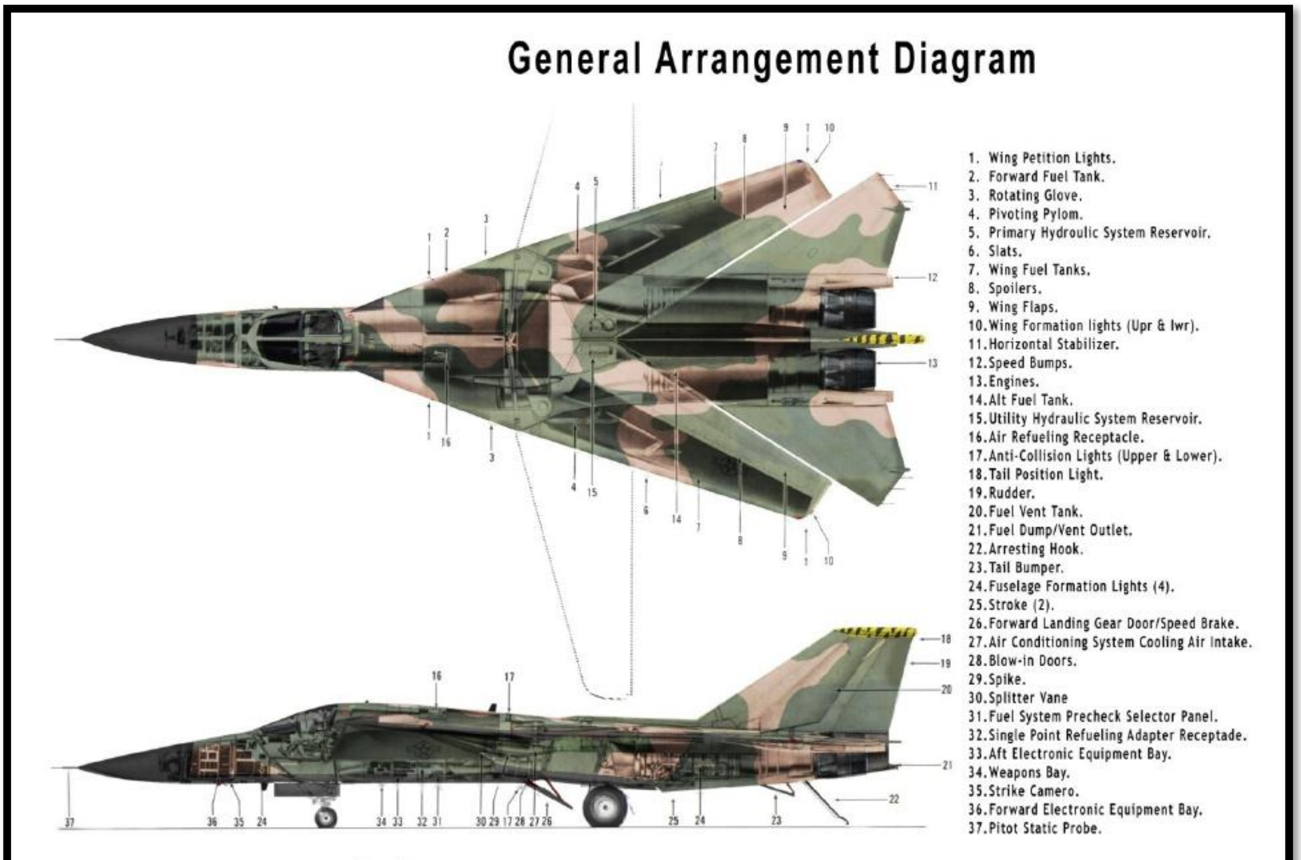


Figure 1-1.

THE AIRCRAFT.

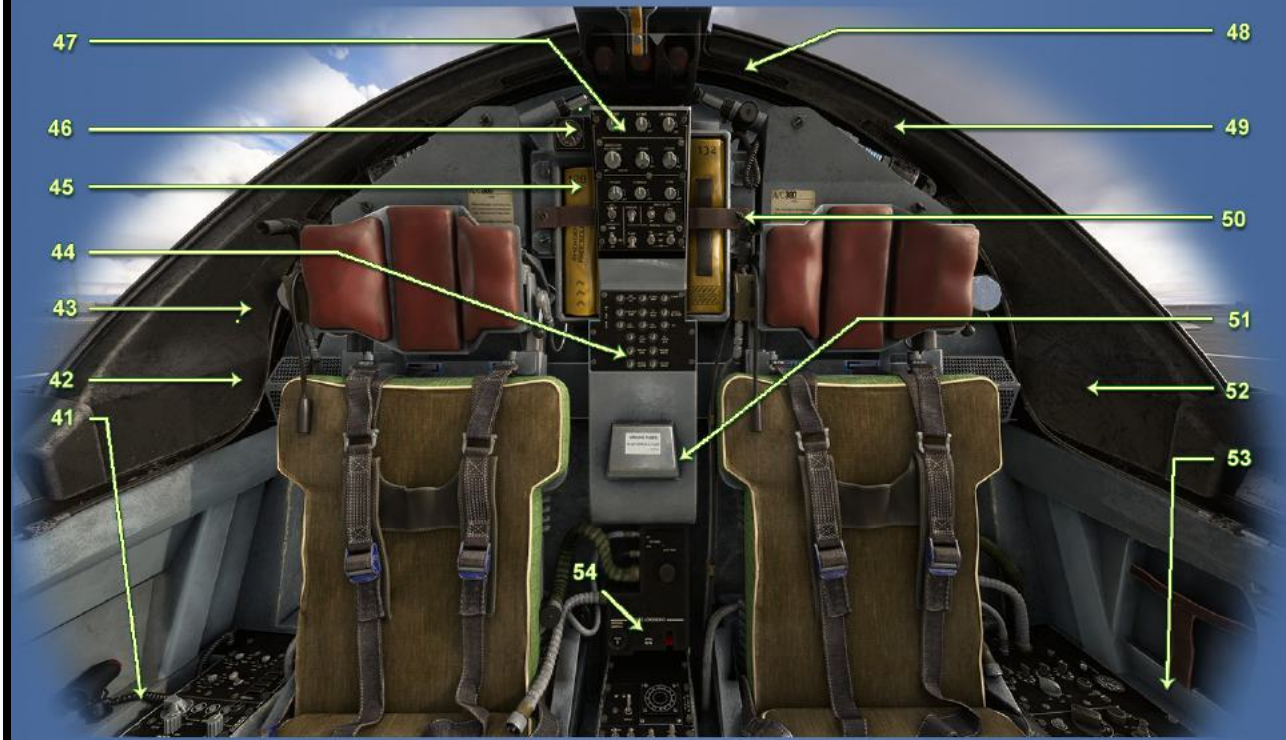
The F-111E is a two place (side-by-side) long range fighter bomber built by General Dynamics, Fort Worth Division. The aircraft is designed for all-weather supersonic operation at both low and high altitude. Mission capabilities include; long range high altitude intercepts utilizing air-to-air missiles and/or guns: long range attack missions utilizing conventional or nuclear weapons as primary armament and close support missions utilizing a choice of missiles, guns, bombs and rockets. An automatic low altitude terrain following system enhances penetration capability. Power is provided by two TF-30 axial-flow, dual-compressor turbo-fan engines equipped with afterburners. The wings, equipped with leading edge slats and trailing edge flaps, may be varied in sweep, area, camber, and aspect ratio, by the selection of any wing sweep angle between 16 and 72.5 degrees. A selective forward wing sweep provides takeoff and landing capabilities at minimum speeds. For all other regimes the wings are manually swept in accordance with desired Mach number. This feature provides the aircraft with a highly versatile operating envelope. The empennage consists of a fixed vertical stabilizer with rudder for directional control, and a horizontal stabilizer that is moved symmetrically for pitch control and asymmetrically for roll control. Stability augmentation incorporates triple redundant features which enhance system reliability. The tricycle- type forward retracting landing gear is hydraulically operated. The main landing gear consists of a single common trunnion upon which two wheels are singly mounted, and contains bur one extending/retracing/ locking system which ensures symmetrical main gear operation. Also ground loads imposed upon the gear tend to extend the drag strut to the locked position. Stores are carried in a fuselage-enclosed weapons bay and externally on both pivoting and fixed wing- mounted pylons. The fuel system incorporates both inflight and single point ground refueling capabilities and gravity refueling capability through filler caps in the top of the wing and fuselage. Sec figure 1-1 for aircraft general arrangement and figure 1-2 for crew station general arrangement.

Crew Station General Arrangement (Typical)

1. Left Station Oxygen-Suit Control Panel (See fig 1-45).
2. Oxygen Gage Panel (See fig. 1-46).
3. Interphone Panel (2) (See fig. 1-53). *
4. Auxiliary Flight Control Panel (See fig. 1-25).
5. Flight Control Switch Panel (See fig. I -26).
6. Autopilot Damper Panel (See fig. 1-27).
7. Left Side wall (See fig. 1-18).
8. Throttle Ponel (2) (See fig. 1-4).
9. Miscellaneous Switch Panel (See fig. 1-56). A
10. Auxiliary Gage Panel (See fig. 1-14).
11. Internal Canopy Latch Handles (2).
12. Left Main Instrument Panel (See fig. 1-5).
13. Mirrors (4).
14. Canopy.
15. Thermal Curtain (2).
16. Canopy Center Beam Assembly.
17. Magnetic Compass.
18. Right Main Instrument Panel (See fig. 1-32).
19. Weapons Control Panel (See fig. 1-62).JL
20. Right Sidewall (See fig. 1-42).
21. Attack Radar Control Panel (See fig. 1-70).
22. HF Radio Control Panel (See fig. 1-52).
23. Strike Camera Control Panel (See fig. 1 66).
24. ECM Control Panel.
25. CMRS Control Panel.
26. CMDS Control Panel.
27. ECM Pod Control Panel.
28. ECM Destruct Control Panel.
29. Burst Control and Target Elevation Panels (See fig. 1 60).
30. ILS Control Panel (See fig. 1-55).
31. Fuel Control Panel (See fig. 1-8).
32. TFR Control Panel (See fig. I-77I
33. Electrical Control Panel (See fig. 1-10).
34. Scope Camera Control Panel ISee fig. 1-68)
35. Air Conditioning Control Panel (See tig. 1-40).
36. IFF Control Panel (See fig. 1-57).
37. Ejection Handles (2).
38. Antenna Select Panel (See fig. 1-58).
39. Windshield Wash/Anti-Icing Control Panel (See fig. 1 43).
40. Compass Control Panel (See fig. 1-30).

Figure 1-1. (Sheet 1)

Crew Station General Arrangement (Typical)



41. Hood Stowage Comportment
42 Air Diffusers(2)
43. liquid Contain»»» (2).
44 Circuit Breaker Panel (See fig. 1-12).
45. Letdown Chart Stowage Comportment.
46 Internal Lighting Fuse Panel (2).
47. lighting Control Panel (See lig I 38)
48 Utility light.
49 Quick Rescue Kit
50. letdown Chart Holder Stowage Comportment.
51. Ground Check Panel (See Fig. 1-29)
52 Food Stowage Comportment.
53 Relief Container Stowage Compartment (2)
54 Right Station Oxygen Suit Control Panel (See fig. 1-45).

Figure 1-1. (Sheet 2)

AIRCRAFT DIMENSIONS.

Length (including pitot static boom) —75 feet, 6.5 inches
Wing span (wings swept) — 32 feet
Wing span (wings extended)—63 feet
Height (to top of vertical ail) — 17 feet, 1.4 inches

AIRCRAFT WEIGHT.

The aircraft operating weight is approximately 48,700 pounds. This weight includes two crew members (430 lbs), engine oil (60 lbs), unusable fuel (292 lbs), cooling water (229 lbs), oxygen (2) lbs), weapon bay gun (1100 lbs), and nose wheel well trim ballast (720 lbs).

FLIGHT CREW.

The flight crew consists of an aircraft commander (AO and a weapons system officer (WSO), seated side-by-side.

Left Main Instrument Panel (Typical)

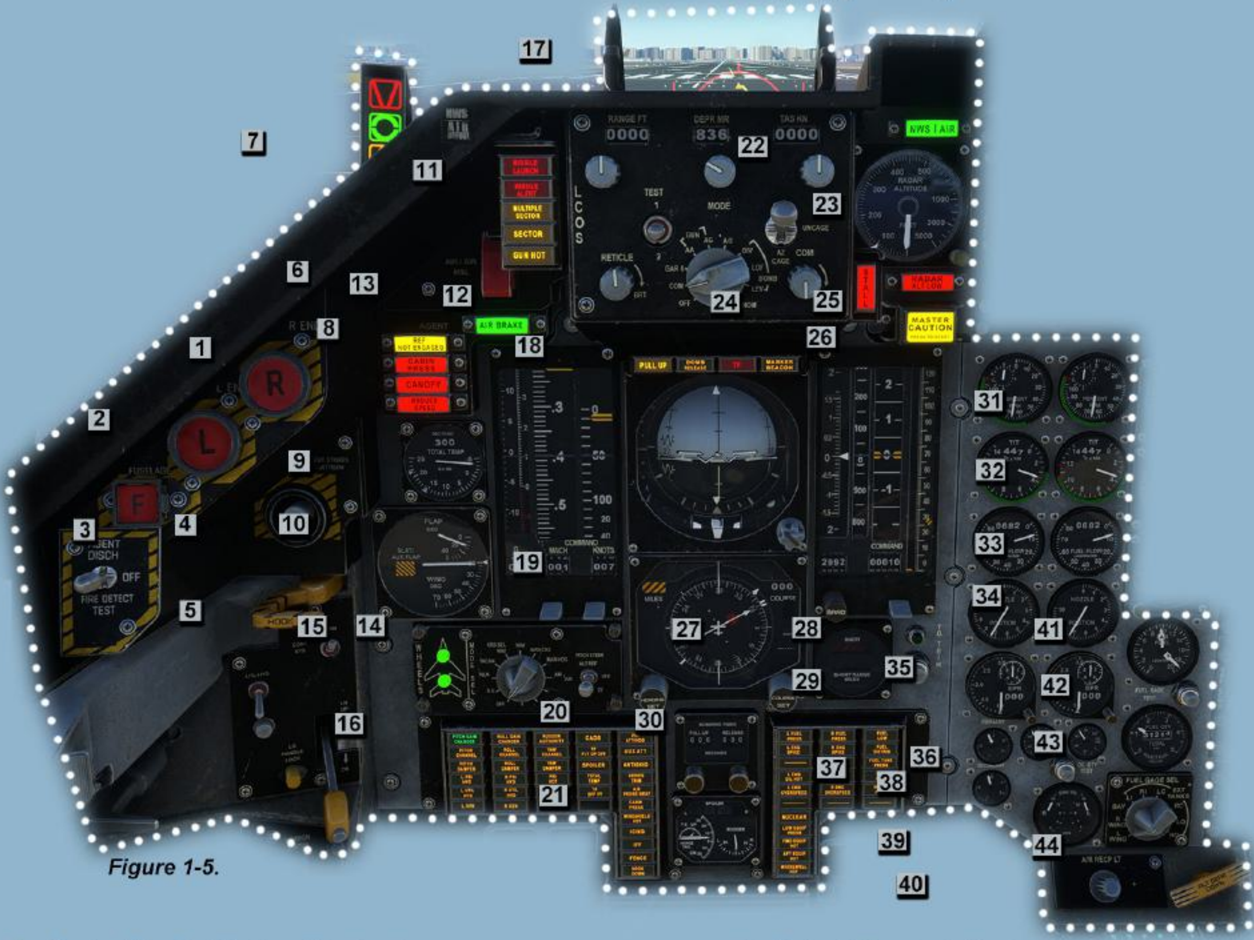
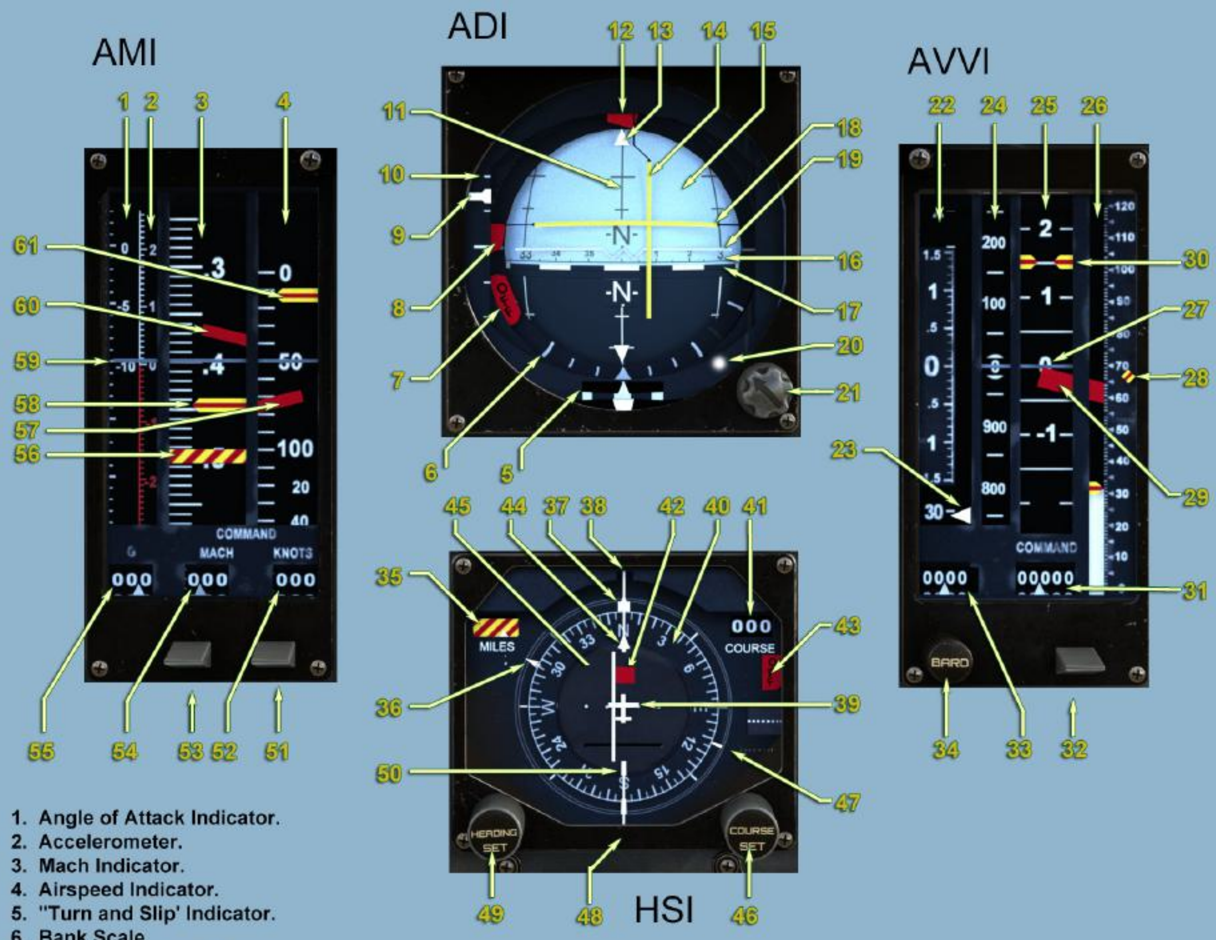


Figure 1-5.

1. Engine Fire Pushbutton Warning Lamps.
2. Fuselage Fire Pushbutton Warning Lamp.
3. Agent Discharge/Fire Detect Test Switch.
4. External Stores Jettison Button.
5. Landing Gear Control Panel (See fig 1-15)
6. Pilot's ECM Pod Control Panel (See T O 1F-11 IE-I-2)
7. Angle-of-Attack Indexer.
8. Left Warning and Caution Panel.
9. Total Temperature Indicator.
10. Wing Sweep Flap/Slat Position Indicator.
11. Upper Warning and Caution Panel.
12. Gun/Camera Control Switch.
13. Air/Air IR Missile Switch.
14. Instrument System Coupler Control Panel.
15. Landing Gear Position Indicator lamps.
16. Left Main Caution Lamp Panel.
17. Lead Computing Optical Sight and Control Panel, (See fig. I 81)
18. Upper Warning and Caution Lamp Panel.
19. Integrated Flight Instruments, (See fig. I -33).
20. Dual Bombing Timer, (See fig. 1-65)
21. Control Surface Position Indicator.
22. Nose Wheel Steering/Air Refueling Indicator Lamp.
23. Radar Altimeter Indicator.
24. Stall Warning Lamp.
25. Radar Altitude Low Warning Lamp.
26. Master Caution lamp.
27. Bomb Nov Distance –Time Indicator.
28. Takeoff Trim Indicator Lamp.
29. Takeoff Trim Button
30. Right Main Caution lamp Panel.
31. Engine Tachometers.
32. Engine Turbine Inlet Temperature Indicators.
33. Engine Fuel Flow Indicators.
34. Engine Nozzle Position Indicators.
35. Engine Pressure Ratio Indicators.
36. Engine Oil Pressure Indicators.
37. Hydraulic Pressure Indicators.
38. Oil Quantity Indicator Test Button.
39. Oil Quantity Indicator.
40. Air Refueling Receptacle lights Control Knob.
41. Fuselage Fuel Quantity Indicator.
42. Fuel Quantity Indicator Test Button.
43. Total/Select Fuel Quantity Indicator.
44. Fuel Quantity Indicator Selector Knob.

Integrated Flight Instruments



1. Angle of Attack Indicator.
2. Accelerometer.
3. Mach Indicator.
4. Airspeed Indicator.
5. "Turn and Slip' Indicator.
6. Bank Scale.
7. Attitude Warning Flag.
8. Glide Slope Warning Flag.
9. Glide Slope Indicator.
10. Glide Slope Deviation Scale.
11. Pitch Reference Scale.
12. Course Warning Flog.
13. Bank Pointer.
14. Bank Steering Bor.
15. Attitude Sphere.
16. Heading Reference Scale.
17. Horizon Bar.
18. Pitch Steering Bar.
19. Miniature Aircraft.
20. Pitch Trim Index.
21. Pitch Trim Knob.
22. Vertical Velocity Indicator.
23. Vertical Velocity Index.
24. Vernier Altimeter.
25. Coarse Altimeter.
26. Gross Altimeter.
27. Fixed Index Line.
28. Target Altitude Marker.
29. Altitude Warning Flag.
30. Command Marker.
31. Command Altitude Readout Window
32. Command Altitude Slewing Switch.
33. Barometric Pressure Readout Window.
34. Barometric Pressure Set Knob.
35. Range Indicator and Warning Flag.
36. Bearing Pointer.
37. Heading Marker.
38. Upper Lubber Line.
39. Aircraft Symbol.
40. Compass Card.
41. Course Selector Window.
42. Course Warning Flag.
43. Power Off Warning Flog.
44. Course Arrow Head.
45. Course Deviation Indicator.
46. Course Set Knob.
47. Bearing Pointer Tail.
48. Lower Lubber Line.
49. Heading Set Knob.
50. Course Arrow Toil.
51. Command Airspeed Slewing Switch.
52. Command Airspeed Readout Window.
53. Command Mach Slewing Switch.
54. Command Mach Readout Window.
55. Acceleration Readout Window.
56. Maximum Allowable Mach Marker.
57. Airspeed Warning Flag.
58. Command Mach Marker.
59. Fixed Index Lines.
60. AMI Power Warning Flag.
61. Command Airspeed Marker

Figure 1-33

INSTRUMENTS.

The instruments consist of the integrated flight instrument system, the total temperature indicator, true airspeed and standby instruments.

INTEGRATED FLIGHT INSTRUMENT SYSTEM.

The integrated flight instrument system takes outputs from the following systems and integrates them into usable displays on the integrated flight instruments.

- Central air data computer
- Auxiliary flight reference system
- Instrument landing system
- Tactical air navigation system
- Terrain following radar
- Radar homing and warning system
- Bomb nav system
- Attack radar system
- Radar altimeter
- Lead computing optical sight system
- Dual bombing timer

The primary components of the system are the integrated flight instruments; consisting of the airspeed-Mach indicator (AMI), altitude-vertical velocity indicator (AVVI), attitude director indicator (ADD and horizontal situation indicator (HSI), a flight director computer (FDC) and an instrument system coupler (ISC). The four integrated flight instruments are grouped together on the left main instrument panel to provide actual and command flight and navigational information in a clear concise manner. Altitude, airspeed, acceleration, Mach, vertical velocity, and angle of attack are displayed on moving tapes on the AMI and AVVI. The ADI and HSI display attitude, heading and navigational information from various other systems in the aircraft. The lead computing optical sight (LCOS) command steering bars operate in conjunction with the system to provide the same pitch and bank steering commands as the ADI. The ISC serves as a coupler between the FDC, the instruments and the various aircraft systems which supply information for presentation on the integrated flight instruments. The FDC accepts information from the various aircraft systems listed above, processes this information and returns it to the ISC and on to the instruments. The system incorporates self-test features to check reliability and isolate malfunctions. The AMI and AVVI receive power from the left main ac bus. The other components of the system operate on 115 volt and 26 volt ac power from the essential ac bus and 28 volt dc power from the essential dc bus.

Angle-of-Attack Indexer.

An angle-of-attack indexer (7, figure 1-5, and 15, figure 1-32) is located on each side of the glare shield. Each indexer consists of 3 color coded symbols arranged vertically. The red low speed (top V-shaped) symbol lights when the angle-of-attack exceeds 10.5 degrees. The green on-speed (center donut-shaped) symbol lights between 9.0 and 11.0 degrees. The amber high speed (bottom inverted V-shaped) symbol will light when the angle-of-attack is less than 9.5 degrees. The indexer lamps function only when the landing gear is in the down position. The indexer lamps may be tested by depressing the malfunction and indicator lamp test button on the lighting control panel. The test should be performed in the bright position. The angle-of-attack indexers receive 28-volt dc power from the essential dc bus.

Airspeed Mach Indicator.

The airspeed Mach indicator (AMI) (figure 1-33), located on the left main instrument panel, provides remote reading vertical presentations of true wing angle-of-attack, "g" acceleration, Mach airspeed and maximum safe Mach on vertical moving scales. Readout windows below each moving scale present digital values for "g" acceleration, Mach, and airspeed. Slewing switches for setting reference Mach and airspeed markers are located on the bottom of the indicator. Signals for operation of the various scales are provided from the central air data computer (CADC), maximum safe Mach assembly and remote accelerometer. In the event of power failure, OFF warning flags will appear across the Mach number and airspeed scales. The (OFF) airspeed warning flag will appear in the event of a malfunction or failure in the airspeed section of the AMI or CADC. The circuit breaker for the airspeed Mach indicator is located on the left main ac bus.

Note

The airspeed indicated on the airspeed Mach indicator has been calibrated for pitot-static system errors by the CADC and therefore is actually KCAS (knots calibrated airspeed). However, this airspeed is referred to as KIAS (knots indicated airspeed) throughout this manual since it is read directly from the instruments.

Presentations on the face of the indicator are from left to right as follows:

Angle-of-Attack Indicator. The angle-of-attack indicator, located on the airspeed-Mach indicator, indicates in degrees the angular position of the wing chord in relation to the aircraft flight path. The vertical moving tape displays angle-of-attack from minus 10 degrees to plus 25 degrees. The angle-of-attack indicator is operated by the central air data computer.

Accelerometer. The accelerometer located adjacent to the angle-of-attack indicator provides normal "g" (load factor) information. The "g"-forces being sustained by the aircraft are continuously shown by the acceleration scale read against a fixed index line. The tape scale is graduated from −4 to + 10 "g's". The presentation on the digital readout is from 0.0 to 9.9 "g's". The accelerometer and readout window are actuated by electrical signals from the remote accelerometer.

Note

During abrupt pitching maneuvers, the aircraft rate of onset may exceed the 2 "g" per second maximum speed of the accelerometer tape. If this occurs, the accelerometer indicator readings will be less than actual aircraft acceleration levels.

Mach Indicator. The Mach scale in the center of the airspeed-Mach indicator indicates true Mach number which is shown on a moving scale and is read against the fixed index. The scale is calibrated in hundredths and shows numbers in tenths from 0.4 through 3.5. At speeds below Mach 0.4, the scale will continue to read 0.4. The moving scale is operated by electrical signals from the CADC. A command Mach marker and command Mach readout window indicate manually selected command Mach. The command Mach marker remains at the top or bottom of the display column until the selected command Mach comes into view on the Mach scale, at which time it will synchronize and move with the scale. The selected command Mach is numerically displayed in the command Mach readout window at all times. Command Mach setting is controlled manually by the command Mach slewing switch under the command Mach readout window. When selecting a command Mach number, slewing speed is proportional to the amount the slewing switch is displaced from its normal center position. The maximum allowable Mach is indicated by a diagonally-striped maximum allowable Mach marker which normally rests at the bottom of the Mach scale. When maximum allowable speed is approached, the marker will climb toward the fixed index line. The maximum allowable Mach marker will show on the scale depending on the aircraft wing sweep position, pressure altitude, and true temperature. The maximum allowable Mach marker is operated by an electrical signal from the maximum safe Mach assembly.

Airspeed Indicator. The airspeed scale on the right column of the airspeed-Mach indicator indicates airspeed on a moving scale read against a fixed index. The scale is calibrated in 10 knot increments and displays numerals at each 20 knot interval from 100 to 200 knots and each 50 knot interval from 200 through 1000 knots. At speeds below 50 knots, the scale will continue to read 50. The airspeed scale is operated by electrical signals from the CADC. If there is a detected instrument failure or airspeed signal failure within the CADC, the IAS monitoring flag marked OFF will appear across the airspeed scale. A command airspeed marker and a command airspeed readout window below the scale indicates selected command airspeed. Command airspeed setting is controlled by the command airspeed slewing switch under the command airspeed readout window. When selecting a command airspeed, slewing speed is proportional to the amount the slewing switch is displaced up or down from the center position. Once the command airspeed is set into the command airspeed readout window, the command airspeed marker remains at the top or bottom of the display column until the selected command airspeed comes into view on the moving scale, at which time it will synchronize and move with the reading on the scale. This will be the same reading as shown in the readout window. If the slewing switch is moved to the detented position on the right, the commanded airspeed marker will align with the fixed index and continuous digital presentation of the airspeed will then be displayed in the readout window.

Altitude-Vertical Velocity Indicator.

The altitude-vertical velocity indicator (AVVI) (figure 1-33), located on the left main instrument panel, provides remote reading presentations of altitude and vertical velocity on vertical moving scales. Readout windows across the bottom of the indicator present digital readout of barometric pressure and command altitude. A barometric pressure set knob and command altitude slewing switch are also located on the bottom of the indicator. Signals for operation of the moving scales, markers and readouts are provided from the CADC. A spring-loaded OFF warning flag will appear across the face of the coarse altitude scale in the event of malfunction or power failure to the indicator. The barometric pressure reading is set by a knob marked BARO located on the lower left corner of the indicator and is numerically displayed in the barometric pressure readout window above the knob.

WARNING

A mechanical failure within the altitude- vertical velocity indicator may not cause the flag to appear even though the indicator reading will be unreliable. If a failure is suspected, rely on the standby altimeter using the position error shown in Appendix I. The radar altimeter also may be used since it provides an absolute indication of distance above the terrain at altitudes below 5000 feet.

Presentations on the face of the indicator are from left to right as follows:

Vertical Velocity Indicator. The vertical velocity indicator is located on the left side of the altitude-vertical velocity indicator. The instrument indicates climb or dive velocities from 0 to 1500 feet per minute by means of a moving index pointer to the right of a vertical fixed scale. The scale is graduated in increments of one hundred feet from 0 to 1.5 thousand. When the vertical velocity exceeds this scale the pointer index will move to the top or bottom of the instrument to a readout window where a moving scale, graduated in thousands of feet from 2 to 40 thousand feet per minute, will indicate the rate of climb or descent. The instrument receives information from the CADC.

Vernier Altimeter. The altitude scales in the center of the altitude-vertical velocity indicator indicate aircraft pressure altitude which is read on the altitude scale against a fixed index line. The vernier scale is calibrated in 50 foot graduations and indicates each hundred foot level from 0 to 1000 feet. The coarse scale is calibrated in 500 foot graduations and indicates each thousand foot level from — 1000 through +120,000 feet. Both the vernier and coarse scales are operated by electrical signals from the CADC. A command altitude marker and the command altitude readout window below the scale indicate manually selected command altitude. The command altitude numerals are controlled manually by the command altitude slewing switch under the command altitude readout window. When selecting a command altitude, slewing speed of the command marker and readout window numerals is proportional to the amount the slewing switch is displaced from center. The command altitude marker remains at the top or bottom of the display column until the selected command altitude comes into view on the altitude scale, at which time it will synchronize and move with the scale. The selected command altitude is numerically shown in hundreds in the altitude readout window at all times.

Gross Altimeter. The gross altimeter located on the right side of the altitude-vertical velocity indicator is a thermometer-type altitude index which shows aircraft altitude against a gross altitude scale. It is operated by electrical signals from the CADC. The gross altitude scale is calibrated in thousands of feet and numerically indicates 10,000 foot levels from 0 to 120,000 feet. Command altitude is indicated by a double line command altitude marker and is simultaneously shown and operated in conjunction with the command altitude marker on the vernier altimeter.

Attitude Director Indicator.

The attitude director indicator (ADI) (figure 1-33), located on the left main instrument panel, is a remote indicating instrument which displays attitude, heading, turn and slip, glide slope deviation, altitude deviation, "g" deviation, and bank and pitch steering information. The indicator includes an attitude sphere, turn and slip indicator, pitch and bank steering bars, miniature aircraft, glide slope indicator, warning flags and a pitch trim knob. The attitude sphere displays pitch, bank and heading in relation to the miniature aircraft. The pitch reference may be adjusted with the pitch trim knob. The turn and slip indicator, located in the bottom of the ADI, is designed for a 4 minute turn. Pitch and bank steering commands from other systems are processed by the instrument system coupler and routed through the flight director computer to the pitch and bank steering bars and glide slope deviation indicator. (Refer to "Instrument System Coupler Mode Selector Knob" and "Instrument System Coupler Pitch Steering Mode Switch," this section, for ADI indications during various modes of operation). An OFF warning flag indicates loss of power to the ADI when the ADI is receiving attitude information from the bomb nav system. Attitude data to the ADI is received directly from either the bomb nav system stabilized platform (SP) or the auxiliary flight reference system (AFRS) depending on the position of the flight instrument reference select switch. Normal operation of the ADI is with this switch in the PR1 position which provides the instrument with signals from the SP. An off warning flag indicates loss of power to the ADI when data is being supplied from the bomb nav system. When data is being supplied from the AFRS, the warning flag indicates loss of power to the ADI or that the data is unreliable. It is possible to have failures within the ADI, AFRS or SF that can result in erroneous or complete loss of attitude reference without the presence of a warning flag or caution lamp indication. Other indications such as unrealistic or rapid changes in winds, ground speeds, or position, excessive radar cursor drift or unusual radar video uniformity, sudden attitude changes while on autopilot or frequent fly-ups while on TF may also indicate a possible erroneous attitude reference. When abnormal disagreement between the ADI and standby attitude indicator is encountered without a warning flag or caution lamp indication, the aircraft should be returned to level flight using basic flight instruments. Do not assume either indicator is reliable until the aircraft is straight and level and one of the indicators is determined to be accurate. If the above checks have determined a mal-functioning SP, the ADI source should be switched to the AFRS. A continuing attitude discrepancy indicates an ADI malfunction, therefore, the standby attitude indicator should be used.

WARNING

Frequent cross checks between the ADI, the standby attitude indicator and other basic flight instruments should be made to detect possible malfunctions. Failure to detect a malfunction and take corrective action could result in a flight attitude from which the aircraft cannot be recovered.

The ADI operates on 115 volts ac power from the essential ac bus.

Horizontal Situation Indicator.

The horizontal situation indicator (HS1) (figure 1- 33), located on the left main instrument panel, is a remote indicating instrument which displays course, heading, distance and bearing information. The indicator includes a compass card, course and heading set knobs, course arrow, to-from indicator, lubber lines, bearing pointer, course deviation indicator and scale, range indicator and course selector windows, warning flags and an aircraft symbol. The compass card is servo driven and receives magnetic heading signals directly from either the bomb nav system or auxiliary flight reference system. Aircraft heading or its reciprocal are read under an upper and lower lubber line. The aircraft symbol is fixed and is oriented to the nose of the aircraft. A heading set knob is provided to set a heading marker to the desired heading in the manual heading mode. Once it is set the marker rotates with the compass card. A course set knob is provided to set the course arrow and digits in the course selector window to the desired course. Ogee set, the arrow will rotate with the compass card. The shaft of the course arrow provides course deviation indications. The reciprocal course may be read off the tail of the arrow. An unreliable course signal or loss of the course signal to the indicator will cause a warning flag to appear in the upper center of the indicator. The bearing and distance to VOR/DME stations are displayed by the bearing pointer and range indicator window. Loss of the VOR/DME signal or an unreliable signal will cause a range warning flag to appear in the range indicator window. Loss of power to the HSI will cause an OFF warning flag to appear on the right side of the instrument. (Refer to "Instrument System Coupler Mode Selector Knob," this section, for HSI indications during various modes of operation). The HSI operates on 115 volt ac power from the ac essential bus.

TOTAL TEMPERATURE INDICATOR.

The total temperature indicator (9, figure 1-5), located on the left main instrument panel, provides indications of aerodynamic heating. The temperature sensing probe is equipped with a heating element for anti- icing. The face of the indicator is graduated in 10 degree increments from — 50 degrees to —250 degrees centigrade, with a critical temperature index mark of 153 degrees and a maximum temperature index mark at 214 degrees. A digital readout counter in the face of the indicator, marked SEC TO GO, indicates the time remaining for operation in the critical temperature range between 153 and 214 degrees. The indicator functions in conjunction with the total temperature caution lamp and the reduce speed warning lamp to provide the following indications:

(1) When the critical temperature of 153 is reached the counter will start to drive down from 300 seconds toward zero and the total temperature caution lamp will light.

(2) The counter will continue to drive until it reaches zero or the temperature is reduced below 153 degrees.

(3) When the maximum temperature index is reached or when the counter drives to zero the reduce speed warning lamp will light and the total temperature caution lamp will go out.

(4) The counter will reverse and drive back to 300 seconds any time the temperature falls below 153 degrees.
   (a) If the reduce speed warning lamp was on when the counter reversed it will go out.
   (b) If the total temperature caution lamp was out when the counter reversed it will light and remain on until the counter has driven back to 300 seconds.

An OFF flag will appear in the face of the indicator when power is removed from the instrument or when the amplifier output signal varies from the temperature probe input signal by 10 to 12 degrees C. The indicator operates on 115 volt ac power from the essential ac bus.

Total Temperature Caution Lamp.

The total temperature caution lamp, located on the left main caution panel (figure 1-37), functions in conjunction with the total temperature indicator and reduce speed warning lamp to provide an indication that the aircraft is being operated in the critical temperature range between 153 and 214 degrees C. Refer to "Total Temperature Indicator," this section, for a description of lamp indications. When lighted, the words TOTAL TEMP are visible in the face of the lamp.

Reduce Speed Warning Lamp.

The reduce speed warning lamp (8, figure 1-5), located on the left main instrument panel, functions in conjunction with the total temperature indicator to indicate that the aircraft has flown for at least 300 seconds in the critical temperature range of from 153 to 214 degrees centigrade or that the maximum temperature index of 214 degrees has been reached or exceeded. Refer to "Total Temperature

Right Main Instrument Panel (Typical)

1. Terrain Following Radar Scope Panel. (See fig. 1-77)
2. Standby Airspeed Indicator. Bearing-Distance-Heading Indicator.
3. Bearing-Distance-Heading Indicator.
4. True Airspeed Indicator.
5. Vertical Velocity Indicator.
6. Clock.
7. ECM Threat Panel.
8. NAV / COM / ADF Combined Radio Control Panel.
9. TACAN Control Panel. (See fig. 1-54)
10. Landing Gear Emergency Release Handle.
11. Radar Homing and Warning Scope Panel.
12. Standby Attitude Indicator.
13. Standby Altimeter.
14. Radar Homing and Warning Threat Panel.
15. NAV/COM/TACAN/ Frequency Notepads.
16. Attack Radar Scope Panel. (See fig. 1-72)
17. Bomb Nav Control Panel (See fig. 1-59)
18. Nuclear Weapons Control Panel. (See fig. 1-63)
19. Settings panels (Radio, Loadout, States)

Figure 1-32.

Indicator," this section, for a description of the lamp functions in conjunction with the indicator. When lighted the words REDUCE SPEED are visible in red on the face of the lamp. The lamp also functions in conjunction with the maximum safe Mach assembly; refer to "Maximum Safe Mach Assembly," this section.

TRUE AIRSPEED INDICATOR.

The true airspeed indicator (4, figure 1-32), located on the right main instrument panel, provides a digital readout of true airspeed. The instrument displays true airspeed on a servo-driven 4-digit counter within the range of 0-1750 knots. The indicator is operated by electrical signals from the CADC. The true airspeed indicator is not reliable when the CADS caution lamp is lighted.

STANDBY INSTRUMENTS.

The standby instruments include the airspeed indicator, altimeter, vertical velocity indicator, magnetic compass, attitude indicator and bearing distance heading indicator. These instruments provide back-up indications in the event of failure of the integrated flight instrument system.

Airspeed Indicator.

The airspeed indicator (2, figure 1-32), located on the right main instrument panel, is operated by pitot and static pressures direct from the pitot-static system. The instrument is graduated from 0.6 to 8.5 times 100 knots.

Altimeter.

The altimeter (13, figure 1-32), located on the right main instrument panel, is a barometric type which operates on static pressure direct from the pitot-static system. A barometric pressure set knob located on the left corner of the instrument provides a means of adjusting the barometric scale on the instrument.

Vertical Velocity Indicator.

The vertical velocity indicator (5, figure 1-32), located on the right main instrument panel, provides rate of climb and descent information. The instrument operates on static pressure from the pitot-static system.

Magnetic Compass.

The magnetic compass (17, figure 1-2), located on the windshield center beam, provides magnetic heading information.

Attitude Indicator.

The attitude indicator (12, figure 1-32), located on the right main instrument panel, provides backup attitude information in the event of malfunction or failure of the attitude director indicator. The indicator displays pitch and roll information on an attitude sphere in relation to a miniature aircraft. Pitch and roll signals are received from the auxiliary flight reference system (AFRS). The indicator receives 115 volt ac power from the ac essential bus. In the event of power failure or an AFRS malfunction, an OFF warning flag will appear on the lower left face of the indicator. A pitch trim knob on the lower right side of the instrument is provided to adjust the attitude sphere to the proper pitch attitude.

Bearing-Distance-Heading Indicator.

The bearing-distance-heading indicator (3, figure 1-32), is located on the right main instrument panel. The instrument is a remote type heading indicator with a rotating compass card. UHF automatic direction finding (ADF) and NAV bearing information is displayed by means of pointers. A synchro driven range indicator is provided which receives signals from the NAV set. Range of the distance display is 0—999 nautical miles. A red and black striped range warning flag partially obscures the range indicator when distance-to-station signals are too weak or there is a loss of lock-on to VOR/DME distance signals. Magnetic heading of the aircraft is shown by the index at the top of the instrument and the compass card. A pointer designated as number one is servo driven and receives signals from a NAV coupler. Bearing information is read from the compass card under the pointer tip. A pointer designated as number 2 is also servo driven and, when required, receives signals by selection from the ADF set.

Note

During NAV operation with the ADF system off, the BDHI (number 1) and ADF (number 2) pointers both indicate NAV bearing.

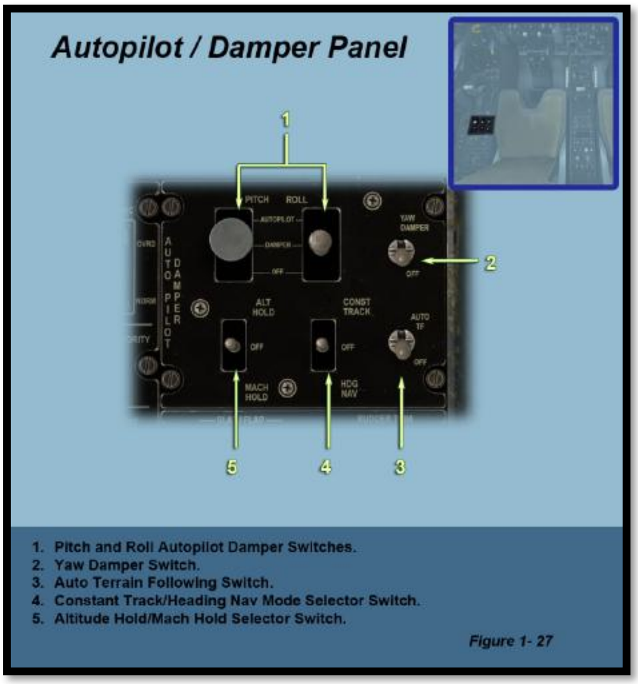
The pointer designated as number 2 is also servo driven and displays bearing to a selected UHF transmitter when the ADF position is selected on the UHF radio control panel. The indicator receives heading information from the auxiliary flight reference system. The set index knob located on the lower right side of the indicator is used to set the heading index to a desired magnetic heading. Once see, the index rotates with the compass card. A flag marked OFF will appear in the window when the indicator is not energized or when power is not available to the compass card.

WARNING, CAUTION AND INDICATOR LAMPS.

In order to keep instrument surveillance to a minimum, warning, caution, and indicator lamps are located throughout the cockpit. All of these lamps except the master caution lamp are described under their respective systems. For location of the lamps throughout the cockpit see (figure 1-37).

MASTER CAUTION LAMP.

The master caution lamp (26, figure 1-5), located on the left main instrument panel, will light to alert the crew that a malfunction exists when any of the individual caution lamps on the caution lamp panel light to indicate a malfunction. The lamp will remain lighted as long as an individual caution lamp is on; however, it should be reset as soon as possible by depressing the face of the lamp so that other caution lamps can be monitored should additional malfunctions occur. The lamp can be checked by depressing the malfunction and indicator lamp test button.



1. Pitch and Roll Autopilot Damper Switches.
2. Yaw Damper Switch.
3. Auto Terrain Following Switch.
4. Constant Track/Heading Nav Mode Selector Switch.
5. Altitude Hold/Mach Hold Selector Switch.

Figure 1- 27

AUTOPILOT SYSTEM.

The autopilot system consists of electronic circuitry that, in conjunction with the primary flight control system, controls the aircraft during the various modes of autopilot flight. The autopilot system receives input signals from other systems and computes command signals to the pitch and roll dampers to control the aircraft. In addition, the autopilot computes command signals to the series pitch trim actuator and the roll trim integrator units. The autopilot modes are pitch attitude stabilization, roll attitude stabilization, Mach hold, altitude hold, heading nav, and constant track. The aircraft may be manually maneuvered at any time by use of control stick steering. Autopilot commands do not cause stick movement.

CONTROL STICK STEERING.

When any autopilot mode is engaged, including basic attitude stabilization, the reference controlling the aircraft can be disengaged by use of control stick steering. Control stick steering is activated in the pitch channel by applying a light force in the forward or aft direction, to the top of the control stick. This mode is activated in the roll channel by applying a light force laterally to the control stick. When force is applied in either or both channels, the reference or references are disengaged. The reference not engaged lamp will light, and the pilot can maneuver the aircraft to a new reference. When the force to the control stick is removed attitude stabilization will automatically reengage in the affected channel or channels provided the attitude limits are not exceeded. The reference not engaged lamp will go out. The nominal attitude limits are ±30 degrees in pitch and ±60 degrees in roll. Actual engage limits will usually be lower than the limits outlined above. Should the engage limits be exceeded in one or both channels, attitude stabilization will not reengage in that channel until its attitude angle is reduced to less than its limit. In addition, the roll channel cannot be engaged if either the pitch attitude is greater than ±30 degrees or the yaw damper is off.

Note

Auto TF is not a mode of the autopilot and control stick steering will not disengage auto TF.

PRINCIPLES OF OPERATION.

The autopilot system is a pilot relief system which allows the aircraft to automatically carry out certain manually selected modes of operation.

Mode Selection.

The autopilot modes are selected by positioning the respective mode switch on the autopilot/damper panel. The mode switches are solenoid held to the selected mode position and may be turned off by manually repositioning the switches to off position. The reference not engaged caution lamp will light whenever a selected autopilot mode is not controlling.

Pitch Attitude Stabilization.

If pitch autopilot (attitude stabilization) is engaged, the pitch attitude synchronizer will lock and any deviation in pitch attitude about the engage attitude will result in an error signal out of the synchronizer. This error signal is sent to the pitch flight control computer and hence to the pitch damper servo. The error signal is also sent to the feel and trim assembly where it is amplified and applied to the series trim actuator which serves as an error integrator. Pitch stabilization may be engaged by placing the pitch autopilot/damper switch to AUTOPILOT. The mode will not engage if pitch attitude exceeds ±30 degrees. A new pitch attitude reference may be established by using control stick steering.

Pitch Sub-Modes.

Altitude Hold. If altitude hold is engaged, an engage signal is sent to the central air data computer which engages a synchro at the reference pressure altitude. Should the pressure altitude change, the synchro will develop an error signal proportional to the deviation from the engage or reference pressure altitude. This error signal is sent to the pitch flight control computer and to the feel and trim assembly. The error signal is summed in the pitch flight control computer with a washed out pitch attitude signal. The purpose of the washed out pitch attitude signal is to provide aircraft damping. This summed signal is sent to the pitch damper servo. The error signal which is sent to the feel and trim assembly is used to drive the series trim actuator as an error integrator which reduces standoff altitude errors.

Mach Hold. *(is not supported in this version)* If Mach hold is selected, the operation is essentially the same as altitude hold except that a auto throttle mode maintains established Mach.

Altitude Hold Characteristics. If the altitude hold mode is engaged while at a stabilized altitude, the flight control system will hold the reference altitude within ' 60 feet unless engine power is changed or wing sweep or speed brake changes are made. The altitude hold mode can be engaged up to 2000 fpm rate of climb or dive. The autopilot will cause the aircraft to appear to stabilize at an altitude slightly above or below the reference altitude. The aircraft will then slowly return to within +60 feet of the reference. Changes in engine power, wing sweep or speed brake while this mode is engaged, will initially cause an altitude standoff, followed by a slow return toward the altitude reference. To ensure stable operation of this mode, it is necessary to maintain a flight speed of no less than 350 knots.

Mach Hold Characteristics. If the Mach hold mode is engaged while at a stabilized flight condition, the flight control system will hold the reference Mach number within ±0.01.

Note

- *Pitch autopilot operation must not be attempted while the slats are extended or if the control system switch is in T.O. & LAND. To do so may cause pitch transients when the autopilot is disengaged.*

- *Do not use the autopilot in the Mach or altitude hold mode during operation in the transonic flight region between 0.90 and 1.10 Mach.*

Roll Attitude Stabilization.

When the roll autopilot is engaged and the roll attitude is less than 3.5 (nominal) degrees, the roll synchronizer signal will cause the aircraft to roll to wings level; if the roll angle is greater than 3.5 (nominal) degrees the synchronizer will lock and the aircraft will maintain the roll attitude existing at the time of engagement. The error signal from the roll attitude synchronizer is supplied to the roll flight control computer and to the feel and trim assembly. In the feel and trim assembly this error signal is integrated and then sent to the roll flight control computer where it is summed with the error signal and used to position the roll damper servo.

Roll Sub-Modes.

Heading Navigate. If heading navigate is selected the aircraft will steer to the heading marker. In the yaw computer the error signal from the bomb NAV system is summed with the absolute roll attitude. The summed signal is bank angle rate limited to ±8 degrees per second and the bank angle command is limited to a nominal ±30 degrees unless a greater bank angle was established at the time of engagement. The signal is then sent to the flight control roll computer and to the feel and trim assembly where it is integrated. The integrated signal from the feel and trim assembly is sent to the roll computer where it is summed with signal from the yaw computer. The resulting signal is then sent to the roll damper servo.

Constant Track. The constant track mode uses a signal from the bomb NAV system to maintain the ground track existing at the time the mode was engaged.

PROCEDURES.

Normal Procedures.

Roll Stabilization. Roll autopilot (roll attitude stabilization) may be engaged by selecting AUTOPILOT with the roll autopilot damper switch. The mode will not engage if pitch attitude exceeds ±30 degrees or roll attitude exceeds ±60 degrees. To establish a new reference, without disturbing the switch position, use control stick steering.

Roll Sub modes. If a sub mode of the roll autopilot is desired, it may be selected by positioning the roll autopilot/damper switch to AUTOPILOT and by positioning the constant track/heading nav selector switch to either position. If constant track is selected, the aircraft should be flown until the desired ground track is reached. The aircraft will then capture and hold the ground track existing at the time of engagement. If heading navigate is selected the aircraft will fly a computed course direct to destination except if MAN CRS is selected on the ISC. In this case the aircraft will turn to intercept the course selected on the HSI. When stabilized, the autopilot will hold the aircraft course within ±1 degree of the steering error received from the bomb nav system. Depressing the autopilot release lever on either control stick will return the constant track/heading nav selector switch to OFF, and the roll autopilot switch to DAMPFR.

Pitch Stabilization. Pitch autopilot (attitude hold) may be engaged by placing the pitch autopilot/damper switch to AUTOPILOT. The mode will not engage if pitch attitude exceeds ±30 degrees. A new pitch attitude reference may be established by using control stick steering. The mode may be disengaged in the same manner as roll autopilot.

Engaging the Autopilot.

Flight instrument reference select switch—PRI.
ADI—Check for normal indications.
Roll and pitch autopilot/damper switches—AUTOPILOT.
Reference not engaged caution lamp—Out.

Check that the reference not engaged caution lamp goes out with no force applied to the control stick.

Selecting the Autopilot Sub modes. After the autopilot is initially engaged in attitude stabilization, the pilot may select a single control mode or a combination of compatible modes by means of the mode switches on the autopilot/damper panel. A mode affecting the pitch channel (Mach hold or altitude hold) may be selected simultaneously with a mode affecting the roll channel (constant track or heading nav).

Note

The autopilot will stabilize on the desired reference Mach or altitude more rapidly when the initial conditions of power and attitude are established prior to engaging the respective mode. When engaged in stabilized flight conditions the autopilot should hold altitude within ±60 feet or speed within ±0.01 Mach.

The following procedures are for selecting each control mode after attitude stabilization has been engaged.

Selecting Mach Hold, Altitude Hold or Constant Track Modes. Manually maneuver the aircraft to the desired Mach, altitude or heading.

Appropriate mode selector switch—Select desired mode.
If it is desired to change the reference speed, attitude or heading, control stick steering may be used to manually fly to the new reference. The new reference may then be established by depressing the reference engage button.

Selecting the Heading Nav Mode.

Instrument system coupler mode selector knob— NAV.
Constant track/heading nav mode selector switch HDG NAV.

Disengaging the Autopilot. To disengage all autopilot functions and place the aircraft under pilot control, either depress the autopilot release lever or place the pitch and roll autopilot/damper switches to DAMPER.

CONTROL AND INDICATORS.

Constant Track/Heading Nav Mode Selector Switch.

The constant track/heading nav mode selector switch (4, figure 1-27), located on the autopilot/damper panel, is a three position switch marked CONST TRACK, OFF and HDG NAV. The switch is solenoid held by 28 volt dc power to CONST TRACK or HDG NAV and is spring-loaded to OFF.

Altitude Hold/Mach Hold Selector Switch.

The altitude hold/Mach hold selector switch (5, figure 1-27), located on the autopilot/damper panel, is a three position switch marked ALT HLD, OFF, and MACH HLD. The switch is solenoid held by 28 volt dc power to ALT HLD or MACH HLD and is spring-loaded to OFF.

Reference Not Engaged Caution Lamp.

The reference not engaged caution lamp (8, figure 1-5), located on the left main instrument panel, will light under the following conditions:

The autopilot/damper switches are in the AUTOPILOT position and control stick steering is being used.

Note

The use of control stick steering in the axis of the autopilot mode that has been engaged will result in the mode being disengaged. The lamp will light and remain on until the mode is engaged again.

Instrument System Coupler Pitch Steering Mode Switch.

The instrument system coupler pitch steering mode switch, located on the instrument system coupler control panel (14, figure 1-5), is a two position switch marked ALT RFF (altitude reference), and OFF. The switch is solenoid held in the ALT RFF position, when used with a compatible position of the instrument system coupler mode selector knob. When the switch is placed in the ALT REF position, pitch steering commands, referenced to the pressure altitude at the time the switch is engaged, will be displayed on the pitch steering bars on the attitude director indicator (ADI) and lead computing optical sight (LCOS). The ALT RFF position is compatible with all positions of the instrument system coupler mode selector knob except AIR/AIR; however, when making an ILS or AILA approach, the switch will automatically return to OFF when the glide slope is intercepted.

Note

Altitude reference submode limits are ±500 feet from the reference pressure altitude. If the set limits are exceeded, the reference altitude will change by the amount that the altitude limits are exceeded.

Instrument System Coupler Mode Selector Knob.

The instrument system coupler mode selector knob, located on the instrument system coupler control panel (14, figure 1-5), has eleven positions. Nine positions of the knob are activated and are marked OFF, ILS, AILA, TACAN, CRS SEL NAV, NAV, MAN CRS, MAN HDG, and AIR/AIR. Two unmarked positions provide space for the installation of new equipment. The knob must be depressed to change positions. The knob positions provide the following functions: For instrument system coupler modes versus instrument indications refer to figure 1-34. Refer to figure 1-35 for ADI and HSI instrument warning flag analysis. For HSI and ADI steering indication limits refer to figure 1-36.

• In the **OFF** position, the steering bars and OFF flags are biased out-of-view on the ADI and LCOS leaving attitude and heading displays.

• The **ILS** (instrument landing system) position provides the capability of flying ILS approaches to runways equipped with localizer and glide slope transmitters. Localizer steering commands are displayed by the bank steering bars on the attitude director indicator (ADI) and lead computing optical sight (LCOS) and course deviation information is displayed on the course deviation indicator of the horizontal situation indicator (HSI). Glide slope deviation is displayed on the glide slope deviation indicator on the ADI. Pitch steering commands are displayed on the pitch steering bars on the ADI and LCOS if the pitch steering mode switch is in the ALT REF position. When the glide slope beam is intercepted the pitch steering mode switch, if on, will return to OFF and glide slope steering commands will then be displayed on the pitch steering bars on the ADI and LCOS.

Note

- *Once the glide slope is intercepted, a glide slope deviation of more than two dots as measured on the glide slope deviation scale will cause the pitch steering bar on the ADI and LCOS to drive out of view and remain out of view until a correction is made to bring the glide slope indicator back to the previous beam intercept point on the deviation scale.*

- *If a localizer deviation of more than two dots on the course deviation indicator occurs when the pitch steering bars or. the ADI and LCOS are in view, they will drive out of view until a correction is made to bring the localizer deviation back within the two dot limit.*

• The **AILA** (airborne instrument low approach) position provides the capability of making instrument letdowns and approaches to runways not equipped with ground based letdown systems. This is an airborne radar approach. The bomb/nav system in conjunction with the attack radar is used to correct the present position longitude and latitude and will furnish simulated localizer and glide slope information to provide the same indications on the ADI, LCOS, arid HSI as when using the ILS position.

Implementation Note

- *The AILA position is same as ILS position. It provides the capability of flying ILS approaches to runways equipped with localizer and glide slope transmitters.*

• The **TACAN** (tactical air navigation) position provides the capability of making instrument approaches and flying a selected course to or from a TACAN station. The course arrow and the course selector window are set to the desired course to be flown using the course set knob. Course steering commands are displayed on the bank steering bars on the ADI and LCOS and course deviation information is displayed on the course deviation indicator and bearing pointer on the HSI. Distance from the TACAN station is displayed in the range indicator window on the HSI. The bearing pointer will indicate the magnetic bearing to the station.

Implementation Note

- *The TACAN Mode provides the capability of making instrument approaches and flying a selected course to or from a VOR/DME and TACAN stations.*

• The **CRS SEL NAV** (course select navigation) position provides the capability of approaching a selected destination along a selected course other than the most direct route. This provides the capability of avoiding weather, obstacles, and enemy areas.

Implementation Note

- *The **CRS SEL NAV** position activates GPS flight plan mode.*

• The **NAV** (basic navigation) position position provides the capability of making instrument approaches and flying a selected course to or from a VOR\DME station.

• The **MAN CRS** (manual course) position provides the capability of flying a manually selected course. This position can be utilized to fly a constant course while taking a fix, changing destination or working a navigation problem. The desired course is set in the course selector windows of the HSI. The selected course is compared with actual course by the bomb nav system and an error signal is provided to display course steering commands on the bank steering bars on the ADI and LCOS and course deviation information on the course deviation indicator on the HSI.

• The **MAN HDG** (manual heading) position provides the capability of flying any desired heading when use of the bomb nav system is impractical or inefficient or when the system is inoperative. The heading marker on the HSI is set to the desired heading on the compass card by using the heading set knob. Turn the aircraft to center the bank steering bars on the ADI and LCOS. Any deviation from this heading will generate a steering command on the bank steering bars on the ADI and LCOS. If the bomb nav system is inoperative the course set knob should be used to set the desired heading in the course selector window. This will provide a numerical setting of the heading and align the course arrow with the heading marker to reduce the possibility of heading confusion.

•The **AIR/AIR** position provides the steering capability to a target being tracked by the attack radar system.

Implementation Note

- *The **AIR/AIR** mode is not implemented.*

FLIGHT CONTROL SYSTEM.

The primary flight control system provides control of the aircraft by movement of the primary control surfaces. The primary control surfaces consist of a rudder, spoilers on each wing and movable horizontal stabilizers. Pitch attitude of the aircraft is controlled by symmetrical deflection of the horizontal stabilizer surfaces. Roll attitude is controlled by asymmetrical deflection of the horizontal stabilizer surfaces; and when the wing sweep angle is less than 45 degrees, roll control is aided by action of two spoilers on top of each wing. Yaw control of the aircraft is accomplished by deflection of a rudder surface located on the trailing edge of the vertical stabilizer. Hydraulic servo actuators are used to produce control surface movement. The control stick at each crew station is mechanically and electrically interconnected with the flight control system. The two sets of rudder pedals are mechanically linked together. The stability augmentation system employs redundant sensors, electronic circuitry and electro-hydraulic dampers. The three damper actuators, the horizontal stabilizer actuators, and the rudder actuator are supplied by both primary and utility hydraulic systems and can operate on either system should one system fail. The pitch and roll damper response (gain) is varied by a self-adaptive system as flight conditions change. Command augmentation, through the pitch and roll dampers, augments the pilot inputs to provide a near constant relationship between control force and aircraft response throughout the operational envelope. Automatic failure detection and rejection, as well as self-test features, are provided in the pitch, roll, and yaw stability augmentation systems. Should electrical power be absent from one or more of the redundant computers, the applicable channel caution lamp will light. Power to all computers is controlled from the three computer power switches located on the ground check panel. The pitch and roll damper systems accept inputs from the CADC and the navigation system to provide pitch and roll autopilot modes.

Pitch Trim System.

Takeoff Trim Button.

The takeoff trim button (29, figure 1-5) is located on the left main instrument panel. When the button is depressed, the pitch trim series actuator drives the horizontal stabilizers to 3.8 degrees trailing edge up. The button also functions during normal airborne operation.

Implementation Note

During normal airborne operation takeoff trim button serves as automatic trim button. This function allows automatically setting of the optimal trim parameters in order to slacken control stick tension during the different modes of flight.

Due to frequent use, it was connected to Brake Controls and become activated when aircraft is airborne.

- In order to auto trim the button should be pressed and held for 3 -5 seconds.

It is recommended to map BRAKES (AUTOTRIM) to Joystick Button (main trigger)

Takeoff Trim Indicator Lamp.

A takeoff trim indicator lamp (28, figure 1-5), located on the left main instrument panel, is provided to indicate when the horizontal stabilizer and rudder are in the proper trim position for takeoff. When the takeoff trim button is depressed and all trims reach their proper position, the lamp lights. When the takeoff trim button is released, the lamp goes out.

Artificial Stall Warning System.

The artificial stall warning system consists of a stall warning lamp, and an audible stall warning signal. The system is automatically armed by the landing gear squat switch when the aircraft becomes airborne. The lamp, and audible signal all occur simultaneously when either of the following conditions exists:

When the wings are swept forward of 50 (±2) degrees and the true wing angle-of-attack exceeds 14 (+ 0.25, -0.75) degrees.
When the wings are swept aft of 50 (±2) degrees and the true wing angle-of-attack is greater than 14 degrees, the stall warning system will be activated when the probe angle-of-attack, in degrees, plus the pitch rate, in degrees per second, total (18 ±1). Since the angle- of-attack presented on the AMI is compensated as a function of Mach number, the AMI reading for stall warning activation will vary as Mach number changes. The AMI reading at which stall warning will occur for zero pitch rate is as follows:

Less than Mach 0.30 18 (±1.6) degrees Greater than Mach 0.45 but less than Mach 1.25 -19.7 (1 1.6) degrees
Greater than Mach 1.40 18.8 (±1.6) degrees

The stall warning lamp (24, figure 1-5) is a flashing red lamp located on the left main instrument panel. When lighted the word STALL appears on the face of the lamp. The audible stall warning signal is a continuous tone applied to the headsets of both crew members. The stall warning audible signal may be silenced by depressing the landing gear horn silencer button. Silencing of either the landing gear warning horn or the stall warning signal will not prevent subsequent audible tone warning from the other circuit. Operation of the horn silencer will not deactivate the stall warning lamp or the rudder pedal shaker.

Spoiler Operation.

When the wings are forward of 45 degrees, roll control is aided by action of two spoilers on the top of each wing. Each spoiler surface is actuated by a hydraulic servo actuator. The outboard pair of spoiler actuators has extension pressure supplied by the utility hydraulic system and has lock down pressure supplied by the primary hydraulic system. The inboard pair of spoiler actuators receives extension pressure from the primary hydraulic system and lock down pressure from the utility hydraulic system. Lateral movement of the control stick causes the stick position transducers to generate electrical command signals which are sent through the feel and trim and the wing sweep sensor assembly to the spoiler actuators. There is no mechanical linkage between the stick and the spoiler. Both commanded spoilers extend to a maximum of 45 degrees at the stick force detent. The spoiler extension versus stick displacement is nonlinear.

Spoiler Lockout.

When the wing sweep angle is at 45 degrees, the electrical commands to the inboard spoiler actuators are switched out by the wing sweep sensor, causing the inboard spoilers to retract and lock down. At 47 degrees wing sweep, primary hydraulic pressure is removed from all spoiler actuators, and the electrical command signal to the outboard spoilers is switched out by the wing sweep sensor, causing them to retract and lock down. When the wing sweep reaches 49 degrees, the utility hydraulic pressure is removed from all spoiler actuators.

Autopilot/Damper Switches.

Three switches, one each for the pitch, roll, and yaw channels, are located on the autopilot/damper panel. The pitch and roll damper switches (1, figure 1-27) are three-position switches marked AUTOPILOT, DAMPER and OFF. These switches are solenoid held in the AUTOPILOT position and are spring-loaded to the DAMPER position. The yaw damper switch (2, figure 1-27) is a two position switch marked DAMPER and OFF. The three switches are lever locked in the OFF position. Also the switch toggle of the pitch autopilot/ damper switch has been enlarged so that it can be readily identified by feel. Placing any of the switches to DAMPER turns the respective damper on. Placing either the pitch or roll switch to AUTOPILOT will engage autopilot attitude stabilization. Placing a switch to OFF disengages the damper system of the respective channel and causes the respective damper caution lamp to light. Refer to "Autopilot System", this section.

Control Surface Position Indicator.

The control surface position indicator (21, figure 1-5), located on the left main instrument panel, is composed of three separate sets of indicators which provide indications of the positions of the spoilers, rudder and horizontal tail (horizontal stabilizer). The position of the spoilers is indicated on four flip-flop type indicators, two for the left and two for the right spoilers. When the spoilers are retracted the letters DN appear in each indicator. As the spoilers extend the indicators become blank. Rudder position is provided by a pointer on a scale, 30 degrees (L) left or (R) right of zero. The scale is graduated in 5 degree increments. The position of the horizontal stabilizers is indicated by two pointers, marked L and R, on a scale, 30 degrees up and 20 degrees down and is graduated in 2 degree increments. An index mark mounted on the axis of the left pointer provides indications of left or right wing down (LWD or RWD) against a scale mounted on the axis of the right pointer. In this manner asymmetric stabilizer position indications also provide left or right wing down indications.

WING SWEEP SYSTEM.

The variable sweep wings are moved to and held in position by two hydraulic, motor-driven, linear actuators. The actuators are mechanically interconnected to insure positive synchronization. Wing position is controlled by a closed loop mechanical servo system in response to an input signal from the wing sweep handle. A mechanical interlock prevents the wing sweep handle from being moved past the 26.5 degree position when either the flap/slat handle is out of the UP position or the flaps are out of the fully retracted position.

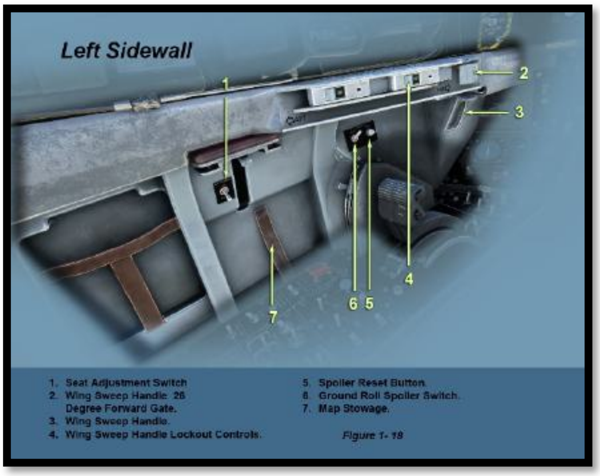


Figure 1- 18

WING SWEEP CONTROL HANDLE.

The wing sweep control handle (3, figure 1-18) is shaped like a pistol grip and is spring loaded to a stowed position under the canopy sill on the left side of the crew module. Teeth in the top of the handle lock it to serrations in the handle support, when it is stowed, to prevent inadvertent movement. To adjust wing sweep, the handle must lie rotated to the vertical position to unlock it; then it can be moved forward or aft as necessary. The handle is mechanically linked to the wing sweep control valve. The handle is pulled aft to sweep the wings aft and pushed forward to sweep the wings forward. As the handle is moved an index mark on the wing sweep position indicator follows the handle position to assist in selecting the desired wing sweep position.

Implementation Note

"ADF2 VOLUME" hotkeys at RADIO section is used for key binding.

"INCREASE ADF2 VOLUME" - increasing wings sweep angle

"DECREASE ADF2 VOLUME"- decreasing wings sweep angle

WING SWEEP HANDLE LOCKOUT CONTROLS.

Two wing sweep handle lockout controls (4, figure 1-18), one labeled FIXED STORES and the other labeled WEAPONS, are located just above and aft of the wing sweep control handle. When either control is moved forward, the word ON is visible, and a latch extends which prevents aft movement of the wing sweep handle past the latch. When either control is moved aft, the word OFF is visible and the latch retracts. The fixed stores lockout control, when ON, prevents the wing sweep handle from being moved aft past the 26 degree position. This is the sweep angle at which the fixed pylons and stores are in a streamlined configuration. The weapons lockout control restricts aft movement of the wing sweep handle to *54* degrees. This is the wing sweep angle past which certain weapons on the inboard pivot pylons would strike the fuselage. The wing sweep handle lockout controls restrict aft movement of the wing sweep handle only. Forward motion is unrestricted between 72.5 and 26 degrees.

WING SWEEP HANDLE 26 DEGREE FORWARD GATE.

A wing sweep handle 26 degree forward gate (2, figure 1-18), located above the wing sweep handle, is provided to stop forward motion of the wing sweep handle at 26 degrees. The gate is thumb-actuated and is spring loaded to the latched position. Depressing the gate will retract a latch, allowing the wing sweep handle to be moved forward past the 26 degree position.

Implementation Note

A wing sweep handle 26-degree forward gate activates automatically unless intentionally depressed.

WING SWEEP POSITION INDICATOR.

The wing sweep position indicator is a part of the wing sweep, flap/slat position indicator (10, figure 1-5), located on the left main instrument panel. The indicator displays the wing position in degrees and is graduated in 2 degree increments from 16 to 72 degrees. An index mark at 26 degrees provides a reference for selecting this position. A movable command index on the outside of the scale is provided to assist in setting the wing sweep handle to the desired position. The angle of wing sweep is monitored by a transmitter which position and converts this information to an electrical signal which drives the wing sweep indicator pointer.

WING FLAPS AND SLATS.

WING FLAPS.

The wing flaps are full span multisection Fowler-type flaps. Integral with each flap section is a mechanically controlled vane. As the flap extends downward the vane is positioned by a mechanical linkage to provide the proper airflow through the space between the flap leading edge and the spoiler trailing edge. Each wing flap is divided into four sections that are mechanically connected and operate as one unit. The flaps are powered from the utility hydraulic system by a single hydraulic motor that is connected to a main drive actuator assembly. The flaps are extended by 6 mechanical actuators (3 for each flap) that are driven by the hydraulic motor through a system of associated gear boxes and torque shafts. An electric motor connected to the main drive actuator assembly provides an emergency mode of operation in the event of either hydraulic system failure. The main drive actuator is mechanically interlocked with the wing sweep control to prevent the wings from being swept aft of the 26 degree position when the flaps are not in the UP position.

WING SLATS.

Each wing is equipped with a leading edge slat. Each slat is divided into four sections which are connected and operate as one unit. The slats operate in conjunction with the flaps and are connected to the flap drive assembly by flexible drive shafts. On the extend cycle, the slats will extend to the full down position before the flaps start to extend. On the retract cycle, the flaps will fully retract before the slats start to retract.

Note

If an asymmetrical slat condition occurs, the aircraft will enter a roll in the direction of the extended slat. The initial movement of the flaps will cause the slats and flaps to lock up.

ROTATING GLOVES.

The outboard edges of the wing gloves, adjacent to the wing inboard leading edges are equipped with movable surfaces to allow full forward movement of the inboard slats. These surfaces are called rotating gloves (3, figure 1-1). A door forms the lower surface of each rotating glove. Each rotating glove and its associated door are operated by a mechanical actuator and linkage which is connected to the slat drive flexible shaft. When the slats are extended, the rotating gloves automatically rotate (leading edge down and trailing edge up) and the doors open to allow full extension of the slats.

Flap/Slat Handle.

The flap/slat handle (1, figure 1-4), located on the left throttle panel has three positions labeled UP, SLAT DOWN and FLAP DOWN. Extension of the slats beyond 70 percent automatically places the flight control system in the takeoff and landing configuration if the flight control system switch is in NORM. (Refer to "Flight Control System Switch" in this section.) The flaps can be set at an infinite number of positions between up and full down. A detent position is provided in the flap/slat control mechanism to aid in selecting the 15-degree and 25-degree flap positions. Full down position of the flap/slat handle will provide 37.5 degrees of flap deflection. The flap and slat drive mechanism is so designed that it will not extend the flaps until the slats are fully down and will not retract the slats until the flaps are up. Therefore moving the handle from the FLAP DOWN position to UP position will first cause the flaps to retract and then the slats to retract. Normal time for retraction or extension of the flaps and slats is approximately 12 seconds.

Flap and Slat Position Indicators.

The flap and slat position indicators are a part of the wing sweep, flap/slat position indicators (10, figure 1-5), located on the left main instrument panel. The flap position indicator provides flap position in degrees. The slat indication is a window which provides the following indications:

UP Slats retracted
SLAT DN Slats down
Crosshatch Power off or slats in transit or at an intermediate position.

AERODYNAMIC DECELERATION EQUIPMENT.

SPEED BRAKE.

The speed brake, which also serves as the main landing gear forward door, is provided as an aid to deceleration during flight. The speed brake is hydraulically operated and may be used as a speed brake only when the landing gear is up and locked. For operation of the speed brake as a landing gear door refer to "Landing Gear System," this section.

GROUND ROLL SPOILERS.

Deceleration during ground roll is aided by symmetrical extension of the flight control spoilers which reduces aerodynamic lift and allows maximum effectiveness of the wheel brakes.

Ground Roll Spoiler Switch.

The ground roll spoiler switch (6, figure 1-18), located on the crew module left sidewall, has positions BRAKE and OFF. If the weight of the aircraft is on the landing gear and both throttles are in IDLE, positioning this switch to BRAKE will cause the flight control spoilers to extend. Under the same conditions placing the switch to OFF will retract the spoilers. With the spoiler switch positioned to BRAKE, if the aircraft weight is removed from the landing gear or if either throttle is advanced out of IDLE, the spoilers will automatically retract.

1. Arresting Hook Handle.
2. Flight Control System Switch.
3. Landing Gear Handle.
4. Landing Gear Warning lamp.
5. Landing Gear Handle Lock Release Button.
6. Landing Gear Warning Horn Silencer Button.
7. Auxiliary Brake Handle.
8. Utility Hydraulic System Isolation Switch.

Figure 1- 15

LANDING GEAR SYSTEM.

The landing gear is tricycle-type, forward retracting, and hydraulically operated. The main landing gear consists of a single common trunnion upon which two wheels are singly mounted. This arrangement of the main landing gear provides symmetrical main landing gear operation. Fusible metal, thermal pressure relief, plugs are incorporated in the main landing gear wheels to relieve tire pressure in the event of overheated brakes. The nose landing gear has dual-mounted wheels. The landing gear system is normally powered by the utility hydraulic system. A pneumatic system is provided as an alternate (emergency) means of extending the gear in the event the normal system fails.

MAIN GEAR.

Three hydraulic actuators are provided for operation of the main landing gear. A single-acting linear actuator retracts the main landing gear. Two double-acting linear actuators, one for an uplock and one for a down lock, are provided to lock the landing gear in the retracted or extended position. There are two main landing gear doors. The aft door is mechanically linked to the main landing gear and opens and closes with movement of the gear. The forward door, which also serves as the speed brake, is hydraulically operated. A mechanical connection between the main landing gear and the speed brake selector valve causes the main landing gear door to open and close in the proper sequence during landing gear operation. Ground safety (squat) switches provide an electrical signal that is used for a number of purposes such as to prevent the landing gear handle from being positioned to UP while the aircraft is on the ground, for antiskid system touchdown feature operation, steering system operation and other functions not related to the landing gear system.

NOSE GEAR.

Three hydraulic actuators are provided for operation of the nose landing gear and nose wheel well doors. A single-acting actuator retracts the nose landing gear. An uplock actuator locks the nose landing gear in the retracted position and also, through linkages, opens and closes the two nose wheel well doors. A down-lock actuator locks the nose landing gear drag strut when the nose landing gear is extended.

LANDING GEAR CONTROLS AND INDICATORS.

Ground Safety (Squat) Switches.

The main landing gear safety (squat) switches are located on the main landing gear lateral beams as shown on figure 1-16 and provide an electrical signal that will affect the operation of certain aircraft systems. While the weight of the aircraft is on the wheels the squat switches prevent activation of the following in-flight systems.

- Weapons firing.
- Cowl anti-icing.
- Adverse yaw compensation.
- Artificial stall warning.
- Operation of landing gear handle from the down position.
- Secondary alpha/beta probe heater.
- Touchdown skid control.

The switches will permit the activation of the following systems when the aircraft is on the ground and de-activate them when the aircraft becomes airborne.

- Vortex Destroyers.
- Nose wheel steering.
- Ground roll spoilers.
- Ground to pilot interphone.
- Ejector air hydraulic cooling.
- Ejector air engine oil cooling.
- Flight control ground test power.
- Engine nozzle ground idle open position.
- Engine bleed opening with throttle below MIL.

Landing Gear Handle.

The landing gear handle (3, figure 1-15), located on the landing gear control panel, has two positions marked UP and DN. A red landing gear position indicator lamp is located in the end of the landing gear handle. Moving the handle to the UP or DN position will cause the following actions to occur.

Gear Up

When the handle is moved to the UP position, an electrical signal actuates a solenoid-powered landing gear control valve, sending hydraulic pressure to the nose gear down lock actuator, nose gear retract actuator, nose gear uplock door actuator, speed brake door actuator, and brake control valve. The nose gear unlocks and retracts. When it is almost retracted, it mechanically triggers the nose gear uplatch which then locks the gear up and closes and locks the doors. As the nose wheel doors close, snubbers mounted on the doors engage the tires to stop nose wheel rotation. The main gear forward door (speed brake) actuator extends the door. Hydraulic pressure at approximately 750 psi is metered to one brake circuit to stop main gear wheel rotation. When the door is sufficiently open to allow the main gear to retract, a linkage from the door opens a valve which sends hydraulic pressure to the main gear down lock actuator, main gear uplock actuator, and main gear retract actuator. The gear then unlocks and retracts. When it is almost retracted, it mechanically triggers the uplatch which locks the gear up and also actuates a valve to close the speed brake door.

Gear Down

When the handle is moved to the DN position, an electrical signal actuates a solenoid-powered valve, sending hydraulic pressure to the nose gear uplock actuator, nose gear down lock actuator, and the speed brake door actuator. The nose gear uplock actuator unlocks and drives the nose gear doors open and locked, at which time the nose gear is allowed to free fall (extend) against the snubbing of its retract actuator. When the gear is almost extended, the downlock actuator drives it fully extended and locked. The speed brake door actuator opens the door until the door clears the main gear. A linkage then actuates a valve to pressurize the main gear uplock actuator and down- lock actuator. The uplock opens, allowing the gear to free fall (extend) against the damping of its retract actuator. When the gear is extended, the downlock actuates. This causes the speed brake door actuator to position the door in the partially retracted (trail) position. The landing gear handle is locked in both UP and DN positions by a sprig- actuated lock. Aircraft weight on gear positions the ground safety switches such that the solenoid is de-energized, thereby permitting the spring actuated lock to secure the handle in the DN position and prevent inadvertent gear retraction on the ground.

Landing Gear Handle Lock Release Button.

The landing gear handle lock release button, located on the landing gear control panel (5, figure 1-15), unlocks the spring actuated handle lock. The button must be depressed to release the landing gear handle from the UP position for landing gear extension. Normally, it is not necessary to depress the button when retracting the gear because the spring actuated lock is unlocked by the ground safety switch operated solenoid. Should the solenoid, safety switch or associated electrical circuit malfunction, depressing the button will release the handle to allow gear retraction.

WARNING

Any time it is necessary to depress the landing gear handle lock release button to move the handle to the UP position, the crew member should immediately suspect a malfunction of the landing gear ground safety (squat) switches. If a malfunction of the landing gear ground safety (squat) switches is suspected, refer to Section III.

Landing Gear Emergency Release Handle.

The landing gear emergency release handle (10, figure 1-32), located on the right main instrument panel, is provided to extend the landing gear in the event the normal hydraulic system fails. When the handle is pulled pneumatic pressure is directed to simultaneously open the speed brake door and unlock the nose and main gear uplocks. The gear will free fall to the extended position, then pneumatic pressure will actuate the nose and main gear downlocks and retract the speed brake door to the trail position. Once the gear has been extended by the emergency method it cannot be retracted.

Landing Gear Warning Horn.

The landing gear warning horn provides an intermittent audible signal in the crew members' headsets when an unsafe landing gear condition exists. If the nose or main landing gear is not down and locked and/or speed brake is not in trail, the horn sounds when all of the following conditions exist:

Indicated airspeed is below 160 (±12) knots.
The aircraft is below an altitude of 10,000 (±350) feet.
One or both throttles are set below minimum cruise setting. (Approximately 90 percent engine RPM)

Note

The warning horn is also used as a stall warning indication. Refer to "Artificial Stall Warning System," this section.

The warning horn may be silenced by depressing the horn silencer button adjacent to the landing gear handle (6, figure 1-15).

Note

The stall warning lamp will flash as long as the horn silencer button is held depressed.

Landing Gear Position Indicator Lamps.

A planform silhouette of the aircraft having two green indicator lamps is located on the left main instrument panel (15, figure 1-5). The lamps are positioned to represent the nose and main landing gear. When the landing gear is down and locked, the green indicator lamps are lighted. A safe up-and-locked landing gear condition is indicated when both the green indicator lamps and the red warning lamp in the landing gear handle are off. The red warning lamp, when lighted, indicates one of the following:

Disagreement between the speed brake position and that commanded by the landing gear handle.
Landing gear is in-transit or has failed to lock in selected position.
When accompanied by the warning horn, denoting that airspeed is below 160 ±12 knots, the aircraft is below 10,000 feet ±350 feet, one or both throttles are below minimum cruise setting and the gear is not down and locked.

TAIL BUMPER SYSTEM.

The tail bumper protects the control surfaces, engines, and portions of the airframe from damage that might occur if the tail inadvertently contacts the ground during ground handling. The tail bumper also provides limited protection during overrotation on take-off and during landings. In flight, the tail bumper is held in the fully retracted position by hydraulic pressure in the tail bumper lift cylinder. The hydraulic pressure is ported to the tail bumper lift cylinder from the speed brake control valve. When the landing gear is extended and the speed brake returns to trail position, the lift cylinder pressure is relieved and the tail bumper is extended by the pneumatic action of the tail bumper dashpot. The dashpot, which functions as the impact shock absorber, has its own separate reservoir that is charged with compressed nitrogen. Retraction of the landing gear allows hydraulic pressure to again be ported to the tail bumper lift cylinder to retract the bumper and hold it in this position.

NOSE WHEEL STEERING SYSTEM.

Nose wheel steering provides aircraft directional control during taxiing, takeoff and landing. The system is electrically engaged, hydraulically powered and controlled by the rudder pedals. The nose wheels are positioned by a linear hydraulic actuator controlled by a mechanical rotary servo valve. Rudder pedal movement at either crew station is transmitted to the steering valve by mechanical linkage which includes a cam device on the valve input shaft. The cam device provides a gradually increasing ratio between steering angle and rudder pedal displacement. A relatively larger pedal displacement is required to obtain an increment of steering angle near the neutral rudder pedal position than is required near the full rudder pedal position. Utility hydraulic system pressure supplied to the steering servo valve is controlled by a solenoid operated shutoff valve and a pressure regulator. When steering is engaged, the energized solenoid valve applies full system pressure to achieve a high level steering torque. When steering is disengaged, the pressure regulator supplies approximately 10 percent system pressure for a low level steering torque used to center the nose wheels during retraction. Steering input linkage motion occurring during nose gear retraction automatically centers the nose wheels with up to 50 percent rudder pedal displacement.

NOSE WHEEL STEERING/AIR REFUELING INDICATOR LAMP.

A green nose wheel steering/air refueling indicator lamp labeled NWS/A/R is located on the left main instrument panel (22, figure 1-5). The lamp will light when the nose wheel steering system is energized. For a description of the air refueling disconnect function of the lamp, refer to "Fuel Supply System," this section. The lamp receives power from the 28 volt dc essential bus.

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BRAKE SYSTEM.

Each main landing gear wheel is equipped with a hydraulically operated multiple disc brake. Pressure for operation of the brakes is supplied by the utility hydraulic system for normal operation and by two hydraulic accumulators for power off braking. Antiskid control, automatic braking during landing gear retraction, and an auxiliary brake are provided.

ANTI-SKID SY5TEM.

The anti-skid control system provides the following functions:

Touchdown skid control.
Proportional skid control.
Lock wheel skid control.
Anti-skid failure detection.
Touchdown skid control prevents the brakes from being applied when the weight of the aircraft is off the landing gear and the speed of both wheels is below 20 MPH, Proportional skid control operates throughout the aircraft ground speed range by utilizing wheel deceleration to reduce brake pressure in proportion to a skid tendency. Locked wheel skid control is activated above 20 MPH and causes either brake to be fully released if proportional skid

control does not prevent a skid from occurring. Locked wheel skid control would function, for example, should a brake seize or if a wheel is unable to spin-up due to hydroplaning. The failure detection circuit will automatically return the brake system to manual control in the event of an anti-skid malfunction.

Anti-Skid Control Switch.

The anti-skid control switch (2, figure 1-4) is located on the left crew member's throttle panel and labeled ANTI-SKID. The switch has two positions, one marked OFF and an unmarked ON (up) position. Placing the switch to ON will provide anti-skid control during normal braking. With the switch in OFF, antiskid control will not be available and brake pressure will be in direct response to pedal displacement.

Anti-Skid Caution Lamp.

An amber caution lamp labeled ANTI-SKID is located on the main caution lamp panel. The lamp will light when the anti-skid switch is in the ON position and a malfunction has caused the antiskid system to become de-energized. The anti-skid caution lamp will light anytime the landing gear is down and the anti-skid switch is not in the ON position.

Note

When the anti-skid caution lamp is lighted, anti-skid control is not available and braking will be in direct response to the pedal displacement.

AIRCRAFT ARRESTING SYSTEM.

The arresting system provides for emergency arrestment of the aircraft. The system consists of an arresting hook, arresting hook dashpot, a dashpot air bottle, an uplock latch, arresting hook controls, a pressure gage, and an air filler valve. Except for the controls the arresting hook components are located in the lower aft end of the fuselage tail cone.

ARRESTING HOOK HANDLE.

The arresting hook handle (1, figure 1-15), located on the landing gear control panel, is labeled HOOK on diagonal stripes. The mechanism provides a direct mechanical linkage from the handle to the arresting hook uplatch mechanism in the tail cone. The arresting hook is released by pulling the handle aft. The total travel of the handle from retract to extend position is approximately four inches. Approximately one second is required for the arresting hook to extend.

ARRESTING HOOK CAUTION LAMP.

The amber arresting hook caution lamp, labeled HOOK DOWN, is located on the main caution lamp panel. The caution lamp lights to indicate hook down position only.

ENGINES.

The aircraft is powered by two Pratt and Whitney TF-30 sixteen-stage axial flow turbofan engines equipped with afterburners. The engines are mounted side by side in the fuselage and arc interchangeable. The sea level, standard day uninstalled thrust rating of the engine is in the 10,000 pound class in military power and in the 18,000 pound class in afterburner. Provisions are made for starting the engines with an external pneumatic ground starter cart. Also the left engine has the capability of being started by means of a pyrotechnic cartridge. With either engine operating, the other engine can be started by using bleed air from the operating engine. Electrical power is supplied for the engine igniter plugs by an engine- driven alternator. Each engine is supplied a flow of air. through a separate inlet duct located below the intersection of the wing and fuselage. An automatically controlled, movable spike is used in each inlet duct to control airflow to the engines. Additional engine inlet air is provided during ground operation and at low airspeeds through blow-in doors located in the outboard side of each nacelle. Boundary layer diverter ducts ate used at the front of the inlet ducts to remove the low- energy air from the fuselage and the lower surface of the wing glove, thus preventing boundary layer air from disturbing engine inlet air. These features allow optimum engine performance throughout a wide range of airplane operating conditions. Air from the inlet of each engine is routed through a single duct for both the basic engine section and the fan section. Three compressor stages provide the initial pressurization of the air flowing into the engine and into the fan duct. The fan duct is a full-annular duct which directs flow aft to join the engine airflow coming from the turbine discharge. The fan air develops a significant portion of total engine thrust. Engine air is compressed by 9 stages of the low pressure compressor (N1) of which three stages are the fan, and 7 stages of the high pressure compressor (N2). The air is then diffused into the combustion section which contains 8 combustion chambers. 'Tie turbine section of the engine consists of a single- stage turbine to drive the high pressure compressor and a three-stage turbine to drive the low pressure com-pressor. The turbines are mechanically independent of each other. High pressure compressor speed is indicated by a tachometer. Speed of the low pressure compressor is not monitored except by an overspeed caution lamp. After leaving the turbine section of the engine, the air is joined with the fan air in the afterburner section. Engine compressor bleed air from the sixteenth stage is utilized for the following functions:

- Cockpit, weapon bay and electronic equipment bay air conditioning and pressurization.
- Fuel tank and hydraulic reservoir pressurization.
- Engine inlet anti-icing.
- Engine inlet vortex destroyers.
- Windshield wash and rain removal.
- Throttle boost.
- Canopy and wing seals.
- Starting opposite engine.
- Engine nacelle ventilation and hydraulic oil, engine oil and constant-speed drive oil cooling on the ground.

Twelfth stage compressor bleed air is used for engine inlet guide vane anti-icing. Seventh stage compressor bleeds open under certain conditions to prevent compressor stall.

ENGINE FUEL CONTROL SYSTEM.

Each engine fuel control system (figure 1-5) automatically provides optimum fuel flow for any throttle setting. This system responds to several engine operating parameters and makes it unnecessary to adjust :he throttle in order to compensate for variations in inlet air temperature, altitude or airspeed. The engine fuel system consists of a two-stage engine-driven fuel pump, fuel control unit, flowmeter, filter, a pressurizing and dump valve, nozzles, and a fuel-oil heat exchanger. Fuel from the tanks is routed through the flowmeter to the centrifugal stage of the engine fuel pump, through a filter, and back to the gear stage of the pump. Bypass valves route fuel past the filter or first pump stage in event of failure of these components. The second pump stage delivers fully pressurized fuel to the fuel control unit which provides metered fuel flow through the fuel-oil heat exchanger to the fuel pressurizing and dump valve. This dual function valve directs the fuel through the primary and secondary- fuel manifolds to the fuel nozzles which spray the fuel into the eight engine combustion chambers. When the fuel pressure drops during engine shutdown, the fuel pressurizing and dump valve automatically opens and drains the primary fuel manifold.

Fuel Control Unit.

The engine fuel control unit is a hydromechanical device incorporating an engine-driven, flyball-tvpe speed governor. The control unit consists of a fuel metering system and a computing system which operates as a function of throttle setting, main combustion chamber pressure, high pressure rotor N2 speed, compressor inlet pressure, compressor inlet temperature, and Mach number which is provided from the central air data computer.

Note

Malfunctions of the CADC are normally indicated by the CADC caution lamp. However, failures can occur which result in incorrect Mach data from the CADC to the fuel control unit without an accompanying CADC caution lamp. The effect of a CADC Mach failure on the fuel control unit can occur only when the landing gear handle is in the UP position and will manifest itself with a sudden reduction in engine thrust. This malfunction will also result in an abnormally high Mach indication on the AMI.

The metering system selects the rate of fuel flow to be supplied to the engine in response to the throttle setting. However, metering sections are regulated by the fuel control computing system which monitors the various engine operating parameters. Fuel enters the fuel control through a filter that is provided with a springloaded bypass. Fuel metering is accomplished by maintaining a constant pressure across a variable valve area which is controlled by the computing system. The constant pressure is maintained by means of a pressure regulating bypass valve. This valve consists of a servo-operated valve and a springloaded valve. Normally, the servo maintains constant valve regulation; but in the event of servo malfunction, the spring valve alone will provide adequate regulation. Deviations from the desired metering pressure are sensed in the valve regulating unit which varies the bypass flow area, thereby restoring the desired pressure by returning excess fuel to the pump inlet.

ENGINE AFTERBURNERS.

The afterburner (AB) augments engine thrust by injecting fuel into the engine exhaust stream in the afterburner section where it is ignited by a hot streak ignition system. Operation is controlled by the throttle. When the throttle is moved forward within the afterburner range, the afterburner fuel control pressurizes the afterburner first fuel manifold, (zone 1) schedules light-off flow, and activates the variable nozzle system. This system senses a pressure change and controls the exit area of the afterburner exhaust nozzle. Six spring- loaded blow-in doors, located near the aft end of the afterburner are provided to allow outside air into the engine to increase total engine thrust under certain flight conditions. The doors will remain open until inside engine pressure is greater than outside pressure plus the spring tension of the doors. The trailing edge of the afterburner consists of free-floating leaves which reduce drag at the aft end of the engine by directing the exhaust gases into the slipstream with minimum turbulence.

ENGINE VARIABLE EXHAUST NOZZLES.

The variable nozzle system incrementally opens and closes the engine exhaust nozzle for afterburner modulation. The control is a hydromechanical computing device that determines and sets the nozzle area required to maintain a desired turbine pressure ratio during afterburner operation. The nozzle position is scheduled by the throttle setting and governed by turbine pressure ratio. The nozzle is closed for all ranges of non- afterburner operation except for ground engine idle at which time it is positioned fully open for minimum thrust. The nozzle closes when the corresponding throttle is advanced 3 degrees above IDLE. If afterburner blowout occurs, the blowout signal valve is actuated, and the nozzle closes. In addition, the afterburner fuel selector valve closes off fuel flow to all afterburner zones, and a signal is directed to the engine main fuel control to reduce fuel flow to the main combustion chamber. When the nozzle has moved to the closed position, the blowout signal is removed. Afterburner operation can again be initiated; however, the throttle must first be moved to the mil-power range.

ENGINE IGNITION SYSTEM.

The functions of the engine ignition system are to provide a means of initiating combustion in the combustion chambers during the starting cycle and to provide a means for furnishing an engine ignition source in the event of a flameout. Each engine has a dual main ignition system including two ignition exciters, two igniter plugs, an ignition alternator, and an automatic restart switch. The alternator is engine driven and is capable of providing sufficient energy to both exciters of the ignition system for ground starting or for windmill starts during all flight conditions. Ignition alternator voltage is stepped up by transformer and capacitor circuits within the exciters to provide ionizing voltage for the igniter plugs. The alternator incorporates two independent current generating circuits for increased reliability. Engine ignition is accomplished by the two spark igniters located in the lower combustion chambers (No. *4* and No. 5) of each engine. Advancing the throttle over the OFF ramp actuates the throttle ignition switch for that engine. This action provides ignition when the engine start switch is in P.VEU or CARTRIDGE. Electrical ignition is cut off when the ground start switch returns to OFF. This normally occurs when the starter centrifugal cutout switch opens on the last engine to be started. Ignition is also cut off when the throttle is retarded over the OFF ramp. An automatic circuit energizes in the event of a combustion chamber flameout by sensing the rate of change of burner pressure. This is accomplished by an automatic ignition switch which will remain activated for 15 to 60 seconds depending on compressor discharge pressure.

ENGINE STARTING SYSTEM.

Several means are provided for starting the engines. The left engine can be started by pyrotechnic cartridge, both engines can be started by external pneumatic pressure, and once either engine is running the remaining engine can he started by pneumatic crossbleed from the operating engine. The left engine is equipped with a cartridge-pneumatic starter to provide the flexibility of operation without ground support equipment. The pyrotechnic cartridge can be installed by selecting corresponding option in the Settings menu located at right side of the glareshield panel. The right engine is equipped with a pneumatic starter only. Electrical power required for starting can be obtained from either an external ground source or the aircraft battery. When starting the left engine with the cartridge, the cartridges is ignited by placing the ground start switch to CARTRIDGE and lifting the left throttle out of the OFF position. When starting the engines with a pneumatic source, either external or crossbleed, placing the ground start switch to PNEU and lifting the left or right throttle out of the OFF position opens the starter pressure shutoff valve, on the engine being started, and allows pneumatic pressure to drive the respective starter. After a pneumatic start the ground start switch will return to OFF when the centrifugal cutout switch in the starter on the second engine started opens. This will occur at 38 to 41 percent on the left engine and at 45 to 48 percent on the right engine. This breaks the starter control circuit and allows the starter pressure shutoff valve to close, shutting off the pneumatic pressure. In the event an engine start was not initially attained, the starter may be energized again when engine rpm falls below 20 percent. Two spare cartridges can be carried in the main landing gear wheel well.

ENGINE CONTROLS AND NDICATORS.

Throttles.

A set of throttles (7, figure 1-4), is provided for each crew member. The respective left and right throttles in each set are mechanically linked together, Each throttle provides thrust setting adjustment for its respective engine. Throttle friction for both sets of throttles is controlled by means of the friction lever located adjacent to the left set. Moving the lever toward INCR increases throttle friction, and moving the lever toward DECR decreases the friction. Pneumatic power boost, from the cabin pressurization system, is provided to assist throttle movement. The force required to move the throttles varies from 2 to 30 pounds, with pneumatic boost, depending on the position of the friction lever. In the event pneumatic boost is lost, the force required to move the throttles is from 10 to 40 pounds depending on the friction lever position. Both sets of throttles have positions marked OFF, IDLE, MIL, and MAX AB, respectively. Only the left set of throttles can be raised to go into or from the OFF position. The right set of throttles cannot be used for engine starting or shutdown. When the left set of throttles are lifted to move them out of the OFF position, the throttle starter switches are actuated. If the ground start switch is in the CARTRIDGE position, lifting the left throttle of the left set will automatically fire the left engine starter cartridge. If the ground start switch is in the PNEU position, lifting either throttle of the left set will open the starter pneumatic pressure shutoff valve on the respective engine to allow starting by pneumatic pressure, Movement of the throttle over the OFF ramp activates the engine ignition system. An adjustable detent at the MIL position provides a means of readily selecting this position. A detent is also provided at the minimum AB position. To attain the minimum AB detent position the throttle must first be advanced into the afterburner range and then retarded until the detent is felt. Refer to figure 1-4 for a detail of both the MIL and minimum AB throttle positions. The left throttle of the left set includes a cage-gyro switch for caging the LCOS gyros. The right throttle of each set includes a microphone switch and a speed brake switch.

Engine Ground Start Switch.

The engine ground start switch (8, figure 1-4), located on the center throttle panel, is a three position switch marked PNEU, OFF and CARTRIDGE. The switch is solenoid held in the PNEU and CARTRIDGE positions and is spring-loaded to and locked in the OFF position. The switch toggle must he pulled out before it can be moved to either PNEU or CARTRIDGE. Placing the switch to either the PNEU or CARTRIDGE position supplies power to arm the throttle start switches. With the switch in the PNEU position lifting either throttle out of the OFF position allows electrical power from the respective throttle start switch to open the starter pressure shutoff valve on the engine being started. With the switch in the CARTRIDGE position lifting the left throttle out of the off position allows electrical power from the throttle start switch to fire the cartridge. A centrifugal cutout switch in the starter of the last engine started will open the circuit to the solenoid holding the engine ground start switch and it will return to OFF.

Airstart Buttons.

Two airstart pushbuttons (6, figure *1-4),* one located on each throttle panel, respectively, provide a means of obtaining ignition for air starting the engines. The buttons are marked AIR START. When either airstart button is momentarily depressed, the airstart timer relay actuates and allows ignition generator power to operate the ignition exciters for both engines. The relay will remain energized for a minimum of 55 seconds after the airstart button is released, thereby providing ignition for this length of time.

Ground Ignition Cutoff Switch.

The ground ignition cutoff switch (10, figure 1-29), located on the ground check panel, is labeled GRD IGNITION and has two positions marked NORM and OFF. When the switch is in OFF, a relay is energized, which deactivates the engine electrical ignition system for both engines by grounding the ignition alternator output. When the switch is in the NORM position, the relay is deactivated and the ignition circuits are not grounded through this relay.

Engine Tachometers.

Two engine tachometers (31, figure 1-5), located on the left main instrument panel, indicate the percent of RPM of the high pressure compressor (NL.) in each engine. Each tachometer main dial is graduated from 0 to 100 percent rpm in increments of 2 percent; the subdial is graduated from 0 to 10 percent in increments of 1 percent.

Engine Fuel Flow Indicators.

Two engine fuel flow indicators (33, figure 1-5), located on the left main instrument panel, show fuel flow for each engine in pounds per hour. The indicators are calibrated from 0 to 80,000 pph in increments of 2000 pph. A digital readout of fuel flow is displayed on the face of the indicator. This readout shows fuel flow to the nearest 100 pph,

Note

Fuel flow indications may fluctuate as much as ± 300 pph for all flow rates. Fluctuation in excess of this amount must be investigated.

Engine Nozzle Position Indicators.

Two engine nozzle position indicators (34, figure 1-5), located on the left main instrument panel, show nozzle position. The indicators are calibrated from 0 (smallest nozzle area) to 10 (largest nozzle area). The indicators use 115 volt ac power from the left main ac bus.

Note

The nozzle position also represents an approximate percent of the available AB thrust.

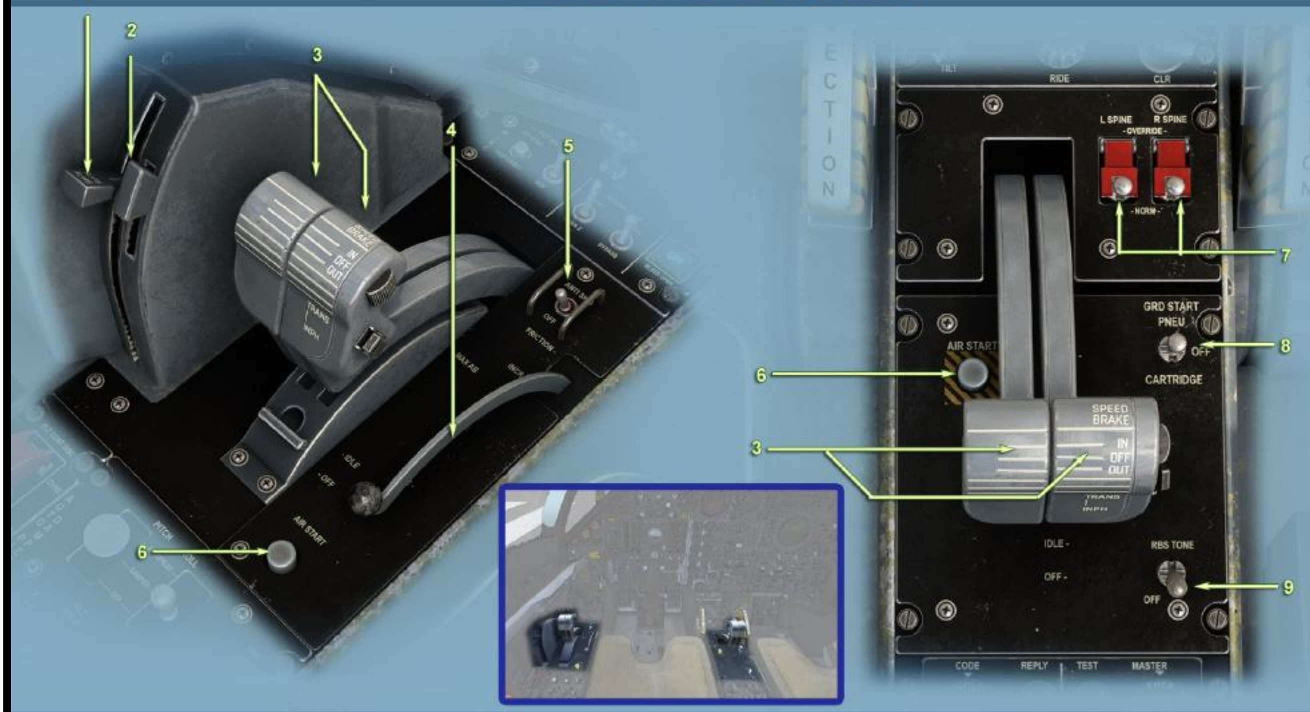
Engine Oil Pressure Indicators.

Two engine oil pressure indicators (36, figure 1-5), located on the left main instrument panel, indicate engine oil pressure in pounds per square inch. The indicators are calibrated from zero to 100 psi in increments of 5 psi. The oil pressure indicating system operates on 26 volt ac which has been reduced by a transformer which has an input of 115 volts ac from the ac essential bus.

Engine Pressure Ratio Indicators.

Two engine pressure ratio (EPR) indicators (35, figure 1-5), located on the left main instrument panel, indicate the ratio of turbine discharge pressure to engine inlet pressure. The main dial of each indicator is calibrated from 1.0 to 3.0 in 0.1 increments. A smaller circular dial (subdial) on the indicator face is calibrated in 0.01 increments for precise reading. The indicators are supplied 115 volt ac power from the left main ac bus.

Throttle Panels (Typical)



1. Flap/Slat Handle.
2. Flap/Slat Handle Gate Release.
3. Throttles.
4. Throttle Friction Lever.
5. Anti-Skid Control Switch.
6. Airstart Button.
7. Spike Control Switches.
8. Engine Ground Start Switch.
9. RBS Tone Switch.

Figure 1-4

Engine Turbine Inlet Temperature Indicators.

Two engine turbine inlet temperature (TIT) indicators (32, figure 1-5), located on the left main instrument panel, show turbine inlet temperature in degrees centigrade. The indicator dials are graduated from 0 to 1400 degrees in 50 degree increments. In addition, a digital readout of turbine inlet temperature in 1 degree increments is displayed. Power to the TIT indicators is supplied from the 28 volt dc engine start bus. Consequently the indicators will operate with the battery switch ON. A flag marked OFF appears on the face of the indicator when power to the indicator is interrupted.

Engine Oil Hot Caution Lamps.

The two engine oil hot caution lamps are located on the main caution lamp panel (figure 1-37). When the oil temperature of either engine exceeds 250 degrees F, the associated lamp will light. When lighted, the letters L ENG OIL HOT; and R ENG OIL HOT will be visible in the respective lamp.

Engine Overspeed Caution Lamps.

Two amber engine overspeed lamps, one for each engine, are located on the main caution lamp panel (16 figure 1-5). When lighted the letters L ENG OVERSPEED and R ENG OVERSPEED are visible. An engine overspeed lamp will light at N1 compressor speeds of approximately 10,500 rpm and above. In addition, the lamps will light prior to engine start, provided there is electrical power on the airplane, and will go out prior to reaching idle rpm. The lamps operate on 28 volt dc electrical power from the essential dc bus.

ENGINE FIRE DETECTION AND EXTINGUISHING SYSTEM.

Engine fire detection is provided by sensing elements routed throughout each engine compartment. Should a fire or overheat condition occur the rise in temperature is detected by the sensors which light the respective left or right engine fire warning lamp. Shutoff valves are provided to isolate fuel and hydraulic fluid from the affected engine. After the shutoff valves are closed fire extinguishing agent can be discharged into the affected engine compartment to put out the fire. The extinguishing agent is contained in a single container with a separate discharge valve for each engine. Self test features are incorporated in the system for maintenance checks and troubleshooting.

Fire Pushbutton Warning Lamps.

Two fire pushbutton warning lamps (1, figure 1-5), labeled L ENG and R ENG, are located on the left main instrument panel. When a fire is indicated by a warning lamp, depressing either button will close the engine fuel shutoff valve and utility and primary hydraulic system shutoff valves to the respective engine and will arm the extinguishing agent discharge switch to the affected engine. Depressing the button again will open the fuel shutoff valve and disarm the fire extinguisher agent discharge valve; however, the hydraulic shutoff valves will remain closed. The buttons are covered by frangible covers to provide a visual indication when the buttons have been actuated.

WARNING

> Caution must be exercised to prevent inadvertently depressing the wrong push button and shutting down the good engine since the hydraulic shutoff valves cannot be reopened in-flight.

Agent Discharge/Fire Detect Test Switch.

The agent discharge/fire detection test switch (3, figure 1-5), located on the left main instrument panel, is a three position lock lever switch marked AGENT DISCH, OFF and FIRE DETECT TEST. The switch is spring loaded to the OFF position and is locked out of the AGENT DISCH position to prevent inadvertent actuation. To move the switch to AGENT DISCH it must be pulled out of the lock. Momentarily positioning the switch to the AGENT DISCH position will discharge fire extinguishing agent into the engine compartment of the engine selected after depressing the affected engine fire pushbutton warning lamp. Holding the switch to the FIRE DETECT TEST position will light both fire warning lamps if the fire detection system is operational.

ENGINE OPERATION.

Engine Acceleration.

Engine acceleration time is severely affected by the amount of compressor discharge air being bled from the engine and by outside temperature. The engine may require 15 seconds to accelerate from idle to military when air conditioning is taken from that engine during ground operation. In flight this effect is minimized but during final approach for landing, engine acceleration may require as much as 10 seconds to increase thrust from idle to military.

OIL SUPPLY SYSTEM.

Each engine is equipped with an oil supply system which consists of an oil tank, a main supply pump, six scavenger pumps, a deoiler, two filters, an overboard breather pressurizing valve, a pressure valve, and three oil coolers (air-oil, fuel-oil, and afterburner fuel-oil). Oil is fed to the main oil supply pump from the oil tank. It is then pumped in series through the two filters, the air-oil cooler, fuel-oil cooler, and afterburner fuel-oil cooler. Oil flow through the fuel-oil coolers is controlled by temperature and pressure sensing bypass valves. The oil is then directed to the engine bearings and to the accessory gearbox. Scavenger pumps return the oil to the oil tank. Capacity of the tank is five gallons, four gallons of which are usable.

ENGINE OIL QUANTITY INDICATOR.

The engine oil quantity indicator (39, figure 1-5), located on the left main instrument panel, is a dual indicating instrument with two displays labeled L and R for the left and right engine respectively. Each display is graduated from 0 to 16 in one quart increments. A pointer for each display provides an indication of the number of quarts of oil remaining in each oil tank. The indicator operates on 115 volt ac power from the left main ac bus and 28 volt dc power from the main dc bus.

OIL LOW CAUTION LAMP.

An oil low caution lamp (figure 1-37), located on the main caution lamp panel, lights any time the oil level in either left or right engine oil supply tank drops to four (4) quarts usable oil remaining. Also, the lamp lights when the Oil. QTY TEST button is depressed. When the lamp is lighted the words OIL LOW are visible.

FUEL SUPPLY SYSTEM.

The fuel supply system consists of a forward and aft integral fuselage tank, two integral wing tanks, an integral vent tank, and the associated fuel pumps, controls, and indicators. The fuel system employs twelve fuel pumps, of which six deliver fuel to the engine and six are used to transfer fuel from the wing tanks and weapons bay tanks to the fuselage tanks. Provisions are made for air refueling of the internal and external fuel tanks from a boom-type tanker aircraft. Single-point refueling is provided for ground servicing. All tanks are equipped with refuel automatic shutoff valves. Gravity refueling can be accomplished through filler caps in the wings and fuselage. For fuel tank capacities, refer to figure 1-6

Fuel tanks

The fuel tanks consist of internal forward and aft fuselage tanks, left and right internal wing tanks, up to six detachable external wing tanks, two removable weapon bay tanks and an integral vent tank in the vertical stabilizer. See figure 1-6 for tank locations and capacities. The fuselage tanks are divided into compartments called bays. The forward fuselage tank is divided into bays F-l and F-2 and a reservoir tank. The reservoir tank includes the fuel contained in the wing carry through box. Flapper valves allow fuel to flow from bay F-l to bay F-2 and from bay F-2 to the reservoir tank. The reservoir tank reserves approximately 2500 pounds of fuel after all other fuel in the system has been used. A float switch in the reservoir tank provides a caution lamp indication when the fuel level in the reservoir tank drops below 2300 (±235) pounds. The aft tank is divided into bay A-l, incorporating two "saddle" tanks, and bay A-2. Interconnecting stand pipes provide fuel flow between bays A-l and A-2, and ejector pumps transfer saddle tank fuel into bay A-l. All fuel in the wing external and internal tanks and weapons bay tanks must be transferred into the fuselage tanks before it can be used. All tanks are pressurized by cooled engine compressor bleed air to prevent fuel vaporization. The vent tank provides space for expansion of fuel in the system when all tanks are fully serviced, booster pumps in the fuselage tanks are provided for engine feed, and transfer of fuel from the aft to forward tank. Transfer pumps in the internal wing tanks and weapon bay tanks transfer fuel into the fuselage. A pressurization system is used to transfer fuel from the external wing tanks

Figure 1-6

NOTES:

These are average figures based on single point refueling at normal ramp altitude. Weights based on JP-4 fuel at 6.5 pounds per gallon. (Std. Day Only)

INTERNAL TANKS					
		QUANTITY			
		USABLE FUEL		FULLY SERVICED	
LOCATION		GALLONS	POUNDS	GALLONS	POUNDS
1	LEFT WING INTERNAL TANK	389.2	2,530.00	390.7	2,540.00
2	RIGHT WING INTERNAL TANK	389.2	2,530.00	390.7	2,540.00
3	FORWARD FUSELAGE TANK	2,808.30	18,254.00	2,825.20	18,364.00
4	FUEL LINES	37.1	241	53.4	347
5	AFT FUSELAGE TANK	1,428.80	9,287.00	1,430.90	9,301.00
TOTAL		5,052.60	32,842.00	5,090.90	33,092.00

EXTERNAL TANKS					
		QUANTITY			
		USABLE FUEL		FULLY SERVICED	
LOCATION		GALLONS	POUNDS	GALLONS	POUNDS
1	PIVOT PYLONS	601.2	3,908.00	603.4	3,922.00
2	FIXED PYLONS	603.2	3,921.00	605.4	3,935.00
3	LEFT WEAPONS BAY TANKS	269.20	1,750.00	272.30	1,770.00
4	RIGHT WEAPON BAY TANKS	290	1,885.00	293.1	1,905.00
TOTAL		1,763.60	11,464.00	1,774.20	11,532.00

FUEL QUANTITY MEASUREMENT SYSTEM

The fuel quantity measuring system is a basic capacitance sensing type system. There are four independent indicating functions: forward, aft, select, and total. The four indicating functions are housed in the fuel quantity indicator and the total select fuel quantity indicator. The independence of the total fuel quantity indication is achieved by use of dual sensor tank units. Each indicating function has a density compensation capacitor that will always be covered with fuel until the respective tank is empty. An exception occurs in the select circuit in the aft tank. The fuel gage test circuit substitutes a fixed value which should indicate 2000 pounds. A normal response by the indicators verifies that the indicator circuit is functioning normally.

FUEL PUMPS

There are 12 fuel pumps in the fuel system. The six fuselage fuel pumps are dual inlet booster pumps, and the four wing fuel pumps are single inlet transfer pumps. Booster pumps 1 and 3 are in bay F-2, 2 and 4 are in the reservoir tank, and 5 and 6 are in bay A-l. Transfer pumps 7 and 9 are in the left wing, 8 and 10 are in the right wing and 11 and 12 are in the left weapons bay tank. Pumps 3, 4, 5 and 6 are the primary engine feed pumps, and 1 and 2 are standby engine feed pumps. Number 1 boost pump is a standby pump and operates continuously with the engine feed selector switch in any position except OFF. When not needed for engine fuel supply, the fuel provided by pump 1 is circulated into the reservoir tank through a pressure relief valve. Number 2 pump is energized by the pressure sensing switch when on AFT feed, BOTH or when on AUTO feed and the fuselage fuel quantity indicator indicates less than approximately 8500 pounds differential between the forward and aft tanks. All pumps are controlled by 28 volt dc power and are energized by 115 volt ac power.

AUTOMATIC FUEL TRANSFER VALVE

Automatic fuel transfer valve is electrically operated by the fuselage fuel quantity indicator or the fuel dump switch, and mechanically operated by a float valve in the forward tank. The mechanical float valve allows the automatic fuel transfer valve to open when the forward tank fuel level drops below 9,000 pounds. If the engine feed selector is placed to a position that will cause the aft tank pumps to operate, the fuel will be transferred forward to maintain the 9,000 pound level until the aft tank is empty. Electrical operation of the automatic fuel transfer valve is described under "Automatic Fuel Distribution (Primary)" and "Fuel Dump System," this section.

ENGINE FUEL SUPPLY SYSTEM.

The engine fuel supply system functions in five modes to provide fuel flow to the engines and control the fuel distribution between the fuselage tanks. The five modes as selected with the engine feed selector knob are: AUTO, BOTH, FWD (forward), AFT and OFF. In the AUTO mode the fuselage fuel quantity indicator automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure an operational airplane center-of-gravity. Refer to "Automatic Fuel Distribution (Primary)," this section, for description of operation in the AUTO mode. In the OFF mode the engines are supplied with fuel by gravity (suction) from the forward tank. In the BOTH mode of operation, the left engine is fed from the forward tank and the right engine is fed from the aft tank. In this mode there is no automatic fuel distribution control and forward and aft tank fuel differential must be controlled by monitoring the fuselage fuel quantity indicator and manually selecting either FWD, AFT, or BOTH feed. During FWD or AFT mode operation, both engines are fed from the forward or aft tank respectively. When on AFT feed, under conditions of high fuel flow, the forward standby pumps will assist in meeting the high demand on an aft tank. In the event of loss of electrical power to the fuel system the engines will gravity (suction) feed from the forward tank.

AUTOMATIC FUEL DISTRIBUTION (PRIMARY).

In the AUTO mode, the fuselage fuel quantity is controlled by the F (forward) and A (aft) pointers on the instrument that automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure aircraft center-of-gravity. The engines are supplied fuel from the forward tank or both tanks depending upon the position of the switches in the indicator. If the differential in the forward tank is greater than approximately 8500 pounds, as is the case when the tanks are fully serviced and until all wing and external fuel has been transferred into the forward tank, the indicator will turn the aft tank pumps off, and feed both engines from the forward tank. As the differential between the tanks is decreased to approximately 8200 pounds, the indicator will detect the proper fuel distribution and feed the left engine from the forward tank and the right engine from the aft tank. When the differential between the tanks decreases to approximately 7900 pounds, the indicator will open an automatic transfer valve, to transfer fuel forward and regain the proper fuel distribution. With the engine feed selector in AUTO, when the differential between the forward and aft tank pointers becomes less than 7,600 pounds or greater than 10,000 pounds, switches in the indicator will cause the fuel distribution caution lamp to light.

WARNING

The use of AUTO engine feed when the fuselage fuel quantity indicator is malfunctioning or inoperative could result in exceeding the center-of-gravity limits and loss of control of the aircraft.

FUEL TRANSFER

In order to use the fuel in the external tanks, internal wing tanks, or weapons bay tanks, it must first be transferred to the fuselage tanks. Normally the tanks are emptied in the order of external, weapons bay, and then internal wing tanks. Fuel transfer is controlled by the transfer knob. The fuel level in the fuselage is maintained by float valves which open or close refuel valves to allow transfer into the fuselage tanks any time they are not full. The refuel valves cannot be controlled from the cockpit. Transfer from any pair of external tanks, weapons bay tanks, or internal wing tanks can be manually selected. (Refer to "Fuel System Operation," this section.) When automatic transfer is selected, the transfer of fuel is automatically sequenced from the outboard, center, and inboard external tanks, weapons bay tanks, and then the internal wing tanks, in that order.

Note

Both external tanks in a pair must be empty before transfer will commence from the next pair.

When the weapons bay tank runs dry, a one minute delay will occur to assure complete scavenging of the tank before the wing tanks will transfer. Transfer from the weapons bay and internal wing tanks is effected by transfer pumps. Transfer from the external wing tank is accomplished by pressurizing the selected tanks with cooled engine compressor bleed air at 36 to 41 psi. When transferring from the weapons bay- tanks, or wing tanks, the fuel pump low pressure indicator lamps should be used in conjunction with the fuel quantity indicator to determine when the particular tank is empty. The exact fuel quantity where the individual wing pump lamps light cannot be established accurately because it depends upon a large number of variables; attitude, wing sweep, roll angle, load factors, fuel temperature and density, weapon loading, wing deflection, etc. However, for level flight with the wing sweep forward, the outboard pumps normally run out of fuel and cause the outboard pump low pressure lamp to light before the inboard pump lights. If the wings are swept AFT, the reverse is true.

FUEL DUMP SYSTEM.

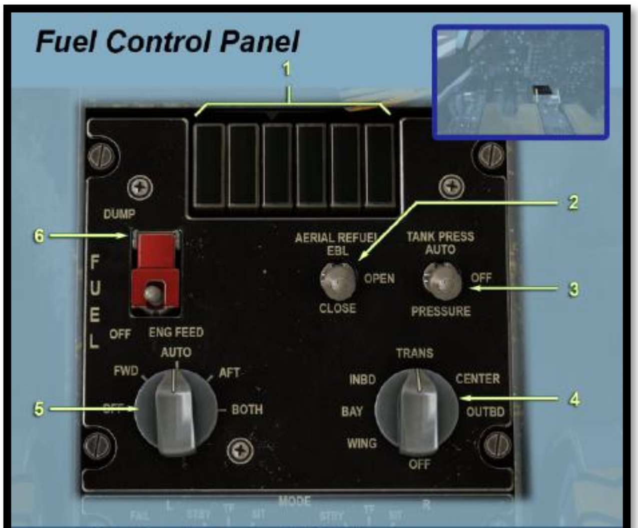
The fuel dump system provides the capability of jettisoning fuel at a rate of 2300 pounds per minute. Fuel tank pressurization provides the force to jettison the fuel from the forward tank into the dump manifold and overboard through the vent/dump outlet at the aft end of the fuselage. This flow is controlled by motor operated dump valves A and B which receive power through circuit breakers located in the crew compartment. These two valves provide redundant shutoff capability for the dump system and valves are normally closed except during dumping operation. Dump valve B normally prevents fuel loss from the forward tank in the event of a broken refuel/dump line. Dump valve A normally prevents refuel and transfer flow from going overboard through the vent/ dump outlet. In addition to dump valves A and B, dump valve C is provided. This valve is normally open but closes during dumping operation to prevent tank pressurization from flowing overboard through the dump line from the wings when the wing tanks are empty. Dump valve C receives power from dump A circuit breaker. The fuel dump system also utilizes the fuel transfer system to transfer fuel from the aft, bay and wing tanks to the forward tank. This is accomplished by relays which also receive power from dump B circuit breaker through the dump switch. When DUMP is selected, fuel immediately tarts to transfer from the aft and wing tanks. Weapons bay tanks (if installed) will transfer before the wing tanks.

AIR REFUELING SYSTEM.

The air refueling system is capable of receiving fuel from a flying-boom type tanker aircraft. The system consists of a hydraulically actuated receptacle and slipway door, a signal amplifier, and the associated controls and indicators. Hydraulic pressure for operation of the receptacle and its latch mechanism is supplied by the utility hydraulic system. The receptacle is located on top of the fuselage offset to the left and aft of the crew module. When the receptacle is extended, a mechanical linkage retracts the aft end of the slipway door into the fuselage forming a slipway into the receptacle. When retracted the slipway door is flush with the fuselage skin. The refueling receptacle is equipped with two lamps located one on each side. As the receptacle extends, the lamps will light the receptacle and the slipway area. During normal refueling operations, the refueling boom enters the receptacle and is automatically latched in place by a hydraulically actuated latching mechanism. When the boom is latched in place, fuel flows through the receptacle and the refuel/transfer fuel manifold lines into the fuel tanks at a rate of 5100 to 5800 pounds per minute. As the tanks are filled, float operated valves automatically close the tank refueling valves shutting off flow to the tanks. When the last tank refuel valve closes an increase in the refuel line pressure is sensed by a pressure switch which automatically provides a signal to unlatch the boom from the receptacle. A disconnect signal can be manually initiated at any time during refueling by either receiver pilot or by the tanker boom operator. If a disconnect cannot be made by other methods, a brute force pull-out can be safely accomplished. An emergency boom latch capability is provided to latch the boom in place in the event the boom will not latch in the receptacle during normal operation. The emergency boom latch function also provides pneumatic power to open the doors and extend the receptacle in the event utility hydraulic pressure is lost. Sufficient pneumatic pressure is available to operate the receptacle through two cycles (open and close) with 4 hookups during each cycle.

SINGLE POINT REFUELING SYSTEM.

The single point refueling system enables all aircraft fuel tanks to be pressure filled simultaneously from a single refueling receptacle. During ground refueling operations, fuel flows through the refueling receptacle and refueling manifold into the fuel tanks. As each tank fills, a float operated valve automatically closes the refuel valve stopping flow to the tank. The single point refueling receptacle is located on the left side of the fuselage forward of the engine air intake.



1. Fuel Pump Low Pressure Indicator Lamps.
2. Air Refueling Switch.
3. Fuel Tank Pressurization Selector Switch.
4. Fuel Transfer Knob.
5. Engine Feed Selector Knob
6. Fuel Dump Switch.

Figure 1-8

FUEL SYSTEM CONTROLS AND INDICATORS.

Engine Feed Selector Knob.

The engine feed selector knob (5, figure 1-8), located on the fuel control panel, has five-positions marked OFF, FWD, AUTO, AFT, and BOTH. When the knob is rotated to OFF, all fuel boost pumps are de-energized. Each knob position will energize the following pumps or place them on standby as indicated:

FWD	1, 2, 3 and 4 energized.
AUTO	Fwd &. Aft fuselage fuel quantity indicator differential approximately 8200; 1, 3, 4, 5 & 6 energized; 2 on standby. Fwd & Aft fuselage fuel quantity indicator differential approximately 7900 or less; 1, 3, 4, 5 & 6 energized, 2 on standby. Fwd & Aft fuselage fuel quantity indicator differential approximately 8500 or greater; 1, 2, 3, & 4 energized.
AFT	1, 5 & 6 energized, 2 on standby.
BOTH	1, 3, 4, 5 & 6 energized, 2 on standby.

When the knob is placed to FWD both engines are fed from the forward tank. When the knob is placed to the AUTO position the fuselage fuel quantity indicator, controlled by the F (forward) and A (aft) pointers on the instrument, automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure an operational aircraft center-of gravity. The engines are supplied fuel from the forward tank or both tanks depending upon the position of the pointers. When the knob is placed to AFT, both engines are fed from the aft tank. However, when on AFT feed under conditions of high fuel flow, the forward standby pumps will assist in meeting the high demand on the aft tank. The standby pumps will also feed the engines from the forward tank should the aft tank run dry when on AFT feed.

WARNING

Do not use AFT feed selection when negative g operation is anticipated. Under negative g conditions only number 2 standby pump will be feeding the engines and engine flameout could result at MIL power or above.

When the knob is placed to the BOTH position the left engine is fed from the forward tank and the right engine is fed from the aft tank. In this position there is no automatic fuel distribution control and forward and aft tank fuel differential must be controlled by monitoring the fuselage fuel quantity indicator and manually selecting either FWD, AFT, or BOTH feed.

Note

The knob must be in either the AUTO or BOTH position to enable the functions of the air refueling switch and the BOTH position should be selected to insure taking on a full load of fuel during air refueling.

Fuel Transfer Knob.

The fuel transfer knob (4, figure 1-8), located on the fuel control panel, has seven positions marked WING, BAY, INBD, AUTO, CENTER, OUTBD, and OFF. When the knob is in the OFF position, all fuel transfer functions are off. When the knob is rotated to WING, four transfer pumps, two in each wing tank, are energized; and fuel is transferred from the wing tanks to the fuselage tanks. When the knob is positioned to BAY, two transfer pumps in the left weapons bay tank are energized to transfer fuel to the fuselage tank. The INBD, CENTER, and OUTBD positions of the knob are for transferring fuel from external tanks when installed. The AUTO position automatically sequences the transfer of fuel from the outboard, center, and inboard external tanks, weapons bay tanks, and the wing tanks in that order. If an external tank is not installed, the sequence of transfer remains the same except the missing tank is skipped.

Note

When all fuel has been transferred, as indicated by the fuel quantity indicator and fuel pump low pressure indicator lamps, the knob should be turned to OFF. This will prevent excessive fuel transfer pump wear, conserve electric power and turn off the fuel pump indicator lamps. The fuel transfer knob must be in the OFF position to allow refueling the wing and weapons bay tanks. Common fuel manifold lines are utilized for both fuel transfer and refueling, therefore if the transfer system is maintaining pressure in the manifold the refueling valves in these tanks cannot open to allow refueling.

Fuel Dump Switch

The fuel dump switch (6, figure 1-8), located on the fuel control panel, is a two-position switch marked DUMP and OFF. A guard holds the switch in the OFF position to prevent inadvertent actuation. The functions of this switch are explained under "Fuel Dump System," this section.

Fuel Tank Pressurization Selector Switch.

The fuel tank pressurization selector switch (3, figure 1-8), located on the fuel control panel, is a three-position, lever-lock switch marked AUTO, OFF, and PRESSURIZE. When the switch is positioned to AUTO, the fuel tanks are pressurized, except when the landing gear is down, or the air refueling door is open.

Note

Only AUTO mode supported.

Air Refueling Switch.

The air refueling switch (2, figure 1-8), located on the fuel control panel, is a three position lever Jock toggle switch marked EBL, OPEN and CLOSE. Refer to "Air Refueling," this section, for operation of the air refueling switch.

Fuel Quantity Indicator Selector Knob.

The fuel quantity indicator selector knob (44, figure 1-5), located on the left main instrument panel, has nine positions marked L WING, R WING, BAY, LI (left inboard external tank), RI, LC (left center external tank), RC, LO (left outboard external tank) and RO. Placing the knob to the desired tank enables reading the amount of fuel remaining in that tank on the total/select fuel quantity indicator.

Total/Select Fuel Quantity Indicator.

The total/select fuel quantity indicator (43, figure 1-5), located on the left main instrument panel, provides indications of total fuel in all tanks and the fuel remaining in individual wing or external pylon tanks. The indicator is graduated from zero to 5 (times 1000 pounds) in increments of 100 pounds and has a pointer and a five digit counter. The pointer will read the fuel remaining in the wing or external tank as selected by the fuel quantity indicator selector knob. The counter continuously reads the total fuel remaining in all tanks. Due to fuel quantity indicating system tolerance it is possible to have a small amount of fuel remaining in the wing tanks when the select fuel indicator reads empty. The fuel pump low pressure indicator lamps for the wing transfer pumps provide the most positive indication that the wing tanks are completely empty. The select fuel quantity indicator circuit uses a compensator sensor, located in the aft tank, to correct for variations in fuel densities. If the aft tank is emptied while there is fuel in one or more of the wing or external tanks, the uncovering of the compensator will cause the select gage indications to read erroneously high. The actual error will depend on the amount of fuel remaining in other tanks, however, a maximum error of 1000 pounds could exist.

Fuselage Fuel Quantity Indicator.

The fuselage fuel quantity indicator (4l, figure 1-5), located on the left main instrument panel, provides indications of the amount of fuel in the forward and aft fuselage tanks. In addition, when operating in automatic engine feed the indicator, through a series of internal switches controlled by the F (forward) and A (aft) pointers on the instrument, automatically maintains the fuel distribution between the fuselage tanks within prescribed limits to assure aircraft center-of- gravity. Refer to "Automatic Fuel Distribution (Primary)," this section, for a description of this function of the fuel quantity indicator.

WARNING

The use of auto engine feed when the fuselage fuel quantity indicator is malfunctioning or inoperative could result in exceeding the center-of-gravity limits and loss of control of the aircraft.

The indicator is graduated from 0 to 20 (times 1000 pounds) in 500 pound increments. The indicator has two pointers marked F (forward) and A (aft) for the forward and aft tanks. When operating in automatic engine feed, the A pointer will be maintained approximately 8200 pounds below the F pointer. In this position the F pointer will be between two dot indices on the outer scale of the indicator. One dot indicates the point at which aft to forward transfer will occur, and the other indicates the point at which the aft tank pumps are shut off to maintain the 8200 pound differential. Two bar indices outboard of the dots indicate the point at which the fuel distribution caution lamp will light to indicate that the fuel differential between the forward and aft tanks is out of tolerance. The indices move with the A pointer and thus provide a ready reference of fuel differential when operating in manual engine feed.

Fuel Manifold Low Pressure Caution Lamps.

Two amber fuel manifold low pressure caution lamps (figure 1-37), are located on the main caution lamp panel. The letters R FUEL PRESS or L FUEL PRESS are visible when the respective lamp is lighted. The applicable lamp lights any time the fuel pressure in the right or left fuel manifold is less than 15.5 psi.

Fuel Low Caution Lamp.

The amber fuel low caution lamp (figure 1-37) located on the main caution panel is controlled by a float switch in the reservoir tank. When the lamp is lighted, the letters FUEL LOW arc visible indicating that the fuel level in the reservoir tank is less than 2300 (+-235) pounds. Due to the gaging system tolerances, the forward fuel quantity indication will be between 1700 and 3000 pounds.

WARNING

Negative g operation must be avoided whenever the fuel low caution lamp is lighted. The fuel system can supply fuel to the engines during negative g operation for 10 seconds if the reservoir tank is initially full. There may be no negative g capability if the fuel low caution lamp is on, indicating that the reservoir tank is not full.

Fuel Pump flow Pressure Indicator Lamps.

Twelve fuel pump low pressure indicator lamps (1, figure 1-8), one for each fuel pump, are located on the fuel control panel. When a fuel pump is energized, whether by automatic or manual tank selection, and the pump is not generating at least 3-5 (±0.5) psi, the lamp corresponding to the pump will light. The lamps are arranged in a double row, and the face of the lamps are marked in pairs to correspond to each pump as follows:

S	Standby pumps 1 and 2
F	Forward fuselage tank pumps 3 and 4
I	Wing tank inboard transfer pumps 7 and 8
B	Weapons bay tank transfer pumps 11 and 12
A	Aft fuselage tank pumps 5 and 6
O	Wing tank outboard transfer pumps 9 and 10.

Fuel Tank Pressurization Caution Lamp.

The fuel tank pressurization caution lamp (figure 1- 37), located on the main caution lamp panel, lights when fuel tank air pressure drops below approximately 3.5 (±.5) psi during flight with the landing gear and the air refueling receptacle retracted. The lamp also lights any time the fuel tanks are pressurized and the landing gear or air refueling receptacle is extended. When the lamp lights the letters TANK PRESS are visible.

Fuel Distribution Caution Lamp.

The fuel distribution caution lamp (figure 1-37), located on the main caution panel, is provided to indicate an abnormal fuel distribution between the forward and aft tanks. The lamp has two signal input sources: (1) With the engine feed selector in AUTO, the automatic fuel distribution control system will light the lamp if the differential between the F and A pointers becomes less than 7600 pounds or greater than 10,000 pounds. (2) With the engine feed selector in any position, including OFF, the alternate fuel distribution monitoring system will light the lamp for abnormal aft center-of-gravity conditions only.

Note

The fuel distribution caution lamp will function only in AUTO mode.

Nose Wheel Steering/Air Refueling Indicator Lamp.

The nose wheel steering/air refueling indicator lamp (22, figure 1-5), located on the left main instrument panel, is labeled NWS/AR. For air refueling, the lamp indicates when the air refueling circuitry is set to receive the refueling boom. As the receptacle extends into place, the lamp will light. When the boom is latched in the receptacle, the lamp will go out. When the boom disconnects, the lamp will light again.

FUEL SYSTEM OPERATION.

The fuel system can be operated in either an automatic or manual mode. The automatic mode is normally used since is requires a minimum amount of crew monitoring. Manual mode serves primarily as a backup in the event automatic operation malfunctions.

Normal (Automatic) Operation.

Normal system operation is accomplished with both the engine feed selector and fuel transfer knobs in AU'1'O. In this configuration the following functions are automatically performed:

- As fuselage fuel is used, fuel is transferred into the fuselage tanks from the external tanks, weapon bay tanks and internal wing tanks, in that sequence.
- If all tanks were fully serviced at takeoff both engines will be fed from the forward fuselage tank until external and internal wing tanks and weapon bay tanks are expended and the fuel level in the forward tank is burned down to approximately 8200 pounds of fuel more than the aft tank. At this point the system will automatically switch to a split feed condition (feeding the right engine from the aft tank and the left engine from the forward tank) to maintain the differential thereby keeping the aircraft center-of-gravity within operational limits.
- If the forward tank is burned down to approximately 7900 differential the automatic transfer valve will open to allow fuel to be transferred from the aft tank to the forward tank. This will re-establish the 8200 pound differential.
- If the aft tank is burned down to 8500 pounds differential, the aft tank pumps are turned off and both engines are fed from the forward tank until the 8200 pound differential is re-established.

Manual Operation.

In the event that either automatic engine feed or automatic fuel transfer become inoperative, manual backup is available. During manual engine feed the forward tank must be maintained at least 8000 pounds more than the aft tank by manual selection of either FWD or AFT feed to establish the proper differential. Once the differential has been established BOTH should be selected to maintain the differential. During manual transfer the fuel transfer knob is positioned progressively to OUTBD, CENTER, INBD, BAY, and WING to empty the external wing, bay, and internal wing tanks, in that sequence. As each tank is selected for transfer, the corresponding fuel quantity indicator selector knob position should be selected to monitor the fuel level in the tank being emptied. It will be necessary to frequently switch the knob between die left and right external and internal wing tanks to monitor fuel transfer from these tanks.

Gravity Fuel Feed.

The engine driven fuel pumps will gravity (suction) feed the engines in the event of an electrical malfunction which prevents booster pump operation. In this condition fuel will be used from the forward tank only. An anti-suction valve between the forward and aft tanks prevents suction feed from the aft tank to prevent the suction of air into the engine feed line in the event the aft tank is empty.

Fuel Dumping.

With the fuel dump switch in the OFF position, dump valves A and B are closed and C is open. When the switch is positioned to DUMP, the following events occur:

- Dump valves A and B open and C closes
- The automatic transfer valve opens
- The fuel tanks pressurize (with the air source selector knob in any position other than OFF or EMER)
- Booster pumps 5 and 6 in the aft tank transfer fuel to the forward tank (If in AUTO with more than 8500 pound differential, 6 only)
- Transfer pumps 11 and 12 in the weapons bay tank, if installed, transfer fuel to the forward tank

When the weapons bay tanks are empty, pumps 7, 8, 9 and 10 transfer fuel from the wing tanks to the forward tank The fuel tanks will pressurize when the dump switch is in DUMP regardless of the position of the fuel tank pressurization selector switch, the landing gear handle, or the air refueling door, provided the air source selector knob is in a position other than OFF or EMER. Sufficient air is available to obtain the normal dump rate of 2300 pounds per minute when either engine RPM exceeds 85 percent. Tank pressurization forces fuel from the forward fuselage tank into the dump manifold and overboard through the vent/dump valve located on the aft center body. Fuel will be transferred from aft to forward tank at approximately 1750 pounds per minute if both aft tank pumps are operating or at 1100 pounds per minute if only one pump is operating. If external tank transfer is selected during a dumping operation, the rate of transfer from the external tanks is relatively slow; therefore, if required by operational considerations, these tanks should be jettisoned. All fuel except that in the reservoir tank (approximately 2500 pounds) can be dumped.

WARNING

To avoid the possibility of dumped fuel reentering the aircraft and causing a fire hazard, fuel dumping should be accomplished in straight and level flight at airspeeds no greater than 350 KIAS or Mach 0.75, whichever is less.

Note

If dumping operation is necessary during afterburner operation, the fuel may ignite behind the aircraft. Other aircraft in the immediate vicinity should be advised to stay well clear during dumping operations.

To eliminate prolonged fuel dripping from the fuel dump outlet after dumping is discontinued, the fuel system may be momentarily depressurized to clear residual fuel from the fuel dump lines. (This will happen automatically when the landing gear is extended for landing.) The quantity of the fuel that can he dumped from the forward tank depends on the attitude of the aircraft, the higher the nose of the aircraft, the more fuel dumped. At level flight, the dump flow from the forward tank will cease at a fuel quantity in the forward tank of approximately 13,000 pounds. In order to obtain maximum fuel dump rate, without tank pressurization, the engine feed selector switch should be positioned to BOTH to prevent the automatic fuel distribution system from turning off number 5 booster pump.

Air Refueling.

In order to open the receptacle the engine fuel feed selector must be selected to AUTO or BOTH, and the air refueling switch must be selected to OFFN or EBL. When the receptacle is open, the NWS A/R lamp will light to indicate the receptacle is open and the system is ready to accept the refueling probe.

Note

During ground operation when the air refueling door is open, the nose wheel steering/air refueling indicator lamp will light to indicate door position and nose wheel steering cannot be monitored.

ELECTRICAL POWER SUPPLY SYSTEM.

The electrical power supply system provides 115 volt, three-phase, 400 cycle ac power and 28 volt tic power. Two ac generator drive assemblies, one mounted on each engine, supply ac power. Two transformer rectifier units provide 28 vole dc power.

ALTERNATING CURRENT POWER SUPPLY SYSTEM.

AC power is supplied by two 60 kva generating systems. Each generator is driven by a constant-speed drive assembly which regulates generator frequency at 400 cycles per second. A cooling system is provided to cool constant-speed drive oil with ram air and by circulating the oil through the fuel-oil cooler. The left and right generators operate independently and there is no phase synchronization between them. Voltage regulation and system protective functions are performed by generator control units. There are three ac buses: a left main ac bus, a right main ac bus, and an essential ac bus. During normal operation, the right generator supplies power to the right main ac bus, and the left generator to the left main ac bus and the essential bus. Each generator is connected to its associated bus with multiple wire generator feeders. Power transfer contactors located near the main ac buses are used to switch the buses from one generator to another. Each main ac bus is normally individually powered and isolated from the other. The power contactors provide a bus tie function automatically in the event of a generator failure. If a fault or malfunction occurs causing an undervoltage, overvoltage, underfrequency, or overfrequency, the associated ac generator control unit removes the generator from the bus. Undervoltage or overvoltage de-excites the generator and disconnects it from the bus. Underfrequency or overfrequency docs not de-excite the generator but disconnect it from the bus. If the Malfunction is corrected, the generator may be reconnected to the bus by properly positioning the generator switch. If a malfunction causing an excessive amount of heat occurs in the constant-speed drive unit, a thermal device in the unit automatically decouples the drive from the engine. Once decoupled, the drive cannot be recoupled during flight. An emergency generator with a 10 kva output is provided to generate electrical power in the event of failure of both main ac generators. The emergency generator is driven by a hydraulic motor which receives power from the utility hydraulic system. In the event of loss of both primary generating systems, a solenoid-operated valve is de-energized, allowing hydraulic pressure to operate the emergency generator. Emergency generator power is applied to the ac and dc essential buses and to the 28 volt dc engine start bus.

Generator Switches.

Two generator switches (1, figure 1-10), located on the electrical control panel are marked OFF-RESET RUN and START. The switches are lever locked in the OFF-RESET position and are spring-loaded from START to RUN. Placing either switch to OFF-RESET will reset the generator-control unit of the respective generator, but will not excite the generator. Holding the switch to START will excite the generator automatically and connect it to its respective bus. This will be indicated by the power flow indicator and the generator caution lamp will go out. Allowing the switch to return to RUN, after the generator has been connected to its bus, establishes a switching configuration that assures safe operation in the event of a subsequent malfunction. The switch must be positioned to OFF-RESET to allow generator de-coupling.

Generator Decouple Pushbuttons.

The generator decouple pushbuttons (5 figure 1-10), located on the electrical control panel, are provided to actuate the constant-speed drive decoupler. When a pushbutton is depressed, the constant-speed drive will be decoupled. Once decoupled, the constant-speed drive cannot be reconnected during flight.

Note

This function is not implemented.

Electrical Power Flow Indicator.

The electrical power flow indicator (4, figure 1-10), located on the electrical control panel, is a flip-flop type indicator labeled AC BUSSES and displays the various bus configurations. If both buses are receiving power from their respective generator, the indicator will display NORM, indicating that the buses are isolated from each other and are operating normally. If only one generator is providing power for both buses, the indicator will display TIE. When the emergency generator is operating and supplying power to the ac essential bus, the indicator will display EMER. When ground power is connected to the aircraft and supplying power to the ac buses, the indicator will display TIE until the right engine is started and its generator comes on the line, then it will indicate NORM. The indicator will display a crosshatched surface if there is no ac power applied to the aircraft while the emergency generator switch is in TEST.

Emergency Generator Switch.

The emergency generator switch (7, figure 1-10), located on the electrical control panel, is a toggle switch having positions marked ON, AUTO, and TEST. When the switch is in the ON position, the hydraulically driven emergency generator is operating, but not connected to the essential ac bus unless all ac power is lost. In the AUTO position, if all ac power is lost, the emergency generator hydraulic valve will open, the emergency generator will operate, and the ac essential bus transfer relay will be energized, thereby connecting the emergency generator to the essential ac bus.

Emergency Generator Indicator/Cutoff Push Button.

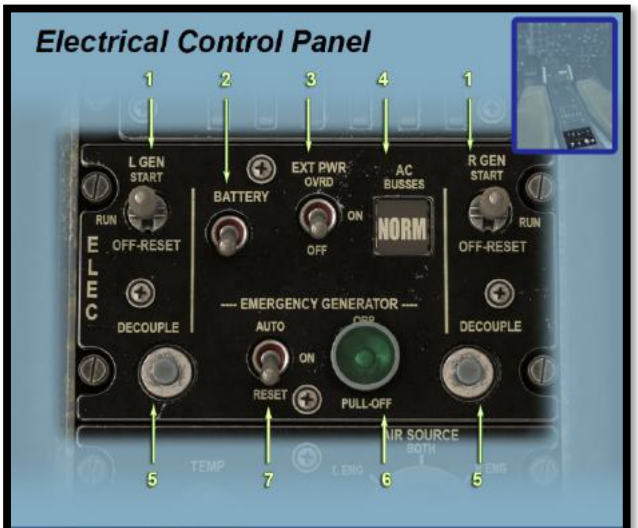
The emergency generator indicator/cutoff push button (6, figure 1-10), located on the electrical control panel, provides a means of de-exciting the emergency generator.

Note

This function is not implemented.

External Power Switch.

The external power switch (3, figure 1-10), located on the electrical control panel, is a toggle switch having positions marked OFF, ON and OVRD. In the OFF position, external power cannot be supplied to the aircraft ac buses. In the ON position with neither engine operating, external power supplies total aircraft power. With the left engine operating, the left main ac generator will supply total aircraft electrical load, and external power is disconnected from the ac buses.



1. Generator Switches.
2. Battery Switch.
3. External Power Switch.
4. Electrical Power Flow Indicator.
5. Generator Decouple Pushbuttons.
6. Emergency Generator Indicator/Cutoff Pushbutton.
7. Emergency Generator Switch.

Figure 1-10

With only the right engine operating, the right main ac generator supplies power to the right main ac bus, and external power feeds the left main ac and essential buses. Associated with the external power is a power monitor which measures external power voltage, frequency and phase sequence. Should any one of these parameters be out of tolerance, the monitor prevents closing of the external power contactor. When the external power switch is in the OVRD position, the external power monitor circuit is bypassed, thus allowing external power which is out of voltage and frequency tolerance to be applied to aircraft buses. The override position does not override external power with improper phase sequence.

Generator Caution Lamps.

Two generator caution lamps (figure 1-37), are located on the main caution lamp panel. Either lamp will light when its respective generator is disconnected from its bus and remain lighted until the generator switch has been placed to START. When lighted, the letters I. GEN are visible in the left lamp and R GEN in the right lamp.

DIRECT CURRENT POWER SUPPLY SYSTEM.

DC electrical power is provided by two 28 volt dc transformer-rectifier units (converters) and a 24 volt battery. There are three dc buses: a main dc bus, an essential dc bus, and an engine start bus. The essential dc bus is divided into two separate buses, one located in the forward equipment bay and one located in the crew module on the aft console. The essential buses are electrically connected. During normal operation, the main dc bus section receives power from the main transformer-rectifier unit which is connected to the right main ac bus. The essential dc bus and the engine start bus receive power from the essential transformer-rectifier unit which is connected to the essential ac bus. A bus-tie contactor connects the essential dc bus to the main dc bus during normal operation. Normally the outputs of the two transformer-rectifier units supply the total dc load in parallel.

Battery Switch.

The battery switch (2, figure 1-10), is located on the electrical control panel. The two position switch is marked OEF and ON. Positioning the switch to ON connects the engine start bus to the airplane 24 volt battery, provided the essential dc bus is not energized. If the essential dc bus is energized, the battery is connected to the main dc bus through the battery charger circuit, and the engine start bus is connected to the essential dc bus. When the battery switch is positioned to OEF, the battery charger circuit is disconnected from the main dc bus.

HYDRAULIC POWER SUPPLY SYSTEM.

Hydraulic power is supplied by two independent, parallel hydraulic systems designated as the primary and utility systems. Both systems operate simultaneously to supply hydraulic power for the flight controls and wing sweep. If one or the other system should fail, either system is capable of supplying sufficient reduced power for wing sweep and flight control operation. The primary hydraulic system supplies hydraulic power solely for operation of the wing sweep and flight control systems. In addition to supplying wing sweep and flight control hydraulic power, the utility system also supplies power for operation of:

- Nose wheel steering
- Landing gear
- Wheel brakes
- Speed brake
- Flaps/slats
- Rotating glove
- Weapons bay doors
- Rudder authority
- Weapons bay gun
- Tail bumper
- Emergency electrical generator
- Air inlet (spike) control
- Air refueling system

Hydraulic pressure for each system is supplied by two engine-driven, variable delivery pumps. To assure hydraulic pressure in the event of single engine failure, one pump in each system is driven by the right engine, and one pump in each system is driven by the left engine. Pressurized accumulators are installed in the system to supplement engine-driven pump delivery during transient hydraulic power requirements. Each system has a piston-type reservoir for hydraulic fluid storage that also acts as a surge damper for return line pressures. These reservoirs are pressurized with nitrogen to insure critical pump inlet pressure for all operating conditions. Hydraulic pressure of each system is displayed on the left main instrument panel. Low pressure caution lights for each of the four pumps are displayed on the caution lamp panel. An isolation unit incorporated into the system reserves utility pressure for flight control and wing sweep only, in the event of primary system failure. It also performs a second function of isolating hydraulic pressure after takeoff from those systems normally only associated with takeoff and landing.

HYDRAULIC PRESSURE INDICATORS.

Two 0-4000 psi pressure indicators (37, figure 1-5), one each for the utility and primary systems, are located on the left main instrument panel.

LOW PRESSURE CAUTION LAMPS.

Four low pressure caution lamps, energized by pressure switches in each pump pressure line, are located on the main caution lamp panel. These lamps light before system pressure descends below 400 psi. When lighted, the letters L PRI HYD, L UTIL HYD, R PRI HYD, and R UTIL HYD will be visible in the respective lamps.

MAXIMUM SAFE MACH ASSEMBLY.

The maximum safe Mach assembly (MSMA) receives Mach number, pressure altitude, and true free-stream air temperature signals from the central air data computer (CADC) and wing sweep position from the wing sweep sensor. The MSMA commands the maximum safe Mach (MSM) bar on the airspeed-Mach indicator (AMD and the reduce speed warning lamp. The MSMA computes the maximum continuous safe Mach (design speed) of the aircraft based upon pressure altitude, wing sweep, and temperature. The lower of the two computed limits: (1) design speed as a function of pressure altitude and wing sweep, or (2) design speed as a function of the aircraft skin temperature limit (418°F) is displayed. The MSMA also computes the actual aircraft Mach number to the maximum safe Mach, computed as a function of pressure altitude and wing sweep, and provides a signal to light the reduce speed warning lamp when the aircraft reaches this allowable design speed. The MSMA utilizes 115 volt ac power from the essential ac bus through the CADC power switch and 28 volt dc power from the essential dc bus. A power failure to the MSMA will cause the CADS caution lamp to light.

WARNING, CAUTION AND INDICATOR LAMPS.

In order to keep instrument surveillance to a minimum, warning, caution, and indicator lamps are located throughout the cockpit. All of these lamps except the master caution lamp are described under their respective systems. For location of the lamps throughout the cockpit see (figure 1-37).

MASTER CAUTION LAMP.

The master caution lamp (26, figure 1-5), located on the left main instrument panel, will light to alert the crew that a malfunction exists when any of the individual caution lamps on the caution lamp panel light to indicate a malfunction. The lamp will remain lighted as long as an individual caution lamp is on; however, it should be reset as soon as possible by depressing the face of the lamp so that other caution lamps can be monitored should additional malfunctions occur. The lamp can be checked by depressing the malfunction and indicator lamp test button.

LIGHTING SYSTEM.

The lighting system is divided into external and internal lights.

EXTERIOR LIGHTING.

The exterior lights include: position lights, formation lights, anti-collision/fuselage lights, air refueling lights, landing lights and a taxi light (Refer to figure 1-1). The position lights consist of green lights in the right glove and wing tip, red lights in the left glove and wing tip and a white tail light. The wing tip position lights will light when the wing sweep angle is between 16 and 30 degrees. When the wings are swept aft of 30 degrees the wing tip light will go out and the glove light will light. The reverse will occur as the wings are swept forward. The formation lights consist of a set of two lights, located on the upper and lower surfaces of each wing tip, and four lights located forward and aft of each side of the fuselage. The lights in the wing tips correspond to the color of the left and right position lights. The fuselage lights are amber. Two anti-collision/fuselage lights, one located on top and one located on the bottom of the fuselage, serve as white fuselage lights when retracted and flashing red anti-collision lights when extended. Two air refueling lights mounted in the air refueling receptacle are provided for night refueling operations. A limit switch on the air refueling receptacle door provides power to the receptacle light control knob when the door is open. Two landing lights and a taxi light are located on the nose landing gear.

Position Light Switches.

Three position light switches (7, figure 1-38) are located on the lighting control panel. Two switches, labeled WING and TAIL, have three positions, marked BRT (bright), OFF and DIM, for selecting the desired intensity of the position lights. The third switch is a two position switch marked FLASH and STEADY to control the operation of the position lights. Placing the switch to FLASH causes the position lights to flash at a rate of 80 cycles per minute.

Lighting Control Panel

1. Formation Lights Switch.
2. Fuselage Lights Switch.
3. Anti Collision Lights Switch.
4. Internal Lighting Control Knobs (9).
5. Malfunction and Indicator Lamp Dimming Switch.
6. Malfunction and Indicator Lamp Test Button.
7. Position Lights Switches.

Figure 1- 38

Formation Lights Switch.

The formation lights switch (1, figure 1-38), located on the lighting control panel, provides selection of the desired intensity of the lights. The switch is marked BRT (bright), OFF and DIM and controls 115 volt ac power from the left main ac bus.

Anti-Collision Lights Switch.

The anti-collision lights switch (3, figure 1-38) is located on the lighting control panel. The switch is labeled ANTI-COLLISION and has one position marked OFF and an unmarked ON position. Placing the switch to ON causes the anti-collision lights to light, extend and rotate. Placing the switch to OFF causes the lights to retract, go out and stop rotating. The switch controls 115 volt ac power from the main ac bus.

Fuselage Lights Switch.

The fuselage lights switch (2, figure 1-38) is located on the lighting control panel. The switch is labeled FUSELAGE and has a position marked OFF and an unmarked ON position. Placing the switch to ON, lights a white light in the top and bottom of the fuselage.

Landing and Taxi Lights Switch

The landing and taxi lights switch (3, figure 1-56) is located on the miscellaneous switch panel. The switch is marked LANDING, OFF and TAXI. If the switch is left in either the LANDING or TAXI positions on takeoff, a switch on the nose gear down lock will turn them off when the gear is retracted. The switch controls 28 volt dc power from the essential bus which in turn controls relays to provide 115 volt ac power to a transformer which in turn provides 28 volt ac power to the filaments in the lights.

INTERNAL LIGHTING.

The internal lights include: red instrument panel and console lights, red and white flood lights and utility lights. The instrument panel and console lights consist of five circuits, each with an individual control knob, for the flight instruments, engine instruments, left and center console, right console and right main instrument panel. They are powered by 115 volt ac power from the right main ac bus.

CANOPY.

The canopy consists of left and right clam shell hatches hinged to a center beam assembly. The hatches open to a maximum of 65 degrees. Each hatch has an external and internal canopy latch handle for opening or closing. When the hatches are closed and latched, the internal handle locks in place to prevent inadvertent unlatching of the hatch in flight. Each hatch is manually raised or lowered with the aid of an air/oil counterpoise. The counterpoise will also hold the hatch in any position selected.

CANOPY UNLOCK WARNING LAMP.

A red canopy unlock warning lamp located on the left warning and caution lamp panel (figure 1-37) will light when either hatch is not locked. When lighted the word CANOPY is visible on the face of the lamp.

FUSELAGE FIRE SYSTEMS.

Two separate systems are provided for fuselage fire detection and extinguishing, and wheel well overheat detection. The fuselage fire and extinguishing system provides protection for the weapons bay, cheek areas, and crew module stabilization glove area. The wheel well overheat detection system provides an indication of overheat in the wheel well area. Both systems consist of sensing elements, warning or caution lamps and test circuits. The fuselage fire detection system also includes an extinguishing agent similar to the engine fire detect system.

FUSELAGE FIRE DETECTION AND EXTINGUISHING SYSTEM.

A fire detection and extinguishing system is provided to detect fire in the weapons bay, cheek areas, and crew module stabilization glove area. When a sufficient rise in temperature is detected by sensors in these areas a fuselage fire warning lamp will light. When a fire is indicated an extinguishing agent may be discharged into the protected areas simultaneously from a single container located in the nose wheel well area. The system is supplied ac power from the ac essential bus, and dc power from the dc essential bus.

Fuselage Fire Pushbutton Warning Lamp.

The fuselage fire pushbutton warning lamp (2, figure 1-5), located on the left main instrument panel, is labeled FUSELAGE. When a fire is detected the warning lamp will light displaying the words FIRE PUSH. Depressing the button will arm the extinguishing agent discharge/fire detect test switch. The agent discharge/fire detect switch must be placed to the AGENT DISCH position to discharge the extinguishing agent. Redepressing the fuselage fire pushbutton warning lamp will disarm the fire extinguisher agent discharge switch.

Note

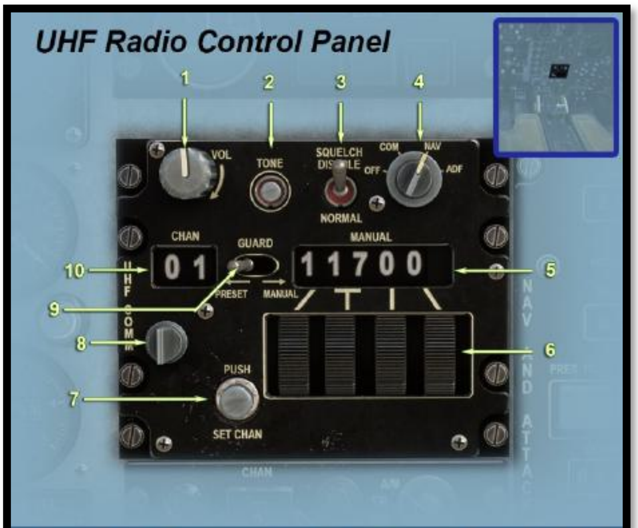
The fuselage fire warning lamp may not go out immediately after discharging the fire extinguishing agent if aircraft structure or equipment adjacent to the sensing element was heated to a temperature above the element setting.

Agent Discharge/Fire Detect Test Switch.

Positioning the agent discharge/fire detect test switch (3, figure 1-5) to the lever-locked AGENT DISCH position causes fire extinguishing agent to be discharged into the affected fuselage area, provided the fuselage fire pushbutton warning lamp has been depressed. Holding the switch to the spring-loaded FIRE DETECT TEST position will light the fuselage fire pushbutton warning lamp if the fuselage fire detection system is operational. For further information on this switch, refer to "Engine Fire Detection and Extinguishing System" and "Wheel Well Overheat Detection System," this section.

UHF COMMAND RADIO (AN/ARC-109).

The UHF command radio provides air-to-air and air-to-ground communications and automatic direction finding (ADF) in conjunction with the AN/ARA-50. The radio equipment consists of a receiver-transmitter unit, a control panel, an antenna selector, blade type upper and lower antenna, and a loop ADF antenna. There are 3500 channels available in 50 kilohertz increments in the frequency range from 225.00 to 399.95 megahertz. The receiver- transmitter unit and guard receiver are located in the right forward equipment bay. The receiver section of the receiver-transmitter unit provides ADF bearing signals to the number two pointer of the bearing distance heading indicator and audio to the interphone when the ADF function is selected. The control panel allows selection of 20 preset channels and manual selection of any frequency in the frequency range of the radio. The upper and lower antenna complement each other to provide omni-directional antenna coverage. An automatic feature allows the receiver to select the antenna which receives the first usable signal; however, either the upper or lower antenna may be manually selected. The UHF radio operates on 115 volt ac power from the ac essential bus and 28 volt dc power from the main dc bus.



1. Volume Control Knob.
2. Tone Button.
3. Squelch Switch.
4. Function Selector Knob.
5. Frequency Indicator Window.
6. Manual Frequency Selector Knobs (4).
7. Channel Set Pushbutton.
8. Preset Channel Selector Knob.
9. Mode Selector Switch.
10. Preset Channel Indicator Window

Figure 1- 51

UHF Radio Function Selector Knob.

The UHF radio function selector knob (4, figure 1-51), located on the UHF radio control panel, has four positions marked OFF, COM, NAV, and ADF. Turning the knob to the COM position activates the COM radio for frequency adjustment and communication. Similarly, switching the knob to the NAV and ADF positions enables the functions for tuning frequencies for NAV and ADF, respectively. Setting the frequencies for NAV and ADF allows the receiver to provide directional information and audio signals to the bearing distance heading indicator and interphone, respectively.

UHF Radio Mode Selector Switch.

The three position UHF radio mode selector switch (9, figure 1-51), located on the UHF radio control panel, permits selection of the desired operating mode. The switch is marked PRESET and MANUAL. The PRESET position is used when selecting one of the 20 preset frequencies. The MANUAL position is used when utilizing frequencies that are selected by the manual frequency selector knobs.

UHF Radio Preset Channel Selector Knob.

The preset channel selector knob (8, figure 1-51), located on the UHF radio control panel, permits selection of one of twenty preset frequencies. With the mode selector switch at PRESET, movement of the preset channel selector knob changes the frequency to that of the channel selected. There are 20 channels, numbered 1 through 20, that may be individually selected. The number of the channel selected is displayed in a window above the knob. Frequencies for each channel are written on a channel frequency log located under the glare shield on the right side. Frequencies of the preset channels can be changed during flight. Presets with channel and frequency information are pre-entered into tables located beneath the glareshield on the front panel.

UHF Radio Manual Frequency Selector Knobs.

Four thumb actuated UHF radio manual frequency' selector knobs (6, figure 1-51), located on the UHF radio control panel, are provided for manually selecting frequencies. Manual frequency selection can be made in steps of 50 kilohertz from 225 through 399.95 megahertz. The first selector knob is not used. The second will select the first two digits of the desired frequency. The third and fourth knobs select the third, fourth and fifth frequency digits respectively. The selected frequency is displayed in a window on the face of the UHF radio control panel.

UHF Radio Volume Control Knob.

The volume control knob (1, figure 1-51), located on the UHF radio control panel, increases the volume of the receiver when turned clockwise and decreases it when turned counterclockwise.

UHF Channel Set Pushbutton.

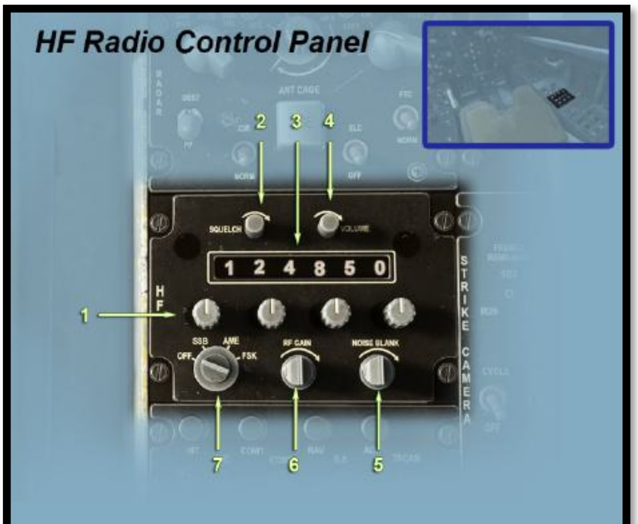
The channel set pushbutton (7, figure 1-51), located on the UHF radio control panel, is used to set or change preset channel frequencies. The button is only effective when the mode selector switch is in the PRESET position. With the mode selector switch in the PRESET position and with the preset channel selector knob set to the desired channel, depressing the button will set the frequency selected in the manual frequency window into the desired channel. The button is recessed in a guard to prevent inadvertent actuation.

UHF Radio Frequency Indicator Window.

The UHF radio frequency indicator window (5, figure 1-51), located on the UHF radio control panel, indicates the manual frequency selected for transmission or receiving. The window has five digits, which are set by frequency selector knobs below the window.

HF RADIO (AN/ARC-123).

The HF radio provides long-range high frequency single side-band air-to-air and air-to-ground communications. There are 760 channels available in 25 KHz increments in the frequency range of 118.000 through 135.975 MHz. Components of the system include a receiver-transmitter unit, amplifier power supply, control panel, antenna, coupler, antenna coupler control, and remote capacitor. The receiver- transmitter unit, amplifier power supply and antenna coupler control are located in the right forward electronic bay. The antenna coupler is located in the aft fuselage below the antenna which is a part of the vertical stabilizer and dorsal fin. The remote capacitor is located at the forward tip of the dorsal fin. The antenna is impedance matched to the receiver-transmitter. The system incorporates self test features for maintenance trouble-shooting. The control panel is located at the navigator's station on the right console. Once the system is placed in operation either crew member can use the equipment. The radio operates on 115 volt ac power from the right main ac bus.



1. Frequency Selector Knobs (6).
2. Squelch Control Knob.
3. Frequency Indicator Window.
4. Volume Control Knob.
5. Noise Blanking Control Knob.
6. RF Gain Control Knob
7. Mode Selector Knob

Figure 1- 52

HF Radio Frequency Selector Knobs.

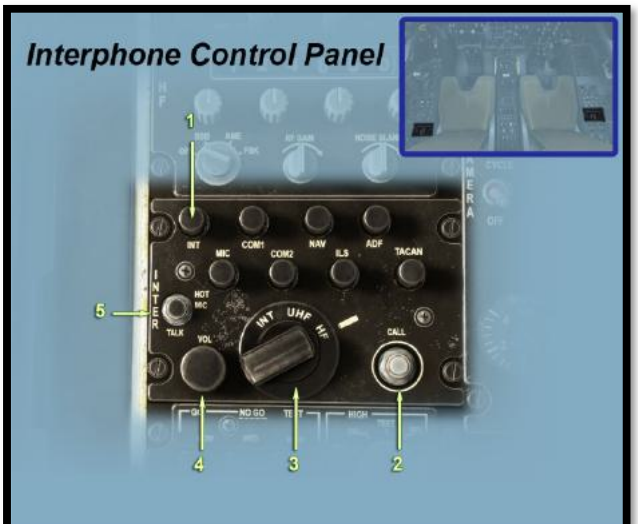
Six HF radio frequency selector knobs (1, figure 1-52), located on the HF radio control panel, provide a means of setting desired frequencies. Each knob has an indicator line drawn to the window it controls on the frequency indicator. To prevent selection of frequencies below 2/0 megahertz, the 10 megahertz and 1 megahertz knobs are interlocked, and in order to select a 1 or 0 on the 1 megahertz frequency indicator, a 1 or 2 must be present on the 10 megahertz frequency indicator.

HF Radio Frequency Indicator Window.

The HF radio frequency indicator window (3, figure 1-52), located on the HF radio control panel, has six digits indicating the frequency selected for transmission or receiving. Each window has an indicator line drawn to its corresponding frequency selector knob.

INTERPHONE (AN/AIC-25).

The interphone provides the following functions: Communications between crew members and between crew members and ground crew; monitoring and volume control UHF radio, HF radio, NAV, ILS, RHAW and missile tone reception, and hot mic and call capability. Two identical interphone control panels (figure 1-54) located on the left and right consoles are provided for each crew member. Interphone stations for ground crew operation are located in the nose wheel well, main landing gear well and ground power receptacle. The interphone operates on 28 volt dc power from the essential dc bus. Power is applied to the interphone whenever power is on the aircraft.



1. Monitor Knobs (8).
2. Interphone Call Button.
3. Transmitter Selector Knob.
4. Master Volume Control Knob.
5. Hot Microphone Switch

Figure 1- 53

Monitor Knobs.

Eight push-pull monitor knobs (1, figure 1-53), located on each interphone control panel, are marked and monitor the functions as follows:

INT	-Interphone
COM1	-COM1 Radio
COM2	- COM2 Radio
ILS	-ILS and Localizer
TACAN	-TACAN Identification
ADF	-ADF Identification
MISSILE	-Missile Tones
HOT MIC LISTEN	-Hot Mic Transmissions

Other signals fed to the interphone panel are the landing gear warning signal and the stall warning signal. The monitor knobs are pulled out to turn on and pushed in to turn off. When pulled out, each knob may be rotated for volume control.

Interphone Call Button.

The interphone call button (2, figure 1-53), located on the interphone control panel, permits either crew member to call the other crew member or the ground crew. Depressing either call button boosts the interphone volume of the other stations and reduces the operator's side tone level, allowing the call signal to override the other station's reception. The call signal will override the reception at the other station regardless of the position of the communications monitor knob or transmitter selector knobs at either station.

Transmitter Selector Knobs.

A three position transmitter selector knob (3, figure1-53), located on each interphone control panel, is provided to select either UHF or HF radio. The knobs are marked UHF, HF and INT. In either the HF or UHF positions only the radio transmitter selected will be keyed when the microphone switch is moved to the TRANS position. In addition, the UHF or HF position will allow continuous monitoring of the respective receiver (UHF or HF) regardless of the position of the communications monitor knobs. Regardless of the position of the transmitter selector switch, the interphone may be used by moving the microphone switch on the throttle to the INPH position. The INT position of the transmitter selector switch has no operational function.

IFF SYSTEM (AN/APX-64). (AIMS)

Note

The air-to-air IFF system provides for Mark X IFF with selective identification feature (SIF), To set the IFF codes in the simulator, the knobs located in section III are employed.

IFF MASTER CONTROL KNOB.

The five-position IFF master control knob is located on the IFF control panel. The knob positions are marked OFF, STBY, LOW, NORM and EMER. The OFF position removes power from the set. When positioned to STBY, the equipment is turned on and warmed up but will not transmit. When positioned to LOW, only local (strong) interrogations are recognized and answered. When positioned to NORM, full range recognition and reply occurs. Transmitted power from the IFF system is the same for both the LOW and NORM positions.

1. JETTISONABLE, NON.PIVOT
2. JETTISONABLE, NON.PIVOT
3. NON.JETTISONABLE, PIVOTING
4. NON.JETTISONABLE, PIVOTING
WB. WEAPONS BAY (LEFT & RIGHT STATIONS)
5. NON.JETTISONABLE, PIVOTING
6. NON.JETTISONABLE, PIVOTING
7. JETTISONABLE, NON.PIVOT
8. JETTISONABLE, NON.PIVOT

		 UP TO 72.5° WING SWEEP						 UP TO 55° WING SWEEP						 26° WING SWEEP									
		3	4	WB	5	6	TOT	3	4	WB	5	6	TOT	1	2	3	4	WB	5	6	7	8	TOT
MISSILES	AIM-9B	1	1		1	1	4	1	1		1	1	4		1	1	1		1	1	1		6
	AGM-84	1	1	2	1	1	6	1	1	2	1	1	6			1	1	2	1	1			6
	AGM-142 (AN/ASW-55)	1				1	2	1				1	2			1				1			2
ROCKET LAUNCHERS	RL-10/A	1	1		1	1	4	1	1		1	1	4	1	1	1	1		1	1	1	1	8
CONVENTIONAL BOMBS	MK-81	6	4	2	4	6	22	6	6	2	6	6	26	6	6	6	6	2	6	6	6	6	50
	MK-82	6	4	2	4	6	22	6	6	2	6	6	26	6	6	6	6	2	6	6	6	6	50
	MATRA	6	4		4	6	20	6	6		6	6	24	6	6	6	6	2	6	6	6	6	50
DISPENSERS	GBU-52	6	6	2	6	6	26	6	6		6	6	24	6	6	6	6	2	6	6	6	6	50
FUEL TANKS	450 GAL	1	1		1	1	4	1	1		1	1	4		1	1	1		1	1	1		6

ARMAMENT SYSTEM.

The armament capability of the aircraft includes the delivery of conventional and nuclear weapons in various configurations and air-to-ground and air-to-air gunnery. An M6lAl gun is installed in the right hand weapons bay. Bombing and launching equipment (pylons and stores release system) weapons bay doors, the weapons themselves, and the gun are considered as the armament system. For detailed description and operation of the armament system refer to the applicable delivery manual, T.O. lF-lllE-25-l for nuclear delivery and T.O. lF-lllE-36-l-l for conventional delivery.

BOMBING AND LAUNCHING EQUIPMENT.

Bombing and launching equipment consists of the various bomb racks, stationary and pivoting wing pylons, and the release systems. Stores can be carried in the weapons bay and on eight wing pylons. Four of the wing pylons pivot to remain streamlined with different positions of the wing. The pivoting pylons are utilized for stores carriage in various configurations. Where applicable, the controls and indicators and operating procedures for the bombing and launching equipment are covered in the following paragraphs, under the
associated equipment headings. For bombing system controls and indicators and bombing procedures, refer to "Bombing-Navigation System," this section.

Master Arm and Release Switch.

The master arm and release switch (4, figure l-14), located on the auxiliary gage panel, is labelled MASTER ARM & RELEASE. The switch has two positions marked ON and OFF. The switch must be placed on the ON position before weapon release can be obtained. The OFF position prevents weapon release. l-152 1 F-l 11 E-l Section I

IR Missile Indicator/Pushbutton.

The IR (infrared radiation) missile indicator/pushbutton (1, figure l-62), located on the weapons control panel, is labelled IR MISSILE. If IR missiles are loaded on the aircraft the letters WPN will be displayed on the pushbutton. When the pushbutton is depressed the letters SEL will appear and each weapon station indicator/ pushbutton will display the letters WPN if an IR missile is loaded at that station.

Air/Air IR Missile Switch.

The air/air IR missile switch (13, figure l-5), located on the left main instrument panel, is marked A/A IR MSL and OFF. When the switch is placed to A/A IR MSL the IR missile can be launched, with the weapon release button. Placing the switch to OFF will prevent launching IR missiles. A red guard must be raised to gain access to the switch.

Weapons Station Indicator/Pushbuttons.

Twelve weapons station indicator/pushbuttons (2, figure l-62), located on the weapons control panel and labelled STATION SELECT, are provided for selection of weapons stations on the aircraft. The pylon stations are numbered 1 thru 8 and correspond to their respective pushbuttons. Pushbuttons 3A and 6A are for outboard shoulder loaded AIM-9B launchers on pylons 3 and 6. Pushbuttons L and R are for the right and left weapons bay stations. Each indicator/pushbutton will display the letters SEL, WPN or blank depending on the condition of selection. When an indicator/pushbutton is enabled by a weapon select cassette/indicator, either WPN or SEL will appear on the pushbuttons. A SEL display indicates that the station has been selected for release and has been accepted by the CPU. A WPN display indicates that the weapon station has been enabled, a weapon is present at that station, and that station has not been selected for release. Depressing the indicator/pushbutton will change the display from WPN to SEL for release. When the indicator/pushbutton is blank the station has not been selected by the weapons select cassette/indicators or a weapon is not present at that station.

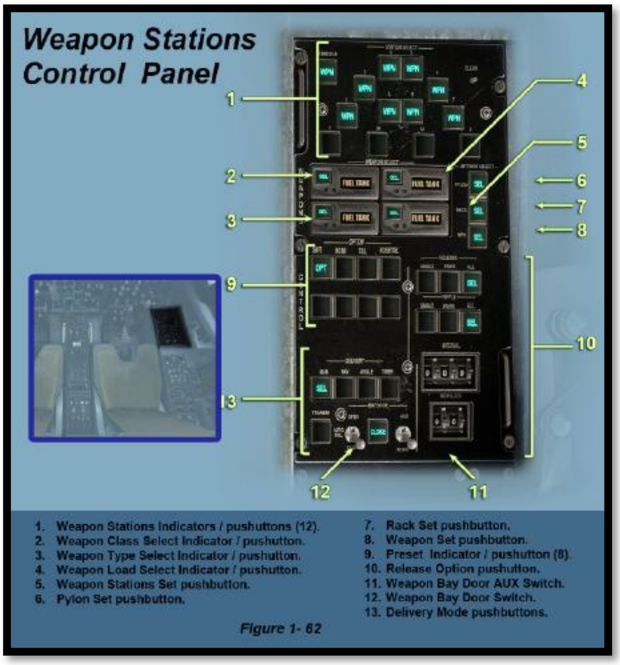


Figure 1-62

Weapon Select Cassette/Indicators.

Four weapon select cassette/indicators (15, figure I- 62), located on the weapons control panel, are labelled WEAPON SELECT. The cassette/indicators provide identification and control of all weapons loaded on the aircraft, and are marked 1, 2, 3 and 4. Cassette no. 1 can control weapon stations 1, 2, 3, 4, 5, 6, 7, and 8, no. 2 can control stations 3, 4, L, R, 5 and 6, no. 3 can control stations 3, 4, 5 and 6, and no. 4 can control stations 1, 2, L, R, 7 and

8. Each cassette contains a weapon type identification window and a code generating tape with a capacity for 21 different weapons. The cassette program tapes have provisions for 14 weapon programs at this time. The ground crew will set the weapon code tape when weapons are loaded on the aircraft. The indicator on the cassette/indicator will display the letters SEL, READY or blank, depending on the selected mode. To select a weapon for program, depress and hold the applicable weapon cassette. At the same time depress the applicable weapons station indicator/pushbuttons for the weapon to be released. The letters SEL will appear on the cassette and the weapon stations. The letters READY will appear on the cassette, when necessary, logic for release has been met and the master arm and release switch has been placed to the ON position. When the cassette/indicator is blank that weapon has not been selected.

Weapon Status Indicator.

The weapon status indicator (3, figure l-14), located on the auxiliary gage panel, is labelled WEAPON STATUS. The indicator will display the letters READY when necessary weapon logic for weapon release has been set on the weapons control panel and the master arm and release switch has been placed to the ON position.
Jettison Select Indicator/Pushbuttons. Three jettison select indicator/pushbuttons (4, figure l-62), located on the weapons control panel, are labelled JETTISON SELECT and are provided for selective jettison of fixed pylons, bomb racks, and weapons. The pushbuttons are marked PYLON, RACK and WPN, which display SEL when depressed or will be blank when not selected. When the pylon pushbutton is depressed to SEL, all weapons station indicator/pushbuttons will display WPN if a store is present. To jettison the fixed pylons, stations 1, 2, 7 and 8 must be depressed to SEL, the master arm and release switch must be on, and the weapon release button depressed. The MAU-12 C/A racks will fire on all other selected stations in this condition.

CAUTION

Pylon jettison can be accomplished with the flaps extended, however, flap damage will probably occur.

The rack pushbutton operates the same as the pylon except only the MAU-12 C/A bomb rack will fire and jettison all loaded BRU/TER racks, tanks and weapons. The weapon pushbutton works the same as the rack pushbutton except only the weapons will jettison from the BRU/TER, or MAU-12 C/A bomb racks.

Delivery Mode Indicator/Pushbuttons.

The four delivery mode indicators/pushbuttons (13, figure l-62), located on the weapons control panel, are labelled DELIVERY. The pushbuttons provide a means of selecting the source of signal for weapon release. Each pushbutton will display the letters SEL if selected or will go blank if another mode is selected. The pushbuttons are marked and function as follows:

Note

The weapon release button on either control stick must be depressed to complete a release circuit in any of the following knob positions.

- MAN - provides manual release using the weapon release buttons mounted on either control stick grip.
- NAV - provides automatic weapon delivery by utilizing release signals generated by the bomb nav system.
- ANGLE -provides loft type weapon delivery capability at various predetermined angles by utilizing release signals generated by the lead computing optical sight.
- TIMER - provides loft and straight fly-over timed weapon delivery capability by utilizing pull-up and release signals generated by the dual bombing timer.

Weapon Release Option Indicator /Pushbuttons

The three weapon release option indicators/pushbuttons (5, figure l-62), located on the weapons control panel, are labelled RELEASE. The pushbuttons provide a means of selecting one or more weapons to be released at the same time. Each pushbutton will display the letters SEL if selected or will go blank if another release option is selected. The pushbuttons are marked and function as follows:

- SINGLE-A weapon will be released each time the weapon release button is depressed. Weapon release will follow an outboard to inboard station sequence. When corresponding left and right stations are selected, the first station selected will release first and then alternate until both stations are empty. Also if corresponding stations are selected all weapons must be dropped prior to system stepping inboard. Weapon release will alternate between symmetrical stations. If unsymmetrical stations are selected (1 and 5) the most outboard station weapons must be dropped prior to system stepping inboard. Whenever the difference between the total number of selected left and right fixed pylons (1 and 2 or 7 and 8) exceeds one, release cannot be accomplished. T.O. 1 F-l 11 E-l Section
- PAIRS-Same as singles except releases occur from each station of a symmetrical pair simultaneously. Both stations of a symmetrical pair must be selected for a release to occur.
- ALL-Same as pairs except releases will occur from all stations symmetrically.

Bomb Arming Option Indicator/Pushbuttons.

Four bomb arming option indicator/pushbuttons (14, figure l-62), located on the weapons control panel, are labelled OPTION. The pushbuttons operate in conjunction with the weapons select indicator/pushbuttons to provide 28 volt dc power from the main dc bus to arm or safe the fuzing systems of conventional bombs. The pushbuttons will display SEL when selected for an arming option or will go blank if no conventional bombs are selected. The pushbuttons are marked and function as follows:

- SAFE-Will allow both nose and tail arming wires to pull out of the arming solenoids and stay in the futes as the bombs are released, thereby rendering the weapon safe.
- NOSE-Provides electrical power to retain only the nose fuze arming wire, thereby arming the nose fuze at bomb release.
- TAIL-Provides electrical power to retain only the tail fuze arming wire, thereby arming the tail fuze at bomb release.
- NOSE/TAIL-Provides electrical power to retain both nose and tail fuzes arming wires, thereby arming both at bomb release.

Weapon Ripple Option Indicator/Pushbuttons.

The three weapon ripple option indicator/pushbuttons (6, figure l-62), located on the weapons control panel, are labelled RIPPLE. The pushbuttons are marked SINGLE, PAIRS and SALVO and when selected will display the letters SEL for that mode. The selection of a ripple release sequence will enable the intervalometer to generate a given number of release pulses at a given interval for selected release.

Intervalometer Set Wheels.

Three intervalometer set wheels (7, figure l-62), located on the weapons control panel, are labelled INTERVAL. A digital counter located by each set wheel provides a readout for setting the desired weapon release time interval. The three set wheels have a range of 10 to 999 milliseconds in 1 millisecond intervals. Due to the rack characteristics the minimum release interval is 50 milliseconds. The intervalometer is activated any time one of the weapon ripple option indicator/ pushbuttons is depressed to SEL. Description & Operation

Number of Pulse Set Wheels.

The number of pulses set wheels (8, figure l-62), located on the weapons control panel, are labelled NO. PULSES. A digital counter is located adjacent to each set wheel to provide readout for selected settings. The set wheels work in conjunction with the intervalometer, to generate a desired number of time interval signals. The set wheels have a range of 0 to 90 in 1 increment steps. Weapons Memory Clear Switch. The weapons memory clear switch (3, figure l-62), located on the weapons control panel, is labelled CLEAR. The switch is used to clear the memory logic when each weapons select indicator/pushbutton is depressed to SEL. When the switch is depressed, the weapons select cassette/indicators and associated weapons station indicator/pushbuttons will go blank. The switch is depressed by inserting a sharp object into the hole and must be pushed down for each activation.

WEAPONS BAY DOORS.

The weapons bay doors enclose the weapons bay area located between the nose and main landing gear. The doors are constructed in left and right clam shell halves which fold outward as they are opened. Normal and alternate systems are provided to operate the doors. The normal system utilizes hydraulic power from the utility hydraulic system to drive a hydraulic motor. The alternate system uses 115 volt ac power from the right main a-c bus to power an electric motor. Hither motor drives a gear reduction mechanism, which through a series of drive shafts interconnected to hinges on the inside of the weapons bay, to open and close the doors. Normal time to open or close is 2 seconds. The alternate system takes approximately 30 seconds to open or close the doors. A ground safety switch and lockpin are provided to assure safe ground crew operations. The weapon bay doors are controlled by a weapons bay door switch. The right weapons bay door is replaced by the weapon bay gun module when it is installed.

Weapons Bay Door Control Switch.

The weapons bay door control switch (12, figure 1-62), located on the weapons control panel, is a three position switch marked OPEN, AUTO MSI. and CLOSE. When the switch is placed to OPEN the doors will open. Placing the switch to CLOSE will close the doors. The AUTO MSL position is inoperative.

RADAR ALTIMETER SYSTEM (AN/APN-167).

The radar altimeter system is a dual channel low altitude radar system which provides precise absolute altitude, rate of altitude change and minimum altitude penetration information. Absolute altitude from 0 to 5000 feet is read on the radar altimeter. Rate of altitude change from 0 to 500 feet per second is furnished to the terrain following radar. Minimum altitude penetration fly-up signals are provided to the integrated flight instruments. The radar altimeter system will provide fly-up signals upon reaching the preset altitude during ILS or AILA. The system is composed of two receiver-transmitter units; two antennas, one for transmitting and one for receiving; a distribution box; a radar altimeter indicator and the necessary controls. The receiver-transmitter units are located in the forward electronic equipment bay. When the system is placed in operation, one receiver- transmitter unit is activated and the other is in standby for use in event the operating unit malfunctions. In the event of a malfunction the standby receiver- transmitter unit must be manually selected. The receiver-transmitter unit in operation is connected to the antennas and its outputs are distributed to other aircraft systems by circuits in the distribution box. A pressure operated switch in each receiver-transmitter unit will place the operating unit to standby when above approximately 38,000 feet pressure altitude. The radar altimeter should maintain lock to bank angles of 45° and pitch angles of ±20°. The system incorporates a self-test feature for checking reliability. The system operates on 115 volt ac power from the main ac bus and 28 volt dc power from the main dc bus.

RADAR ALTIMETER CHANNEL SELECTOR SWITCH.

The radar altimeter channel selector switch (7, figure 1-56), located on the miscellaneous switch panel, is labeled RADAR ALTM and has two positions marked CHAN 1 and CHAN 2. Placing the switch in either position will allow the receiver-transmitter unit in the respective channel to transmit and receive.

RADAR ALTIMETER INDICATOR.

The radar altimeter indicator (23, figure 1-5), located on the left main instrument panel, provides absolute altitude indications from 0 to 5000 feet. Indications are provided by a pointer on a dial graduated in increments of 10 feet from 0 to 500, 50 feet from 500 to 1000, and 500 feet from 1000 to 5000. An OFF warning flag in a window on the right side of the dial will appear when power is removed from the system, when the altitude of the airplane is over 5000 feet above the terrain, if the pitch or roll limits of the system are exceeded or if the system malfunctions.

WARNING

If power is lost on the system, the OFF warning flag will appear on the dial and the pointer will remain at the last indication.

The radar altimeter control knob on the lower right of the altimeter serves three functions; as an on-off control, to set a minimum altitude index pointer on the dial and as a test button to check the system. Initially turning the knob clockwise applies power to the system; further rotation of the knob rotates the index pointer from zero to any desired minimum altitude setting. Depressing and holding the knob activates the self-test feature of the system and provides an indication of 95 ±12 feet if the receiver-transmitter unit is operating properly.

CAUTION

The radar altimeter must be turned off after each flight to prevent damage to the receiver-transmitter unit, should power be applied without cooling air.

RADAR ALTITUDE LOW WARNING LAMP.

The radar altitude low warning lamp (25, figure 1-5), located on the left main instrument panel, will light when the absolute altitude of the aircraft is at or below the minimum altitude set into the radar altimeter. When lighted the letters RADAR ALT LOW are displayed on the face of the lamp in red.

LEAD COMPUTING OPTICAL SIGHT (AN/ASG-23) (LCOS).

The LCOS is integrated with other systems in the aircraft to, (1) deliver bombs, missiles and gun fire and (2) provide homing, navigation and landing information. The system consists of the optical display sight and control panel, located at the left crew station, a lead and launch computing amplifier and a lead computing gyro package, both located in the forward electronics bay. The optical display sight provides indications in the form of two presentations: an aiming reticle, lighted in red, and a set of command steering bars, lighted in green. Refer to figure 1-80 for aiming reticle and command steering bar presentations. The aiming reticle consists of a 2-milliradian center piper, a 30-milliradian diameter circle, roll reference tabs, a 50-milliradian diameter circle, analog bar reference tabs and range scale, an analog bar presentation, and two deviation indicators. All elements of the aiming reticle are fixed with respect to one another as the aiming reticle display moves about on the sight combining glass. The reticle will move about on the sight in relation to the handset depression angle in elevation, and the drift angle correction in azimuth. The system utilizes 28 volt dc power from the main dc bus and 115 volt, three phase, 400 hertz, ac power from the left main ac bus.

This is the last page of Section II.

Section III

NORMAL PROCEDURES

TABLE OF CONTENTS

QUICK START TUTORIAL.

Refer to following links for video tutorial.

Engines start procedure
https://youtu.be/uwOWUxXTghk

Autopilot standard procedures
https://youtu.be/1gWTkSzlZeI

PREPARATION FOR FLIGHT.

FLIGHT RESTRICTIONS.

Refer to Section V for the operating limitations imposed on the aircraft.

FLIGHT PLANNING

Refer to the Performance Appendix to determine takeoff, cruise control, fuel planning and management, and landing data necessary to complete the mission.

TAKEOFF AND LANDING DATA CARDS.

Refer to the Performance Appendix for information necessary to complete the Takeoff and Landing Data Card in the Flight Crew Checklist.

WEIGHT AND BALANCE.

Refer to Section V for weight limitations and to the Manual of Weight and Balance Data.

CHECKLISTS.

This Flight Manual contains only amplified procedures.

PREFLIGHT CHECK.

BEFORE EXTERIOR INSPECTION.

Check aircraft and crew module weight and balance chart C for correct limits.

EXTERIOR INSPECTION.

The exterior inspection is based upon the fact that maintenance personnel have completed all of the requirements of the Scheduled Inspection and Maintenance Requirements Manual for preflight and post- flight; therefore, duplicate inspections and operational checks of systems have been eliminated except for those needed in the interest of flight safety: Check all surfaces for any type of damage; signs of fuel, oil, hydraulic or other fluid leaks that may have developed since the preflight inspection. Check all access doors and covers for security and all protective covers removed.

BEFORE ENTERING COCKPIT. (AC)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Bilge pump lockpin—Stowed.
4. Quick rescue kit—Stowed. (If applicable)
5. Emergency oxygen bottle pressure Check, 1400-2500 psi.
6. All circuit breakers—In.
7. Ground check panel—Check and close door. 2-2

    - Computer power switches (3)—On.
    - Central air data computer power switch—POWER.
    - Ground ignition cutoff switch—NORM.
    - Gyros power switch—GYROS.
    - Mach trim test switch—NORM.
    - Fire detect switches—NORM.

8. Utility light—Stowed as desired.
9. Radio beacon set—ON or as applicable.

BEFORE ENTERING COCKPIT. (WSO)

1. Ejection handle safety pins (2)—Installed.
2. Canopy center beam safety pins (3)—Installed.
3. Survival equipment compartment door — Closed and sealed.
4. Crew module chaff dispenser control lever—As required.
5. The lever should be ON over friendly territory and OFF as directed by tactical requirements.
6. Publications—Check.

INTERIOR INSPECTION.

Power Off. (AC)

1. Harness and leads—Attach and check.

    - Insure that the yoke of the restraint harness is adjusted firmly against the neck with head against headrest and sitting erect to allow full reel-in, in the event of subsequent ejection.
    - Restraint harness and inertia reel—Checked. Check the condition of the restraint harness. Check operation of the inertia reel in the locked and unlocked position.
    - Oxygen regulator—Inserted in harness receptacle.
    - Anti-g suit hose—Connect and check. (As applicable)

2. Pressure suit ventilation knob—Full CCW. (As applicable)
3. Oxygen system and personal equipment— Checked.

    - Oxygen mask and communications cord—Connected.
    - Oxygen control lever—OFF then ON.
    - Check the control lever is OFF and after several breaths note that breathing becomes more difficult due to the restriction of the anti-suffocation valve. Also observe that the anti-suffocation valve unseats with each inhalation. Place the oxygen control lever to ON.
    - Oxygen control knob—Checked, then NORM.
    - Oxygen control knob—NORM.
    - Inhale and check movement of the diluter valve through the screen in the side of the regulator.
    - Oxygen control knob—100 percent.
    - Inhale and check that the diluter valve does not move.
    - Oxygen control knob—EMER.
    - Check that a positive pressure is felt in the mask and check that the diluter valve does not move.

4. Interphone panel—Set.
5. Auxiliary pitch trim switch—STICK.
6. Flap/slat switch—NORM.
7. Auto TF switch—OFF.
8. Rudder authority switch—AUTO.
9. Flight control disconnect switch—NORM. (Cover down)
10. Throttles—OFF.
11. Speed brake switch—IN.
12. Ground roll spoiler switch—OFF.
13. Anti-skid switch—OFF.
14. Flight instrument reference select switch—PRI.
15. Landing/taxi lights switch—OFF.
16. Compressor bleed valve control switches— AUTO.
17. Flares/chaff dispense switch—OFF.
18. Nuclear consent switch—Cover down and safe- tied.
19. Master arm and release switch—OFF.
20. Landing gear handle—DN.
21. Auxiliary brake handle—Pull. (If previous landing not within two hours)
22. Utility hydraulic system isolation switch — NORM.
23. Control system switch—NORM.
24. Arresting hook handle—In.
25. ECM pod control switch— STBY. (If installed)
26. Air/air IR missile switch—OFF, guard down.
27. Gun selector switch—OFF.

28. Lead computing optical sight control panel— Set.
    - Mode selector knob—COM.
    - Caging lever—CAGE.
29. Radar altimeter control knob—OFF.
30. Instrument system coupler mode selector knob — NAV.
31. Dual bombing timer—Set to zero.
32. Auxiliary flight reference system compass mode selector knob—Slaved and set. (Present latitude)
33. Windshield wash/rain removal selector switch —OFF.
34. Pitot/probe heater switch—OFF/SEC.
35. Engine/inlet anti-icing switch—AUTO.
36. Antenna select panel (UHF, TACAN, and IFF) — AUTO.
37. Landing gear emergency release handle—In.
38. Fuel panel—Set.
    a. Fuel dump switch—OFF.
    b. Air refueling switch—CLOSE.
    c. Fuel tank pressurization selector switch — AUTO.
    d. Fuel transfer knob—OFF.
    e. Engine feed selector knob—OFF.
39. TFR channel mode selector knobs (2)—OFF.
40. Spike control switches (2)—NORM.
41. Ground start switch—OFF.
42. Electrical control panel—Set.
    a. Generator switches (2)—RUN.
    b. Battery switch—OFF.
    c. External power switch—OFF.
    d. Emergency generator switch—AUTO.
    e. Emergency generator indicator/cutoff push-button—In. (Safeties)
43. Air conditioning control panel—Set.
    a. Temperature control knob—As desired.
    b. Air source selector knob—BOTH.
    c. Mode selector switch—AUTO.
    d. Pressurization selector switch—NORMAL.
    e. Air flow selector switch—NORMAL. (If installed)
    f. Exchange exit air control switch—NORMAL. (If installed)
44. AC—Ready for electrical power.

Power On. (AC)

1. Battery switch—ON.

   Check the engine turbine inlet temperature indicators. The power-off flag in the indicators will go out of view when the battery is on. If the engines are to be started using battery power the following "Power On" checks must be delayed until at least one generator is on the line.

2. External power—Connected. (If applicable) (GO)
3. External power switch—ON. (If applicable)

   If external power is to be used, place the external power switch ON and check that the electrical power flow indicator displays TIE.

   Note

   - If external power is not obtained when ON is selected, the external power source should be replaced or a battery start made. OVRD should not be selected unless all electronic equipment is off.
   - The FWD EQUIP HOT lamp will light in 120 seconds after power on if cooling is not available.

4. Caution lamps—Check.
   a. Following lamps will be lighted:
      PRI ATT/HDG
      PITCH, ROLL, YAW DAMPER
      ANTI-SKID
      a/b PROBE HEAT
      L & R PRI HYD
      L & R UTIL HYD
      L & R ENG OVERSPEED
   b. Following lamps may be lighted: CANOPY; PITCH, ROLL, YAW CHANNEL (must reset) AUX ATT (Until initial erection) L & R FUEL PRESS
      If the caution lamps in a. are not lighted or lamps other than in b. are lighted, a malfunction is indicated and should be checked prior to starting engines. If the pitch, roll or yaw channel caution lamps are lighted, depress the damper reset button. If lamps remain lighted a malfunction is indicated.
5. Lighting control pane!—Check. (If required)
   Check operation of the interior light rheostats and set for desired intensity. Check operation of bright and dim switch and select desired intensity. Check external lights with GO.
6. Malfunction and indicator lamps and stall warning system—Check. (GO)
   - Pitot/probe heater switch—OFF/SEC.

If pitot/probe heater switch has been in the HEAT position, residual heat in the probe may be sufficient to cause injury to ground personnel.

   - Alpha probe slots—Full up. (Lowest angle-of-attack value)
   - Malfunction and indicator lamps test button — Depress and check all malfunction and indicator

lamps light, check for intermittent (landing gear) audible warning tone through headset.

- With malfunction and indicator lamps test button depressed.
- Warning horn silence button operation.
- Stall warning system—Check.
- Alpha probe slots—Full down. (Highest angle- of-attack value)
- With malfunction and indicator lamps test button depressed, check stall warning lamp flashing, steady audible warning tone through headset, and rudder pedals shaker activated.

Note

When the lamps test button is depressed, the rudder may deflect due to AYC input and the yaw channel caution lamp may light. This is normal.

- Malfunction and indicator lamps test button—Release.

Note

When the lamps test button is released, the yaw channel caution lamp may remain lighted, in which case, reset to put lamp out.

7. Seat and headrest—Adjusted.
8. Anti-skid switch—ON then OFF.
   Check anti-skid caution lamp operation.
9. Flap/slat handle—Corresponds with surface position.
10. Wing sweep handle—Corresponds with wing position.
11. Oxygen quantity—Check.
    Check that oxygen quantity is adequate for mission. Depress oxygen quantity button: Oxygen quantity indicator should decrease to zero. Note that the oxygen quantity caution lamp lights when indication is approximately 2 liters or below. Release the test button and note that the caution lamp goes out at 2 liters and that the quantity indication returns to original value.
12. External air conditioning unit—Check. (If applicable)
    Check that air conditioning is connected and functioning properly to provide equipment cooling.
13. Fire detect circuit—Checked.
    Hold the agent discharge/fire detect test switch to FIRE DETECT TEST and check that the wheel well hot caution lamp, the fuselage fire warning lamp, and both engine fire warning lamps are lighted. Release the switch.
14. Landing gear position indicator lamps—Checked.
15. AFRS synchronization indicator—Nulled.
16. Oil quantity indicators—Check, 12 to 16 quarts.
    Check that indicators show 12 to 16 quarts, depress the oil quantity indicator test button, and check that indicators show decrease to 5 quarts on the left indicator and 5.7 quarts on the right indicator. Check that the oil low caution lamp lights. Release test button and check that indicators return to original readings and that the oil low caution lamp goes out.
17. Engine feed selector knob—FWD, then AFT.
    Check that the appropriate fuel pump low pressure indicator lamps light and go out and that the fuel pressure caution lamps go out (if on).
18. Fuel quantity indicators—Check.
    If forward or aft tank pointers or totalizer fail to test or all tank quantities do not add up to the total fuel indication (±1000 pounds), a malfunction is indicated.

Abbreviated Check:

- Fuel quantity indicator test button—Depress and hold until the fwd. and aft tank pointers are out of indicator distribution limits to the extent that the fwd. pointer will require more than 15 seconds to return to distribution limits.

If for any reason aircraft commander desires to perform the complete fuel quantity gage test, the following checks may be performed.

Complete Check:

- Fuel quantity indicator test button—Depress and hold for the following indications:
- Forward and aft tanks—2000 (±400) pounds.
- Select tank—2000 (±100) pounds.
- Total fuel—2000 (±1250) pounds.

The external tanks positions need not be checked unless fuel is loaded at any of these positions. If the fuel gage select switch is positioned to an external tank position and no tank is installed at that station, the selected fuel quantity gage should drive to below zero, against the mechanical stop.
Continue the abbreviated or complete check as follows:

- Check that forward and aft tank fuel quantity indicator pointers, totalizer, and select tank pointer move smoothly.

If either forward or aft tank fuel quantity indicator pointers indicate a malfunction, do not fly the aircraft.

- Fuel distribution caution lamp—Lighted after 12 seconds.

- Fuel quantity indicator test button—Release.

- Fuel distribution caution lamp — Remains lighted for 10 to 15 seconds, then goes out.

19. Engine feed selector knob—AUTO.
Select AUTO when the forward tank pointer is approximately 2000 pounds outside the bar index of the fuselage fuel quantity indicator.

Note

If fuel tank expansion space has been reduced due to fuel overfill or thermal expansion, some fuel venting may occur while the fuselage fuel quantity indicators are returning from the test indications if the engine feed selector knob is positioned to AUTO too soon. Fuel venting must cease prior to takeoff.

- Fuel distribution caution lamp—Lighted until distribution is within limits.

Note

If a malfunction is indicated in the fuel distribution system, position the engine feed selector knob to OFF to preclude possible fuel venting.

- Appropriate fuel pump low pressure indicator lamps—Light and go out.

- All indicators—Return to original indications.

20. Fuel transfer knob—AUTO, or as applicable.
Fuel pump low pressure indicator lamps 7 thru 12 should light and go out unless the . tank is empty and then the lamp should remain lighted.
21. Report ready for engine start. (Verified by GO)

Power Off. (WSO)

1. Harness and leads—Attach and check.

- Insure that the yoke of the restraint harness is adjusted firmly against the neck with head against headrest and sitting erect; to allow full reel-in, in the event of subsequent ejection.

- Restraint harness and inertia reel—Checked.

Check the condition of the restraint harness. Check operation of the inertia reel in the locked and unlocked position.

- Oxygen regulator—Inserted in harness receptacle.

CAUTION

Valve port screens are easily damaged by improper/careless handling or placing fingers on screens.

- Anti-g suit hose—Connect and check. (As applicable)

2. Oxygen system and personal equipment — Checked.
- Oxygen mask and communication cord—Connected.

- Oxygen control lever—OFF then ON.

Check the control lever is OFF and after several breaths note that breathing becomes more difficult due to the restriction of the anti-suffocation valve. Also observe that the anti-suffocation valve unseats with each inhalation. Place the oxygen control lever to ON.

- Oxygen control knob—Checked then NORM.

- Oxygen control knob—NORM.

Inhale and check movement of diluter valve through the screen in the side of the regulator.

- Oxygen control knob—100 percent.

Inhale and check that the diluter valve does not move.

- Oxygen control knob—EMER.

Check that a positive pressure is felt in the mask and check that the diluter valve does not move.
3. Pressure suit ventilation knob—Full CCW. (As applicable)
4. Electronic countermeasures destruct control panel—Lockout pin installed. (If applicable)
5. Countermeasures dispense system arm switch—SAFE.
- Mode selector knobs (3)—OFF.

6. Infrared receiver system control knob—OF>,
7. Electronic countermeasures pod operate knobs (2) OFF. (If installed)
8. Interphone panel—Set.
9. HF control switch OFF.
10. Strike camera switches (2)—OFF.
11. Attack radar function selector knob—OFF.
12. Electronic countermeasures (ALQ) control knob — OFF. (If installed)
13. Weapons control panel—Set:

a. Weapons bay auxiliary control switch— NORM.

b. Weapon bay door control switch—Checked.

Check that the weapon bay door control switch position agrees with the position of the weapon bay doors.

If the position of the weapon bay doors disagrees with the position of the switch, the doors will actuate (open/close) when power is applied to the aircraft.

14. Nuclear control panel knobs (2)—OFF.
15. Instrument landing system power switch—OFF.
16. Burst altitude/train lead counter—As required.
17. Target elevation selector switch—As required.
18. Bomb nav mode selector knob—OFF.
19. Bomb nav magnetic variation counter—Set, to best known local value.
20. Attack radar indicator recorder panel—Set.
    - Switches—OFF/NORM.
    - Antenna tilt control knob—Detent.
    - Sensitivity time control knob—OFF.
    - All other control knobs—Fully CCW.
21. RHAW threat panel—Both knobs CCW.
22. RHAW scope panel—Set.
    - Memory control knob—CCW.
    - Sensitivity knob—CW.
    - Reticle/scope intensity knob—CCW.
    - Gate select knob—N.

23. UHF radio—OFF.
24. TACAN—OFF.
25. IFF master control knob—OFF.
26. Scope camera power switch—OFF.
27. WSO—Report ready for electrical power.

Power On. (WSO)

1. UHF radio—On and set.
2. Bomb nav present position—Set. (As required)

    - Platform alignment knob—OFF.
    - Bomb nav mode selector knob—ALIGN.
    - Man fix mode selector button—Depressed.
    - Present position latitude and longitude—Set.

3. Bomb nav mode selector knob—HEAT.

Note

When ambient temperature exceeds 110 degrees F, do not leave bomb/nav mode selector knob in HEAT for more than 5 minutes without external air conditioning.

4. Platform alignment knob—NORMAL.
5. Platform heat indicator lamp—Lighted.
6. Altitude/test selector knob—NORM.
7. Attack radar system camera magazine—Check. Fill in the identification with the desired information and check the clock for proper operation.
8. Report ready for engine start.

BEFORE STARTING ENGINES.

Refer to figure 2-1, "Danger Areas," for the extent of engine intake and exhaust hazard areas, and the engine turbine and starter turbine planes of rotation.

1. Ground crew report—Ready for engine start. Fire guard posted, engine and run area clear, chocks in place, nacelle vent and fire access doors checked for hinge integrity and freedom of movement.

DEFINITIONS.

Hot Start—TIT indicates engine ignition but exceeds the limit specified in Section V. If at any time during start the TIT increases at an abnormally rapid rate or approaches within 50 degrees C of the limit and is still climbing, a hot start can be anticipated.

False or Hung Start—TIT indicates engine ignition but rpm will not increase to IDLE within 2 minutes.
Failure to Start—TIT does not indicate ignition within 20 seconds after throttle advance. RPM will stabilize at the maximum for starter output. Cartridge Start Misfire—Cartridge fails to ignite as indicated by lack of smoke at the starter exhaust port. There will be no engine rpm indication. Cartridge Start Hangfire—Cartridge ignites as indicated by smoke at the starter exhaust port, however there will be little or no rpm indication. If any of the above conditions occur return the throttle to OFF and investigate. The engine should be inspected for residual fuel before a second start is attempted. If no fuel is visible a second start may be attempted. The engine should be motored until TIT is approximately 100 degrees C before advancing the throttle to minimize the possibility of a hot start. If visible fuel or vapors are found the engine must be cleared using the pneumatic starter as follows:

ENGINE CLEARING.

- Engine ground start switch—PNEU.
- Affected engine throttle—Lift.

Lift the throttle of the affected engine out of the OFF detent to motor the engine. This may be done any time rpm is below 20 percent.

CAUTION

To avoid a possible hot start do not advance the throttle.

- Affected engine throttle—Release.
  Release the throttle to OFF prior to the time limit specified for starter operation in Section V.

CAUTION

To prevent possible engine damage due to overtemperature, do not attempt to restart the engine until TIT is below 100 degrees C.

STARTING ENGINES. (AC)

Engine starts can be accomplished by using air pressure from a ground source or by a pyrotechnic cartridge. Only the left engine has cartridge starting capability. Either engine may be started by the use of external air when supplied by an adequate source; however, when using the MA-1A starter cart, left engine starting capability is marginal. For normal flight operations it is recommended that the right engine be started first with external air due to the higher starter torque available. With either engine operating, the remaining engine may then be started by pneumatic crossbleed. Electrical power required for engine starting may be supplied either by the aircraft battery or by an external source.

- Do not attempt a pneumatic start or fly the aircraft with an unfired cartridge in the breech. Abnormal cartridge conditions of an explosive nature could be generated due to the combination of vibration and high temperatures that can exist in the engine nacelle.

- Do not initiate a cartridge start with any nacelle door open on the engine being started. To do so could result in possible overheating of adjacent structure and/or ignition of accumulated fuel and oil.

CAUTION

- If engine has had insufficient time to cool from a previous operation, do not attempt a restart until TIT is below 100 degrees C.

1. Engine ground start switch—PNEU or CARTRIDGE. (As applicable)
2. Applicable engine throttle—Lift to start position.
   a. On cartridge start advance the throttle to IDLE immediately.

In the event of aborted start during a cartridge start due to misfire, hangfire, or slow burning cartridge, the breech will not be opened until a time period of 5 minutes has elapsed after attempted start and no smoke can be observed emitting from the starter exhaust.

Note

If battery power only is used during start, only TIT indicators and tachometers are operating until one engine driven generator is supplying power to the ac buses.

   b. Oil pressure—Checked.

Note

- Oil pressure should be indicated within 10 seconds after first indication of rpm.

- During second engine start, check that the engine ground start switch moves to OFF prior to reaching 50 percent engine rpm. Cooling air will not be available if the switch is in any position other than OFF.

3. Engine throttle—IDLE.
   On a pneumatic start advance the throttle to IDLE after the engine rpm reaches 17 percent.

Note

Turbine inlet temperature rise should occur within 20 seconds after advancing throttle.

4. Nacelle vent ejector system—Check.
5. Engine instruments—Check.
   a. Fuel flow—1100 pph maximum.
   b. Turbine inlet temperature indicator—710 degrees .C maximum.
   c. Idle rpm—57 to 69 percent.
   d. Hydraulic pressure indicators — 2950-3250 psi, caution lamps out.
   e. Idle oil pressure—30 to 50 psi.
   f. Nozzle position—Open.
6. Engine overspeed caution lamp—Out.
7. Generator switch — START (pause), then release to RUN; check caution lamp out.

Note

If the generator caution lamp remains lighted, place the generator switch to OFF-RESET, hold to START (pause) then release to RUN.

8. Power flow indicator—TIE or NORM. (As applicable) The power flow indicator will read NORM if a ground power unit is plugged in or TIE if battery was used or if the left engine was started first.
9. Speed brake ground lock—Removed. (GO)
10. External power switch—OFF.
11. External power and air—Disconnected, if cross- | bleed is used. (GO)
12. Power on checks—Complete. (If battery start accomplished)
13. j 13. Air refueling receptacle—Check. (If required) (GO)

14. Remaining engine—Start. (Repeat steps 1 thru 8)

CAUTION

If left engine is started with external air at high ambient temperatures, starting TIT must be closely monitored for possible overtemperature.

Note

If crossbleed is being used for starting the second engine, obtain ground clearance and then advance the throttle to 80-85 percent on the operating engine, depending on ambient conditions, until second engine reaches 50 percent or until pneumatic ground start switch cuts off, then retard throttle to IDLE.

15. Engine ground start switch—OFF.
16. Power flow indicator—NORM.
17. Emergency generator switch—TEST, ON, thea AUTO. Place the emergency generator switch to TEST. The emergency generator indicator lamp will light within one second, indicating that the emergency generator is operating within limits. The power flow indicator should display a crosshatch. Check operation of T/R units by noting that the angle-of-at- tack indexers and the LCOS reticle lamps are lighted. Place the emergency generator switch to ON, check power flow indicator displays NORM. Place the emergency generator switch to AUTO. Check that indicator lamp goes out and that the power flow indicator displays NORM.

AFTER ENGINE START. (AC)

1. Radar altimeter—Set 80 feet.
2. L & R TFR channels—STBY.
3. Wing sweep handle—Set for takeoff.
4. Wing sweep handle lockout controls—ON. (If applicable)
   If fixed stores or multiple weapon racks are being carried, place the respective lockout control to ON.
5. Ground crew check flight controls—Clear. (GO)
6. Flight control and damper system—Check. (GO optional)

Note

During the following checks, the required flight control surface positions will be verified by the control surface position indicator or the ground observer.

a. Slats—Extended.
b. Takeoff trim—Set.
c. Damper switches (3)—OFF.

Place the pitch and roll autopilot/damper and yaw damper switches to OFF and check that the pitch, roll, and yaw damper caution lamps light.

d. Flight controls—Checked.

- Move the control stick aft, then left wing down, right wing down: check for freedom of movement and verify that the control surfaces and surface position indicators correspond with control stick movement. Check that pitch and roll channel caution lamps do not light.
- Move the control stick full forward, then rapidly full left through the detent to the forward left corner and hold firmly for one second. Verify that the right horizontal stabilizer indicates 12 to 18 degrees down while the stick is held in this extreme position.
- Move the control stick rapidly full right through the detent to the forward right corner, firmly holding forward pressure. Verify that the left horizontal stabilizer indicates 12 to 18 degrees down while the stick is firmly held for one second in this extreme position, then release.
- Rudder pedals—Check for more than 25 degrees of rudder in each direction.

e. Damper switches (3)—DAMPER.
f. Damper reset button — Momentarily depressed. (If necessary)
Check that the pitch, roll, and yaw damper caution lamps go out.
g. Trim—Checked. (Optional)

Move auxiliary pitch trim switch to OFF, actuate stick trim button to NOSE DOWN and NOSE UP and check for no movement of stabilizers. Move auxiliary pitch trim switch to NOSE DN, then NOSE UP; check control surfaces travel in response to switch positions. Move auxiliary pitch trim switch to STICK and check trim button NOSE DOWN, NOSE UP, RWD, LWD, and rudder trim left and right; check control surfaces give proper response to trim inputs. Leave control surfaces out of center for subsequent check of takeoff trim system.

7. Flaps/slats—Retracted.

Note

When the control system switch is in NORM and the slats are retracted, a small oscillation may occur in the horizontal stabilizers which will be transmitted through the airframe. This condition is normal and will disappear when the slats are extended.

8. Series trim—Check.
   - Takeoff trim—Set.
   - Trim nose up for one second.
   - Wait for the horizontal stabilizers to stop driving at more than 8 degrees trailing edge up before completing the next step.

9. Auto TF switch—AUTO TF.
   The control stick shall drive slightly forward, the TF fly up off caution lamp shall light and the reference not engaged lamp shall light. These checks are valid whether TF is operational or not.

CAUTION

Do not initiate the next step unless both stabilizers indicate more than 8 degrees trailing edge up. If necessary, place the auto TF switch to OFF and repeat "Series Trim" checks.

10. Surface motion test—Complete. (GO optional)

   - Stability augmentation test switch—SURFACE MOTION, and hold until next step is completed.
   - Flight control master test button—Depress and hold for the following checks:
   - Rudder moves to right, then to the left.
   - Left horizontal stabilizer drives to near zero degrees.
   - Right horizontal stabilizer drives to approximately 10 degrees down.
   - Control system caution lamps do not light.
   - Flight control master test button—Release.
   - Rudder returns to neutral.
   - Both horizontal stabilizers may drift together in pitch.

11. Surface motion and light test—Complete. (GO optional)

   - Stability augmentation test switch—SURFACE MOTION & LIGHTS and hold until next step is completed.

CAUTION

Do not initiate the next step unless the horizontal stabilizers are more than 8 degrees trailing edge up. If necessary, place the auto TF switch to OFF and repeat "Series Trim" checks.

   - Flight control master test button—Depress and
   - hold for the following checks:
   - Rudder initially drives right, then returns to neutral.
   - Left horizontal stabilizer drives to near zero degrees.
   - Right horizontal stabilizer drives to approximately 10 degrees down.
   - Pitch, roll, and yaw damper, channel, and pitch and roll gain changer caution lamps light (8).
   - Master test button—Release.
   - Rudder initially drives left then returns to neutral.
   - Both horizontal stabilizers may drift together in pitch.

Note

If all the lamps do not light, cycle the control system switch to T.O. & LAND and return to NORM, then repeat the "Surface Motion and Light Test" checks. If all lamps still do not light, a malfunction is indicated and correction will be required before flight.

12. Flap/slat handle—Set for takeoff.
13. Auto TF switch—OFF.
14. Damper reset button—Depress momentarily.
15. All caution lamps—Out.
16. Spoiler monitor test—Checked. (GO optional)

   - Flight control master test button—Depress and
   - hold.
   - Spoiler test switch—OUTBD and hold until:
   - Outboard spoilers momentarily extend, then retract.
   - Spoiler caution lamp lights.
   - Spoiler reset button—Depress.
   - Check spoiler lamp out.
   - Spoiler test switch—INBD and hold until:
   - Inboard spoilers momentarily extend, then retract.
   - Spoiler caution lamp lights.
   - Flight control master test button—Release.
   - Spoiler reset button—Depress.
   - . Check spoiler caution lamp out.

17. Ground roll spoilers/throttles—Check. (GO optional)

   - Ground roll spoiler switch—BRAKE.
   - Check all spoilers extend.
   - Left throttle—Advance slightly, then IDLE.
   - Check all spoilers retract, then extend.
   - Right throttle—Advance slightly, then IDLE.
   - Check all spoilers retract, then extend.
   - Ground roll spoiler switch—OFF.
   - Check all spoilers retract.

18. Autopilot—Checked. (Optional)
19. Radar altimeter—Checked.

Depress and hold radar altimeter control knob; check for an indication of 95 (±12) feet and radar altitude low warning lamp goes out. Select other channel and repeat test.

20. TFR operational check:

Note

- *If time prohibits pilot accomplishing this check on the ground, both crew members must accomplish inflight prior to TF operation.*

- *This check must be accomplished on the ground or above low altitude radar altimeter range (5000 feet absolute) to obtain proper light indications.*

- *When switching channels, or changing clearance plane settings, a momentary TF fail and fly-up maneuver may occur. The autopilot release lever can be held depressed to prevent the fly-up maneuver from occurring.*

a. Antenna cage pushbutton indicator lamp— Out.

b. TF, SIT, and GM mode check—Complete.

Note

If, on the ground, the TF warning lamps stay lighted, check angle-of-attack indicator. If the reading is not in the range of plus 2 to plus 6 degrees, moving probe into this range will put the lamps out.

1) TFR channel mode selector knobs—L TF, R SIT.
   a) Channel fail caution lamp—Lighted.
   b) The channel fail caution lamp of the channel in TF should be ON, and the lamp of the channel in SIT should be OFF.
   c) Reference not engaged caution lamp —Lighted.
   d) TF fly-up off caution lamp—Lighted.
   e) TF fail warning lamp—Lighted.

2) Instrument system coupler pitch steering mode switch—TF.

3) Radar altimeter bypass switch — BYPASS.

   a) If check is performed on the ground the switch must be held in the bypass position.
   b) Check TFR channel fail caution lamps—Out.
   c) Check TF fail warning lamp—Out.
   d) TF fly-up off caution lamp—Out.
   e) Reference not engaged caution lamp —Lighted.

4) Radar altimeter bypass switch—Release to NORMAL. (Ground check only)
   Any time the aircraft is below 5000 feet absolute with radar altimeter operating, this switch will automatically release to normal.
5) E scope—Checked.
   Adjust the contrast control until a thin vertical line along the right side of the E scan is discernible- Adjust the memory control knob so the sweep is repainted just prior to the fade point. Set the video knob to midpoint (adjust for optimum target display when at low altitude).
6) Self-test pulse—Checked.
   Check for the presence of a test pulse.

7) Zero command line—Check.
   a) Ride control knob—Checked.
      Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for the three ride settings.
   b) Terrain clearance knob—Checked.
      Rotate thru each position. Check the zero command line position for proper movement and a smooth curve for all clearance settings.

8) SIT and GM check—Checked.

Rotate the range selector knob from E to 5, checking for following indications: In 15 mile position, scope should show 15 mile range with three cursors evenly spaced. Check 10 and 5 for proper range and 5 evenly spaced range cursors. Switch to GM and check for antenna tilt in 5 NM range. Return range selector knob to E and check range and cursors in GM 5, 10, and 15 as above.

9) TFR channel mode selector knobs — STBY.

   c) Radar altimeter channel selector switch — Opposite channel.
   d) Repeat TF, SIT, and GM mode check with TFR channels reversed.

21. Takeoff trim—Set. (GO optional)

After the takeoff trim lamp lights, check the control surface position indicator to insure that the horizontal stabilizer and rudder are within tolerance for takeoff and/or have the ground observer verify.

22. Pitot/heat, angle-of-attack, and engine inlet anti-ice probes—Check. (If applicable)

AFTER ENGINE START. (WSO)

Note

If cooling air is available, this checklist portion may be performed prior to engine start. Loss of cooling air during normal engine start is not sufficient to damage equipment.

1. Bomb nav mode selector knob—ALIGN.

2. Attack radar control panel—Set.

   - Function selector knob—STBY.
   - Antenna tilt indicator—Check +30.
   - Antenna cage pushbutton indicator lamp—Check.
   - Function selector knob—ON.
   - Mode selector knob—GND AUTO or GND VEL.
   - Antenna tilt indicator—Check (±2) degrees.

3. RHAW power audio knob—CW, out of detent.
   The RHAW system requires approximately 5 minutes for warm up.
4. TACAN—T/R and set.
5. IFF—STBY and set.
6. ILS switch—POWER.
7. Scope camera power switch—Set.
8. Bomb nav destination storage—Set.
   - Fix mode destination storage 1 button—Depress.

When counters stop driving enter destination storage coordinates into the destination position counters. Repeat for destination storage 2 and 3.

9. Fix mode target selector button—Depressed and set.
   Depress the target button and set destination counters to coordinates to destination or first steering point.
10. Ballistics and offset data—Set.
11. Attack radar—Tune.

Do not place attack radar to XMIT in parking area unless the area ahead of the aircraft has been checked and cleared of all personnel.

- Cathode ray tube intensity knob—CW until sweep is just visible on scope.
- Video control knob—Advance to mid-range.
- IF gain knob—CW to obtain snow then decrease until snow just disappears.
- Bezel/range marks—Check and set.
- Range/azimuth cursors—Checked and set.

12. Attack radar camera—Expose a minimum of 8 clearing frames.
13. RHAW system—Check. (If required)
14. Countermeasures dispense system—Check. (If required)
15. Infrared receiver system—Check. (If required)
16. Electronic countermeasures system (ALQ) control knobs—STBY. (If installed)
17. Electronic countermeasures pod control knobs— STBY. (If installed)
18. HF radio—Set. (If required)

Takeoff brief

1. Wing sweep – Set for takeoff
2. Flaps/Slats – Set for takeoff
3. Yaw switch - ON
4. Trim – Set for takeoff
5. Anti Skid switch - ON

A possible malfunction is indicated if trim has drifted during taxi out. Once trim has been set, with slats extended as indicated by the T.O. trim lamp lighting, and slats have not been retracted the lamp should light immediately when the T.O. trim button is depressed.

6. Fuel quantity and distribution—Checked.
7. Fuel panel—Checked.
8. Anti-collision light — On, position light STEADY.
9. Canopies—Closed and latched, unlock warning lamp out and the lock tab flush.
10. Warning and caution lamps—Checked.
    Check that all warning lamps are out and that caution lamps are compatible with mission. The *a/b* probe heat and anti-skid caution lamps will be lighted if the switches are left in the OFF position. The *a/b* probe heat caution lamp will go out when the aircraft weight is off the gear.
11. Helmet visors—Lowered. (As practicable)
12. Takeoff brief—Completed.

Note

If required remove electronic countermeasures destruct lockout pin prior to flight.

TAKEOFF.

RUNWAY CHECK. (BOTH)

1. Anti-skid switch—ON, caution lamp out

2. IFF—As required.
3. Attack radar video—Check.
4. Flight instruments—Check.

Do not take off if the airspeed Mach indicator reads greater than Mach 0.42. An erroneous CADC output can result in improper Mach trim functions of the engine fuel control unit, causing a significant reduction in engine thrust (as much as 40 percent) on both engines when the landing gear handle is placed to UP after takeoff. In the event of a

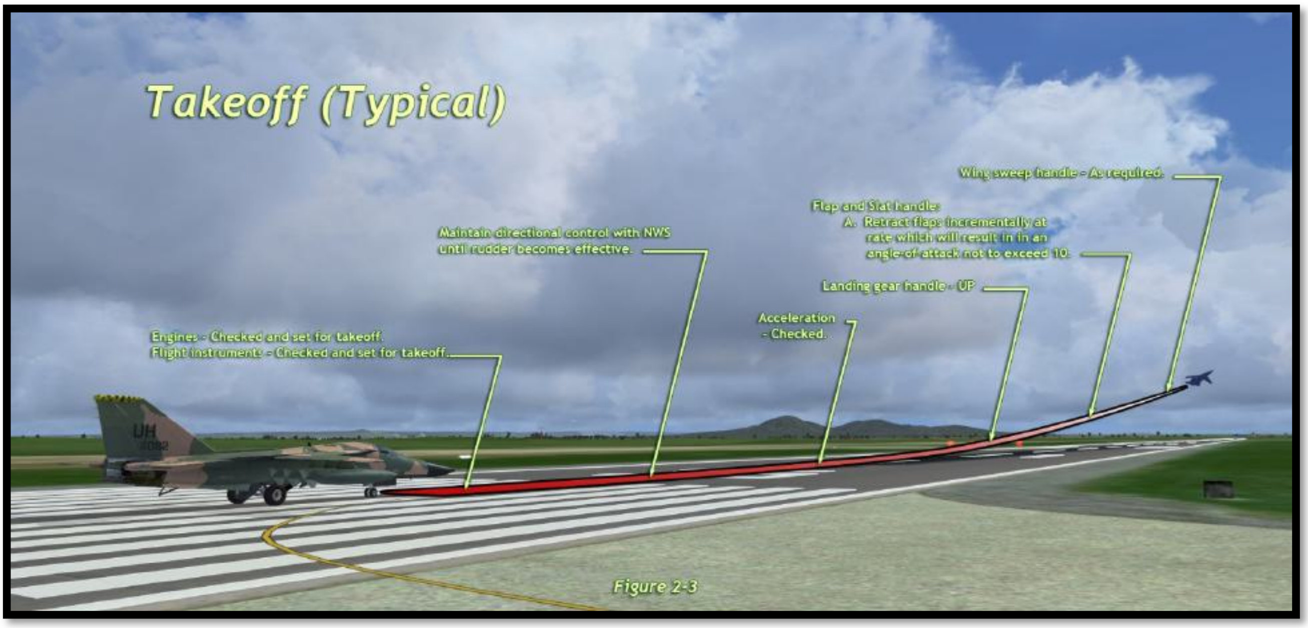


Figure 2-3

sudden thrust reduction when the landing gear handle is placed to UP, with an accompanying abnormal Mach indication, recover normal thrust by returning the landing gear handle to DN and land as soon as practicable.

5. Throttles—MIL. (Check bleed valve indicator indicates NONE)

Note

If additional engine instrument checks are desired, MAX AB power may be selected prior to brake release.

6. Brakes—Release.
7. Throttles — MAX AB. (Check engine instruments)

NORMAL TAKEOFF.

Normal takeoffs will be accomplished with wing sweep positioned at 16 degrees and 25 degrees flaps. The recommended flap setting provides an optimum trade-off between single engine rate of climb at takeoff speed and ground roll. After lining up on the runway, hold brakes and complete necessary pre-takeoff checks. With brakes held, engines may be operated up to maximum afterburner at gross weights in excess of 60,000 pounds with no skidding of the tires. Below 60,000 pounds skidding may be encountered and reduced afterburner thrust should be used. To begin takeoff roll, smoothly release brake pedals. It is recommended that maximum afterburner thrust be used for all normal takeoffs. Asymmetric afterburner operation presents no directional control problem and can easily be controlled with nose wheel steering or rudder as required. Differential wheel braking will extend takeoff roll. Nose wheel steering should be disengaged as the rudder becomes effective (50 to 70 knots). At 15 knots below takeoff speed initiate back stick pressure to achieve a rotation rate that will result in a takeoff attitude at the recommended takeoff speed. Adequate longitudinal control may be available to lift the nose wheel from the runway at lower speeds, but it is recommended that this not be done since it will lengthen the takeoff distance slightly due to increased drag.

Note

- Rotational characteristics of the aircraft will vary with gross weight, center-of-gravity position and external stores loading. Certain combinations (light gross weight and/or aft center-of-gravity location) will result in a fairly rapid rotation when aft stick force is applied. With a heavy aircraft and/or a forward center-of-gravity location immediate rotation may not occur with aft stick movement and a much slower rate of rotation may be experienced. In some cases, takeoff attitude may not be achieved until takeoff speed is reached. Therefore, takeoff should not be aborted due to failure to rotate until takeoff speed is attained.

- If obstacle clearance is required, aircraft pitch attitude should be increased after takeoff to 15 degrees (not to exceed 13 degrees angle- of-attack). Do not retract flaps or slats until the obstacle has been cleared, pitch attitude reduced, and angle-of-attack is within recommended flap retraction limits

Immediately after nose wheel lift-off, a forward stick motion may be required to arrest the rotation of the aircraft, and the stick should be adjusted to maintain 10 degrees of pitch attitude for aircraft lift-off. Landing gear retraction should be initiated when safely airborne. After lift-off, maintain this attitude constant and, as the aircraft accelerates, retract the flaps/slats incrementally at a rate which will result in an angle- of-attack not to exceed 10 degrees. During heavy gross weight takeoff conditions (above 90,000 pounds), it will be necessary to maintain an angle-of-attack between 8 and 10 degrees to avoid exceeding the flap limit speed.

- Excessive angles-of-attack may result from retracting the flaps too rapidly in this flight regime.
- Maneuvering flight at angles-of-attack greater than 10 degrees should be avoided.

For typical takeoff, see figure 2-3. Refer to the Performance Appendix for takeoff data.

AFTER TAKEOFF. (BOTH)

1. Landing gear handle – UP
   When the aircraft is definitely airborne, retract the landing gear. Check that the landing gear position indicator lamps and warning lamp in the landing gear handle go out. The landing gear and landing gear doors should be up and locked before reaching 295 KIAS

If it is necessary to depress the landing gear handle lock release button to move the handle to the UP position, the crew member should suspect a malfunction of the landing gear ground safety switch. Refer to Section III.

Note

The fuel tank pressurization caution lamp may light when the landing gear handle is moved to the UP position and remain lighted until the tanks are pressurized.

2. Flap/slat handle:

   a. Flaps—Retract flaps incrementally at a rate which will result in an angle-of-attack not to exceed 10 degrees.

- Excessive angle-of-attack may result from retracting flaps too rapidly.
- If aircraft starts to roll off while retracting the flaps immediately return the flap/slat handle to original position and make no further attempts to operate the flaps. Sufficient lateral control may not be available to counter an asymmetrical flight condition. Refer to the appropriate procedure under "Landing With Flap And Slat Malfunctions," Section III.
- If any malfunction is indicated or suspected during flap retraction it is recommended, flight conditions permitting, that the flaps not be further actuated until over an approved drop or unpopulated area. A landing utilizing normal landing procedures can be accomplished if the slats/flaps return to original position. If they do not, refer to appropriate procedure under "Landing With Flap And Slat Malfunctions," Section III.

   b. Slats—UP, and verified.
      Retract slats after verifying flaps are full up. Check that slat/aux flap indicator displays UP.
      Maintain 1 "g" until slats/flaps are fully retracted.

3. Wing sweep handle—As required.

CAUTION

If the slat/aux flap indicator displays cross- hatch, do not sweep the wings without other verification that the flaps are up.

4. Throttles—As required.
5. For military power climb, reduce throttles to MIL when climb speed is attained.
6. Engine instruments—Checked.
7. Fuel quantity indicators—Checked.
8. Check the fuel quantity indicators for normal fuel usage.
9. Oxygen and cabin altitude—Checked.
10. Altimeters—As required.

CLIMB.

The recommended climb speed, as shown in the Performance Appendix should be followed.

CRUISE.

After transfer of all external, weapon bay, and wing tank fuel, check fuselage fuel quantity indicators for normal distribution and usage. Forward and aft together should equal totalizer (±.1000) pounds.

Failure of either fwd or aft indicator pointers will cause improper fwd and aft tank fuel distribution if engine feed is in AUTO. Do not remain in AUTO. Fuel distribution must be controlled manually to maintain eg within safe limits. On aircraft prior to T.O. 1F-111- 673, the fuel distribution caution lamp is inoperative in manual modes. Refer to "Abnormal Fuel Distribution," Section III.

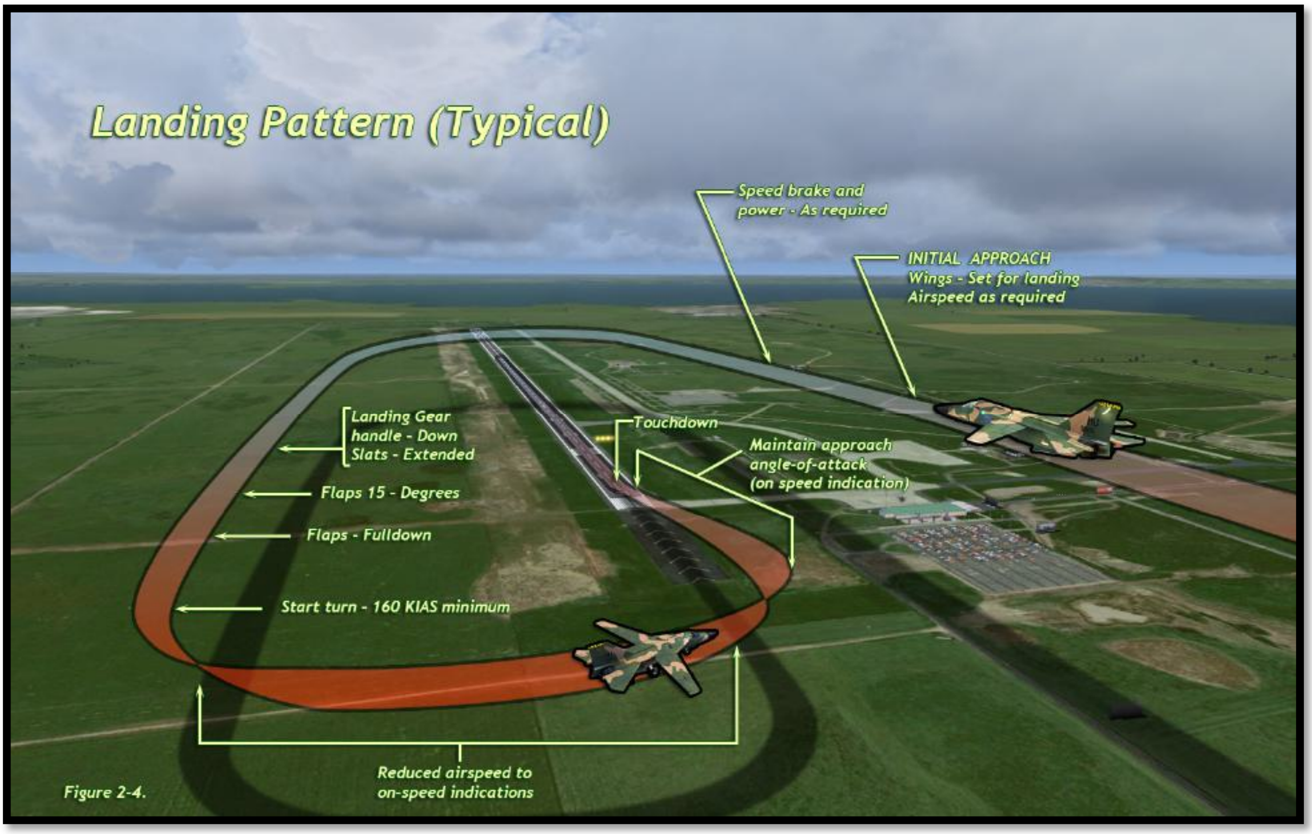


Figure 2-4.

Refer to the Performance Appendix for cruise operating data, and to Section I for complete fuel system operation.

DESCENT FOR OTHER THAN LANDINGS. (COMMAND RESPONSE)

1. Wing sweep handle—As required.
2. Check wing position indicator to assure wings moved to position selected.
3. Radar altimeter—Set minimums.
4. Magnetic variation—Set.
5. Altimeters—Set.

DESCENT/BEFORE LANDING. (COMMAND RESPONSE)

Note

The use of slats during the descent/before landing phase is optional.

1. Wing sweep handle and lockout control—Set 26 or forward, ON.
   Check wing position indicator to assure wings moved to position selected.
2. Radar altimeter—Set minimums.
3. Altimeters—Set.
4. Ground roll spoiler switch—BRAKE.
5. Anti-skid switch—ON.
6. Landing and taxi lights switch—LANDING.
7. Fuel quantity and fuel distribution—Check.

Check fuselage fuel indicator totals against totalizer reading (±1000) pounds. If engine feed is in AUTO, verify normal distribution. If aft tank is empty (pump lamps lighted) switch to FWD.

If any fuselage fuel quantity gage abnormality is noted, do not remain in AUTO. Place the engine feed selector knob to AFT and refer to "Landing With Abnormal Fuel Distribution," Section III.

8. Elevator check—Complete (if an abnormal eg is indicated or suspected).

   The elevator check may be performed at Mach 0.70 or below and below 20,000 feet MSL in level flight with 26 degrees wing sweep, slats up, and speed brake retracted. If the elevator trailing edge deflection is between 2 degrees trailing edge up and 1 degree trailing edge down, 26 degrees sweep may be used for landing. If the elevator trailing edge deflection is greater than 2 degrees trailing edge up, the wing should be swept forward until an elevator position of 2 degrees trailing edge up or 16 degrees is reached. This wing sweep may be used for landing. For trailing edge deflections greater than 1 degree trailing edge down, refer to "Landing With Abnormal Fuel Distribution," Section III.

9. CMDS—Checked, SAFE and OFF.
10. Magnetic variation—Set.
11. Landing brief—Completed.
12. Autopilot/damper switches—DAMPER.

LANDING PATTERN. (BOTH)

1. Wing sweep handle—Set for landing.

Check wing position indicator to assure wings move to position selected.

Note

- Wing sweep selected for landing will depend on gross weight and runway conditions as long as elevator position limits in the landing configuration are maintained.
- The wings must be at 26 degrees or less to allow flap/slat extension.

2. Landing gear—DN and check.

Extend the landing gear after airspeed is below 295 KIAS. Check that warning light in landing gear handle is out and landing gear position indicator lights are lighted, and hydraulic pressure is normal.

- After placing the landing gear handle to on, selection of slats/flaps during decelerating flight should not be delayed and extension of slats should be accomplished while landing gear is in the extend cycle. The command augmentation feature masks stall warning characteristics and rapid drag rise as airspeed decreases without flaps and slats extended. This may result in a rapid increase in angle- of-attack which the pilot may not be able to arrest before critical angle-of-attack limits are exceeded.
- Under landing conditions wherein airspeed may be above the gear warning horn setting 160 (±12) KIAS exercise caution to insure the landing gear is down and locked.

Note

The pitch and roll gain changer caution lamps will light when the gear is extended and will remain lighted until the slats are extended to approximately 70 percent.

3. Slats—Extend. (240 KIAS minimum)

Extend slats while gear is in the extend cycle by positioning the flap/slat handle to the slat gate and make positive verification of slat position using the wing sweep flap/slat position indicator, visual check of slats and/or observation of the gain changer caution lamps. Since the gain changer caution lamps will remain lighted until the slats have extended to approximately 70 percent, this will provide an indication of slat position. When the gain changer caution lamps go out, extend the flaps. If the gain changer lamps remain lighted and 70 degree slat extension cannot be verified by other means, do not extend flaps. (Refer to Section III)

- For normal operation, slats should be extended by a minimum airspeed of 240 KIAS. Do not roll or execute abrupt maneuvers with slats only extended.
- Do not extend flaps by normal or emergency method until approximately 70 percent slat extension has been verified. To do so could result in the flaps being locked at approximately 15 degrees with zero (or partial) slat extension. Flight in this configuration could result in stall or uncontrolled roll off. If the system locks, refer to "No (Or Partial) Slats and Partial Flaps Landing," Section III.

Note

- Airloads may prevent full slat extension of airspeed approaching the slat limit speed; however as airspeed is reduced resultant lowering of airloads will allow full slat extension.
- Maintain 1 "g" wings level until slats/flaps are extended to the desired position.

4. Flaps—Down and verified.

- Flaps—Down to 15 degrees.
- Flaps—Full down.

In the event of an asymmetrical flap condition with flaps extended beyond the 15 degree position, lateral control available to effect recovery may be marginal. (Refer to "Asymmetric Flap In Flight," Section III)

• Center-of-gravity—Check elevator position. At 10 degrees angle-of-attack check elevator position. If the elevator position is between 10 degrees trailing edge up (forward limit) and 1.5 degrees trailing edge up (aft limit) at 26 degrees wing sweep or between 10 degrees trailing edge up and 4 degrees trailing edge up at 16 degrees wing sweep, the aircraft is within the center-of-gravity limits. For wing sweeps between 26 and 16 use linear interpolation in determining the elevator position for the aft limit. If the elevator position is not in the above envelope, sweep the wing until it is. As the wing is swept forward from 26 degrees, the elevator required to trim will move in the down direction.

Note

The eg elevator position range will provide safe operation for all landing wing sweeps and store loadings. For the aft limit for landing with a specific configuration refer to Section V.

LANDING.

See figure 2-4 for a typical landing pattern. Brakes should be used as required compatible with runway available. Engage nose wheel steering as required for landing roll. For Landing Data, refer to Performance Appendix.

NORMAL LANDING

Normal landing should be accomplished with the wings at 16 to 26 degrees sweep, full flaps,• and the pattern flown as illustrated in figure 2-4. Enter the pattern as local policies dictate. On the downwind leg, reduce thrust to obtain 250 KIAS or below. Extend the landing gear and slats. Do not decelerate below 240 KIAS prior to full extension of slats. Flaps should be extended by a two step procedure, first, extend flaps to 15 degrees. Continue to slow aircraft to approximately *770* KI AS and lower flaps to full down. Trim changes associated with gear and flap extension are small, but a noticeable decrease in angle-of-attack and pitch attitude will be evidenced as slats and flaps are extended. Start turn on to base leg at a minimum of 160 KIAS. On base leg, airspeed should be reduced to obtain an "on-speed" indication upon rolling out on final. Un final, establish and maintain "on-speed" indication by adjusting power (to maintain glide slope/ rate of descent) and pitch (to maintain angle-of-attack). A normal glide slope will produce a rate of descent of approximately 600-700 feet per minute. The "on-specd" indication represents optimum angle-of-attack and airspeed for all pattern work including maneuvering, and will automatically adjust airspeed for the gross weight of the aircraft. Aircraft pitch attitude should be maintained to touchdown. Power should be reduced to IDLE immediately upon touchdown and nose wheel lowered to runway as soon as possible. Upon touchdown, landing roll brakes will extend, and the aircraft nose will tend to fall through due to the center of rotation being shifted from the aircraft center-of-gravity to the main gear. Directional control can be maintained with rudder and differential braking down to the lower speed regions. Differential braking and nose wheel steering, if required, may be used in the lower speed regions (rudder loses effectiveness below approximately 50 knots). Nose wheel steering should be engaged at minimum speeds, when necessary for directional control, with the rudder pedals at or near neutral. Brakes can be used as required throughout the landing roll. Ease the control stick aft when brakes are applied to utilize aerodynamic braking effects of the horizontal tail. The stick can be held full aft without unsticking the nose wheel at speeds below approximately 90 KIAS

Under no circumstances, during the landing phase, should the I-f degree angle-of-attack limit or stall warning activation be exceeded. Possible inadvertent stall and post-stall gyrations can result from exceeding these limits.

CAUTION

Rapid or abrupt lateral or longitudinal stick motions can cause momentary increases in rate of sink and therefore should he avoided.

SHORT FIELD LANDING.

A short field landing is accomplished in the same manner as a normal landing except that particular attention must be given to precise airspeed, angle of attack, and glide slope control. Touchdown should be as close to the end of the runway as possible with no landing flare. Observe sink rate limits. Refer to Section V. Reduce the power to IDLE at touchdown if this has nut previously been done and allow the airplane to settle on the main gear and the ground roll spoilers to extend. After the spoilers have extended and the nose wheel is firmly on the runway, apply maximum antiskid braking. Maximum braking performance is obtained in the three-point attitude with maximum weight on the main gear. The stick can be brought to the full aft position without unsticking the nose wheel at speeds below approximately 90 KIAS. Be prepared to lower the arresting hook and engage the runway barrier if the airplane cannot be stopped prior to reaching the end of the runway. Maximum braking should be released, if practical, at approximately 25 knots to prevent the brakes from fusing and immobilizing the airplane on the runway. At light gross weights the antiskid system cycling will be quite extreme and continue throughout the ground roll until just before the airplane is stopped. At heavier gross weights, little antiskid cycling will be noted. If safety or operational considerations dictate that the ground roll must be the absolute minimum possible, touchdown can be made with full antiskid braking applied.

HEAVY GROSS WEIGHT LANDING.

A heavy gross weight landing will be accomplished with a 16 degree wing sweep (if eg permits) in the same manner as a normal landing except that, maintaining an on-speed indication will result in higher approach and touchdown speeds. These higher speeds, due to heavier weights, result in increased braking requirements and stopping distances. Refer to Appendix I for landing data.

HYDROPLANING.

Dynamic hydroplaning is a condition where the tires of the airplane are separated from the runway surface by a fluid. Uudei conditions of total dynamic hydroplaning, the hydrodynamic pressures between the tires and runway lift the tires off the runway to the extent that wheel rotation slows or actually stops. The major factors in determining when an airplane will hydroplane are groundspeed, tire pressure, and depth of water on the surface. To a lesser degree, the surface texture, type of tire, and tire tread depth influence the total hydroplaning speed. Total dynamic hydroplaning in this airplane with recommended tire pressure and .1 inch or more of water or slush on the runway can be expected at approximately 115 knots groundspeed (main landing gear) and 150 knots groundspeed (nose wheel) considering a takeoff gross weight of 86,000 to 90,000 pounds. These speeds will change as tire pressure is varied for takeoff gross weight. Partial dynamic hydroplaning occurs to varying degrees below these speeds. When an airplane is subjected to hydroplaning to any degree, directional control becomes difficult. Under total dynamic hydroplaning conditions, nose wheel steering is ineffective and wheel braking is nonexistent. In addition to dynamic, two other types of hydroplaning can occur. Viscous hydroplaning can occur on a damp runway and at speeds less than those associated with dynamic hydroplaning, and is caused by a thin film of water mixed with rubber deposits and/or dust. Reverted rubber hydroplaning is caused by skid which boils the water on the runway, causing the rubber to revert to its natural latex state and seals the tire grooves, delaying water dispersal. Reverted rubber hydroplaning can occur at very low airspeeds. When possible hydroplaning conditions exist, pilots should be aware of the following:

1. Smooth tires tend to hydroplane with as little as .08 inch of water. New tires tend to release hydro-dynamic pressures and will require in excess of .2 inches of water depth to hydroplane.

2. Takeoffs with crosswinds on water covered runways should be made with caution. An aborted takeoff on a wet runway initiated at or near hydroplaning speed will require considerably more runway than a dry runway abort and directional control of the airplane will be critical until the speed has decreased below-hydroplaning velocity.

3. In the absence of accurately measured runway water depths, pilots may use the following information to determine the possibility of hydroplaning when landing must be accomplished on a wet runway that does not have a porous surface or is not grooved:

    a. Rain reported as LIGHT—Dynamic hydroplaning unlikely, viscous and reverted rubber hydroplaning are possible.

    b. Rain reported as MODERATE—All types of hydroplaning are possible. Smooth tires will likely hydroplane; however, new tires are less likely to hydroplane.

    c. Rain reported as HEAVY—Hydroplaning will occur.

LANDING ON SLIPPERY RUNWAYS.

If hydroplaning conditions exist the landing roll will be increased an indeterminate amount, therefore, be prepared for a departure end barrier engagement.

The technique for a slippery runway landing is essentially the same as that for a short field landing. During the high speed portion of the landing roll, particularly under wet or icy conditions, little braking capability will be available. This is because of the low coefficient of friction available due to hydroplaning or a very low RCR. Maximum aerodynamic braking should be used throughout the landing roll to aid in decelerating the aircraft. To avoid inhibiting wheel spin-up, and to improve wet runway wheel cornering capability, insure that the aircraft is firmly on the runway and positively under control prior to applying brakes. On wet runways during the high speed portion of the roll, little deceleration will be felt due to rapid anti-skid cycling. As speed decreases, braking potential on a wet runway will increase and brakes should be applied as required to stop the aircraft. On an icy runway, the coefficient of friction will remain fairly constant throughout the landing roll and brakes should be applied as required. Aerodynamic control, differential braking and nose wheel steering may be used to maintain directional control. Nose wheel steering should not be required until aerodynamic control becomes ineffective. If planned stopping distance indicates that a stop on the runway is doubtful, divert or make either an approach end or departure end barrier engagement, depending on the severity of the situation. Refer to Appendix 1 for ground roll distance for various runway conditions.

CROSSWIND LANDING (DRY RUNWAY).

When crosswind conditions are encountered, a crab technique on final approach should be used to compensate for drift. Under visual conditions a wing-low drift correction technique may be used, however, airspeed and glidepath control becomes more difficult. Additionally, when the aircraft sideslips to the right, airflow to the angle of attack sensor begins to be blanked by the aircraft nose at a sideslip angle of approximately 10 degrees. As the sideslip angle is increased beyond this point, the angle-of-attack sensor indicates increasingly lower values of angle-of-attack. Therefore, it is recommended that steady-state rudder inputs be kept below seven degrees as inputs of a larger magnitude may result in erroneous angle-of-attack indications.

Sideslip to the left will not affect the angle-of-attack sensor; therefore, the aircraft may sideslip to the left to the limits presented in Section V. During the transition to touchdown (approximately 75 feet above the ground), the drift correction technique should shift gradually from a crab to a wing low crabbed correction at touchdown. The pilot should attempt to touch down with no drift and the longitudinal axis of the aircraft aligned with the runway, which will minimize sideloads on the landing gear. However, if the crosswind components is excessive, it will be necessary to land in a combination wing-low crabbed attitude, not to exceed 10 degrees yaw or crab angle at touchdown.

CAUTION

External tanks at stations 2 or 7 will contact the ground at a bank angle of 15 degrees.

During touchdown from a wing-low crabbed approach, the pilot may experience the sensation of bouncing from gear to gear which may be aggravated by use of roll control in attempting to keep the wings level. The probability of this occurring will be reduced if a firm touchdown at the recommended angle of attack is accomplished. If this condition is encountered, minimize use of roll control until the aircraft has settled through the struts and is firmly on the ground. After touchdown, the pilot should use rudder, roll control and differential braking as required to maintain directional control. Roll control effectiveness may be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nosewheel steering is required, it should be initiated with the rudder pedals at or near neutral, since the nosewheel will rapidly assume a position relative to the rudder pedal position at engagement. Unless required for directional control, nosewheel steering should not be engaged until the aircraft has slowed to taxi speed and just prior to turning off the runway. When landing with slats/flaps up, refer to "Crosswind Takeoff And Landing Limits," Section V, for recommended touchdown technique and limits. When landing with augmentation off, refer to "Dampers Off Landing," Section III.

CROSSWIND LANDING (SLIPPERY RUNWAY).

The problem of maintaining directional control on a slippery runway becomes more difficult as the effective crosswind is increased. Consequently, aircraft flight path alignment with the runway must be established during the approach to prevent drift at touchdown. Restricted visibility, poor ground references, and crab angle will further complicate the task of establishing alignment during the approach. Pilots should be aware that excessive maneuvering during the final phase of the approach may induce misalignment and/or drift and may make it impossible for the pilot to determine actual aircraft track.

Proper runway alignment for approaches and landings under low RCR conditions is extremely critical. Avoid excessive maneuvering on final approach under these conditions. Aircraft drift or flight path misalignment at touchdown increases susceptibility to skidding or hydroplaning, which may cause loss of directional control during landing roll. If aircraft drift is not corrected prior to touchdown, execute a missed approach.

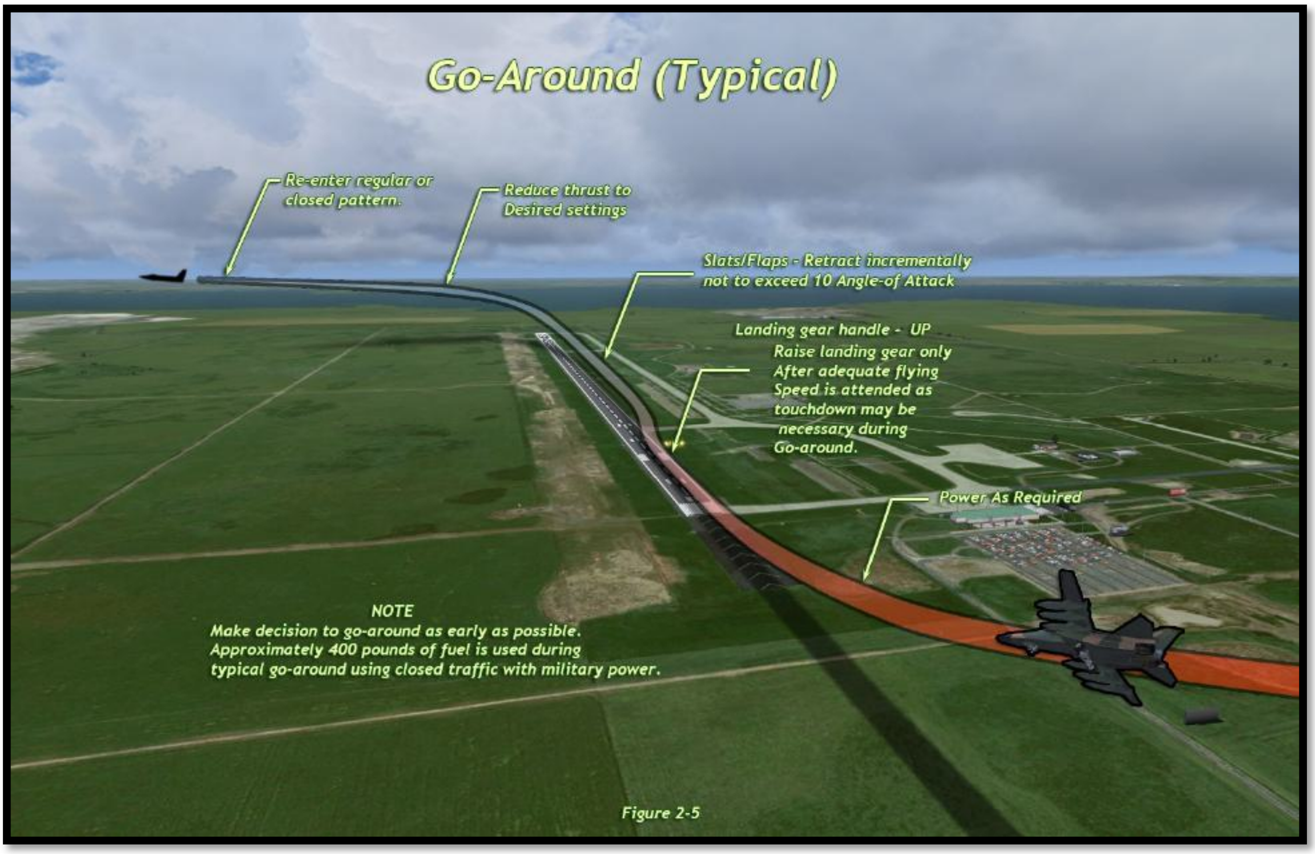
Plan the landing pattern to be established on final approach using a crab technique to correct for drift. This will insure that the aircraft is tracking straight down the center line of the runway. Establish a normal rate of descent and plan to touch-down approximately 500 feet down the runway or at the glide slope/runway interception point (if applicable). Make a firm touchdown with no flare (observe sink rate limitations, Section V) while maintaining the drift correction. Touching down in a crab will help insure that the runway center line track is maintained. Due to visibility restrictions that may occur with a crabbed approach, a combination crabbed/wing-low technique may be necessary during the transition to touchdown. Immediately after touchdown, retard throttles to idle and lower the nose to the runway. Aerodynamic (rudder and roll) control, differential braking, and nose-wheel steering may be used to maintain directional control; however, nose-wheel steering should not be required until aerodynamic control becomes ineffective. Roll control effectiveness will be increased significantly by "cracking" a throttle, thereby retracting the spoiler brakes and allowing the spoilers to function as an aid to roll control. When the desired directional control change is achieved, return the throttle to idle to extend the spoiler brakes. If nose-wheel steering is engaged, inputs should be kept small as steering effectiveness diminishes rapidly with nose-wheel deflections of more than 10°.

Note

- If directional control cannot be established or maintained, immediately advance power as required to accomplish a go-around.
- After directional control is well established, use the technique described under "Landing on Slippery Runways," this section, to stop the airplane.

LANDING WITH PARTIAL FLAPS.

A partial flap landing is accomplished in the same manner as a normal landing except that, maintaining an "on-speed" indication will result in higher approach and touchdown speeds (approximately 1.7 knots increase in airspeed for



each degree of flap less than full flaps with 16 to 26 degree wing sweep). Due to the higher approach and touchdown speeds, braking requirements as well as stopping distances will be significantly increased.

LANDING WITH SLATS EXTENDED AND FLAPS RETRACTED OR WITH SLATS AND FLAPS RETRACTED.

Approaches with wings and flaps in other than normal landing configuration will necessitate a long shallow, straight-in approach. If it is necessary to land the aircraft in this configuration, refer to "No Flap Landing," Section III.

TOUCH AND GO LANDING.

Touch and go landings should be accomplished using the same technique as presented in the "Normal Landing and Takeoff" procedures this section. After touchdown power should be reduced to IDLE to allow the aircraft to decelerate and the nose wheel lowered to the runway. Directional control should be maintained with the rudder pedals. After the nose wheel has been lowered to the runway, smoothly advance the throttles to MIL or AB power as required. Check engine instruments for normal indications and caution lamps for malfunction warning. Lift nose wheel off runway 10 knots below previous approach speed.

SIMULATED SINGLE ENGINE LANDING.

Simulated single engine landing should be flown with one engine at idle rpm, following the "Single Engine Go-Around," procedure, Section III.

GO-AROUND

The decision to go around should be made as early as possible. When the decision to go around is made, smoothly advance the throttles and continue the approach because a touchdown may be necessary. As the aircraft accelerates, rotate the nose to a climbing attitude and when the altimeter and vertical velocity show a definite rate-of-climb proceed with the normal after takeoff checklist. Fly clear of the runway as soon as practicable. (See figure 2-5.) In the accomplishment of a go-around from the approach condition at light gross weight, application of MAX AB on both engines will result in a significant nose-up pitching moment. The forward stick movement to counter the induced nose-up moment, plus the normal forward stick required to maintain level flight as the aircraft accelerates, results in a large forward stick deflection. Forward stick trim authority may not be sufficient to correct this nose-up tendency, and forward control stick application may be required. However, adequate longitudinal control is available to maintain level flight.

BEFORE CLEARING RUNWAY. (COMMAND RESPONSE)

1. Attack radar function selector knob—ON.

The attack radar must not be left in the XMIT position after landing due to the possible danger to personnel in front of the aircraft.

2. TFR channels—STBY.
3. Nose wheel steering—As required.
4. Anti-skid switch—OFF.

   Place anti-skid switch to OFF when aircraft speed is reduced to approximately 20 knots or below.

AFTER LANDING. (COMMAND RESPONSE)

CAUTION

To prevent damage to the canopy, do not open canopy with cabin pressurized. Prior to opening canopy, check cabin pressure altimeter agrees with field elevation. If cabin is pressurized, place the pressurization selector switch to DUMP prior to opening canopy. (Equipment cooling is not affected with this switch in DUMP.)

1. Nose wheel steering—Engaged.

Note

Nose wheel steering should be engaged prior to turning off runway.

2. Anti-skid switch — OFF. (Approximately 20 KIAS)
3. Radar function knob—ON.

The attack radar must not be left in the XMIT position after landing due to the possible danger to personnel in front of the aircraft.

4. Fuselage and landing lights—As required.
   - Landing lights—OFF or TAXI. (If necessary)
   - Anti-collision light—OFF.
   - Fuselage lights—FLASH.
5. Radar altimeter—OFF.
6. Ground roll spoiler switch—OFF.
7. Flap/slat handle—As required. (Normally extended)

   If slats are retracted, place rudder authority switch to FULL to insure full nose wheel steering.
8. Wing sweep—Set. (Normally 16 degrees)
9. Pitot/probe heater switch—OFF/SEC.
10. IFF mode 4 control knob—HOLD or ZERO.
11. IFF master control knob—OFF.
12. Ejection handle and center beam safety pins—Inserted.

Note

- The ejection handle safety pins provided must be inserted from center console outboard to preclude interference of the pins with seat adjustment.
- Destruct panel lockout pin installed if previously removed.

ENGINE SHUTDOWN. (BOTH)

CAUTION

To prevent damage to the brakes from overheating, do not pull the auxiliary brake handle.

1. Wheels—Chocked. (GO)
2. Wing sweep handle—As required.
3. Flap/slat handle—As required.
4. Weapon bay door(s)—As required. (GO) •Ground crew check weapon bay doors—
   - Checked, clear.
   - Weapon bay door(s) switch—OPEN. (As required)
   - Ground crew report weapon bay door(s)— OPEN.
5. Bomb nav computer—Set. (If required)
   - Present position latitude and longitude—Corrected.
   - Rapid alignment. (If applicable)
6. Bomb nav mode selector knob—OFF.
7. Pitch, roll and yaw damper switches—OFF.
8. Computer power switches(3)—OFF.
9. Applicable throttle—OFF.

   Place the throttle of first engine started to OFF.

Note

If shutdown is after operation above 80 percent, reduce power to IDLE for approximately five minutes.

10. Nacelle vent ejector system—Check.

Prior to engine shut down the ground crew will observe that the nacelle vent and fire access doors are in an open position indicating that the nacelle vent system is functioning. A positive movement of the doors from open to close should occur during engine shut down. If the doors are closed prior to shut down, it is indicative of a broken nacelle vent system duct or a faulty nacelle vent system pressure regulating and shut off valve.

11. Hydraulic pressure—Check.

Check for 2950 to 3250 psi indication.

12. Remaining throttle—OFF.

CAUTION

To prevent possible engine damage due to overtemperature, do not attempt to restart the engine until TIT is below 100 degrees C.

Note

Do not move the control stick after shutting down the last engine. To do so will invalidate the following horizontal tail droop check.

13. Horizontal tail droop check—Completed.

    Do not move the control stick. A minimum trailing edge down position of 12 inches must occur within 60 seconds of zero hydraulic pressure. Zero hydraulic pressure is considered to be the point at which the audible whine associated with emergency generator operation begins to decay.

14. Emergency generator—Checked.
    - Emergency generator OPR light—Lighted, within one second.
    - Emergency generator lamp—Out.

    Light remains on until utility hydraulic pressure drops. The emergency generator indicator lamp will light as the last engine driven generator disconnects from the ac buses. The lamp will go out when hydraulic pressure driving the emergency generator is depleted.

15. Battery switch—OFF.
16. All switches and controls—OFF, NORMAL or SAFE.

If oxygen lever is left on and regulator is set to EMER, liquid oxygen may flow through the regulator creating a potentially hazardous situation.

17. Camera magazine—Removed (if required).

AIRCRAFT EMERGENCY MOVEMENT CHECKLIST.

CAUTION

Pilot will ascertain from ground crew or Form 781 that the aircraft status will allow ground movement.

STARTING ENGINE.

1. Connect external power and air or install cartridge—Accomplished.
2. Ground ignition cutoff switch—NORM.
3. Battery and/or external power switches —ON.(As applicable)

   Engine start may be accomplished using either battery or external power, or both.
4. UHF radios—ON and set.
5. Engine feed selector knob—AUTO.
6. Position lights— BRT and FLASH.
7. Auxiliary brake handle—Pulled.
8. Engine ground start switch—PNEU or CARTRIDGE. (As applicable)

   Place the engine ground start switch to PNEU when starting the engines with external starter air or to CARTRIDGE for a cartridge start.
9. Throttle—START, then IDLE:
   a. On a cartridge start, advance the applicable throttle to IDLE immediately.
   b. On a pneumatic start, advance the applicable throttle to IDLE after engine rpm reaches 17 percent.
10. Engine instruments, caution lamps, and hydraulics—Checked.
11. Engine ground start switch—OFF.
12. Generator switch—START (pause), release to RUN.

Note

If the generator caution lamp remains lighted, place the generator switch to OFF/ RESET, hold to START (pause), then release to RUN.

13. Air refueling switch—CLOSE.
14. External power switch—OFF, power unit removed.
15. Rudder authority switch—FULL.

TAXIING.

1. Auxiliary brake handle—In.
2. Nose wheel steering—Engaged.

Check that the nose wheel steering indicator lamp is lighted. Check engagement of nose wheel steering by sliglu movement of rudder pedals.

3. Brakes—Checked.

   Depress brake pedals and check for proper braking.

4. Hydraulic pressure—Checked. (2950 to 3250 psi)

ENGINE SHUTDOWN.

1. Wheels—Chocked.
2. Generators—OFF.
3. Throttle—OFF.

BEFORE LEAVING AIRCRAFT.

1. All switches and controls—OFF, normal or safe.

This is the last page of Section III.

Section IV

OPERATING LIMITATIONS

TABLE OF CONTENTS

INFLIGHT OPERATION.

Engine operation should be conducted within the military rating and maximum rating time limits whenever practicable. However, if the mission or flight conditions require operation in excess of these time limits, thrust should not be reduced for only a short interval and then advanced to the high thrust level. Operation at the high thrust level should be continued until conditions permit a reduction in thrust. Overtime operation can be sustained without immediate adverse results, but the total operating life of the engine will be shortened. Operating continuously for one slightly longer period instead of using two or more shorter periods will avoid an additional heat cycling of the engine, which is detrimental to engine life. The engine may be operated continuously, with no time limitation, as long as the turbine inlet temperature limit for continuous operation is not exceeded.

Fuel Supply.

To prevent possible flameout of both engines, do not exceed 10 seconds under zero "g" or negative "g" flight condition.

WARNING

Do not initiate a zero or negative "g" maneuver when the fuel low caution lamp is lighted. To do so could result in a flameout of both engines.

Note

The fuel low caution lamp may light during a negative "g" maneuver.

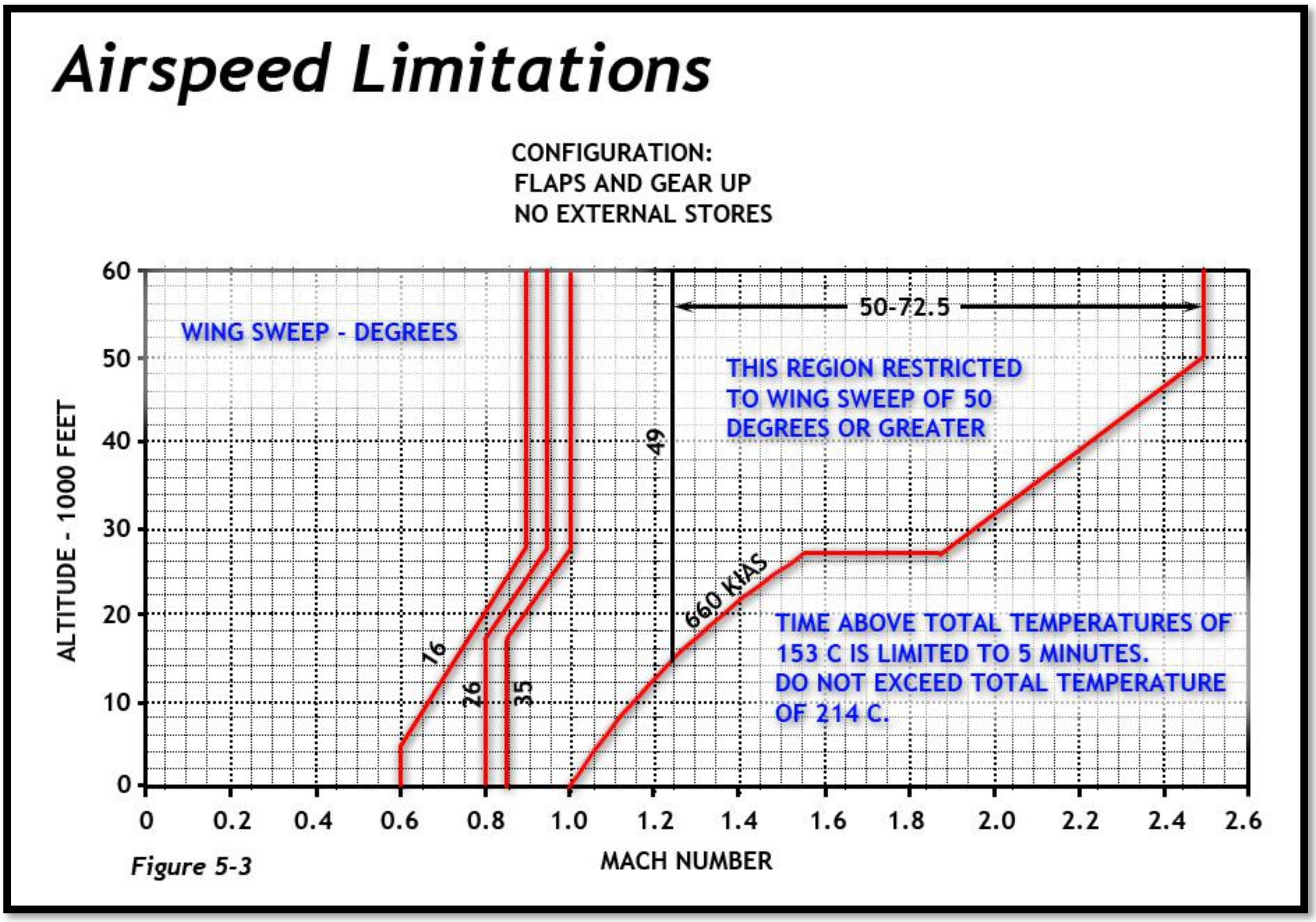


Figure 5-3

AIRSPEED LIMITATIONS.

AIRSPEED AND ALTITUDE OPERATIONAL LIMIT ENVELOPES.

The airspeed restrictions for the aircraft with flaps retracted and gear up are presented in figure 5-3. With wings swept between 16 and 49 degrees the airspeed limits shown in figure 5-3 coincide with the limits programmed into the maximum safe Mach assembly (MSMA). With the wings swept between 50 and 72.5 degrees, the maximum airspeeds presented are permitted. The maximum sustained speed is coincident with a total temperature of 153 C (308 F) degrees. The maximum dash speed is coincident with a total temperature of 214 C (418 F) degrees or Mach 2.50, whichever is less. Flight at speeds which result in total temperatures greater than 153 C (308 F) degrees is limited to 5 minutes per flight.

FUEL DUMP LIMIT SPEED.

Do not dump fuel at airspeeds above 350 KIAS or Mach 0.75, whichever is less. To do so may cause dumped fuel to reenter the fuselage, resulting in a fire hazard.

AIR REFUELING RECEPTACLE LIMIT SPEED.

Do not exceed 400 KIAS or Mach 1.0 whichever is less, with the air refueling receptacle in any position other than fully closed.

SLATS/FLAPS LIMIT SPEEDS.

The slats and flaps in the extended position can structurally withstand higher airspeeds than they can be driven against.

1. Flap limits are as follows:

During Extension

• Flaps — 0 to 25 degrees	250 KIAS or 0.62 Mach, whichever is less
• Flaps — 26 degrees to full down	220 KIAS or 0.48 Mach, whichever is less

Static Extended Condition or During Retraction

- Flaps — 0 to 25 degrees: 270 KIAS or 0.62 Mach, whichever is less
- Flaps — 26 degrees to full down: 245 KIAS or 0.48 Mach, whichever is less

2. Slat limit speed is 295 KIAS or 0.62 Mach, whichever is less.

WEAPONS BAY DOOR(S).

1. Do not open weapons bay door(s) at airspeed in excess of Mach 2.0 or exceed Mach 2.0 with the doors open.
2. Do not open the weapons bay doors with external stores installed on the pivot pylons above Mach 0.90.
3. Due to buffeting, do not open the weapons bay doors with the speed brake extended.
4. Observe 0 to 4 "g" limit during operation of the weapons bay doors.

LANDING GEAR OPERATION LIMIT.

Do not exceed 1.20 "g" during landing gear extension. The maximum speed for landing gear extension, flight with the landing gear extended or for retraction is 295 KIAS.

FLIGHT CONTROL SYSTEM LIMITS.

Do not exceed 300 KIAS or Mach 0.45, whichever is less, with the control system switch in T.O. & LAND. With the flaps retracted, and wings aft of 26 degrees, do not place the control system switch to T.O. & LAND without first placing the flight control disconnect switch to OVRD.

TAXI SPEED.

Maximum taxi speeds:

1. 25 knots straight away
2. 10 knots turning

These limits are based on the possibility of overheating the tires during prolonged straight away taxiing and preventing excessive side loads on the landing gear when turning.

MINIMUM FLYING SPEEDS.

The minimum flying speeds are defined by the maximum angle-of-attack limits presented in figure 5-6. For a discussion of minimum flying speeds, refer to "Minimum Recommended Flying Speeds," Section VI.

Note

Flight below minimum speeds is permitted for time not to exceed five minutes to accomplish required maneuvers.

GROSS WEIGHT LIMITATIONS.

MAXIMUM GROSS WEIGHT.

Maximum gross weight limits are as follows:

1. Taxi and takeoff 91,500 pounds.
2. Inflight — 100,000 pounds.
3. Landing — 80,000 pounds.

AIRCRAFT SINK RATE AT TOUCHDOWN.

The allowable sink rate at touchdown shall not exceed 600 feet per minute at landing gross weights up to the maximum allowable with any authorized weapon and/or stores loading, except if any usable fuel remains in the external tanks, the allowable sink rate shall not exceed 360 feet per minute.

SPEED BRAKE LIMITS.

Speed brake operation is limited to 600 KIAS or Mach 2.0, whichever is less.

With ECM pods installed on weapon bay doors, do not extend the speed brake at speeds in excess of 5(H) KIAS or Mach 1.20, whichever is less.

LEVEL FLIGHT CHARACTERISTICS.

Refer to Section II for discussion of takeoff and landing characteristics.

SUBSONIC FLIGHT.

- Operation of the aircraft at subsonic speeds up to Mach 0.80 should normally be accomplished with wings swept between 26 and 50 degrees. Generally, response and damping about all axes in this speed range is considered excellent based on flight experience to date. Rolling maneuvers in the subsonic region (airspeeds greater than 250 KIAS but less than Mach 0.80) with wings swept aft of *45* degrees are not recommended due to the fact that the spoilers are locked out aft of this wing sweep. With the spoilers locked out, roll control is significantly reduced and, therefore, aircraft roll performance is reduced. If flight is required with wings swept aft of *45* degrees, uncoordinated rolling maneuvers should not exceed 60 degrees of bank and coordinated rolling maneuvers should not exceed 360 degrees of roll (at maximum roll rate) to prevent excessive sideslip angles from being developed. Excessive sideslip angles tend to reduce the aircraft roll performance and may in some 360 degree rolls reduce the roll rate to values which may appear to the pilot as if the aircraft has ceased rolling. However, all other characteristics of the aircraft are considered good at the aft sweep angles. The angle-of-attack limits presented in Section V should not be exceeded in either 1 "g" or maneuvering flight. Based upon these angle-of-attack limits, minimum airspeeds for 1 "g" and limited maneuvering flight are presented for nominal center-of- gravity positions associated with automatic fuel sequence. (See "Minimum Airspeeds," this section.) The minimum airspeeds will vary as much as one knot from these values for each one percent MAC center-of-gravity deviation from the quoted values. These minimum airspeeds are for operational planning purposes only, and the angle-of-attack limits presented in Section V should not be exceeded in either 1 "g" or maneuvering flight.

TRANSONIC FLIGHT.

- During operation of the aircraft at transonic Mach numbers (Mach 0.80 to 1.1) wing sweep angles of 45 to 72.5 degrees should be utilized. At 20,000 feet and above, sweep angles of 45 degrees are recommended to keep the aircraft angle-of-attaclc low which will result in better acceleration characteristics. At the lower altitudes, more aft sweep angles are recommended to optimize acceleration. Although the spoilers will be locked out with the more aft sweeps, roll performance will be improved due to the lower angle of attack and higher dynamic pressure. During transonic flight above 25,000 feet a relatively small directional trim change may occur just prior to achieving supersonic flight. As altitude is decreased in this speed re-gime, the trim change is more noticeable and below 10,000 feet may be exhibited as a small Dutch roll transient accompanied by mild buffet. No trim changes occur longitudinally or laterally.

SUPERSONIC FLIGHT.

- Flight in the supersonic flight spectrum (Mach 1.10 and above) should normally be accomplished with the wings fully swept. Some external store loadings preclude full aft sweep and as such are limited to 54 degrees. Flight - can be performed in the supersonic speed range with wing sweep angles as low as 50 degrees; however, such sweep angles are detrimental to optimum performance. Deceleration at supersonic speeds can be greatly enhanced by sweeping the wing forward to obtain increased drag. This allows the pilot to either reduce power to aid deceleration or maintain power for more rapid acceleration should the need arise. During wing sweeping and ensuing deceleration or acceleration, aircraft trim changes will be small and will appear to the pilot principally as attitude changes. Throughout the supersonic flight spectrum covered to date, response and damping characteristics have been good; however the potential of directional instability associated with angle-of-attack in excess of handbook limits still exists.

CAUTION

As the wings are swept forward, exercise caution to avoid exceeding the speed limitations or computed MSMA indications which apply to the forward wing sweep positions, especially wing sweep angles less than 50 degrees. Refer to "Airspeed Limitations" Section V.

This is the last page of Section IV.