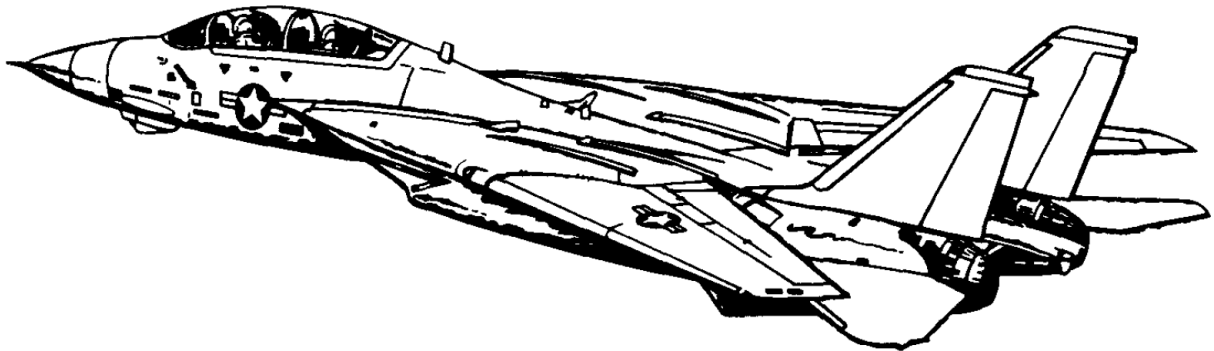




**VIRTUAL NATOPS FLIGHT MANUAL
NAVY MODEL
F-14D
FOR MICROSOFT FLIGHT SIMULATOR X:
ACCELERATION**



DISTRIBUTION STATEMENT: This document is part of the freeware F-14D Tomcat add-on package for Microsoft Flight Simulator X: Acceleration and is supplied with the sole scope of providing help and information for the usage of such software in the Microsoft Flight Simulator videogame. No warranty of any kind is provided nor any level of realism or accuracy is granted: the information in this manual may differ significantly from real world – **DO NOT USE THIS MANUAL AS A SOURCE OF INFORMATION FOR REAL WORLD FLIGHT OPERATIONS OR TRAINING!**

LETTER OF PROMULGATION

1. With the release of the new version of the F-14D Tomcat for Flight Simulator X: Acceleration, I have decided to include in the package this "VNATOPS" Flight Manual, that is a flight manual that mimics the structure and the information contained the real world NATOPS manual. The intent is to provide the users, gamers and aviation enthusiasts with more information and details about the F-14D Tomcat (both real and virtual) in order to provide more fun for those looking for more realism, and a detailed source for those willing to learn something about fighter jets and naval aviation in general.
2. Although this manual closely resembles the structure and content of the first chapters of real world flight manual, it has been extensively modified for use within the Flight Simulator X videogame. Whenever possible, the differences between the real plane and its virtual counterpart have been highlighted and explained. This manual also includes some informations that are not relevant to Flight Simulator X, but that were considered interesting or fun for the aviation enthusiast.
3. This manual, as well as the whole F-14D Tomcat for Flight Simulator X: Acceleration project, has been created on the basis that Flight Simulator X is a videogame and nothing more than that. Therefore, although the project is quite detailed, we cannot guarantee any level of realism.

Have fun!
Dino Cattaneo

GLOSSARY

A

A/A Air-to-air.
AAA Anti-aircraft artillery.
AAC Aviation armament change.
AAI Air-to-air interrogator.
AAW Anti-air warfare.
AB Afterburner.
ac Alternating current.
ACC Aircrew system change.
ACL Automatic carrier landing.
ACLS Automatic carrier landing system.
ACM Air combat maneuver.
ACQ Acquisition (TCS).
ACS Automatic channel select.
A/D Analog-to-digital.
ADAC Airborne data acquisition computer.
ADF Automatic direction finder.
ADI Altitude director indicator.
ADL Armament datum line.
ADRL Automatic distribution requirements list.
AEC Automatic exposure control.
AFB Airframe bulletin.
AFC Airframe change.
AFTC Augmenter fan temperature control.
A/G Air-to-ground.
AGI Armament gas ingestion.
AGL Above ground level.
AGR Air-to-ground ranging.
AIC Air inlet control; air intercept control.
AICS Air inlet control system.
A/J Antijam.
AM Amplitude modulation.
A/N Alphanumeric.
AOA Angle of attack.
AOB Angle of bank.
AON Angle-off-the-nose.
APC Approach power compensator.
APCS Approach power compensator system.
ARDP Advance radar data processor.
ARI Automatic rudder interconnect.
ARSP Advance radar signal processor.
ASC Advanced signal converter.
ASE Allowable steering error.
ASH Automatic stored heading.
ASPJ Airborne self-protection jammer.
ASR Air surveillance radar.
ATDC Airborne tactical data control.
ATDS Airborne tactical data system.
ATLS Asymmetric thrust limiting system.
AVB Avionic bulletin.
AVC Avionic change.
AVIA TID AOA, VV, ILS, and ACLS.
AWCS Airborne weapons control system.
AWL All-weather landing.
AYC Accessories change.

B

BARO Barometric.
BATR Bullet at target range.
BCD Binary code decimal.
BDA Bomb damage assessment.
BDHI Bearing distance heading indicator.
BER BIT evaluation report.
BFCM Backup flight control module.
BIDI Bidirectional hydraulic pump.
Bingo Return fuel state.
BIST Built-in self test.
BIT Built-in test.
BLD Basic landing display.
BMT BIT moving target.
BOL BOFORS launcher.
Bolter Hook down, unintentional touch and go.
BOS Backup oxygen system.
BPS Beam power supply.
BRU Bomb rack unit.
BSF Band suppression filter.
BTOF Bullet time of flight.

C

CA Cartridge actuated device.
CADC Central air data computer.
CAINS Carrier aircraft inertial navigation system.
CAP Combat air patrol; computer address panel.
CARQUAL Carrier qualifications.
CAS Calibrated airspeed.
CAT Catapult.
CATM Captive air training missile.
CATCC Carrier air traffic control center.
CAW Caution, advisory, warning.
cb Circuit breaker.
CC Cubic centimeter.
CCA Carrier controlled approach.
CCIP Continuously computed impact point.
CCRS Command course.
CCTVS Color cockpit television sensor.
CDI Course deviation indicator.
CDIR Camouflage detection infrared.
cg Center of gravity.
CGTL Command ground track line.
Charlie time Expected time over ramp.
CIC Combat information center.
CICU Computer integrated converter unit.
CIPDU Control indicator power distribution unit.
CIU Converter interface unit.
CM Continuous monitor.
CMB Code matrix box.
CMM Continuous monitor mode.
CMPTR Computer.
CNI Communication-navigation-identification.
CNO Chief of Naval Operations.
COT Crew operation trainer.
CP Central processor.
CPS Controller processor signal unit; cycles per second.
CRT Cathode ray tube.
CSD Constant speed drive.

CSS Control stick steering.
CV Aircraft carrier.
CVA Aircraft carrier approach.
CVIC Aircraft carrier intelligence center.
CVS Course vectoring symbols.
CWI Continuous-wave illuminator.

D

D/A Digital-to-analog.
dB Decibel.
dc Direct current.
DD Digital display.
DDP Digital data processor.
DDPG Digital data processor group.
DDS Data display system; digital data system.
DECM Defensive electronic countermeasures.
DEST Destination.
DEU Data entry unit.
DF Direction finder.
DFCS Digital flight control system.
DFM Dogfight mode.
DG Directional gyro.
D/L Data link.
DLC Direct lift control.
DLS Data-link system.
DMA Degraded mode assessment.
DME Distance measuring equipment.
DP Decision point.
DPG Data processor group.
DPGS Data processing ground station.
DR Dead reckoning.
DRO Destructive readout.
DROT Degraded range on target.
DSPT Dynamic steering point.
DSS Data storage set.
DSU Data storage unit.
DTM Data transfer module.

E

EAC Expected approach clearance time.
EAS Equivalent airspeed.
ECA Expanded chaff adapter.
ECCM Electronic counter-countermeasures.
ECM Electronic countermeasures.
ECS Environmental control system.
ECU Electronic control unit.
EED Electroexplosive devices.
EGT Exhaust gas temperature.
EIF Exposure interval factor.
EIG Engine instrument group.
EMCON Electronic radiation control.
EMSP Engine monitoring system processor.
ETA Estimated time of arrival.

F

FAM Familiarization.
FCF Functional checkflight.
FCLP Field carrier landing practice.
FD Fault direction.
FEMS Fatigue engine monitoring system.

FF Fuel flow.
F/F Fighter to fighter.
FF/DL Fighter-to-fighter data link.
FHF Failure history file.
FI Fault isolation.
FL Flight level.
FLOLS Fresnel lens optical landing system.
FLRP Fighter link reference point.
FMC Fighter mode command; forward motion compensation;
forward motion correction.
FMI Flight maintenance indicator.
FMLP Field mirror landing practice.
FOD Foreign object damage.
FOV Field of view.
fpm feet per minute.
FRL Fuselage reference line.
FRS Fleet replacement squadron.
FTCM Flight test continuous monitoring.
FTJU Fuel tank jettison unit.
FWD Forward.

G

G Guard channel.
g Gravity.
G/A Ground to air.
GACH Gimble angle crosshair.
GCA Ground-controlled approach.
GCI Ground-controlled intercept.
GCU Generator control unit; gun control unit.
GPS Global positioning system.
GSS Gun scoring system.
GT Ground track.

H

HDG Heading.
HEFOE Hydraulic electric fuel oil engine.
HERO Hazards of electromagnetic radiation to ordnance.
hot start A start that exceeds normal starting temperatures.
HPRF High pulse repetition frequency.
HSD Horizontal situation display.
HSI Horizontal situation indicator.
HUD Heads-up display.
hung start A start that results in a stagnated rpm and temperature.

I

IAS Indicated airspeed.
IBIT Initiated BIT.
ICAO International Civil Aviation Organization.
ICS Intercommunications systems.
IDG Integrated-drive generator.
IF Intermediate frequency.
IFB Interference blanker.
IFF Identification, friend or foe.
IFOV Instantaneous field of view.
IFR Instrument flight rules.
IFT In-flight training.

IFX IFF transponder.
IGV Inlet guide vane.
ILCOS Instantaneous lead computed optical sight.
ILS Instrument landing system.
IMC Instrument meteorological conditions.
IMN Indicated Mach number.
IMU Inertial measurement unit.
InHg Inch of Mercury.
INS Inertial navigation system.
IP Initial point.
IPF Interference protection feature.
IR Infrared.
IRCM Infrared countermeasures.
IRLS Infrared line scanner.
IRNR Infrared not ready.
IRRS Infrared reconnaissance set.
IRST Infrared search and track.
IRT Infrared test.
IRW Infrared wide.
ITER Improved triple ejector track.
ITS Integrated trim system.
IU Interface unit.

J

JAT Jam angle track.
JTIDS Joint tactical information distribution system.

K

KCAS Knots calibrated airspeed.
KCP Keyer control panel.
KEAS Knots equivalent airspeed.
kHz Kilohertz.
KIAS Knots indicated airspeed.
KTS Knots.

L

LAOT Low-PRF antenna on target.
LAR Launch acceptability region.
LARI Lateral automatic rudder interconnect.
LBA Limits of basic aircraft.
LCD Liquid crystal display.
LCOS Lead computing optical sight.
LCU Load control unit.
LE Leading edge.
LOROP Long-range oblique photography.
LOS Line of sight.
LOX Liquid oxygen.
LPA Life preserver assembly.
LPRF Low pulse repetition frequency.
LS Line scanner.
LSO Landing signal officer (Paddles).
LTE Launch to eject.

M

M Mach.
MAC Mean aerodynamic chord.
MAD Magnetic azimuth detector.
MAG VAR Magnetic variation.
MAN Manual.

MAS Missile auxiliary subsystem.
MATs Missile auxiliary test set.
MAX Maximum.
MCF Motion compensation factor.
MCM Monitor control message.
MCS Mission computer system.
MCT Memory confidence test.
MDL Mission data loader.
meatball Glideslope image of mirror landing system.
MEC Main engine control.
MER Multiple ejector rack.
MFD Multifunction display.
MFT Mission flight trainer.
MHz Megahertz.
MIL Military.
MITS Missile interface test set.
MLC Mainlobe clutter.
MLG Main landing gear.
MMGS Multiple mode gunsight.
MOAT Missile on aircraft test.
MPRU Missile power relay unit.
MPS Missile power supply.
MR Maintenance readout.
MRL Manual rapid lock-on.
MRT Military rated thrust.
MSEC Message security.
MSI Multistatus indicator.
MSL Mean sea level.
MSS Mission support system.
MTDS Marine tactical data system.
MTM Magnetic tape memory.
MTP Master test panel.
MVR Mission video recorder.
MWOD Multiple word of day.

N

NACES Navy aircrew common ejection seat.
NAG Air-to-ground mode.
NATOPS Naval Air Training and Operating Procedures Standardization.
NATSF Naval Air Technical Services Facility.
NAV GRID Navigation command and control grid.
NAVRIT Naval airborne video recorder and image transceiver.
NDRO Nondestructive readout.
NECT Net entry control terminal.
NFL Notch filter let.
NFO Naval flight officer.
NFOV Narrow field of view.
NFR Notch filter right.
nm Nautical miles.
NOTAM Notice to airmen.
NOZ Nozzle.
NPG Network participant group.
NPS Navigation power supply.
NR Number.
NRNG No range.
NSV Navigation state vector.
NTDS Naval tactical data system.
NTR Network time reference.
NVIS Night vision imaging system.

NWP Naval warfare publication.
NWPM Non-write-protected memory.
NWS Nosewheel steering.
N₁ Low-pressure compressor rotor speed.
N₂ High-pressure compressor rotor speed.

O

OAT Outside air temperature.
OBC On-board check.
OBCCM On-board check continuous monitor.
OBOGS On-board oxygen generating system.
OFT Operational flight trainer.
OFP Operational flight plan.
ORT Operational readiness test.
OSP Overspeed.
OWF Overwing fairing.

P

Paddles Landing signal officer.
PA Power approach.
PAL Pilot automatic lock-on.
PAN Panoramic.
PAP Precision approach point.
PAR Precision approach radar.
PC Pulse compression.
PCD Precision course direction.
PD Pulse Doppler.
PDCP Pilot display control panel.
PDS Pulse Doppler search.
PDSTT Pulse Doppler single-target track.
PFPM Potential flightpath marker.
PGU Improved round for the M-61 gun (new bullet).
PH Phoenix missile.
PID Positive identification.
PIO Pilot-induced oscillation.
PLM Pilot lock-on mode.
POL Petroleum, oil, lubricants.
PP Peak power.
PPC Powerplant change.
pph Pounds per hour.
PPI Plan position indicator.
PPLI Precise participant location and identification.
PRI Primary.
PS Pulse search.
P_s Static pressure.
psi Pounds per square inch.
PSTT Pulse single-target track.
PSU Power switching unit.
PT Engine power trim.
P_t Total pressure.
PTID Programmable tactical information display.
PTO Pilot takeover.
PTP Point to point.
PT₇ Turbine exhaust pressure.

Q

Q Dynamic pressure.

R

RACH Radar angle crosshair.
RARI Rudder automatic rudder interconnect.
RATS Reduced arrestment thrust system.
RDO Recovery duty officer.
RDP Radar data processor.
RDR Radar.
RDSCU Radar sensor control unit.
RECON Reconnaissance.
RF Radio frequency.
RFCI Radio frequency/control indicators.
RGSTT Range-gated single target track.
RHA Recording head assembly.
RIO Radar intercept officer.
RNAV Area navigation.
ROE Rules of engagement.
ROM Read-only memory.
ROT Range on target.
rpm High-pressure compressor rotor speed (N₂).
RRC Rounds remaining counter.
R/T Receiver-transmitter.
RTF Return to force.
RTGS Real time gunsight.
RTT-I Round trip timing interrogation.
RWR Radar warning receiver.
RWS Range while search.

S

SA Semiautomatic acquisition mode.
SAHRS Standard attitude heading reference system.
SAM Surface-to-air missile.
SAR Search and rescue.
SAS Stability augmentation system.
SAT Simultaneous alignment and test.
SC Sensor control.
SCADC Standard central air data computer.
SCP Sensor control panel.
SDIS Sensor display indicator set.
SEAD Suppression of enemy air defense.
SEAM Sidewinder expanded acquisition mode.
SEAWARS Seawater-activated release system.
SEC Secondary.
SHC Sensor hand control.
SHDG Stored heading ground align.
SIF Selective identification feature.
SINS Ship's inertial navigation system.
SMAL Single-mode alignment.
SMDC Shielded mild detonator cord.
SMP Store management processor.
SMS Stores management system.
SOP Standard operating procedures.
SP Sparrow missile.
SPAM Special aid to maintenance.
SPS Solenoid power supply.
SRA Shop replaceable assembly.
STAB AUG Stability augmentation.
STBY Standby.
STN Source track number.
STT Single-target track.
SSI Standard serial interface.
SW Sidewinder missile.

T

TACAN Tactical air navigation.
TAC DRO Tactical destructive readout.
TADIL Tactical digital information link.
TAMPS Tactical aviation mission planning system.
TARPS Tactical air reconnaissance pod system.
TAS True airspeed.
TBT Turbine blade temperature.
TCA Turbine compressor assembly.
TCR Time code readout.
TCS Television camera set.
TDC Throttle designator controller.
TDRS Tactical data recording system.
TDMA Time-division multiple access.
TDS Tactical data system.
TED Trailing edge down.
TER Triple ejector rack.
TEU Trailing edge up.
TID Tactical information display.
TIMS Terminal input messages.
TIS Tactical imaging set.
TIT Turbine inlet temperature.
TLN Takeoff, landing, navigation.
TMA Target under missile attack.
TMN True Mach number.
TOD Time of day.
TOF Time of fall.
TOMS Terminal output messages.
TOT Time on target.
T/R Transformer-rectifier.
Ts Static temperature.
TSD Tactical situation display.
TSEC Transmission security.
Tt2 Compressor inlet temperature.
Tt4 Compressor discharge temperature.
TTG Time to go.
TV Television.
TVS Television search.
TVT Television track.
TWS Track while scan.

U

UHF Ultra high frequency.
UHT Unit horizontal tail.
UTM Universal test message.

V

Vc Closing velocity rate.
vC Computed MAG VAR.
VDI Vertical display indicator.
VDIG Vertical display indicator group.
VEC Vector.
VERT Vertical.
VFR Visual flight rules.
Vg/H Velocity/height.
V/H Velocity altitude factor (Vg/H).
VHF Very high frequency.
VID Visual identification.
VLA Vertical lever arm.
vM Manual MAG VAR.
V_{mcg} Minimum control groundspeed.
VMCU Voltage monitor control unit.
Vr Rotation speed.
VSL Vertical scan lock-on.
VSV Variable stator vane.
VSWR Voltage standing wave ratio.
VTR Videotape recorder.
VV Vertical velocity.
V1 Critical engine failure speed.

W

WCS Weapon control system.
WDIR Wind direction.
WFOV Wide field of view.
WOD Wind over the deck; word of the day.
WOW Weight on wheels or weight off wheels.
WPM Weapons program memory.
WRA Weapons replaceable assembly.
WSPD Windspeed.
WST Weapons system trainer.

Y

YY Geographic reference point for NAV GRID.

Z

ZTOD Zulu time of day.
ZTOT Zulu time on target.

VIRTUAL NATOPS FLIGHT MANUAL CONTENTS

Chapter 1 - General Characteristics

Chapter 2 - System Descriptions

Chapter 3 - Servicing

Chapter 4 - Operating Limitations

Chapter 5 - Indoctrination

Chapter 6 - Flight Preparation

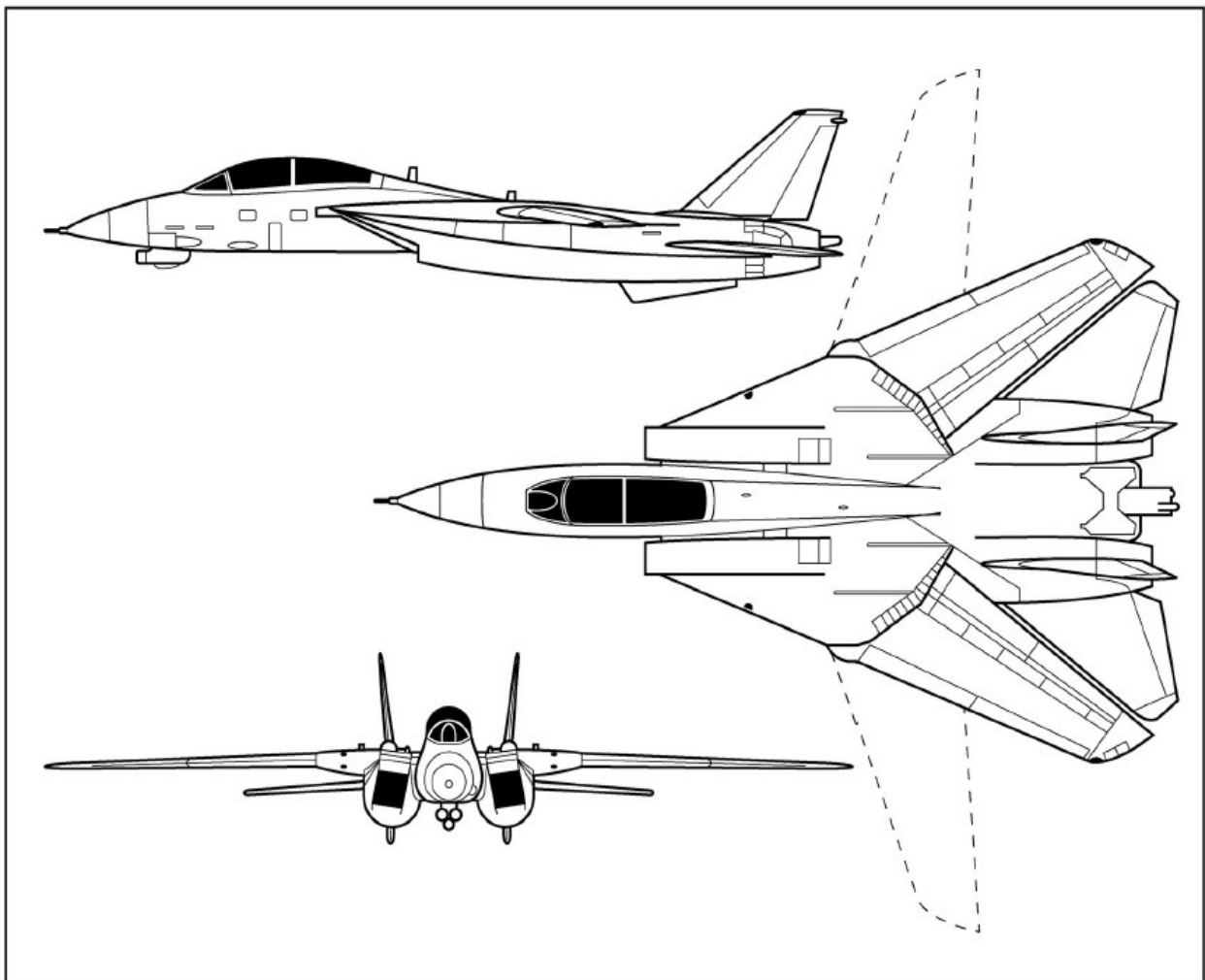
Chapter 7 - Shore based procedures

Chapter 8 - Carrier based procedures

Chapter 9 - Special procedures

Chapter 10 - Flight Characteristics

F-14D TOMCAT



CHAPTER 1

General Characteristics

1.1 AIRCRAFT

The F-14D aircraft is a supersonic, two-place, twin-engine, swing-wing, air-superiority fighter designed and manufactured by Grumman Aerospace Corporation. In addition to its primary fighter role, carrying missiles (Sparrow and/or Sidewinder) and an internal 20-mm gun, the aircraft is designed for fleet air defense (Phoenix missiles) and ground attack (general purpose and precision ordnance) missions.

Armament and peculiar auxiliaries used only during secondary missions are installed in low-drag, external configurations. Mission versatility and tactical flexibility are enhanced through independent operational capability or integration under existing tactical data systems.

The forward fuselage, containing the flightcrew and electronic equipment, projects forward from midfuselage and wing glove. Outboard pivots in the highly swept wing glove support the movable wing panels, which incorporate integral fuel cells and full-span leading-edge slats and trailing-edge flaps for supplemental lift control. In flight, the wings may be varied in sweep, area, camber, and aspect ratio by selection of any leading-edge sweep angle between 20 and 68°. Wing sweep can be automatically or manually controlled to optimize performance and thereby enhance aircraft versatility. Separate variable-geometry air inlets, offset from the fuselage in the glove, direct primary airflow to two F110-GE-400 dual-axial compressor, turbofan engines equipped with afterburners for thrust augmentation. The displaced engine nacelles extend rearward to the tail section, supporting the twin vertical tails, horizontal tails, and ventral fins. The middle and aft fuselage, which contains the main fuel cells, tapers off in depth to the rear where it accommodates the speedbrake surfaces and arresting hook.

All control surfaces are positioned by irreversible hydraulic actuators to provide desired control effectiveness throughout the flight envelope.

Stability augmentation features in the flight control system enhance flight characteristics and thereby provide a more stable and maneuverable weapons delivery platform. The tricycle-type, forward-retracting landing gear is designed for nose gear catapult launch and carrier landings. Missiles and external stores are carried from eight hardpoint stations on the center fuselage

between the nacelles and under the nacelles and wing glove; no stores are carried on the movable portion of the wing. The fuel system incorporates both in-flight and single-point ground refueling capabilities. Aircraft general dimensions are shown in Figure 1-1.

Aircraft general arrangement is provided in Figure 1-3.

A summary of aircraft limitations and characteristics are shown in Figure 1-2.

Refer to Chapter 4 for detailed information on operating limitations.

1.1.1 Aircraft Weight

The basic weight of the aircraft is approximately 43,735 pounds, which includes trapped fuel, oil, gun, and pylons. Consult the applicable Handbook of Weight and Balance (NAVAIR 01-1B-40) for the exact weight of any series aircraft.

1.1.2 Cockpit

The aircraft accommodates a pilot and RIO in a tandem seating arrangement. To maximize external field of view, stations within the tandem cockpit are prominently located atop the forward fuselage and enclosed by a single clamshell canopy. Integral boarding provisions to the cockpit and aircraft top deck are on the left side of the fuselage. Each crew station incorporates a rocket ejection seat that is vertically adjustable. A single environmental control system provides conditioned air to the cockpit and electronic bays for pressurization and air-conditioning. Oxygen for breathing is supplied to the crew under pressure from an on-board oxygen generating system with stored gaseous oxygen as backup. The cockpit arrangement provides minimum duplication of control capability, thereby necessitating two air crew for safe flight.

1.1.2.1 Pilot Cockpit

The forward station of the cockpit is arranged and equipped for the pilot (figure 1-4). In addition to three electronic displays for viewing tactical, flight, navigational, and ECM data, the pilot instrument panel also contains armament controls, flight and engine instruments. Engine controls, fuel management, auxiliary devices,

autopilot, and communication control panels are on the left console. Display, power, lighting, and environmental controls are on the right console.

1.1.2.2 RIO Cockpit

The aft station of the cockpit is equipped for the RIO (Figure 1-5). This instrument panel contains controls and three electronic displays for the radar, tactical, and navigational flight instruments. Armament controls, sensor controls, and communication panels are on the left console. The right console contains a navigational display, data entry unit, ECM controls, data-link controls, lighting controls, and the IFF panel.

NOTE: In this FSX rendition, RIO cockpit has been modeled upon the configuration the airframe 164601, as preserved in Castle Air Museum, California, US and is substantially different from a standard RIO cockpit.

1.1.3 Electronic Nomenclature

Figure 1-6 is an alphabetical listing of the tactical, communication, navigation, flight control, and instruments in the aircraft.

1.1.5 Block Numbers

The following production block numbers include the indicated aircraft serial numbers (BuNo). Selected aircraft in blocks 85 and 110 have been updated to create the F-14D/ block 170 configuration.

Block No.	Serial No. (BuNo)
160	163412 – 163418
165	163893 – 163904
170	164341 – 164351 and 164599 – 164604
85	159592, 159595, 159600, 159603, 159610, 159613, 159618, 159619, 159628 – 159630
110	161159, 161163, 161166.

NOTE: In this FSX rendition, there is no difference whatsoever between the different Block No.s: all aircrafts have the same equipment and characteristics.

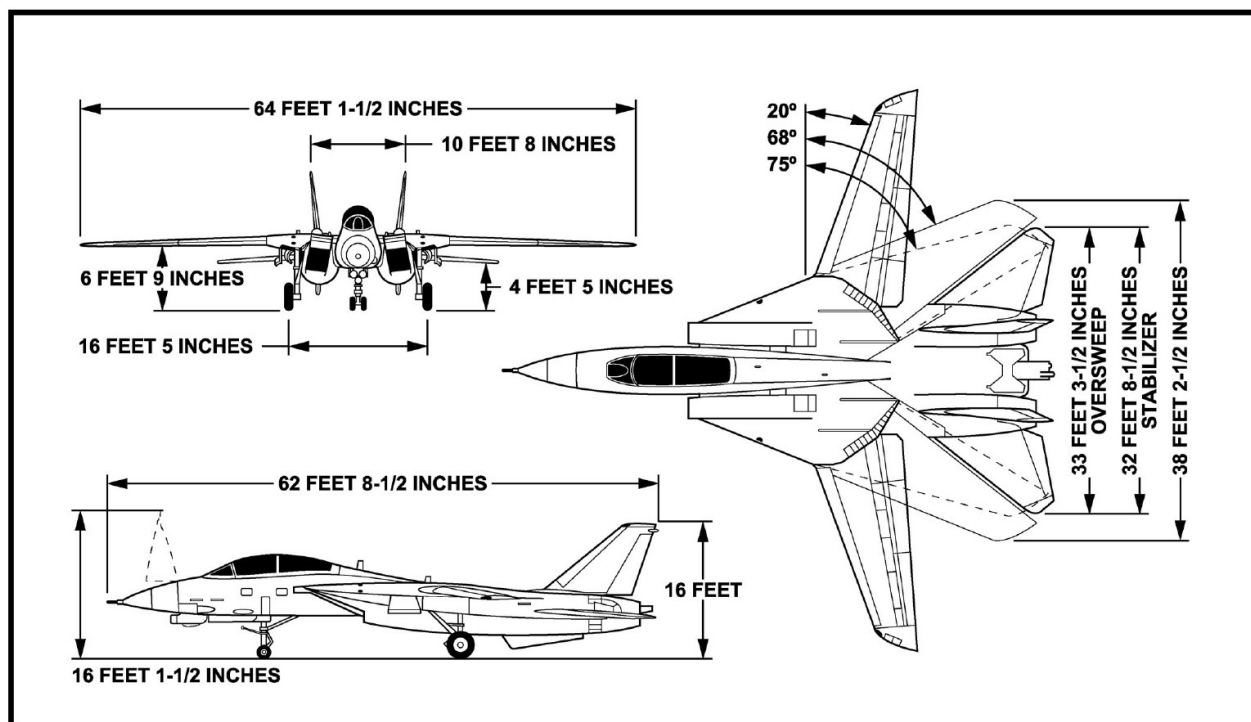


Figure 1–1 Aircraft General Dimensions

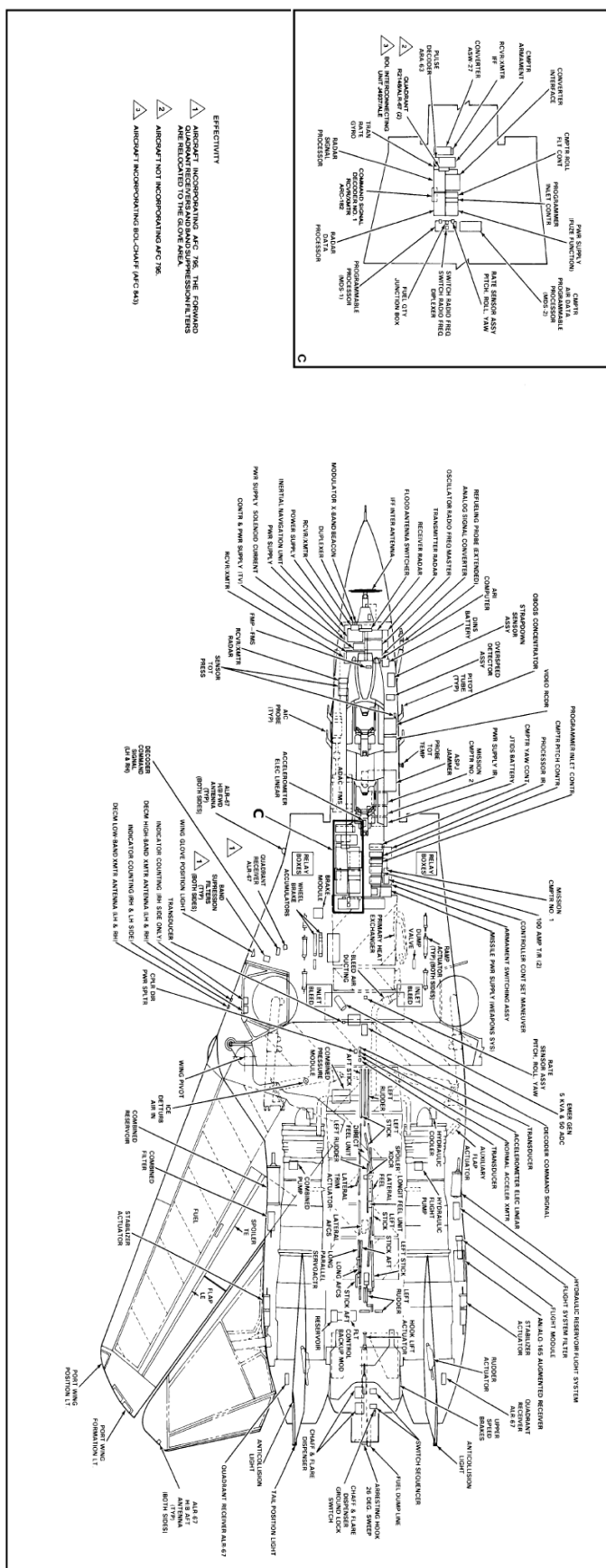
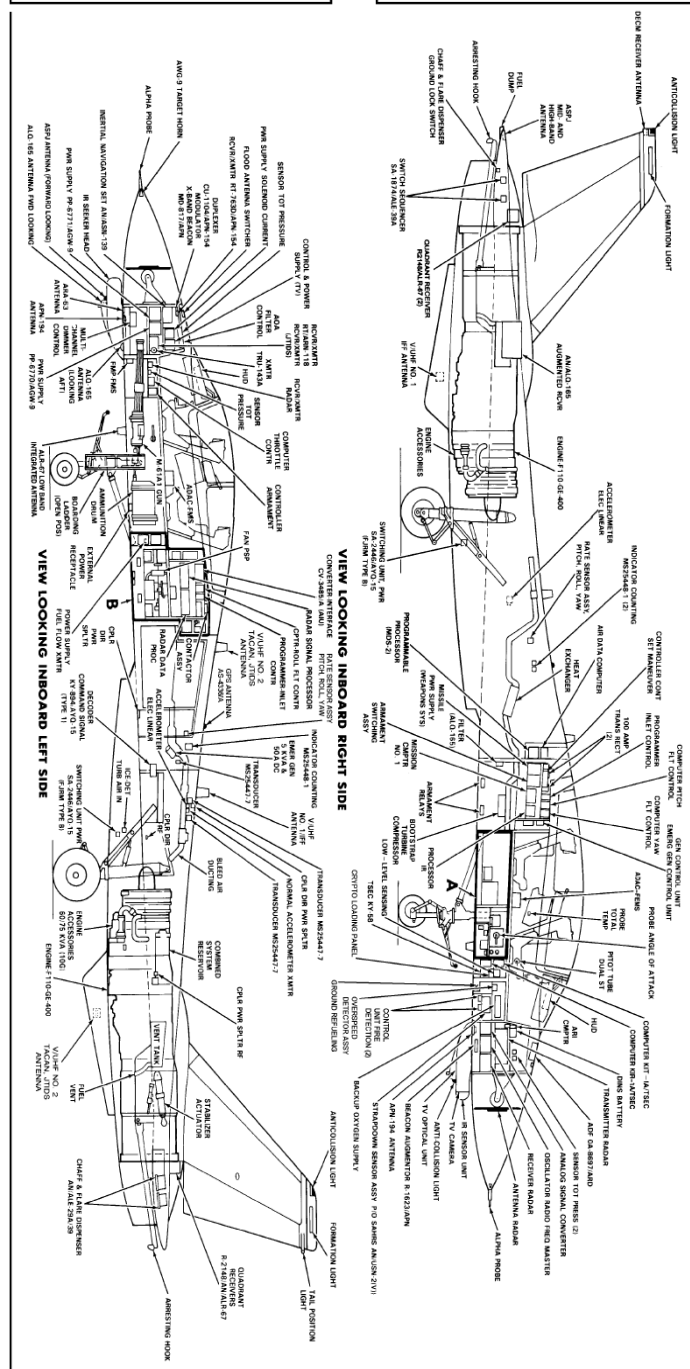
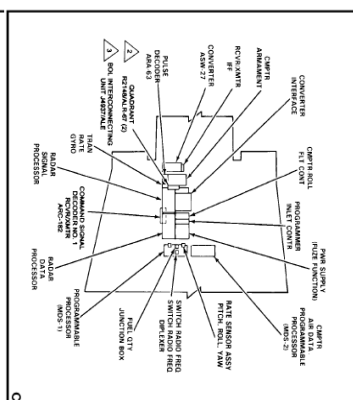
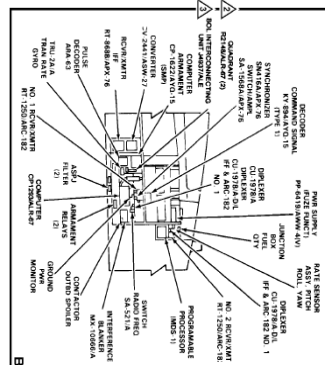
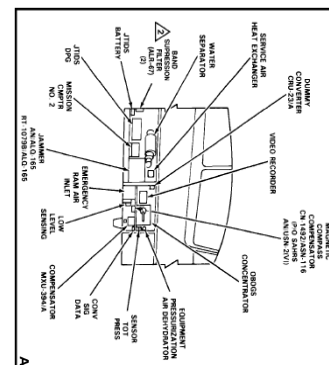


Figure 1–2 Aircraft General Arrangement

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS

Aircraft Dimensions			Starter Cranking Limits	
Length	62'	8.5"	Cross bleed	2 min continuous then 10 min off
Height (Tail)	16'	0"	Start Cart	5 min continuous then 10 min off
Wingspan @ 20° wingsweep	64'	1.5"	Idle	
Wingspan @ 68° wingsweep	38'	2.5"		
Wingspan in oversweep	33'	3.5"		
Wing Area	565 sq/ft			
Gross Weights			RPM = 62 - 78% OIL PRESS = 15 - 45 psi EGT = 350 - 650°C NOZ POS = 100% FF = 950 - 1400 PPH HYD PRESS = 3000 psi	
Empty A/C (w/crew & trapped fuel)	43,735 lbs		MIL (and above)	
Catapult	76,000 lbs		RPM = 95 - 104% OIL PRESS = 25 - 65 psi EGT = 780 - 935°C NOZ POS INFLIGHT: MIL = 3 - 10% Min AB = 5 - 12% Max AB = 60 - 90%	
Field takeoff	72,000 lbs			
Min descent rate landing (350 fpm)	72,000 lbs			
Field landing (max 500 fpm ROD)	60,000 lbs			
Carrier/FCLP land	54,000 lbs		Ground Start Malfunctions	
T/O & Land Flap/Slat Transition Limits			HOT START: 890°C (will normally peak @ 30 - 40% RPM) HUNG START: Hung RPM below 63% with rising EGT WET START: No lightoff within 20 sec of throttle to IDLE	
AOB < 45°				
ROLL SAS ON				
Min 200' AGL for flaps/slats up on takeoff				
Min 800' AGL for dirty-up			INST Test	
Min 180 kts for retraction of flaps			RPM = 96% EGT = 950 ± 10°C (initiates engine overtemp alarm) FF = 10,500 pph AOA = 18 ± 0.5 UNITS W/S = 45 ± 2.5° FUEL = 2,000 ± 200# (all tapes and windows) LIGHTS: L and R FUEL LOW	
12 units AOA for all transitions				
225 kts max flap/slat speed				
280 kts max landing gear speed				
Landing & Braking			Oil System	
15 kts min speed for antiskid operation			Normal Range 25 - 65 psi Min (stabilized idle) 15 psi Oil pressure light on @ 11 psi decreasing off @ 14 psi increasing	
145 kts max wheel braking (51.0 k A/C)				
165 kts max wheel braking (46 k A/C)				
190 kts max tire speed				
145 kts max E-5 engagement speed (69.8 k A/C)			Pneumatic Pressure	
175 kts max E-28 engagement speed			Min auxiliary canopy (3000 psi) 800 psi Min normal canopy (3000 psi) 1200 psi CHS accumulator 1800 psi FHS accumulator 1800 psi Min emergency gear preflight 3000 psi Min emergency gear extension 1800 psi Wheel brake accumulator (2 gages) 1900 ± 50 psi Arresting hook dashpot 800 ± 10 psi	
20 kts max 90° crosswind component				
60 kts max canopy open				
Engine Speeds (RPM)				
10% Ignition system becomes operative				
30 - 46% Engine crank switch will not engage				
20% Min RPM with throttle at idle				
30% Max RPM with pneumatic starter				
30% RPM must fall below for generator auto-reset				
50% Engine crank switch automatically shuts off				
60% Generator comes on line				
50% Generator light illuminates (if RPM falling)				
60% Ensure engine crank off (osp/valve)				
62 - 78% Normal idle				
75 - 90% Auto throttle range				
95 - 104% MIL & above				
107.7% Overspeed (chevrons flash)				
110.0% Engine secures (fuel shutoff)				

Figure 1-3 (Sheet 1 of 2) Aircraft Characteristics and Limitations

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS (CONTINUED)			
Fuel System		In-Flight Refueling	
Aft-Left Tank Group Capacity	5900 - 6200 lbs	170 - 200	Approach configuration
Fwd-Right Tank Group Capacity	6300 - 6600 lbs	200 - 300/0.8 TMN	Cruise configuration
Max split between cockpit totals	300 lbs	400/0.8 TMN	Max IFR probe speed
Fuel dump rate	1500 lbs/min		
Fuel dump auto shutoff with	4000 lbs remaining		
Ground refuel rate @ 50 psi	450 gal/min		
In-flight refuel rate @ 57 psi	475 gal/min		
Hydraulic System		SAS Stability Augmentation System	
Normal Hyd. system operating press	3000 ± 100 psi	FCS CAUTION:	Airspeed < 600 kts/1.3 TMN
BIDI activates when one system is	< 2100 psi		> 0.5 TMN/10 units No cross controls
BIDI output w/3000 psi on good side	2400 - 2600 psi		> 0.6/15 units AOA coordinate all lateral stick
BIDI shuts off when failed system is	< 500 psi for 10 sec	PITCH SAS:	No Limitations
Emer. Flt. Hyd. on if both systems	< 2100 psi	ROLL DGR/YAW DGR and/or ARI DGR	Airspeed <1.0 TMN
Outb'd Spoiler Module electrically inhibited @	62° W/S	ARI/SAS OUT:	Airspeed <1.0 TMN, AOA - max 15 units
Outb'd Spoiler Module depressurized @	65° W/S		No aggressive maneuvering
Miscellaneous		Prohibited Maneuvers	
450	Windmill airstart airspeed required	1. Intentional Spins.	
300	Spooldown airstart airspeed required	2. During AB operations; sustained 0 to -0.5 g flight; -0.5 g to -2.4 g's for more than 10 seconds.	
250	With RUDDER AUTH, limit inputs to <10°	3. At MIL power or less; zero or negative g flight for more than 20 seconds.	
400	Rudder authority limits inputs to < 9.5°	4. AIM-9 launch with flaps/slats extended.	
400/0.9	With HZ TAIL AUTH, limit lateral stick<1/4 throw	5. Fuel dump while in AB or with S/Bs extended.	
400	Speedbrake blowback	6. Dual eng AB takeoff, waveoffs, bolters or cat launches.	
300	Hook blowback in transit	7. Single eng MAX AB takeoff, waveoff, bolter, or cat launches.	
300/0.8 TMN	Max speed w/ airtsource off (overwing fairing)	8. Rolling maneuvers with bank angle changes in excess of 360 degrees.	
350/1.5 TMN	Max ramdoor open airspeed - heat from friction		
> 0.7 TMN	Coordinate stick and rudder input		
> 0.5 TMN	No cross controls above		
2.4 TMN	Reduce speed light (airframe limit)		
Ejection		G Limits	
Zero - 250 KIAS	Ejection Safe		
250 - 600 KIAS	Ejection Hazardous		
> 600 KIAS	Ejection Extremely Hazardous		
External Tank Limits		Gear Down Symmetric Limit	0 - 2.0
		Gear Down Rolling (coordinated turns only 225 - 280 KTS)	0 - 2.0
		Flaps/Slats Down	0 - 2.0
650	Max below 12,000 ft	68,000 lb aircraft symmetric limit	4.6
700	Max 12 - 25,000 ft	58,000 lb aircraft symmetric limit	5.5
650	Max 25 - 34,000 ft	53,000 lb aircraft symmetric limit	6.0
1.75 TMN	Max above 34,000 ft	50,000 lb aircraft symmetric limit	6.5
1.6 TMN	Max with ROLL SAS OFF		

Figure 1-3 (Sheet 2 of 2) Aircraft Characteristics and Limitations

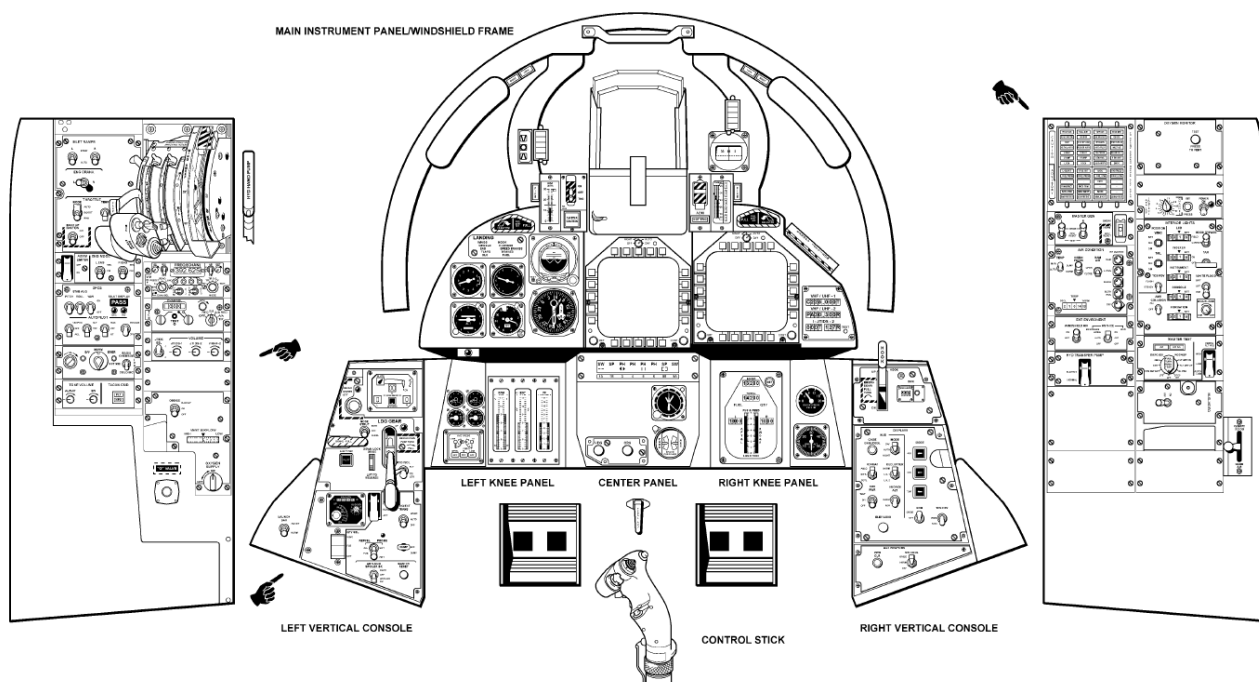


Figure 1-4 Pilot Cockpit Arrangement

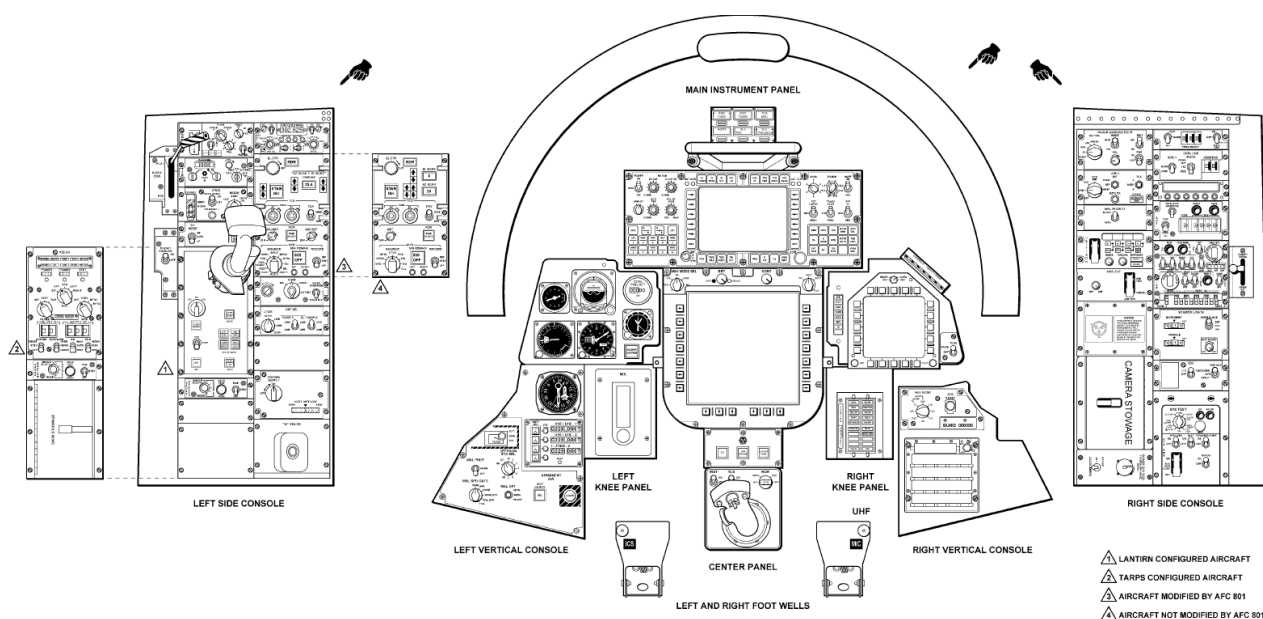


Figure 1-5 RIO Cockpit Arrangement

TACTICAL

CHAFF DISPENSING SET	AN/ALE-39
DIGITAL DATA LINK	AN/ASW-27B/C
ELECTRONIC COUNTERMEASURES SET	AN/ALQ-165
FUZE FUNCTION CONTROL SET	AN/AWW-4
GUN CONTROL UNIT	C-11414/AYQ-15
IFF INTERROGATOR SET	AN/APX-76C
IFF TRANSPONDER SET	AN/APX-100(V)
INTERFERENCE BLANKER	MX-10666/A
IRSTS	AN/AAS-429XN-1
JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM	AN/URC-107
MISSILE LAUNCHER/BOL CHAFF DISPENSER	LAU-138A/A
MISSILE POWER SUPPLY	PP-8043/A
MISSION COMPUTERS	AN/AYK-14 9XN-60 PMM
PANORAMIC CAMERA	KA-99A
RADAR SYSTEM	AN/APG-71 (XN-1)
RADAR WARNING SET	AN/ALR-67(V)
SERIAL FRAME CAMERA	KS-87B
STANDARD CENTRAL AIR DATA COMPUTER	CPU-175/A
STORES MANAGEMENT SET	AN/AYQ-15
TARPS POD	LA-610
TELEVISION CAMERA SET	AN/AXX-1

COMMUNICATION

CRYPTOGRAPHIC SYSTEM	TSEC/KY-58
INTERCOMMUNICATIONS SYSTEM	LS-460B/AIC
VHF/UHF COMMUNICATIONS SET	AN/ARC-182

NAVIGATION

AUTOMATIC DIRECTION FINDER	OA-8697/ARD
INERTIAL NAVIGATION SYSTEM	AN/ASN-139
MAGNETIC AZIMUTH DETECTOR SET	DSU-4A/A
MINIATURIZED AIRBORNE GPS RECEIVER	R-2512
MISSION DATA LOADER	MU-1053/A
RADAR ALTIMETER	AN/APN-194(V)
RADAR BEACON AND AUGMENTOR SET	AN/APN-154(V) and R-1623/APN
RECEIVER DECODER GROUP	AN/ARA-63
STANDARD ATTITUDE HEADING REFERENCE SYSTEM	AN/USN-2(V)
TACTICAL NAVIGATION SET	AN/ARN-118(V)

FLIGHT CONTROL AND INSTRUMENTS

AIR INLET CONTROL PROGRAMMER	C-8684B/A
APPROACH POWER COMPENSATOR SET	AN/ASN-146
DIGITAL FLIGHT CONTROL SET	AN/ASW-59
BEARING DISTANCE HEADING INDICATOR	ID-663D/U
STANDBY AIRSPEED INDICATOR	AVU-30/A
STANDBY COCKPIT ALTIMETER	AAU-39/A
STANDBY COMPASS	AQU-5/A
VERTICAL VELOCITY INDICATOR	AAU-8/A

Figure 1-6 Electronic Equipment Nomenclature

CHAPTER 2

System Descriptions

NOTE: This section has been vastly reduced from the original flight manual, and some systems descriptions have been completely omitted. Still, all the major aircraft systems will be described. Differences between this FSX rendition and real-life aircraft, or systems that will have no function in the game (even if the relevant controls are clickable), will be highlighted in *italic*.

2.1 AIR INLET CONTROL SYSTEM (AICS)

The purpose of the AICS is to decelerate supersonic air and to provide even, subsonic airflow to the engine throughout the aircraft flight envelope. The AICS consists of two variable-geometry intakes, one on each side of the fuselage at the intersection of the wing glove and fuselage.

Intake inlet geometry is varied by three automatically controlled hinged ramps on the upper side of the intakes. The ramps are positioned to decelerate supersonic air by creating a compression field outside the inlet and to regulate the amount and quality of air going to the engine. The rectangular intakes are separated from the fuselage to minimize boundary layer ingestion and are highly raked to optimize operation at high angle of attack. Inlet ramps are positioned by electrohydraulic actuators that respond to fixed schedules in the AICS programmers. Separate programmers, probes, sensors, actuators, and hydraulic power systems provide completely independent operation of the left and right air inlet control systems.

Figure 2-1 shows the basic elements of AICS mechanization.

Electrical power for the AICS programmers is provided by the ac and dc essential No. 2 buses.

The ramp stow function is powered by the dc essential No. 1 bus. Hydraulic power is supplied individually to the left AICS from the combined hydraulic system and to the right AICS from the flight hydraulic system. The left AICS programmer also functions as a wing-sweep backup computer.

NOTE: In this FSX rendition, AICS control is completely automatic. AICS switches, located on the left console of the pilot cockpit are clickable but have no actual function.

2.1.1 Normal AICS Operations

No pilot control is required during the normal (AUTO) mode of operation. Electronic monitoring in the AICS detects failures that would degrade system operation and performance.

Sectional side views of representative variable geometry inlet configurations scheduled by AICS programmers and descriptive nomenclature are shown in Figure 2-2.

2.1.1.1 Ground and Low-Speed Operation

During ground static and low-speed (Mach < 0.35) operation, the inlet ramps are mechanically restrained in the stowed (retracted) position. The predominant airflow is concentrated about the lower lip of the inlet duct and is supplemented by reverse airflow through the fixed bleed door, around the forward lip of the third ramp. As flight speed is increased to 0.35 Mach, hydraulic power is ported to the ramp actuators but the ramps are not scheduled out of the stowed position until Mach 0.5. The fixed bleed door bleeds low-energy, boundary layer air from the movable ramps.

2.1.1.2 Subsonic and Transonic Speeds

At airspeeds greater than 0.5 Mach, the ramps program primarily as a function of Mach for optimum AICS performance. At transonic speeds, a normal shock wave attaches to the second movable ramp. The third ramp deflects above 0.9 Mach to maintain proper bleed slot height (Δh) for transonic and low-supersonic flight.

At supersonic speeds, four shock waves compress and decelerate the inlet air. The bleed slot removes boundary layer air and stabilizes the shock waves. This design results in substantially higher performance above Mach 2 than simpler inlet designs.

2.1.2 AICS Anti-Ice

AICS anti-ice is activated only by selecting ORIDE/ON with the AICS ANTI-ICE switch and airspeed between 0.35 to 0.9 Mach (hydraulic power is available at 0.3 Mach). Above and below these airspeeds the AICS anti-ice is disabled.

NOTE: In this FSX rendition, all anti-ice systems are simplified and are operated by general Anti-ice controls.

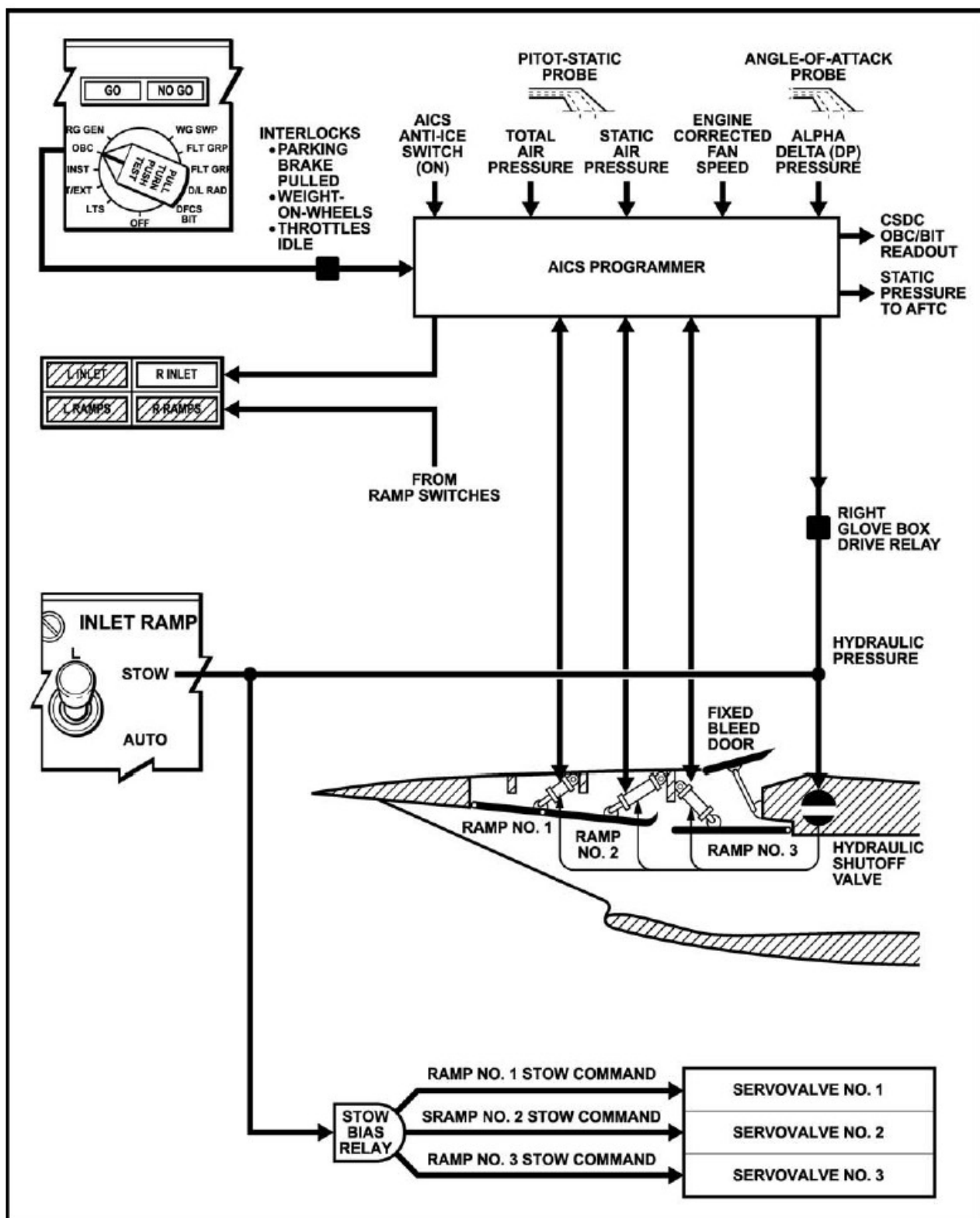


Figure 2-1 Air Inlet Control System

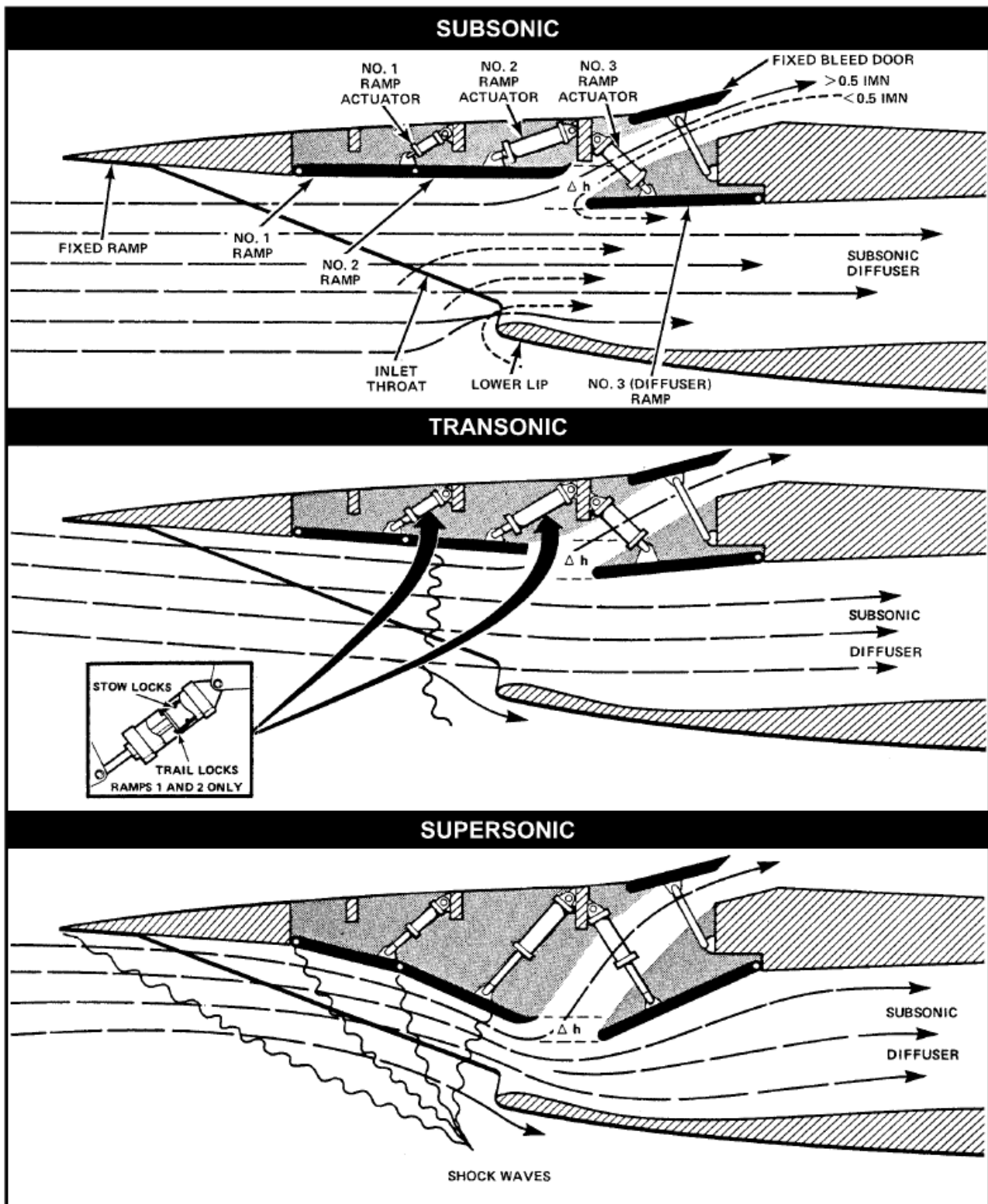


Figure 2-3 Variable Geometry Inlet Configuration

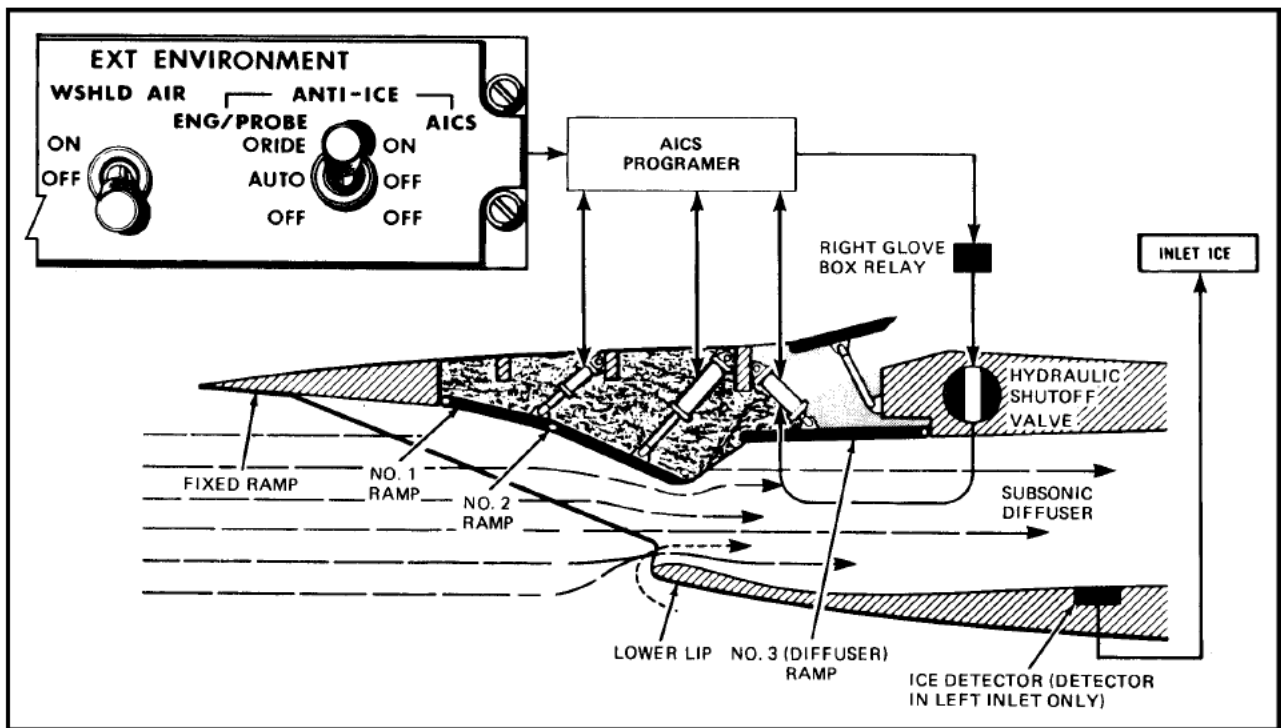


Figure 2-3 AICS Anti-Ice System

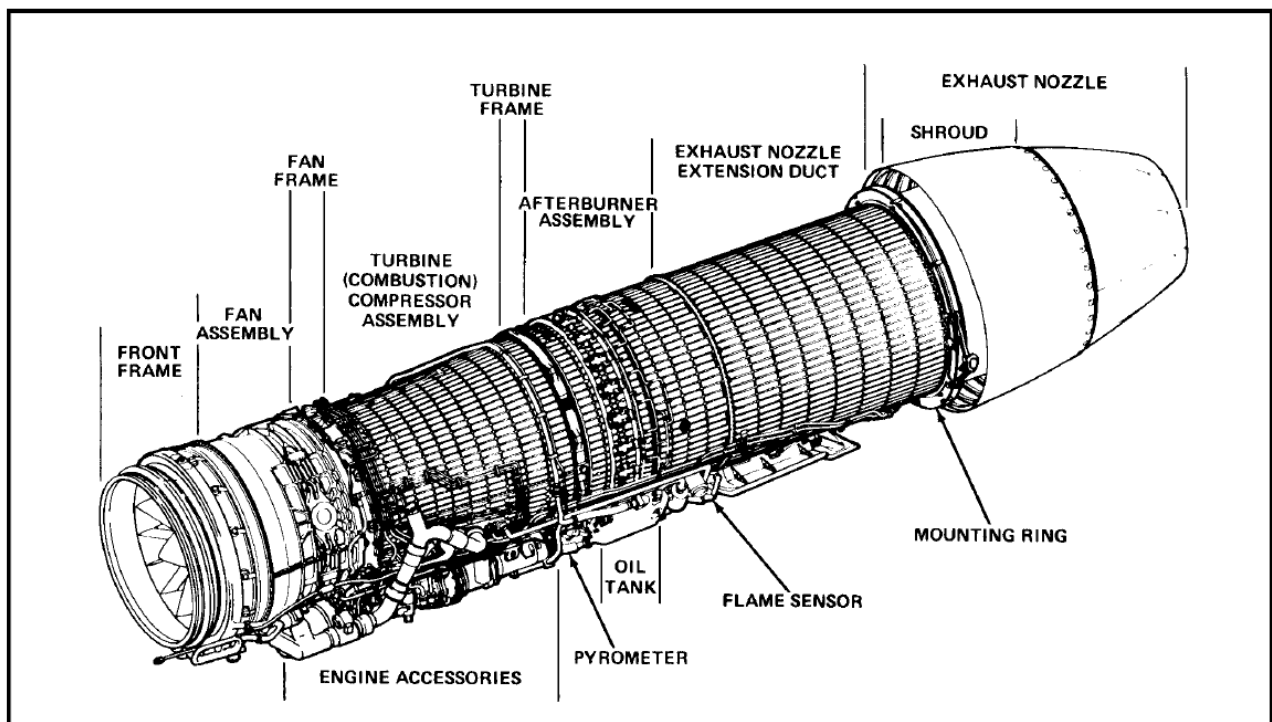


Figure 2-4 F110-GE-400 Engine

2.2 ENGINE

The aircraft is powered by two F110-GE-400 turbofan engines (Figure 2-4) with variable exhaust nozzles and AB augmentation. They are dual-rotor engines consisting of a three-stage fan driven by a two-stage, low-pressure turbine and a mechanically independent, aerodynamically balanced, nine-stage, high-pressure compressor driven by a single-stage, air-cooled high-pressure turbine. Engine operation is automatically regulated and maintained electrically by the augmentor fan temperature control unit and by throttle inputs to the main engine control.

Each engine is slung in a nacelle with the thrust axis laterally offset approximately 4½ feet from the aircraft centerline. The installed static engine thrust at military power is 13,800 pounds and, at maximum AB power, thrust is 23,600 pounds. Installed engine thrust at maximum AB at 0.9M at sea level is 30,200 pounds. Acceleration time from idle to military power is approximately 4 seconds.

During operation, air entering the engine is directed into the fan, which initially compresses the air and directs its flow into the engine core compressor and fan bypass duct.

Direction of airflow into the fan is optimized by variable-geometry inlet guide vanes (IGV) and into the compressor by variable geometry stator vanes. The high-pressure compressor further compresses the air through the nine-stage compressor before discharging it into the annular combustion chamber to mix with fuel from the fuel nozzles. This fuel-air mixture is initially ignited by the main spark igniter in the combustion chamber. As a result of this combustion, expanding gases drive the high- and low-pressure turbines.

Power to drive the two accessory gearboxes is obtained from the high-pressure rotor.

From the turbine section, the exhaust gases pass into the afterburner section and are mixed with air from the fan bypass duct. During AB operation, fuel is sprayed into this mixed airflow and ignited for additional thrust.

result in severe aircrew disorientation/vertigo.

2.2.1 Engine Control

The engine is controlled by three units: the hydro mechanical main engine control, the electronic augmentor fan temperature control, and the AB fuel control. There are two modes of operation: primary (electronic) and secondary (mechanical), with provisions for automatic and manual switchover to secondary. Manual selection is controlled through the ENG MODE SELECT panel.

Automatic or manual selection of the secondary mode illuminates an ENG SEC caution light. When one engine reverts to secondary mode, the other engine continues in primary mode. Cycling the ENG MODE SELECT switch may reset the AFTC if the faults are temporary. If the change back to primary mode is successful, the ENG SEC light will go out.

Automatic or manual selection of secondary mode is possible throughout the flight envelope. Selection of secondary mode will cause a loss of fan speed signal to the AICS. SEC mode transfers with throttles in AB above 450 KCAS could result in pop stalls and damage to the IGV linkage.

NOTE: Engine control in this FSX rendition is vastly simplified, and it is always automatic. Switching engine modes has no effect in-game, and engine modes are not implemented. For this reason, most of the information provided in the paragraphs 2.2.2 to 2.2.7 has no effect during the simulation.

2.2.2. Afterburner Fuel Control

The AFC is controlled by the AFTC for afterburner operation. The AFTC computes AB fuel flow ratios and provides them to the AFC. The AFC converts ratio commands to metered fuel flows into local, core, and fan AB fuel manifolds. When staging up the AB, local fuel flow is initiated first, followed by core and fan flow last. When staging down, the reverse sequence occurs. Thrust changes are smooth when staging up or down.

2.2.3 Primary Mode

In the primary mode, the AFTC controls the MEC, AFC, and AB nozzle hydraulic pump to provide optimum engine operation with unrestricted throttle movement throughout the flight envelope. The AFTC computations are used to control basic engine and AB fuel flow, IGV, and AB

CAUTION!

During night and/or IFR conditions, the increased acceleration during AB use will result in inner ear disturbances. In addition, the large amount of light generated by the AB exhaust reflecting around the aircraft will compound this condition. These factors may

nozzle positioning; VSV positioning is controlled by the MEC. The AFTC incorporates independent control schedules that are prioritized so that the optimum amount of fuel flow is provided to the main combustor. At any given time, only one of these schedules is actually in control of fuel flow. The remaining schedules are always active and are calculating the change in fuel flow required (if any) to attain the desired value of their assigned parameter. The selection of the schedule in control is accomplished by a series of minimum and maximum selectors. These selectors control scheduling of the following:

1. Acceleration/deceleration
2. Minimum/maximum compressor discharge pressure
3. Minimum/maximum rpm
4. Fan speed limiting
5. Maximum turbine blade temperature limiting
6. Idle lockup speed.

Other AFTC functions include engine start control, asymmetric thrust limiting, reduced arrestment thrust, automatic relight, and fault detection. Fault detection automatically switches the engine control to the secondary mode in the event of core overspeed, fan speed signal loss, nozzle full open when engine is not at idle or maximum AB, AFTC power deviations, fuel flow demand mismatch with throttle settings, fan speed greater than 800 rpm and not accelerating, or throttle signal error.

2.2.3 AB Operation (Primary Mode)

Unrestricted throttle operation into and out of AB is permitted throughout the flight envelope. During AB operation, rpm, EGT, fuel flow, and nozzle position vary with altitude and airspeed. The nozzle position will also increase as the throttle is transitioned from minimum AB to maximum AB. If an AB blowout occurs, the autorelight feature attempts to reinitiate AB without throttle movement. The engine has reduced AB region of operation at high altitudes and low air speeds. An AFTC automatic rich stability cutback feature reduces or limits maximum AB fuel flow at high altitudes and low airspeeds to prevent AB instabilities. Indication of rich stability cutback is a nozzle position of approximately 30 to 50 percent at maximum AB rather than the normal 60 to 70 percent. Also, because of air flow and temperature characteristics, AB light-off characteristics are slower at high altitudes and low airspeeds.

2.2.4 Secondary Mode

Basic engine operation in SEC mode is extremely reliable. In the secondary mode, the electronic functions performed by the AFTC are eliminated. The MEC provides complete control of the engine with the exception of fan speed limiting. SEC mode is manually selected via the ENG MODE SELECT switch or the autopilot emergency disengage paddle switch, or via automatic default. In SEC MODE, the exhaust nozzle is commanded full closed, the nozzle position indicator goes to the not-powered position (subzero indication), the IGVs are fixed full open, high-energy ignition is continuously energized, AB is inhibited, and idle lockup protection is lost.

In SEC mode, engine stall margin is decreased at low rpm because of IGV positioning. The FEMS engine stall detection circuit is inoperative, but overtemperature warning is still available. A low-level vibration/rumble may be sensed in ground idle operation when in secondary mode. This vibration/rumble has no adverse affect on the engine and disappears when the throttle is advanced slightly (5-percent rpm increase or less).

SEC mode transfers with throttles in AB above 450 KCAS could result in pop stalls and damage to the IGV linkage.

Note:

SEC mode transfer from AB may result in pop stalls. Nonemergency manual selection of SEC mode on the ground should be performed in basic engine. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with power set above 85-percent rpm. If the fan speed limiter circuit has failed, engine rollback may occur with selection of SEC mode. In the event of engine rollback, PRI mode must be reselected above 59-percent rpm or flameout will occur and airstart will not be possible.

2.2.4 Engine Alternator

Each engine's electrical system is powered by an alternator mounted on the engine aft gearbox. The alternator consists of four windings. Two windings are redundant in providing power to the AFTC and its components. A third winding provides power for both main high-energy ignition and AB ignition. The fourth winding provides power to the engine monitoring system processor (for FEMS), and a signal for the rpm gauge. The last winding is also an alternate source of power for the fan speed limiting circuit. The fan speed limiting circuit may be powered by

either the essential No. 2 dc bus or the engine-driven alternator winding, depending on which source has the highest stable output. If engine alternator power output drops below a preset value, engine control will automatically transfer to SEC mode, illuminating the respective engine SEC light. If the engine reverts to SEC mode as a result of a sheared alternator shaft, engine high-energy ignition will not be available and the engine SEC light will not illuminate. Cockpit indications are loss of engine rpm and nozzle position indicating below zero. In failure modes, redundant aircraft electrical power will be available for fan overspeed protection. The engine is completely operable should the aircraft experience a complete electrical failure. The engine operates in either PRI or SEC mode, which can be selected automatically or manually. In case of a complete electrical failure all engine lights and indicators are inoperative.

2.2.5 Turbine Blade Temperature (Pyrometer)

The pyrometer is a fuel-cooled, photodiode, optical unit that measures infrared radiation from the metal surface of the high-pressure turbine blades. This temperature signal is transmitted to the AFTC and is used to regulate engine fuel flow, which maintains turbine blade temperature within limits. Cockpit indications of turbine blade temperature appear on the MFD.

2.2.6 Asymmetric Thrust Limiting

The asymmetric thrust limiting circuit is designed to hold both engines to minimum AB until both ABs are lit off.

The AFTC releases the hold on the AB when both engine AB pumps are on and both engine flame sensors are on. Selecting the ASYM LIMITER switch to OFF (guard cover up) overrides the comparison of left and right AB status and allows each AB to operate independently. A malfunctioning or deselected ATLS can greatly increase the magnitude of asymmetric thrust because of engine stall or failure.

2.2.7 Reduced Arrestment Thrust System

The RATS is a feature of the AFTC provided to reduce thrust for carrier landings to a level consistent with carrier (CV) wind-over-deck operations. When activated, the AFTC automatically reduces the military power core speed (N2) by approximately 4.5 percent. This results in an approximate 20 to 25-percent decrease in thrust. RATS employs two enabling circuits: an engine circuit incorporated within each engine's AFTC, and an aircraft circuit. The

engine circuit is enabled by the aircraft circuit via switch closure. Since the engine circuit is a function of the AFTC, it is not available in SEC mode and can be overridden in PRI mode with selection of AB. The aircraft circuit is enabled when weight is placed on either or both main landing gear with the hook handle down or the hook out of the stowed position. The RATS light, located on the pilot's advisory panel, illuminates when the aircraft circuit is activated but it is not an indication that the engines are operating at reduced thrust.

NOTE: RATS system is not implemented in this FSX rendition.

2.2.8 Variable Exhaust Nozzle

Engine exhaust gases at higher thrust settings are discharged through the nozzle throat at sonic velocity and are accelerated to supersonic velocity by the controlled expansion of the gases. Varying nozzle throat area controls fan stall margin, which optimizes performance.

The variable exhaust nozzle is a three-flap, convergent-divergent-type nozzle. Nozzle variation is accomplished by axial movement of four hydraulic actuators mechanically synchronized for geometric stability. These hydraulic actuators use oil from a separate compartment in the engine oil storage tank and are operated by a hydraulic pump that responds to AFTC signals. A failed open nozzle may be caused by an oil leak, but if the leak is in the nozzle system, only a portion of the main engine lube oil will be lost. During basic engine operation, the nozzle area is modulated to a near-closed position, and, in AB, the nozzle area is infinitely variable to a full-open position. The nozzle will go full open airborne with the throttle at IDLE at low altitude and airspeeds 2.5. A gauge for each engine on the pilot instrument panel next to the engine instruments indicates nozzle position in percentage from 0 to 100. Normal indication for maximum AB is approximately 70 percent.

Note

When AFTC is operating in secondary mode, the nozzle is commanded closed and the exhaust nozzle indicator is inoperative.

With the landing gear handle down, engine at IDLE, and weight off wheels, the nozzle is restricted to a near closed position (maximum 26 percent) to prevent exhaust nozzle flap contact with the deck/hook during landing. Five seconds after weight on wheels, the nozzle resets to full

open to reduce idle power during landing rollout and while taxiing.
On deck in PRI mode with throttle above IDLE detent, nozzle position varies linearly with throttle position.

NOTE: In this FSX rendition, nozzle position is linked to throttle position and it is independent on engine mode or any other factor.

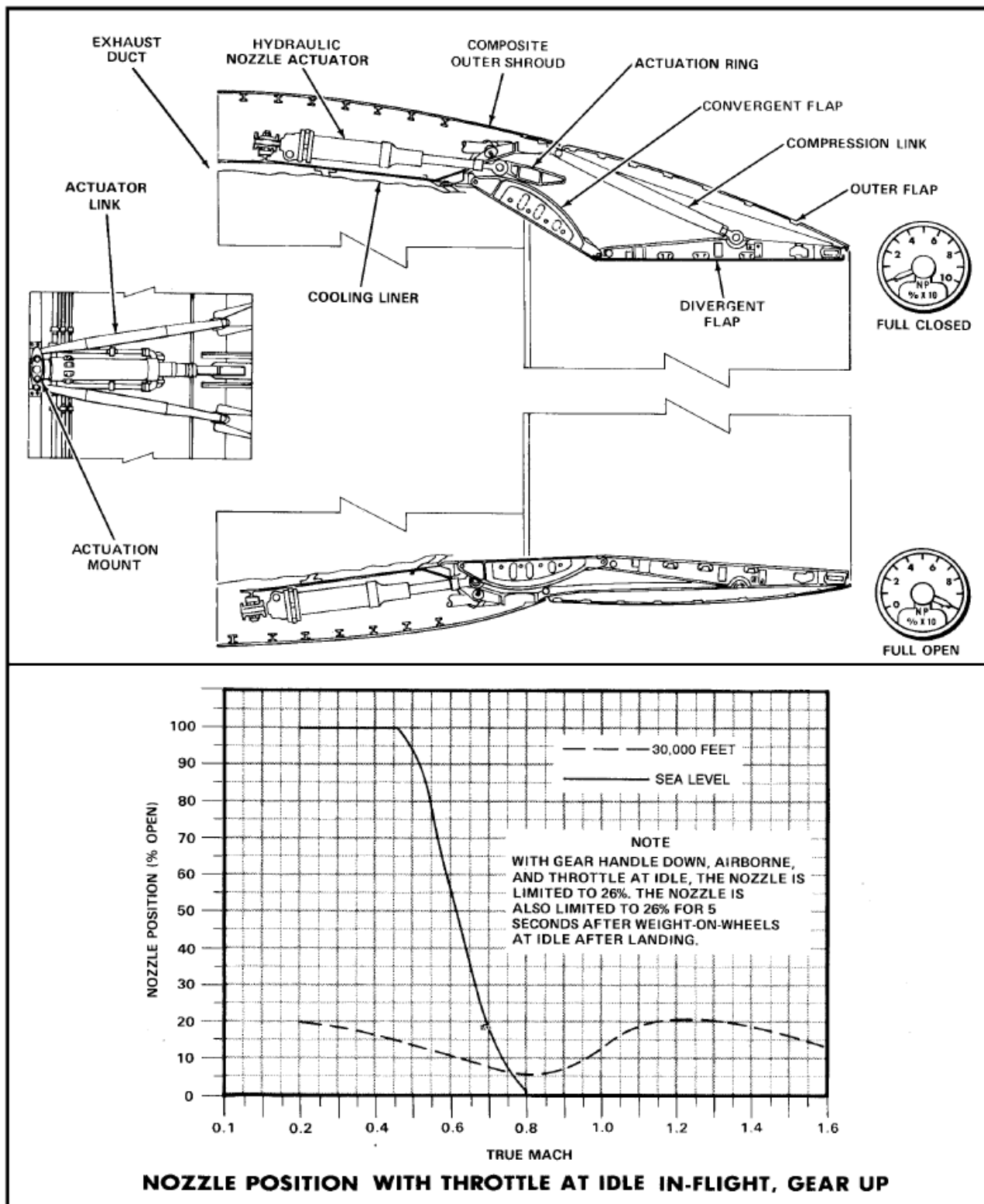


Figure 2-5 Variable Area Exhaust Nozzle

2.3 FATIGUE ENGINE MONITORING SYSTEM

The FEMS is a solid-state electronic system that provides data acquisition, processing, and storage. The system accumulates airframe stress and fatigue data and relevant engine performance data, both in flight and on deck, from the engine monitoring system processors. Engine faults are isolated to the appropriate WRA or combinations of WRAs and recorded for later transfer to the DPGS for diagnostic analysis, troubleshooting, and appropriate maintenance. The DPGS also computes and stores engine parts life tracking and failure-trending data. This tracking of engine data extends the life and safety of fleet aircraft by permitting maintenance routines at periodic intervals. FEMS also provides a signal to the stall warning system that initiates a 10-second warning tone (identical to overtemperature tone) and illuminates the L or R STALL warning legend on the MFD/HUD indicating an engine stall.

FEMS will record aircraft overstress when it determines that normal acceleration has exceeded:

1. 7.5g with landing gear UP and Mach greater than .24
2. 4.5g with landing gear DOWN (as in hard landing)
3. 4.5g when Mach is .24 or less.

NOTE: FEMS is not implemented in this FSX rendition, however aircraft stresses and engine limitations are implemented. If maximum realism is selected in game, it is possible to overstress the airframe.

2.4 ENGINE FUEL SYSTEM

The engine fuel system, which is identical for each engine, provides motive flow fuel to effect fuel transfer and metered fuel for combustion as a function of pilot throttle commands and numerous engine parameters (Figure 2-6).

2.4.1 Motive Flow Fuel Pump

The motive flow fuel pump is a gear-driven centrifugal pump on each engine accessory gearbox that returns high-pressure fuel to the fuselage and wing tanks to effect normal fuel transfer. Motive flow is used to power the boost pump in the respective sump tank. This fuel continues through control valves to ejector pumps in the fuselage and wing fuel tanks. There is no cockpit control for the motive flow fuel pumps. Failure of one pump illuminates the R or L FUEL PRESS caution light and reduces the

rate of fuel transfer but does not inhibit the transfer of fuel from any tank.

Motive flow pump failures cause the engine to draw fuel through suction feed. Higher altitudes and decreased ambient pressure result in reduced fuel flow, which may cause engine flameout because of fuel starvation. With a single motive flow fuel pump failure, AB selection above 15,000 feet MSL may cause engine flameout. With failure of both motive flow fuel pumps, high power settings in basic engine may cause flameout above 25,000 feet MSL. If a dual motive flow fuel pump failure occurs, wing fuel will not be available.

2.4.2 Engine Fuel Boost Pump

The engine (total flow) fuel boost pump is an engine-driven centrifugal pump on the aft accessory gearbox that provides boosted pressure and flow from the fuel supply system to meet main and AB fuel requirements. The pump receives fuel at aircraft boost pressure and boosts fuel pressure to levels adequate to operate the engine at all power settings (maximum 40-psi pressure rise). During non-AB operation, some fuel is circulated between AB fuel control and the engine fuel boost pump so that fuel pressure is readily available to the spray bars for AB light-off.

2.4.3 Main Fuel Pump

The main fuel pump is a two-stage pump that receives fuel flow from the engine fuel boost pump. It provides additional fuel pressurization and transmits mechanical-gear-driven power to the MEC from the gearbox.

2.4.4 Main Engine Control

The MEC is a fuel-operated, hydromechanical fuel flow regulator that operates in tandem with the main fuel pump and is capable of operating in two modes. In the primary mode, it meters main fuel flow as commanded by the AFTC and provides VSV scheduling. The secondary mode hydromechanically meters main fuel flow to govern N2 speed based on pilot throttle commands and provides basic engine control except for AFTC fan speed limiting.

2.4.5 Afterburner Fuel Pump

The AB fuel pump is a centrifugal gear-driven pump that receives fuel from the engine boost pump, increases pressure, and delivers fuel to the AB fuel control. During non-AB operation, fuel is circulated between the AB fuel control and the engine boost pump; the AB fuel pump

impeller runs dry with the bearings lubricated by the engine oil system. Failure of an AB fuel pump will result in an AB blowout.

2.4.6 Afterburner Fuel Control

The AB fuel control is a fuel-operated, electrohydro mechanical unit that regulates fuel flow in response to AFTC scheduling and compressor discharge pressure. Fuel pressure from the AB fuel control provides on-off signals to the AB fuel pump. The AB fuel control splits fuel flow into three metered streams (local, core, and fan) on a sequential basis into the AB manifolds for distribution through spraybars in the AB duct. Throttle commands initiate local fuel flow and AB ignition (minimum AB). Once local fuel flow and flame are established, core fuel flow commences. As maximum core fuel flow is established, fan fuel flow commences and increases until maximum AB is achieved. The transitions between local, core, and fan fuel flow are smooth and unnoticed (Figure 218). During non-AB operation, fuel flow is circulated through the AB manifolds to prevent thrust lags and surges when AB is initiated.

CAUTION!

Zero- or negative-g flight longer than 10 seconds in AB or 20 seconds in MIL or less will deplete the fuel sump tanks resulting inflameout of both engines. To prevent engine instability and/or flameout, avoid holding zero or negative g when doing a low-altitude, maximum-thrust acceleration. With fuel in feed group below 1,000 pounds, AB operation could result in AB blowout.

Note: The above limitation is implemented as a special function in the FSX rendition, and will apply regardless of the realism setting.

Note

Fuel dump operations with either engine in AB are prohibited. The fuel dump mast can be torched.

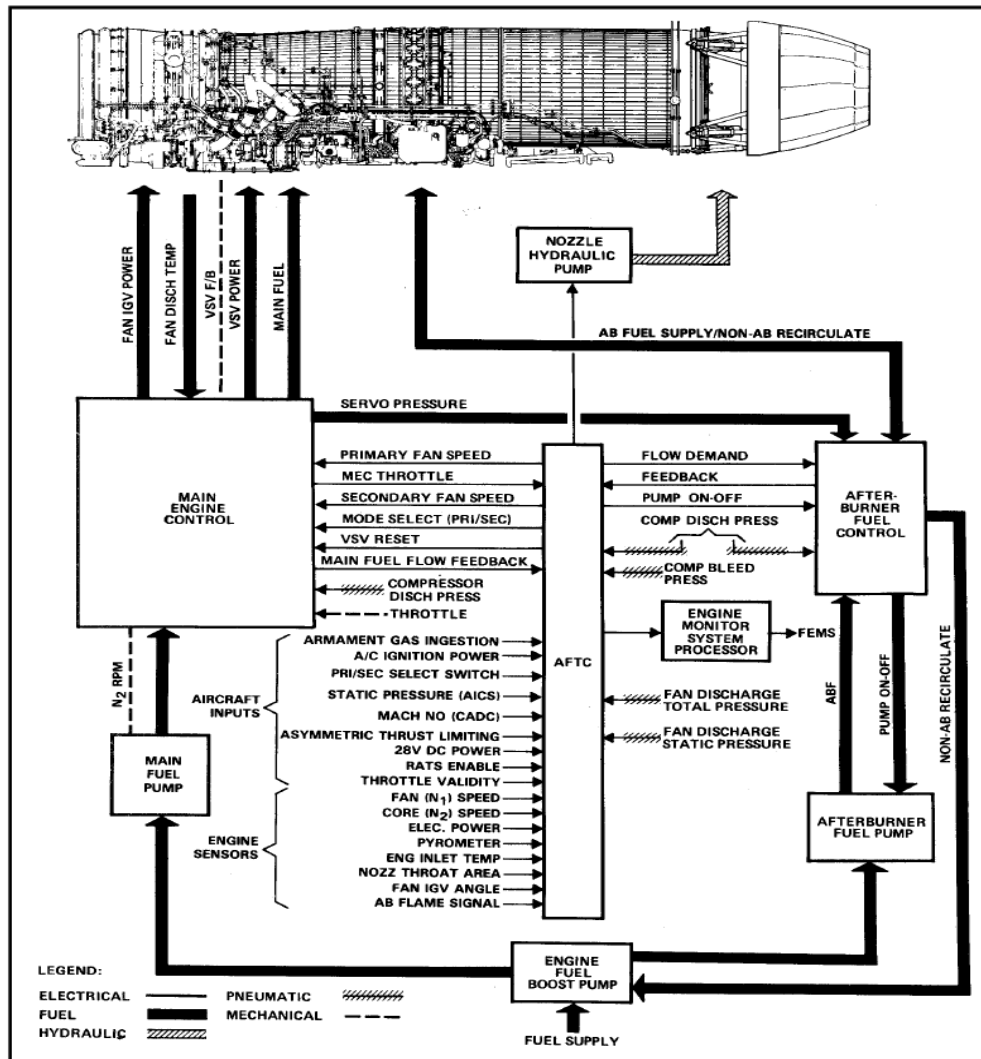


Figure 2-6 Engine Fuel System

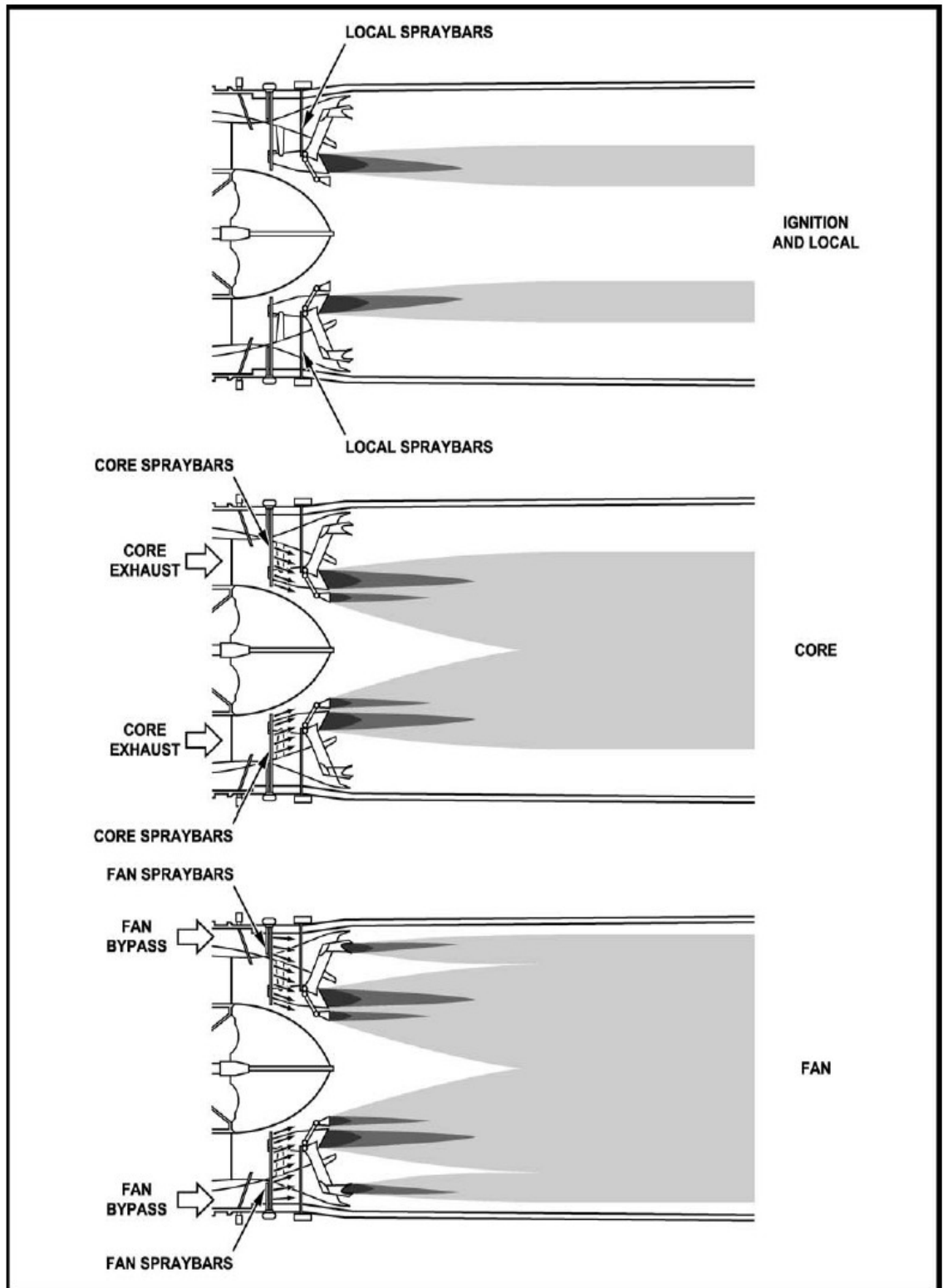


Figure 2-7 Afterburner Fuel Sequencing

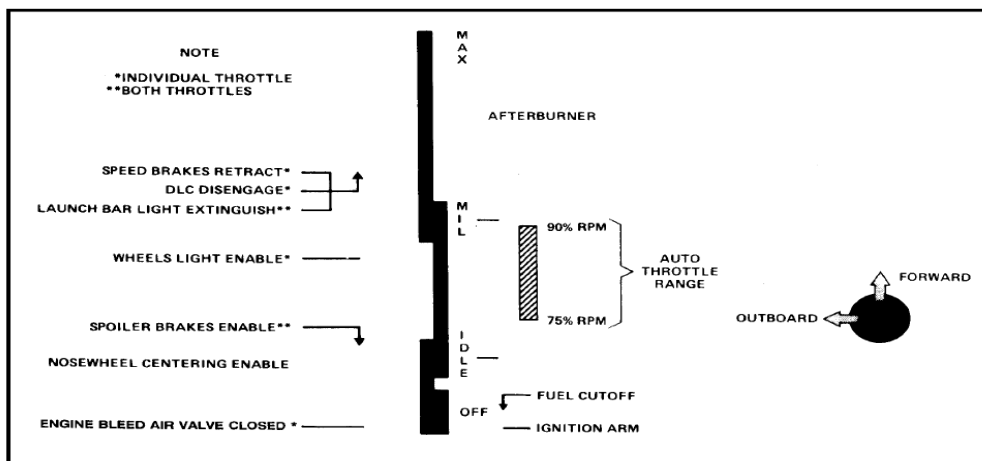


Figure 2-8 Throttle Travel and Interlocks

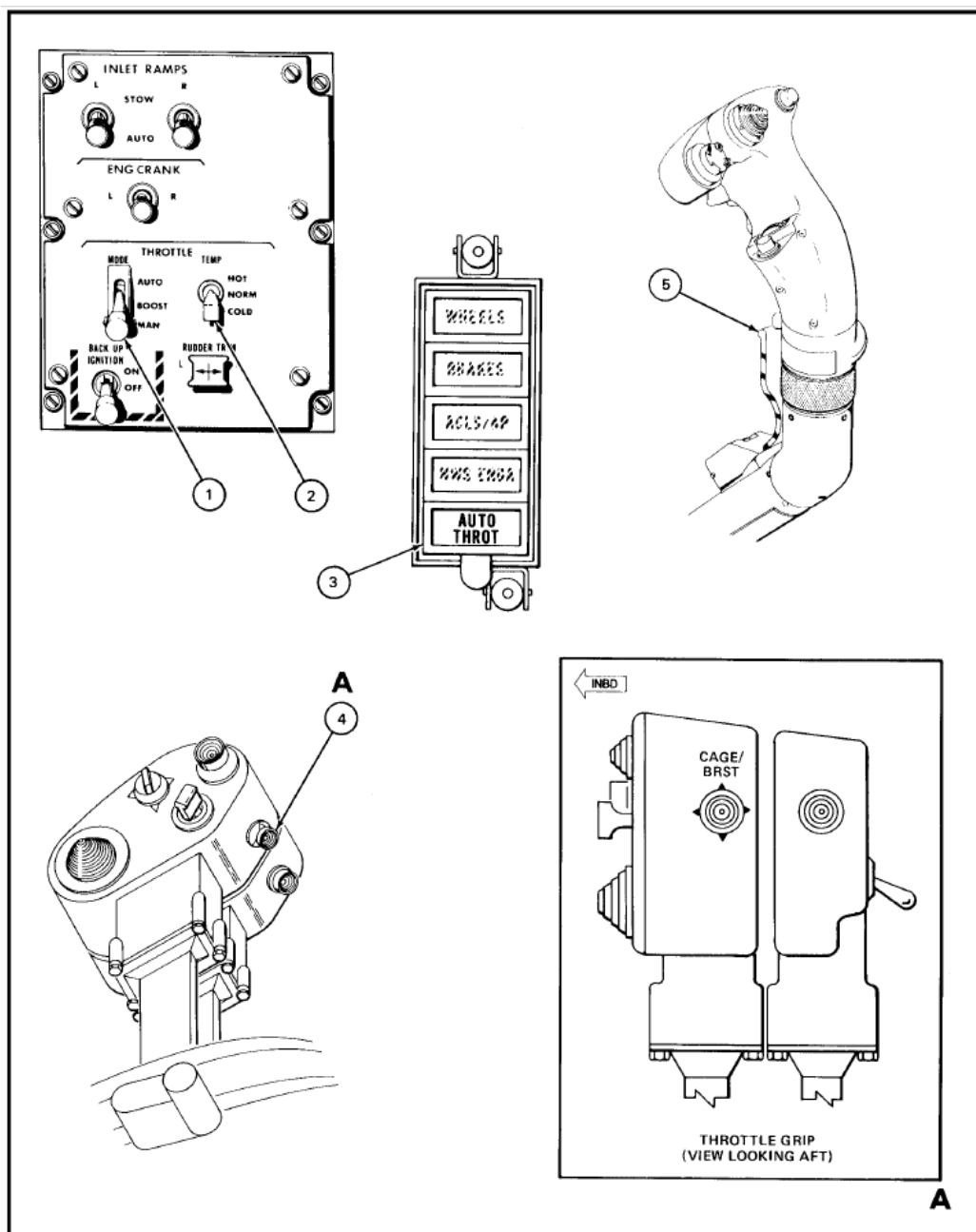


Figure 2-9 Autothrottle controls

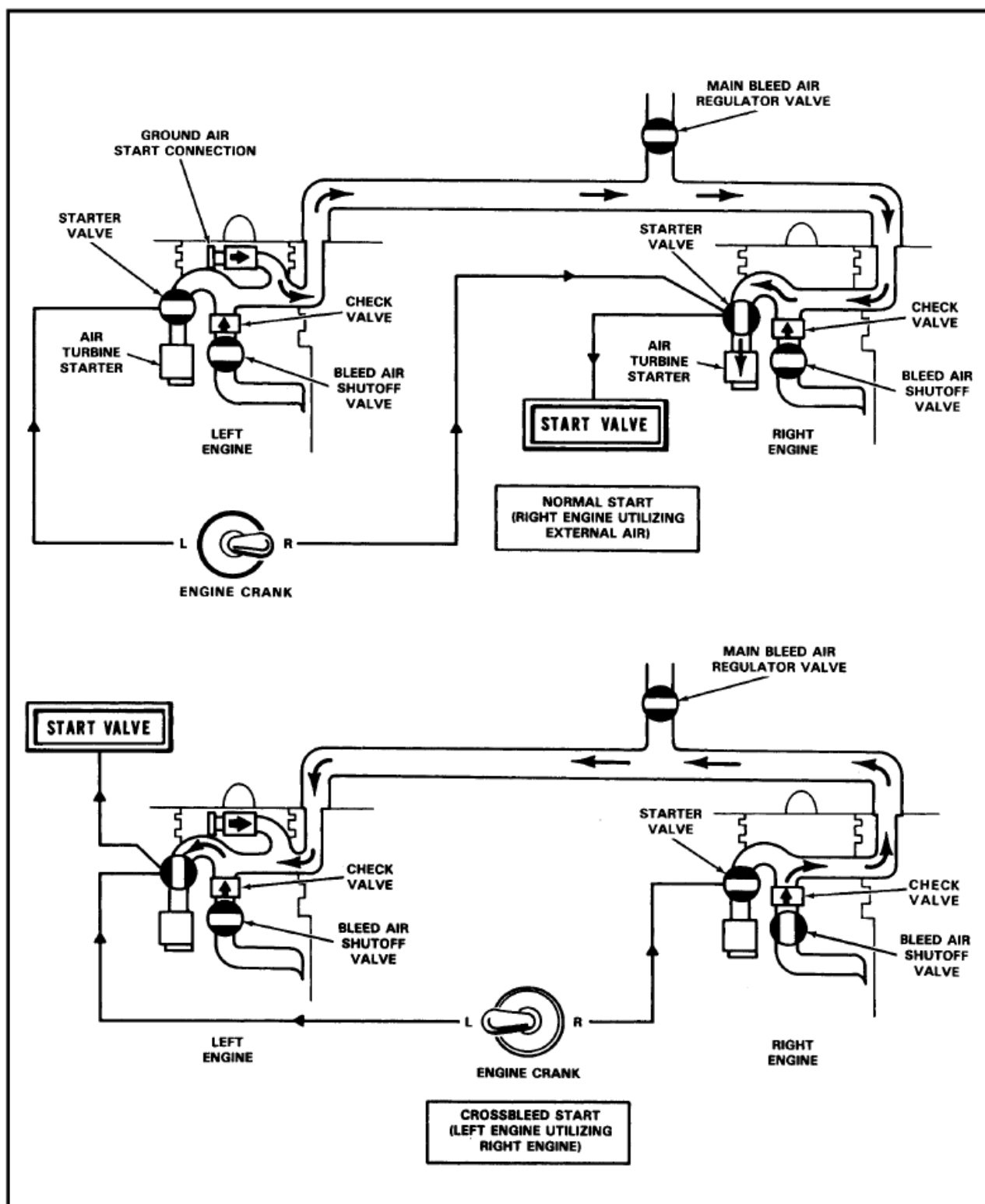


Figure 2-10 Engine Start System

2.5 THROTTLES

Two throttle levers for regulating engine thrust are on the left console of the forward cockpit.

Unrestricted engine operation under independent control is afforded; however, normal symmetric thrust control is provided by collective movement of the throttle levers. Numerous engine control and subsidiary functions are performed by movement of the throttle levers within the full range of travel as shown in figure 2.8. The forward and aft throw of each throttle lever in the quadrant is restricted by hard detents at the OFF, IDLE, MIL, and MAX (AB) positions. At the OFF and IDLE detents, the throttles are spring loaded to the inboard position.

At the MIL detent, the throttles can be shifted outboard to the AB sector or inboard to the basic engine sector of operation by merely overcoming a lateral breakout force.

Lateral shifting of the throttles at the MIL detent does not affect engine control. Thus, placement of the throttle outboard at MIL provides a natural catapult detent to prevent unintentional retarding of the throttles during the launch. This, however, does not inhibit the selection of afterburner. The friction control lever on the outboard side of the quadrant permits adjustment of throttle friction to suit individual requirements. With the friction lever in the full aft position, no throttle friction is applied at the quadrant; increased throttle friction is obtained by forward movement of the lever.

A locking pin device prevents the left throttle from moving into the cutoff position when the right throttle is either traversing or at rest on the face of the right-hand idle stop block.

2.5.1 Throttle Control Modes

Manual, boost, and automatic are the three modes of throttle control over engine operation selectable by the THROTTLE MODE switch located outboard of the quadrant on the pilot console. The toggle switch must be lifted out of a detent to select MAN from BOOST or BOOST from MAN.

The switch is solenoid held in AUTO upon successful engagement of the automatic mode. Except for the autothrottle computer and mode control switch, the throttle control system for each engine is completely redundant.

Independent engine operation is possible in the manual or boost mode of throttle control; however, full system operation is necessary in the automatic mode since operation under single-engine control is impracticable because of asymmetric thrust considerations.

NOTE – There is difference between BOOST and MANUAL modes in this FSX rendition. Also, throttle will not move sideways when A/B is engaged. A/B will be engaged when throttle control device is above 90% of its nominal travel.

2.5.1.1 Approach Power Compensator (Automatic Throttle Mode)

The automatic mode of throttle control is a closed-loop system that automatically regulates basic engine thrust to maintain the aircraft at 15 units angle of attack for landing.

All components of the throttle control system except the throttle position sensor are used in the automatic mode of control. The AOA signal from the AOA probe on the left side of the forward fuselage is the controlling parameter within the autothrottle computer. Additional parameters are integrated within the computer to improve response. The air temperature switch on the pilot left console effects a computer gain change to compensate for pilot-preferred reaction rate. In order to engage the autothrottle, throttles must be between 75 to 90-percent rpm with weight off wheels, gear handle down, and throttle friction off. With all conditions met, the throttle mode switch will be held by an electrical solenoid when placed in AUTO. The throttle control mode automatically reverts to the boost mode upon interruption of any interlock in the system or by manually overriding the throttles with a force of approximately 11 pounds per throttle in either direction. The throttle mode switch automatically returns to BOOST and the AUTO THROT caution light illuminates for 10 seconds.

See Figure 2-9 for autothrottle controls.

The pilot can revert from automatic to boost mode by selecting the CAGE/BRST (UP) position on the CAGE/SEAM switch located on the inboard throttle grip. This provides a smooth throttle override for an automatic-to-boost mode approach, while maintaining a grip on both throttles.

NOTE: AUTO Throttle mode is implemented as a standard Flight Simulator Autothrottle – that is, when engaged, the engine control system will try to achieve and maintain the airspeed set in the autopilot system.

In order to engage or disengage autothrottle mode, the user may want to assign specific controls to his/her input devices.

2.6 ENGINE BLEED AIR

Bleed air is extracted from the high-pressure compressor to perform engine-associated

services and to supply hot, high pressure air for operation of auxiliary equipment.

Fifth-stage bleed air supplies hot air for the engine anti-icing system and is used to draw cooling air through the aircraft hydraulic heat exchangers to cool flight and combined fluids and to ventilate the nacelle when weight is on wheels. Ninth-stage bleed air supplies hot air to the environmental control system, provides air for crossbleed engine starts, and draws air through the integrated drive generator heat exchanger (ventral fin) when weight is on wheels.

2.6.1 Engine Anti-Ice

The fan IGV and nosedome are susceptible to icing under a wider range of conditions, particularly at static or low speed with high engine rpm, than that which cause ice to form on external surfaces of the airframe. Ice formation at the fan face can restrict engine maximum airflow, which results in a thrust loss, decreased stall margin, and dislodgment of ice, which can damage the compressor. The engine anti-icing system is designed to prevent the formation of ice rather than de-ice the IGV and nose dome. Hot bleed air (5th stage) is passed through the hollow IGV to the nose dome and is discharged into the engine along the vanes and at the rotor hub. Cockpit control of the engine anti-icing system is effected through the ANTI-ICE switch.

NOTE: In this FSX rendition, all anti-ice systems are activated through the ANTI-ICE switch.

2.7 ENGINE IGNITION SYSTEM

There are three electrical ignition circuits, each utilizing a dedicated igniter, for each engine: main high energy, after burner, and backup.

2.8.1 Main High-Energy Ignition

The main high-energy ignition provides ignition in the combustion chamber for ground and air starts. It is powered by one of the four windings in the engine-driven ac alternator. The AFTC provides logic to control main high-energy ignition automatically.

2.8.2 Afterburner Ignition

The AB ignition ignites AB fuel flow for AB light-offs and relights (in the event of an AB blowout). The AB ignition is powered by the same winding in the engine-driven alternator that powers the main energy ignition. The AFTC provides logic to control AB ignition automatically and prevents simultaneous powering of the main high-energy and AB ignitions. In the event of an AB blowout, relight is normally provided within

1.5 seconds.

2.8.3 Backup Ignition

The backup ignition provides ignition in the combustion chamber for ground and air starts when the BACK UP IGNITION switch on the THROTTLE CONTROL panel is set to ON. It is powered by the essential No. 1 ac bus and provides less power than main high-energy ignition. After use, the BACK UP IGNITION switch should be set to OFF. To allow ground checkout of backup ignition, main high-energy ignition is disabled when the BACK UP IGNITION switch is ON and weight is on wheels. The BACK UP IGNITION switch shall be selected to OFF prior to applying external electrical power to prevent ignition of fuel puddled in the engine.

Note: Backup ignition is not implemented in this FSX rendition.

2.9 ENGINE STARTING SYSTEM

Each engine is provided with an air turbine starter that may be pressurized from an external ground starting cart or by crossbleeding high-pressure bleed air from the other engine. Figure 2.10 shows the components of the Engine Starting System.

NOTE: Engine start procedure in FSX differs significantly from real life. See next paragraphs for details.

2.9.1 External Airstart

A high-pressure (75 psi) air source and 115 volt, 400 Hz ac power are required for engine start on the deck.

The air hose is connected to the aircraft fitting in the left sponson area, behind the main gear strut. Ground start air is ducted into a central bleed air (9th stage) manifold, which interconnects the air turbine starters on both engines.

The air supply to each air turbine starter is pressure regulated (52.5 psi) and controlled by a shutoff and regulating valve at the turbine. Each pneumatic starter is composed of a turbine, gear train, sprag clutch with a speed-sensing device, and an overspeed disengagement mechanism with a shear section. Shutoff valves in the bleed air manifold selectively isolate the other starter, subsidiary bleed lines, and the environmental control system air supply. Maximum engine motoring speed with the pneumatic starter is approximately 30-percent rpm.

NOTE: Simulation of external air start

procedures is not implemented in this FSX rendition.

2.9.2 Engine Crank

Placing the ENG CRANK switch in either L or R opens the corresponding starter pressure shutoff valve to allow pressurized air to drive the turbine. The ENG CRANK switch energizes the appropriate shutoff valves to configure the bleed manifold for starting.

2.9.2.1 Engine Crank Switch

The ENG CRANK switch is held in L or R by a holding coil. At approximately 50-percent rpm, a centrifugal cutoff switch closes the turbine shutoff valve and returns the ENG CRANK switch to the center or off position. A START VALVE caution light illuminates if the starter valve remains in the open position after the ENG CRANK switch automatically returns to the center (off) position. If the starter valve does not close during engine acceleration to idle rpm, continued air flow through the air turbine starter could result in catastrophic failure of the starter turbine. If the START VALVE caution light illuminates after the ENG CRANK switch is off, select AIR SOURCE to OFF to preclude starter overspeed.

If the ENG CRANK switch does not automatically return to the OFF position by 50 percent, ensure that the ENG CRANK switch is off by 60-percent rpm to avoid starter turbine failure as a result of an inoperative automatic starter cutout.

NOTE: In this FSX rendition, Engine Crank Switch operates as standard FSX "engine starter" switch. Also Engine Crank switch will not automatically return to OFF position.

2.9.3 Crossbleed Start

Engine cranking procedures during a crossbleed start are the same as with a ground start cart. Engine crossbleed start on the ground can be accomplished with the throttle on the operating engine at or above idle rpm. When high-residual EGT (remains from a hot start) and/or throttles are advanced from OFF to IDLE prior to 20-percent rpm, higher than normal EGT readings may occur.

When initiating crossbleed starts with ambient temperature less than 40° F (4° C), the starter torque load is increased. Above 80° F (27° C), engine bleed air provides less energy potential to the starter turbine. Either extreme can affect engine starting acceleration rates, resulting in

hotter-than-normal starts. When crossbleed starting with an operating engine at idle, the operator should be aware of either condition and increase the operating engine rpm in 5-percent increments until normal starting acceleration rate is achieved. Low percentage rpm-to-EGT ratio can increase turbine distress without necessarily exceeding the EGT limit.

When performing an idle crossbleed start, advance the throttles from OFF to IDLE at 20-percent rpm or greater while monitoring EGT. If EGT rises rapidly, advance the operating engine rpm to slightly above idle. The exhaust nozzles start to close when rpm is slightly above idle.

NOTE: Crossbleed start is not properly implemented in this FSX rendition.

2.10 ENGINE OIL SYSTEM

Each engine has a self-contained, dry sump non-pressure regulated oil system that provides filtered oil for lubricating and cooling engine main shaft bearings, oil seals, gearboxes, accessories, and provides a hydraulic medium to operate the engine exhaust nozzles (FO-5). A storage tank feeds oil to an oil pump that supplies oil under pressure to the forward sump in the engine front hub, the mid sump in the fan hub, the aft sump in the turbine hub, and the inlet and accessory gearboxes. Oil is recovered from the sumps and accessory gearboxes, pumped past a chip detector, and cooled in a fuel/oil heat exchanger before returning to the storage tank. A separate compartment in the storage tank provides oil to the exhaust nozzle hydraulic system. Oil returning from the nozzle to the tank provides auxiliary oil supply to the No. 3 bearing when normal supply is interrupted or during engine spooldown.

The oil system permits engine operation under all flight conditions. During zero- or negative-g flight, oil pressure may decrease to zero but will return to normal when positive-g flight is resumed. Normal oil consumption is 0.03 gallon per operating hour with the maximum being 0.1 gallon per operating hour. Capacity of the oil storage tank is 3.7 gallons, with 2.9 gallons usable. A sight gauge on the side of the storage tank indicates down to a 2-quart-low oil level. The protrusion of a bypass indicator underneath the oil scavenge pump indicates a clogged filter element.

2.10.1 Oil Pressure Indicators

An oil pressure transducer in each engine's oil supplyline provides a continuous signal to the oil

pressure indicator.

Another, independent oil pressure switch in each oil supply line activates the OIL PRESS light when either engine's oil pressure decreases to 11 psi. The oil pressure switches and lights receive electrical power from the essential No. 2 ac bus. The OIL PRESS light and oil pressure indicator are independent of each other.

2.10.2 OIL HOT Caution Lights

The L or R OIL HOT caution light may be illuminated by either high engine oil temperature or by high forward-engine gearbox scavenge oil temperature. The caution lights illuminate when respective engine oil temperature exceeds 300° F during a temperature increase and go out at 280° F minimum during a temperature decrease. The caution lights also illuminate when respective forward engine gearbox scavenge temperature exceeds 375° F during a temperature increase, and go out at 345° F minimum during a temperature decrease.

2.11 ENGINE INSTRUMENTS

Instruments for monitoring engine operation are on the pilot left knee panel (Figure 2-11). Engine operating parameters are displayed on the engine instrument group which is a single WRA with LCD readouts. The display provides white readout segments and scales on a dark background.

Left and right engine compressor speed (rpm), EGT, and fuel flow are displayed on the EIG. Adjacent to the EIG are circular instruments for both engines' oil pressure and nozzle position. Data on engine operating limits are provided in Chapter 4.

2.12 FIRE DETECTION SYSTEM

The fire detection system provides a cockpit indication of fire or overheating in either engine compartment. There is a separate system for each engine compartment, each consisting of a thermistor-type sensing loop monitored by a transistorized control unit. The system is powered by 28 volts from the essential dc No. 1 bus.

The sensing loop for each engine compartment consists of a 45-foot continuous tubular element routed throughout the entire length of the engine compartment on both sides above the nacelle door hinge line. The tube sheath, which is clamped in grommets to the engine compartment structure, contains a ceramic-like thermistor material in which are embedded two electrical conductors; one of the conductors is grounded at both ends of the loop. Electrical resistance

between two conductors varies inversely as a function of temperature and length, so that heating of less than the full length will require a higher temperature for the resistance to decrease to the alarm point. The L or R FIRE warning lights in the cockpit illuminate when the respective entire sensing loop is heated to approximately 600° F or when any 6-inch section is heated to approximately 1,000 F.

2.13 FIRE EXTINGUISHING SYSTEM

The fire extinguishing system is capable of discharging an extinguishing agent into either engine nacelle and its accessory section. The system consists of two containers of extinguishing agent, piping and nozzles to route and discharge the agent, cockpit switches to activate the system, and advisory lights that alert the flightcrew to a drop in system pressure below a predetermined level. The fire extinguishing agent is a clean, colorless, odorless, and electrically nonconductive gas. It is a low-toxicity vapor that chemically stops the combustion process. It will not damage equipment because it leaves no water, foam, powder, or other residue. The retention time of an adequate concentration of the extinguishing agent in the engine compartment will determine probability of reignition, and, therefore, the probability of aircraft survival. At high airspeeds, where airflow through the engine compartment is increased, agent retention time is reduced. The slower the airspeed at the time the extinguisher is fired, the higher the probability of fire extinction and the lower the probability of reignition.

2.13.1 Fire Extinguisher Pushbuttons

The discharge pushbuttons for the fire extinguishing system are located behind the FUEL SHUT OFF handles.

The FUEL SHUT OFF handle for the affected engine must be pulled to make the pushbutton for that engine accessible (see Figure 2-12). If the left or right fire extinguishing pushbutton is activated, the contents of both extinguishing containers are discharged into the selected engine and its accessory section. Since it is a one-shot system, both system advisory lights, ENG FIRE EXT and AUX FIRE EXT, will illuminate and remain illuminated after container pressures drop below a preset level.

2.14 AIRCRAFT FUEL SYSTEM

The aircraft fuel system normally operates as a split feed system, with the left and aft tanks

feeding to the left engine and the right and forward tanks feeding the right engine. Except for the external tanks, the system uses motive flow fuel to transfer fuel. The supply of high-pressure fuel from engine-driven motive fuel pumps operates fuel ejector pumps to transfer fuel without the need of moving parts. The system is not dependent on electrical power for normal fuel transfer and feed. Total internal and external fuel quantity indication is provided, with a selectable quantity readout for individual tanks. Fuel system management requirements are minimal under normal operation for feed, transfer, dumping, and refueling. Sufficient cockpit control is provided to manage the system under failure conditions. The aircraft fuel system is designed so that all usable fuel will normally be depleted under two or single-engine operating conditions before an engine flame-out occurs from fuel starvation. However, with complete motive flow failure, engine fuel starvation can occur with usable fuel aboard.

Note

All fuel weights in this manual are based on the use of JP-5 fuel at 6.8 pounds per gallon, JP-4 fuel at 6.5 pounds per gallon, or JP-8 fuel at 6.7 pounds per gallon.

2.14.1 Fuel Tankage

Figure 2-13 shows the general fuel tankage arrangement in the aircraft. The fuel supply is stored in eight separate fuselage cells, two wing box cells, two integral wing cells, and (optional loading) two external fuel tanks.

2.14.1.1 Sump Tanks

The engine feed group, consisting of the left and right box-beam tanks and the left and right sump tanks, spans the fuselage slightly forward of the mid-center of gravity. Fuel in each box-beam tank gravity flows to its respective sump tank. The sump tanks (self-sealing) are directly connected to the box-beam tanks and contain the turbine-driven boost pumps. The feed tanks supply fuel to the engine.

CAUTION!

A negative-g check valve traps fuel in the feed tank during negative-g flight.

Zero- or negative-g flight longer than 10 seconds in AB or 20 seconds in MIL or less will deplete the fuel sump tanks (cell Nos. 3 and 4), resulting in flameout of both engines. AB operation in the 0 to 0.5-g regime may result in air ingestion into the fuel boost

pumps, causing possible AB blowout or engine flameout. With fuel in feed group below 1,000 pounds, AB operation could result in AB blowout.

Note: the above limitation is coded as special function in FSX and will apply regardless of the simulation realism settings.

2.14.1.2 Forward Tank

The forward fuselage fuel tank is between the inlet ducts and immediately ahead of the feed group. The forward tank is partitioned into two bladder cells (Nos. 1 and 2) that are interconnected by open ports at the top for vent and over flow purposes. Flapper valves at the base provide for forward-to-aft fuel gravity transfer.

2.14.1.3 Aft Tank

The aft fuselage fuel tank group is partitioned into four bladder cells (Nos. 5, 6, 7, and 8) and a vent tank. The forward-most cell in the aft tank group (cell No. 5) lays laterally across the center fuselage. Extending aft are two coffin-shaped tanks that contain two cells (Nos. 6 and 8) on the right side and one cell (No. 7) plus an integral fuel vent tank on the left side. The coffin tanks straddle the center trough area, which contains the control rods, Sparrow missile launchers, and electrical and fluid power lines. All fuel cells in the aft tank group are interconnected by one-way flapper valves at the base for aft-to-forward fuel gravity transfer.

2.14.1.4 Wing Tanks

There are integral fuel cells in the movable wing panels between the front and aft wing spars. Because of the wing-sweep pivot location and the extensive span (20 feet) of the wing tanks, wing fuel loading provides a variable aft cg contribution to the aircraft longitudinal balance as a function of wingsweep angle. Each wing panel consists of the integral fuel cell, which is designed to withstand loads because of fuel sloshing during catapulting and extreme rolling maneuvers with partial or full wing fuel. Fuel system plumbing (transfer and refuel, motive flow, and vent lines) to the wing tanks incorporate telescoping sealed joints at the pivot area to provide normal operation independent of wing-sweep position.

2.14.1.5 External Tanks

Fuel, air, electrical, and fuel precheck line connectors are under the engine nacelles for the external carriage of two fuel tanks. Check valves

in the connectors provide an automatic seal with the tank removed. Although the locations are designated as armament stations Nos. 2 and 7, no other store is designed to be suspended there so that the carriage of external fuel tanks does not limit the weapon-loading capability of the aircraft. Suspension of the drop tanks and their fuel content has an insignificant effect on the aircraft longitudinal center of gravity, and, even under the most adverse asymmetric fuel condition, the resultant movement can be compensated for by lateral trimming.

2.14.6 Fuel Dump

Fuel dump standpipes in the forward (cell No. 2) and aft (cell No. 5) fuselage tanks are connected to the fuel dump manifold at the dump shutoff valve. The manifold extends aft to the fuselage boattail.

Actuation of the fuel DUMP switch to DUMP supplies power (dc essential No. 2) to open the solenoid-operated pilot valve, which ports motive flow fuel pressure to open the dump shutoff valve with weight off the main landing gear and the speedbrakes retracted.

The fuel DUMP switch circuit is deactivated on deck or with speedbrakes extended. Fuel dump with the speed brakes extended is inhibited because of the resulting flow field disturbance, which would result in fuel impingement on the fuselage boattail and exhaust nozzles. The speedbrake switch is electrically bypassed during a combined hydraulic system failure, enabling the pilot to dump fuel when the speedbrakes are floating. The electrical bypass is accomplished whenever the combined pressure falls below 500 psi.

CAUTION!

The speedbrake/fuel dump interlock does not prevent speedbrakes from being deployed if fuel dump is activated. It only prevents the dumping of fuel if the speedbrakes are already extended.

Note

The FUEL FEED/DUMP circuit breaker (RE1) is on the pilot right-knee circuit breaker panel.

Dump operations with either engine in after burner should be avoided since the fuel dump mast discharge will be torched.

After terminating fuel dump, wait approximately 1 minute to allow residual fuel in the fuel dump line to drain before extending speedbrakes or lighting afterburners.

Fuel in the wings and external tanks is dumped by transferring to the fuselage. When the fuselage fuel dump circuit is activated, wing and external tank transfer to the box-beam tanks is automatically initiated. Fuel dump is by gravity flow with a nominal discharge rate of 1,500 pounds per minute. The dump rate is affected by aircraft pitch attitude and total fuselage fuel quantity with discharge flow inhibited at nosedown conditions. The standpipes in the fuel cells control the minimum fuel dump level in the tanks, which, under normal operations (feed group full), is approximately 4,000 pounds.

2.14.7 In-Flight Refueling Probe

The retractable in-flight refueling probe is in a cavity on the right side of the forward fuselage section, immediately forward of the pilot vertical console panel. Extension of the refueling probe is provided through redundant circuits by the REFUEL PROBE switch. A hydraulic actuator within the probe cavity extends and retracts the probe. The probe actuator is powered by the combined hydraulic system. It can be extended and retracted by means of the hydraulic handpump in the event of combined system failure.

2.15 ELECTRICAL POWER SUPPLY SYSTEM

In normal operation, ac power is supplied by the engine-driven generators. This ac power is converted by two transformer-rectifiers (T/R) into dc power.

One generator is capable of assuming the full ac power load and one T/R is capable of assuming the full dc power load.

Additionally, a hydraulically driven emergency generator provides an independent backup supply of both ac and dc power for electrical operation of essential buses. Ground operation of all electrically powered equipment is provided through the supply of external ac power to the aircraft.

Switching between power supply systems is automatically accomplished without pilot action; however, sufficient control is provided for the flightcrew to selectively isolate power sources and distribution in emergency situations. All electrical circuits are protected by circuit breakers accessible in flight to the pilot and RIO.

2.15.1 Normal Electrical Operation

2.15.1.1 Main Generators

Two engine-driven, oil cooled, integrated drive generators (IDG) produce the normal 115-volt,

400 Hz, three-phase ac electrical power. The normal rated output of each generator is 75 kVA, which is sufficient to individually assume the complete electrical load of the aircraft. Each main ac generator is controlled by a separate switch on the pilot MASTER GEN control panel. Indication of a main power supply malfunction is provided by a L GEN and R GEN caution light. See figure 2-15 for generator panel details.

2.16 HYDRAULIC POWER SUPPLY SYSTEMS

The aircraft employs two main, independent, engine-powered hydraulic systems, supplemented by two electro hydraulic power modules, a bi-directional transfer unit, and a cockpit handpump. The systems are pressurized to 3,000 psi and use MIL-H-83282 hydraulic fluid circulated through stainless steel and titanium lines. Hydraulic fluid is cooled by heat exchangers that use ejector air on deck. Hydraulic power system controls and indicators are shown in Figure 2-16.

2.16.1 Flight and Combined Systems

2.16.1.1 Engine-Driven Pumps

The flight and the combined systems are each pressurized by engine-driven pumps. The flight hydraulic system pump is driven by the right engine and the combined hydraulic system pump by the left engine. Each of the main systems is normally pressurized to 3,000 100 psi at any time the respective engine is operating.

2.16.1.2 Hydraulic Pressure Light

A HYD PRESS caution light illuminates when the discharge pressure from either engine-driven hydraulic pump falls below 2,100 psi; thereafter, the light goes out when pressure in both systems via the engine-driven pumps exceeds 2,400 psi. If the HYD PRESS caution light has been illuminated by low pressure in one main system, pressure failure in the other system will not cause the MASTER CAUTION light to illuminate again. The COMB and FLT gauges on the hydraulic pressure indicator reflect system pressure provided by either the engine-driven pumps or the hydraulic transfer pump. With both systems normally pressurized to 3,000 psi, the gauge needles form a horizontal line.

2.16.1.3 Hydraulic Transfer Pump (Bi-Directional Pump)

To assure the continuance of main system hydraulic pressure with an engine or engine-driven pump inoperative, a second source of pressure is provided by the hydraulic

transfer pump. This unit consists of two hydraulic pumps, one in each of the main hydraulic systems, interconnected by a common mechanical shaft. Thus, a pressure deficiency in one system is automatically augmented using pressure in the other system as the motive power. The result is bi-directional transfer of energy without an interchange of system fluid. The efficiency of the pump is such that a 3,000 psi system on one side will pressurize the other system to approximately 2,400 to 2,600 psi.

The pilot has no direct control over the direction of pump flow, the system automatically shifts in the direction that supplemental power is required.

2.16.1.3 Cockpit Handpump

A manually operated pump handle is provided as a supplementary source of power for ground operations with engines shut down and as a backup for the loss of combined system pressure to operate the in-flight refueling probe or charge the brake accumulator. It is an extendable handle in the pilot cockpit between the left console and ejection seat.

Forward and aft stroking of the handpump operates a double-acting wobble pump. The pump, which draws fluid from the combined system return line, recharges wheelbrake accumulator pressure when the landing gear handle is down. With the gear handle up, it also serves as a backup means of extending or retracting the in-flight refueling probe by placing the REFUEL PROBE switch in the desired position (EXT or RET).

The handpump is the only means of pressurizing the radome fold actuator, an operation that must be manually selected and the radome unlocked on deck from the nose wheelwell. The recommended rate of operation is approximately 12 cycles per minute (a cycle is a complete forward and aft movement of the pump handle).

NOTE: In this FSX rendition, the cockpit hand pump serves as emergency landing gear extension control.

2.16.2 Hydraulic Power Distribution

Except for the left empennage control surfaces, the flight system services only those components on the right side of the aircraft and does not penetrate into the wings. The combined system distribution is more extensive throughout the aircraft, yet its services are predominantly

concentrated to the left side and extend to the inboard sections of the movable wing panels and to the landing gear. Although the flight and combined systems are completely independent of each other, in certain components both pressure sources are used without an interchange of fluid. Both systems operate in parallel to supply power for operation of the primary flight control surfaces (except spoilers) and stability augmentation actuators; if one system fails, the other can continue to supply pressure for operation (with reduced power capability of such components). If either or both main hydraulic systems should fail, backup sources provide the capability for safe return flight and landing.

Each system has a piston-type reservoir and filter module in the sponson aft of the main landing gear strut on the respective side (combined-left; flight-right). Protrusion of mechanical pins on each filter module indicates a clogged filter.

2.16.3 Outboard Spoiler System

The outboard spoilers are powered by a separate closed-loop system, independent of the main hydraulic systems. An electrohydraulic power module supplies hydraulic pressure for outboard spoiler deflection and provides a backup power source for the main flaps and slats. Outboard spoiler operation is electrically inhibited at wing-sweep angles greater than 62 and the power module is deactivated at wing-sweep angles greater than 65.

2.16.4 Flap and Slat Backup Operation

Although normal operation of the main flap and slat segments is powered by a combined system motor on the flap and slat gearbox, an auxiliary motor powered by the outboard spoiler system is geared to the same shaft to provide for emergency operation (retraction and extension) of the main flaps and slats at a reduced rate. Failure of combined system pressure activates the auxiliary motor to drive the flap and slat gearbox when selected by the normal flap handle or maneuvering flap thumbwheel.

2.16.5 Backup Flight Control System

The backup flight control system consists of a two-speed electrohydraulic power module known as the backup flight control module. The BFCM provides fluid energy to operate the horizontal tails and rudders at a reduced rate. Emergency

power provides sufficient pitch, roll, and yaw control for return flight and landing with both main hydraulic power systems inoperative. Return flow from the combined side of the rudder and stabilizer actuators is first used to ensure the BFCM reservoir is filled. When filled, a reservoir bypass valve opens, which allows return flow to the combined system.

2.17 PNEUMATIC POWER SUPPLY SYSTEMS

The pneumatic power supply systems consist of three independent, stored pneumatic pressure sources for normal and auxiliary operation of the canopy and for emergency extension of the landing gear. The high-pressure bottles for normal canopy operation and emergency landing gear extension are ground-charged through a common filter connection in the nose wheelwell to 3,000 psi at 70 F ambient temperature.

Individual bottle pressure is registered on separate gauges on the right side of the nose wheelwell. An auxiliary canopy-open N2 bottle, filter valve, and gauge is on the turtleback behind the cockpit to allow opening the canopy from the cockpit or ground. Charges may be compressed air; however, pressurized dry nitrogen is preferred because of its low moisture content and inert properties.

NOTE: In this FSX rendition, pneumatic power supply is not simulated. Emergency landing gear extension is commanded by the cockpit hand pump.

2.17.1 Normal Canopy Control

The bottle that supplies a pressurized charge for normal operation of the canopy is on the right side of the forward fuselage, inboard of the air refuel probe cavity. Expenditure of bottle pressure for normal operation of the canopy is controlled by three (pilot, RIO, and ground) canopy control handles. A fully charged bottle provides approximately 10 complete cycles (open and close) of the canopy before reaching the minimum operating pressure of 225 psi.

2.17.2 Auxiliary Canopy Open Control

The auxiliary canopy air bottle supplies a pneumatic charge to translate the canopy aft so that the counter-poise action of the canopy actuator facilitates opening. It is on the turtleback behind the canopy hinge line. Activation of the auxiliary mode can be effected from either of the three (pilot, RIO, or ground) canopy control handles.

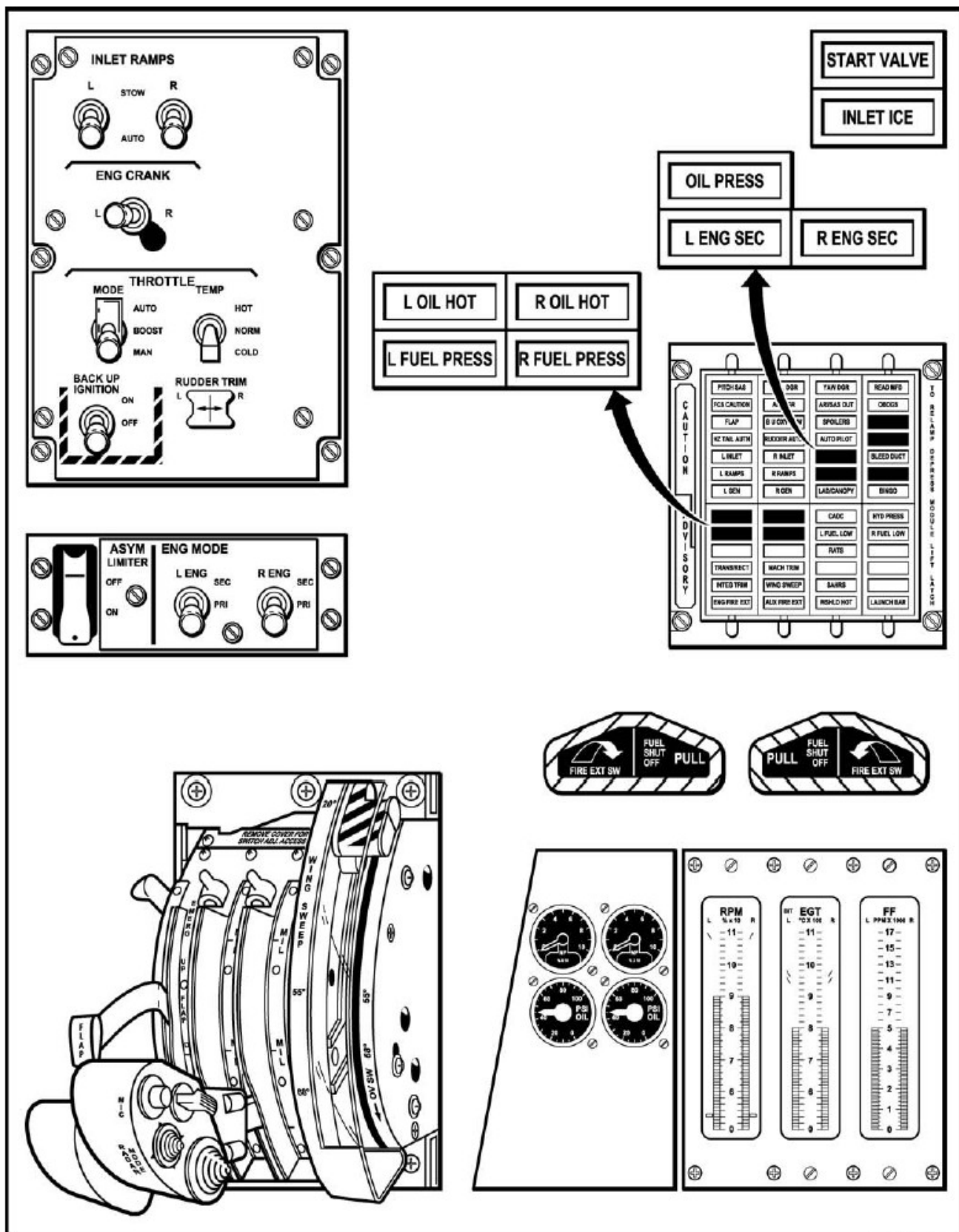


Figure 2-11 Engine Instruments

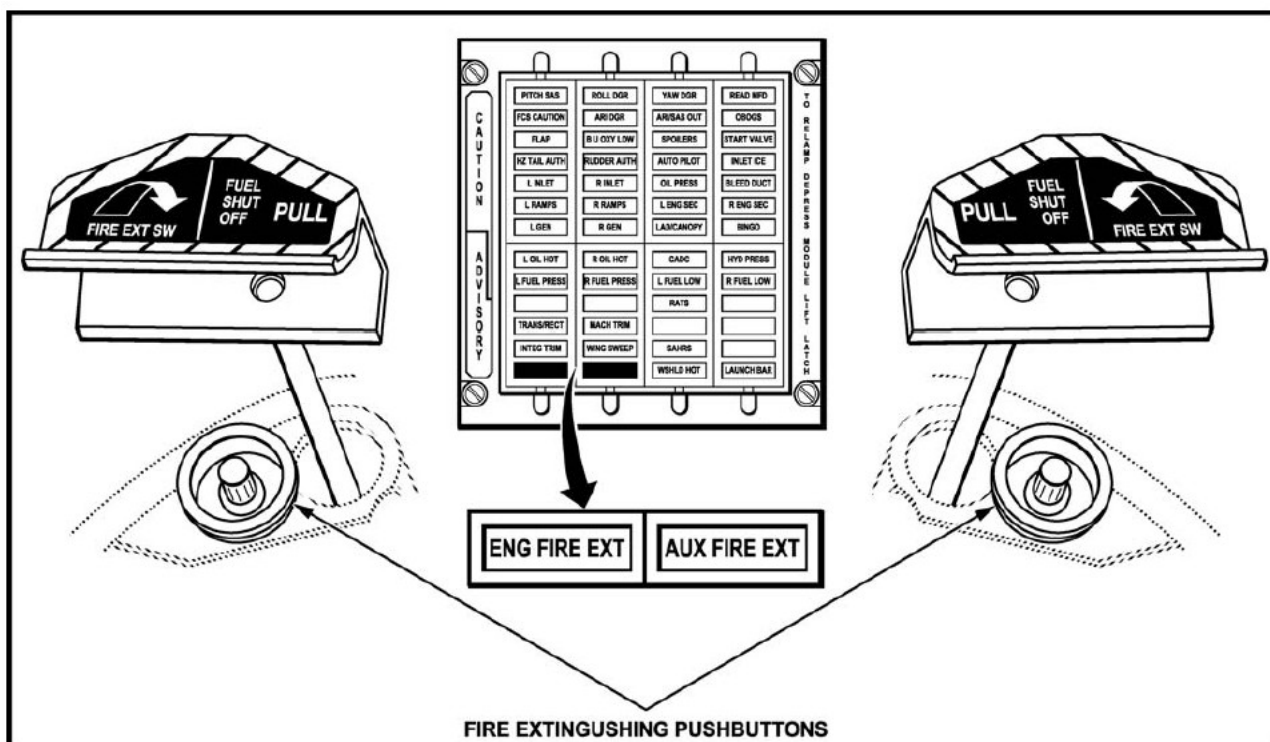


Figure 2-12 Fire Extinguishing System And Advisory Lights

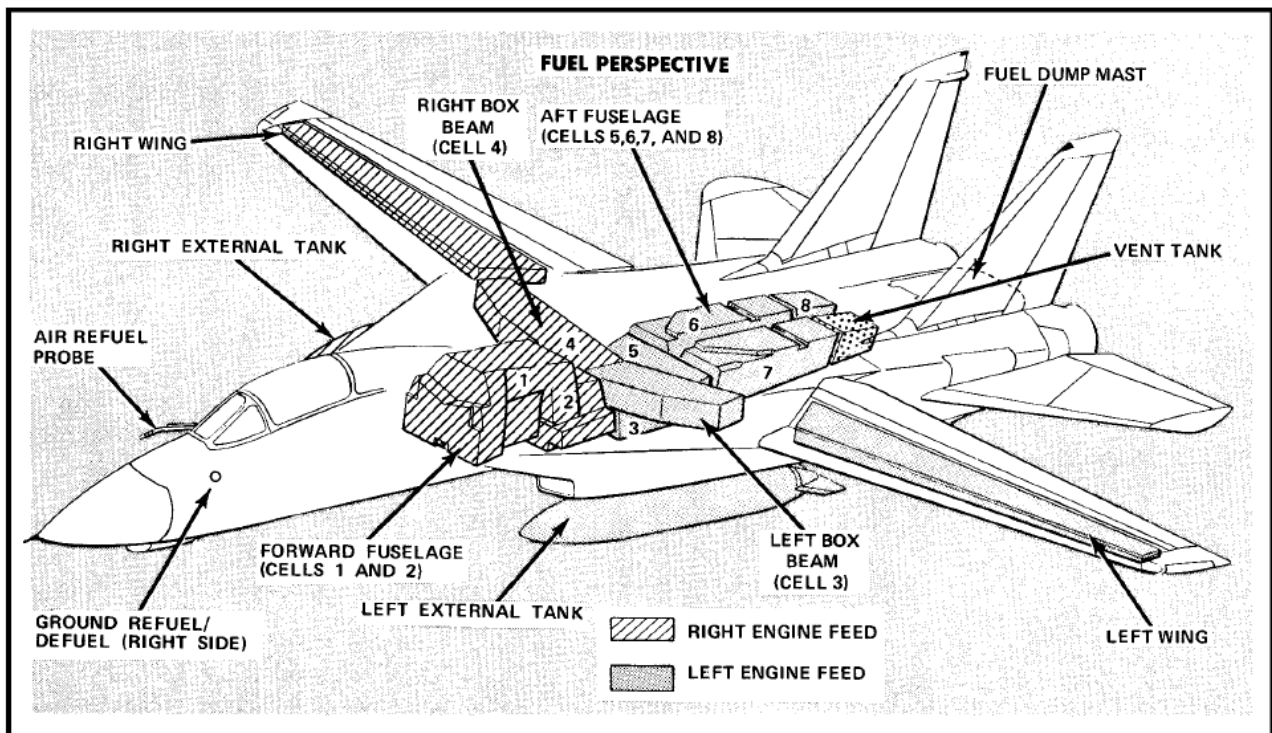


Figure 2-13 Fuel Tanks

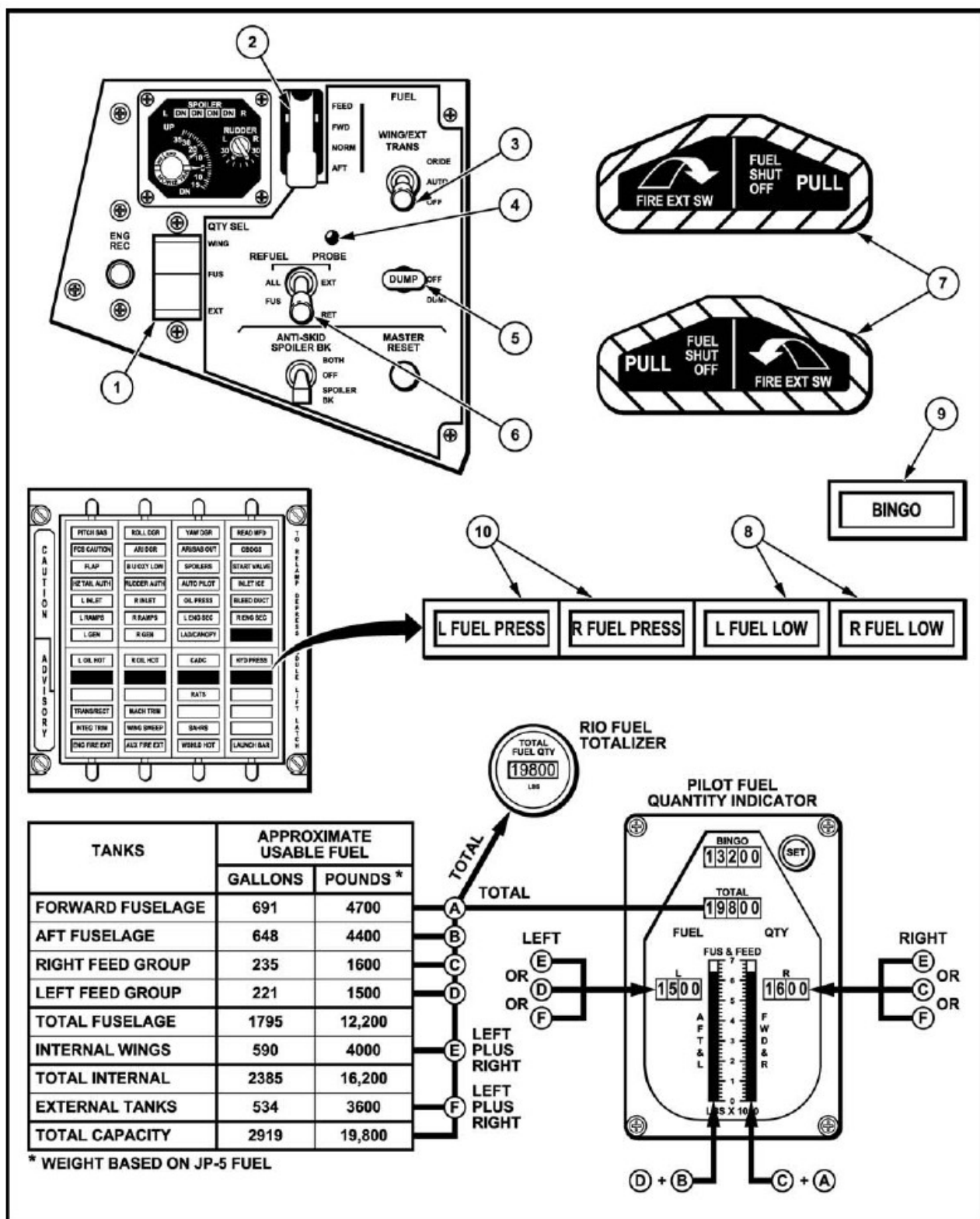


Figure 2-14 Fuel Control Indicators

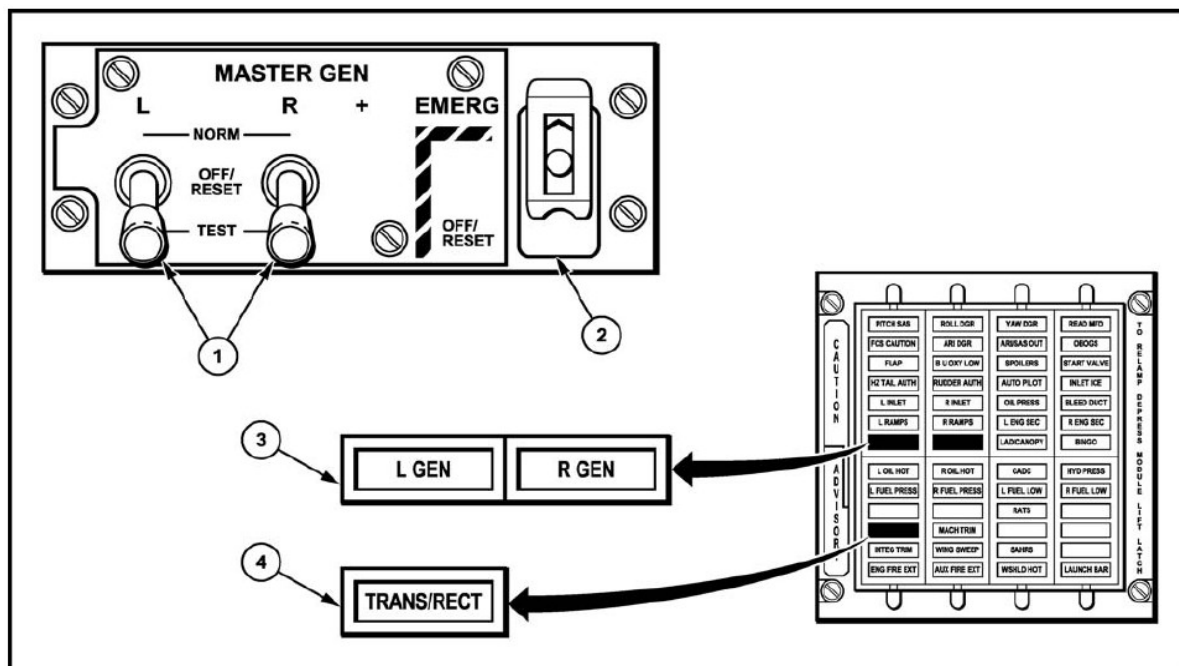


Figure 2-15 Generator Panel

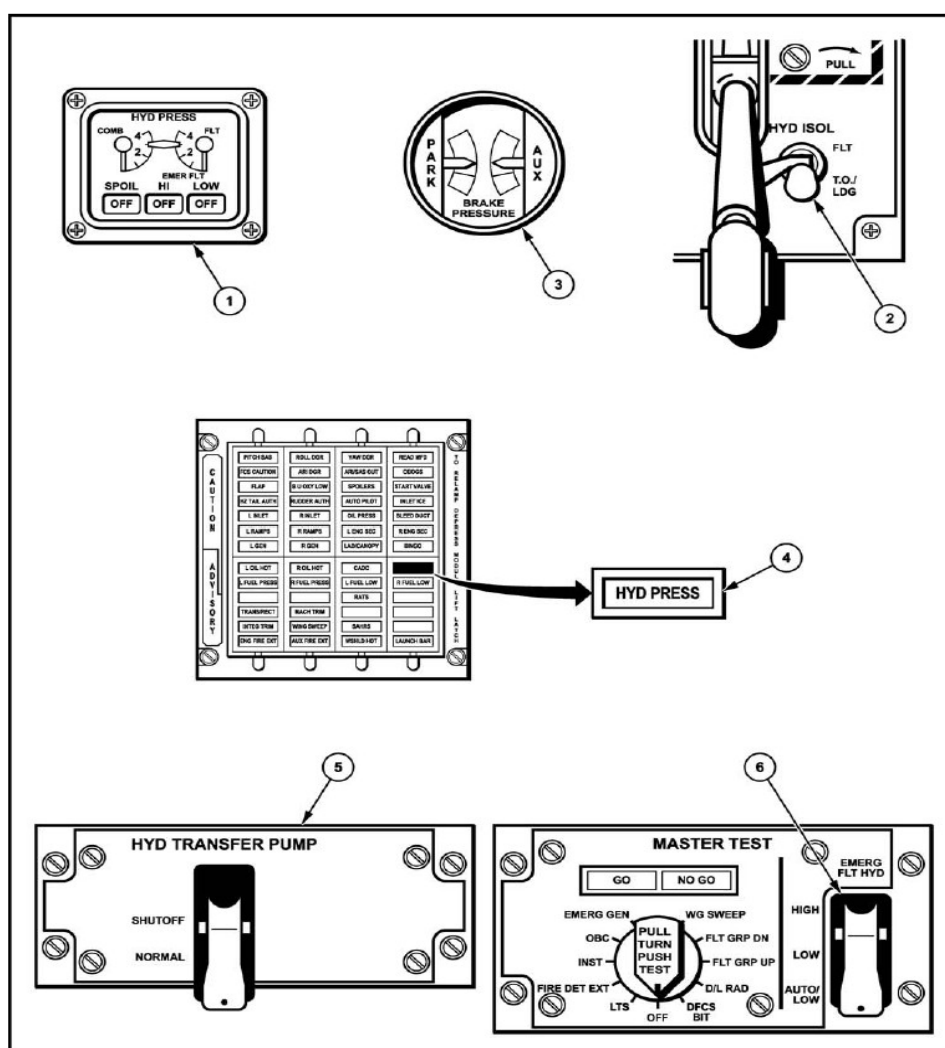


Figure 2-16 Hydraulic Systems Controls and Indicators

2.18 MISSION COMPUTER SYSTEM

The MCS consists of two AN/AYK-14 digital computer (MC1 and MC2) and the dual redundant MIL-STD-1553B buses. The MCS is operated at 16 MHz clock speed to perform 1 million instructions per second using up to 1 megabyte of memory. The 1553B bus system in the F-14D uses time division multiplexing (TDM) with information coded into 20-bit words. Communication protocol is established by a command response system in which all bus transmissions occur under command of a bus controller or, in case of failure of primary bus controller, a backup bus controller. Each bus is capable of addressing up to 31 remote terminals; however, address 31 is not used in the aircraft.

Remote terminals incapable of communicating directly with the MCS on the 1553 data buses are routed through the converter interface unit for required analog-to-digital and digital-to-analog conversion.

NOTE: This FSX rendition uses default Flight Simulator X: Acceleration F/A-18 Hornet Avionics suite. This avionics rendition is somewhat similar to the real-life F-14D Tomcat, but some functions are quite different. Relevant information and instructions can be found on the internet.

2.18.1 Aircrew Interface

The principle aircrew interface with the MCS is accomplished through the pushbuttons on each MFD. The RIO has an additional interface through the DEU communicating directly with the MCS as a remote terminal. The RIO can also interface indirectly with the MCS through the radar system digital display.

2.18.2 Aircraft Master Modes

There are three aircraft master modes of operation: takeoff-landing-navigation (TLN), air-to-air (A/A), and air-to-ground (A/G). The controls, displays, and avionics equipment are tailored as a function of the master mode selected by the pilot. The TLN master mode is entered automatically when power is applied to the aircraft, when the landing gear is down, or when the TLN master mode pushbutton is selected on the PDCP. The A/A master mode is entered by pressing the A/A master mode pushbutton on the PDCP, selecting an air-to-air weapon with the weapon select switch on the pilot control stick, or by commanding a radar dogfight mode. The A/G master mode is entered by pressing the A/G

master mode pushbutton on the PDCP.

NOTE: In this FSX rendition, all master modes are selected by pressing the respective pushbutton on the PDCP.

2.19 STANDARD CENTRAL AIR DATA COMPUTER

Note:

The acronyms SCADC and CADC are used interchangeably throughout this manual.

The SCADC CPU-175/A is installed in F-14D aircraft incorporating AFC 793. The SCADC is functionally interchangeable with the CADC 1166B/A with one difference, the SCADC software incorporates the static-error source-correction curve required for the true values of Mach number, airspeed, and altitude. In aircraft prior to AFC 793 (CADC 1166B/A), aircrew should refer to performance charts, NAVAIR 01-F14AAP-1.1 for HUD-displayed altitude and Mach number correction curves.

Note:

The standby airspeed indicator is not corrected for position error.

The SCADC is a single-processor digital computer with a separate, independent, analog, backup wing-sweep channel. It is capable of making yes and no decisions, solving mathematical problems, and converting outputs to either digital or analog form as required by each aircraft system. The SCADC gathers, stores, and processes pitot pressure, static pressure, total temperature and AOA data from the aircraft airstream sensors. It performs wing-sweep and flap and slat schedule computations, limit control and electrical interlocks, failure detection, and systems test logic.

2.20 WING-SWEEP SYSTEM

The variable geometry of the wing-sweep system provides the pilot with considerable latitude for controlling wing lift and drag characteristics to optimize aircraft performance over a broad flight spectrum. Under normal operating conditions, the wings are automatically positioned to the optimum sweep angle for maximum maneuvering performance. The pilot can selectively position the wings at sweep angles aft of optimum.

A mechanical backup control system is provided for emergency and oversweep operations.

The outboard location of the wing pivot reduces the change in longitudinal stability as a function of wing-sweep angle. Two independently powered, hydromechanical screw jack actuators, mechanically interconnected for synchronization, position the wings in response to pilot or CADC commands. In flight, the wings can be positioned between 20 and 68 wing sweep angle. On the deck, the range is extended aft to 75 (oversweep position) to reduce the span for spotting. Such authority results in a variation of wing span from approximately 64 to 33 feet. Cavities above the engine nacelles and the midfuselage accommodate the inboard portions of the wing panels as they sweep aft. Sealing of the underside is by a wiper seal and airbag. The bag is pressurized by engine bleed air. Airbag pressure is released during oversweep to avoid overloading of the flap mechanism. An overwing fairing encloses the wing cavity and provides a contoured seal along the upper surface of the wing for the normal range of in-flight sweep angles. The left and right overwing fairing actuators are pressurized by the combined and flight hydraulic systems, respectively.

NOTE:

In this FSX rendition, Flaps, Wingsweep and DLC are all simulated with the FSX-flaps function, with in total 10 discrete positions; this implies that they are operated sequentially. In following description, the term FLAPS.x is used to refer to the position of the FSX-flaps function.

Wingsweep modes are limited to AUTO or MANUAL control. Mode can be toggled by clicking the sweep hat switch on the Throttles (in Virtual Cockpit) toggles the control mode. Default setting is AUTO. BOMB mode is not simulated. The wing sweep uses FLAPS.0 (swept backward) to FLAPS.6 (swept forward) setting. Flaps must be retracted for AUTO wing sweep to work.

Flaps are manually controlled, and use FLAPS.6 (Flaps fully up) to FLAPS.8 (Flaps fully down).

Direct Lift Control, uses FLAPS.8 (DLC Off) and FLAPS.9 (DLC On). If the wingsweep is in AUTO mode, when airborne, DLC is set:

- On, when airborne AND AoA greater then 10.5***
- Off, when airborne and AoA less then 7.5***

When on the ground, DLC is set:

- On, when Flaps are full, Airbrakes extended and Throttle at Idle.***
- Off, otherwise.***

This simulation of Wingsweep, Flaps and DLC with FLAPS leads to a few restrictions, some of which are valid in the real F-14 anyway:

- Flaps can only be lowered when wings are swept in full forward position.***
- Wings can only be swept backward (both Auto and Manual) when Flaps are fully up.***
- DLC can only be activated when Flaps are fully down.***

When Wingsweep control is set to Manual, you can simply step through all Wingsweep, Flaps and DLC positions (in sequence) by using FLAPS Increase and Decrease commands.

2.20.2 Wing-Sweep Modes

Normal control of the wing-sweep position in AUTO, AFT, FWD, and BOMB modes is by the four-way wing-sweep switch on the inboard side of the right throttle grip. As an emergency mode of control, changes in wing-sweep position can be selected manually with the emergency WING SWEEP handle on the inboard side of the throttle quadrant. The handle is connected directly to the wing-sweep hydraulic valves. The command source for positioning the wings depends upon the mode selected by the pilot or, in certain cases, is automatically selected. Wing-sweep modes are shown in figure 2-18.

2.20.2.1 AUTO Mode

Selection of the AUTO mode is made by placing the four-way wing-sweep switch in the upper detented position (AUTO) permitting the CADC wing-sweep program to position the wings automatically. The program positions the wings primarily as a function of Mach number but includes pressure altitude biasing. Wing position is scheduled to the optimum sweep angle for developing maximum maneuvering performance. In addition to providing an automatic wing positioning function, the programmer also defines the forward sweep limit that cannot be penetrated using any of the other electrical (manual or bomb) modes. The forward sweep limiter prevents electrical mispositioning of the wings from a wing structure standpoint. Pilot selection of the AUTO mode or automatic

transfer from the manual mode causes the AUTO ground, the oversweep position (75° sweep) is flag to appear in the wing-sweep indicator. Once commanded. in the AUTO mode, the four-way wing-sweep switch can be in the center position without changing the command mode.

2.20.2.2 Manual Mode

The manual wing-sweep mode is commanded by selecting AFT or FWD from the neutral position of the wing-sweep switch, driving the wings in the commanded direction to any wing-sweep position aft of the automatic program. The switch is spring-loaded to return to the center position. Manual command mode exists during the two modes of operation: takeoff or landing, and maneuvering flight. The flaps are of the single-slotted type, sectioned into three panels on each wing. The two outboard sections are the main flaps utilized during both modes of operation. The inboard section (auxiliary flap) is commanded only during takeoff or landing. The slats consist of two sections per wing mechanically linked to the main flaps. Flaps down greater than 10 enables the wheels warning light interlock, and greater than 25 enables direct lift control and power approach spoiler gearing.

2.20.2.3 Bomb Mode

Bomb mode is selected by moving the wing-sweep switch to the down (BOMB) position. With the switch in BOMB, the following occurs:

1. Wing SWEEP indicator shows MAN flag.
2. If wing sweep is less than 55, wings will drive to 55.
3. If wing sweep is greater than 55, wings will not move.
4. If maneuver flaps are extended, they will retract and wings will sweep to 55.

As the aircraft accelerates and the AUTO wing-sweep schedule is intercepted, the wings will follow the AUTO schedule even though the switch remains in BOMB mode.

Upon decelerating, the wings will sweep forward to 55 and stop.

NOTE: Bomb mode is not implemented in the FSX rendition

2.20.2.4 Emergency Mode

During normal mode operation of the wing-sweep system, the wing-sweep control drive servo drives the hydraulic valve command input through a spider detent mechanism. The emergency handle under a transparent guard is moved in parallel with the servo output. The emergency mode provides an emergency method of controlling wing sweep. It bypasses the normal command path of the system (CADC and control drive servo loop).

NOTE: In this FSX rendition, Emergency Mode is not implemented. By clicking on the Emergency Wingsweep control while the aircraft is on the

2.20.3 Wing-Sweep Interlocks

Automatic limiting of wing-sweep authority is provided under normal in-flight control modes to prevent mispositioning of the wings at conditions that could result in the penetration of structural boundaries (see figure 2-19).

2.21 FLAPS AND SLATS

The flaps and slats form the high-lift system, which provides the aircraft with augmented lift during the two modes of operation: takeoff or landing, and maneuvering flight. The flaps are of the single-slotted type, sectioned into three panels on each wing. The two outboard sections are the main flaps utilized during both modes of operation. The inboard section (auxiliary flap) is commanded only during takeoff or landing. The slats consist of two sections per wing mechanically linked to the main flaps. Flaps down greater than 10 enables the wheels warning light interlock, and greater than 25 enables direct lift control and power approach spoiler gearing.

2.21.1 Flap and Slat Controls

Pilot controls for flap and slat takeoff, landing, and maneuvering modes are illustrated in Figure 2-20.

2.21.1.1 FLAP Handle

The FLAP handle, located outboard of the throttles, is used to manually command flaps and slats to the takeoff and landing position. Flap handle commands are transmitted by control cable to the flap and slat and wing-sweep control box where they are integrated with CADC electromechanical inputs to command proper flap and slat position.

2.21.1.1.1 Emergency Flaps

EMER UP enables the pilot to override any electro mechanical commands that may exist because of malfunction of the CADC. To position the flaps, move the FLAP handle to the end of the normal travel range; then, move the handle outboard and continue moving to extreme EMER UP. While moving the handle, forces may be higher than normal. EMER DN has no function.

2.21.1.2 Maneuver Flap and Slat Thumbwheel

The maneuver flap and slat thumbwheel is located on the left side of the stick grip and is

spring loaded to the center position. With LDG GEAR and FLAP handles up, automatic CADC flap and slat positioning can be overridden with pilot thumbwheel inputs to partially or fully extend (Figure 2-21.) As the flaps pass 25° deflection, a negative command received from the DFCS depresses the spoilers to $-4\frac{1}{2}^\circ$ to meet with the cove doors. Because the spoilers do not span the entire wing as do the flaps, gusses inboard and outboard of the spoilers perform the flaps-down function of the spoilers. With the flaps retracted, the eyebrow doors, which are the forward upper surface of the flaps, are spring-loaded in the up position to close the gap between the trailing edge of the spoiler or guss and the leading edge of the flaps. Mechanical linkage retracts the eyebrow door when the flaps are lowered to provide a smooth contour over the upper surface of the deflected flap.

2.21.1.3 Main Flaps

The main flaps on each wing consist of two sections simultaneously driven by four mechanical actuators geared to a common flap driveshaft. Each wing incorporates a flap asymmetry sensor and flap overtravel switches for both the extension and retraction cycles. Cove doors, spoilers, eyebrow doors, and gusses operate with the flaps to form a slot to

optimize airflow over the deflected flap. The cove doors are secondary surfaces along the underside of the wing forward of the flap (Figure 2-21.) As the flaps pass 25° deflection, a negative command received from the DFCS depresses the spoilers to $-4\frac{1}{2}^\circ$ to meet with the cove doors. Because the spoilers do not span the entire wing as do the flaps, gusses inboard and outboard of the spoilers perform the flaps-down function of the spoilers. With the flaps retracted, the eyebrow doors, which are the forward upper surface of the flaps, are spring-loaded in the up position to close the gap between the trailing edge of the spoiler or guss and the leading edge of the flaps. Mechanical linkage retracts the eyebrow door when the flaps are lowered to provide a smooth contour over the upper surface of the deflected flap.

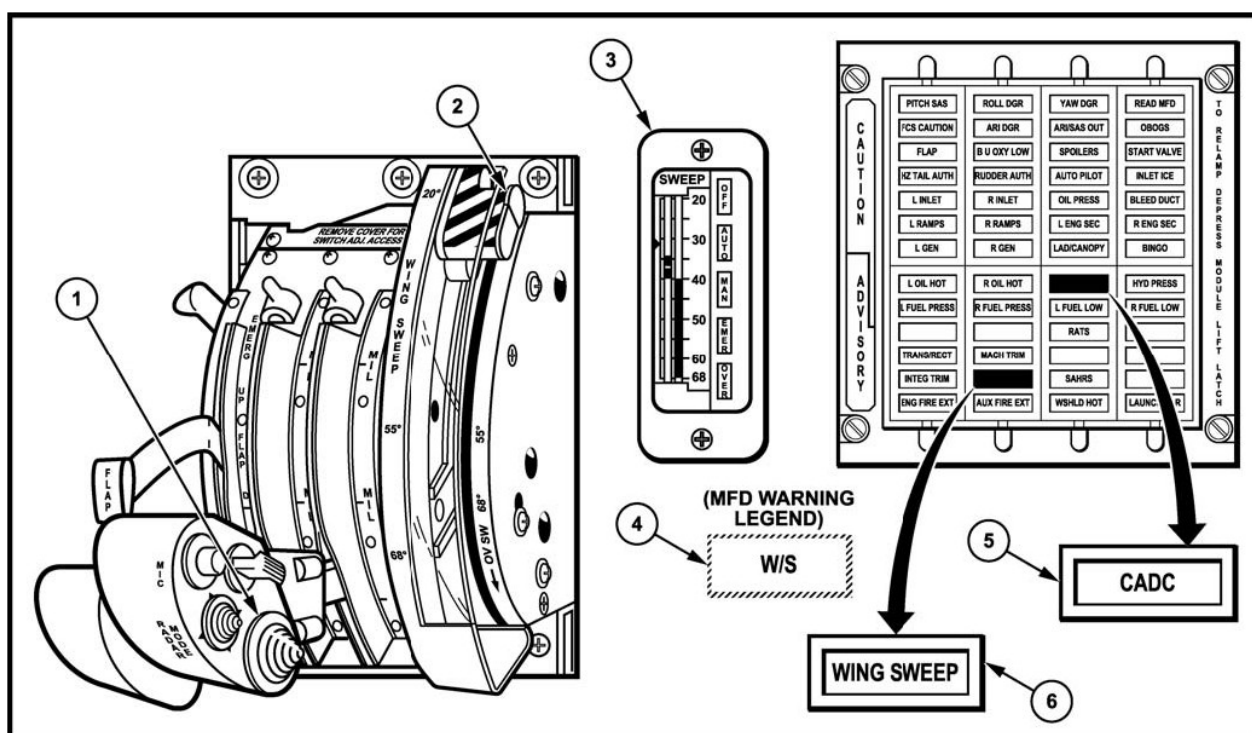


Figure 2-17 Wing Sweep Controls and Indicators

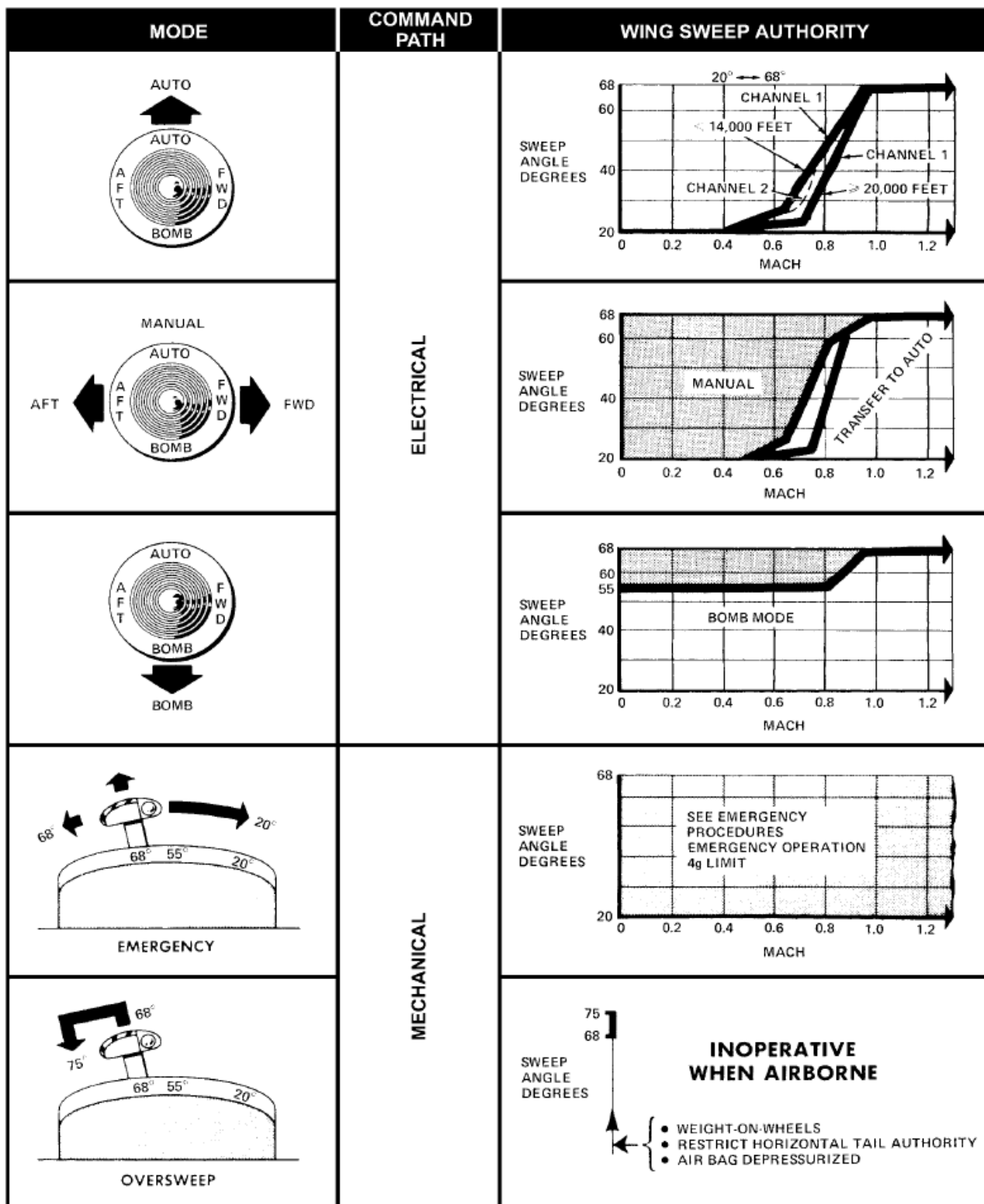


Figure 2-18 Wing Sweep Modes

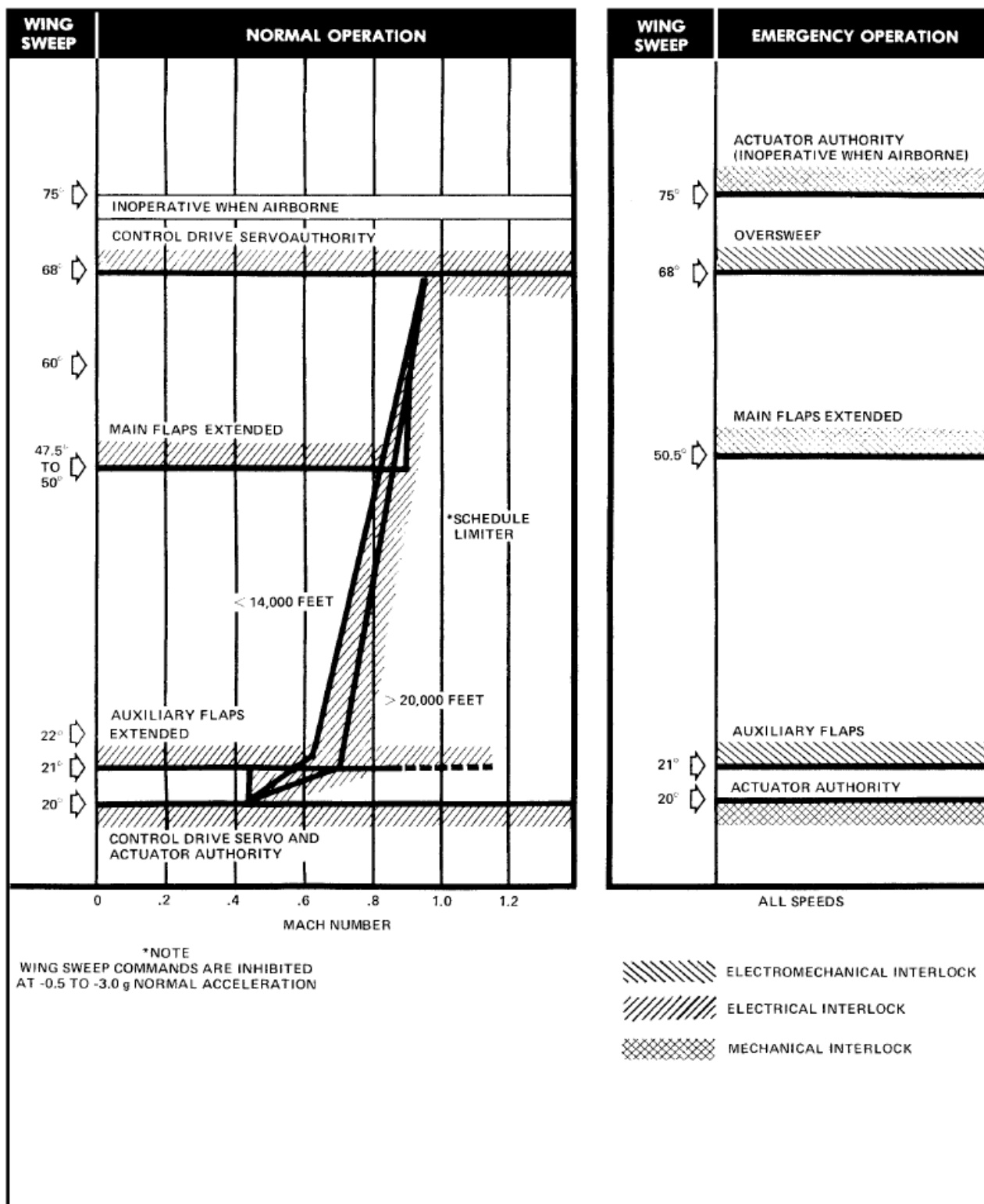


Figure 2-19 Wing Sweep Interlocks

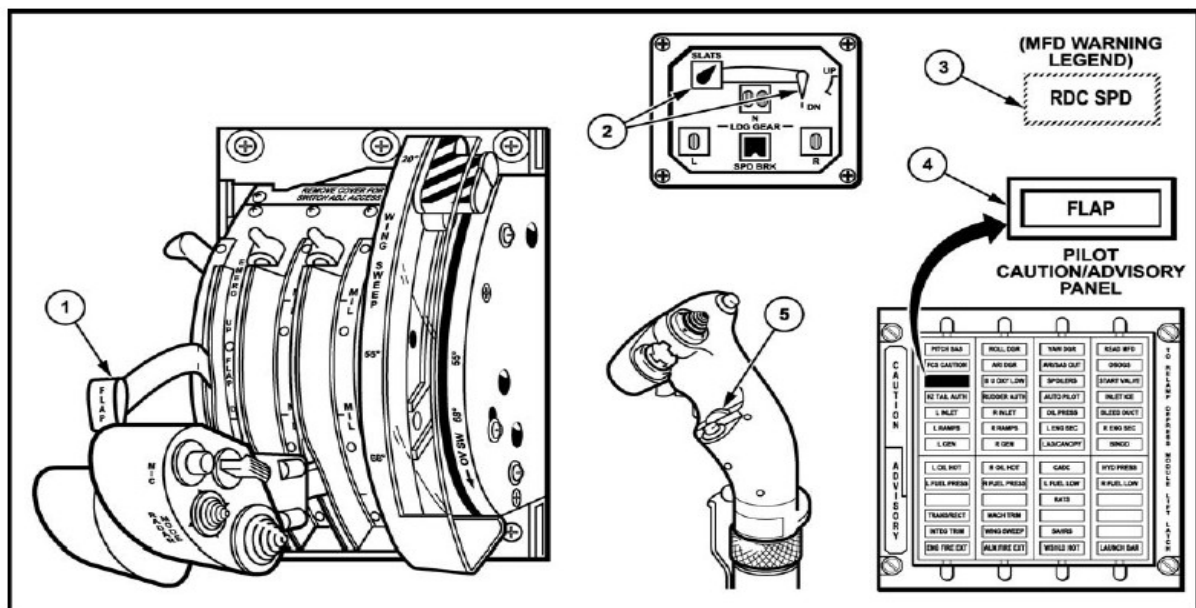


Figure 2-20 Flap and Slat Controls and Indicators

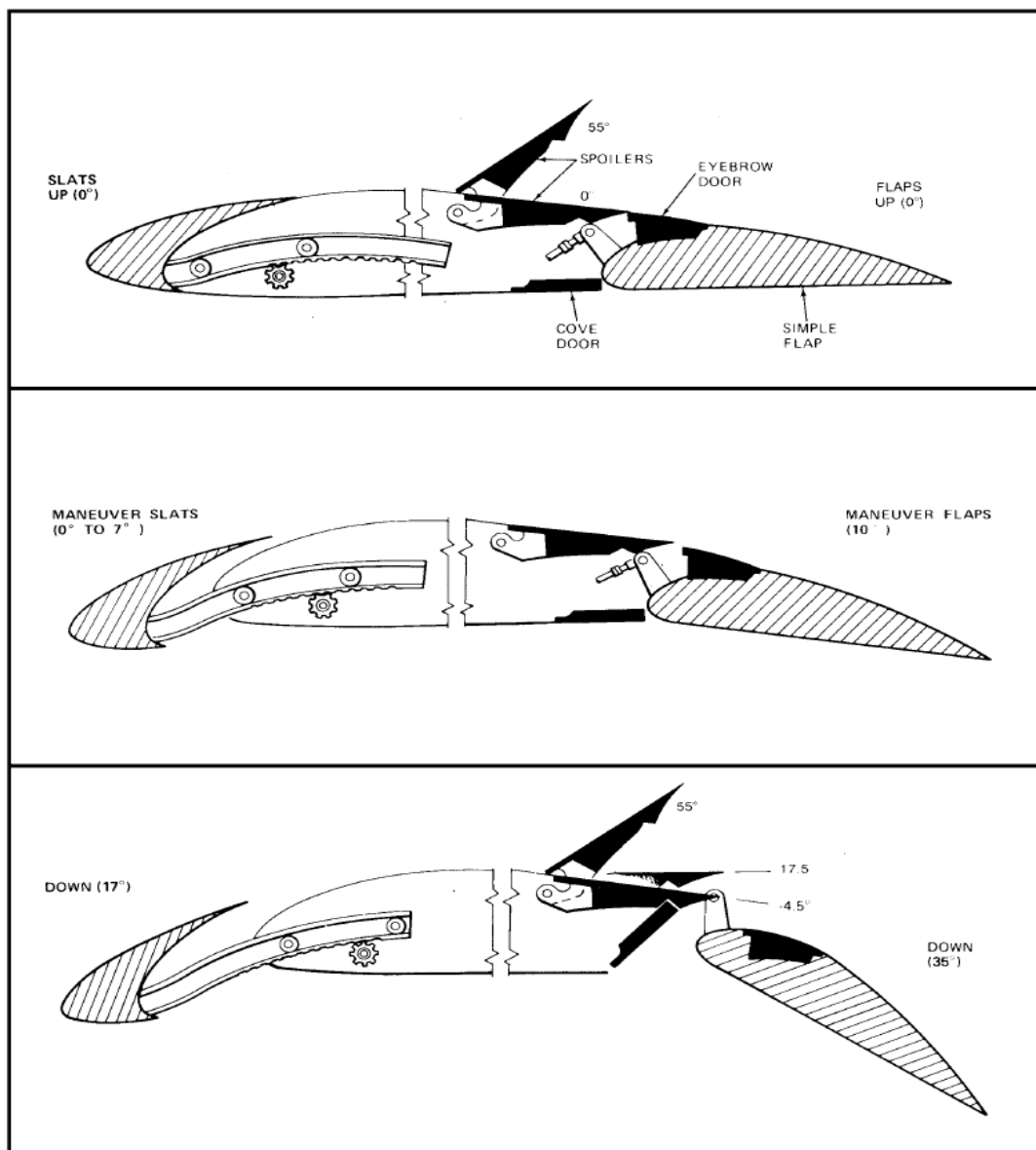


Figure 2-21 Wing Control Surfaces

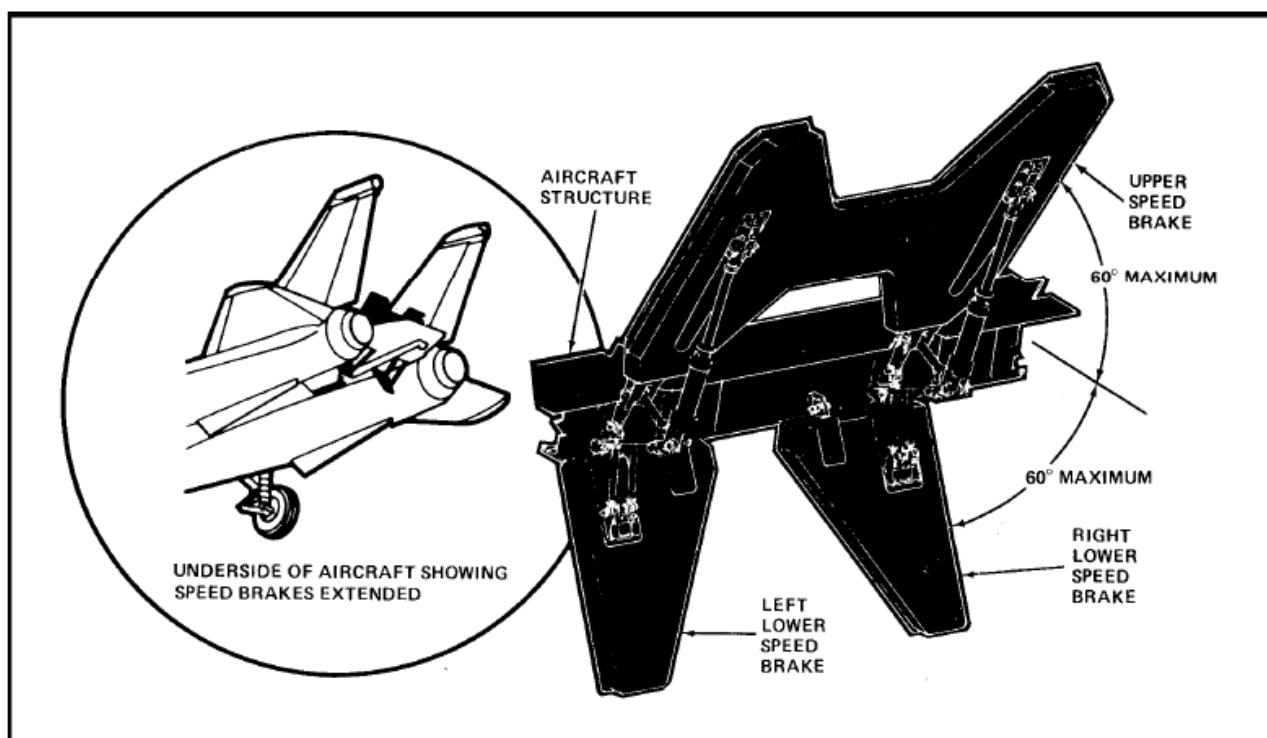


Figure 2-22 Speedbrake

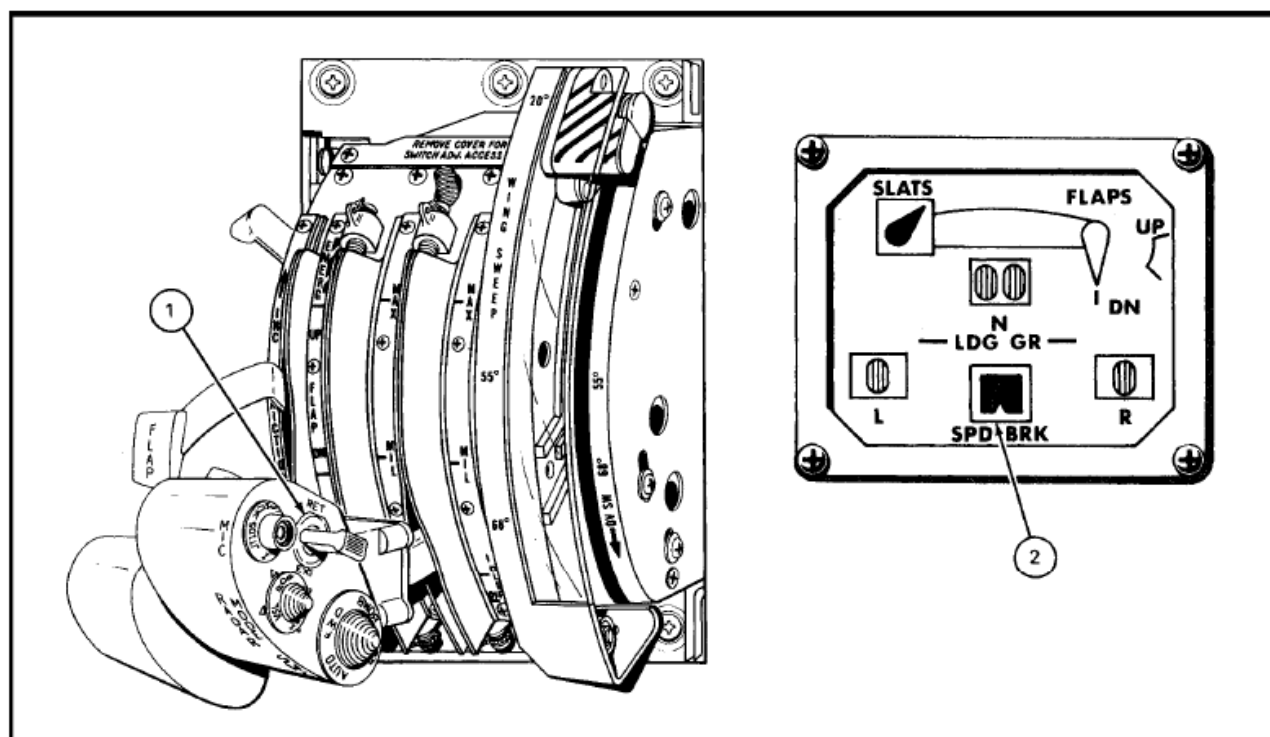


Figure 2-23 Speedbrake Controls and Indicator

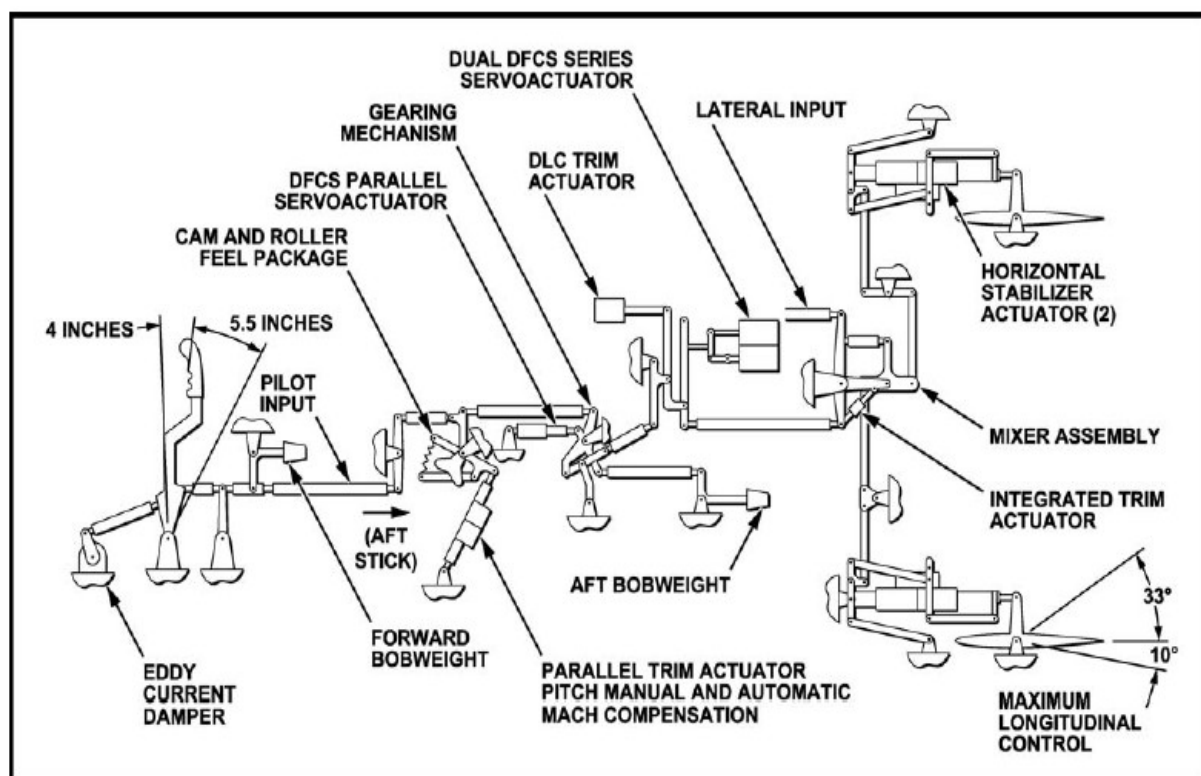


Figure 2-24 Longitudinal Control System

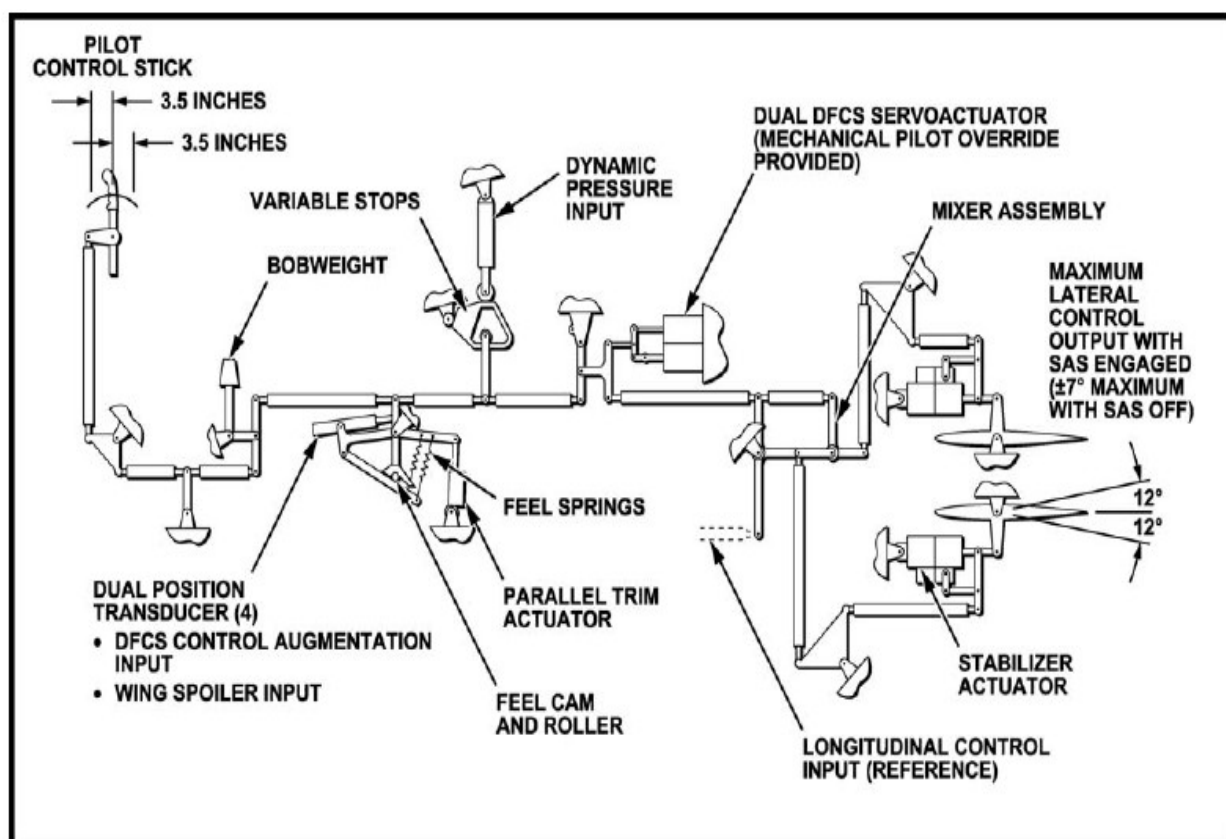


Figure 2-25 Lateral Control System

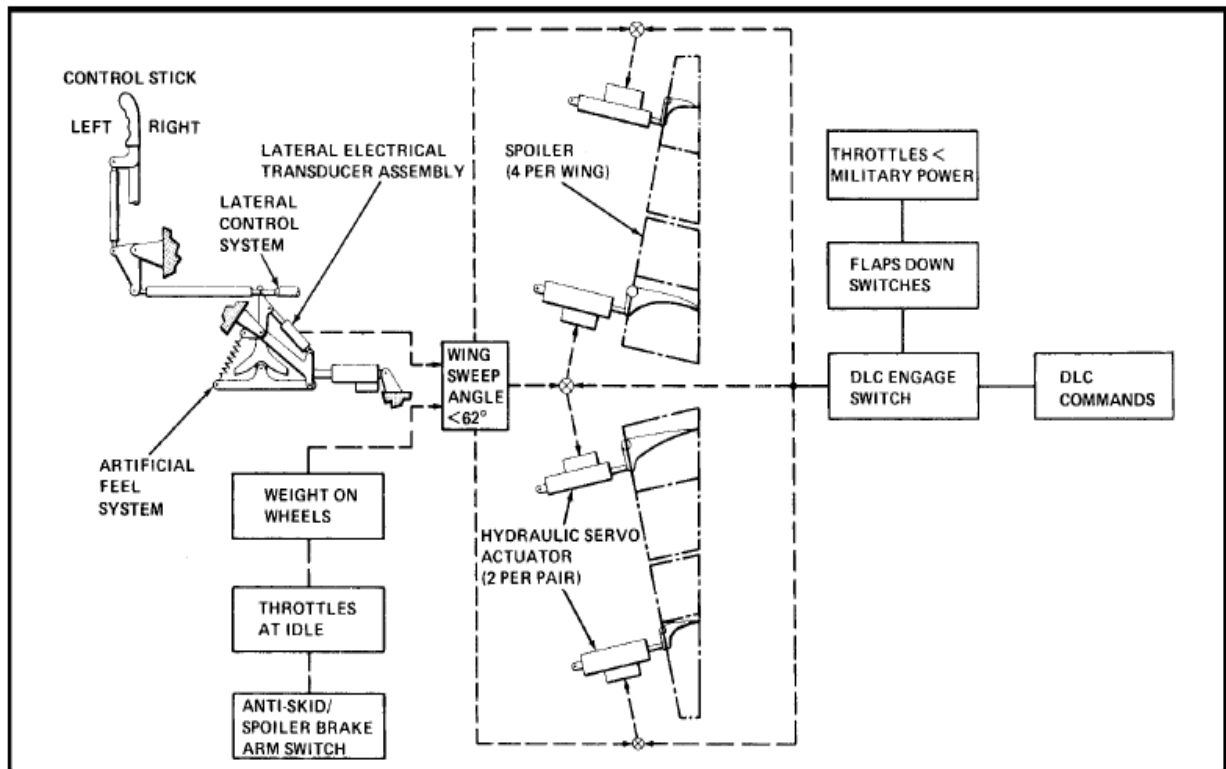


Figure 2-26 Spoiler Control System

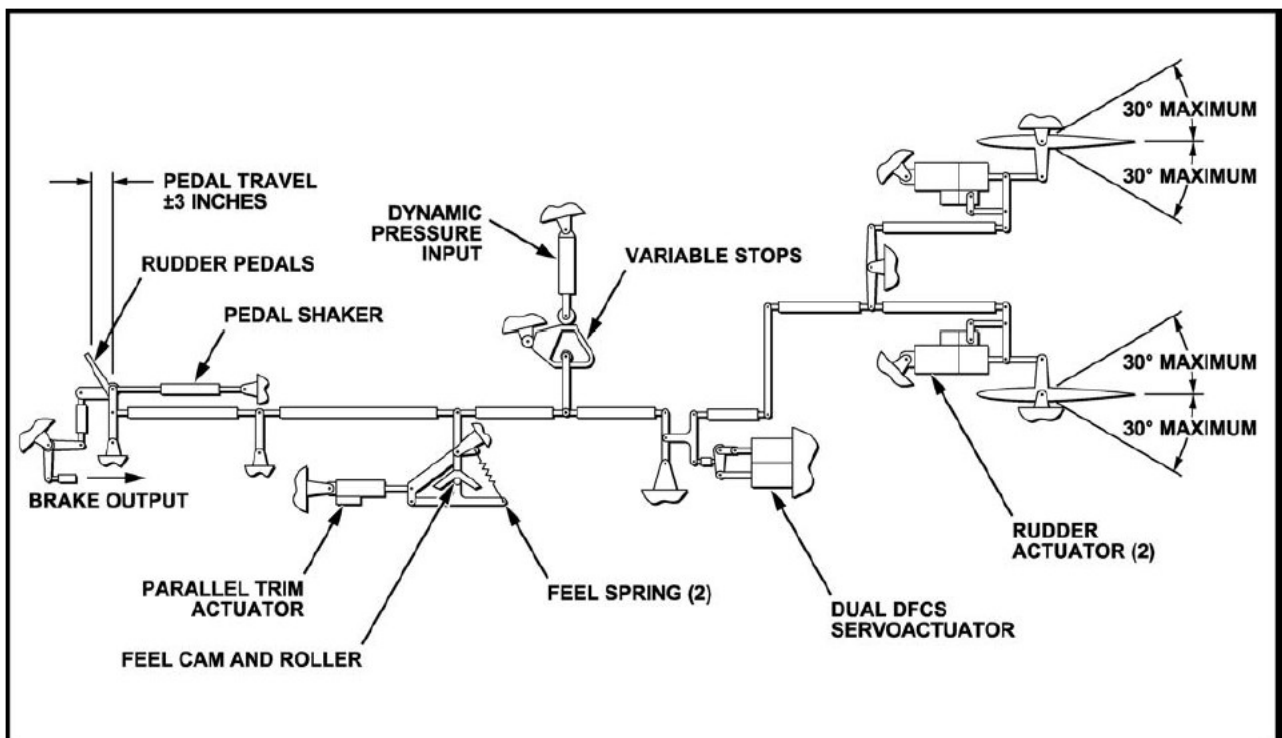
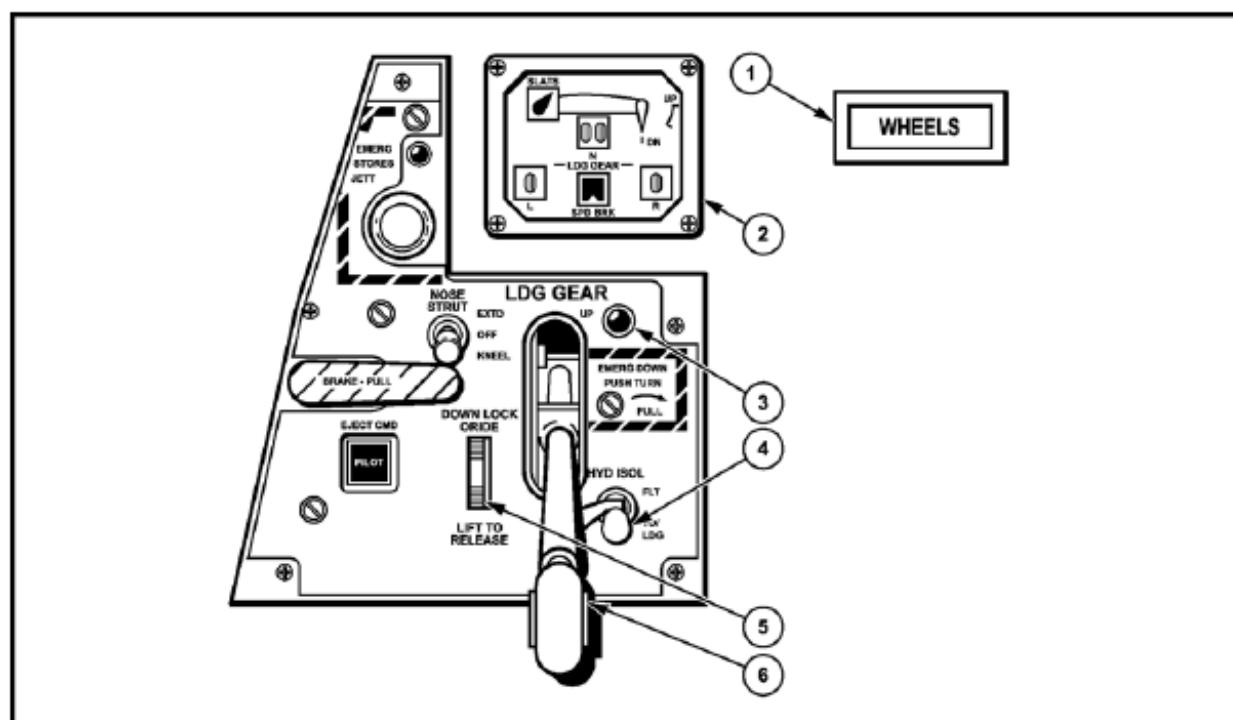


Figure 2-27 Yaw Control System



Figure 2-28 Digital Flight Control Systems and Indicators



CSC-F14D-1-2-025A

NOMENCLATURE	FUNCTION
① WHEELS warning light	Light flashes with flaps greater than 10° deflection and either or both throttles less than approximately 85% rpm, and all landing gear not down and locked. Approach lights and indexer will illuminate when the LDG GEAR handle is placed in the down position, but this is not an indication of gear down and locked.
② LDG GR indicator	 — Landing gear down and locked (except main landing gear sidebrace actuator).  — Landing gear retracted and doors closed.  — Unsafe gear or power off indication.
③ Landing gear transition light	On whenever gear and door positions (including main landing gear sidebrace actuators) do not correspond to handle position. Off when gear and doors are locked in position selected by handle.

Figure 2-29 Landing Gear Controls and Indicators

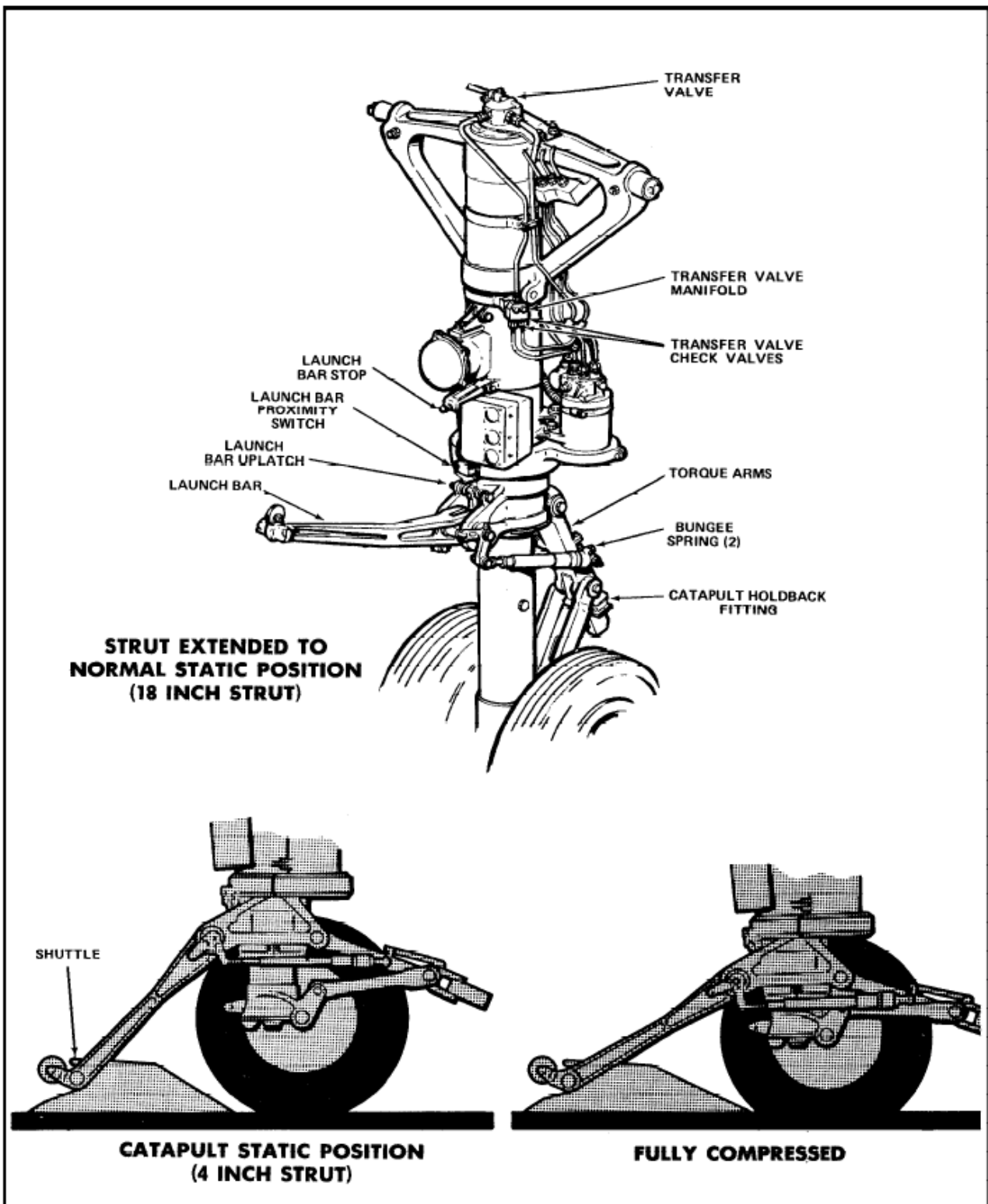


Figure 2-30 Nose Landing Gear Strut

2.21.1.4 Auxiliary Flaps

The auxiliary flaps are inboard of the main flaps and are powered by the combined hydraulic system. The actuator is designed to mechanically lock the auxiliary flaps when in the up position. In the event of high dynamic pressure conditions, a bypass valve within each control valve opens causing the auxiliary flap to be blown back, thus avoiding possible structural damage. During loss of electrical power, the control valve is spring-loaded to retract, retracting the auxiliary flaps within 1 minute. The auxiliary flaps use cove doors, eyebrow doors, and gusses identical in purpose and operation with those associated with the main flaps.

2.21.1.5 Slats

The slats on each wing are divided into two sections, both of which are driven simultaneously by a single-slat driveshaft. The slats are supported and guided by seven curved tracks.

2.21.2 Flap and Slat Operation

There is no automatic flap/slat retraction. With flaps extended by the FLAP handle and an airspeed of 225 knots or greater, the RDC SPD legend appears on the MFD and HUD.

2.21.2.1 Normal Operation

The main flap and slat portion of the high-lift system is positioned with a dual redundant hydromechanical servo loop in response to the FLAP handle command. The auxiliary flap is a two-position control surface powered by the combined hydraulic system. With the FLAP handle exceeding 5 deflection, the auxiliary flaps fully extend. Conversely, they retract for a FLAP handle position equal to or less than 5. The torque of the flap and slat drive hydraulic motor is transmitted by flexible driveshafts to each wing.

2.21.2.2 Degraded Operation

In the event of a combined hydraulic system failure, outboard spoiler module fluid is automatically directed to a backup hydraulic motor to lower main flaps and slats only. In the event of main flap asymmetry greater than 3, slat asymmetry greater than 4, or flap surface overtravel, the flap and slat system is disabled. Flaps and slats will remain in the position they were in when failure or malfunction occurred. The auxiliary flaps are automatically commanded to retract. There is no asymmetry protection for the auxiliary flaps.

2.21.2.3 Flap Wing Interlocks

The main flap and auxiliary flap commands are interlocked electrically and mechanically with the wing sweep to prevent flap/fuselage interference. An electrical interlock in the CADC and a mechanical command in the wing-sweep control box prevent wing sweep aft of 22 with auxiliary flaps extended.

2.22 SPEEDBRAKES

The speedbrakes consist of three individual surfaces, one upper and two lower panels on the aft fuselage between the engine nacelles (Figure 2-22). The speedbrakes may be infinitely modulated on the extension and retraction cycle. Operating time for full deflection is approximately 2 seconds.

2.22.1 Speedbrake Operation

Pilot control of the speedbrakes is effected by use of the three-position speedbrake switch on the inboard side of the right throttle grip (Figure 2-23). Automatic retraction of the speedbrakes occurs with placement of either or both throttles at MIL or loss of electrical power. To avoid fuel impingement on the fuselage boattail and nozzles, fuel dump operations are prevented with the speed brakes extended.

NOTE:

Do not extend the speedbrakes in flight within 1 minute (nominal) after terminating fuel dump operations to allow residual fuel in the dump mast to drain. A throttle must be held in MIL (or greater) for approximately 3 seconds in order for the automatic function to completely retract the speedbrake. Anything less will cause partial retraction.

The speedbrakes will start to blowback (close) at approximately 400 knots and will continue toward the closed position as airspeed increases to prevent structural damage.

A reduction in airspeed will not automatically cause the speedbrakes to extend to the originally commanded position.

2.23 FLIGHT CONTROL SYSTEMS

Flight control is achieved through an irreversible, hydraulic power system operated by a control stick and rudder pedals. Aircraft pitch is controlled by symmetrical deflection of the horizontal stabilizers. Roll control is effected by differential stabilizer deflections and augmented by spoilers at wing-sweep positions less than 62. Directional control is provided by dual rudders. During power approach maneuvers, the aircraft

flightpath can be controlled through symmetric spoiler displacement by the pilot selecting direct lift control.

The horizontal stabilizer and rudders are powered by the flight and combined hydraulic systems and controlled by pushrods and bellcranks. A third independent flight control hydraulic power source is provided by the backup module.

Spoiler control is effected by an electrohydraulic, fly-by-wire system and powered by the combined hydraulic system (inboard spoilers) and outboard spoiler module (outboard spoilers). The DFCS includes a stability augmentation system, an autopilot and auxiliary control functions for spoiler control, rudder authority control, lateral stick authority control, and Mach trim compensation.

2.23.1 Longitudinal Control

Longitudinal control (Figure 2-24) is provided by symmetric deflection of independently actuated horizontal stabilizers. Control stick motion is transmitted to the stabilizer power actuators by pushrods and bellcranks to dual tandem actuators independently powered by the flight and combined hydraulic systems. The power actuators control the stabilizers symmetrically for longitudinal control and differentially for lateral control. This is accomplished by mechanically summing pitch and roll commands at the pitch-roll mixer assembly. Nonlinear stick-to-stabilizer gearing provides appropriate stick sensitivity for responsive and smooth control.

2.23.2 Lateral Control

Lateral control (Figure 2-25) is effected by differential displacement of the horizontal stabilizers and augmented by wing spoilers at wingsweep positions of less than 62°. With gear handle up, a $\pm\frac{1}{2}$ -inch stick deadband is provided to preclude spoiler actuation with small lateral stick commands.

The spoilers are commanded to the flush-down (0) position at wing-sweep angles of greater than 62°, and roll control is provided entirely by differential stabilizer. At wing-sweep angles of 65° and greater, the hydraulic power to the spoiler actuators is cut off, locking the spoiler in the 0 position.

Lateral stick commands are transmitted by pushrods and bell cranks to the independent stabilizer power actuators and electrically to the spoiler actuators.

NOTE: In this FSX rendition, spoilers will deploy

for roll control at any sweep angle.

2.23.3 Spoiler Control

Four spoiler control surfaces (Figure 2-26) on the upper surface of each wing augment roll control power and implement aerodynamic ground-roll braking. The inboard spoilers also provide DLC. The inboard and outboard spoilers are powered and controlled by separate hydraulic and electrical command systems. The DFCS monitors each spoiler panel individually. The pitch computer and outboard spoiler module control the outboard spoilers; and the roll computer and the combined hydraulic system control the inboard spoilers.

The inboard spoilers are controlled and monitored by the ROLL A and PITCH A computer segregations respectively. The outboard spoilers are controlled and monitored by the PITCH B and YAW B computer segregations respectively. Hydraulic actuation of the servo actuators is controlled by electric servo valves at the actuator and commanded by control stick displacement.

CAUTION!

Full slat asymmetry (17°) can result in an out-of-control situation at 15 units AOA or greater even with 55° of spoilers available.

NOTE: In this FSX rendition, spoilers will deploy as speedbrakes also in-flight.

2.23.3.1 Ground-Roll Braking

Aerodynamic ground-roll braking is provided by symmetric deflection of all spoilers to +55°. Ground-roll braking is controlled by the ANTI SKID SPOILER BK switch on the pilot left vertical console. The three-position switch allows optional selection of BOTH (spoiler brake and wheel antiskid braking), SPOILER BK (spoiler brake only), or OFF where neither spoilers nor antiskid is armed. With SPOILER BK or BOTH selected, two conditions are required to actuate the spoilers:

1. Weight on wheels
2. Both throttles at idle.

Failure to satisfy any one of the above conditions will cause the spoilers to return to the down position.

Ground-roll braking may fail to extend spoilers on touchdown due to a momentary miscompare of the weight-on-wheels switches.

During initial spoiler brake operation, it is

normal for the indicators in the SPOILER window to momentarily flip-flop.

2.23.5 Yaw Control

Yaw control (figure 2-27) is effected by twin rudders, one on each vertical tail. The rudder pedals adjust through a 10-inch range in 1-inch increments with the adjust control on the lower center pedestal, forward of the control stick. Yaw commands are transmitted mechanically from the rudder pedals to the rudder power actuators by pushrods and bellcranks. Tandem power actuators are powered independently by the flight and combined hydraulic systems.

2.23.6 Direct Lift Control

During landing approaches, the inboard spoilers and horizontal stabilizers can be controlled simultaneously to provide vertical glidepath correction without changing engine power setting or angle of attack. Only the inboard spoilers are used for DLC.

Before DLC can be engaged, the following conditions are required:

1. Flaps down greater than 25.
2. Throttles less than MIL power.
3. Inboard spoilers operational.
4. Pitch B, and yaw B computers operational.
5. Operable combined hydraulic pump.

NOTE: in this FSX rendition, DLC is only partially simulated. DLC will automatically deploy when proper conditions are met if wingsweep control is AUTO, or can be manually deployed if wingsweep in MANUAL mode by selecting the "fully extended" flaps position in FSX – see wingsweep section for more details.

2.24 DIGITAL FLIGHT CONTROL SYSTEM

The DFCS augments the aircraft natural damping characteristics and provides automatic commands for control of attitude, altitude, heading, and approach modes selected by the pilot. All DFCS functions are integrated into the primary flight control system. The DFCS also provides an Up and Away Automatic Rudder Interconnect (UA-ARI) to enhance departure resistance, spin recovery and high angle of attack flying qualities, and a Power Approach Automatic Rudder Interconnect (PA-ARI) to enhance the landing approach flying qualities.

The DFCS consists of three computers, one computer for each axis (pitch, roll, and yaw). Each computer has two distinct and independent processors called channels or segregations (one

A" and one B" channel per axis), each controlling one of the dual series servoactuators. All channels share data through cross channel data links.

DFCS controls and indicators are shown in figure 2-28.

NOTE: In this FSX rendition, DFCS is not properly simulated. Flight dynamics are modeled assuming the DFCS is active and working, regardless of the control switches and system status.

2.25 LANDING GEAR SYSTEMS

The aircraft has fully retractable, tricycle landing gear operated by combined hydraulic pressure in the normal mode of operation and a stored source of pressurized nitrogen for emergency extension. The landing gear retract forward so that airloads and gravity assist on emergency extension. Airoil shock struts with oil metering pins reduce landing loads transmitted to the airframe, and the struts are fully extended with the gear in the wells. All landing gear doors remain open with the gear extended. Design limit landing sink speed for the aircraft is 1,520 feet per minute (nominal landing sink speed is about 650 feet per minute).

NOTE: In this FSX rendition, emergency landing gear extension is provided by the cockpit hand pump (hydraulic system). Also, sink speed limit is set to 1800 feet per minute for the main landing gear and 1600 feet per minute for the nose landing gear.

2.25.1 Landing Gear Handle

The landing gear handle mechanically positions the landing gear valve for normal operation. Pulling the handle mechanically selects emergency extension of the gear using the pneumatic backup source. Both modes of gear operation can be accomplished without electrical power except for the gear position indication, which requires dc essential No. 2 bus power. Gear downlock actuators incorporate internal mechanical finger locks that maintain the downlock inserted position in the absence of hydraulic pressure. The landing gear handle contains other interlocks that are discussed under their respective systems such as weapons firing, jettison systems, APC, maneuvering flaps, and ground power system test panel.

Normal and emergency controls and displays associated with operation of the landing gear are shown in Figure 2-29.

2.25.2 Main Landing Gear

Each main landing gear shock strut consists of an upper outer cylinder and a lower internal piston, which has a maximum stroke of 25 inches. A hard step (31,000 pounds required for further compression) in the strut air curve provides a consistent 4-inch stroke remaining in the ground static condition. A side-brace link is mechanically extended from the inboard side of the strut outer cylinder to engage in a nacelle fitting and thus provides additional side load support for ground operations. The path of the wheel assembly is controlled by the drag brace as it folds (jackknives upwards) during gear retraction and unfolds during extension. The fully extended shock strut and jackknifed drag brace retracts forward and rotates the wheel assembly 90 to lie flat in the wheelwell. Inboard, outboard and aft main gear doors are individually actuated closed in sequence to provide fairing for the retracted gear.

An uplock hook on the shock strut engages a roller in the wheelwell to hold the gear in the retracted position. The main landing gear actuator on the inboard side of the shock strut retracts and extends the gear assembly.

The gear downlock actuator, mounted at the drag brace knee pin, extends to prevent unlocking (jackknifing) of the drag brace. Hydraulic pressure must be supplied to the downlock actuator in order to retract it against the spring action of the integral locking mechanism. A paint stripe across the drag brace knee pin provides an external visual indication of the drag brace locked condition. A ground lock device clamps onto the downlock actuator rod for safetying the main gear.

Maximum strut extension and wheel alignment are controlled by torque arms that incorporate cam-operated microswitches to detect a weight-on-wheels condition (greater than 5 inches of strut compression). The single split-type wheel assembly incorporates thermal fuse blow plugs and a pressure relief device to prevent overinflation of the tire.

CAUTION!

- **Illumination of indexer lights does not indicate that the main landing gear are clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.**
- **Illumination of indexer and approach**

lights is not an indication of gear down and locked.

2.25.3 Nose Landing Gear

The dual-wheel nose landing gear has a shock strut consisting of an outer cylinder and a lower internal piston that has a maximum stroke of 18 inches. During normal ground operations, the strut is fully extended. Pilot control is provided to kneel the strut (4 inches stroke remaining) for catapult operations (see Figure 2-30). During retraction, the fully extended nose strut is rotated forward by the retract actuator into the well and enclosed by two forward and two aft doors.

The forward doors are operated by a separate actuator that also engages the gear uplock, whereas the two aft doors are mechanically linked to the shock strut. An uplock hook actuator engages a roller on the lower piston to hold the gear and doors in the retracted position. During extension, the telescoping drag brace compresses so that a downlock actuator mechanically locks the inner and outer barrel to form a rigid member for transmission of loads to the airframe.

NOTE: Nose Strut Kneeling is not implemented in this FSX rendition.

2.25.4 Landing Gear Normal Operation

The landing gear handle is mechanically connected to the landing gear valve that directs combined hydraulic fluid into the gear-up and gear-down lines and provides a path for return flow. In the down position, the handle mechanically sets the hydraulic isolation switch to provide hydraulic pressure for gear operation. The handle is electromechanically locked in the down position with weight on wheels to prevent inadvertent gear retraction. Pilot override of the solenoid-operated handle lock can be effected by lifting the downlock lever next to the gear handle. Vertical movement of the gear handle causes a corresponding up and down selection of the landing gear with the combined hydraulic system pressurized. Three flip-flop indicators provide a position display for each of the landing gear, and a gear transition light on the control panel illuminates anytime the gear position and handle do not correspond. In addition, a WHEELS warning light alerts the pilot if the landing gear is not down with flaps deflected greater than 10 and either or both throttles set for less than approximately 85-percent rpm.

CAUTION!

- **Unless attempting fast-cycle troubleshooting for gear that indicates unsafe nosegear down, transition light illuminated, wait for gear to completely transition (15 seconds with normal hydraulic pressure) before recycling the landing gear handle. When fast cycling the gear handle, the pilot must immediately return the gear handle to the down position to avoid damaging the main landing gear doors and inducing a possible combined hydraulic or brake system failure.**
- **Maximum landing gear tire speed is 190 knots.**

2.26 WHEELBRAKE SYSTEM

The wheelbrake system provides power boost hydraulic control of the multiple disk-type main wheelbrakes using pressurized fluid in the landing gear down line from the combined hydraulic system. Individual or collective wheelbrake control can be modulated by depression of the rudder toe pedals, or collective, unmodulated brake control is available with the parking brake. An antiskid system is provided to operate electrohydraulically in conjunction with the normal wheelbraking mode. Brake pedal and parking brake control motions are mechanically transmitted to the power brake module together with the antiskid valve. Separate hydraulic lines transmit normal and emergency fluid pressure from the power brake module to the left and right wheelbrake assemblies. At each brake assembly, the normal and emergency lines input fluid to the brake shuttle valve, which applies brakes as a function of normal or emergency line fluid pressure. Two wear-indicator pins on the brake piston housing measure lining wear for preflight inspection. For new brakes, these pins extend approximately one-half inch above the piston housing. When the pin is flush with the piston housing with the parking brake applied, the brake assembly is worn to the point of replacement.

2.26.1 Parking Brake

The parking brake mode provides a means for collective locking of the wheelbrakes to maintain a ground static position during normal operations or during emergency conditions.

Aft movement of the parking brake handle provides for unmodulated porting of accumulator fluid pressure through emergency lines to the shuttle valve at the wheelbrake assembly. In the

parking brake mode, the brake pedals have no effect on wheelbrake operation. Pushing the parking brake handle forward releases wheelbrake pressure and the power brake module reverts to the normal and auxiliary braking mode.

2.27 NOSEWHEEL STEERING SYSTEM

The electrohydraulic nosewheel steering system provides for on-deck aircraft directional control, nosewheel shimmy damping, and nosewheel centering. The power unit is located on the lower portion of the nose landing gear strut outer cylinder, which, through a ring gear, controls the directional alignment and damping of the lower piston assembly.

NOTE: Nosewheel steering system is automatically engaged and disengaged in this FSX rendition.

2.28 NOSEGEAR CATAPULT SYSTEM

Catapult connection components on the nose landing gear shock strut piston provide nosegear catapult capability.

A launch bar attached to the forward face of the nosegear steering collar guides the aircraft onto the catapult track and serves as the tow link that engages the catapult shuttle. A holdback fitting secures the holdback restraint prior to launch.

The two-piston nose strut uses the stored energy catapult principle to impart a positive pitch rotation movement to the aircraft at shuttle release, thus providing for a hands-off launch fly-away technique.

2.28.1 Nose Strut Kneel

Prior to catapult hookup, the nose strut is compressed 14 inches. Control of the nose strut kneel function is provided by the NOSE STRUT switch on the landing gear control panel. The three-position (EXTD, OFF, and KNEEL) toggle switch is spring-loaded to return to the center detent position of OFF. The position of the strut remains in the last commanded position independent of electrical or hydraulic power interruptions. In both cases, the transfer control valve source of electrical power is the essential No 2 bus and combined hydraulic system fluid is used as the transfer medium. With external electrical power

on the aircraft, the combined hydraulic system must be pressurized (>500 psi) before the control switch can command a position change of the transfer control valve. The control switch need only be held momentarily to effect a change in transfer control valve position.

Selection of KNEEL releases hydraulic fluid from the shock strut transfer cylinder to the combined hydraulic system return line, causing the weight of the aircraft to compress the shock strut 14 inches. Stroking of the nose strut causes the aircraft to rotate about the main wheels. The aircraft may be taxied or towed in the strut-kneeled position except for the nuisance trip of the launch bar at greater than 10 steering angle; this is the position used for taxiing onto the catapult and enhances accessibility to the forward fuselage compartments during ground maintenance. Since the nose strut is bottomed during the catapult launch stroke, the energy stored in the last 4 inches of strut-piston stroke is released upon shuttle release at the end of the catapult stroke to impart a noseup pitching moment to rotate the aircraft to the fly-away attitude without any control required by the pilot. All the stored energy is expended before the nosewheels leave the deck edge.

Note: Nose Strut Kneel function is not simulated in this FSX rendition, although the NOSE STRUT switch can be operated.

2.28.2 Launch Bar

The launch bar is attached to the nose gear and serves as the tow link for catapulting the aircraft. With the nose strut extended, the launch bar is held in the retracted position. The launch bar can be lowered by kneeling the aircraft and turning the nosewheel greater than $\pm 10^\circ$ from the centered position. The launch bar can also be lowered by the deck crew with no pilot action after the aircraft has been kneeled. A proximity sensing switch on the uplock detects the latch out of the locked position and illuminates the LAUNCH BAR advisory light. Ears on the head of the launch bar engage under the lip of the catapult lead-in track and the head serves as a guide to steer the nosewheel on the catapult track and engage the shuttle. For an abort, the launch bar cannot be raised until the shuttle is disengaged.

NOTE: In this FSX rendition, launch bar operation is implemented as standard FSX:A launch bar. Refer to FSX:A documentation for operation. If the launch bar does not retract automatically after launch, pilot is required to manually command the retraction.

2.28.3 Holdback Fitting

The holdback fitting is provided on the nose strut for insertion of the holdback bar. Groundcrew must manually attach the bar before the aircraft

is taxied into the catapult lead track. The holdback bar is reusable and provides for repeated releases at a tow force of 76,000 pounds. Force greater than this on launch causes the holdback bar to release the aircraft holdback fitting.

Single-engine, high-power turnup operations can use the holdback fitting to attach aircraft restraining hardware to deck-secured fittings. Prior to the application of single engine high power, the nose strut should be kneeled and slack taken out of the holdback mechanism, otherwise dynamic loads may exceed mechanism design strength conditions.

NOTE: Holdback bar is not implemented in this FSX rendition

2.29 ARRESTING HOOK SYSTEM

The arresting hook installation consists of a stinger tailhook and associated control mechanism mounted to the underside of the center fuselage. The hook shank is free to pivot up and down at its attachment point. A pneumatic dashpot preloads the hook down to minimize hook bounce on contact with the deck. The hook shank is free to pivot left or right within a $\pm 26^\circ$ sway angle with positive centering action provided by a pneumatic damper housed inside the tailhook shank. The trail angle of the arresting hook provides for hookpoint-deck contact even with the nose landing gear strut fully compressed.

2.29.1 Arresting Hook Operation

Normal operation of the arresting hook requires combined and flight hydraulic system pressure, dashpot charged, and dc essential No. 2 electrical power. Because of a redundant means of pilot control (electrical and mechanical), emergency extension of the arresting hook can be accomplished without these sources of power.

Note

Hook retraction requires electrical and combined hydraulic power.

NOTE: In this FSX rendition, tailhook operation is implemented as standard FSX:A tailhook. Refer to FSX:A documentation for operation.

2.30 ENVIRONMENTAL CONTROL SYSTEM

The ECS regulates the environment of flightcrew and electronic equipment. The system provides temperature-controlled, pressure-regulated air for the following systems.

1. External drop tank pressurization

2. OBOGS
3. Cockpit pressurization
4. Canopy seals
5. Windshield and canopy defogging
6. Windshield ant-ice
7. Anti-g suit inflation
8. Wing airbag seals
9. Gun-gas purging
10. Electronic equipment cooling and pressurization
11. Temperature control of liquid coolant supplied to APG-71 radar control system, television camera set, and infrared search and track.

NOTE: The ECS is not implemented in this FSX rendition.

2.31 OXYGEN SYSTEM

Breathing oxygen is provided to each crewmember by the OBOGS. A backup oxygen system provides a supply of gaseous oxygen sufficient for a maximum range descent in the event of a failure of the OBOGS. In addition, emergency oxygen is available to each crewmember through a high-pressure, gaseous oxygen bottle located in the ejection seat survival kit.

NOTE: OBOGS has no function in this FSX rendition.

2.32 PITOT-STATIC SYSTEM

The pitot-static pressure system supplies impact (pitot) and atmospheric (static) pressure to the pilot and RIO flight instruments, to the CADC, and to the engine AICS program mers. Some systems require static pressure only; others require static and pitot pressure (see Figure 2-31).

The pitot-static system is composed of two separate systems with individual pitot-static probes, one on each side of the forward fuselage.

The left pitot pressure (PT) probe supplies the pilot standby airspeed indicator and the left AICS programmer. The right pitot pressure (PT) probe supplies the RIO standby airspeed indicator, the right AICS programmer, and the CADC with airspeed indications. An electrical PT input from the left AICS programmer is supplied to the CADC backup channel as airspeed indications for wing sweep.

The left and right forward static ports (PS1) are manifolded to provide static pressure to the pilot standby airspeed indicator, standby altimeter, vertical speed indicator, and the CADC. Static pressure from the right aft (PS2) static ports

supply the RIO standby airspeed indicator, standby altimeter, and the right AICS programmer. The static pressure from the left aft (PS2) static ports supply the static pressure to the left AICS PS sensor. An electrical PS input from the left AICS programmer is supplied to the CADC backup channel for wing sweep. Static pressure from the left aft (PS2) static ports supply the left AICS programmer.

The CADC and AICS programmers provide Mach number information to the digital flight control computers (DFCCs). The alpha computer, angle of attack probe (used for displaying angle of attack to the pilot), and the AICS programmers provide angle of attack information to the DFCCs.

Note:

With the in-flight refueling probe extended, the pilot and RIO standby altimeters and air speed indicators may show erroneous readings because of changes in airflow around the pitot-static probes.

The RUDDER AUTH caution light may illuminate when the in-flight refueling probe is extended. Press the MASTER RESET button to reset the light.

2.32.1 Pitot-Static Heat

Each pitot-static probe is equipped with electrical heating elements to prevent icing. Pitot-static heat is controlled by the pilot through the ANTI-ICE switch on the pilot right console. In AUTO/OFF, pitot probe heat is available only with weight off wheels. ORIDE/ON activates the probe heat elements independently of the weight-on-wheels switch and illuminates the INLET ICE caution light on the CAUTION ADVISORY panel. OFF/OFF removes heat from the probes.

2.33 CONTROL AND DISPLAY SYSTEM

The control and display system (Figure 2-32) provides the crew with navigation, aircraft status, and flight tactical information. The control and displays system consists of two display processors (DP1 and DP2), three multifunction displays (pilot center MFD1, pilot right MFD2, and RIO MFD3), and a heads-up display system, cockpit television sensor, HUD-VIDEO panel, pilot displays control panel, and a multistatus indicator.

The control and display system also sends display information to the digital display, the radio frequency indicator, radio frequency/control indicator, and the mission video recorder. The data entry unit is a remote terminal that communicates with the mission computers via

the multiplex buses.

2.33.1 Heads-Up Display (HUD)

The HUD provides a combination of real-world cues and flight direction symbology, projected directly on a combining glass assembly. The flight information on an optical combiner is projected in the pilot forward field of view. The display is focused at infinity, thereby creating the illusion that the symbols are superimposed on the real world (and so that visual cues received from outside the aircraft are not obscured). The pilot usually steers based on interpretation of the visually observed real world. The HUD can be selected to be the primary flight reference for all flight regimes displaying navigation and weapon delivery information. The HUD symbol brightness control is on the HUD; all other HUD controls are on the PDCP.

2.33.2 Multifunction Displays (MFD)

The three identical MFDs are CRT displays with 20 pushbuttons around the perimeter of the display screen. The MFD pushbuttons with adjacent legends are used for menu selection, data entry/readout, and system test and/or status indications. The three programmable MFDs, two in the pilot instrument panel and one in the RIO instrument panel provide display flexibility such that either crewmember is able to select any display available, allowing the pilot and RIO to monitor and back up each other. The HUD format may be repeated on any MFD by depressing pushbutton No. 11 from the MENU1 format. Multifunction pushbuttons with adjacent CRT legends located around the perimeter of the MFD are used for menu selection, data entry/readout, and system test and/or status indications. An MFD displays tactical and flight command situations, navigation, and discrete information either separately or simultaneously with radar and TV data.

Normally the pilot uses the MFD below the HUD on the aircraft centerline as the primary in-the-cockpit flight instrument.

Attitude information is displayed on the MFD VDI format by an aircraft reticle, a horizon line, and a calligraphic pitch ladder. The aircraft reticle is fixed at the center of the display, and the horizon line and pitch ladder move about it in accordance with the aircraft pitch and roll attitudes.

velocity.

Note

If pitch or roll data is not updated within 240 milliseconds, the pitch ladder and roll marker will be blanked and the horizon, sky, and ground

plane will darken.

NOTE: This FSX rendition implements a bespoke MFD system that closely resembles the real-life MFD system of the F-14D. However, some pages are inoperative and some others are cosmetic only.

2.33.3 HUD Formats

HUD format category (TLN, A/A, A/G) is normally selected by use of MODE buttons on the PDCP. However, air-to-air formats are selected automatically if the pilot selects a weapon using the weapon select switch on the stick grip; selects RDR PLM/PAL, IR PLM/PAL (all with gear up) with the sensor mode switch; lifts the ACM guard; or if VSL HI/VSL LO is selected with the sensor mode switch or DD.

Air-to-ground formats are automatically selected when an air-to-ground weapon is selected on the SMS format. The HUD default format is the TLN basic format (Figure 2-33).

This format is displayed on power-up and if DP1 experiences a cold start (power outage of over 1 second).

The amount of information displayed on HUD formats is pilot selectable by means of the FORMAT and DECLUT TER switches on the PDCP. Symbols are also added or deleted by the mission computer depending on aircraft status, steering mode, and weapon selection. When the FORMATS switch is set to BOTH, airspeed and altitude information are displayed as boxed digital readouts with analog dials. In the ANLG position, the boxes are removed from the digital readouts. In the DGTL position, only the boxed digital readout is presented and the analog dials are removed.

The position of the HUD/VDI ALT switch on the PDCP selects the type of altitude data that is to be displayed, either radar or barometric.

2.34 DATA ENTRY UNIT

The DEU on the RIO right vertical console provides manual data entry and control of certain mission functions. The DEU is a remote terminal that communicates with the mission computers via the multiplex buses.

NOTE: Data Entry Unit is not implemented in this FSX rendition.

2.35 FLIGHT INSTRUMENTS

2.35.1 Standby Attitude Indicator

A 3-inch standby gyro horizon indicator on the left side of the pilot instrument panel and another on the left side of the RIO instrument panel are

for emergency use should the system (INS or SAHRS) attitude information become unreliable. It is a self-contained, independent gyro that displays aircraft roll and pitch from the horizontal and includes a standard turn-and-slip indicator. The presentation consists of a miniature aircraft viewed against a rotating gray and black background, which represent sky and ground conditions, respectively. Caging should be accomplished at least 3 to 4 minutes before takeoff to allow the spin axis to orient to true vertical.

An OFF flag appears on the right side of the instrument face when power is removed or when the gyro is caged, but the gyro is capable of providing reliable attitude information for up to 3 minutes after a complete loss of power. The gyro can be manually caged by pulling the pitch trim knob on the lower right corner of the instrument.

2.35.1.1 Turn-and-Slip Indicator

The standby attitude indicator includes a standard needle and ball turn-and-slip indicator. The pointer is tested when the TEST button is pressed and it deflects to the right and lines up with the fixed marker.

2.35.2 Standby Airspeed Indicator

The standby airspeed indicator on the pilot and RIO instrument panels is a pitot-static instrument that displays indicated airspeed from 0 to 800 knots. The indicator is graduated in 10-knot increments up to 200 knots, then in 50-knot increments.

Note

The indicated airspeed displayed is not corrected for position error.

2.35.3 Standby Altimeter

Both the pilot and RIO standby altimeters display altitude up to 99,000 feet on the five-digit counter but only the left two digits are moveable. The pointer moves about a dial calibrated from 0 to 1,000 feet in 50-foot increments.

A BARO setting knob, on the bottom left, is used to set in the local atmosphere pressure (INCHES HG) between 28.10 to 30.99 inclusive. The four-digit counter displays the BARO setting. The BARO setting from the pilot standby altimeter is provided to the mission computers via the

converter interface unit and can be displayed on the HUD and the MFDs.

2.35.4 AN/APN-194(V) Radar Altimeter System

The radar altimeter is a low-altitude (0 to 5,000 feet), pulsed, range-tracking radar that measures the surface or terrain clearance below the aircraft. Altitude information is developed by radiating a short-duration radio frequency pulse from the transmit antenna to the Earth's surface and measuring elapsed time until radio frequency energy returns through the receiver antenna. The altitude information is continuously presented to the pilot, in feet of altitude, on an indicator dial.

The system also outputs a digital signal for display of radar altitude on the HUD from 0 to 5,000 feet during takeoff and landings. Reliable system operation in the altitude range of 0 to 5,000 feet permits close altitude control at minimum altitudes.

The system will operate normally in bank angles up to 45° and in a climb or dive except when the reflected signal is too weak.

Note

Radar altimeter can read as much as 100 feet higher than actual altitude when operating over water.

2.35.5 Vertical Velocity Indicator

The vertical velocity indicator on the left side of the pilot and RIO instrument panel is a sealed case connected to a static pressure line through a calibrated leak. It indicates rate of climb or descent. Sudden or abrupt changes in attitude may cause erroneous indications because of the sudden change of airflow over the static probe.

2.35.6 Standby Compass

A conventional standby compass is above the pilot instrument panel. It is a semifloat-type compass suspended in compass fluid.

2.35.7 Clock

A mechanical 8-day clock is on the instrument panel in each cockpit. It incorporates a 1-hour elapsed-time capability.

A winding and setting selector is in the lower left corner of the instrument face. The knob is turned in a clockwise direction to wind the clock and pulled out to set the hour and minute hands. An elapsed time selector in the upper right corner controls the elapsed time mechanism. This mechanism starts, stops, and resets the sweep second and elapsed time hands.

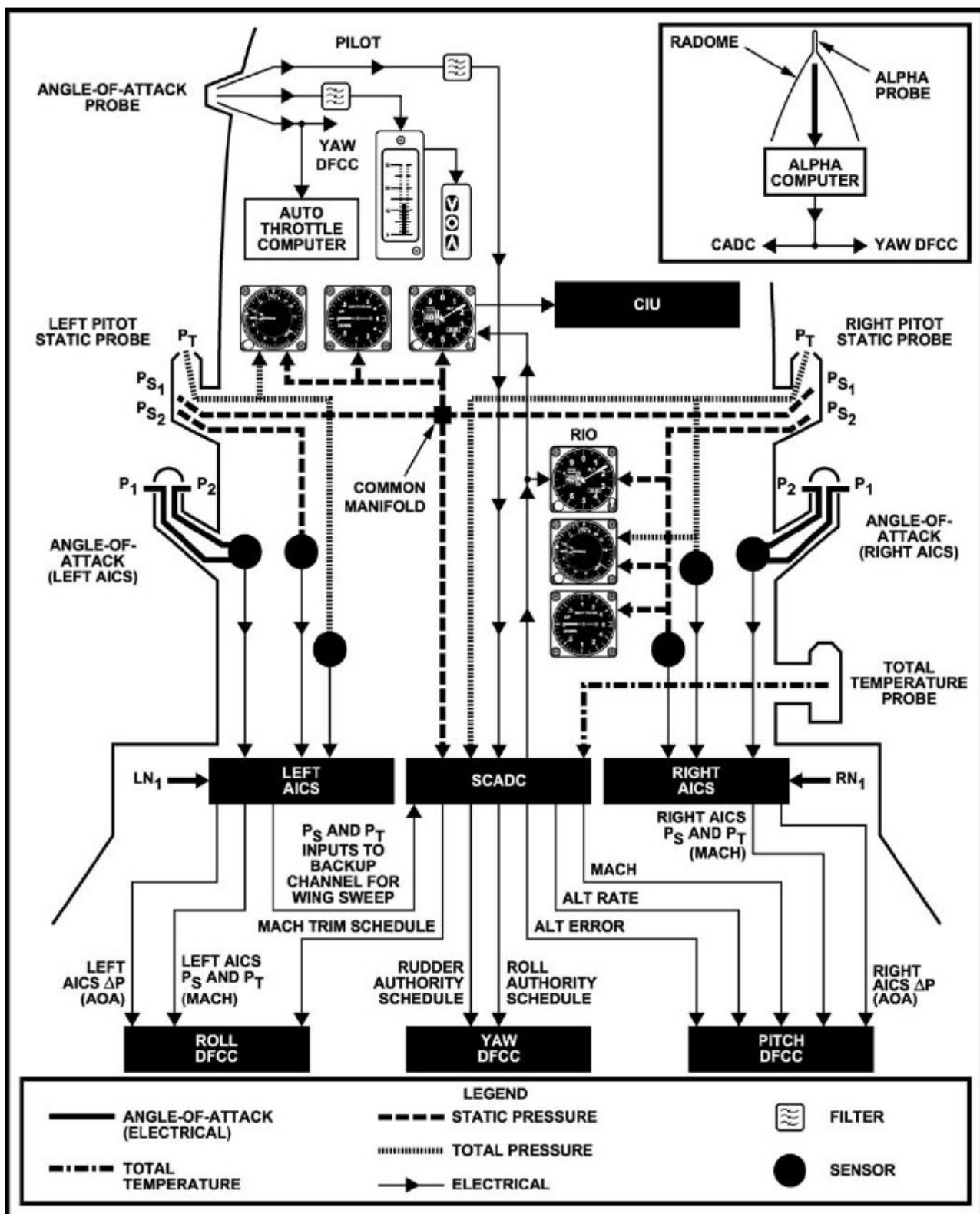


Figure 2-31 Airstream sensors

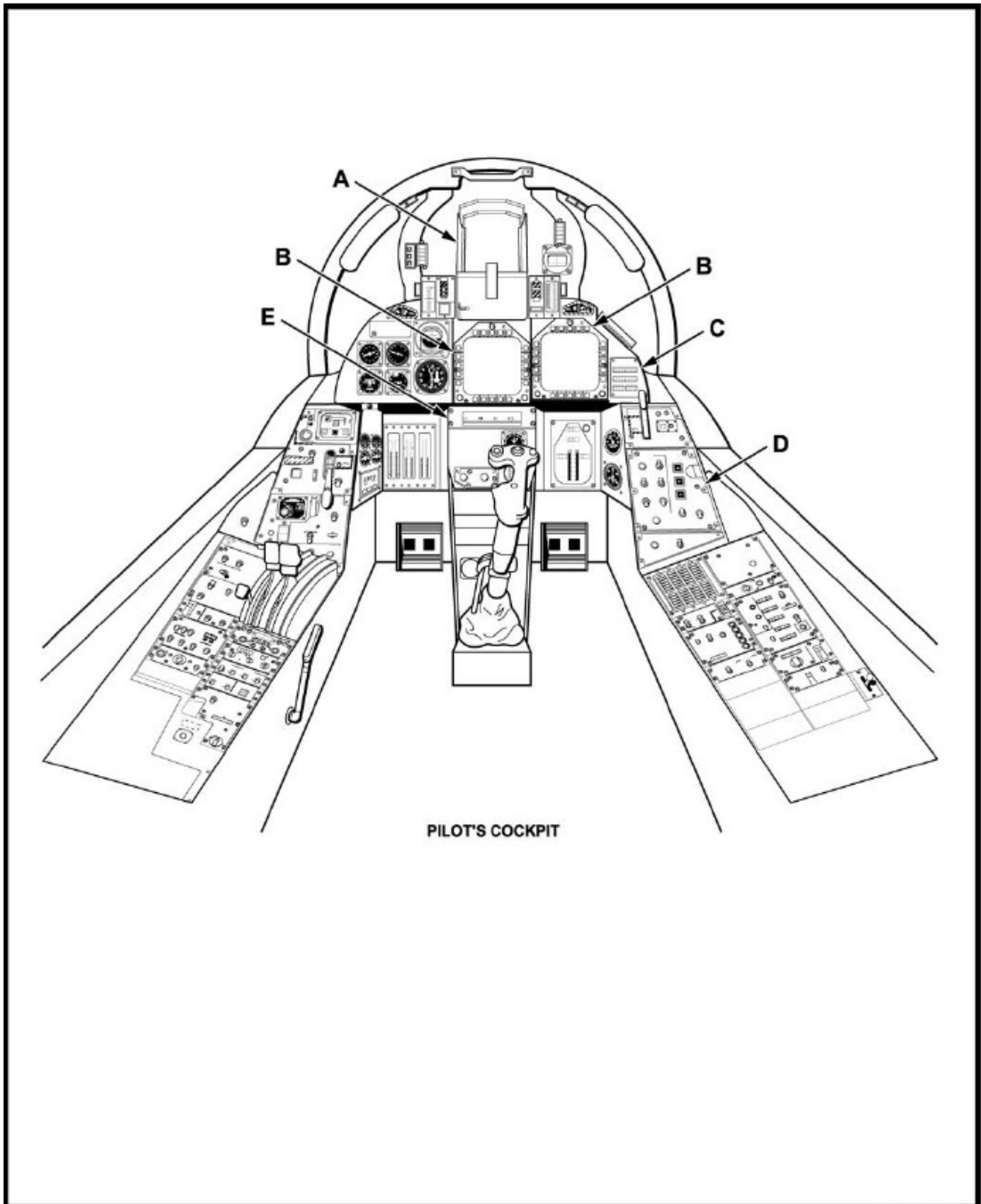


Figure 2-32 Display Systems Controls and Indicators (Sheet 1 of 4)

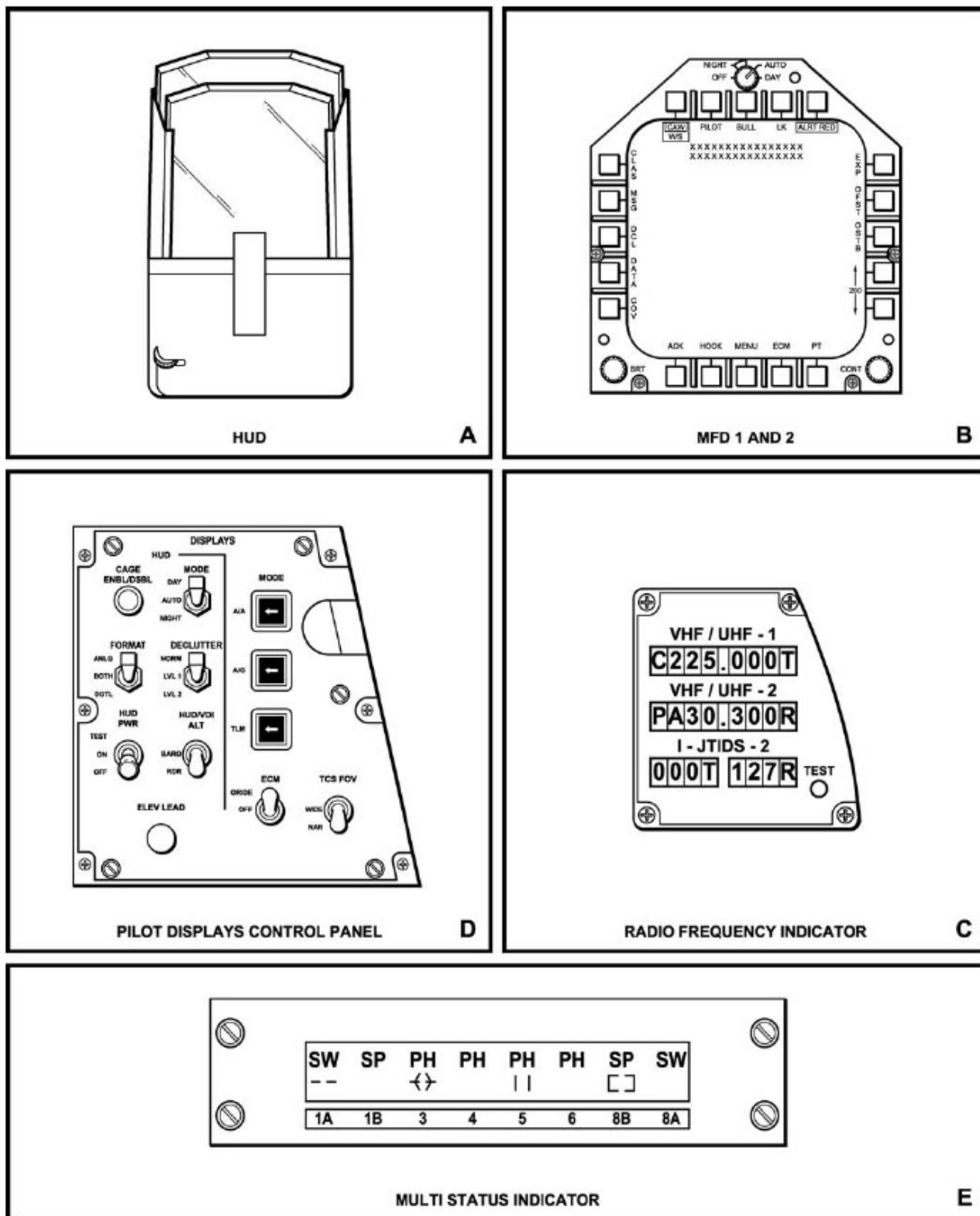


Figure 2-32 Display Systems Controls and Indicators (Sheet 2 of 4)

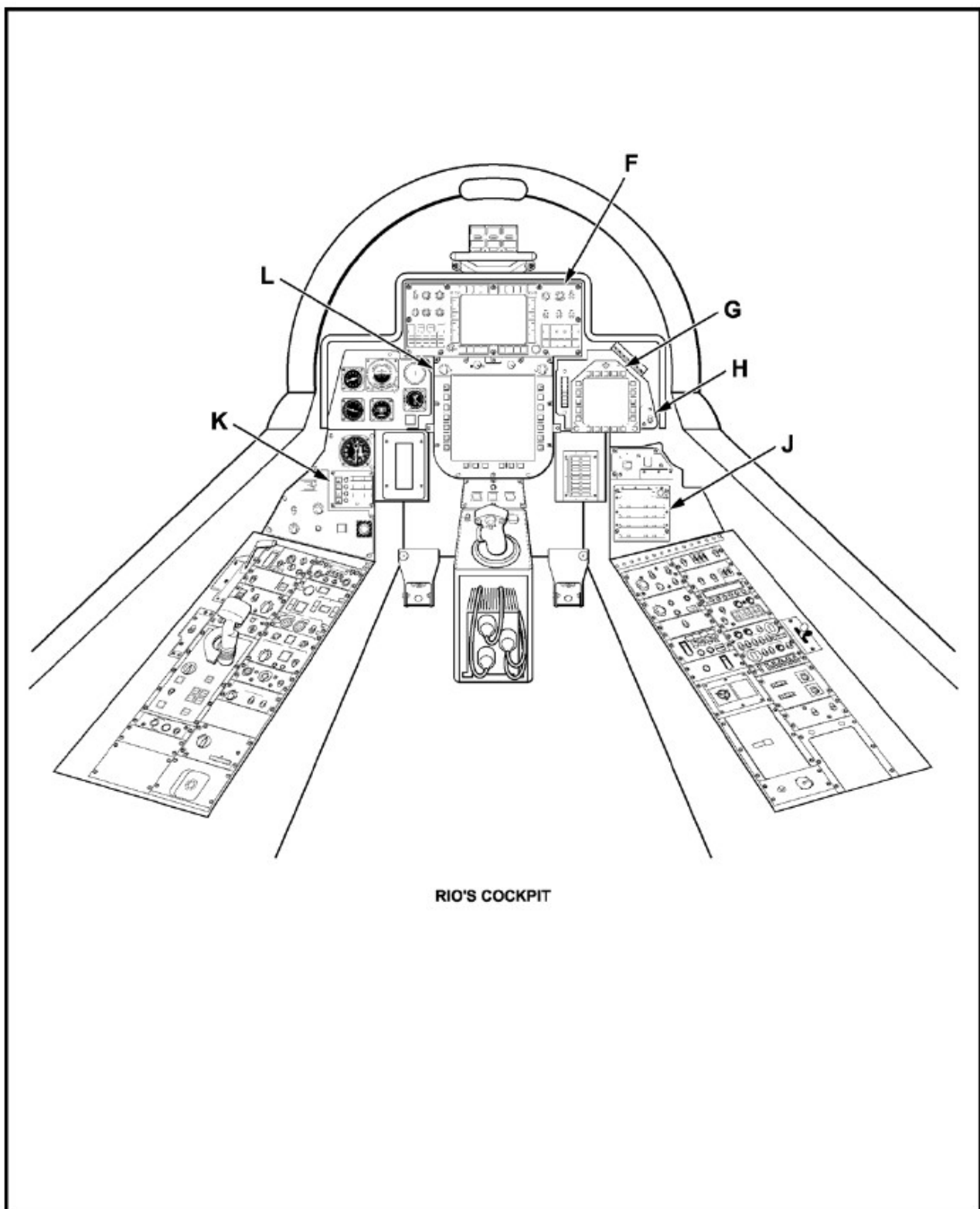


Figure 2-32 Display Systems Controls and Indicators (Sheet 3 of 4)

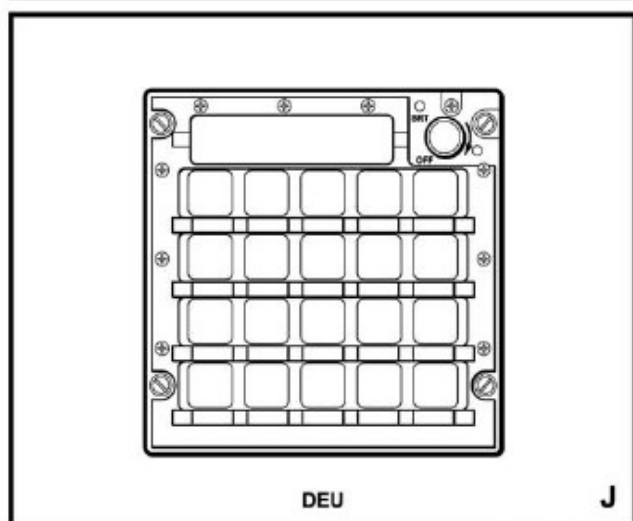
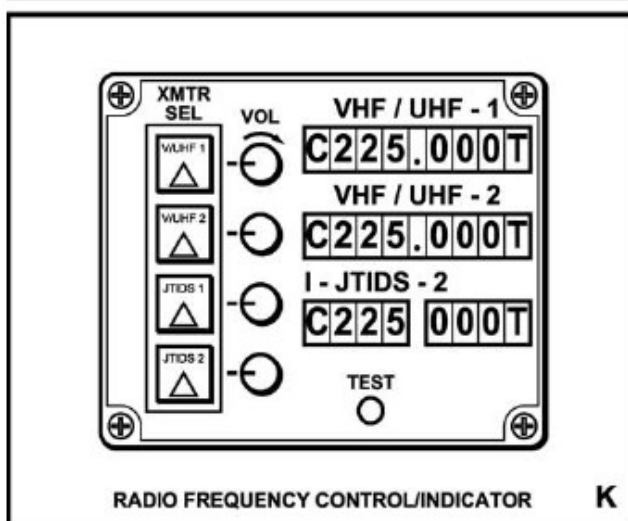
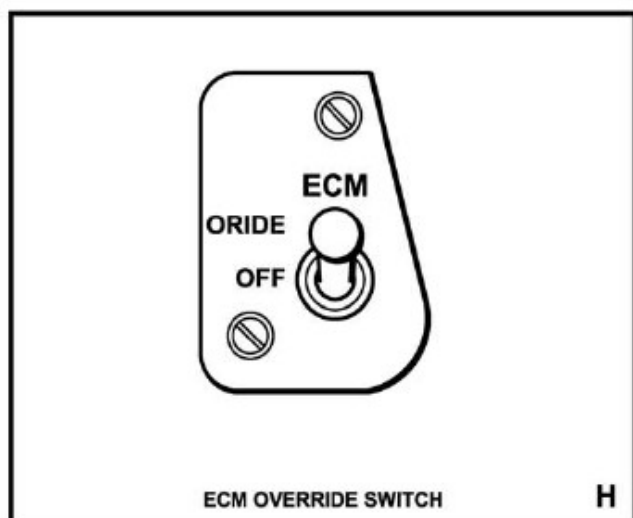
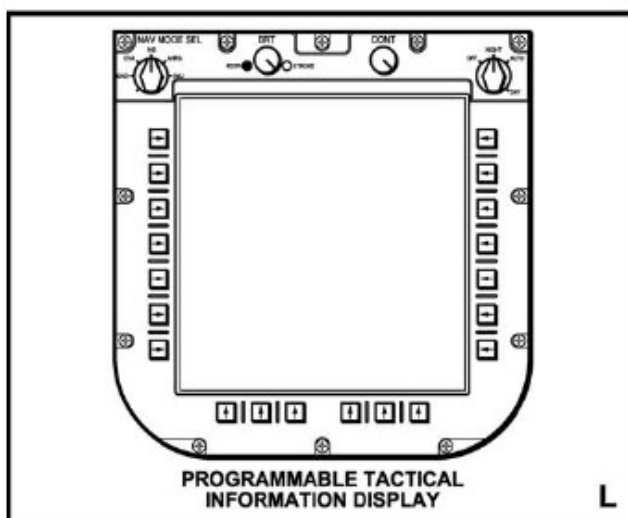
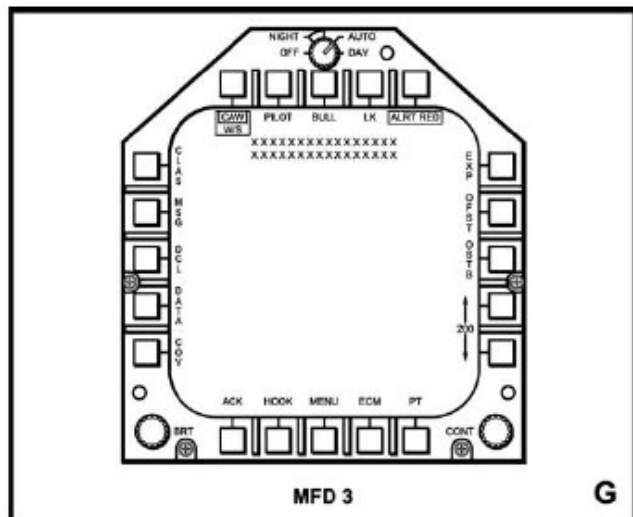
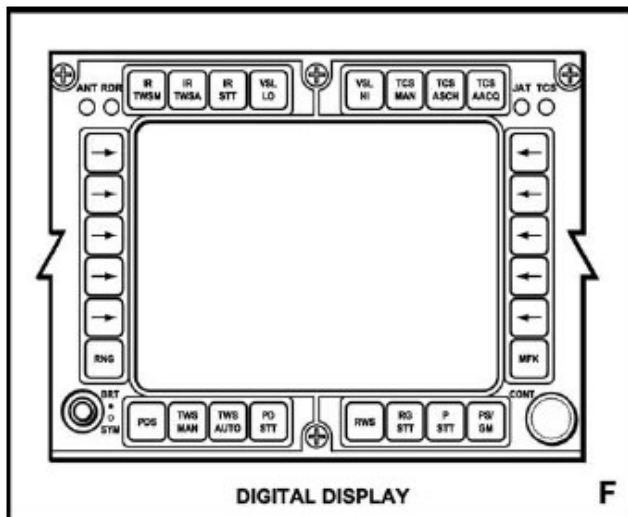
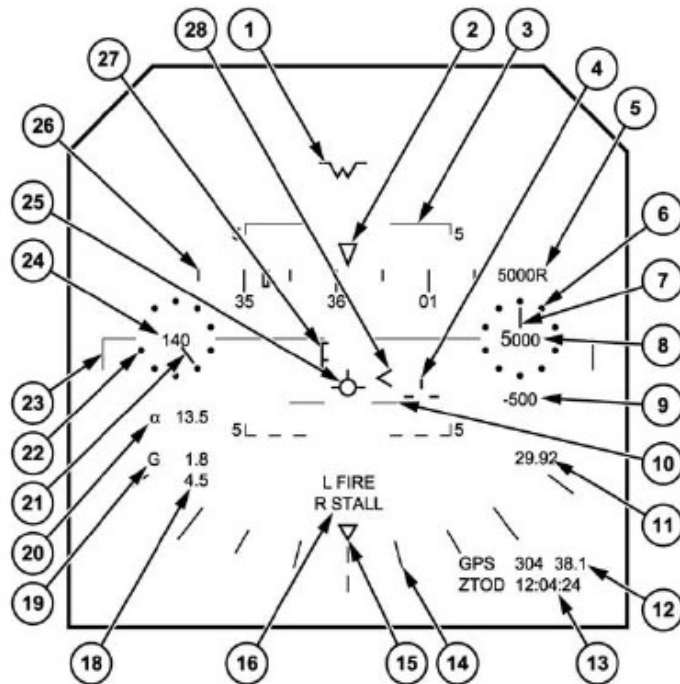


Figure 2-32 Display Systems Controls and Indicators (Sheet 4 of 4)

GEAR DOWN - ANALOG



GEAR UP - ANALOG

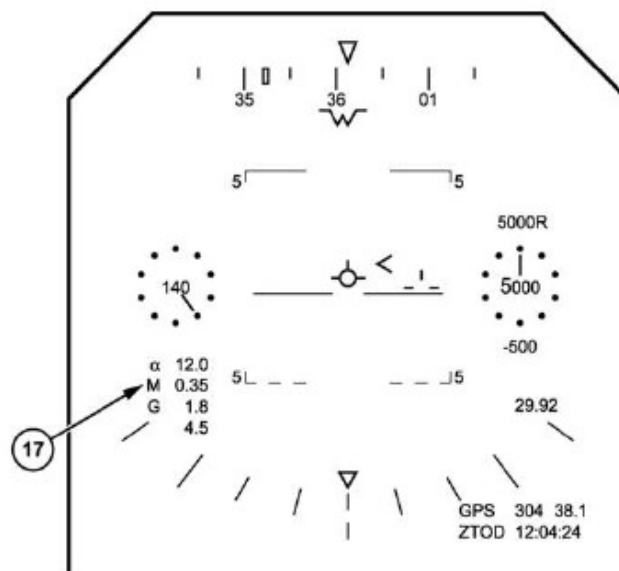


Figure 2-33 HUD TLN Basic Format (Sheet 1 of 4)

SYMBOL	FUNCTION
① Water line	Indicates fuselage reference line (FRL). Displayed when attitude information is not valid. Also displayed when gear down or the flight path marker is at, or beyond the HUD's full field of view.
② Heading pointer	Actual aircraft heading is displayed below the stationary heading pointer.
③ Pitch/flight path ladder	Ladder displays aircraft climb/dive angle and roll angle. Aircraft vertical flight path angle is indicated by the position of the flight path marker on the pitch/flight path ladder. Positive pitch lines are solid and negative pitch lines are dashed. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flight path angle. For example, in a 40° climb, the pitch lines are angled 20° toward the horizon. "Up" appears at +90° and "down" appears at -90°.
④ Ghost flightpath marker	Displayed at the true velocity vector position when the flight path marker is caged and the true velocity vector position differs from the caged position in azimuth. When the true flight path marker position is actually outside the HUD total field of view, the symbol will be pegged at the edge of the total FOV and flash.
⑤ Radar altitude indicator	Displays radar altitude when the aircraft is below 5000 feet AOL and bank angle is less than 45°. If RDR is selected as the altimeter source and valid radar altitude exists, the radar altitude is displayed within the dial, replacing the barometric altitude. An R is displayed to the right of dial to indicate radar altitude. If BARO is selected and a valid radar altitude exists, radar altitude is displayed above the altitude dial or box.
⑥ Altitude analog dial	The HUD analog altimeter consists of ten dots encircling the altitude read-out. Each dot indicates altitude in hundreds of feet with the zero mark located at the top center of the dial.
⑦ Altitude pointer	An analog pointer indicating altitude moves uniformly around the inside of the altitude dial based on indicated altitude. Increasing altitude is indicated by clockwise rotation of this pointer.
⑧ Digital altitude readout	Digital barometric, radar, or GPS altitude is displayed depending on the source of the data. When the ALT switch is in the BARO position, barometric altitude is displayed. When the ALT switch in the RDR position and if aircraft altitude is 5000 feet or lower, radar altitude is displayed within the dial and is identified by an R to the right of the least significant digit. If the radar altitude becomes invalid by exceeding 5000 feet or 45° AOB, barometric altitude is substituted and a B will flash to indicate that barometric altitude is being displayed rather than radar altitude. A G is only displayed when SCADC altitude becomes invalid and the GPS altitude is used. The G acronym will flash if RADALT is selected and both SCADC and radar altitude are invalid.
⑨ Vertical velocity readout	The vertical velocity readout consists of a maximum of five digits for a positive vertical velocity indication and a maximum of four digits with a leading minus sign for a negative vertical velocity indication. If the limit 32,999 or -9,999 is exceeded, a minus sign with four X's (-XXXX) is displayed. It is displayed below the six o'clock dot of the altitude dial.

Figure 2-33 HUD TLN Basic Format (Sheet 2 of 4)

SYMBOL	FUNCTION
10 Negative three degree marks	Indicates the negative 3 degree position on the pitch ladder.
11 Barometric pressure setting	The barometric pressure setting used by the display system and the weapon system is the value set on the pilot's barometric altimeter. The setting will be displayed for up to 5 seconds on the HUD and VDI in the TLN mode when the setting is changed. At 18,000 feet, if it is off, the symbol comes on and blinks for 5 seconds.
12 Navigation source and range readout	WPT, GPS or TCN; waypoint number, range.
13 Clock/timer readout	Derived from the GPS clock. Default time is ZTOD. Options selectable from the HSD ZTOD pushbutton are ZTOD, TTG, TTGT, TREL, ETA, ET and CD.
14 Bank scale	Provides indication of bank angle to $\pm 45^\circ$. Tick marks are provided at 0° , $\pm 10^\circ$, $\pm 20^\circ$, $\pm 30^\circ$ (slightly larger) and $\pm 45^\circ$.
15 Bank angle pointer	Moving pointer provides indication of aircraft bank angle. At bank angles in excess of $\pm 45^\circ$, the pointer will be pegged at $\pm 50^\circ$ and will flash.
16 Warning/caution/advisory readout	The warnings L STALL, R STALL, L FIRE, R FIRE, and RDC SPEED and the CLSN advisory will appear on the HUD in the steady condition. Up to two indications may be displayed at any one time. When more than two indications are present, they scroll up from the bottom at the rate of one per second.
17 Mach number	Indicates speed of the aircraft in mach.
18 Peak aircraft g	Peak Aircraft g is displayed on the HUD as follows; TLN Gear Down: If aircraft g falls below +0.0 or exceeds +2.0. TLN Gear Up, A/A, A/G: If aircraft g falls below -2.0 or exceeds +4.5. Peak g indication is displayed until a declutter mode is cycled.
19 Aircraft g	Aircraft g is displayed on the HUD as follows; TLN Gear Down: If aircraft g falls below +0.5 or exceeds +1.5. TLN Gear Up, A/A, A/G: If aircraft g falls below -2.0 or exceeds +4.5.
20 Angle of attack	Indicates angle of attack in units. Note When the TLN gear down format is displayed, the AOA readout is removed when AOA is between 14 and 16 units. If AOA is greater than 14 units and decreasing, the readout remains off until AOA decreases below 13 units. If AOA is less than 16 units and increasing, the readout remains off until AOA increases above 17 units.
21 Airspeed pointer	An analog pointer indicating airspeed moves uniformly around the inside of the airspeed dial based on indicated airspeed. Increasing airspeed is indicated by clockwise rotation of the pointer.
22 Airspeed dial	The HUD analog airspeed dial consists of ten dots encircling the airspeed readout. Each dot indicates airspeed in tens of knots with the zero mark located at the top center of the dial.
23 Extended horizon line	Represents the horizon with respect to the aircraft and changes orientation with any change in aircraft pitch or roll.

Figure 2-33 HUD TLN Basic Format (Sheet 3 of 4)

SYMBOL	FUNCTION
(24) Digital airspeed readout	Provides digital readout of calibrated airspeed.
(25) Flight path marker	The flight path marker is displaced in azimuth and elevation to present computed flight path. Aircraft vertical flight path angle is indicated by the position of the flight path marker on the pitch/flight path ladder. In the caged mode, the flight path marker is caged in azimuth and the true flight path marker position is indicated by the display of the ghost flight path marker when the true position is more than 2° from the caged position. The flight path marker can be caged or uncaged by alternately pressing the CAGE/SEAM switch. On selection of TLN or A/A, the flight path marker is initially caged; selection of A/G presents the uncaged mode initially.
(26) Heading scale	Aircraft magnetic heading is indicated by the moving 360° heading scale. In TLN, the major divisions are numbered every 10 degrees. In A/A, the major divisions are numbered every 20 degrees. Note When the aircraft is in the TLN mode with the gear handle down, the heading scale remains 2 degrees above the position of the flight path marker. The lowest point of the heading scale, including the numbers, will never rise above the normal (gear up) position. The heading scale is occluded by the altitude and airspeed dials and readout.
(27) Angle of attack bracket	The AOA bracket is a pitch related variable that indicates the deviation of the current AOA from a desired value and is vertically referenced to the left wing of the flight path marker symbol. The center of the bracket represents the optimum AOA. The bracket moves lower with respect to the flight path marker as AOA increases and it moves higher as AOA decreases.
(28) Potential flight path marker (PFPM)	Indicates the acceleration along the flight path marker. Provides a graphical representation of the ability to change the flight path angle by varying the thrust acceleration and/or angle of attack. Deceleration is indicated by the PFPM below the flight path marker and acceleration by the PFPM above the flight path marker.

Figure 2-33 HUD TLN Basic Format (Sheet 4 of 4)

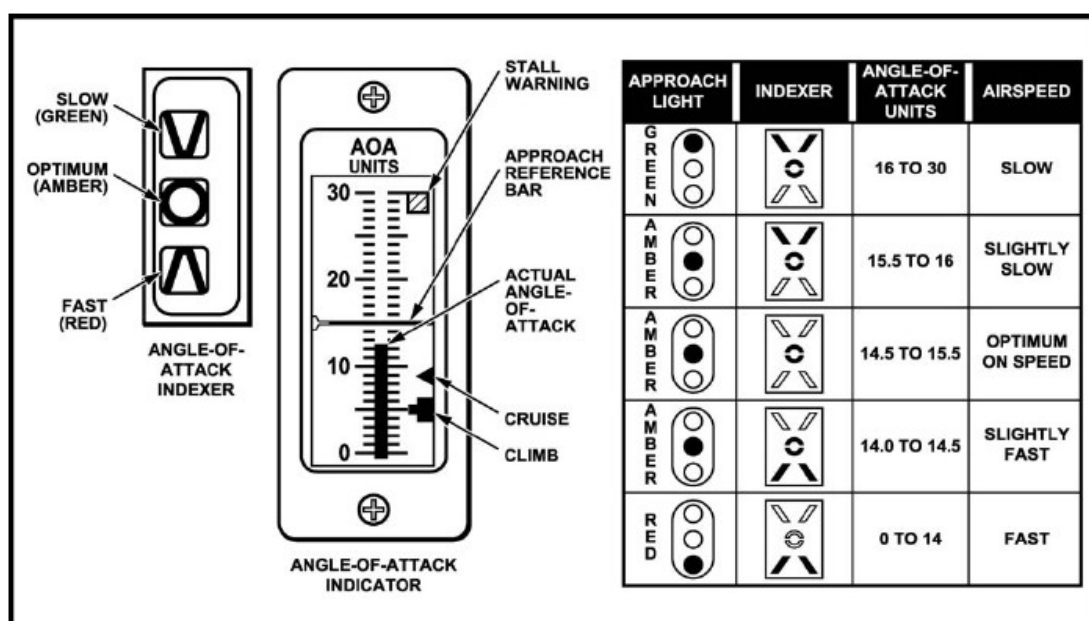


Figure 2-34 Angle of Attack Indicators

2.36 ANGLE-OF-ATTACK SYSTEM

The AOA system measures the angle between the longitudinal axis of the aircraft and the relative wind. This is used for approach monitoring and to warn of an approaching stall. Optimum approach AOA is not affected by gross weight, bank angle, density altitude, or load configuration.

The system includes a probe-type transmitter, approach lights, an indicator, and an indexer. The indexer and approach lights are controlled by the indicator, which is electrically slaved to the sensor probe transmitter. In flight, the probe, which is on the left side of the fuselage, aligns itself with the relative airflow like a weather vane.

Probe anti-icing is provided by means of a 115-Vac heating element along the probe and probe housing. The heating element is controlled by the ANTI-ICE switch on the pilot right console. During ground operation, probe heat is on with the landing gear handle down and the switch in ORIDE/ON. With weight on wheels, the position OFF/OFF and AUTO/OFF deactivate the probe heating element.

2.36.1 AOA Indicator

This indicator (see figure 2-34) displays the aircraft AOA and provides a stall warning reference marker, a climb bug, cruise bug, and an AOA approach reference bar for landing approach. AOA is displayed by a vertical tape on a calibrated scale from 0 to 30 units, equivalent to a range of -10° to +40° of rotation of the probe. The approach reference bar is provided for approach (on speed) AOA at 15 units. The AOA indexer and approach lights will automatically follow the indicator.

2.36.2 AOA Indexer

The AOA indexer on the pilot glareshield has two arrows and a circle illuminated by colored lamps to provide approach information. The relay-operated contacts in the AOA indicator also control the AOA indexer. The upper arrow is for high AOA (green), the lower arrow is for low AOA (red), and the circle is for optimum AOA (amber). When both an arrow and a circle appear, an intermediate position is indicated.

The indexer lights function only when the landing gear handle is down. A flasher unit causes the indexer lights to pulsate when the arresting hook is up and the HOOK BY-PASS switch is in CARRIER. The intensity of the indexer lights is controlled by the INDEXER thumbwheel control on the pilot MASTER LIGHT panel.

2.36.4 Approach Lights

The approach lights consist of red, amber, and green indicator lights above the nose gear strut. The lights are actuated by the AOA indicator and provide qualitative AOA information to the landing signal officer during landing approaches.

NOTE: Approach lights in this FSX rendition may give incorrect values and should be disregarded.

2.37 CANOPY SYSTEM

The cockpit is enclosed by a one-piece, clamshell, rear-hinged canopy. Provisions are included to protect the pilot and RIO from lightning strikes by the installation of aluminum tape on the canopy above the heads of the crew. Normal opening and closing of the canopy is by a pneumatic and hydraulic actuator with a separate pneumatic actuator for locking and unlocking. The canopy can be opened to approximately 25° for ingress and egress in approximately 8 to 10 seconds. In emergencies, the canopy can be jettisoned from either crew position or externally from either side of the forward fuselage. For rescue procedures, see paragraph 12.1.6. The maximum permitted taxi speed and headwind component with the canopy open is 60 knots.

Note

An occasional howl inside the canopy may occur in some aircraft when subjected to an approximate 4g maneuver. The howl has been attributed to the canopy rain seals; when they are removed the howl disappears. A canopy howl in aircraft with rain seals installed does not limit aircraft operation.

2.38 EJECTION SYSTEM

The aircraft is equipped with an automatic electronically sequenced command escape system incorporating two Navy aircrew common ejection seat (SJU-17(V) 3/A (pilot) and SJU-17(V) 4/A (RIO)) rocket-assisted ejection seats. Both seats are identical in operation and differ only in nozzle direction of their lateral thrust motors, which provide a divergent ejection trajectory away from the aircraft path.

When either crewmember initiates the command escape system, the canopy is ballistically jettisoned and each crewmember is ejected in a preset-time sequence. The RIO is ejected to the left and the pilot to the right.

Safe escape is provided for most combinations of aircraft altitude, speed, attitude and flight path within an envelope from zero airspeed, zero

altitude in a substantially level attitude to a maximum speed of 600 KCAS between zero altitude and 50,000 feet.

Regardless of the SJU-17 Ejection Seat limitations, any person whose nude body weight is below 136 pounds or above 213 pounds is subject to increased injury from ejection.

Loose gear in the cockpit is a FOD and missile hazard, especially during carrier operations, maneuvering flight, or ejection sequences.

Carriage of gear that cannot be contained in the cockpit storage compartment shall be kept to a minimum consistent with mission requirements and the mission environment.

NOTE: Ejection Seat is not simulated in this FSX rendition, and only the ARM switch is operational. Information in this paragraph is for educational purposes only.

2.38.1 Ejection Seat

The Navy Aircrew Common Ejection Seat (NACES) (Figure 2-35) is provided with a rocket-deployed 6.5 meter (20-foot), aeroconical, steerable parachute that is packed with a ribbon extraction drogue in a container behind the seat occupant's head. The seat bucket holds the survival kit and also has the seat firing handle and other operating controls. The parachute risers attach to the crewmember's torso harness by means of seawater-activated release switches.

Normal ejection includes canopy jettison before the seats are catapulted out of the cockpit; however, the parachute container is fitted with canopy penetrators. This permits a backup ejection through the canopy after a time delay in the event of safe-and-arm unit failure or failure of the canopy to separate from the aircraft. After ejection has been initiated, two pitot heads mounted next to the parachute container are deployed. Airspeed and altitude are provided to the battery-operated electronic sequencer mounted under the parachute container.

The sequencer uses the information to determine the release time for the drogue bridles, the deployment time for the parachute, and release time for the harness locks. Depending on MSL altitude and airspeed, the seat drogue, which is catapult-deployed from a canister on the back of the seat and has a three-point attachment bridle, can be used to stabilize the seat, slow its descent, or be jettisoned before the parachute deployment rocket is fired. To ensure parachute deployment and man-seat separation, a barostatic release

operates to fire the parachute deployment rocket and release the harness locks in the event of complete or partial sequencer failure. As a further backup, operating the manual release handle on the seat bucket will also fire the parachute deployment rocket and release the harness locks.

2.38.1.1 Seat Firing Handle

Ejection is initiated by pulling up on the seat firing handle on the front of the seat bucket between the crewmember's thighs. A pull force of 25 to 40 pounds is required to remove the firing handle from its housing. A continued pullforce of 30 to 60 pounds is required to initiate ejection. This action operates linkage that withdraws the sears from the two seat initiator cartridges, commencing the ejection sequence.

2.38.1.2 SAFE/ARMED Handle

The SAFE/ARMED handle on the right side of the seat bucket forward of the manual override handle is the only control for arming and safing the seat. (On the ground, a safety pin is also installed in the seat firing handle.) The handle locks in the selected position. It is operated by releasing a catch to remove the locking plunger. When the handle is rotated forward (up) to safe the seat, the SAFE legend is displayed on a white background and a safety plunger is inserted into the firing handle linkage so that the handle cannot be pulled up, rendering the seat inoperative.

Rotating the handle aft (down) displays the ARMED legend on a yellow-black striped background. This pulls the safety plunger from the firing handle linkage, freeing the handle and allowing the seat to be fired. With the canopy closed, the SEAT UNARMED caution light in the RIO cockpit is illuminated if the SAFE/ARMED handle on either seat is in the SAFE position.

2.38.1.3 Manual Override Handle

The manual override handle on the right side of seat bucket behind the SAFE/ARMED handle is connected by linkage to the lower harness lock release mechanism and to an initiator in the seat bucket. The handle is locked in the down position by a catch operated by a thumb button at the forward end of the handle. Depressing the thumb button allows the handle to be rotated aft. Operating the handle also rotates the SAFE/ARMED handle to the SAFE position. A catch in the lower part of the manual release handle must be reset before the handle can be returned to the down position.

With the seat in the aircraft, operation of the

handle linkage is restricted by the pin puller and releases only the lower locks, and the leg restraint line locks to permit emergency ground egress with the survival kit attached.

2.38.2 Command Ejection Lever

A command ejection lever above the RIO left outboard console allows the RIO to select either pilot or RIO control of the command ejection system. Each position has an internal locking detent. The handle is unlocked by lifting upward and moved by a forward or aft motion. If the handle is released before reaching the aft position, it is spring loaded to return forward. It will automatically lock in the forward position; however a downward motion is required to positively lock it into the aft position. To select MCO command ejection position, raise the handle and pull aft. An EJECT CMD flip-flop-type indicator on the landing gear panel indicates the command mode selected. The RIO may eject individually when the command ejection lever is in the pilot control position. When the command ejection lever is in the MCO command position, the RIO can initiate ejection of both seats.

Regardless of the position of the command ejection lever, an ejection initiated by the pilot will always eject both crewmen. Command ejection by either crewmember will eject the RIO first and the pilot 0.4 second later. Depending on aircraft dynamics, the total time for command ejection of both seats in the normal (safe and arm device) mode is from 0.4 to 0.9 second; in the backup initiator mode, the total time is 1.5 second. In aircraft with an LCP installed, the controller handrest may interfere with the CMD EJECT lever, preventing the handle from reaching the full-aft (MCO) position. Adjusting the handrest to the full-down position will minimize this interference and should allow normal operation of the CMD EJECT lever.

2.38.3 Ejection Initiation

With the SAFE/ARMED handle in the ARMED (down) position, pulling the seat firing handle upward to the extent of its travel begins the ejection by pulling the sears on the seat initiators. The following events occur:

1. Canopy jettison is initiated.
2. The powered inertia reel retracts, pulling the crewmember back in the seat.
3. The delay initiators are activated. These initiators have built-in delays of 1.0 second for the RIO seat and 1.5 seconds for the pilot seat.
4. The restriction is removed from the manual

override mechanism.

5. The 4.0-second delay cartridge for the barostatic release is initiated.

6. The safe and armed device is armed.

When canopy jettison is complete, a lanyard attached to the canopy pulls a sear, firing the safe and arm device. This initiates the thermal batteries that power the seat electronic sequencer and fires the two-stage catapult, ejecting the seat.

The RIO seat is fired immediately on firing of the safe and arm device, while the pilot seat is delayed 0.4 second. The IFF switch is actuated when the pilot seat is fired.

If the canopy fails to separate or the safe and arm device does not fire, the backup initiators operate at the expiration of their delays, firing the RIO seat 1.0 second after firing handle actuation and the pilot seat 0.5 second later, through the canopy.

As the seat ascends the guide rails, the following events occur:

1. The multipurpose initiator lanyards begin to withdraw.
2. Personnel services between seat and aircraft are disconnected.
3. The emergency oxygen supply is initiated.
4. The emergency locator beacon is activated.
5. The leg restraint lines are drawn through the snubbers and restrain the crewmember's legs to the front of the seat bucket. When the leg restraint lines become taut, the break ring in each line fails and the lines are freed from the aircraft. The snubbers prevent forward movement of the legs.

At the end of the catapult stroke (approximately 35 inches of seat travel), the multipurpose initiator lanyards become taut and withdraw the firing unit sears. This routes gas pressure to the electronic sequencer start switches,

2.38.4 Seat Operation After Ejection

Post-ejection operation begins at the end of catapult travel when the rocket motor fires and the start switches actuate. In normal operation, the electronic sequencer selects the operating mode depending on altitude and airspeed. A barostatic release unit provides an automatic backup for electronic operation. Four seconds after the seat firing handle is pulled, the barostatic unit is armed permitting parachute deployment and harness release as determined by the barostat setting if the sequencer has not functioned. As a further backup, the crewmember

can manually fire the parachute deployment rocket and release the harness locks by using the manual override handle.

2.38.4.1 Electronic Sequencing

In all modes, following start switch actuation, the pitot heads extend, environmental sensing for mode selection commences, and the seat drogue is deployed on its three-point bridle to stabilize and slow the seat. While this is occurring, the sequencer selects one of the five operating modes from its lookup tables based on sensed altitude and airspeed. The modes are described as follows:

1. Mode 1: This is the low-altitude, low-air-speed mode. The bridles are released 0.32 seconds after seat first motion. The parachute deployment rocket fires to deploy the parachute and the harness release system operates to free the occupant from the seat.

2. Modes 2, 3, and 4: These modes are for low to medium altitudes. The seat is decelerated by the drogue and after a time delay determined by the electronic sequencer, the parachute deployment rocket fires to deploy the parachute before the drogue bridles are released. The harness release system operates to free the occupant from the seat.

3. Mode 5: This mode is selected at high altitude. The seat (with drogue bridles connected) descends to 18,000 feet, where the bridles are released. The parachute deployment rocket fires to deploy the parachute and the harness release system operates to free the occupant from the seat.

In all modes, parachute deployment lifts the crew-member and survival kit from the seat, pulling the stickerstraps from the clips.

2.38.4.2 Barostatic Release

To ensure that the parachute is deployed and the harness locks are released, the barostatic release unit, consisting of a barostat and a cartridge, provides an independent automatic backup to the electronic sequencer.

2.38.4.3 Manual Override

After ejection, the manual override handle provides a further backup to both the electronic sequencer and the barostatic release. Pulling the handle fires a cartridge that provides gas pressure to fire the parachute deployment rocket and operate the harness lock release.

2.39 LIGHTING SYSTEM

2.39.1 Exterior Lights

The exterior lights include position lights, formation lights, anticollision lights, a taxi light, approach lights, and an air refueling probe light. All exterior lighting controls, except for the air refueling probe light and approach lights, are located on the MASTER LIGHT panel on the pilot right console. The exterior lights master switch on the outboard throttle must be on for any exterior light to function (except for approach lights).

2.39.1.1 Position Lights

The position lights consist of a red light on the left wingtip, a green light on the right wingtip, and a white position light in the left fin cap assembly. Supplemental position lights include upper and lower red lights on the left wing glove and upper and lower green lights on the right wing glove.

2.39.1.2 Anticollision Lights

There are three red, flashing anticollision lights. One anticollision light is installed in the bottom of the infrared pod on the lower forward fuselage. Another anticollision light is installed in the top forward part of the left vertical stabilizer and its lens is blacked out except for 1½ inches at the rear of the light. The third anticollision light is on the top aft part of the right vertical stabilizer and directs its anticollision beacon up and down.

2.39.1.3 Formation Lights

The formation lights consist of wingtip lights on each wing, fuselage lights, and vertical fin tip lights on both sides of the aircraft.

All formation lights are green. Intensity of the lights is controlled by the FORMATION thumbwheel on the MASTER LIGHT panel.

2.39.1.4 Taxi Light

The taxi light installed on the nosewheel is a fixed-position light. A limit switch on the nosegear door will turn the light off when the gear is retracted. A two-position, ON and OFF, switch is on the MASTER LIGHT panel.

2.39.2 Interior Lights

The interior lighting of the cockpit consists of green floodlights mounted on the glareshield, the instrument console and above each outboard console, and utility lights for each flightcrew station. The MASTER LIGHT panel, at the pilot's station on the right outboard console, permits varying the intensity of the floodlights from dim to

bright.

The RIO's interior lights control panel permits varying the intensity of his interior lighting.

2.39.2.1 Instrument and Console Panel Lights

All flight instruments in the pilot and RIO instrument panel and console panel lights are lighted by white lighting.

Individual thumbwheel controls are provided for the pilot and RIO instrument and console lighting.

2.39.2.2 Floodlights

The floodlights consist of night vision green floodlights that illuminate the instrument and console panels.

When navigating around thunderstorms, the storm floodlights should be turned on bright to assist in preventing temporary blindness from lighting. The WHITE FLOOD toggle switch on the pilot master light panel and another on the RIO light panel are safety interlock switches that must be pulled up to be positioned to BRT or DIM. In DIM, low-intensity floodlighting is provided. During NVIS mode, rotating the NVIS FLOOD potentiometer on the RIO interior light panel to vary the intensity of the NVIS flood lights will also vary the intensity of the backlighting on the CDNU.

2.39.2.3 Utility and Map Lights

The pilot utility and map light is on a bracket above the right outboard console. The RIO utility and map light is in a bracket above and midway along the right and left console.

2.39.3 Warning and Indicator Lights

Warning, caution, and advisory lights are provided in both cockpits to alert the pilot and RIO of aircraft equipment malfunctions, unsafe operating conditions, or that a particular system is in operation.

Warning lights illuminate red with black letters to warn of hazardous conditions that require immediate corrective action. Caution lights show yellow letters on an opaque background to indicate an impending dangerous condition. The lower half of the CAUTION ADVISORY panel consists of advisory lights that show green letters on opaque background. Advisory lights indicate degraded operations that may require corrective action.

WARNING

Radiation hazard exists on deck when the RDR ENABLED caution light is illuminated. The light indicates that the RADAR TEST

ENABLE switch (maintenance switch) is in the "A" (radiate and scan) position. This condition permits the weight-on-wheels interlock to be bypassed, allowing the transmitter to radiate through the antenna when RADAR XMIT is selected on the hand control unit. Illumination of the light does not indicate a weight-on-wheels failure

2.39.3.1 MASTER CAUTION Light

The pilot MASTER CAUTION light is centrally located on the master caution/master arm control panel, and, in the aft cockpit, the RIO MASTER CAUTION light is on the left instrument panel. When the lights are illuminated, yellow letters show on an opaque background. Individual MASTER CAUTION lights flash whenever a caution light on the respective caution and advisory panel illuminates.

2.40 STORES MANAGEMENT SYSTEM/JETTISON

The SMS is the interface between aircraft stores and the mission computer system. It provides signal processing and logic control required for inventory and identification of all stores; preparation and test of missiles; and weapon select, arm, and launch functions. The emergency generator (1 kVA mode) provides backup power (28 Vdc essential) for emergency jettison. The SMS has extensive self-test capabilities and reports failures to the MCS for display to the crew.

NOTE: SMS is not implemented in this FSX rendition.

2.41 MISCELLANEOUS EQUIPMENT

2.41.1 Boarding Ladder

A boarding ladder consisting of three folding sections is housed in the left fuselage between the two cockpits. It is held in the closed position by two mechanical locking pins actuated by the ladder control handle in the face of the boarding ladder. The ladder must be manually released or stowed from the ground level. Unfolding the remaining two sections places the ladder in a fully extended position.

A LAD/CANOPY caution light on the pilot caution advisory panel advises the pilot that the boarding ladder is not in a full up-and-locked position.

NOTE: In this FSX rendition, the boarding ladder and steps are deployed by Exit 3 controls (exit.2 variable), which by default is commanded by pressing SHIFT+E and then 3.

2.41.1.1 Boarding Steps and Handhold

There are two positive locking board steps, one on either side of the boarding ladder directly below each cockpit. They may be opened or closed from either cockpit or while standing on the boarding ladder. A single handhold is directly above the boarding ladder. It is a spring-loaded door that fairs with the fuselage when released.

2.41.2 Nose Radome

The nose radome is attached to the aircraft by a top hinge and bottom mounted latches, permitting it to be rotated up for access and maintenance. A jury strut attached to the lower part of the dome can be fastened to the aircraft bulkhead to hold the dome open. A minimum overhead clearance of 16 feet is required when opening the radome. The radar antenna must be stowed before opening the radome. Antenna stow position is 0 azimuth and 60 tilted down.

NOTE: In this FSX rendition, the radome and other maintenance panels can be opened by Exit 4 controls (exit.3 variable), which by default is commanded by pressing SHIFT+E and then 4.

2.41.3 Systems Test and System Power Ground Panel

The SYS TEST and SYS PWR ground check panel is on the RIO right console panel (accessible from the boarding ladder with the

canopy open) for controlling the activation of electrical circuits using ground external power. The panel cover is designed so that, when it is closed, the switches inside are in the proper position for flight. In addition, when the landing gear handle is in UP, all switches are deactivated. The panel serves a maintenance and preflight purpose and is not intended for use by the flightcrew.

2.41.4 External Baggage Container (CNU-188/A)

The external baggage container is a modified Aero ID 300-gallon fuel tank that incorporates forward and aft baggage compartments. Each compartment has an access door (forward, left side, aft, right side), a shelf and a baggage tiedown harness. The tiedown harness consists of two sets of seatbelt straps that form a crossover pattern to secure baggage to the shelf. The external baggage container may be loaded with any equipment that fits within the confines of the shelf, does not exceed the shelf weight, and maintains the cg limits. Locate baggage as near the center of the shelf as possible. Care should be taken to ensure that straps are tight to preclude any significant shift of cargo.

NOTE: Baggage container is not implemented in this FSX rendition.

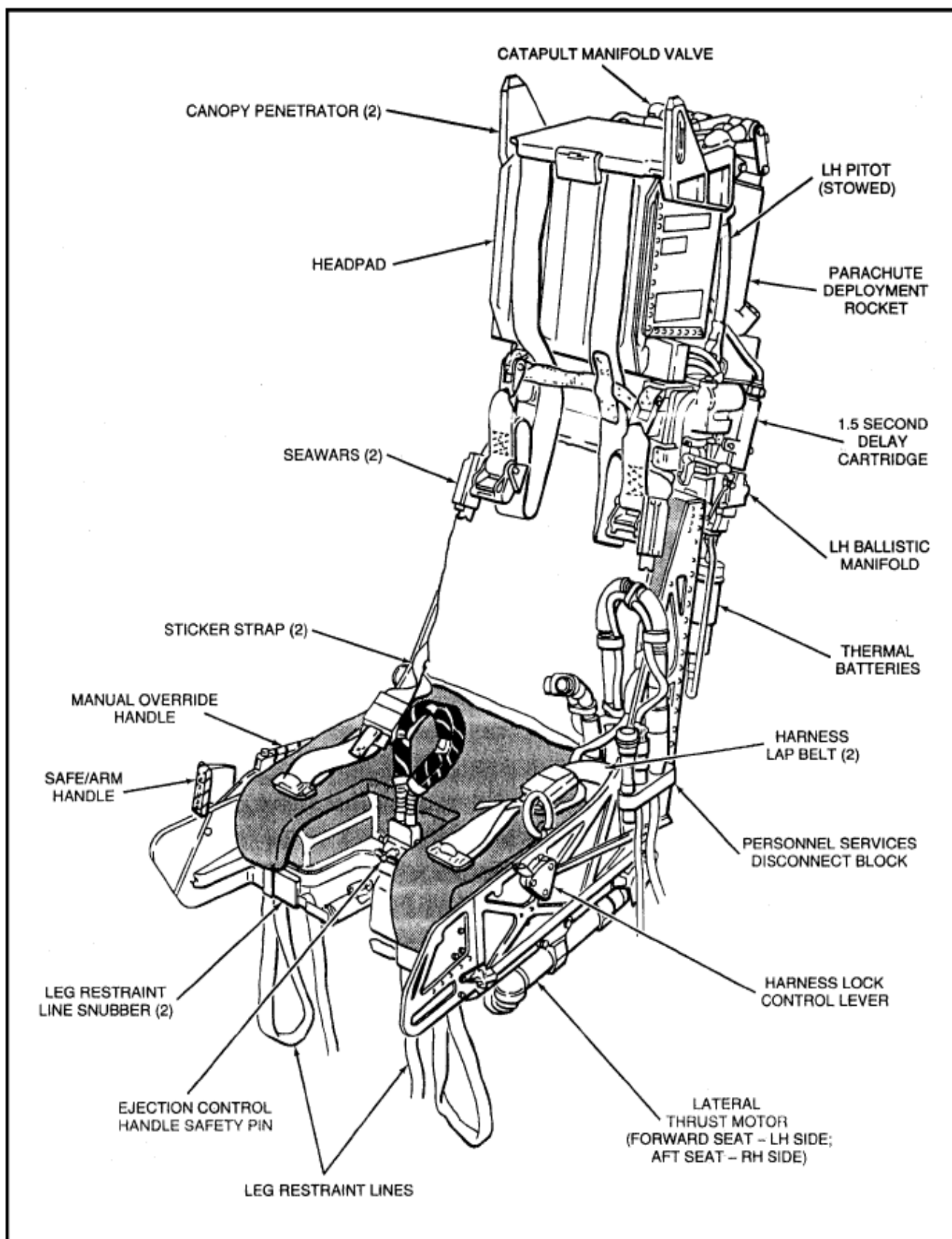


Figure 2-35 Ejection Seat (sheet 1 of 2)

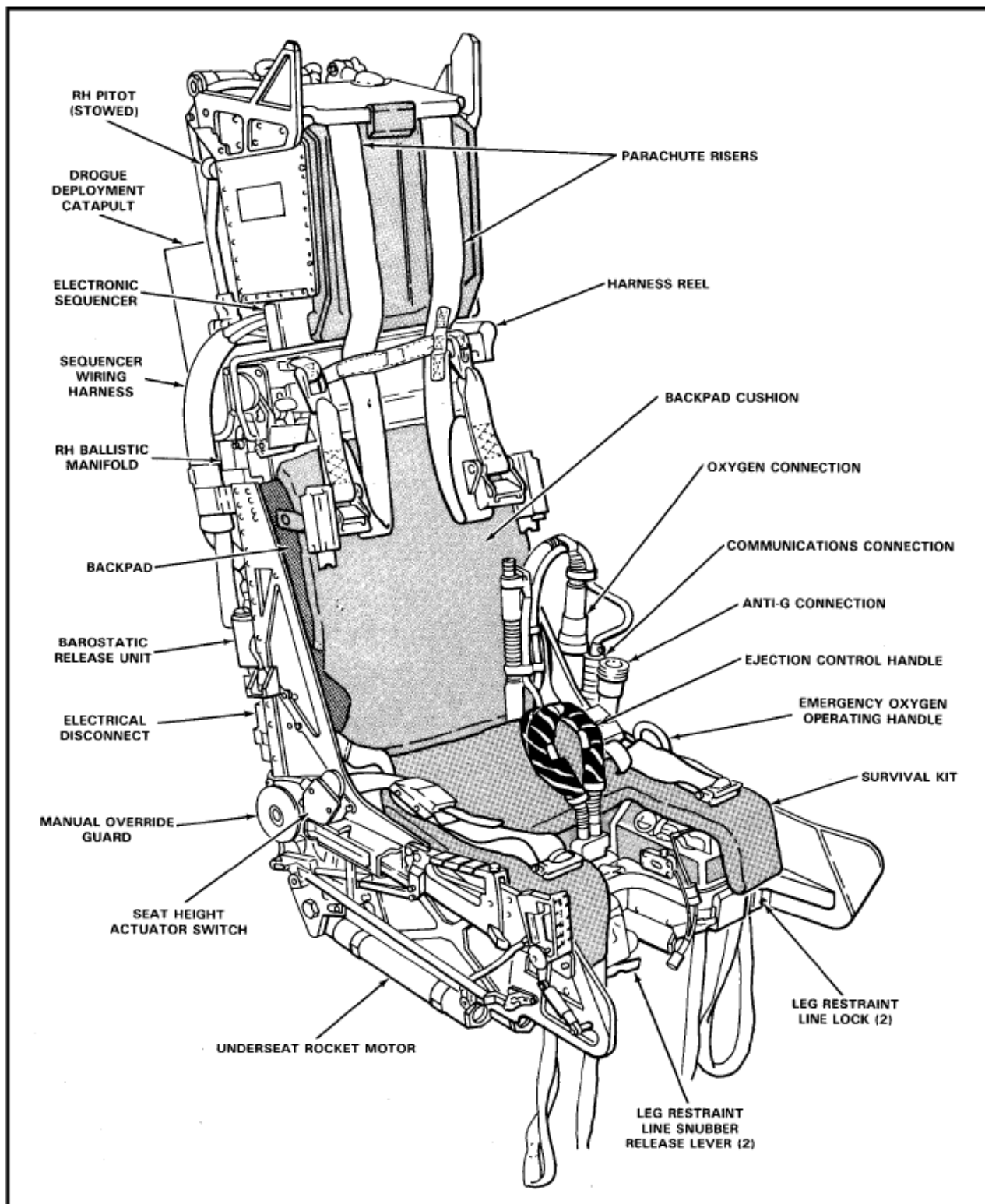


Figure 2-35 Ejection Seat (sheet 2 of 2)

CHAPTER 3

Servicing and Handling

3.1 GENERAL

Servicing information is presented for educational purposes only and has no function in Flight Simulator X.

NOTE: In this FSX rendition, the radome and other maintenance panels can be opened by Exit 4 controls (exit.3 variable), which by default is commanded by pressing SHIFT+E and then 4.

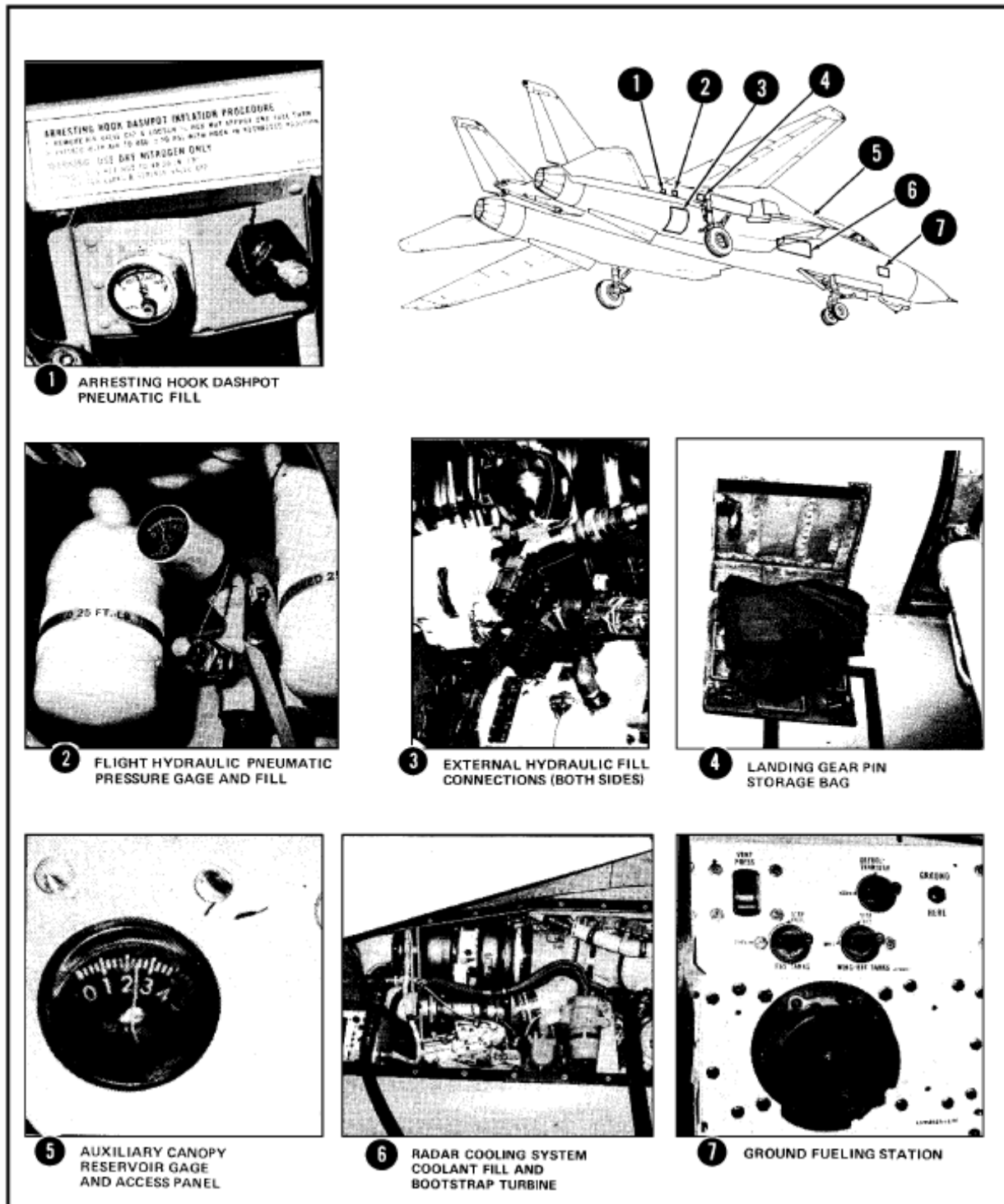
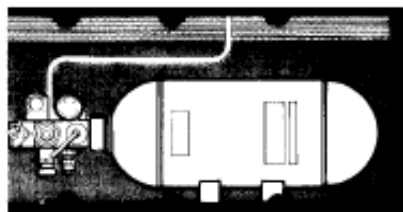
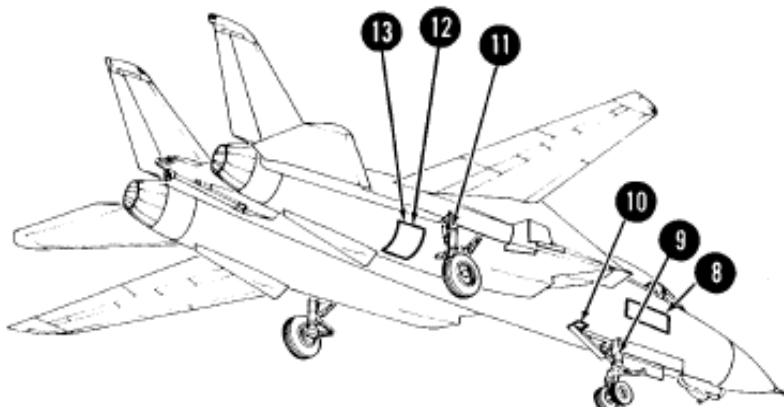


Figure 3-1 Aircraft Servicing (sheet 1 of 3)



8 BACKUP OXYGEN SUPPLY



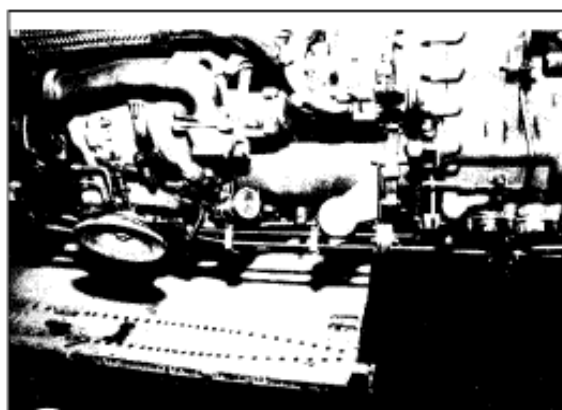
9 NOSE GEAR SHOCK STRUT



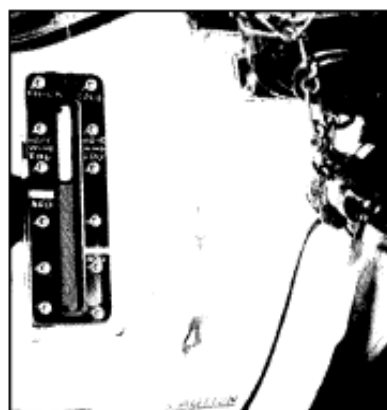
10 EXTERNAL AIR CONDITIONING



11 MAIN LANDING GEAR SHOCK STRUT



12 OIL SERVICE LINE DUST CAPS

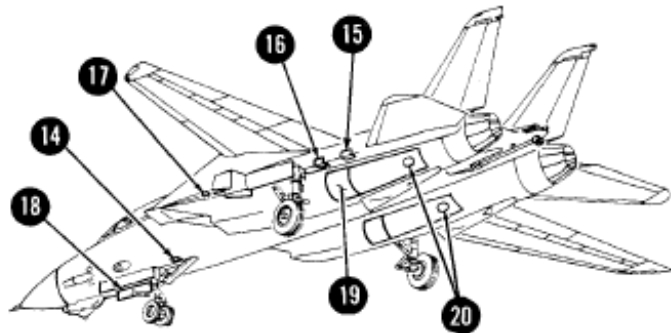


13 GENERATOR TRANSMISSION OIL FILL AND GAGE

Figure 3-1 Aircraft Servicing (sheet 2 of 3)



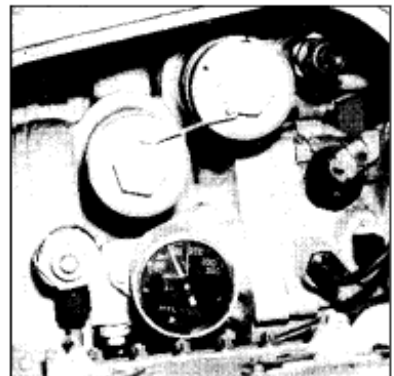
14 EXTERNAL ELECTRICAL POWER PANEL



15 COMBINED HYDRAULIC TEMPERATURE GAGE.



16 ENGINE GROUND START AND COMBINED FILL



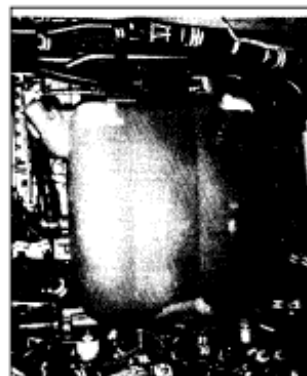
17 OUTBOARD SPOILER MODULE.



18 AUX AND PARK BRAKE/CANOPY/ EMERGENCY LANDING GEAR PRESSURE GAGES.



19 STARTER FILL AND DRAIN



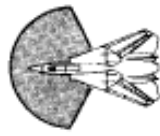
20 ENGINE OIL LUBE TANK AND SIGHT GAGE



Figure 3-1 Aircraft Servicing (sheet 3 of 3)

WARNING

AT HIGH THRUST SETTINGS, THE SUCTION DANGER AREA AROUND ENGINE INLETS MAY EXTEND AS FAR AS 4 FEET AFT OF THE INLET DUCT LOWER LIP. EAR PROTECTION SHALL BE WORN AT ALL TIMES.



NOTE

- THIS ILLUSTRATION CONTAINS ESTIMATED EXHAUST JET WAKE VELOCITY AND TOTAL TEMPERATURE DISTRIBUTION OF F110-GE-400 MIXED FLOW AUGMENTED (AFTER-BURNING) TURBOFAN ENGINE. THIS IS IN ACCORDANCE WITH GENERAL ELECTRIC GEK 92500 OPERATION AND SERVICING MANUAL WITH MAXIMUM OPENING FOR IDLE POWER AND FULLY CLOSED (MINIMUM OPENING) FOR MILITARY POWER.
- IF ENGINES ARE RUN UP IN FRONT OF BLAST DEFLECTOR, EXHAUST JET WAKE IS DEFLECTED UP AND TO SIDES, RESULTING IN DISTORTION OF PATTERNS SHOWN.

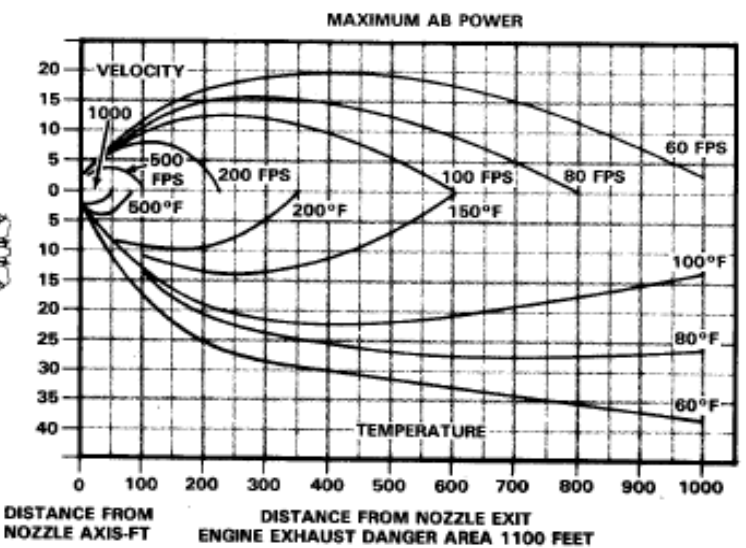
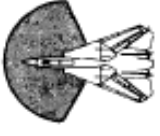
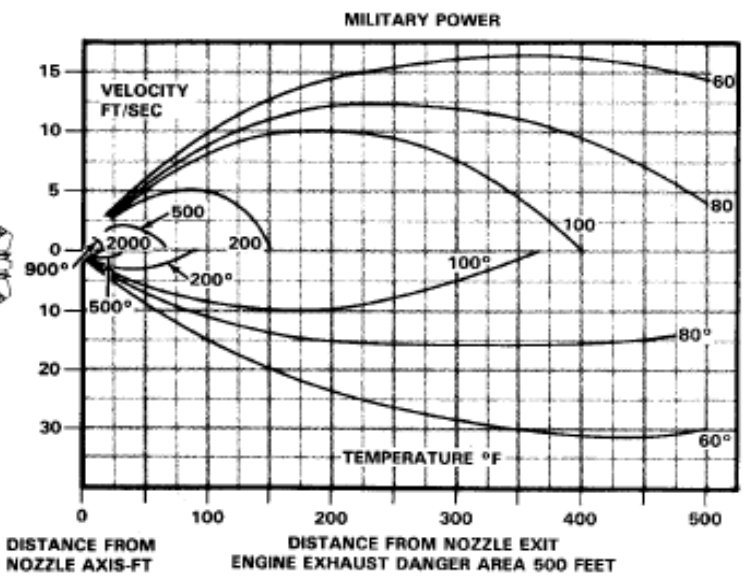
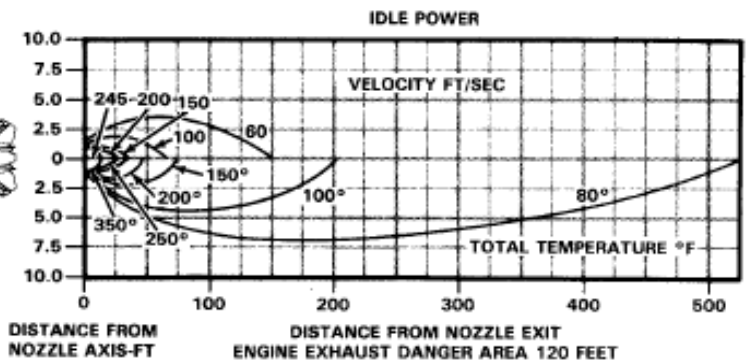
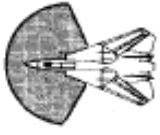


Figure 3-2 Runup danger areas – Jet exhaust wake and temperature

SOUND LEVELS IN dBA		
THIS TABLE CONTAINS ESTIMATED SOUND LEVELS FOR F110-GE-400 (MIXED FLOW) AUGMENTED) AFTERBURNING TURBOFAN ENGINE. SOUND LEVEL CONTOUR LETTERS A, B, C, AND D (SHOWN IN THIS ILLUSTRATION) REPRESENT A SPECIFIC dBA VALUE. WHEN dBA VALUE IS IN THIS TABLE, IT SHALL BE SUBSTITUTED IN PLACE OF CONTOUR LETTER.		
CONTOUR	MAXIMUM AFTERBURNER POWER	MILITARY POWER
A	145	140
B	140	135
C	135	132
D	130	130

ALLOWABLE NOISE EXPOSURE SOUND LEVEL IN dBA (SLOW RESPONSE)							
TYPE EAR PROTECTIVE DEVICES	EXPOSURE TIME (HOURS)*						
	1/4	1/2	1	2	4	6	8
NO PROTECTION	109	104	99	94	89	86	84
EARPLUGS WITH AVERAGE SEAL	123	118	113	108	103	100	98
EARPLUGS AND EARMUFFS	129	124	119	114	109	106	104

*DURATION OF EXPOSURE PER DAY
REF. BUMED INST 6260.6B, 5 MARCH 1970

NOTE

SOUND LEVEL CONTOURS SHOWN ARE FOR SINGLE-ENGINE OPERATION. CONTOURS ARE SYMMETRICAL ABOUT ENGINE CENTERLINES DURING DUAL-ENGINE OPERATION.

EAR PROTECTIVE DEVICES

			
UNIVERSAL FIT EARPLUG	EARPLUG V-51-R TYPE OR SIMILAR	TYPICAL EAR MUFF	FLIGHT DECK SOUND-ATTENUATING HELMET (INCLUDES EAR MUFF)

WARNING

- EARPLUGS AND EAR MUFFS SHALL BE WORN TOGETHER WHEN PERFORMING ENGINE RUNUP.
- IF ENGINES ARE RUN UP IN FRONT OF BLAST DEFLECTOR, EXHAUST JET WAKE AND SHOULD BE DEFLECTED UP AND TO SIDES, RESULTING IN DISTORTION OF CONTOUR PATTERNS SHOWN.
- AT MAXIMUM POWER, F110-GE-400 ENGINE AFTERBURNERS ARE AT MAXIMUM NOZZLE OPENING (ZONE 5). AT MILITARY POWER THE NOZZLES ARE FULLY CLOSED (MINIMUM OPENINGS).

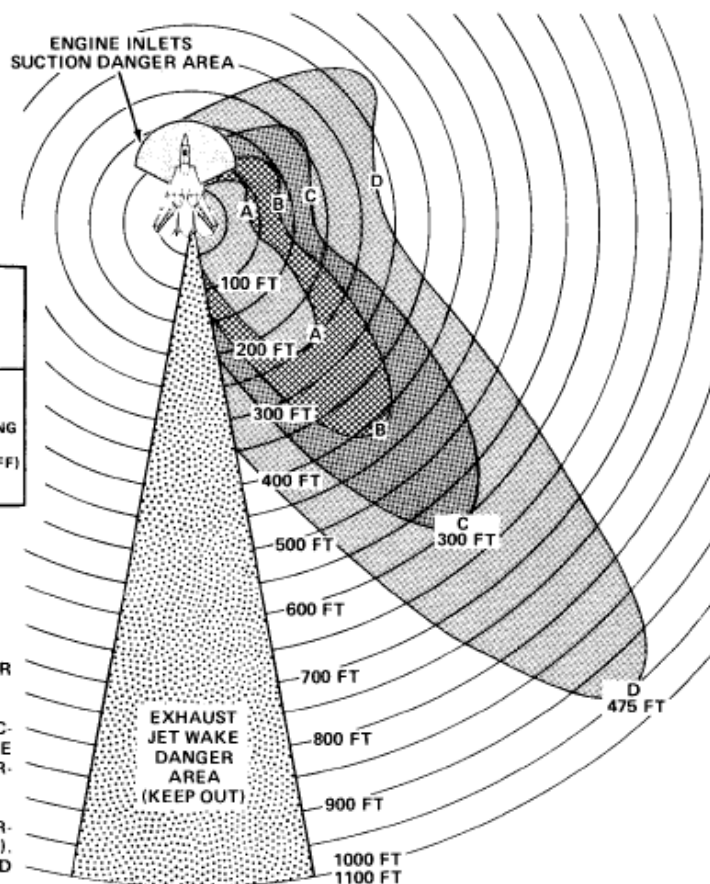


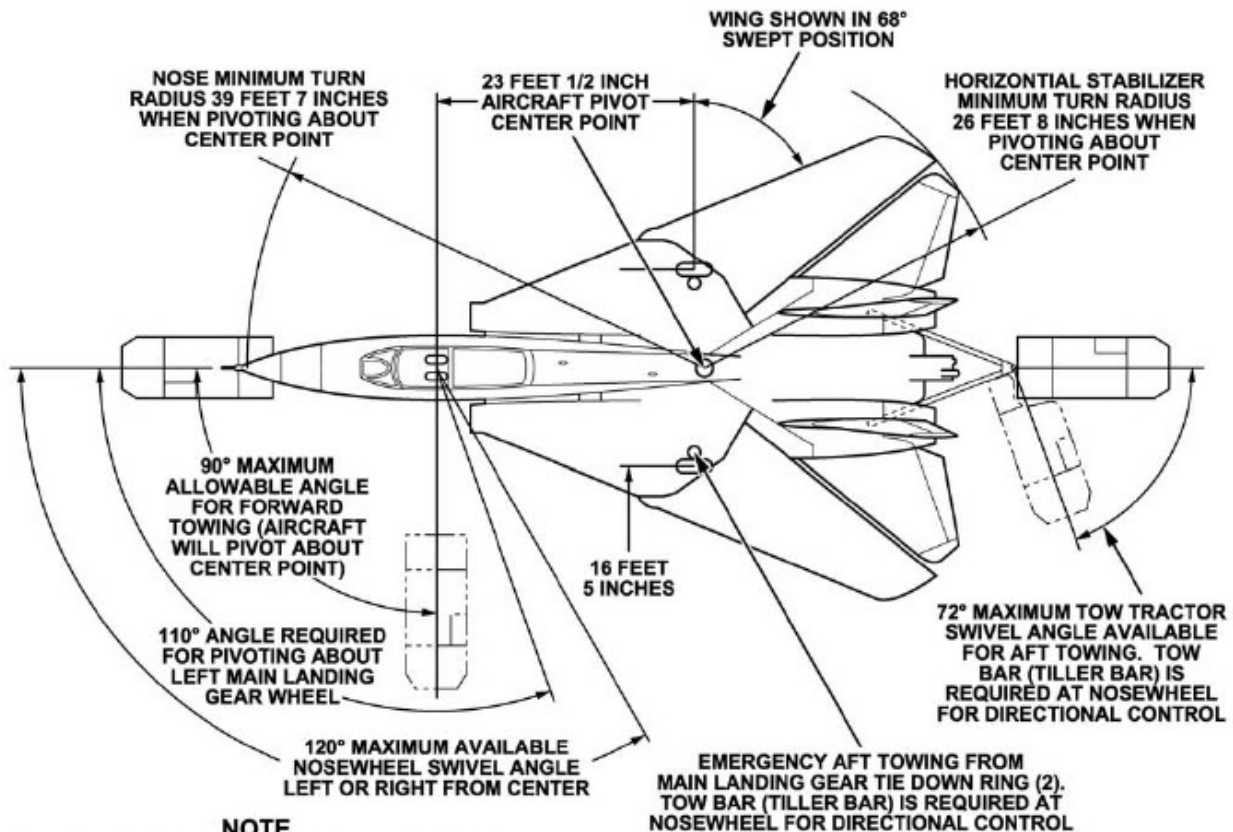
Figure 3-4 Noise Danger Areas

CAUTION

CAUTION

DO NOT EXCEED 90° MAXIMUM AVAILABLE NOSEWHEEL SWIVEL ANGLE DURING PARKING OR SPOTTING IN TIGHT SPACES; STEERING DAMPER UNIT WILL BE DAMAGED.

- AUTHORIZED BRAKE RIDER SHALL MAN PILOT STATION AT ALL TIMES DURING TOWING, EXCEPT WHEN TOWING AIRCRAFT WITH INOPERATIVE BRAKES.
- WING AND TAIL WALKERS, AND MAIN LANDING GEAR CHOCK MEN SHALL BE AVAILABLE AT ALL TIMES DURING TOWING.
- IN NOSEWHEEL WELL, BRAKE ACCUMULATOR PRESSURE GAGE SHALL INDICATE 3,000 PSI. ON PILOT CENTER CONSOLE, BRAKE PRESSURE INDICATOR NEEDLE SHALL BE AT RIGHT END OF AUX GREEN BAND.



NOTE

AIRCRAFT CAN BE TOWED WITH WINGS IN ANY SWEEP ANGLE FROM 20° (UNSWEEP) TO 75° (OVERSWEEP)

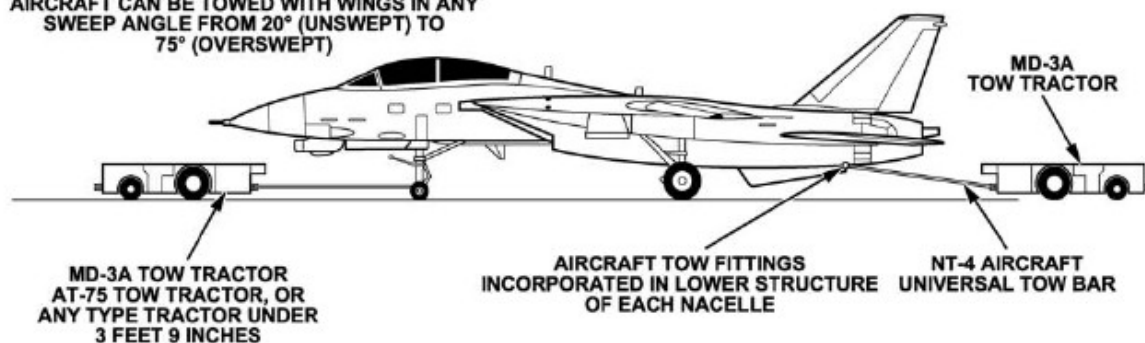


Figure 3-5 Towing

CHAPTER 4

Operating Limitations

4.1 LIMITATIONS

This section includes the aircraft and engine limitations that must be observed during normal operations.

The aerodynamic and structural limitations in this section apply only to F-14D aircraft for the store station configurations shown in Figure 4-1.

Engine limitations apply to all aircraft with the F110-GE-400 engine.

NOTE: Most of the data in this chapter refers to real-world F-14D. Behaviour in game may differ. However, some of the limitations are coded into the simulated aircraft and will apply regardless of the realism setting of FSX.

NOTE: In this FSX rendition, there are no external loads but fuel tanks, applicable configuration is 1C.

4.1.1 Engine Limits

Engine instrument markings for various operation limitations are shown in Figure 4-2. Engine operating limitations are shown in Figure 4-3. The engine secondary (SEC) mode may be intentionally selected in flight only under the following conditions:

1. Engine operating between 85-percent rpm and Autopilot should not be used under the following conditions:
2. Airspeed less than 1.0 IMN.

NOTE: Primary and secondary engine modes differences are not simulated in this FSX rendition.

4.1.2 Starter Limits

The starter cranking limits are as follows:

1. Cross bleed 2 minutes.

2. Start cart 5 minutes.

When the time limit is reached, 10 minutes cooling is required between cranking.

4.1.3 Crosswind Limits

Crosswind takeoffs and landings are permitted with a crosswind component not to exceed 20 knots at 90.

4.1.5 Ground Operations Limits

1. Maximum tire speed 190 knots.
2. Maximum canopy open speed 60 knots.

WARNING!

Use of antiskid must be in accordance with the following procedures:

- Select antiskid while stopped on the runway in the takeoff position; after landing, turn antiskid off once slowed below 15 knots prior to clearing the runway.
- Use only during landing or aborted takeoff.
- Do not use antiskid while taxiing.

4.1.6 Ejection Seat Operation Limits

1. Maximum speed (seat) 600 knots.

WARNING!

Ejection above 350 knots is hazardous, the decision to exceed 350 knots rests with the aircrew.

4.1.7 Autopilot Limits

Autopilot should not be used under the following conditions:

1. Airspeeds greater than 400 KCAS/0.9 IMN.
2. Altitude above 42,500 feet.

4.2 AIRSPEED LIMITATIONS

The limits and restrictions in this part represent the maximum capability of the aircraft commensurate with safe operations. Aerodynamic and structural excesses of these limits shall be entered on the maintenance action form for appropriate maintenance action.

4.2.1 Maximum Airspeeds

Maximum speeds are presented in calibrated knots and true Mach number. These values are derived from the position error-correction curves of the production pitot-static-operated airspeed and altitude system. AOA is presented utilizing the conventional indicated units AOA while sideslip angle limits are presented in terms of degrees of rudder deflection.

Note

Unless otherwise specified, the limits presented herein pertain to flight with the stability augmentation system on.

4.2.1.1 Cruise Configuration

With wing sweep in the MANUAL or AUTO mode, the maximum allowable airspeeds are shown in Figure 4-3. In emergency wing-sweep mode, the following combination of Mach and wing-sweep schedule must be used:

1. ≤ 0.4 TMN - 20° .
2. ≤ 0.7 TMN - 25° .
3. ≤ 0.8 TMN - 50° .
4. ≤ 0.9 TMN - 60° .
5. > 0.9 TMN - 68.

4.2.1.2 Approach Configuration

1. Landing gear - 280 KCAS.
2. Landing flaps and slats - 225 KCAS.

CAUTION!

- **With the landing gear extended or in transit, abrupt rolls or uncoordinated turns above 225 KCAS can cause structural failure of the landing gear doors.**
- **After takeoff, move the FLAP handle to the UP position passing 180 KCAS to ensure flap and slat airspeed limits are not exceeded.**

4.2.1.3 In-Flight Refueling

1. Refueling probe - 400 KCAS/0.8 TMN.
2. In-flight refueling (cruise configuration) - 200 to 300 KCAS/0.8 TMN.
3. In-flight refueling (approach configuration) - 170 to 200 KCAS.

4.3 ACCELERATION LIMITS

Note: Limits are based on a gross weight of 49,548 pounds. See Figure 4-5 for the variation of maximum load factor with gross weights greater than 49,548 pounds. Coordinated turns with small rudder and lateral stick inputs are

defined as symmetrical flight.

4.3.1 Cruise Configuration

See Figure 45 and Figure 48.

4.3.2 Approach Configuration

1. Landing gear and/or landing flaps and slats extended - 0 to 2.0g (symmetrical or rolling).

4.4 ANGLE-OF-ATTACK LIMITS

4.4.1 Cruise Configuration

AOA is limited by the maximum allowable load factor of Figure 4-5, additional limitations as follows:

TMN 0 to 0.5: Maximum AoA is 28 units

TMN 0.5 to 0.8: Maximum AoA is 20 units

TMN 0.8 to 0.92: Maximum AoA is 13 units.

TMN > 0.92: Maximum AoA limited by maximum allowable load factor.

Aircraft has significantly improved roll rate capability with ROLL SAS ON, which increases susceptibility to inertia coupled departures due to overly aggressive multi-axis control inputs. With ROLL SAS ON, departure resistance is increased because of DFCS ARI functionality and therefore should remain on at all times.

4.4.2 Approach Configuration

Maximum allowable AOA and rudder deflection with landing gear and flaps extended are as follows:

Rudder position: 0° to $\pm 8^\circ$ - Max AoA 25.5 units.

Rudder position: -20° to -8° or 8° to 20° - Max AoA is 16.2 units.

Below 5,000 feet, Maximum AoA is 20.6 units.

4.5 MANEUVERING LIMITS

4.5.1 Approach Configuration

With landing gear and/or landing flaps and slats extended, abrupt yaws are prohibited. With landing gear extended or in transit, abrupt rolls and uncoordinated turns shall not be performed above 225 KCAS.

4.5.2 Cruise Configuration

With maneuver slats/flaps extended, maximum allowable load factor is 6.5g.

4.5.3 Rolling Limits

With maneuver slats and flaps extended, maximum allowable load factor is 5.2g. Do not initiate full lateral stick inputs above 4.5g if a 5.2g limit applies or above 3.5g if a 4.0g limit applies. Control system dynamics may cause load factor to increase beyond limits. If outboard spoilers fail with airspeed greater than 400 KCAS and wing sweep less than 62°, limit lateral stick deflection to one-half pilot authority.

4.5.4 Sideslip Limits

1. Below 0.7 TMN - Rudder inputs as required to maneuver aircraft at high AOA.

2. Above 1.7 TMN - Intentional sideslips prohibited.

If a supersonic engine stall and/or failure occurs, arrest roll rate with lateral stick only. Yaw SAS will maintain sideslip angle within acceptable limits.

Note

Use of full available rudder is permitted at all airspeeds if required to counteract adverse yaw encountered in maneuvering flight.

4.5.5 Prohibited Maneuvers

The following additional maneuvers are prohibited:

1. Intentional spins.

2. During afterburner operations:

- Sustained 0 to -0.5g flight.

- Flight from -0.5g to -2.4g's for more than 10 seconds.

3. At MIL power or less: zero or negative-g flight for more than 20 seconds.

4. AIM-9 launch with landing flaps and slats extended.

5. Fuel dumping with afterburner operating or with speedbrakes extended.

6. Dual-engine afterburner takeoffs, waveoffs, bolters, or catapult launches.

7. Use of maximum AB in event of engine failure

during takeoff, catapult launch, waveoff or bolter.

8. Rolling maneuvers with AOB change greater than 360° are prohibited.

4.6 TAKEOFF AND LANDING FLAP AND SLAT AND TRANSITION LIMITS

4.6.1 Clean and Symmetric Stores Loading

1. All transitions will be made in less than 45° bank angle, ROLL SAS ON.

2. All normal (flaps and slats fully down) takeoff transitions will be initiated at a minimum altitude of 200 feet AGL.

3. All other transitions will be made at standard field operating altitudes, but no less than 800 feet AGL.

4. All flap and slat extensions and retractions will be made at a maximum of 12 units AOA.

4.6.2 External Stores Loading With Up to 66,000 Inch-Pounds (5,500 Foot-Pounds) Asymmetry (AIM-7 on Stations 1B or 8B equals 63,000 inch-pounds)

1. All transitions will be made in wings-level flight with ROLL SAS ON.

2. All normal (flaps and slats fully down) takeoff transitions will be initiated at a minimum altitude of 200 feet AGL.

3. All flap and slat extensions and retractions will be made at a maximum of 12 units AOA.

4.6.3 External Stores Loading With Greater Than 66,000 Inch-Pounds (5,500 Foot-Pounds) Asymmetry

1. All transitions will be made in wings-level flight with ROLL SAS ON at a minimum altitude of 1,200 feet and at a maximum of 12 units AOA.

4.8 GROSS WEIGHT LIMITS TAKEOFF, LAUNCH, AND LANDING

1. Catapult launch - 76,000 pounds. Single-engine rate of climb at 76,000-pound gross weight using optimum flight control technique is predicted to be between 300 and 600 fpm. Emergency jettison of stores may be required to establish adequate rate of climb.

1. Field takeoff and emergency landing (minimum considerations.
rate of descent only) - 72,000 pounds.

2. Field landings - 60,000 pounds.

3. Carrier landings - 54,000 pounds
Field carrier landing practice - 54,000 pounds.

Note

Landing approaches to touchdown should not exceed 17 units AOA to avoid nozzle/ventral fin damage.

2. Carriage of external tanks not incorporating AYC598 is limited to 300 KCAS/0.72 TMN. CV arrestment, CV touch and go, or normal field landings with full or partial fuel in the external tanks is not authorized because of overload of the nacelle backup structure. Only minimum descent rate landings are authorized.

Dive angles in excess of 10 nose down with 900 pounds or more fuel in an external tank will result in fuel venting (dumping).

4.9 EXTERNAL STORES AND GUN LIMITS

4.9.1 280-Gallon External Fuel Tank Limits

1. Catapult launch with a partially filled external tank is not authorized because of surge load

4.11.3 Gun Burst Limits

1. Burst limit - 200 rounds.

If two consecutive 200-round bursts are fired, a 30-second cooldown period is required.

STORE CONFIGURATION	AIRCRAFT STORE STATION						
	1A	1B	2	3, 4, 5, & 6	7	8B	8A
1A(*)	-	-	-	-	-	-	-
1B1	AIM-9	AIM-9	-	-	-	AIM-9	AIM-9
1B2	AIM-9	-	-	-	-	-	AIM-9
1C	-	-	TANK	-	TANK	-	-
2A(*)	-	-	-	4 AIM-7	-	-	-
2B1	AIM-9	AIM-9	-	4 AIM-7	-	AIM-9	AIM-9
2B2	AIM-9	-	-	4 AIM-7	-	-	AIM-9
2B3	AIM-9	AIM-7	-	4 AIM-7	-	AIM-7	AIM-9
2B4	-	AIM-7	-	4 AIM-7	-	AIM-7	-
2C(*)	-	-	TANK	4 AIM-7	TANK	-	-
2C1	AIM-9	AIM-9	TANK	4 AIM-7	TANK	AIM-9	AIM-9
2C2	AIM-9	-	TANK	4 AIM-7	TANK	-	AIM-9
2C3	AIM-9	AIM-7	TANK	4 AIM-7	TANK	AIM-7	AIM-9
2C4	-	AIM-7	TANK	4 AIM-7	TANK	AIM-7	-
3A(*)	-	-	-	4 AIM-54	-	-	-
3B1	AIM-9	AIM-9	-	4 AIM-54	-	AIM-9	AIM-9
3B2	AIM-9	-	-	4 AIM-54	-	-	AIM-9
3B3	AIM-9	AIM-7	-	4 AIM-54	-	AIM-7	AIM-9
3B4	-	AIM-7	-	4 AIM-54	-	AIM-7	-
3B5	AIM-9	AIM-54	-	4 AIM-54	-	AIM-54	AIM-9
3B6	-	AIM-54	-	4 AIM-54	-	AIM-54	-
3C(*)	-	-	TANK	4 AIM-54	TANK	-	-
3C1	AIM-9	AIM-9	TANK	4 AIM-54	TANK	AIM-9	AIM-9
3C2	AIM-9	-	TANK	4 AIM-54	TANK	-	AIM-9
3C3	AIM-9	AIM-7	TANK	4 AIM-54	TANK	AIM-7	AIM-9
3C4	-	AIM-7	TANK	4 AIM-54	TANK	AIM-7	-
3C5	AIM-9	AIM-54	TANK	4 AIM-54	TANK	AIM-54	AIM-9
3C6	-	AIM-54	TANK	4 AIM-54	TANK	AIM-54	-

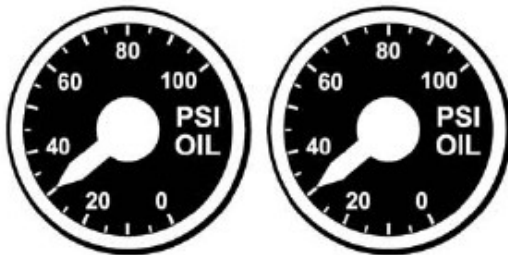
- (*) These store configuration limits also apply when multipurpose stub pylons are carried at stations 1 and 8.
- Flight operating limitations applicable to the above configurations are also applicable to down loadings, except down load of external tank to MXU-776/777 which shall be considered as a clean store station for limitation purposes.
- For captive carriage of inert or live AIM-54, installation of ejector cartridges in LAU-132 is mandatory in order to provide jettison capability.
- For captive carriage of inert or live AIM-7, installation of ejector cartridges in LAU-92 is mandatory in order to provide jettison capability. This does not apply to CATM-7F-2 missiles used for ballast (refer to NAVAIR 01-F14AAD-75 Weapon Stores Loading Manual).
- For shore-based operations all CATM-7F-1 (Sparrow training rounds) shall be configured with a modified shear wafer to preclude inadvertent activation of the guidance and control unit, and subsequent ejection of the missile.
- Simultaneous loading of AIM-7 on store station 4 and AIM-54 on store stations 3 and 6 is an authorized configuration. Limitations of fuselage AIM-54 apply for carriage, individual missile limitations apply for launch/jettison.
- AIM-9 configurations include both LAU-7 and LAU-138 carriage.

WARNING

- In all cases the center of gravity position must remain within limits. The aft limit can be easily exceeded if stations 3 and 6 are not loaded.
- With MA ARM ON and all conditions satisfied for AIM-54 launch, an ATM-54 (training round) will be ejected if the trigger or launch button is depressed.
- With MA ARM ON and all other conditions satisfied for AIM-7 launch, a CATM-7F-1 (Sparrow training round) will be ejected when the trigger or launch button is pressed unless a modified shear wafer is installed. Emergency/selective jettison of a CATM-7F-1 is still possible with a modified shear wafer installed.

Figure 4-1 – Store Stations Configurations (applicable configuration for this FSX rendition is 1C)

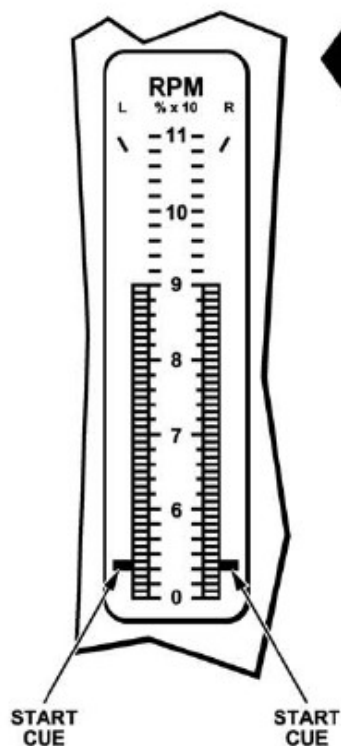
F110-GE-400
OIL: MIL-L-23699 OR MIL-L-7808
FUEL: MIL-J-5624 JP5 (JP4, JP8 ALTERNATES)



OIL PRESSURE

- 15-45 PSI AT IDLE
- 25-65 PSI AT MIL/AB
- ± 5 PSI ALLOWABLE FLUCTUATION

NOTE
 OIL PRESSURE GREATER THAN
 65 PSI ALLOWABLE FOR 1 MIN OR
 LESS ON COLD DAY STARTS



TACHOMETER RPM

107.7%  MAXIMUM RPM

EXHAUST GAS TEMPERATURE

935°C  AFTERBURNER POWER

935°C  MILITARY POWER

890°C  { GROUND STARTS
AIR STARTS

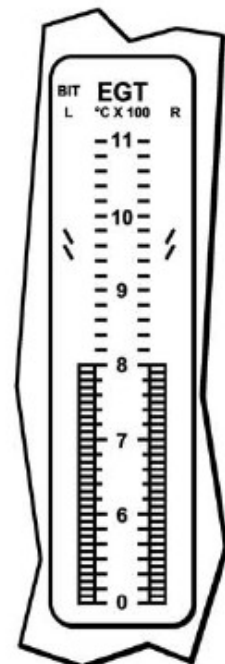


Figure 4-2 Instrument Markings

F110-GE-400 OIL: MIL-L-23699 OR MIL-L-7808 FUEL: MIL-J-5624 (JP-5)(JP-4, JP-8 ALTERNATES)		
OPERATING CONDITIONS		OPERATING LIMITS
THRUST SETTING	MAXIMUM MEASURED EXHAUST GAS TEMP (°C)	NORMAL OIL PRESSURE (PSIG)
MAXIMUM (AFTERBURNING)	935	25 TO 65
MILITARY	935	25 TO 65
IDLE STABILIZED	935	15 TO 45
STARTING (GROUND) (AIRSTART)	890 890	— —
NOTE • OIL PRESSURE WILL INCREASE PROPORTIONATELY WITH RPM. • UNDER COLD CONDITIONS, OIL PRESSURE MAY EXCEED 65 PSI FOR 1 MINUTE.		
RPM LIMITS		
ANY EXCEEDED LIMIT SHOULD BE REPORTED AS A DISCREPANCY AND MAXIMUM RPM, EGT, AND TIME NOTED.		
OPERATING CONDITIONS		OPERATING LIMITS
STEADY STATE OR TRANSIENT		107.7% RPM

Figure 4-3 Engine Operating Limits

DATE : FEBRUARY 1992
DATA BASIS : FLIGHT TEST

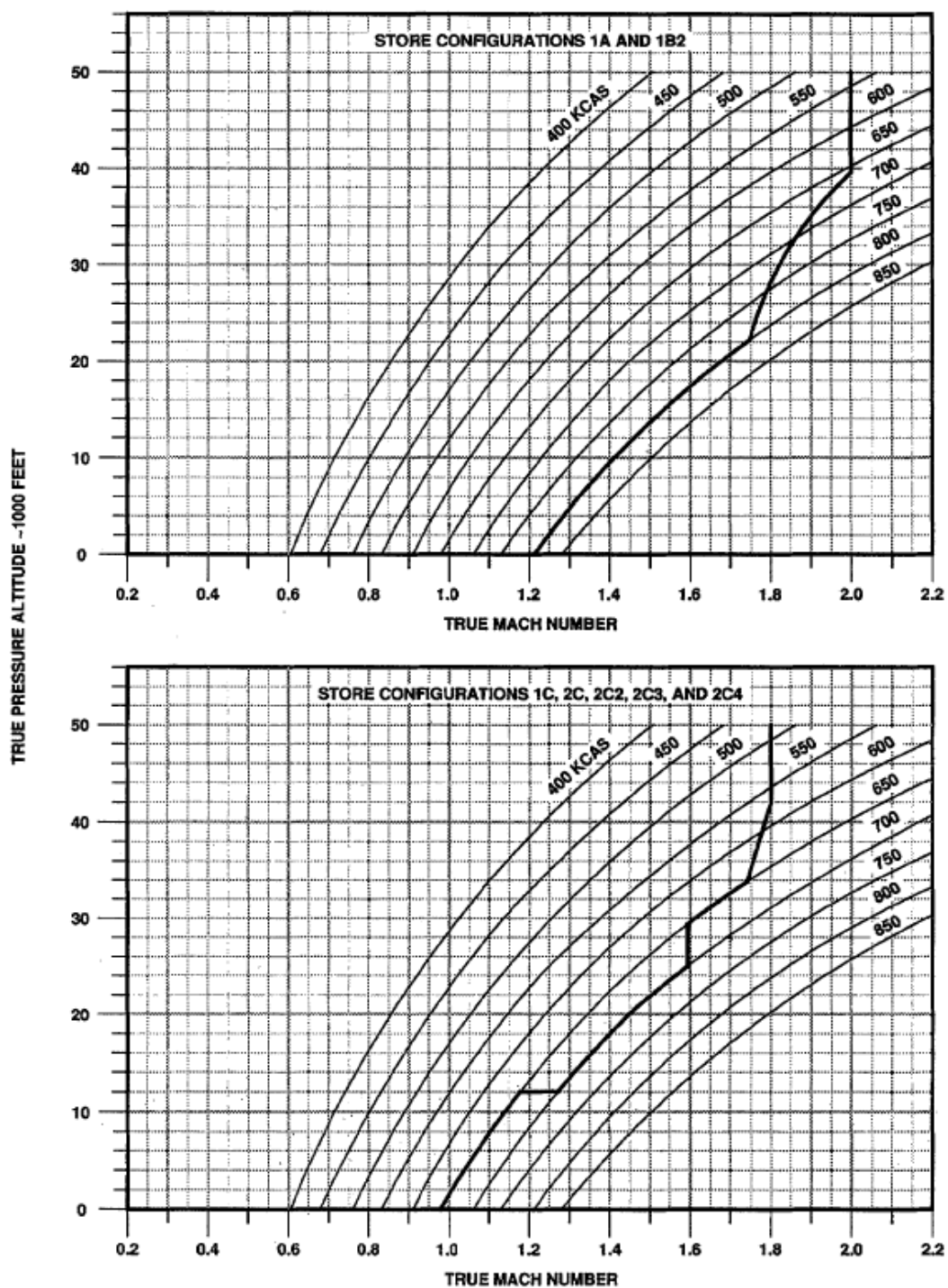


Figure 4-4 Maximum Allowable Airspeeds

DATE: JUNE 1992
DATA BASIS: FLIGHT TEST

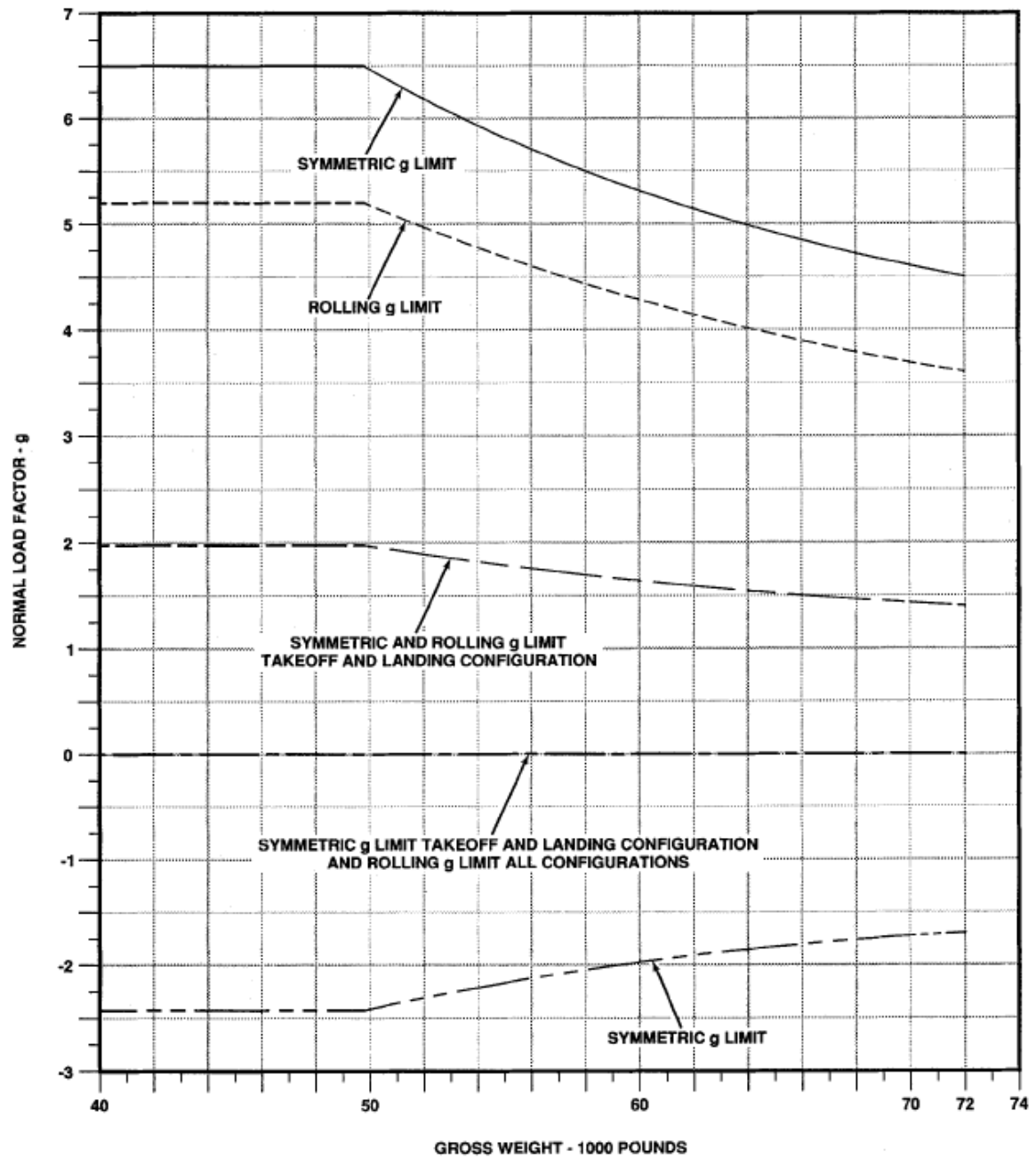
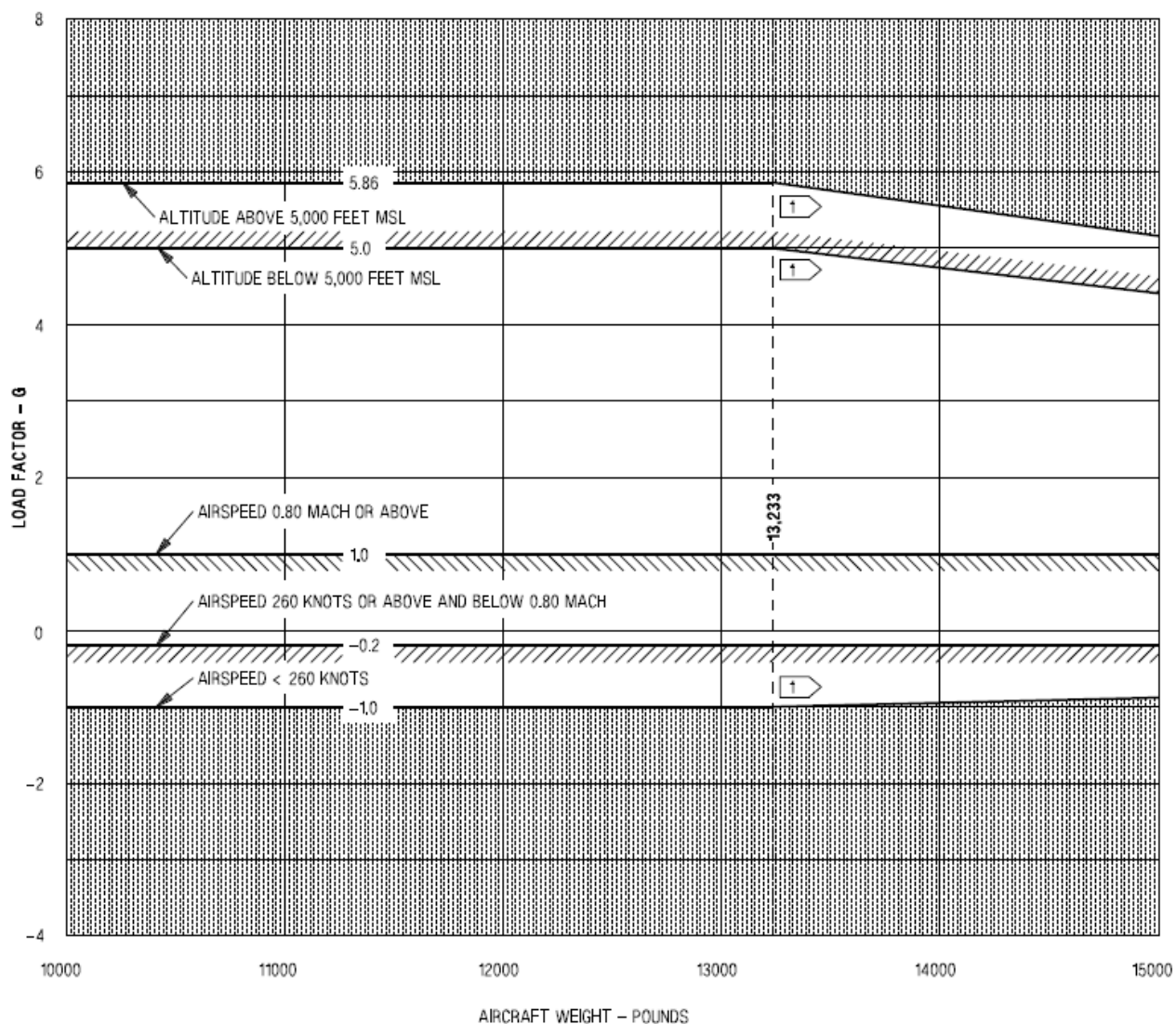


Figure 4-5 Maximum Allowable Load Factor

UNSYMMETRICAL MANEUVERING



LEGEND

1. FOR GROSS WEIGHTS ABOVE 13,233 POUNDS, THE MAXIMUM N_z EQUALS 13,233 MULTIPLIED BY THE LOAD FACTOR LIMIT. FOR AIRCRAFT GROSS WEIGHTS BELOW 13,233, THEN DIVIDED BY THE AIRCRAFT GROSS WEIGHT.

$$N_z = \frac{13233 * (\text{LOAD FACTOR})}{\text{AIRCRAFT WEIGHT}}$$

2. UNSYMMETRICAL MANEUVERS ARE ROLLING MANEUVERS AT OTHER THAN 1 G FLIGHT.

CHAPTER 5

Indoctrination

5.1 INTRODUCTION

NOTE: *This section of the flight manual does not apply to Flight Simulator X and is given for information only.*

5.1 GROUND TRAINING SYLLABUS

5.1.1 Minimum Ground Training Syllabus

The ground training syllabus sets forth the minimum ground training that must be satisfactorily completed prior to operating the F-14D. If the aircrewmember has a current F-14A/B NATOPS qualification, the ground syllabus will consist of the F-14D unique systems. The ground training syllabus for each activity will vary according to local conditions, field facilities, requirements from higher authority, and the immediate unit commander's estimate of squadron readiness. The minimum ground training syllabus for the pilot and the RIO is set forth in the following paragraphs.

5.1.1.1 Familiarization

1. Flight physiological training as appropriate
2. F-14D flightcrew academic course
3. F-14D MFT/WST (within 5 days).

5.1.1.2 Flight Support Lectures

1. F-14D flightcrew academic course.

5.1.1.3 5.1.1.1 Intercept Flight Support

1. F-14D flightcrew academic course.

5.1.1.4 Weapons Firing Flight Support Lectures

1. Weapons preflight procedures
2. Arming/dearming procedures
3. Firing procedures
4. Safety procedures
5. Jettison/dump areas.

5.1.1.5 Field Carrier Landing Practice/Carrier Qualification Flight Support Lectures

1. Mirror and Fresnel lens optical landing system
2. Day landing pattern and procedures
3. Night landing pattern and procedures
4. Shipboard procedures and landing patterns
5. CCA/ACLS procedures
6. In-flight refueling (day/night).

5.1.2 Waiving of Minimum Ground Training Requirements

All F-14D flight crewmembers shall be instructed on the differences from model in which qualified and comply with those items listed below, as directed by the unit commanding officer.

Where recent crewmember experience in similar aircraft models warrant, unit commanding officers may waive the minimum ground training requirements provided the flight crewmember meets the following mandatory qualifications:

1. Has obtained a current medical clearance
2. Is currently qualified in flight physiology
3. Has satisfactorily completed the NATOPS flight manual open- and closed-book examinations
4. Has completed at least one emergency procedure period in the MFT/WST (within 10 days)
5. Has received adequate briefing on normal and emergency operating procedures
6. Has received adequate instructions on the use and operation of the ejection seat and survival kit.

5.2 FLIGHT TRAINING SYLLABUS

5.2.1 Flightcrew Flight Training Syllabus

Before flight, all flight crewmembers will have completed the familiarization and flight support lectures previously prescribed. A qualified FRS instructor pilot will occupy the rear seat for the first familiarization flight. A qualified FRS instructor RIO can occupy the rear seat if the pilot in command has been previously NATOPS qualified in the F-14A/B. The geographic location, local command requirements, squadron mission, and other factors will influence the actual flight training syllabus and the sequence in which it is completed. The specific phases of training are listed in the following paragraphs.

5.2.2 Flightcrew Flight Training Phases

5.2.2.1 Familiarization

1. Military power takeoffs
2. Buffet boundary investigation
3. Approach to stalls
4. Slow flight
5. Acceleration run to Mach 1.3
6. Subsonic and supersonic maneuvering
7. Investigate all features of the DFCS/stab aug
8. Formation flight
9. Aerobatics
10. Single-engine flight at altitude and airstarts
11. Simulated single-engine landings

12. Landing with full and with no flaps
13. Acceleration runs at various altitudes.

5.2.2.2 Instruments

1. Basic instrument work
2. Penetration and approaches
3. Local area round-robin (day and night) flights.

An F-14D pilot is considered instrument qualified if currently instrument qualified in the F-14A/B.

5.2.2.3 Weapons System Employment

Qualification is in accordance with existing training and readiness directives.

5.2.2.4 Field Carrier Landing Practice and Carrier Qualifications

Qualification is in accordance with existing training and readiness directives.

5.3 OPERATING CRITERIA

5.3.1 Ceiling/Visibility Requirements

Before the pilot becomes instrument qualified in the aircraft, field ceiling, visibility, and operating area weather must be adequate for the entire flight to be conducted in a clear airmass according to visual flight rules. After the pilot becomes instrument qualified, the following weather criteria apply:

F-14D HOURS: Less than 10
VFR ONLY

F-14D HOURS: 10 to 20
CEILING AND VISIBILITY: (FEET) (MILES)
800 and 2; 900 and 1½; 1,000 and 1

F-14D HOURS: 20 to 45
CEILING AND VISIBILITY: (FEET) (MILES)
700 and 1; 600 and 2;

F-14D HOURS: 45 and above
Field minimums or 200 and ½, whichever is higher.

F-14A/B FLEET EXPERIENCED AIRCREW:

F-14D HOURS: Less than 10
VFR ONLY

F-14D HOURS: 10 to 30
CEILING AND VISIBILITY: (FEET) (MILES)
700 and 1; 600 and 2; 500 and 3

F-14D HOURS: 30 and above
CEILING AND VISIBILITY: (FEET) (MILES)
Field minimums or 200 and ½, whichever is higher.

Where adherence to these minimums unduly hampers pilot training, commanding officers may waive time-in-series requirements for actual instrument flight, provided pilots meet the following criteria:

1. Have a minimum of 10 hours combined time in the F-14A/B/D
2. Completed two simulated instrument sorties
3. Completed two satisfactory TACAN penetrations
4. Completed five satisfactory ground-controlled approaches.

5.3.2 NATOPS Qualification and Currency Requirements

F-14 NATOPS qualifications are for a specific aircraft series. The following terms are defined for use in interpreting the F-14 qualification and currency requirements.

1. Aircraft type: The broadest classification of aircraft as to its physical characteristics (e.g., fixed wing or rotary wing).
2. Aircraft model: The basic mission symbol and design number of an aircraft (e.g., P-3, F-14, H-3).
3. Aircraft series: The specific version of an aircraft model (e.g., F-14A, F-14B, or F-14D).

5.3.2.1 Initial NATOPS Qualification in Aircraft Series

Initial F-14 NATOPS qualification in series shall include satisfactory completion of the following requirements:

1. Formal ground phase training.
2. The NATOPS open-book, closed-book, and bold face exams.
3. A flight syllabus at a fleet replacement squadron. The syllabus shall include 10 flight hours under instruction, 4 hours of which may be flown in a CNO-approved flight simulator for the same aircraft series.
4. A NATOPS evaluation check in a CNO approved flight simulator by an FRS instructor. If a simulator is not available, a separate NATOPS evaluation checkflight is required.
5. Fleet replacement squadron commanding officers may waive the flight hour requirement for radar intercept officers.

5.3.2.2 Continued NATOPS Qualification

To maintain a continued NATOPS qualification after initial qualification in aircraft series until currency is established, pilots and RIOs shall comply with the minimum flight hour

requirements in each specific phase as determined by the unit commanding officer.

5.3.2.3 NATOPS Currency

Flight crewmembers who have more than 45 hours in F-14A/B/D aircraft model are considered current in aircraft series, provided they continue to satisfy the following requirements:

1. Have satisfactorily completed the ground phase of the NATOPS evaluation check, including OFT/ COT/WST/MFT emergency procedures check (if available) and have completed a NATOPS evaluation check with a grade of Conditionally Qualified or better within the past 12 months.
2. Have flown 10 hours in aircraft model, 5 hours of which shall be in aircraft series, and made five takeoffs and landings in aircraft model within the last 90 days.
3. Are considered qualified by the commanding officer of the unit having custody of the aircraft. Flight crewmembers who are current in the F-14A and F-14D are considered current in the F-14B. NATOPS requalification for the F-14A, and F-14B can be accomplished during the same evaluation check, provided the NATOPS open, closed, boldface, and currency requirements are met for each series.

5.3.2.4 Currency Renewal

Flight crewmembers who have not remained current shall complete the following requirements in order to reestablish currency:

1. Flight crewmembers who have not maintained 10 hours in model, 5 hours of which shall be in aircraft series, and five takeoffs and landings in aircraft model within the last 90 days, shall do the following:
 - a. Complete a safe-for-flight simulator check with a squadron NATOPS instructor.
 - b. Be considered qualified by the commanding officer of the unit having custody of the aircraft.
2. Flight crewmembers who are current in series except for a NATOPS evaluation check within the last 12 months shall do the following:
 - a. Complete a NATOPS evaluation check (including emergency procedures simulator check, NATOPS open-book, closed-book and boldface examinations) with the squadron NATOPS instructor.
 - b. Be considered qualified by the commanding officer having custody of the aircraft.

3. Flight crewmembers without a current NATOPS evaluation check and who have not maintained 10 hours in model, 5 hours in aircraft series, and five takeoffs and landings in aircraft model within the last 90 days shall do the following:

- a. If 6 months or less since last flight:
 - (1) Perform an emergency procedures and safe-for-flight check in a CNO-approved simulator.
 - (2) Fly one flight with squadron NATOPS instructor.
 - (3) Complete a NATOPS evaluation check (including NATOPS open-book, closed-book, and boldface examinations).
 - (4) Be considered qualified by the commanding officer of the unit having custody of the aircraft.
- b. If greater than 6 months since last flight, a repeat of the initial NATOPS qualification requirements is required at the fleet replacement squadron.

5.3.3 Requirements for Various Flight Phases

5.3.3.1 Night: Pilot

1. Combined time in F-14A/B/D not less than 10 hours.

5.3.3.2 Night: RIO

1. Combined time not less than 3 hours in the F-14A/B/D as crewmember.

5.3.3.3 Cross Country: Pilot

1. Have a minimum of 15 hours total in the F-14A/B/D as first pilot or fly with a qualified instructor RIO.
2. Have a valid instrument card.
3. Have completed at least one night familiarization flight in the F-14A/B/D or fly with a qualified instructor RIO.
4. Have completed maintenance checkout for servicing aircraft.

5.3.3.4 Cross Country: RIO

1. Have completed at least one night familiarization flight in the F-14A/B/D or fly with a qualified instructor pilot.

5.3.3.5 Air-to-Air Missile Firing: Pilot

1. Have a minimum of 15 hours combined time in the F-14A/B/D, 5 of which must have been flown in the F-14D.
2. Be considered qualified by the commanding officer.

5.3.3.6 Air-to-Air Missile Firing : RIO

1. Have a minimum of 25 hours combined time in the F-14A/B/D as crewmember, 10 of which must be in the F-14D.
2. Have satisfactorily completed a minimum of two in intercept flights during which simulated firing runs were conducted utilizing the voice procedures and clear-to-fire criteria to be utilized in live firing.
3. Be considered qualified by the commanding officer.

5.3.3.7 Carrier Qualifications

Each crewmember will have a minimum of 50 hours combined time in the F-14A/B/D (15 hours minimum in F-14D), of which 15 hours is night time (5 night hours in F-14D) and meet the requirements set forth in the CV NATOPS manual. Minimum hour requirement for radar intercept officers may be waived by the commanding officer based upon individual experience level and crew composition.

5.3.4 Mission Commander

The mission commander shall be a NATOPS-qualified pilot or RIO, qualified in all phases of the assigned mission, and designated by the unit commanding officer.

5.3.5 Minimum Flightcrew Requirements

The pilot and the RIO (or two pilots) constitute the normal flightcrew for performing the assigned mission for all flights. Unit commanders may authorize rear-seat flights for personnel other than qualified pilots and RIOs provided such personnel have received thorough indoctrination in the use of the ejection seat and oxygen equipment and in the execution of rear-seat functions and emergency procedures. Where operational necessity dictates, unit commanders may authorize flights with the rear seat unoccupied provided the requirement for such

flight clearly overrides the risk involved and justifies the additional burden placed on the pilot. In no case is solo flight authorized for shipboard operations, combat, or combat training missions.

5.4 FLIGHT CREWMEMBER FLIGHT EQUIPMENT REQUIREMENTS

In accordance with OPNAVINST 3710.7, the flying equipment listed below will be worn or carried, as applicable, by flight crewmembers on every flight. All survival equipment shall be secured in such a manner that it will be easily accessible and will not be lost during ejection or landing. All equipment shall be the latest available as authorized by the Aircrew Personal Protective Manual, NAVAIR 13-1-6.

1. Protective helmet
2. Oxygen mask
3. Anti-g suit
4. Fire-retardant flightsuit
5. Steel-toed flight safety boots
6. Life preserver
7. Harness assembly
8. Shroud cutter
9. Sheath knife
10. Flashlight (for all night flights)
11. Strobe light
12. Pistol with tracer ammunition or approved flare gun
13. Fire-retardant flight gloves
14. Identification tags
15. Antiexposure suit in accordance with OPNAVINST 3710.7
16. Personal survival kit
17. Other survival equipment appropriate to climate of the area
18. Full pressure suit and Mk 4 life preserver on all flights above 50,000 feet MSL
19. Pocket checklist
20. Navigation packet.

CHAPTER 6

Flight Preparation

6.1 PREFLIGHT BRIEFING

Preflight briefings shall be conducted immediately before the launch of scheduled flights and must be carried out in an expeditious but thorough manner. Ample time should be given for briefing with external assets as well as for conducting internal element briefs. When scheduling a brief, consideration should be made to ensure that enough time is given for the aircrew to finish briefing, don all flight gear, check out any special items required for the mission (authenticators, cameras, guns), read the aircraft discrepancy book, and man up the aircraft in order to make the scheduled launch time. For this reason, it is imperative that all pilots and RIOs be in flightsuits ready for the brief at the designated time.

The brief should optimally be conducted in a designated briefing room, free of distractions, with a white dry erase board and 1/72 scale aircraft models. A briefing board should be put up prior to the brief, depicting applicable admin items, mission objectives, flight conduct, special instructions, and necessary diagrams. Aircrew should utilize appropriate tactical manuals and current weapon school manuals and journals for mission planning. The brief shall include, but not be limited to, the following.

6.1.1 Administration

The following items should be covered for each flight, regardless of the mission.

1. Event number
2. Launch/recovery times/recovery order
3. Lineup/call signs/avionics plan
4. Mission assigned/alternate missions
5. External assets/call signs
6. Weather
 - a. Base, en route, target, area, divert
 - b. Water/air temperature, sea state
7. Ordnance and stores carried/ preflight/ restrictions on use
8. Communications plan

9. Area/NOTAMs

10. Clearance/NAVAIDs
11. Ground/deck procedures
12. Takeoff/departure/rendezvous
13. En route/formation
14. Tanking plan
15. Combat checks/alpha check
16. Recovery procedures (VFR/IFR)
17. Joker/bingo fuel
18. NORDO procedures
19. Emergencies/diverts/SAR/birdstrike
20. Training rules
21. Contingencies.

6.1.2 Missions

Aircrew should brief each section that applies to their expected mission. Missions not specifically discussed in this chapter should be covered using the appropriate tactical manual.

6.1.2.1 Low-Level/Strike Ingress

1. Time hack
2. Controlling agency route brief
 - a. Restrictions/hot areas
3. Current charts/Chart Update Manual
4. Entry/exit times
5. Formation/altitude/airspeed
6. Navigation mode/plan
 - a. Waypoint LAT/LONG
7. Communications
8. Checkpoints/turnpoints
9. Timing/corrections

10. Radar plan/search contracts
11. Threat awareness (SAM, AAA, A/A)
12. DECM/RWR/expendables
13. Target area ingress Initial point/target
14. Abort criteria/procedures
15. Safety.

6.1.2.2 Air-to-Ground Strike

1. Time hack
2. A/G checklist complete
3. Range/area
4. Time on target
5. Communications
6. Swing fighter consideration
7. Target area tactics
 - a. SEAD window
 - b. Target ID/acquisition
 - c. Tactic/backup tactic
 - d. Aircraft interval/sequence
 - e. Aim points/backup aim points
 - f. Threat awareness (SAM, AAA, A/A)
 - g. DECM/RWR/expendables
8. Weaponeering/switchology
 - a. Target type
 - b. Weapon
 - c. Attack/delivery mode
 - d. Fuze/delay
 - e. Functioning delay
 - f. Interval
 - g. Stick length
 - h. Frag pattern
 - i. Manual MIL setting
 - j. Stations selected
 - k. Laser codes
9. Release conditions
 - a. Dive angle
 - b. Airspeed/Mach
 - c. Release/recovery altitude
 - d. Heading
 - e. Slant range
 - f. Time of fall

10. Off-target rendezvous/egress/RTF
11. Hung ordnance/jettison
12. Abort criteria/procedures
13. Safety.

6.1.2.3 Air-to-Air

1. Mission type/objectives/strike integration/friendly assets
2. Threat awareness (A/A, SAM, AAA)
3. ROE/PID criteria
4. GCI/control/bullseye
5. Precommit
 - a. Position/time/CAP management
 - b. Formation/visual lookout
 - c. Radar gameplan
 - d. Defense in depth
6. Commit
 - a. Authority/criteria
 - b. Abort/reset
7. Intercept
 - a. Geometry/flow
 - b. Formation/altitude/airspeed
 - c. Communications (cadence/priority)
 - d. Radar search responsibilities
 - e. Meld/targeting
 - f. Sort/lock range/no sort
 - g. Missile employment
 - h. Crank/expendables
 - i. Drop criteria/factor bandit range
 - j. Degrades
 - k. Float/split
 - l. Preplanned coordinated maneuvers
 - m. Radar warning receiver
 - n. Abort/reset
8. Approaching the merge/merge
 - a. Fuel package
 - b. IRCM
 - c. Section/division maneuvering
 - d. Engage/blowthrough
9. Postmerge/egress
 - a. Target area considerations/frag
 - b. Flow/new ROE
 - c. Radar gameplan
 - d. Visual lookout doctrine/commit
 - e. Rendezvous
10. Defensive considerations

- a. Communications
- b. Threat/nose position/RWR
- c. Missile/guns defense
- d. E-pole.

6.1.2.4 TARPS

- 1. Mission type
 - a. SSC/mapping/standoff/point target
- 2. Pod checks ☐ on deck/airborne
- 3. Operating area/route/TOT
- 4. Navigation mode/plan ☐ primary/secondary
 - a. INS/GPS/visual/DR
 - b. Checkpoint
 - c. Post target IPs
 - d. Topography/terrain
- 5. Target acquisition/ID/placement

- 6. Sensors
 - a. Primary/secondary/tertiary
 - b. Vg/H settings
 - c. Troubleshooting

- 7. Formation/altitude/airspeed

- 8. Communications

- 9. Radar plan

- 10. Threat awareness (SAM, AAA, A/A)

- 11. DECM/RWR/expendables

- 12. Egress
 - a. Target area considerations/frag
 - b. Rendezvous/RTF

- 13. Abort criteria/procedures

- 14. Safety.

CHAPTER 7

Shore-Based Procedures

NOTE: REAL WORLD CHECKLISTS HAVE BEEN MODIFIED FOR USE IN FLIGHT SIMULATOR X VIDEOGAME.

NOTE: SECTIONS 7.1 TO 7.3 HAVE NO USE IN FLIGHT SIMULATOR X AND HAVE BEEN INCLUDED WITHOUT SPECIFIC MODIFICATIONS. THESE SECTIONS HAVE BEEN INCLUDED FOR INFORMATION ONLY

NOTE: FROM SECTION 7.4 ONWARDS CHECKLIST ITEMS IN *ITALIC* ARE NOT APPLICABLE TO THIS FSX RENDITION OR HAVE NO EFFECT IN THE GAME.

7.1 CHECKLISTS

Aircraft checklists are available in two forms, based on the degree of flightcrew familiarization; since the sequence remains the same, the only difference in the forms is the degree of amplification. As the flightcrew becomes more proficient in type, a more abbreviated form is available to promote operational efficiency, and safety is not compromised since, in all instances, the thoroughness of checks remains the same. The placarded takeoff and landing checklists on the forward cockpit instrument panel is a fundamental element in all instances. In the interest of procedural standardization, the shore-based and carrier-based procedures are maintained the same, except for the response relative to the checks. The expanded procedures presented in this flight manual describe in detail those items that should be checked on each flight. Adherence to these procedures will provide the flightcrew with a detailed status of weapons system performance incident to flight. However, it is incumbent on the flightcrew to expand the checks as necessary to verify the corrective status of previously reported discrepancies.

7.1.1 Tactical Air Reconnaissance Pod System

A [T] preceding the text of a procedural step identifies items pertaining only to TARPS aircraft.

7.2 EXTERIOR INSPECTION

A proper preflight inspection begins with a thorough review of aircraft status and past maintenance history. An understanding of

previous discrepancies, corrective action and their impact on the flight can best be gained at this time. The flightcrew should ensure that any and all discrepancies have been properly corrected or deferred prior to accepting the aircraft as ready for flight.

7.2.1 Area Around Aircraft

En route to the aircraft, attention should be directed to the maintenance effort going on in the line area. The flight crew should ensure that no hazardous situations exist. The entire area should also be generally examined for FOD hazards.

The area around the aircraft that may not be visible from the cockpit should be examined. Particular attention should be paid to support equipment adjacent to the aircraft.

It should be determined that the wings and flight controls can be safely moved and that the effect of jet blast during start and taxi will not create a dangerous situation.

7.2.2 Foreign Object Damage and Leak Inspection

Engine intakes and adjacent deck area are of prime concern since the F110-GE-400 is highly susceptible to FOD damage and the engines are capable of picking up objects from the deck. AICS ramps, bleed doors, ECS cooling intakes, exhausts, and afterburner ducts are catchalls for loose objects. They should be closely inspected for security and foreign objects. Inspect all panels for security and loose fasteners. While inspecting the aircraft for FOD, the flight crew should also be alert for any evidence of oil, hydraulic fluid, or fuel leaks.

7.2.3 Ground Safety Devices and Covers

The following items should be installed:

1. Main landing gear ground safety locks (two)
2. Nose landing gear ground safety pin
3. Tailhook safety pin (ashore)
4. Wheel chocks
5. LAU-7/LAU-138/LAU-92 ground safety pins

6. Sidewinder seeker-head covers (if applicable).
- The following items should be removed:
1. Intake, probe, bleed door, and ECS duct covers
 2. Water-intrusion tape
 3. Launch abort mechanism lock (if the aircraft is to be towed)
 4. Tailhook safety pin (shipboard).
4. Nose wheelwell:
 - a. Electrical leads Connected, No Evidence of Overheating.
 - b. Hydraulic lines - No Chafing or Leaks.
 - c. Doors and linkages - Cotter Pins Installed, No Distortion.
 - d. Brake accumulators □ 1,900 Psi Minimum.
 - e. Canopy air bottle gauge 1,200 Psi Minimum.
 - f. Emergency landing gear nitrogen bottle gauge 3,000 Psi Minimum.
 - g. Emergency landing gear air release valve Ensure That Valve Is in Closed Position.
 - h. Retract actuator Piston Clean, No Leaks.
 - i. Flight maintenance indicator Secure.
 - j. Antiskid control box BIT flags Not Tripped.
 - k. Cabin pressure port screens Clean.
 - l. Master arm override Cover Closed.
 5. Nose strut Piston Clean, Free of Cracks and Scoring, and Uplock Roller Free.
 6. Steering actuator Secure, No Leaks.
 7. Launch bar and holdback fitting
 - a. Abort Full Up.
 - b. Roller Free Rotation.
 - c. Upclatch and holdback Free Movement.
 8. Nosewheels and tires Inflation, No Cuts, Bulges, Uneven Wear, or Imbedded Objects.
 9. Drag brace No Leaks, Door Secure.
 10. Approach lights Lenses Clean, No Cracks, Secure.
 11. TV camera Check, Blue Desiccant.
 12. Dual chin pod IRST, TV Cameras (or simulators), and Anticollision Light Secure.
 13. Radome Lock Handle Fastened, Rosemont

7.2.4 Surface Condition

All surfaces should be checked for cracks, distortion, or loose or missing fasteners. All lights and lenses should be checked for cracks and cleanliness.

7.2.5 Security of Panels

All fasteners should be flush and secure on all panels.

7.2.6 Leaks

All surfaces, lines, and actuators should be checked for oil, fuel, and hydraulic leaks. Particular attention should be paid to the underside of the fuselage, engine nacelles, and outer wing panels.

7.2.7 Movable Surfaces

All movable surfaces (flight controls and high-lift devices) should be inspected for position, clearance, and obvious damage.

7.2.8 Inspection Areas

The following exterior inspection is divided into 10 areas. (See [Figure 7-1](#).) Checks peculiar to only one side are designated (L) or (R) for the left or right side. Both the pilot and RIO should preflight the entire aircraft individually.

7.2.8.1 (A) Forward Fuselage

1. Access panel: fasteners forward of engine inlets - No Loose or Missing Fasteners.
2. Gun - Safety Pin Installed in Clearing Sector Holdback Assembly, Louvers Clear, cannon plug connected, wheelwell armament safety override switch guard down.
3. Probes - Secure, Openings Clear, AOA Probe Free For Rotation.

Probe Straight.

14. OBOGS concentrator vent outlet No Obstructions.

7.2.8.2 (B) Right Inlet

1. Ramps, metal seals, and rubber seals Intact, Free of Dirt, Grit, and Cracks.

2. IGV Blades and Stators Free of Nicks and Cracks. Plane captain to verify that all visible damage has been blended.

3. ECS heat exchanger inlet and fan

a. Fan Free Rotation.

b. Overspeed pin Recessed.

c. ECS inlet Free of FOD, Cables Connected (two).

4. Inlet Free of Standing Water, Drains Clear.

7.2.8.3 (C) Right Nacelle and Sponson

1. Station 7 and 8 stores

a. Stores Aligned.

b. Access panels Secure.

c. Sidewinder missile launcher

(1) LAU-7 Sidewinder coolant doors Latched.

(2) LAU-138 chaff loading and gas bottle safety handle Stowed.

d. Stores safety pins Installed.

If external tank/MXU – 611 aboard:

d. Ground safety handle Pulled.

e. Fuel quantity sight gauge Ball Float Vertical.

f. Sway braces Tightened Down.

g. Hook latched indicator White Vertical Line Visible.

h. Inboard and outboard fuel caps Fastened With Butterfly Latch Secured Facing Aft.

2. Main wheelwell

a. Doors and linkages Secure.

b. Uplock microrollers Free.

c. Uplock hooks Secure.

d. Hydraulic lines No Chafing or Leaks.

3. Drag brace Secure, Downlock Safety Pin Forward.

4. Side brace Seated in Latch.

5. Main struts Pistons Clean, Free of Cracks or Scoring.

6. Brakes Pucks Safety – Wired; Wear Indicators Visible (pins at least flush). Lower Torque Arm Swivel; Key and Key Retainer Properly Installed and Safety Wired.

7. Hubcap Secure, Safety–Wired.

8. Main wheels and tires

a. Wheels and tires Inflation, Cuts, Bulges, Uneven Wear, Imbedded Objects (look behind chocks)

b. Uplock Hooks Secure.

9. Gear down microrollers Contact Made.

10. Engine compartment (if applicable)

a. Integrated drive generator – transmission fluid Fluid Visible, Filter Pins (two) Flush.

b. Engine oil servicing caps Check.

c. Bilges No FOD, Evidence of Overheating, or Leakage.

d. Fuel, oil, and hydraulic lines Free of chafing or Leaks.

e. Bleed air lines No Heat Discoloration or Damage.

f. AB fuel pump filter Pin Flush.

g. Lube and scavenge bypass filter Pin Flush.

h. Oil nozzle filter Pin Flush.

11. Flight hydraulic reservoir 1,800 Psi Minimum,

Filter Pins Flush.

12. Flight hydraulic system tape gauge Minimum of Seven on Tape.

Note: Engine must be running for an accurate reading.

13. Hook dashpot pressure gauge 800 ± 10 Psi.

14. Ventral No Damage, IDG Oil Cooler Intake Clear.

7.2.8.4 (D) Right Glove and Wing

1. Slats, flaps, and cove doors Surfaces and Hinges Secure.

2. Wing cavity seal Free of Cuts and Chafing.

3. Formation and position lights Intact, Lenses Clean.

7.2.8.5 (E) Aft and Under Fuselage

1. Horizontal tails Leading Edges Free of Damage.

2. Exhaust nozzles and fairings:

a. Nozzles and fairings No Cracked or Missing Flaps or Seals.

b. Fairing cable Properly Tensioned (pull on cable, fairing flaps should not move).

c. Bottom surface No Scrapes or Cracks.

d. Spray bars and flameholder Intact.

e. Turbine blades No Evidence of Overheating.

3. Fuel vent No Leakage or FOD.

4. Tailhook

a. Hook point Smooth.

b. Nut and cotter pin Installed.

c. Safety pin Remove if Hook Is Securely Latched Up.

5. Backup flight control module No Leaks (feel after of inspection doors), Filter Pins Flush, Close Both Access Doors.

6. Fuel dump No Leakage From Mast, Free of

FOD.

7. Stations 3 through 6 stores

a. Stores Aligned.

b. Access panels Secure.

c. Stores safety pins Installed.

8. Fuel cavity drains No Leakage.

9. [T] Pod Check for Security.

10. [T] Protective window covers Removed.

11. [T] Camera windows Clean.

12. [T] Camera sensor control As Briefed.

13. [T] Light meter Facing Outboard.

14. [T] Lens filter As Briefed.

7.2.8.6 (F) Left Glove and Wing

1. Slats, flaps, and cove doors Surfaces and Hinges Secure.

2. Wing cavity seal Free of Cuts and Chafing.

3. Formation and position lights Intact, Lenses Clean.

7.2.8.7 (G) Left Nacelle and Sponson

1. Station 1 and 2 racks and stores

a. Racks and stores Aligned.

b. Access panels Secure.

c. Sidewinder missile launcher

(1) LAU-7 Sidewinder coolant doors Latched.

(2) LAU-138 chaff loading and gas bottle safety handles Stowed.

d. Stores safety pins Installed.

If external tanks aboard:

e. Ground safety handle Pulled.

f. Fuel quantity sight gauge Ball Float Vertical.

g. Sway braces Tightened Down.

h. Hook latch indicator White Vertical Line Visible.

i. Inboard and outboard fuel caps Fastened With Butterfly Latch Secured Facing Aft.

2. Main wheelwell

a. Doors and linkages Secure.

b. Uplock microrollers Free.

c. Uplock hooks Secure.

d. Hydraulic lines No Chafing or Leaks.

3. Drag brace Secure, Down Lock Safety Pin Forward.

4. Side brace Seated in Latch.

5. Main struts Pistons Clean, Free of Cracks or Scoring.

6. Brakes - Pucks Safety-Wired; Wear Indicators Visible (pins at least flush). Lower Torque Arm Swivel; Key and Key Retainer Properly Installed and Safety-Wired.

7. Hubcap Secure, Safety-Wired.

8. Main wheels and tires

a. Wheels and tires Inflation, Cuts, Bulges, Uneven Wear, Imbedded Objects (look behind chocks).

b. Uplock hooks Secure.

9. Gear-up microrollers Contact Not Made.

10. Engine compartment (if applicable)

a. IDG Fluid Visible (two) Pins Flush.

b. Engine oil servicing caps Check.

c. Bilges No FOD, Evidence of Overheating, or Leakage.

d. Fuel, oil, and hydraulic lines Free of Chafing or Leaks.

e. Bleed air lines No Heat Discoloration or Damage.

f. Afterburner fuel filter Pin Flush.

g. Lube and scavenge bypass filter Pin Flush.

h. Oil nozzle filter Pin Flush.

11. Combined hydraulic reservoir 1,800 Psi Minimum, Filter Pins Flush.

12. Combined hydraulic system tape gauge Minimum of Seven on Tape.

Note: Engine must be running for an accurate reading.

13. Airstart door Ground Hydraulic and Electric Covers Tight.

14. Ventral No Damage, IDG Oil Cooler Intake Clear.

7.2.8.8 (H) Left Inlet

1. Ramps, metal seals, and rubber seals Intact, Free of Dirt, Grit, and Cracks.

2. IGV Blades and Stators IGV Free of Nicks and Cracks. Plane captain to verify that all visible damage has been blended.

3. Ice detector (L) Secure.

4. ECS heat exchanger inlet and fan

a. Fan Free Rotation.

b. Overspeed pin Recessed.

c. Inlet - Free of FOD, Cables Connected (two).

5. Outboard spoiler module temperature indicator and servicing No Leaks, Fluid Indicator Rod Protruding.

6. Inlet Free of Standing Water, Drains Clear.

7.2.8.9 (I) Fuselage Top Deck and Wings

1. Bleed exit doors Free of FOD, Hardware Intact.

2. ECS heat exchanger exhausts Free of FOD and Cracks.

3. Antennas Check.

4. Overwing fairings No Cracked or Bent Fingers.

5. Eyebrow doors Intact.
6. Speedbrake No Distortion or Leaks.
7. Vertical tails and rudders No Distortion, Lights Intact.

7.2.8.10 (J) Canopy

1. Canopy lanyard Connected, Yellow Flag Attached at Both Ends.
2. Auxiliary canopy bottle Cable Taut.
3. Canopy hooks and seal Secure, Seal Intact.
4. Ejection seat safe-and-arm device safety pins Pulled.
5. Auxiliary canopy bottle gauge 800 psi Minimum.
6. Blade antennas Intact.
7. Canopy Clean, Free of Cracks and Deep Scratches.

7.3 EJECTION SEAT INSPECTION

The pilot and RIO shall perform the following checks on their respective ejection seats prior to flight. The ground safety pin in the seat firing handle is the only ground safety device. It must be removed and stowed before flight. Abbreviated preflight checklists for the ejection seat are provided in the pocket checklist and on the ejection seat headbox.

1. SAFE/ARMED handle SAFE.
2. Manual override handle Full Down and Locked.
3. Catapult manifold valve Secure, Hoses Connected. Check that retaining pin is installed.
4. Top latch mechanism Latched.
Check that indicator plunger is flush with end of top latch plunger.

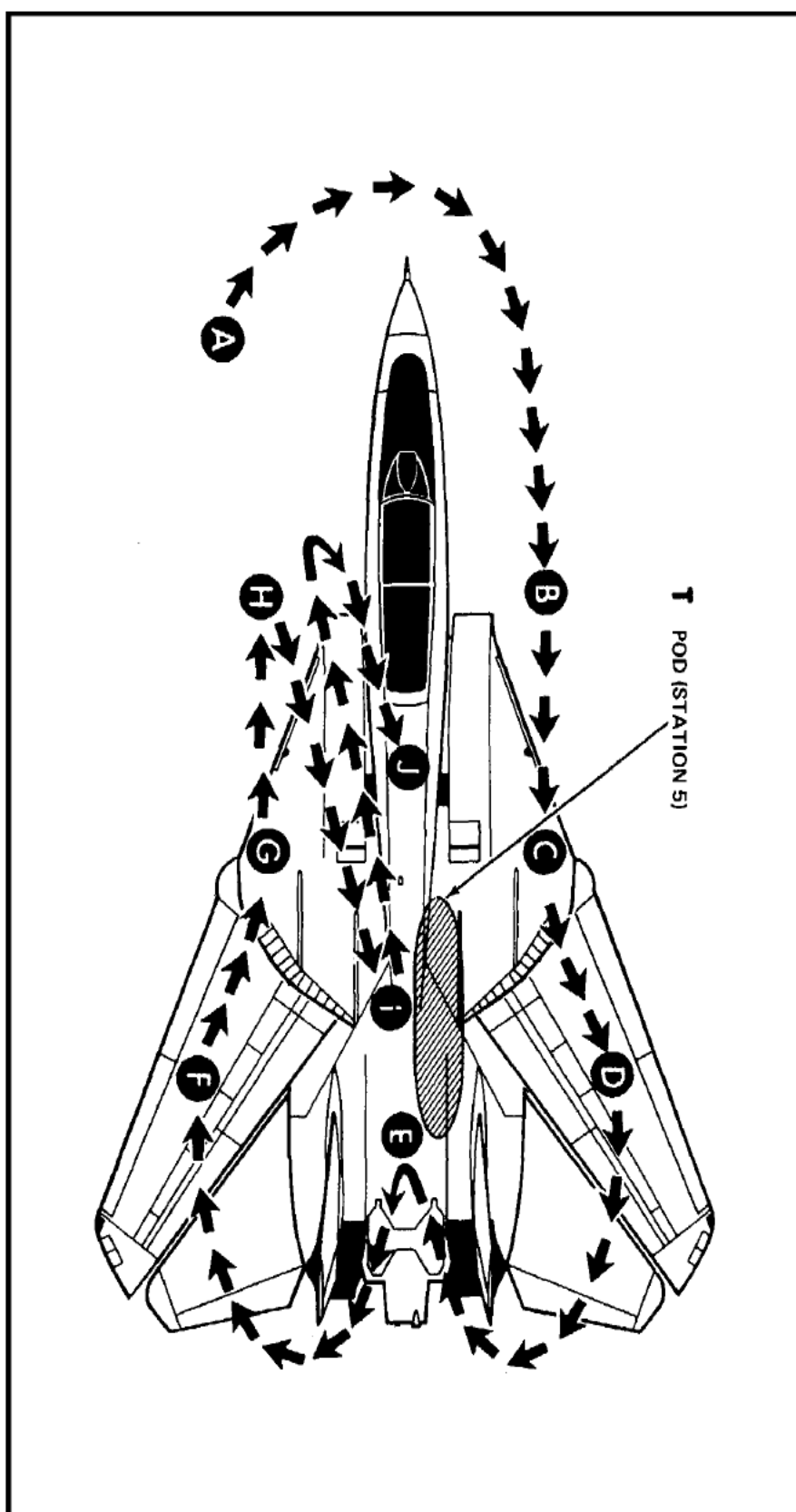
WARNING!

If the top latch mechanism is not latched, the seat could rise up the catapult rails during aircraft maneuvers.

5. Parachute withdrawal line Connected.

Check that parachute withdrawal line is correctly secured to parachute deployment rocket stirrup.

6. Left pitot head Stowed.
7. Thermal batteries Not Expended.
Check that battery-expend indicator on electronic sequencer is not activated.
8. Left trombone tubes Connected, Retaining Pin Installed.
9. Leg restraint lines Secured to Deck, Not Twisted, End Fittings Secured in Seat Bucket Locks.
10. Seat firing initiators Firing Linkage Connected to Seats.
11. Pyrotechnic quick disconnects Connected, Red Bands Not Visible.
12. Survival kit Check.
 - a. Oxygen pressure gauge In the Black.
 - b. Emergency oxygen manual actuator Connected and Stowed.
 - c. Emergency oxygen and locator beacon lanyards Connected to Deck.
13. Oxygen/communications and anti-g lines Connected to Aircraft Connections.
14. Personnel services disconnect block Secured to Seat Bucket, Lanyard Attached to Deck.
15. Lapbelts Secure. Pull up on each lapbelt to ensure that lugs are secure in seat bucket locks.
16. Right trombone tubes Connected, Retaining Pin Installed.
17. Right pitot head Stowed.
18. Parachute container lid Secure, Sealed.
Check environmental seal indicator for correct indication. Ejection Seat Safe-and-Arm Module
19. Parachute risers Properly Routed. Check that risers are routed down forward face of parachute container and behind retention strap.
20. Ejection seat and canopy pins Stowed.



7-1 Exterior Inspection

7.4 PILOT PROCEDURES

The interior inspection provides a systematic coverage of all cockpit controls to ensure proper setup prior to the application of external power, assuming no external air-conditioning source will be used prior to engine start. These checks correspond to the condition that the plane captain should set up in the cockpit as part of the preflight. Each cockpit setup consists of a sequential sweep of controls on the left console, instrument panel, and right console.

7.4.1 Interior Inspection – Pilot

WARNING!

NATOPS prohibits the attaching or stowing of unauthorized equipment on or above the canopy rails during CV launch and arrestment, due to the potential for missile hazard.

1. Harnessing Fasten.

a. Leg restraint lines and garters Connect. Ensure that leg lines are not twisted or looped.

b. Lapbelt Connect and Adjust. Connect lapbelt straps and adjust snug so as to provide secure lap restraint in flight and seat kit suspension for ground egress or ejection.

c. Parachute release fittings Attach to Harness Buckles.

d. Anti-g and oxygen/communication leads Attach. When connecting the oxygen/communication fitting, avoid twisting the hard hose.

e. Inertia reel Check. Position shoulder harness lock lever forward to lock position. Check that both shoulder straps lock evenly and securely. Move lever aft to unlock harness. Attach composite fitting without causing unnecessary twisting of hard hose.

2. OBOGS master switch OFF.

3. TONE VOLUME controls Set.

4. ICS panel

a. VOL knob As Desired.

b. Amplifier NORM.

c. Function switch COLD MIC.

5. Radio VOLUME panel.

a. JTIDS SEL switch Set.

b. VOLUME knobs As Desired.

6. TACAN mode switch OFF.

a. Channel Set.

b. VOL knob Counterclockwise.

7. STAB AUG switches OFF.

8. U/VHF OFF.

WARNING!

The emergency wingsweep handle can be moved independent of the wings and wingsweep indicators when no hydraulic power and/or electrical power are on the aircraft. Care must be taken to accurately determine the position of the emergency wingsweep handle prior to application of hydraulic power. Inadvertent wingsweep to the position selected by the emergency wingsweep handle may occur, resulting in potential damage to the aircraft. When positioning the wings during ground operation other than pilot poststart or postlanding checklist procedures, use the emergency wingsweep handle to minimize the possibility of moving the wings inadvertently.

9. Wing-sweep switch MAN.

10. Emergency wingsweep handle Corresponding.

11. Left and right throttles OFF.

12. Exterior lights master switch Set. Position switch in accordance with standard procedures for day or night and field or carrier operations.

13. FLAP handle: CORRESPONDING.

14. Throttle friction lever - OFF (aft).

15. *ASYM LIMITER switch ON (guard down).*

16. *L and R ENG mode switches PRI.*

17. *BACK UP IGNITION switch OFF.*

18. *THROTTLE TEMP switch NORM.*

19. *THROTTLE MODE switch BOOST.*

20. *L and R INLET RAMPS switches AUTO.*

21. *ANTI SKID SPOILER BK switch OFF.*

22. *FUEL panel*

a. *WING/EXT TRANS switch AUTO.*

b. *REFUEL PROBE switch RET.*

c. *DUMP switch OFF.*

d. *FEED switch NORM (guard down).*

23. *LDG GEAR handle DN.*

Check HYD ISOL switch in TO/LDG.

24. *NOSE STRUT switch OFF.*

25. *Parking brake Pull.*

26. *Altimeter Set.*

Set field or carrier elevation as applicable.

27. *Radar altimeter OFF.*

28. *Standby attitude gyro Caged.*

29. *Left and right FUEL SHUT OFF handles In.*

30. *MA ARM switch OFF (guard down).*

31. *ACM switch OFF (guard down).*

32. *Multifunction display mode switches OFF.*

Note: Visually check for security of cockpit equipment, particularly the multifunction displays, HUD, and instrument panel gauges.

33. *Clock Wind and Set.*

34. *Fuel BINGO Set.*

Set total fuel remaining value for initial activation of fuel BINGO caution reminder consistent with mission profile to be flown.

35. *Circuit breakers Checked.*

36. *HYD HAND PUMP Check.*

Extend handpump handle and stroke to check firmness of pumping action and an indication of pressure buildup on the brake pressure gauge. Stow handpump handle in a convenient position for ready access.

37. *HOOK handle Corresponding.*

38. *GUN ROUNDS panel Set.*

39. *DISPLAYS panel*

a. *HUD MODE switch Set.*

b. *HUD DECLUTTER switch Set.*

c. *HUD FORMAT switch Set.*

d. *HUD/VDI ALT switch BARO.*

e. *HUD PWR switch OFF.*

f. *ECM switch Set.*

g. *TCS FOV switch Set.*

40. *ELEV LEAD knob Set.*

41. *SW COOL switch Set.*

42. *L and R generator switches NORM.*

Ground engine operation without electrical power supplied by either the generators or external power may cause 20-mm ammunition detonation because of excessive heat in the gun ammunition drum.

43. *EMERG generator switch NORM (guard down).*

44. *Air-condition controls*

a. *TEMP mode select switch AUTO.*

b. *TEMP thumbwheel control As Desired*

c. *CABIN PRESS switch NORM.*

d. *AIR SOURCE OFF.*

45. *WSHLD AIR switch OFF.*

46. *ANTI-ICE switch AUTO/OFF.*

47. ARA-63 panel

a. CHANNEL selector - Set.

b. POWER switch OFF.

48. MASTER LIGHT panel controls As Required. Set external and interior lighting controls consistent with day or night and field or carrier operating conditions.

49. MASTER TEST switch OFF.

50. EMERG FLT HYD switch AUTO (guard down).

51. HYD TRANSFER PUMP switch SHUTOFF (guard up).

52. CANOPY air diffuser lever CABIN AIR.

53. VIDEO CONTROL switch OFF.

54. Storage case Inspect.

Check adequacy of flight planning documents and storage of loose gear.

7.4.2 Prestart Pilot

1. External electrical power ON.

2. If wings are not in OV SW:

a. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2/MANUV FLAP cb's Pull (LD1, LE1).

b. Emergency WING SWEEP handle Extend and Match Captain Bars With Wing Position Tape.

CAUTION!

Wings will move to emergency handle position regardless of wing-sweep cb position. Note: If wings are in OV SW, do not extend handle.

3. ICS Check.

4. Landing gear indicator and transition light _ Check. Check gear position indication down and transition light off.

5. MASTER TEST switch Check. Coordinate with RIO.

a. LTS.

Check that all warning, caution, and advisory lights illuminate. The brightness of the indexer lights should be set during the test.

b. FIRE DET/EXT.

L and R FIRE lights illuminate to verify continuity of respective system. The GO light will illuminate verifying continuity through the four squib lines, that 28 Vdc is available at the left and right fire switches, and that the fire extinguisher containers are pressurized.

c. INST

Check for the following responses after 5 seconds:

(1) RPM 96 percent.

(2) EGT- $950 \pm 10C$.

Initiates engine overtemperature alarm.

(3) FF 10,500 Pph.

(4) AOA (units) $18 \pm .5$ Reference and indication.

(5) Wing sweep 45 ± 2.5 .

Program, command, and position.

(6) FUEL QTY 2,000 $\pm$ 200 Pounds (both cockpits).

(7) Backup oxygen pressure 1,800 to 2,100 Psi.

(8) L and R FUEL LOW lights Illuminated (both cockpits).

d. MASTER TEST switch OFF.

6. Ejection seat SAFE/ARMED handles – ARMED. Verify seat armed with RIO.

7. CANOPY Clear RIO To Close.

WARNING!

Flightcrews shall ensure that hands and foreign objects are clear of front cockpit handholds and top of ejection seats and canopy sills to prevent personal injury and/or structural damage during canopy opening or closing sequence. Only minimum clearance is afforded when canopy is transitioning fore and aft.

Note:

If CLOSE does not close the canopy, depress the grip latch, release and push handle outboard and forward into BOOST. If it is necessary to use BOOST, the handle shall be returned to CLOSE to avoid bleed-off of pneumatic pressure.

8. LAD/CANOPY light OFF.

Plane captain shall stow boarding ladder and steps.

9. Inform RIO Ready To Start.

10. Starter air ON.

The ECS air source shall remain off during engine start until external air is disconnected in order to reduce the possibility of bleed air duct contamination.

7.4.3 Engine Start Pilot

Prior to engine start, the pilot and plane captain should ascertain that the turnup area is clear of FOD hazards, adequate fire-suppression equipment is readily available, and engine intakes and exhausts are clear. Although the engines cannot be started simultaneously, either can be started first.

The following procedure establishes starting the right engine first. Whenever possible the aircraft should be positioned so as to avoid tailwinds, which can increase the probability of hot starts.

WARNING!

Coordinate movement of any external surfaces and equipment with the plane captain or director.

CAUTION!

If engine chugs and/or rpm hangup is encountered with one engine turning during normal ground start, monitor EGT for possible hot start. AIR SOURCE pushbutton should be set for the operating engine until rpm stabilizes at idle; then set to BOTH ENG.

To prevent possible engine overtemperature during crossbleed start attempts, select the operating engine for air source and return to BOTH ENG after rpm stabilizes at idle or above.

1. ENG CRANK switch L (left engine).

2. ENG CRANK switch - OFF.

3. ENG CRANK SWITCH - R (right engine).

5. EMERG FLT HYD switch LOW-HIGH-AUTO (LOW).

a. EMERG FLT HYD switch LOW.

Check that ON flag is displayed in EMER FLT LOW hydraulic pressure window. Verify control over horizontal tail and rudder control surfaces as viewed on surface position indicator.

b. EMERG FLT HYD switch HIGH.

Check that ON flag is displayed in EMER FLT HI hydraulic pressure window. Verify control over empennage flight control surfaces and higher surface deflection rate.

c. EMERG FLT HYD switch AUTO (LOW).

Check that OFF flags are displayed in both EMER FLT HI and LOW hydraulic pressure windows.

CAUTION!

Combined and brake accumulators should be charged prior to backup module checks. Checks should be made slowly enough to ensure continuous ON indication in the hydraulic pressure indicator and to prevent damage to the pump or motor.

Note:

Ensure combined and flight hydraulic pressures are zero prior to testing emergency flight hydraulic system to allow proper check of 300-psi priority valve.

6. ENG CRANK switch R (right engine).

Place the crank switch to the R position where the switch is solenoid held until automatically released to the neutral (OFF) position at the starter cutout speed of approximately 49 to 51-percent rpm. Manual deselect of the switch to OFF will interrupt the crank mode at any point in the start cycle. Oil pressure and flight hydraulic pressure rise will become evident at 20-percent rpm.

CAUTION!

If no oil pressure or hydraulic pressure is indicated, start shall be aborted by setting ENG CRANK switch to OFF.

If the ENG CRANK switch does not automatically return to the OFF position by 50-percent

rpm during start, ensure that the **ENG CRANK** switch is off prior to 60-percent rpm to prevent starter overspeed.

If the **START/VALVE** caution light illuminates after the **ENG CRANK** switch is off, select **AIR SOURCE** to OFF to prevent starter overspeed.

When attempting a crossbleed or normal ground start, do not attempt to reengage the **ENG CRANK** switch if the engine is spooling down and rpm is greater than 46 percent. Between 30 and 46-percent rpm, the **ENG CRANK** switch may not stay engaged because of normal variations in starter cutout speed.

Note:

During cold starts, oil pressure may exceed 65 psi. This pressure limit should not be exceeded for more than 1 minute.

7. Right throttle IDLE at 20-Percent Rpm.

CAUTION!

If an idle crossbleed start is attempted with high-residual engine EGT and/or throttles are advanced from OFF to IDLE prior to 20-percent rpm, higher than normal EGT readings may occur. If the EGT appears to be rising abnormally, increasing the supply engine to 80-percent rpm may yield a normal start temperature.

Note

Advancing the R throttle from OFF to IDLE automatically actuates the ignition system. An immediate indication of fuel flow (300 to 350 pph) will be exhibited and light-off (EGT rise) should be achieved within 5 to 15 seconds. Peak starting temperatures will be achieved in the 40 to 50-percent rpm range. After a slight hesitation, the EGT will return to normal. Exceeding 890C constitutes a hot start. During the initial starting phase, the nozzle should expand to a full-open (100 percent) position. Loss of electrical power may result in smoke entering the cockpit via the ECS.

8. R GEN light - OUT.

The right generator should automatically pick up the load on the left and right main ac buses as indicated by the R GEN light going out at approximately 59-percent rpm.

9. R FUEL PRESS light OUT.

The fuel-pressure lights should go off by the time the engine achieves idle rpm.

10. Idle engine instrument readings Check.

a. RPM - 62 to 78 Percent.

b. EGT 350 to 650C (nominal).

c. FF 950 to 1,400 Pph (nominal).

d. NOZ position 100 Percent.

e. OIL 25 to 35 Psi (nominal) (15 psi minimum).

f. FLT HYD PRESS 3,000 Psi.

11. External power Disconnect.

NOTE: Readings may differ in this FSX rendition

WARNING!

Ground engine operation without electrical power supplied by either the generators or external power may cause 20-mm ammunition detonation because of excessive heat in the gun ammunition drum.

12. ENG CRANK switch L (left engine).

When combined hydraulic pressure reaches 3,000 psi, return switch to neutral (center position).

13. *HYD TRANSFER PUMP switch NORMAL Hydraulic transfer pump will operate from flight side to maintain the combined side between 2,400 to 2,600 psi.*

CAUTION!

If the transfer pump does not pressurize the combined system within 5 seconds, immediately set HYD TRANSFER PUMP switch to SHUTOFF.

14. HYD TRANSFER PUMP switch SHUTOFF.

15. Repeat steps 6 through 10 for left engine.

16. Starter air Disconnect.

17. AIR SOURCE L ENG, R ENG, then BOTH ENG.

Verify cockpit airflow in each position.

CAUTION!

Ensure ECS service air is available to OBOGS prior to selecting the OBOGS master switch ON.

18. OBOGS master switch ON.

19. HYD TRANSFER PUMP switch NORMAL.

20. Ground safety pins Remove and Stow.
Plane captain should remove landing gear pins and tailhook safety pin (ashore) and stow them.

7.4.4 Poststart Pilot

1. STAB AUG switches All ON.

2. MASTER TEST switch EMERG GEN.

The resultant power interruption should cause the DFCS flight control computers to self-isolate, activating the lights listed below. With a good emergency generator check, (green 'GO' light) ensure that all lights clear with a MASTER RESET prior to deselecting the emergency generator. DFCS voltage monitoring should result in illumination of all lights when emergency generator is deselected.

Lights will remain on when normal voltage is regained, requiring a MASTER RESET to re-engage DFCS flight control computers. STAB AUG switches should remain engaged.

DFCS caution/advisory lights:

PITCH SAS, ROLL DGR, YAW DGR, FCS CAUTION, ARI DGR, ARI/SAS OUT, HZ TAIL AUTH, RUDDER AUTH, SPOILERS, AUTO PILOT, & MACH TRIM.

3. MASTER RESET pushbutton Depress.
Verify DFCS caution lights extinguished.

4. MASTER TEST switch OFF.

5. MASTER RESET pushbutton Depress.
Verify DFCS caution lights extinguished. STAB AUG switches should not disengage.

6. Advise RIO that test and checks are completed.

7. Controls and displays ON.

8. AFTC Check.

a. L ENG MODE SELECT switch SEC.
L ENG SEC light illuminates; left NOZ indicator pointer below zero.

b. L ENG MODE SELECT switch PRI.

L ENG SEC light goes out, left NOZ indicator to 100 percent.

c. R ENG MODE SELECT switch SEC.
R ENG SEC light illuminates, right NOZ indicator pointer below zero.

d. R ENG MODE SELECT switch PRI.
R ENG SEC light goes out, right NOZ indicator to 100 percent.

CAUTION!

Selecting secondary (SEC) mode closes exhaust nozzles increasing exhaust nozzle jet-wake hazard.

Note

Performing AFTC check during OBC inhibits AICS ramps from programming. Ramps must be reset before another OBC can be performed. Operating engines in secondary mode inhibits the engine monitoring system portion of FEMS until primary mode is reselected.

9. Emergency WING SWEEP handle OV SW.

CAUTION! If the over" flag is not displayed in the wing-sweep indicator with the wings in oversweep, the stick should remain centered.

If wings are not in oversweep, move the wings to 68 using wing sweep emergency handle in raised position. Then raise handle to full extension and hold until HZ TAIL AUTH caution light goes out and OVER flag appears on wing-sweep indicator. Move handle to full aft OV SW and stow.

10. WING-SWEEP MODE switch AUTO.

11. WING SWEEP DRIVE NO. 1 and WG SW DR; NO. 2/MANUV FLAP cb's IN (LD1, LE1).

12. WING/EXT TRANS switch OFF.

13. OXYGEN SUPPLY valve ON.

Turn OXYGEN SUPPLY valve ON, place mask to face and check for normal breathing, regulator, and mask operation. Turn OXYGEN SUPPLY valve OFF, check no breathing.

14. COMM/NAV/GEAR/DISPLAYS ON.

a. V/UHF RADIO MODE switch T/R or T/R & G.

- b. TACAN function selector T/R.
- c. MFDs ON.
- d. ARA-63 POWER switch ON.

e. HUD PWR switch-ON.

f. Radar altimeter ON.

g. VIDEO control switch ON.

15. Trim Set 000.

16. Standby gyro Erect.

17. MASTER RESET pushbutton Depress.

18. DCP Verify codes (FAIL, FLT, IBIT).

Note

An FCS CAUTION at this point probably indicates a PQVM fault due to a lack of pitch and roll attitude inputs from the IMU (DCP FAIL group will indicate IMU). This fault will not affect DFCS IBIT results and can be cleared with a MASTER RESET before or after, but not during OBC.

19. MASTER TEST switch OBC.

20. AUTOPILOT switch ENGAGE.

CAUTION!

OBC commencement with autopilot engaged and nose down trim may result in a force link disconnect when the stick hits the forward stick stop during the pitch parallel actuator checks.

21. Failure History File Clear.

22. MFD OBC TEST Select.

(Coordinate with RIO and plane captain.)

WARNING!

Increased suction around intakes during inlet ramp programming and the automatic movement of the horizontal stabilizers presents a FOD hazard and a potential for injury to ground personnel not clear of these areas.

The following systems are automatically exercised during the 1½ minutes required to complete the OBC tests. Failures are displayed on the TID display.

a. The AICS self-test turns on hydraulic power and exercises the ramps through full cycle:

STOW-EXTND-STOW. During the test, the respective RAMP light illuminates until the ramps return to the fully stowed position and the hydraulics are shut off. A failure is indicated by an INLET light and/or OBC readout.

b. AUTO THROTTLE.

This test is a computer self-test with output commands inhibited to prevent throttle movement.

c. Verify DFCS IBIT operation by flashing A/P REF and ACLS advisories. During the course of the test, the DFCS caution lights remain illuminated until the test is satisfactorily completed.

All lights should be off at termination of test. Observe following:

DFCS caution and advisory lights

Pitch trim check (slow longitudinal stick motion)

Pitch parallel actuator (rapid longitudinal stick

motion)

Individual spoiler operation (only if wings 20° and flaps down)

Stab actuator tests (horizontal tail and rudder movement)

Autopilot disengage

Rudder pedal shaker

DCP display LED check

d. Check for PASS" in DCP. If faults are displayed, record FCS fault codes using INC/DEC push buttons. Ensure FAIL and FLT codes are cleared prior to takeoff.

23. Speedbrake switch EXT, then RET.

Cycle speedbrake switch to EXT; release and check for partial extension. Select EXT again, checking indicator for transition for full extension. Select RET and check indicator for an indication of full retraction. Check for stabilizer position fluctuation during speedbrake extension and retraction to verify integrated trim operation.

24. REFUEL PROBE switch ALL EXT, then RET.

Cycle the probe to the extend position, noting illumination of the probe transition light with switch-probe position disparity. Check probe nozzle head for condition. Retract probe and again check that transition light goes out when fully retracted and doors closed.

25. WSHLD AIR switch Cycle.

26. MASTER TEST switch OFF.

If engaged, verify that autopilot disengages automatically.

27. WING/EXT TRANS switch OFF.

28. Trim Checked and set 000.

CAUTION!

Ensure adequate clearance before moving wings. Sweep times from 68° to 20° in excess of 9 seconds may be indicative of an impending wingsweep motor failure and should be further investigated.

Note

For CV operations, omit steps 29 through 55.

29. EMERGENCY WING SWEEP handle 20. Move the emergency WING SWEEP handle to 20 (full forward) and engage the spider detent. Stow handle and guard. HZ TAIL AUTH light illuminates coming out of OVSW. Light goes off when OVSW stops removed.

30. MASTER RESET pushbutton Depress. The WING SWEEP warning and advisory lights go out and the AUTO and MAN modes are enabled.

31. External lights Check (prior to night/IMC flight).

WARNING!

During night operations, aircraft with inoperable tail and aft anticollision lights will not be visible from the rear quadrant even under optimum meteorological conditions, thus increasing midair potential.

32. Flaps and slats DN.

Check for full deflection of the flaps and slats to the down position and automatic activation of the outboard spoiler module. Check for 3 TEU stabilizer position.

33. Flight controls Cycle.

Complete full cycle sweep of longitudinal, lateral, directional, and combined longitudinal-lateral controls while checking for full authority on surface position indicator. Check that all spoilers extend at the same rate with slow lateral stick deflections and extend to full up position.

Observe the following:

a. Pitch control 36 TEU to 9 TED horizontal tail (33° to 12° without ITS).

b. Lateral control 24 total differential tail.

c. Directional control ± 30 rudder.

d. Longitudinal/Lateral combined 35 TEU, 15 TED horizontal tail.

e. Spoilers 55°.

Note

A stabilizer vibration may occur when the control system linkage is held in contact with the tail stops fully engaged during stick cycling checks. This vibration is acceptable, provided it damps when the control stick is moved to clear the stop in contact. Clearance from the stop can best be verified by movement of the matching stabilizer indicator needle away from its maximum travel position.

34. DLC Check.

Verify horizontal tail shift with DLC input.

35. ANTI SKID SPOILER BK switch SPOILER BK.

36. Spoilers and throttles Check.

37. ANTI SKID SPOILER BK switch OFF.

38. DCP Verify codes (FAIL, FLT, IBIT).

Aircraft shall be considered down with PFCC, RFCC, or YFCC codes in the DCP FAIL group or with an inoperative DCP display. Initiation of OBC/IBIT with this condition will result in invalid IBIT indications.

39. MASTER TEST switch DFCS BIT (IBIT ARM). (Coordinate with RIO and plane captain.)

40. AUTOPILOT switch ENGAGE.

41. MASTER TEST switch DFCS BIT (IBIT RUN).

(Coordinate with RIO and plane captain.)

42. DCP Verify & record codes (FAIL, FLT, IBIT). Check for PASS" in DCP. If faults are displayed, record FCS fault codes using INC/DEC pushbuttons.

43. DCP Clear codes (FAIL & FLT).

Ensure FAIL and FLT codes are cleared prior to takeoff.

44. Flaps and slats UP.

45. Maneuver flaps DN.

46. WING-SWEEP MODE switch MAN 50°.

CAUTION!

If wing-sweep commanded position indicator (captain bars) does not stop at 50, immediately select AUTO with WING-SWEEP switch.

47. Maneuver flaps Crack up.

48. WING-SWEEP MODE switch BOMB.
Check maneuver flap retraction.

49. EMERGENCY WING SWEEP handle 68.

50. EMERGENCY WING SWEEP handle OV SW.

51. WING-SWEEP MODE switch AUTO.

52. MASTER RESET pushbutton Depress.

53. ANTI SKID SPOILER BK switch BOTH.

54. ANTI SKID BIT.
Ensure coarse alignment is completed before releasing parking brake.

55. ANTI SKID SPOILER BK switch OFF.
Note
CV checklist resumes.

56. Radar altimeter BIT.
Depress SET knob; check that radar altitude displays 100 feet and indicator green light is illuminated. Release knob and pointer should display 0 feet; warning tone signal (both cockpits) and ALT LOW light illuminated momentarily.

57. Displays/SMS Check.
Note
If tanks are not ID'd on the SMS page, the possibility exists that they will jettison with weight off wheels or fail to jettison if selected airborne.

58. TACAN BIT.

59. ARA-63 BIT.

60. HUD-VIDEO BIT.

61. Altimeter Set.
Barometric setting and error determined.

62. Compass CHECK.
Validate inertial navigation system desired heading on the display by cross-checking with the SAHRS derived heading on the BDHI. Cross-checking can also be accomplished by

cycling the navigation system between INS and SAHRS.

63. SAHRS attitude reference Check.
With parking brake in, check SAHRS attitude reference by boxing, then unboxing SAHRS on the MFD OWN A/C format. HUD attitude should not change.

Note
Do not perform this check by boxing SAHRS, then boxing INS. This will manually select INS, preventing an automatic change to SAHRS in the event of INS failure.

64. Flight instruments - Check.

65. Oxygen monitor Test.

7.4.4.1 Final Checker (Ashore)

1. NOSE STRUT switch KNEEL; Check Launch Bar DN.

CAUTION!

Ensure all tiedowns have been removed before selecting KNEEL.

2. Hook DN; Check RATS Advisory Light On, Then Up.

3. LAUNCH BAR switch – Cycle.

4. NOSE STRUT switch - EXTD.

7.4.4.2 Final Checker Aboard CV

1. Hook Down On Director's Signal; Check RATS Advisory Light On, Then Up.
Carrier operations with an inoperative RATS will increase CV wind-over-deck requirements. Failure to notify CV OPS may result in damage to the ship's arresting gear and aircraft tailhook assembly structure. Consult applicable recovery bulletins.

2. Nosewheel steering Cycle OFF, Then ON.
Failure to cycle nosewheel steering following hook check will permit nosewheel steering centering to remain engaged and can cause mispositioning of the launch bar during catapult hookup. This may result in launch bar disengaging from shuttle during catapult stroke.

7.4.5 Taxiing

To set the aircraft in motion starting from a static

position requires advancing the throttles slightly.

While departing the line area, flightcrew should clear the extremities of the aircraft and the wings should remain at 68 or in OV SW to minimize the span clearance. Once in motion, IDLE thrust is normally sufficient to sustain taxi speeds and full nose wheel steering authority may be realized.

7.4.5.1 Taxi Speed

Taxi speed should be maintained at a reasonable rate consistent with traffic, lighting, and surface conditions. Subsequent to flight, while returning to the line at light gross weights, the right engine may be shut down to prevent excessive taxi speeds at IDLE thrust.

CAUTION!

Before taxiing aircraft with wings in oversweep and full wing fuel tanks, trim stabilizer to zero to prevent wingtip and stabilizer interference.

When taxiing across obstacles ensure nose wheel is centered to preclude launch bar from impacting nose wheelwell doors.

To prevent overheating, do not ride the wheel brakes.

Note

When shutting down one engine during taxiing, only the right engine should be shut down so that normal braking is maintained.

7.4.5.2 Taxi Interval

The taxi interval should be sufficient to avoid taxiing through another aircraft's jet wash, which presents additional FOD potential. Although the antiskid system is armed at speeds less than 15 knots, the antiskid system is not operative. The nosewheel steering can remain engaged throughout the taxi phase. Application of wheelbrakes in conjunction with nosewheel steering should be performed symmetrically to minimize nose tire side loads. In minimum radius turns using nosewheel steering, the inboard wheel rolls backwards as the axis of rotation is between the main gear. Because of the distance from the cockpit to the main landing gear, the pilot should make allowance for such to prevent turning too soon and cutting corners short.

7.4.5.3 Crew Comfort

Crew comfort during taxi operations is affected by the nose strut air curve characteristics, that maintains the strut in the fully extended (stiff strut) position except during deceleration. Because of the wide stance of the main gear, differential application of wheelbrakes is effective for turning the aircraft without the use of nosewheel steering. Subsequent to flight, while returning to the line at light gross weights, one engine may be shut down to prevent excessive taxi speeds at IDLE thrust.

CAUTION!

On-deck engine operations for extended periods can result in an unacceptable buildup in fluid (hydraulic, engine oil, and IDG oil) temperatures by taxing heat exchanger capacities.

Since the left IDG supplies the majority of the electrical power, it is more susceptible to overheating than the right. Tail winds or large power demand, or both, at high ambient air temperatures, increase the chance of fluid overtemperature.

Since the outboard spoiler module is automatically energized with the flap handle down and weight on wheels, it is necessary to restrict the amount of flaps down operation on the deck to prevent module fluid overheating, or pull outboard spoiler module circuit breaker.

7.4.6 Taxi Pilot

CAUTION!

Taxiing with the left engine secured is not authorized. Normal braking and nosewheel steering control will be lost if the hydraulic transfer pump (BI-DI) fails while taxiing with the left engine secured.

1. Parking brake Release.

2. Nosewheel steering Check.

NWS ENGA light illuminates upon engagement. Check control and polarity in static position before commencing to taxi.

Note

If nosewheel steering is inoperative, the emergency gear extension air release valve may be tripped, which will prevent gear retraction.

3. Brakes Check.

Check for proper operation by applying left or right brake individually and observing brake pressure recovery to the fully charged condition.

4. Turn-and-slip indicator Check.

5. Ordnance Safe.

Perform the following functions at prescribed location prior to takeoff in accordance with base operating procedures:

a. Missile seeker and tuning Check.

b. Gun and external stores - Ground Safety Pins Removed and Armed.

7.4.7 Takeoff

The aircraft takeoff checklist should be completed prior to calling for takeoff clearance, and all annunciator lights should be off, except NWS ENGA. Full flaps and slats are optional for all takeoff regardless of thrust or gross weight conditions. Flightcrew should be operating in HOT MIC during this phase of flight to enhance communications in event of emergency. Upon tower clearance and after visually clearing the approach zone, the pilot should taxi onto the runway (take downwind side if another aircraft to follow) and roll straight ahead to align the nosewheel and to check compass alignment. Hold in position for takeoff using the toe pedal brakes with nosewheel steering engaged. Perform engine checks at 85 to 90-percent rpm. Select MIL on the roll and monitor engine performance.

WARNING!

Takeoffs with the HUD uncaged can produce HUD symbology that is difficult to interpret during turning or asymmetric flight conditions. If takeoff is anticipated following an uncaged landing, selecting the cage/seam switch on the inboard throttle will ensure the HUD returns to the caged format.

Note

Do not use the parking brake to restrain the aircraft under the high-power conditions since tire skid might result.

If static engine runup greater than 90-percent rpm is required, runup should be performed one engine at a time.

7.4.7.1 Afterburner Takeoff

Afterburner takeoffs are limited to single-engine,

minimum afterburner takeoffs, waveoffs, bolters, or catapult launches. Dual-engine afterburner and single-engine maximum afterburner takeoffs, waveoffs, bolters, or catapult launches are prohibited.

7.4.7.2 Brake Release

After takeoff power checks are completed and at a safe interval behind the preceding aircraft, release the toe pedal brakes. Nosewheel steering should be used for directional control during the initial takeoff roll. Although the rudder becomes effective at 40 to 60 knots, to ensure adequate directional control in the event of an engine failure, nosewheel steering should remain engaged until 100 KCAS.

Note

Takeoffs performed with standing water on the runway may result in unstable engine operation because of water ingestion. The nose strut should return to the fully extended position (+1.5° pitch attitude) upon brake release; failure to do so will increase the takeoff ground roll. Use of differential braking to control directional alignment should be avoided because of its attendant effect on ground roll distance.

7.4.7.3 Takeoff Roll/Lift-Off

Minimum ground roll takeoff procedures do not differ from the normal procedures. Maintain the control stick at the trimmed condition during the prerotation ground roll phase to minimize aircraft drag. After the pre-computed rotation speed, smoothly pull the control stick aft to position the HUD waterline at a 7° to 10° pitch attitude until safely airborne. With the flaps down, the aircraft seems to balloon from the runway in a near-level nose attitude with a more docile transition to flight than characteristic of swept-wing aircraft.

Note

The use of excessive back stick on takeoff may cause the tail surfaces to stall, delaying aircraft rotation and extending takeoff distance.

Although on-deck pitch attitude rotation in excess of 10° provides marginal tail-ground clearance, the aircraft is airborne well before such a phenomenon becomes a limiting factor.

7.4.7.4 After Lift-Off

After lift-off, relax the aft stick force as the aircraft

accelerates toward an in-trim condition. Raise the landing gear control handle after ensuring that the aircraft is definitely airborne. Pitching moments associated with gear retraction are negligible and a gear-up indication should be achieved about 15 seconds after initiation. Illumination of indexer lights is not a positive indication that the main landing gear are clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.

At approximately 180 KCAS (depending on longitudinal acceleration) and at a minimum of 200 feet AGL, the FLAP handle can be placed in the UP position. A moderate noseup pitching moment occurs during the flap and slat retraction phase, which takes approximately 8 seconds.

Immediately after liftoff, do not attempt to counter a lateral drift caused by a crosswind condition. The use of large lateral control deflection should be avoided to keep from breaking out the wing spoilers, which have a negative effect on lift and drag. Differential tail authority within the spoiler deadband (½-inch lateral stick deflection) is adequate for maintaining wings-level flight or effecting gradual turns with symmetric thrust. Before reaching the flap (225KCAS for 10_ flaps) and gear (280 KCAS) limit speeds, the pilot should ascertain that all devices are properly configured for higher speed flight. The combined hydraulic system nonflight essential components (landing gear, brakes, and nosewheel steering) may be isolated by selecting FLT on the hydraulic isolate switch. A gradual climbout pitch attitude should be maintained until intercepting the optimum climb speed. A recheck of engine instruments and configuration status should be performed after cleanup during the climbout phase.

7.4.8 Flaps-Up Takeoff

Before the takeoff roll, the procedures for flaps-up takeoff are identical to flaps down, except that the flaps remain retracted and only inboard spoiler brakes are available.

During the prerotation ground roll phase, maintain the control stick at the trimmed condition to minimize aircraft drag.

At the pre-computed rotation speed, smoothly pull the control stick aft to position the HUD waterline at a 7° to 10° pitch attitude until safely airborne.

Do not exceed 10° of pitch attitude until well clear of the runway, as excessive noseup attitudes will cause the vertical fins and tailpipes to contact the runway surface.

Because of increased longitudinal control effectiveness with the flaps retracted, overcontrol of pitch attitude during takeoff is possible. Large or abrupt longitudinal control inputs should be avoided until well clear of the runway.

Transition to flight will occur smoothly as compared to the ballooning effect in flaps-down takeoffs. After main gear lift-off, relax the aft stick force as the aircraft accelerates.

Because of the smooth, flat transition to flight, care should be taken to avoid premature landing gear retraction and resulting blown tires. Raise the landing gear control handle only after ensuring that the aircraft is airborne.

During flaps-up takeoffs, all flap/wing electromechanical interlocks are removed from the CADC and wing-sweep control box, allowing possible inadvertent wing sweep in the event of a CADC failure.

Outboard spoilers are inoperative with weight on wheels.

7.4.8.1 Maneuvering Flaps Takeoff

Maneuvering flaps provide improved takeoff performance when compared to the flaps-up configuration and eliminate the pitching moment associated with main flap and slat retraction after takeoff. Slow-speed handling characteristics are superior to the flaps-up configuration. Additionally, possible automatic maneuvering flap/slat extension during rotation/transition to flight can be avoided by extending maneuvering flaps before takeoff.

7.4.9 Formation Takeoff

Formation takeoffs are permitted in the flaps-up/maneuvering flaps-down configurations for section only. However, they shall not be permitted at night with: crosswind component in excess of 10 knots; standing water on the runway; runways less than 8,000 feet long and 200 feet wide; or with dissimilar aircraft. All aspects of the takeoff must be briefed by the flight leader. Briefing should include flap setting, power settings, use of nosewheel steering, abort procedures, and signals for power and configuration changes.

7.4.9.1 Military Lead

With the completion of the takeoff checks, the

lead aircraft will take position on the downwind side of the run way with the wingman on a normal parade bearing with no wing overlap. Upon signal from the leader, the engines will be advanced to 90-percent power. When ready for flight, the pilots shall exchange a thumbs-up signal. On signal from the leader, brakes are released, MIL is selected, and the leader then reduces power by 2 percent. Directional control is then maintained with nosewheel steering until rudder becomes effective. During takeoff roll, the leader should make only one power correction to enhance the wingman position. If optimum position cannot be obtained, relative position should be maintained until the flight is safely airborne. At the precomputed rotation speed, the leader should rotate the aircraft 7 to 10 noseup on the HUD or MFD and maintain this attitude until the flight is airborne. Turns into the wingman should not be made at altitudes less than 500 feet above ground level.

7.4.9.2 Wingman

The wingman should strive to match the leader's attitude as well as maintain parade bearing with wingtip separation. When both aircraft are safely airborne, the gear is retracted on signal from the leader.

In the event of an aborted takeoff, the aborting aircraft must immediately notify the other aircraft and the tower. The aircraft not aborting should ensure positive wingtip separation is maintained and select full military power to accelerate ahead of the aborting aircraft. This will allow the aborting aircraft to move to the center of the runway and engage the available arresting gear, if required.

It is imperative that the wingman be alert for the overrunning situation and take timely action to preclude this occurrence. Should an overrunning situation develop after becoming airborne, the wingman should immediately increase lateral separation from the leader to maintain wing position. Safe flight of both aircraft must not be jeopardized in an attempt to maintain position.

7.4.10 Takeoff Aborted

Aborted Takeoff procedure is not part of this manual. Real-life aborted takeoff procedure is found in Chapter 13 or F14AAD-1 NATOPS

7.4.11 Takeoff Checklist

Prior to takeoff, the checklist will be completed by the challenge (RIO) and reply (pilot) method via the ICS on HOT MIC as a double-check of the aircraft configuration status.

For CV operations, steps 1 through 9 may be completed while tied down. For field operations, steps 1 through 14 should be completed in the warmup area.

	RIO CHALLENGE	PILOT RESPONSE
1	BRAKES	CHECK OK, ACCUMULATOR - PRESSURE UP
2	FUEL	NORMAL FEED, AUTO TRANSFER, DUMP OFF, TRANSFER CHECKED (If AUX tanks carried), TOTAL _____ WINGS, EXT (If app.) AFT AND LEFT FORWARD AND RIGHT _____ FEED TANKS FULL BINGO SET
3	CANOPY CLOSED, LOCKS ENGAGED, LIGHT OUT, STRIPES ALIGNED, HANDLE IN CLOSE POSITION	CLOSED, LOCKS ENGAGED, LIGHT OUT, SEAL INFLATED, HANDLE IN CLOSE POSITION
4	SEAT . . . ARMED, STRAPPED IN EIGHT WAYS COMMAND EJECT	ARMED, STRAPPED IN EIGHT WAYS, PILOT/MCO IN WINDOW"
5	STAB AUG	ALL ON
6	ATLS	ON
7	ALL CIRCUIT BREAKERS SET	ALL IN
8	MASTER TEST SWITCH	ON
9	BI-DIRECTIONAL	NORMAL
10	COMPASS, STANDBY GYRO, TURN NEEDLE AND ALTIMETER	COMPASS SYNCHRONIZED, STANDBY GYRO ERECT, GOOD TURN NEEDLE, AND ALTIMETER SET (local settings)
CV APPROACHING CAT ON DIRECTOR'S SIGNAL		
11	OXYGEN	OBOGS ON, MONITOR CHECKS GOOD
12	WINGS (visually checked)"	20", AUTO, NO WING-SWEEP CAWS"
13	FLAPS AND SLATS" (visually checked)	AS REQUIRED.
14	SPOILERS AND ANTI-SKID	SPOILER MODULE ON, SPOILER BRAKES SELECTED"(field) SPOILER MODULE ON,

		SPOILER BRAKES OFF (CV).	a. <i>Select OBC basic format.</i>
15	TRIM	0.0.0, (field) AS REQUIRED (CV)	b. <i>Depress desired test.</i>
16	SAHRS ATTITUDE REFERENCE	GOOD SAHRS ATTITUDE	<i>This initiates the in-flight BIT.</i>
17	DISPLAYS	SET FOR TAKEOFF, HUD CAGED	7.4.14 Preland and Descent
18	HARNESS LOCKED	LOCKED	1. HOOK/HOOK BYPASS As Desired.
19	CONTROLS (RIO visually check for full spoiler deflection)	FREE, 33° AFT STICK, FULL SPOILER DEFLECTION LEFT AND RIGHT, HYDRAULICS 3,000 PSI	2. Exterior lights As Desired.
20	ALL WARNING AND CAUTIONS OUT	ALL WARNING AND CAUTIONS OUT	3. Displayed heading/BDHI Check With MAG Compass.
ASHORE IN TAKEOFF POSITION			4. Wing-sweep switch As Desired.
21	ANTI-SKID/SPOILER BRAKES"	BOTH	5. ANTI SKID SPOILER BK switch BOTH (If operable, CV-OFF).
			6. Altimeter Set.

7.4.12 Ascent Checklist

At level-off or 15,000 feet (whichever occurs first):

1. Cabin pressurization Check.
2. Fuel transfer Check.
3. *Oxygen monitoring system Test.*

WARNING!

Subsequent failure of the oxygen monitor system will not be evident to the aircrew resulting in OBOGS output of unknown quality.

Note

Pilot should ensure oxygen monitor test button is released as soon as possible after illumination of the OBOGS caution light to preclude unnecessary depletion of the backup oxygen system.

7.4.13 In-Flight BIT

If desired or required IBIT check should be run.

1. OBC disabled on pilot MASTER TEST PANEL Check.
2. Verify MA ARM OFF.
3. *Multifunction display.*

7. Radar altimeter — ON/BIT Check.

8. Fuel quantity and distribution — Check.

9. *Armament — Safe.*

10. *CANOPY DEFOG/CABIN AIR lever — DEFOG.*

11. ANTI-ICE switch — AUTO/OFF.

12. *Display mode — TLN.*

13. *Steering — AWL.*

14. ARA-63/ACLS — ON/BIT Check.

15. *RADAR WARNING RCVR PWR switch — OFF.*

16. *ASPJ SYS switch — STBY.*

17. *AN/ALE-47 DCDU, MODE/PWR switch — OFF.*

18. *RDR switch — STBY OR XMIT (pulse). The RIO should place RDR switch to STBY or XMIT (pulse) on final approach to prevent unnecessary exposure of flight deck personnel to RF radiation hazard.*

19. **[T]** *Resolution run — Complete.*

Note

Before reconnaissance system shutdown, run

film leader to protect target imagery from inadvertent exposure during film download.

20. **[T]** FRAME switch — OFF.

21. **[T]** PAN switch — OFF.

22. **[T]** FILM switch — OFF.

Before selecting system switch to OFF, delay 15 seconds for sensor shutdown, and mount to drive to vertical.

23. **[T]** TARPS control panel SYSTEM switch—OFF.

7.4.15 Pattern Entry

Entry to the field traffic pattern will be at the speed and altitude prescribed by local course rules. When approaching the initial for the break, wings may be positioned manually full aft to facilitate multiplane entry and break deceleration. Break procedures shall comply with squadron, field, and/or CV standard operating guidelines.

7.4.16 Landing

7.4.16.1 Approach

At the abeam position for landing, the aircraft should be at the prescribed altitude, trimmed up to 15 units AOA with the Landing Checklist completed.

Indicated airspeed should be cross-checked with gross weight in wings-level flight to verify AOA accuracy. Direct lift control and the approach power compensator should be engaged as desired and checked for proper operation. The turnoff from the 180° position should be made based on surface wind conditions and interval traffic (type, pattern, touch-and-go or final landing, etc.) so as to allow sufficient straightaway on final prior to touchdown.

The quality of the approach and touchdown is enhanced by starting from on-speed and on-altitude. The low thrust required in the landing approach leaves little margin for corrections from a high, fast position. Therefore, the pilot must control these parameters precisely from the onset of the approach to touchdown. Inertia and tail movement in conjunction with engine thrust response characteristics dictate the use of small, precise corrections on the glideslope for the most effective control technique.

The landing should be planned for the downwind side of the runway with traffic behind, or opposite, the nearest traffic on landing rollout, or

on the turnoff side of the runway.

When surface wind is not a factor, pilots should practice flying on the field optical landing aid system whenever possible.

Fly the aircraft down to the deck without flaring so as to accurately establish a touchdown point and achieve initial compression of main gear struts to arm the spoiler brakes.

Note

Landing with DLC engaged will reduce the amount of aft stick deflection available. DLC should be deselected when established on landing rollout.

7.4.16.2 Touchdown

To avoid tail-ground clearance problems, pitch attitude should not exceed 15 units AOA. At touchdown, immediately retard throttles to IDLE and confirm spoiler brake deployment.

Expediently lower the nosegear to the deck and, without allowing the nose to come up, smoothly program the stick full aft.

7.4.16.3 Rollout

The braking technique to be utilized with or without antiskid selected is essentially the same; a single, smooth application of brakes with constantly increasing pedal pressure. Do not pump the brakes. Directional control during rollout may require some differential braking. Nosewheel steering may be used during rollout but it must be engaged with the rudder pedals centered to avoid a directional swerve upon engagement. Restrict the use of nosewheel steering during rollout until or unless required for directional control. Under conditions of normal braking (antiskid selected), the antiskid system is passive and has no effect on wheelbrake operation. However, if maximum deceleration is desired, commence braking as the nose is lowered and smoothly apply sufficient pressure to activate the antiskid system. When an impending skid is sensed, antiskid operation will result in a series of short wheel-brake releases and a surging deceleration. Constant pedal pressure should be maintained. Approaching taxi speed (about 15 knots), ease brake pressure and deselect antiskid.

CAUTION!

If brakes are lost, release brake pedals and secure antiskid. If antiskid is not deselected before 15 knots, continued hard braking could result in blown tires.

Ensure feet are off brakes before crossing field arresting gear.

If nosewheel steering hardover is suspected upon engagement of NWS, deselecting NWS, lowering the hook, and/or differential braking may be required to regain directional control.

Note

If maximum-effort braking or antiskid is not required, or antiskid is not selected, delaying brake application until the aircraft aerodynamically decelerates below 80 knots greatly reduces the possibility of blown tires and overheated brakes. Follow the Postlanding Checklist for proper configuration cleanup procedures. Clear the area behind before turning off across the runway. The right engine may be shut down to reduce residual thrust during low-gross-weight taxiing.

7.4.16.4 Touch and Go

For touch-and-go landings, MIL thrust is applied after touchdown while thumbing speedbrakes in manually to configure the aircraft for a go-around. Automatic retraction of speedbrakes occurs upon application of MIL thrust as a safety backup mode of retraction. Control for rotation is greater than experienced on takeoff, although the aircraft has the same basic lift-off characteristics. Fuel required per pass is normally 300 pounds, contingent on traffic pattern.

7.4.16.5 Minimum Descent Rate Landings

Minimum descent rate landings are required for heavy weight and landing gear emergency landings. Aircraft pitch attitude at touchdown is critical. Do not exceed 10 pitch attitude (on the water line) and 14 units AOA at touchdown to prevent speedbrake, exhaust nozzle, and/or ventral fin damage.

After touchdown, throttles should be immediately placed at the idle stops. The nosewheel should be lowered to the ground, fully compressing the main landing gear struts.

Delaying either action will delay the deployment of ground roll braking spoilers and may increase landing rollout. Additionally, until ground roll braking spoilers are deployed, lateral control remains responsive and pilot-induced lateral oscillation is possible. Aerodynamic braking should not be used as speedbrakes, exhaust nozzle, and/or ventral fin damage may occur. The Fresnel lens may be used for precise glideslope control until arresting the approach rate of descent. Do not attempt to recenter a high

ball in close. The approach should be flown on-speed at 15 units AOA. At approximately 30 feet AGL (2 to 3 seconds prior to touchdown), arrest the rate of descent by a slight addition of power. Maintain approach attitude until touchdown. If the Fresnel lens is not available or runway length is critical, fly a shallow approach to touch down in the first 1,000 feet of runway. If runway length is critical, consideration should be given to reducing touch down speed by flying a no DLC approach.

7.4.16.6 Crosswind Landings

Crosswind landings may be accomplished using either the sideslipped or crabbed technique, up to the crosswind limit (20 knots). The roll rate command function and revised spoiler gearing of the DFCS affect crosswind landing flight characteristics. During a sideslipped approach the DFCS spoiler gearing schedule results in nearly immediate spoiler breakout with lateral stick deflection from trim. This spoiler breakout may result in an overly sensitive roll response during lineup corrections. Because crabbed approaches are flown without this offset lateral stick input and do not exhibit this characteristic, pilots may find this technique easier for DFCS equipped aircraft. If a landing must be made in crosswind conditions in excess of the limits, the techniques must be changed. At some crosswind component, the upwind wing will be raised excessively and, as a result, directional control will be marginal.

It is estimated that this will occur with a greater than 25-knot crosswind component. If after touchdown the wing is raised excessively, the spoiler brakes should be turned off and lateral stick applied to maintain a wings level attitude. If the crosswind component is greater than 25 knots, do not arm the spoiler brakes for landing and again maintain a wings level attitude with lateral stick. It must be realized that antiskid will not be available.

7.4.16.7 Landing On Wet Runways

If operable, antiskid shall be used on wet runways to minimize the possibility of skidding or blowing tires. Standing water greatly decreases braking effectiveness and may cause total hydroplaning in certain conditions. Intermittent puddles may cause wheels to lock while braking with antiskid not engaged. As the locked wheel leaves the puddle and encounters a good braking surface, it will skid and blow unless brake pressure is released. The following procedures are recommended when landing on a wet

runway:

1. Determine field condition before approach (braking action, crosswind component, arresting gear status).

2. If adverse wind and runway conditions exist, make a short-field arrested landing. In the event that the arresting gear is not engaged, execute a waveoff or bolter as appropriate.

3. Consideration should be given to reducing touch down speed by flying a no-DLC approach. Plan the pattern to be well established on final in a wings-level attitude (crab, if required) on speed. Land on runway centerline, using normal FCLP landing techniques.

4. If a rollout landing is desired, touch down on center line within the first 500 feet of runway.

Landing rollout procedures are the same as in a normal landing. When directional control is clearly established, utilize normal braking. During the high-speed portion of the landing roll, little or no deceleration may be felt. Do not allow the aircraft to deviate from a straight track down the runway. If a skid develops, release the brakes, and use rudders or nose-wheel steering for directional control. Reapply the brakes cautiously. If the skid continues and adequate runway remains, select power as required and fly away.

If conditions do not permit flyaway, use the long field overrun gear if required. If the aircraft is leaving the runway to an unprepared surface, secure both engines.

Note

A blown tire on landing rollout may result in directional control difficulties, particularly at high speeds.

7.4.17 Landing Checklist

The placarded Landing Checklist should be completed in sequence prior to arriving at 180 abeam the touchdown point. All checklist items are essential elements to be checked prior to each landing. With the ICS on HOT MIC, the pilot shall call out the accomplishment of each step so that the RIO can double-check that all items have been performed.

1. Wing-sweep mode switch 20 AUTO. Check wings in AUTO sweep control mode and verify at 20.

2. Wheels THREE DN.

Check for wheels-down indication on all three gear, LAUNCH BAR light, and that gear transition light is out. Check that brake accumulator pressure is fully charged.

During aircraft carrier (CV) qualifications and other operations when the landing gear are not raised after catapult launch, the pilot shall check the LAUNCH BAR advisory light is off prior to each landing.

3. SAS ON.

4. Flaps Full DN.

Check for flap and slat full-down indication and no FLAP light.

5. DLC Checked.

6. Hook As Desired.

Transition light should be out.

7. Harness Locked.

8. Speedbrakes EXT (out).

Check indicator for full speedbrake extension.

9. Brakes Check.

10. Fuel Check.

7.4.18 Postlanding Pilot

1. Speedbrake switch RET.

2. ANTISKID SPOILER BK switch OFF.

3. Flaps and slats UP.

Move FLAP handle UP and check for complete retraction of main flaps and slats and auxiliary flaps (flaps indicator 0 and no FLAP caution light). Check automatic deactivation of the outboard spoiler module. As soon as the auxiliary flaps are retracted (8 seconds) the wings will sweep aft if commanded.

4. Wing-sweep mode switch BOMB.

Ensure that emergency WING SWEEP handle and wings move to 55.

NOTE: In this FSX rendition, either select Oversweep by the FSX: A Wingfold command or set Wingsweep control to MANUAL and set wings to 55°.

5. Emergency WING SWEEP handle OV SW.

Raise handle and move aft to 68. Raise handle

to full-up extension and hold. When HZ TAIL AUTH caution light goes out and the OVER flag appears, move EMERGENCY WING SWEEP handle full aft (75 sweep position) and stow. Rotate handle guard to stowed position.

6. Avionics OFF.

Turn off all avionics (data link, radar altimeter, displays, TACAN, ARA-63) except V/UHF radio.

7. DCP Verify & record codes (FAIL, FLT, IBIT).

8. Right throttle OFF.

Note

Care should be taken when shutting down the right throttle (with the left throttle at IDLE) to prevent inadvertent contact with the left throttle, moving it aft to the cutoff position.

Run both engines at idle for 5 minutes before shutdown, especially if they have been run at high power.

9. OBOGS master switch OFF (alert RIO).

10. OXYGEN SUPPLY valve OFF.

11. HYD TRANSFER PUMP switch SHUTOFF. (after BI-DI check)

Check hydraulic transfer pump operation in the combined-flight direction with the HYD PRESS, OIL PRESS, R GEN, and R FUEL PRESS caution lights illuminated.

12. Ejection seats Safe (coordinate with RIO).

13. *Ordnance Dearm (field).*

Dearm and safety ordnance in accordance with local operating procedures.

14. *Wheels Chocked.*

15. Parking brake Pull.

Do not pull parking brake subsequent to a field landing if the brakes have been used extensively.

16. V/UHF RADIO MODE switch OFF.

17. Standby attitude gyro Cage.

18. Left throttle OFF (alert RIO).

Alert RIO and upon signal from plane captain, secure left engine. Check emergency generator automatic operation upon shutdown.

19. *EMERG generator switch OFF.*

20. Lights OFF.

Turn off internal and external light switches.

21. *EJECT CMD indicator Verify PILOT.*

22. CANOPY handle Clear RIO To Open.

23. Flightcrew Egress.

7.5 RIO PROCEDURES

NOTE: IN THIS FSX RENDITION, FUNCTIONALITY IN THE RIO VIRTUAL COCKPIT IS LIMITED. MOST OF THE RIO CHECKLIST PROCEDURES IS NOT APPLICABLE.

7.5.1 Interior Inspection RIO

WARNING!

NATOPS prohibits the attaching or stowing of unauthorized equipment on or above the canopy rails during CV launch and arrestment, due to the potential for missile hazard.

1. Circuit breakers Set.

2. Left and right foot pedals Adjust.

3. Harnessing Fasten.

a. Leg restraint lines and garters Connect
Ensure that leg lines are not twisted or looped.

b. Lapbelt Connect and Adjust.
Connect lapbelt straps and adjust snug so as to provide secure lap restraint in flight and seat kit suspension for ground egress or ejection.

c. Parachute release fittings Attach to Harness Buckles.

d. Anti-g and oxygen/communication leads ATTACH.
When connecting the oxygen/communication fitting, avoid twisting the hard hose.

e. Inertia reel Check.
Position shoulder harness lock lever forward to lock position. Check that both shoulder straps lock evenly and securely. Move lever aft to unlock harness.

4. ANT SEL panel As Desired.

5. [T] TARPS control panel switches OFF.

6. ICS panel

a. VOL knob Set.

b. Amplifier NORM.

c. Function selector COLD MIC.

7. SENSOR control panel

a. TCS FOV WIDE.

b. TCS trim As Set.

c. MVR source As Briefed.

d. MVR RECORD OFF.

8. TACAN mode switch OFF.

9. JTIDS

a. MODE switch STBY.

Note

If the primary link system for the mission is JTIDS, ensure the JTIDS MODE switch is in STBY position. STBY provides the backup battery power required to hold the crypto variables and initialization data required for JTIDS missions.

10. KY MODE/TACAN/CMD panel As Desired.

11. KY-58

a. PLAIN switch PLAIN.

b. Power switch OFF.

c. MODE As Desired.

d. FILL switch As Set.

12. V/UHF radio MODE switch OFF.

13. RADAR COOLING switch OFF.

14. EJECT CMD lever Set.

Determined by squadron policy.

15. Data storage unit Secure.

16. ARMAMENT control panel

a. SEL JETT switch SAFE.

b. MSL PREP switch OFF.

c. MSL SPD GATE knob Per SOP.

d. MSL OPT switch NORM.

e. JETTISON STA SEL switch OFF.

17. Radio frequency control indicator As Desired.

18. Standby attitude gyro Caged, Turn Needle/Ball Centered.

19. Clock — Set and Wind.

20. Sensor hand control panel.

a. RDR switch — OFF.

b. FIRST switch — OFF.

c. TCS switch — OFF.

21. Programmable tactical information display — As Desired.

Note

PTID NAV MODE and DEST switches are inoperative.

22. DD power switch — OFF.

23. MFD 3 power — OFF.

24. ECM switch — OFF.

25. NAV MODE switch — OFF.

26. Data entry unit power — OFF

27. RADAR WARNING RCVR

a. PWR switch — OFF.

b. DISPLAY TYPE switch — As Desired.

28. ASPJ

a. SYS switch — OFF.

b. BIT switch — OFF.

c. TAC switch — NORM.

29. MFA priority switch — NORM.

30. AN/ALE-47 DCDU, MODE/PWR switch —

OFF.

31. AN/ALE-47 Ground Test/Dimmer PNL — GUARD DOWN

32. Data-link panels

a. TEST/NORM/AJ switch — NORM.

b. FREQ selector — Set.

c. Power switch — OFF.

d. REPLY switch — NORM.

e. MODE switch — TAC/JTIDS (as required).

Note

The data-link MODE switch must be set to the required link system (JTIDS or TAC) for appropriate MFD display processing.

f. ADDRESS — Set.

33. APX-76 — OFF.

34. IFF MASTER knob — OFF.

35. MODE 4 switch — OUT.

36. IFF ANT switch — DIV.

37. INTERIOR LIGHTS panel — As Desired.

38. RADAR BEACON switch — OFF.

39. RADAR BEACON MODE switch — As Desired.

40. GND CLG switch — OFF.

41. SYS TEST-SYS PWR ground check panel — Closed.

42. POWER SYS TEST switch — OFF.

7.5.2 Prestart — RIO

The following checks are performed by the RIO after starting air and electrical power are applied prior to starting engines.

CAUTION!

Starting air, which provides full ECScapability, must be connected to the aircraft with electrical power to cool temperature-critical avionics.

If starting air is not available, a forced-air ground cooling unit and servo airmust be connected before turning on avionics equipment.

If electrical power is not connected with spare starting air, the ECS will drive to full hot.

To prevent overheating the outboard spoiler module, pull the OUTBD SPOILER PUMP circuit breaker (2B3) anytime external power is connected and the flaps are extended.

Failure of the COOLING AIR light to illuminate on external electrical power indicates a miswired or failed sensor. The COOLING AIR light will not be available to indicate a subsequent ECS turbine failure.

1. Seat, ICS, and U/VHF foot switches Adjust. Adjust seat height so helmet is beneath the canopy breaker. Adjust ICS and UHF foot pedal fore-aft position for sitting comfort.

2. External power and air ON.

3. ICS Check.

Verify two-way communications between flight crewmembers and adjust volume to a comfortable level.

4. DL, JTIDS, TACAN, and U/VHF Set.

Set communications/TACAN/command control in accordance with mission and flightcrew operating procedures.

5. Fuel quantity Check.

6. Lights Check.

Check for illumination of console and instrument lighting.

7. LTS test Check.

Check that all caution and advisory lights and ECM lights illuminate.

Note

During pilot INST test, the RIO should observe fuel counter decrease to 2,000 pounds and MASTER CAUTION and FUEL LOW lights illuminate.

8. Ejection seats ARMED.

Arm ejection seat by releasing catch and rotating SAFE/ARMED handle down to ARMED.

9. CANOPY handle CLOSE.

RIO will normally close canopy. Ensure verbal

clearance from pilot. Check that CANOPY light goes out with full forward transition of canopy into the sill locks. Check that SEAT UNARMED light does not illuminate.

WARNING! Flightcrews shall ensure that hands and foreign objects are clear of front cockpit handholds, top of ejection seats, and canopy sills to prevent personal injury and/or structural damage during canopy opening or closing sequence. Only minimum clearance is afforded when canopy is transiting fore and aft.

Note

If CLOSE does not close the canopy, depress the grip latch and release and push handle outboard and forward into BOOST. If it is necessary to use BOOST, the handle shall be returned to CLOSE to avoid bleed off of pneumatic pressure.

10. Acknowledge Ready To Start.

7.5.3 Engine Start RIO

The RIO must monitor pilot procedures and plane cap tain signals to ensure maximum safety during the engine start sequence.

7.5.4 Poststart RIO

1. NAV MODE switch Align.

2. DD power switch ON.

Failure to turn DD power on prior to RDR switch causes a false DD power fault indication in ORT.

3. RDR switch XMIT.

Verify that the SENSOR COND advisory light illuminates.

4. RADAR COOLING switch ON.

Verify that the SENSOR COND advisory light goes out.

5. MFD 3

a. Power switch DAY/NIGHT/AUTO.

b. BRIGHTNESS and CONTRAST Set.

6. DEU On.

7. MSL PREP switch As Required.

8. TCS switch ON.

9. Align coordinates Verify/Update.

10. OXYGEN SUPPLY valve ON.

Turn OXYGEN SUPPLY valve ON, place mask to face, and check for normal breathing and regulator and mask operation. Turn OXYGEN SUPPLY valve OFF; ensure oxygen flow has stopped.

11. [T] TARPS control panel SYSTEM switch—RDY. Observe DATA/MAN/Vg/H light illuminated.

12. TACAN mode switch — T/R.

13. IFF MASTER knob — STBY.

a. Set CODE knob — As Required.

b. IFF panel — Test.

(1) MC switch — Out.

(2) MI, M2, M3 — Test.

Select NORM and observe that TEST light illuminates.

(3) MC — Test.

Observe that TEST light illuminates.

c. IFF ANT switch — As Desired.

14. JTIDS MODE switch — As Required.

15. Communications — ON/Set.

16. KY-58 — As Required.

17. Standby attitude gyro — Erect.

18. DD — Set.

19. PTID controls — Set.

a. POWER — As Required.

b. SYM ELEM — ON.

c. DATA LINK — As Required.

d. NON ATTK — As Required.

e. RU — As Required.

f. EXP — As Required.

g. LAUNCH ZONE — As Required.

h. JAM strobe — As Required.

- i. TCS — As Required.
 - j. RIDD — OFF.
 - k. PTID Display Mode — As Required.
 - l. RANGE scale — As Required.
 - m. THLD — As Required.
 - n. CLSN — OFF.
 - o. BRIGHT control — Set.
 - p. CONTRAST — Set.
 - 20. Hand control — Set.
 - 21. ASPJ SYS switch — STBY.
 - 22. RADAR WARNING RCVR panel — Set.
 - a. Display type switch — NORM.
 - b. PWR switch — ON.
 - c. TEST switch — SPL.
 - d. MODE button — LMT.
 - 23. DATA LINK power — As Required.
 - 24. D/L reply — As Required.
 - 25. AAI control panel — Set.
 - a. TEST/CHAL CC switch — Test.
Check DD display.
 - 26. AN/ALE-47 DCDU, MODE/PWR switch — STBY.
- Note
Ensure correct mission loadout is displayed in LED window.
- 27. CANOPY DEFOG-CABIN AIR lever — CABIN AIR.
 - 28. Indicator lights — Test.
 - 29. [T] V/H check
 - a. Manual V/H thumbwheels set — 360 Knots/200 Feet.

- b. V/H switch — Test.
 - c. Observe MAN V/H light is out.
 - d. V/H switch — MANUAL.
30. [T] Vertical frame check
- a. Manual V/H thumbwheels set 350 Knots/1,800 Feet
 - b. FRAME switch VERT.
 - c. FILM switch RUN.
Observe exposure interval of 1.0 second, frame camera green light illuminated, and check camera frame counter for proper operation.
 - d. FILM switch OFF.
 - e. FRAME switch VERT.
31. [T] PAN autocycle check.
- a. PAN switch CTR.
 - b. FILM switch RUN.
Observe exposure interval of 1.0 second, green PAN light illuminated, and check camera frame counter for proper operation.
 - c. PAN switch LEFT or RIGHT.
Observe exposure interval of 2.0 seconds, PAN go light illuminated, and check camera frame counter for proper operation.
 - d. FILM switch OFF.
Do not run PAN BIT (it may cause film jams).
32. [T] PAN pulse mode check.
- a. Manual V/H thumbwheel set 350 Knots/13,500 Feet.
 - b. PAN switch CTR.
 - c. FILM switch RUN.
Observe exposure interval of 5.0 seconds, green PAN light illuminated, and check camera frame counter for proper operation.
 - d. FILM switch OFF.
 - e. PAN switch OFF.
After INS ALIGN COMPLETE computer message or when ready for takeoff:
33. NAV mode switch INS.

Observe MFD transition from align format. Wait 5 seconds.

34. NAV mode switch IFA.

35. DEST data Verify.

36. BRG/DIST to destination Check.

37. OWN A/C groundspeed Check.

38. MAG VAR Check.

39. Notify pilot Ready To Taxi.

7.5.5 Taxi RIO

The RIO primary responsibility during taxiing is to act as copilot/safety observer. BIT checks may be performed while taxiing, provided that RIO attention is not diverted from copilot/safety observer duties.

1. Record ORT/IBIT and maintenance display results on BER form.

2. OWN A/C groundspeed Check.
Own-aircraft groundspeed when stopped should be less than 3 knots.

3. [T] OWN A/C altitude CHECK.

7.5.6 In-Flight Reconnaissance System Check RIO

Not applicable to this FSX rendition

7.5.7 TARPS Degraded Mode Procedures

Not applicable to this FSX rendition

7.5.8 Postlanding RIO

Note

Before shutdown, run IBIT. Note results on BER card.

1. Ejection seat SAFE (coordinate with pilot).

2. EJECT CMD lever PILOT.

3. Harnessing Unstrap.

4. Radar beacon OFF.

5. IFF MODE 4 HOLD, Then OFF.

6. Data link OFF.

7. ASPJ SYS switch OFF.

8. INS VIS FIX.

9. NAV MODE switch OFF.

10. RECORD switch OFF.

Requires at least 20 seconds to allow tape to unthread prior to removal of electrical power.

11. IRST switch OFF.

12. RDR switch OFF.

13. DD power switch OFF.

14. RADAR COOLING switch OFF.

15. TACAN mode switch OFF.

16. JTIDS MODE switch STBY/OFF.

Note

If network operations are anticipated within 24 hours, select STBY; otherwise, select OFF. Do not leave the system in DATA SILENT or NORM for more than 90 seconds without electrical power or the battery will be depleted.

17. Standby attitude gyro CAGE.

18. OXYGEN supply valve OFF.

19. V/UHF radio MODE switch OFF.

20. [T] TARPS control panel switches OFF.

21. DEU OFF.

22. MFD OFF.

23. Report Ready for Shutdown.

After shutdown of both engines:

24. CANOPY handle OPEN (alert pilot).

25. Flightcrew Egress.

7.6 HOT REFUELING PROCEDURES

Not applicable to this FSX rendition

7.7 DECK-LAUNCHED INTERCEPT PROCEDURES

Note

These procedures assume that a quick reaction,

full-mission-capable launch is essential. Prestart procedures and cockpit configuration may vary in accordance with airwing policy and specific EMCON conditions. All CNI equipment as applicable, should be placed in ON or STBY, all SAS switches on, and the HYD TRANSFER PUMP switch should be in NORMAL before application of electrical power. The LTS, INST, EMERG GEN, and DFCS IBIT tests on MASTER TEST panel should be conducted and verified during periodic aircraft turnups. Compliance with the Takeoff Checklist is mandatory to ensure proper aircraft configuration before launch.

7.7.1 Pilot Procedures

1. External electrical power ON.
2. Seat ARM.
3. Fire detect Check.
4. Left engine IDLE.
5. Right engine IDLE.
6. Displays ON.
7. OBC Select.
8. SW COOL NORM.
9. OBC Deselect.
10. Hook operation Check.
11. Takeoff Checklist.
12. Ordnance crew Arm.

7.7.2 RIO Procedures

1. NAV MODE switch CV ALIGN.
2. CAINS/WPT Select.
3. MFD 3 ON.
4. Alignment coordinates Verify/Update.
5. Seat Arm.
6. RDR switch XMIT.
7. TCS switch ON.
8. IRST switch ON.

9. MSL PREP switch NORM.

10. [T] TARPS control panel SYSTEM switch RDY.

11. Takeoff Checklist (complete non-OBC functions).

When ALIGN QUALITY ≤ 2.0 :

12. NAV MODE INS.

13. Wait for IFA AVAILABLE." NAV MODE IFA.

14. Ordnance crew Arm.

Note

Sparrow tune occurs after CW is enabled and can complete after transmitter timeout. PH attack capability is present after launch and Sparrow tune occurs automatically when ever CW is enabled.

7.8 HOT SWITCH PROCEDURES

Not applicable to this FSX rendition

7.9 FIELD CARRIER LANDING PRACTICE

7.9.1 Preflight Inspection

A normal preflight inspection will be conducted with specific attention directed to tire condition, nosestrut extension, AOA probe conditions, and windshield cleanliness.

Check that the hook bypass switch is in FIELD.

7.9.2 Takeoff

The takeoff will be individual.

7.9.3 Radio Procedures and Pattern Entry

A radio check with Paddles is advisable before pattern entry to confirm Charlie time. Approaches to the field for break will be controlled by the tower and then switched to Paddles for FCLP pattern control. At no time will an aircraft remain in the pattern without a UHF receiver. On each succeeding pass, the following voice report will be made at normal meatball acquisition positions:

1. Side number

2. TOMCAT

3. Ball/Clara

4. Fuel state

5. Type of approach, if appropriate (automatic,

degraded, etc.).

7.9.4 Pattern

The pattern should be a racetrack with the 180 approximately 1¼ miles abeam at 600 feet above field elevation (see Figure 7-2). The length of the groove should be adjusted to give a wings-level descent on the glideslope of 15 to 18 seconds (approximately ¾ mile). For maximum gross weight at touchdown, refer to Chapter 4, Operating Limitations. The turn to the downwind leg should be commenced after climbing to pattern altitude (600 feet AGL) utilizing 30 angle of bank and 150 KCAS. Turning from the 180, power should be adjusted to maintain optimum angle of attack. A gradual descent may be commenced at this position with a minimum altitude of 450 feet AGL at the 90 position and 350 feet AGL as a minimum until the pilot is receiving glideslope information. At

approximately 45, the meatball appears on the Fresnel lens. Fly a rate of descent such that the ball is centered as the aircraft arrives wings-level in the groove. For manual, automatic, and DLC approach techniques, refer to Carrier-Based Procedures, Chapter 8.

7.9.5 Night FCLP

All provisions that apply to day FCLP also apply to night FCLP, plus the following items:

1. External lights BRIGHT and STEADY.
2. Hook bypass switch FIELD.

When comfortably situated in the pattern, instruments should be flown as much as possible up to the 45 position.

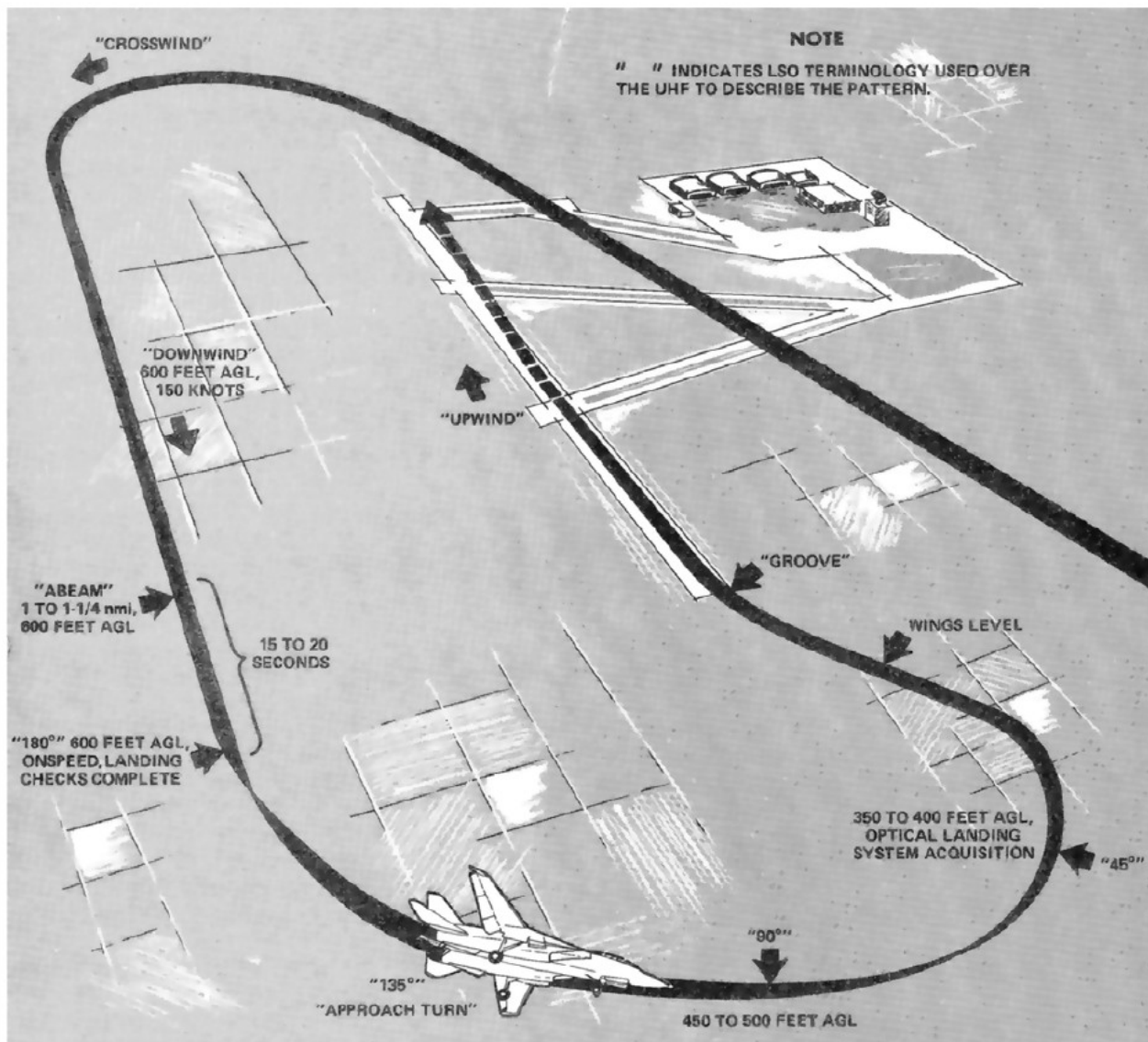


Figure 7-2 Field Carrier Landing Procedure

CHAPTER 8

Carrier-Based Procedures

NOTE: REAL WORLD CHECKLIST HAVE BEEN MODIFIED FOR USE IN FLIGHT SIMULATOR X VIDEOGAME.

MOST OF THE INFORMATION DETAILED INFORMATION THIS CHAPTER IS FOR EDUCATIONAL PURPOSES ONLY. USER SHALL FOLLOW THE STANDARD FSX:ACCELERATION PROCEDURES AND COMMANDS FOR CARRIER OPERATION.

NOTE: CATAPULT HOOKUP AND LAUNCH PROCEDURES SHALL THE SAME AS THE DEFAULT PROCEDURES FOR FLIGHT SIMULATOR X: ACCELERATION

8.1 CARRIER PREFLIGHT

8.1.1 Launch

Applicable aircraft launching bulletins, the CV and LSO NATOPS Manuals and the pertinent CV air operations manual shall be read by all flight crewmembers prior to carrier qualification. In addition, the predeployment lecture syllabus contained in Chapter 1 of the CV NATOPS Manual shall be completed.

8.1.2 Briefing

A thorough briefing shall be accomplished by the flight leader prior to launch. This briefing should call particular attention to current BINGO fields, emergency procedures peculiar to carrier operations, operating area NOTAMs, fuel management, and ship NAVAID status. Aircraft configuration, gross weight, expected WOD, and applicable launch trim settings will be verified prior to man-up.

8.1.3 Preflight

Preflight inspection should be accomplished with particular attention given to nose strut, main landing gear tires, hook, and underside of the fuselage. Note carefully the actual wing sweep, the lateral spacing between parked aircraft, and the general direction of engine exhaust. Do not preflight the aircraft topside aft of the bleed air doors if spotted with the tail outboard of the safety nets. In the cockpit, particular attention should be given to the flightcrew displays to ensure that they are properly secured and that the retaining devices have been installed. Ensure that the WING SWEEP handle is secure in the oversweep position when applicable. If the wings

are not in oversweep, ensure that the emergency WING SWEEP handle position corresponds with the actual wing position. Leave the emergency WING SWEEP handle guard up, extend the emergency WING SWEEP handle, and pull WING SWEEP DRIVE NO. 1 and WG SW DR NO. 2/ MANUV FLAP circuit breakers (LD1, LE1). Crossbleed starts should not be performed unless the area aft of the aircraft is clear. Tiedowns should not be removed and engines should not be started unless the auxiliary brake air pressure gauge indicates a full charge.

8.2 START AND POSTSTART

Shipboard start and poststart procedure abbreviations of the shore-based checklists are as delineated for the poststart-pilot procedures. Certain steps are omitted because aircraft are spotted too close together to allow the wings to be swept forward while tied down. Cranking the left engine prior to starting the right, as outlined in the shore-based procedures, will ensure that auxiliary brake pressure is available and will ensure that backup flight control module is full of hydraulic fluid prior to cycling.

8.3 TAXIING

Shipboard taxi operations differ slightly from the field. Taxiing aboard ship requires higher power settings and must be conducted under positive control of a plane director. Any signal from the plane director above the waist is intended for the pilot and any signal below the waist is intended for deck-handling personnel.

8.3.1 Nosewheel Steering

The nosewheel steering system characteristics are excellent and enable extremely tight cornering capability. At full nosewheel steering deflection (70°), the inside main mount wheel backs down and turn radius will be restricted if the inside brake is locked. For a minimum radius turn, momentarily depress the brake on the inside wheel and then allow the inside wheel to roll freely while controlling the turn rate by braking the outside wheel. For normal turns, symmetric brake applications should be applied to control aircraft forward motion. Forward motion should be initiated before effecting a tight radius turn to reduce power requirements.

8.3.2 Taxi Speed

Taxi speed should be kept under control at all times, especially on wet decks and approaching the catapult area.

Be prepared to use the parking brake should normal braking fail. While taxiing, both ejection seats should be armed. The parking brake is an excellent feature that may be used to prevent leg fatigue during taxi delays. However, it should not be used once forward of the jet-blast deflector.

8.3.3 Final Checker Aboard CV

1. Hook Down On Director Signal; Check RATS Advisory Light On, Then Up.

CAUTION!

Carrier operations with an inoperative RATS will increase CV wind-over-deck requirements. Failure to notify CV OPS may result in damage to the ship's arresting gear and aircraft tailhook assembly structure. Consult applicable recovery bulletins.

2. Nosewheel steering Cycle OFF, Then ON.

WARNING!

Failure to cycle nosewheel steering following hook check will enable nosewheel steering centering to remain engaged and can cause mispositioning of the launch bar during catapult hookup. This may result in launch bar disengaging from shuttle during catapult stroke.

8.4 CATAPULT HOOKUP (DAY)

Set the attitude displays to show level flight at normal strut extension. Proper positioning on the catapult is easily accomplished if the entry is made with only enough power to maintain forward motion and if the plane director signals are followed explicitly.

All functional checks shall be performed before taxiing onto the catapult. Ensure that the Takeoff Checklist is complete and that the proper trim is set for launch before entering the nosetow approach ramp.

All catapult launches shall be conducted with the HUD in the caged mode. If approaching the catapult after an uncaged HUD landing, cycle the TLN display mode button to ensure the HUD defaults to the caged format.

The catapult director will direct the pilot to approach the catapult track, using nose gear steering and brakes. Upon

signal from the plane director and when positioned immediately behind the mount of the lead-in track, kneel the aircraft.

If the launch bar is to be lowered from the cockpit, upon signal from the plane director, deflect the nosewheel to lower the launch bar, center the nosewheel, and disengage nose wheel steering. If the launch bar is to be lowered by the deck crew, no pilot action is required. After the hold-back bar has been attached to the aircraft and checked by squadron maintenance personnel, the catapult director will direct the aircraft forward until the holdback bar is snug against the catapult buffer unit. The aircraft will be stopped in position for shuttle tension up. The attitude displays will show 2° to 3° nosedown with the aircraft in the kneeled position.

WARNING!

Nosewheel centering can contribute to launch bar misalignment in the catapult shuttle, which could result in premature launch bar separation during launch. The nosewheel centering latching relay must be deactivated by depressing the nose wheel steering button after the hook check and before entering the catapult. It will also deactivate the nosewheel steering automatic disengagement function; nosewheel steering must be manually disengaged when entering the catapult.

CAUTION!

If the LAUNCH BAR light illuminates immediately upon selecting KNEEL with the NOSE STRUT switch, a malfunction in the system has occurred and the landing gear will not retract following the catapult launch.

Nosewheel steering is designed to disengage and the NWS ENGA light goes off when deck personnel lower the launch bar on the catapult. The arresting hook must have been cycled on deck and the throttles set at IDLE to enable the system. This feature prevents the pilot from inadvertently damaging the launch bar during control checks after final tensioning.

8.4.1 Catapult Trim Requirements

The following requirements are applicable to clean aircraft or any combination of air-to-air store, external tank, gross weight combinations, and launch cg locations between 7.0-percent and 18.5-percent MAC.

8.4.2 Catapult Launch

Aircraft launch gross weight will be cross-checked and verified by signal with the flight deck personnel prior to kneel. If the aircraft is to be catapulted with a partial fuel load, the pilot should ensure that longitudinal trim settings are adjusted if necessary. Upon receipt of the tension-up and release brakes" signal, release the brakes, ensure the parking brake is off, and advance the throttles to MIL. Ensure nosewheel steering is disengaged prior to performing control wipeout. When a turnup signal is received from the catapult officer, grip the throttles firmly, check engine instruments, ensure that the caution and advisory panel is clear, and the RIO is ready. When satisfied that the aircraft is functioning properly, salute the catapult officer. Normally, a 3 to 5-second delay will occur before the catapult fires. Optimum launch technique is to maintain a loose grip on the control stick while allowing it to move aft during the catapult stroke.

WARNING!

Failure to allow the control stick to move aft during the catapult stroke will result in degraded pitch rate and excessive sink rate off the bow.

Catapult launch with a partially filled external tank is not authorized.

Initial catapult firing results in a short-term vertical acceleration of 15 to 20gs caused by full compression of the stored-energy nose strut. Firmly restrain the throttles to prevent their aft travel during the catapult stroke.

The F-14 must be flown off the catapult by the pilot. At shuttle release, the energy stored in the nose strut is released, rotating the aircraft to the initial flyaway attitude of approximately 12-15 degrees nose-up on the VDI and HUD.

The aircrew should plan for the standard excess endspeed of 15 knots, unless notified otherwise. Lower excess endspeed than anticipated or a lower pitch trim setting than recommended will require the pilot to use backstick at the end of the catapult stroke to capture and maintain the desired climbout pitch attitude of 10 degrees. Higher endspeed than expected or a higher pitch trim setting than recommended will require the pilot to stop the rotation at 10 degrees with slight forward stick. While rotating to the flyaway attitude, the flightcrew will feel the aircraft settle approximately 5 feet before commencing a climb.

For catapult launches with excess endspeed less than 15 knots, the AOA will rise abruptly to 17 units and then gradually decrease as airspeed increases during the flyaway.

Aircrew coordination is particularly critical in this regime, since the aircrew must ensure that initial flyaway parameters are maintained while remaining alert for any abnormal launch characteristics and engine malfunctions. High endspeed and/or single-engine flyaway with trim settings above 2 degrees may require significant forward stick pressure. In all configurations, the use of afterburner and/or level rapid acceleration will require reduced nose trim settings. The RIO shall scan a repeat of the pilot's heads up display and associated standby flight instruments to ensure the correct flyaway conditions are met (airspeed, altitude and attitude).

Additional considerations exist for night/IFR catapult launches. Aircraft acceleration and the lack of external visual cues will cause the aircrew to sense that the nose is higher than actual and can result in spatial disorientation. Under these conditions, a vigilant instrument scan is required to ensure that the proper attitude is maintained throughout the launch and subsequent climbout.

8.4.3 Catapult Abort Procedures (Day)

If after turnup on the catapult, the pilot determines that the aircraft is down, the pilot gives the no-go signal by shaking his head from side to side. Never raise the hand into view or make any motion that might be construed as a salute.

After the catapult officer observes the pilot's no-go signal, he will cross his forearms over his head, and then give the standard release tension signal. When the catapult is untensioned, the catapult officer will signal the pilot to raise the launch bar. The pilot shall ensure that the throttles are seated in the catapult detent and will raise the launch bar with the LAUNCH BAR ABORT switch.

CAUTION!

To avoid damage to the launch bar retract mechanism, do not actuate the LAUNCH BAR ABORT switch with the nosewheel deflected off center.

When the launch bar is clear of the shuttle, the catapult officer will move the shuttle forward of the aircraft launch bar. At this point the aircraft is no longer in danger of being launched. The catapult officer will signal the pilot to lower the launch bar and then step in front of the

aircraft and signal the pilot to throttle back.

seconds.

CAUTION!

If the aircraft is down prior to it being pushed or pulled back for release from the holdback fitting and when directed by the catapult officer, the launch bar shall be raised by the LAUNCH BAR ABORT switch.

Unkneeling the nosegear while the launch bar is in the catapult track or shuttle will damage the launch bar linkage and bungees. The pilot should unkneel the aircraft only when he is sure that the launch bar is free to rise and upon signal from the catapult officer or taxi director.

If the aircraft is down after the go signal is given, transmit the words Suspend, Suspend"; however, the flightcrew should be prepared for the catapult stroke and to perform emergency procedures if required.

8.5 LANDING

8.5.1 Carrier Landing Pattern (VFR)

The VFR carrier landing pattern (Figure 8-1) shall be in accordance with the CV NATOPS manual. The pattern starts with the level break at 800 feet and 300 to 350 knots.

The break interval will be approximately one-half of the desired ramp interval time (15 to 17 seconds normal interval). When established wings level on the downwind leg, descend to and fly the pattern at 600 feet MSL. Engage DLC upon completion of flap extension.

Note

Selection of DLC during the flap extension cycle can generate excessive pitch rates. DLC is to be selected only upon completion of the flap cycle. DLC must be deselected prior to flap retraction to avoid excessive pitch trim change with automatic DLC stowage during the flap retraction cycle.

Slow to 15 units AOA or computed on-speed (which ever is faster) and verify airspeed/AOA correlation, engage APC if desired, check for proper DLC operation, and complete the Landing Checklist prior to reaching the 180° position. The 180° turn is commenced 1 to 1.2 nm abeam the LSO platform to arrive at the 90° position at approximately 450 feet MSL. The nominal bank angle throughout the turn should be 25° to 27°. Glideslope meatball acquisition will occur at approximately 0.6 nm. Do not descend below 300 feet prior to acquiring the ball. On rollout to final, slightly overshoot the ship's wake. Optimum time on glideslope is approximately 15 to 18

WARNING

The LSO and tower must be informed if the landing is to be made in any wing or flap configuration other than 20° wing sweep, flaps and slats down, or RATS inoperative, to ensure wind-over-deck requirements are met.

Do not attempt shipboard landing with inoperative ROLL SAS and store asymmetry greater than 170,000 inch-pounds because of lateral pilot-induced oscillation in the approach unless field divert is not possible. (Example: weapon rail at station 6 and AIM-54 missile at station 8 equals 170,000 inch-pounds.)

Note

With the hook down, airspeed in excess of 300 knots may cause the hook transition light to illuminate.

8.5.2 Manual Approach Technique

The rapid engine response characteristics allow the pilot to make timely, small amplitude power changes to make glideslope corrections.

Because of the rapid engine response and high-throttle sensitivity, the pilot must avoid over controlling power. DLC should be engaged for all approaches. Approaches flown without DLC will degrade flying qualities resulting in significant glideslope and lineup deviations. Pitch compensation for DLC inputs is optimized for approach airspeeds. Activation of DLC at higher airspeeds will result in inducing noticeable changes in pitch attitude. DLC may be employed by vernier or bang-bang control depending on the extent of the correction required. DLC is most effective in correcting for glideslope deviations caused by gusty conditions or ship burble. Caution should be taken not to use DLC to compensate for a major overpowered or underpowered condition.

CAUTION!

Caution must be taken to avoid sustained full- down DLC commands for a high condition at the ramp as this will result in excessive sink rates and subsequent hard landings.

Once established on glideslope, keep the scan going, cross-checking meatball, lineup, and AOA. Be alert for a waveoff. With rough seas and pitching decks, some erratic meatball movements

may be encountered. If this is the case, average out the ball movement to maintain smooth and safe rate of descent. To avoid being cocked up, "arrest a come down in close" with power and up DLC. Attempts to arrest high sink rates with nose attitude alone could result in landing damage to the ventral fins and afterburner. Also, avoid dropping the nose prior to touchdown as this significantly increases the chances of a hook skip bolter. Upon touchdown, add full MIL power, manually retract speedbrakes, and maintain aft stick pressure to minimize chances of a hook skip bolter. Selection of MIL power will automatically disengage DLC and retract the speedbrake. A good start is imperative to minimizing lineup corrections while on the glideslope and will prevent the tendency to chase lineup. Small, coordinated rudder inputs should be used to reduce the nose yaw that is easily generated by lateral stick inputs.

8.5.3 Approach Power Compensator Technique

Practice is required to develop the proper control habits necessary to use the APC. For the APC to perform satisfactorily, smooth attitude control is essential. Large, abrupt attitude changes result in excessive power changes. APC use is not recommended in gusty conditions. The APC will overcontrol AOA fluctuations resulting in large airspeed and/or glideslope deviations. The APC system was designed to be used with the engines operating in the primary mode and is not recommended with either one or both of the engines in secondary mode.

As the initial turn from the 180° position is made, the aircraft will momentarily indicate up to 2 units slow. The APC will adjust power to correct back to onspeed condition throughout the remainder of the turn. Upon rollout on glideslope, the pilot must override the tendency for the nose to pitch up by maintaining slight forward stick. The aircraft will indicate 1 to 2 units fast, which will slow to onspeed within 5 seconds. The use of DLC in conjunction with small attitude changes to maintain glideslope will minimize AOA deviations and result in optimal APC performance. Timely use of DLC can also be used to more rapidly correct from a fast or slow condition. Close-in corrections are very critical. If a high in-close situation develops, the recommended procedure is to stop the meatball motion and not attempt to recenter it. A low in-close condition is difficult to correct with APC and often results in an over-the-top bolter. It may be necessary to disengage or manually override APC in order to safely recover from a

low in-close situation. Throughout the approach, the pilot should keep his hand on the throttles in the event APC disengages inadvertently. A smooth throttle transition from AUTO to BOOST mode can be achieved by depressing the CAGE/SEAM button on the inboard throttle grip.

8.5.4 Waveoff Technique

A waveoff will be initiated immediately upon a signal or voice call from the LSO. MIL power should be used for all dual-engine waveoffs. Maintain the landing attitude until a positive rate of climb is established. Do not over rotate the aircraft in close as this significantly increases the chance of in-flight engagement.

WARNING!

Dual engine afterburner waveoffs are prohibited. Inadvertent arrestment or in-flight engagement in dual afterburner would result in catastrophic damage to the aircraft and/or arresting gear.

Normally, waveoffs will be taken straight ahead, especially when close in. When using APC, waveoff technique is the same as for manual approaches except that a force of approximately 8 pounds is required to disengage the throttle torque switches. Disengagement of the APC by overriding the throttle forces results in the throttle MODE switch automatically returning to BOOST and illuminates the AUTO THROT light on the pilot left-hand ladder light assembly. A time delay relay holds the AUTO THROT light on for 10 seconds following APC disengagement.

CAUTION!

If a force in excess of 14 pounds is applied to break the throttles out of the automatic mode, the throttle MODE switch will return to BOOST but the throttle mode will revert to manual. The switch must be cycled to MAN and back to BOOST to regain the BOOST mode.

8.5.5 Bolter Technique

The bolter maneuver is effected by selecting MIL and slight aft control stick until the desired flyaway attitude is established.

The use of excessive backstick on a bolter may cause the tail surface to stall, delaying aircraft rotation and causing the aircraft to settle off the angle.

8.5.6 Bingo Fuel

Fuel reserves should be programmed depending

on distance of the field from the CV, aircraft configuration, and en route weather. This bingo fuel quantity should be set before takeoff.

8.5.7 Arrested Landing and Exit From the Landing Area

As the aircraft touches down, advance throttles to MIL. Upon completion of landing rollout, reduce power to IDLE.

Raise the hook and flaps and select wing-sweep BOMB while allowing the aircraft to roll aft. Apply brakes on signal. Flaps retraction requires approximately 7 seconds. When the flaps are fully retracted the wings will sweep aft.

Engage nosewheel steering and taxi forward on the come-ahead signal. If the wings sweep aft to 55, auxiliary and main flap retraction has been verified and full-aft wing sweep may be selected using the emergency handle. The RIO should

monitor wing-sweep position while taxiing.

Oversweep should be selected prior to final spot and shutdown. The engines should remain running until the cut signal is given by the plane director. If at any time during this phase of operations a brake failure occurs, pull the parking brake. If the aircraft continues to roll, drop the hook, advise the tower, and signal for chocks to be installed. Use nosewheel steering to ensure that the aircraft remains on the deck. Do not unstrap, disarm the ejection seat, or leave the cockpit until tiedowns have been installed.

Note

Aircrew shall inform tower in the event of RATS failure on landing.

NOTE: See Chapter 2 for instructions on manual/auto wingsweep for this FSX rendition

8.5.8 Carrier-Controlled Approaches

Should these procedures conflict with the applicable CV Air Operations manual, the latter shall govern. Detailed pilot-controller voice procedures must be established in accordance with each ship's CCA doctrine.

NOTE: Automated Carrier Landing System is not simulated in this FSX rendition.

8.5.9 Hold Phase

Five minutes before penetration, defogging shall be actuated and maximum comfortable interior temperature will be maintained to prevent possible fogging or icing on the windshield and canopy.

Note

Fuel dump is accomplished by gravity flow and

its effectiveness is reduced during the penetration descent. Fuel dump, if required, should be planned accordingly for the level leg.

1. Before descent, check shoulder harness handle locked, set lights as directed by existing weather, and lower arresting hook.

2. Accomplish final changes to radio and IFF upon departing marshal or earlier. After these changes are made, the pilot should make no further changes except under emergency conditions.

3. When commencing penetration, initiate a standard descent: 250 knots, 4,000 fpm, speedbrakes as required.

If a gear and/or flaps down penetration is required, ensure that the wings are programmed forward of 22° prior to lowering flaps. If flaps are lowered with wings swept aft of 22, auxiliary flap extension will be inhibited resulting in rapid nosedown pitch rates.

4. Radar and barometric altimeters shall be cross-checked continuously when below 5,000 feet.

8.5.10 Platform

At 20 miles passing through 5,000 feet, aircraft descent shall be slowed to 2,000 fpm. At this point, a mandatory, unacknowledged voice report will be broadcast by each pilot.

The aircraft side number will be given and platform" will be reported. Continue descent to 1,200 feet.

8.5.11 Ten-Mile DME Fix

1. Commence transition to landing configuration, unless otherwise directed by CCA, maintaining 1,200 feet.

2. Gear and flaps shall be down by 8 miles.

3. Complete the landing checklist. Check anti-ice, lights, and rain removal, as required.

8.5.12 Six-Mile DME Fix

For a precision radar approach, maintain 1,200 feet at approach speed until intercepting the glidepath at 3 to 3.25 miles, unless otherwise directed. For an air surveillance radar approach, a gradual descent of 600 fpm can be commenced departing the 6-mile DME fix. Maintain 600 feet until the aircraft intercepts the center of the glideslope at 1¼ to 1½ miles on a

3.5° slope.

Commence a descent of 500 to 700 fpm, using the following checkpoints:

1. 1 mile - 460 feet.
2. ¾ mile - 360 feet.
3. ½ mile - 260 feet.

8.5.13 Meatball Contact

When transitioning to a visual approach (at approximately ¾ of a mile), make a report call with the following information: side number, TOMCAT, meatball or Clara (no meatball), fuel state, and type pass. The LSO will acknowledge, and instructions from the final controller will cease.

Pilots are cautioned against premature contact reports and transition to visual glideslope during night recoveries when visibility permits sighting the ship beyond 2 to 3 miles. The height and dimension of the entire lens or mirror optical beam at 1¼ miles is over 200 feet and the true center cannot be distinguished. This, coupled with the relatively short length of the runway lights, will give the pilot the illusion of being high when, in fact, the aircraft may be well below optimum glideslope. An additional advantage of delaying the meatball report (even though the ball is in sight) is that the final controller will continue lineup instructions that can greatly assist the pilot in establishing satisfactory lineup. Use the vertical velocity indicator to set up a rate of descent of 500 to 700 fpm. The AN/ARA-63 instrument landing system (ILS) is an excellent aid during the approach and should be used whenever possible. ILS glideslope azimuth and elevation signals are provided as command fly to" indications and are displayed via the VDI and/or the HUD in the TLN mode.

8.6 WAVEOFF AND BOLTER

In the event of a waveoff or bolter, climb straight ahead to 1,200 feet and maintain 150 knots.

When directed by CCA, initiate a level turn to the downwind leg reporting abeam with fuel state. (If no instructions are received within 2 minutes or 4 miles DME, attempt radio contact; if unable, assume communications failure and initiate the downwind turn to the reciprocal of final bearing reporting abeam with fuel state. If no acknowledgment is received, start a turn at 4 miles or 2 minutes to intercept final bearing.) A 20° bank angle at 150 knots on the upwind turn

establishes the aircraft at the desired 2 miles abeam on the downwind leg. CATCC clears the aircraft to turn inbound to intercept final bearing. A level, on-speed approach turn of 18° to 22° bank angle from the normal downwind position allows the aircraft to properly intercept final bearings at a minimum of 3 miles aft of the ship. Traffic spacing ahead may require that the aircraft continue on downwind leg well past the normal abeam position before being directed to turn to final bearing.

No attempt should be made to establish visual contact with the ship when executing a CCA until the final approach turn has been executed.

Note

The radar beacon (AN/APN-154) should be turned off as soon as practicable after landing to avoid causing interference with AN/SPN-42 control of other aircraft in the pattern.

8.7 NIGHT FLYING

Night carrier operations will have a much slower tempo than daylight operations and it is the pilot's responsibility to maintain this tempo. Normal day carrier operations shall be used except as modified below.

8.7.1 Briefing

Before initial night flight operations, all pilots should receive an additional briefing from the following persons:

1. Flight deck officer
2. Catapult officer
3. Arresting gear officer
4. LSO
5. CATCC.

Individual flight briefings will include all applicable items outlined above, with particular emphasis on weather and bingo fuel.

8.7.2 Preflight

In addition to normal cockpit preflight, ensure that external light switches are properly positioned for poststart light check. Install night filters on applicable cockpit displays.

8.7.3 Poststart

Adjust cockpit light to desired brightness. When ready for taxi, indicate with appropriate signal.

8.7.4 Taxi

Night deck-handling operations are of necessity slower than those used during the day. When a doubt arises as to the meaning of a signal from a taxi director, stop.

8.7.5 Catapult Hookup (Night)

Procedures for aircraft catapult hookup at night are identical to those used during day operations. However, it is difficult to determine your speed or degree of motion over the deck. The pilot must rely upon, and follow closely, the plane director's signals.

8.7.6 Catapult Launch

On turnup signal from the catapult officer ensure throttles in MIL and check all instruments. When ready for launch, place external light master switch ON (bright and steady). After launch, establish an 8° to 10 pitch attitude, cross-checking instruments to ensure a positive rate of climb. Retract the landing gear. An altitude of 500 feet is considered to be minimum altitude for retraction of flaps. When well established in a climb, switch lights to flashing or as applicable for an instrument climbout. The standby indicator should be used in the event of a primary display(s) malfunction.

WARNING!

If wings sweep back inadvertently, close attention should be paid to maintaining positive rates of climb. The loss of lift incurred by premature wing sweep aft can result in significantly decreased rates of climb, with very little change in pitch attitude and trim requirements.

8.7.7 Catapult Abort Procedures (Night)

The pilot no-go signal for night launches will be to not turn on the exterior lights, and to transmit on the land/launch frequency the aircraft side

number, the catapult the aircraft is on, and the words Suspend, Suspend." After the catapult is untensioned, the catapult officer will signal to raise the launch bar. The pilot shall ensure that the throttles are seated in the catapult detent or throttle friction is full forward before raising the launch bar with the LAUNCH BAR ABORT switch. When the launch bar is clear of the shuttle, the catapult officer will move the shuttle forward of the aircraft launch bar. At this point the aircraft is no longer in danger of being launched. The catapult officer will signal the pilot to lower the launch bar and then step in front of the aircraft and signal the pilot to throttle back. If the aircraft is down after the go signal is given, transmit the words Suspend, Suspend"; however, the flightcrew should be prepared for the catapult stroke and to perform emergency procedures if required.

WARNING!

If the aircraft is down prior to it being pushed or pulled back for release from the holdback fitting and when directed by the catapult launching officer, the launch bar shall be raised by the LAUNCH BAR ABORT switch.

CAUTION!

Unkneeling the nosegear while the launch bar is in the catapult track or shuttle will damage the launch bar linkage and bungees.

The pilot should unkneel the aircraft only when sure that the launch bar is free to rise and upon signal from the catapult officer or taxi director.

8.7.8 Arrested Landing and Exit From Landing Area (Night)

During approach, all lights shall be on bright and steady. At the end of arrestment rollout, turn off external lights and follow the director's signals while effecting the normal aircraft cleanup procedures.

MAXIMUM LANDING GROSS WEIGHT 54,000 POUNDS

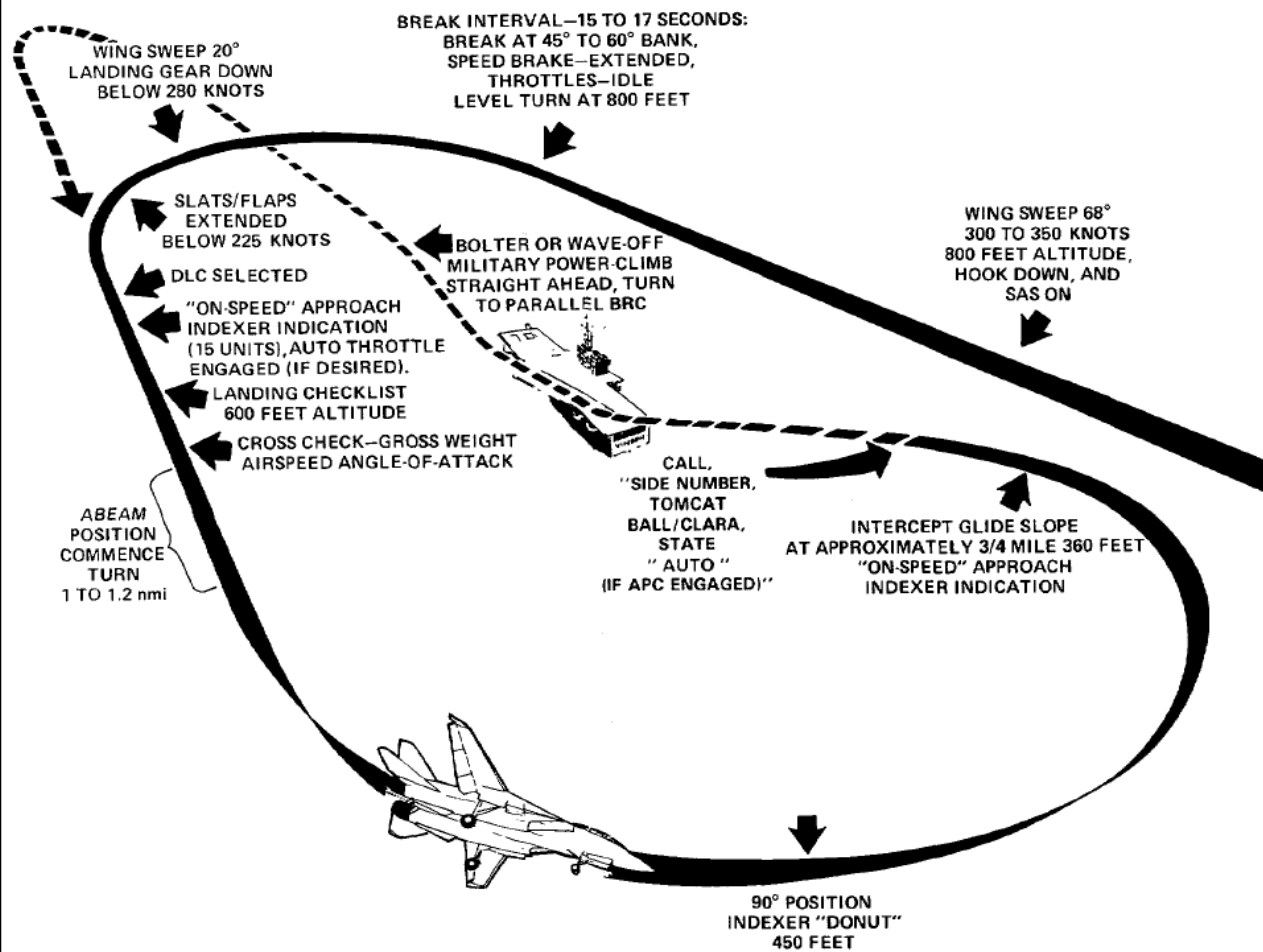


Figure 8-1 Carrier Landing Pattern

MAXIMUM LANDING GROSS WEIGHT 54,000 POUNDS

VOICE REPORTS

1. SIDE NUMBER - ESTABLISHED IN MARSHAL - ANGELS - FUEL STATE
2. SIDE NUMBER - COMMENCING - FUEL STATE - ALTIMETER SETTING
3. SIDE NUMBER - PLATFORM
4. SIDE NUMBER - 10 MILE FIX
5. **BALL CALL:** SIDE NUMBER - TOMCAT BALL/CLARA - FUEL STATE - (type approach: AUTO/COUPLED).
6. **IF AFTER BOLTER / WAVE-OFF:** SIDE NUMBER - AIRBORNE
7. **WHEN ABEAM:** SIDE NUMBER - FUEL STATE

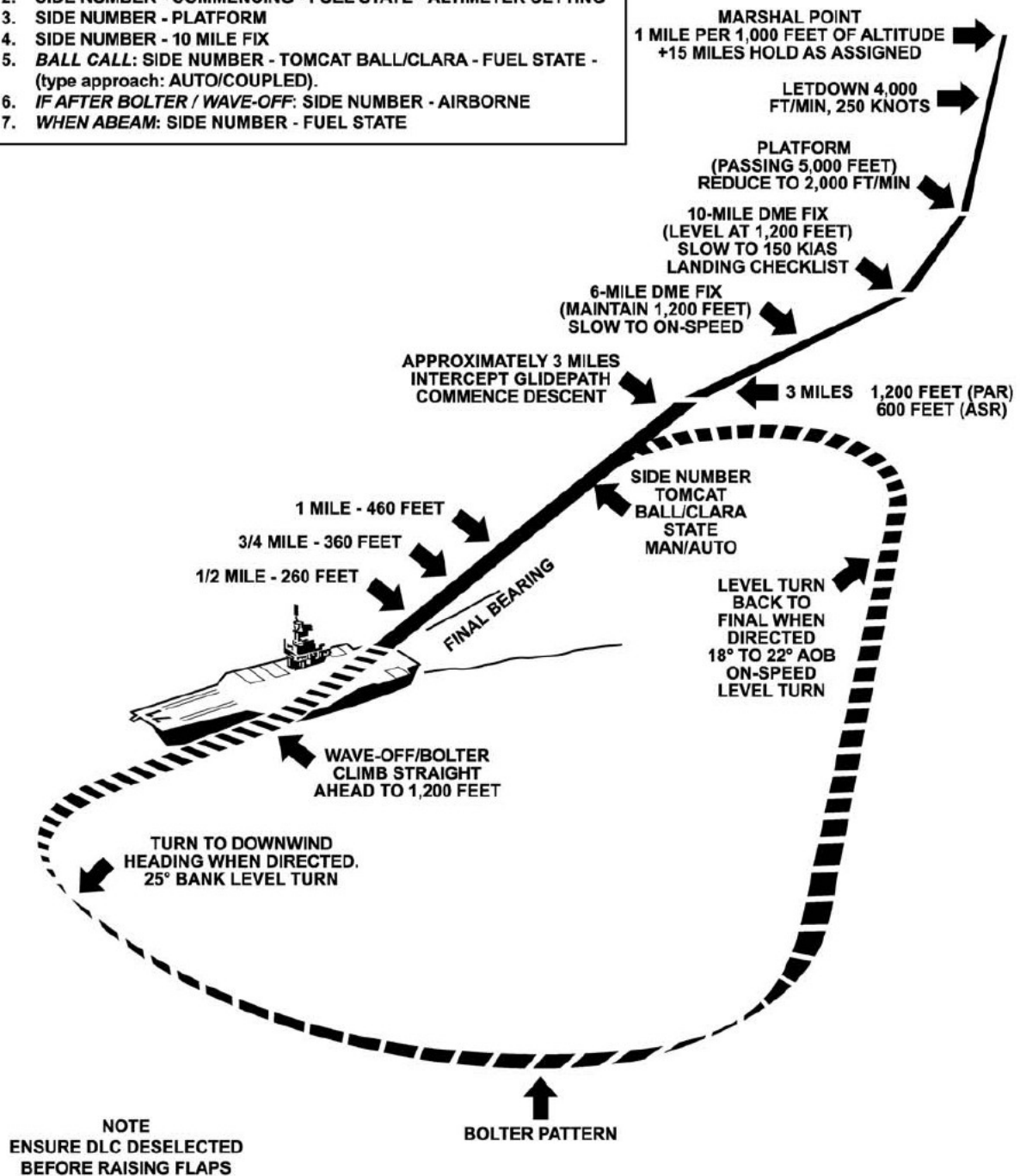


Figure 8-2 Carrier Controlled Approach (typical)

CHAPTER 9

Special Procedures

9.1 IN-FLIGHT REFUELING PROCEDURES

Note

Before commencing in-flight refueling operations, each flight crewmember shall become familiar with the NATOPS Air Refueling Manual, NAVAIR 00-80T-110, and in-flight refueling system description.

9.1.1 In-Flight Refueling Controls

Regardless of fuel management panel switch positioning, at low fuel states the initial resupply of fuel is discharged into the left- and right-wing box tanks. Thereafter distribution of the fuel to the forward, aft, wing, and external tanks is controlled by the WING/EXT TRANS switch position. The split refueling system to the left and right engine feed group provides for a relatively balanced center of gravity condition during refueling. Selective refueling of the fuselage or all fuel tanks is provided on the REFUEL PROBE switch with the probe extended. In the FUS/EXTD position, normal fuel transfer and feed is unaltered. This position is used for practice plugins, fuselage only refueling, or return flight with a damaged air-refueling probe. The ALL/EXTD shuts off wing and external tank transfer to permit the refueling of all tanks. The REFUELING PROBE switch circuit uses essential dc No. 2 power to control operation of the probe actuator through redundant-extend solenoids and a single-retract solenoid.

9.1.2 In-Flight Refueling Checklist

The in-flight refueling checklist shall be completed before plug-in.

1. RDR switch - STBY.
2. Arming switches - SAFE.
3. DUMP switch - OFF.
4. AIR SOURCE pushbutton - L ENG.
5. REFUEL PROBE switch - As Desired (transition light OFF).
6. Wing-sweep switch - MAN/wing-sweep angle - As Desired.
7. Visors - Recommended Down.

WARNING!

To prevent fuel fumes from entering the cockpit through the environmental control system (ECS) because of possible fuel spills

during in-flight refueling, select AIR SOURCE pushbutton L ENG.

9.1.3 In-Flight Refueling Techniques

Note

The following procedures, as applied to tanker operation, refer to single-drogue tanker only. Refueling altitudes and airspeeds are dictated by receiver and/or tanker characteristics and operational needs, consistent with the tanker's performance and refueling capabilities. This covers a practical spectrum from the deck to 35,000 feet, 170 to 300 knots, and wing-sweep angles of 20° to 68°. Optimum airspeed and wing-sweep position is 240 knots and approximately 40° wing-sweep. This configuration increases aircraft angle of attack enough to lower the receiver's vertical tails below the tanker's jetwash and decreases bow wave effect. SAS-off tanking can most easily be performed at 200 KCAS with 40° of wing-sweep.

9.1.3.1 Approach

Once cleared to commence an approach and with refueling checklists completed, assume a position 5 to 10 feet in trail of the drogue with the refueling probe in line in both the horizontal and vertical reference planes. Trim the aircraft in this stabilized approach position and ensure that the tanker's (amber) ready light is illuminated before attempting an approach. Select a reference point on the tanker as a primary alignment guide during the approach phase; secondarily, rely on peripheral vision of the drogue and hose and supplementary remarks by the RIO. Increase power to establish an optimum 3 to 5-knot closure rate on the drogue. It must be emphasized that an excessive closure rate will cause a violent hose whip following contact and/or will increase the danger of structural damage to the aircraft; too slow a closure rate results in the pilot fencing with the drogue as it oscillates in close proximity to the aircraft nose. During the final phase of the approach, the drogue has a tendency to move slightly upward and to the right as it passes the nose of the receiver aircraft because of the aircraft-drogue airstream interaction.

Small corrections in the approach phase are acceptable.

However, if alignment is off in the final phase, it is

best to immediately return to the initial approach position and commence another approach, compensating for previous misalignments by adjusting the reference point selected on the tanker. Small lateral corrections with a shoulder probe are made with the rudder, and vertical corrections with the horizontal stabilizer. Avoid any corrections about the longitudinal axis since they cause probe displacement in both the lateral and vertical reference planes.

9.1.3.2 Missed Approach

If the receiver probe passes forward of the drogue basket without making contact, a missed approach should be initiated immediately. Also, if the probe impinges on the canopy-lined rim of the basket and tips it, a missed approach should be initiated. Realization of this situation can be readily ascertained through the RIO. A missed approach is executed by reducing power and backing to the rear at an opening rate commensurate with the optimum 3 to 5-knot closure rate made on an approach. By continuing an approach past the basket, a pilot might hook the probe over the hose and/or permit the drogue to contact the receiver aircraft fuselage. Either of the two aforementioned hazards require more skill to calmly unravel the hose and drogue without causing further damage than to make another approach. If the initial approach position is correctly in line with the drogue, the chance of hooking the hose is diminished as the need for last-minute corrections is minimized. After executing a missed approach, analyze previous misalignment problems and apply positive corrections to preclude a hazardous tendency to blindly stab at the drogue.

9.1.3.3 Contact

When the receiver probe engages the basket, it will seat itself into the drogue coupling and a slight ripple will be evident in the refueling hose. The tanker's drogue and hose must be pushed forward 3 to 5 feet by the receiver probe before fuel transfer can be effected. This advanced position is evident by the tanker's amber ready light going out and the green fuel transfer light coming on. While plugged in, merely fly a close tail-chase formation on the tanker. Although this tucked-in condition restricts the tanker's maneuverability, gradual changes involving heading, altitude, and/or airspeed may be made. The precise flying imposed on both the tanker and receiver pilots requires a lot of "heads down" time, yet a sharp lookout doctrine must be maintained. This is the receiver RIO's primary responsibility.

9.1.3.4 Disengagement

Disengagement from a successful contact is accomplished by reducing power and backing out at a 3 to 5-knot separation rate. Care should be taken to maintain the same relative alignment on the tanker as upon engagement. The receiver probe will separate from the drogue coupling when the hose reaches full extension. When clear of the drogue:

1. REFUEL PROBE switch - RET.
2. Probe transition light - Check Out.
3. AIR SOURCE pushbutton - BOTH ENG.
4. Wing-sweep switch - AUTO.

Resume normal flight operations.

9.2 FORMATION FLIGHT

The following formation descriptions are recommended guidelines for F-14 multiplane positioning.

Parade formation IFR/VFR and loose cruise flight shall not be performed with the flight lead utilizing autopilot ground-track destination steering because of the midair collision potential associated with inadvertent way-point steering selection and rapid aircraft AOB changes.

9.2.1 Parade Formation

The basic parade position is either left or right echelon, or a combination of both, as in fingertip three-plane formation. The parade formation is used primarily for multiplane maneuvering at night, in IMC, or during entry into or exit from an airport traffic area.

Wing sweep: 20

Configuration: Clean or dirty.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the explosive seat warning triangle below the RIO cockpit.
2. Wingtip separation is determined by a position on the bearing line where the leading edges of the lead aircraft's ventral fins are aligned.
3. Stepdown is determined by aligning the lead's opposite engine nacelle just under the near engine nacelle. This positioning should provide the wingman with approximately 5 feet of wingtip separation and 10 feet of stepdown.

9.2.2 Break Formation

The basic break formation is either left or right

echelon, or a combination of both as in a fingertip three-plane formation. This formation is used primarily for multiplane entry into the overhead break pattern.

Wing sweep: 68°

Configuration: Clean.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the explosive seat warning triangle below the RIO cockpit.

2. Wingtip separation is determined by a position on the bearing line where approximately 1 foot of the forward edge of the lead's opposite ventral fin shows in front of the near ventral fin.

3. Stepdown is determined by aligning the lead's opposite engine nacelle just under the near engine nacelle.

This position should provide the wingman with approximately 15 feet of wingtip separation and 10 feet of stepdown.

9.2.3 Diamond Four-Plane Formation

The diamond is the basic four-plane formation used for entry into the overhead break or for aerial fly-bys.

Wing sweep: 68°

Configuration: Clean.

Right and left echelon (dash-2 and dash-3, respectively)

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the pilot's helmet.

2. Wingtip separation is determined by a position on the bearing line where the trailing edges of the lead aircraft's ventral fins are aligned. At this position, the trailing edge of the exhaust nozzles should appear in line to the RIO.

3. Stepdown is determined by allowing approximately 6 inches of the lead's opposite engine nacelle to show below the near engine nacelle.

This position should provide the wingman with approximately 12 feet of wingtip separation and 12 feet of stepdown.

Slot (dash-4)

1. Line of bearing is determined by lining up on the lead aircraft's centerline.

2. Approximately 20 feet of nose-to-tail separation can be established by placing the wingman's canopy bow on the lead aircraft's on exhaust nozzles.

3. Approximately 25 feet of stepdown should be used. This position may be cross-referenced by placing the upper leading edge of dash-2's or dash-3's intake on the pilot's helmet.

9.2.4 Cruise Formation

Cruise is the basic formation used for multiplane transit to or from an operating area where increased maneuver ability is desired.

Wing sweep: 20°

Configuration: Clean.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the RIO's canopy bow.

2. A second line of bearing is determined by placing the lead aircraft's wingtip light on the forward upper UHF antenna.

3. Wingtip separation is determined by allowing approximately 1 foot of the lead's opposite exhaust nozzle to show behind the near exhaust nozzle.

This position should provide the wingman with approximately 64 feet of wingtip separation and 10 feet of nose-to-tail separation.

9.2.5 Aircraft Lighting During Night Formation Flight

The lead aircraft anticollision lights will normally be off during night formation flight in parade. However the possibility exists that the wing aircraft can inadvertently stray into a position aft of the normal bearing where only a single white tail light on lead is visible. In this position, serious misjudgment of separation and closure rate can occur. To prevent this, lead aircraft anticollision lights should be on when the wing aircraft is not in normal parade and mission requirements permit.

CHAPTER 10

Flight Characteristics

NOTE: ALBEIT THIS CHAPTER HAS BEEN HIGHLY MODIFIED FROM THE ORIGINAL FLIGHT MANUAL, IT DEPICTS THE FLIGHT CHARACTERISTICS OF THE REAL F-14D. FLIGHT CHARACTERISTICS OF THE VIRTUAL TOMCAT IN FLIGHT SIMULATOR X MAY DIFFER SIGNIFICANTLY.

10.1 PRIMARY FLIGHT CONTROLS

Primary flight controls are devices that change the flightpath of the aircraft. They consist of the differential horizontal stabilizer for pitch and roll control, the spoilers for supplementary roll control, and the rudders for directional control. A stability augmentation system is provided for the three axes of aircraft motion.

10.1.1 Pitch Control

The horizontal tail is effective from under 100 KIAS to over Mach 2. Its effectiveness gives the aircraft several capabilities not enjoyed by other fighters, including low takeoff rotation speeds and the ability to reach or exceed limit load factor over much of the subsonic and supersonic envelope; it is also an excellent drag device below 100 KIAS on landing rollout. The major disadvantages of the large horizontal stabilizer authority are that the pilot can generate high enough pitch rates (particularly in the nosedown direction) to cause coupling under certain conditions, and that a pitch attitude sufficient to scrape tailpipes and ventral fins can be attained on landing rollout or takeoff rotation.

10.1.2 Roll Control

Differential deflection of the horizontal tail surfaces provides primary roll control throughout the flight envelope and is the only roll control when the wings are swept beyond 62° (disabling the spoilers).

Note

Spoilers are activated to 62° of wing sweep, reducing aft fuselage structural loads during roll maneuvers. Spoilers are very effective at low to medium AOA for roll control, and reduce the aft fuselage torsional loads induced by the differential tail. The spoilers are also the primary mechanism for direct lift control and spoiler braking. With flaps down, the spoilers provide the majority of available roll control power.

10.1.3 Directional (Yaw) Control

Twin rudders furnish directional control. Through strong dihedral effect (roll because of sideslip), good roll control is also available from rudder inputs at medium and high AOA. Rudder power is sufficient to provide adequate control under all asymmetric store loading conditions.

10.1.4 Stability Augmentation System

PITCH SAS increases damping of the longitudinal, short-period dynamic response, but the aircraft can be operated safely throughout the flight envelope without it.

ROLL SAS increases roll acceleration during the initial lateral stick input. The SAS reduces differential tail deflection to limit maximum roll rate to less than 200 deg/sec to reduce aft fuselage loads and to prevent roll coupling in the transonic speed range. The DFCS ROLL SAS differential tail authority has been tailored to reduce structural loads and provide expanded, simplified rolling maneuver envelopes defined in Chapter 4. ROLL SAS differential tail inputs are automatically faded out over the airspeed range from approximately 400 to 500 KIAS. An undesirable byproduct of the roll-rate limiting is an oscillatory roll rate perceived as a nonlinear roll response encountered in aggressive rolling maneuvers at medium subsonic speeds and higher.

Because ROLL SAS provides structural protection, flight above 1.0 TMN is prohibited without ROLL SAS with wing-mounted AIM-54 (loadings 3B5, 3B6, 3C5, 3C6).

Should tactical considerations necessitate violating this restriction, restrict rolls to less than full lateral stick deflection and to not more than 180° of bank angle change at one time. This minimizes the possibility of aircraft damage. Initial roll acceleration is slower without ROLL SAS. High AOA handling qualities are significantly improved by keeping ROLL SAS on (see paragraph 11.6).

Over the majority of the flight envelope, YAW SAS is the most critical of the stability augmentation functions.

Directional dynamic response (yaw oscillations or dutch roll) is poorly damped without it. In regions of reduced directional stability above 24 units AOA or when supersonic, the SAS dampens yaw rates that might otherwise cause loss of control, or structural damage. Below 1.0 TMN, with YAW SAS OFF, normal maneuvering can be

accomplished if extra care is taken to control yaw and sideslip excursions with rudder (maintain coordinated flight), but high AOA maneuvering (above approximately 15 units AOA) should be avoided due to increased probability of departure from controlled flight.

At high AOA flight conditions, both the ROLL and YAW SAS are required to provide automatic rudder interconnect (ARI) functions which significantly improve the handling qualities, departure resistance, and recovery capability of the aircraft.

10.2 SECONDARY FLIGHT CONTROLS

Secondary flight controls affect the flightpath of the aircraft although they have other primary purposes, such as increasing lift or drag. Secondary flight controls of the aircraft include main, auxiliary, and maneuver flaps, leading edge slats, speedbrakes, DLC, and the variable sweep wing.

10.2.1 Maneuver Flaps and Slats

Maneuver flaps and slats provide increased turn performance (increased turn rate/decreased turn radius) when extended. Additionally, the extension of the maneuver slats decreases departure susceptibility by increasing positive dihedral effect (roll because of sideslip). The longitudinal trim change upon extension and retraction of the devices is slight (2 to 4 pounds aft on extension, approximately 2 pounds forward on retraction).

10.2.2 Landing Flaps, Slats, and DLC

Trim changes during extension and retraction of flaps/slats are significant. During extension of flaps/slats at 200 KIAS, an initial push force of approximately 5 pounds is required followed by a pull force of up to 15 pounds. Engagement of DLC at approach speeds causes essentially no trim change. Forces during retraction of the flaps/slats are generally opposite and of approximately the same magnitude. The force required during retraction of flaps/slats may be less objectionable than those during extension, as the flaps are generally raised at a slower airspeed and, therefore, require less opposing force.

11.2.2 Landing Flaps, Slats, and DLC

Trim changes during extension and retraction of flaps/slats are significant. During extension of flaps/slats at 200 KIAS, an initial push force of approximately 5 pounds is required followed by a pull force of up to 15 pounds. Engagement of DLC at approach speeds causes

essentially no trim change. Forces during retraction of the flaps/slats are generally opposite and of approximately the same magnitude. The force required during retraction of flaps/slats may be less objectionable than those during extension, as the flaps are generally raised at a slower airspeed and, therefore, require less opposing force.

Note

Retracting the flaps with DLC engaged may require up to 30 pounds push force to maintain pitch attitude when the DLC automatically disengages as the flaps pass 25.

10.2.3 Speedbrakes

The speedbrakes provide some deceleration capability throughout the flight envelope. However, the most effective means to slow the aircraft is to reduce thrust while applying g, since the speedbrakes are marginally effective at moderate to low speeds. Extension and retraction of the speedbrakes results in a pitch trim change that varies with flight conditions. In general, this change is not objectionable except at higher airspeeds where the rapidity of the change (1.5 seconds for full extension) may prevent fine gunsight tracking and possibly lead to a minor case of pilot-induced oscillation.

10.3 GENERAL FLIGHT CHARACTERISTICS

10.3.1 Static Longitudinal Stability

Static longitudinal stability indicates the direction of longitudinal stick force required with changing airspeed from a trim condition. At slow speeds where the wings are not sweeping, static longitudinal stability is slightly positive (forward stick is required for increasing speeds, aft stick is required for decreasing speeds). At speeds where the wings are automatically sweeping aft, static stability becomes neutral to slightly negative. In the transonic region, from Mach 0.8 to 1.5, static longitudinal stability is essentially neutral. There is, however, a minor reversal in the stick force gradient (forward stick force may have to be relaxed to maintain level flight when accelerating) at approximately Mach 0.95. Above Mach 1.5, the stick force gradient becomes neutral. Since the engine line of thrust is below the aircraft cg, reducing power causes a slight nosedown pitch; power addition causes a noseup pitch.

10.3.2 Dynamic Longitudinal Response Characteristics

The initial response of the aircraft to a

longitudinal stick input is greatly dependent on the dynamic longitudinal response or short period" characteristics. Dynamic longitudinal response to pilot inputs is somewhat sluggish in cruise and approach configurations when compared to most other modern day fighters. In cruise configuration this may not be evident until high gain, close coupled tasks, such as fine gunsight tracking, are attempted. Here, the pilot's tendency is to overdrive the aircraft with the control stick resulting in a slight porpoising of the nose. This can be avoided by applying a longitudinal stick input and waiting for a nose response before applying a further correction. In approach configurations, the sluggish nose response will be most noticeable during approaches without DLC, as more nose movement must accompany the larger power adjustments required to maintain onspeed AOA when flying the ball.

10.3.3 Maneuvering Stick Force

Maneuvering stick force, or stick force per g of the aircraft, is predictable throughout most of the flight envelope. That is, an increase in force commands a corresponding increase in g (approximately 4 pounds per g). The stick force per g generally changes very little with altitude, airspeed, loading, or cg position. Stick displacements required during maneuvering are relatively large and may be uncomfortable to some pilots. While the stick forces are not especially high, the stick must be placed relatively close to the pilot's torso to attain a given g. This gives the pilot less leverage with his arm and is more tiring, especially at lower airspeeds and higher AOA, where stick force per g can be as high as 10 pounds per g.

10.3.4 Roll Performance

The roll performance (maximum roll rate attainable) is generally satisfactory, particularly at high airspeeds. At lower speeds, however, the high-aspect ratio and roll inertia of the aircraft restrict its time to roll to considerably less than that of smaller, more nimble tactical aircraft (A-4, F-16).

Note

Although DFCS improves maximum roll rate capability at low airspeed and high AOA, these flight conditions are definite tactical limitations. Large aft stick inputs applied with lateral stick during supersonic rolling maneuvers result in increased adverse sideslip and should be avoided. High Mach number, high-altitude rolling maneuvers may result in oscillatory sideslip

and roll ratcheting during aggressive maneuvering with ROLL SAS off. Depending on the phasing of these dynamics, centering lateral stick may be insufficient to stop the rolling motion and opposite lateral stick may be required in order to terminate roll.

CAUTION!

Large sideslip angles generated during full lateral stick supersonic rolling maneuvers at high altitudes may result in engine stalls.

10.3.5 Roll Response

In the cruise configuration, the roll response to lateral stick inputs is generally satisfactory throughout the flight envelope. The increased roll acceleration and peak roll rate attainable with ROLL SAS on significantly improves the tactical maneuvering capability. However, at high airspeeds, the roll command augmentation (CAS) and roll rate limiting feature of the ROLL SAS can cause high roll accelerations and marked variations in roll rate during aggressive rolling maneuvers with large lateral stick inputs. This effect is most pronounced at high subsonic airspeeds (from approximately 0.7 to 0.93 Mach) and medium to low altitudes (below approximately 20,000 feet). This characteristic may lead to bank angle overshoots during maximum roll rate maneuvers at high airspeeds. Smoother and/or smaller lateral stick inputs will reduce or eliminate this oscillatory roll response at these flight conditions.

At high angles of attack, the up-and-away (UA) UA-ARI control functions dramatically improve the roll response of the aircraft. The roll reversal characteristic experienced without ARI is eliminated throughout the majority of the available AOA range. Roll response is in the direction of commanded lateral stick up to and beyond 30 units AOA. Some variation in normal roll response may be seen due to aircraft control system and/or wing sweep and flap rigging tolerances, external store loading, or wing fuel imbalance. Maximum roll rate commanded by lateral stick decreases as AOA increases, decreasing to near zero above 30 units AOA, without pilot commanded coordinating rudder inputs. Proper sense roll response can be attained at increasingly higher AOA through use of pilot coordinating rudder. At very low airspeed and high AOA conditions (less than 0.4 Mach and above 30 units AOA), the Low Speed Cross Control feature (LSXC) can be safely utilized to obtain a transient roll maneuvering capability. This feature is enabled by applying rudder in the

desired roll direction, while applying an opposite lateral stick input. Peak roll rate of approximately 60 deg/sec is available through the use of LSXC. If long duration inputs are utilized, the roll response may become oscillatory, with hesitations in bank angle and roll rate. Precise bank angle control is typically not possible with LSXC, but the feature can be effectively utilized during sustained slow speed / high AOA maneuvering such as a flat scissors engagement. In the landing configuration, the power approach (PA-ARI) control functions and modified spoiler gearing provide a crisp roll response to pilot lateral stick inputs. Control gains are scheduled with AOA to provide a linear roll response of approximately 20 deg/sec roll rate per inch of lateral stick deflection. This responsiveness may lead to a tendency to overcontrol bank angle if large amplitude stick inputs are utilized. Therefore, relatively small stick deflections are required to perform these corrections. Once accustomed to the increased roll response in the landing configuration, pilot workload to perform lateral corrections and precisely maintain lineup will be significantly reduced, allowing the pilot to devote valuable time to controlling both glideslope and AOA.

10.3.6 Dutch Roll

Dutch roll is characterized by a wallowing, snaky motion of the nose that severely degrades heading and/or lineup control. Large lateral stick inputs can excite the Dutch roll mode of the aircraft in the cruise configuration, but the most severe degradation in flying qualities from the Dutch roll is in the approach configuration. The period of this motion is quite long and has the unfortunate result that the pilot perceives a heading error when referenced to centerline, when in fact the flightpath is correct. In the landing configuration, the PA-ARI control functions provide a nearly deadbeat directional response. Precise lineup control is exhibited due to the increased Dutch roll damping and the automatic stick to rudder interconnect function which provides coordinating rudder inputs with lateral stick deflection. Additional pilot coordinating rudder inputs are typically not required during approach, but may be used for aggressive bank and/or lineup corrections if desired.

10.3.7 Trim Characteristics

The trim rate in pitch is slow. During acceleration runs in MAX power at low altitude, trim may have to be run nearly continuously to maintain

longitudinal stick force at or near zero. Lateral control authority and roll rates at slow speeds will be reduced by almost one-half with full stick deflection in the direction of full lateral trim because of decreased spoiler deflection. Therefore, when maximum lateral control authority is required, such as during an asymmetric flap condition, trim in the direction of stick displacement should be avoided. Runaway trim in any axis is controllable. During field landings, the aircraft can be recovered safely with runaway trim; however, carrier approaches with full runaway pitch trim may be difficult. Trimming the aircraft to level flight can be broken down into two areas. At airspeeds slower than those using automatic wing-sweep programming, the aircraft is relatively easy to trim to level flight because it has positive longitudinal static stability. At airspeeds where the wings automatically move with a change in airspeed, it becomes very difficult to achieve a hands-off trim. Because of the change in aircraft pitching moment caused by movement of the wings, the nose tends to pitch further down with each increase in speed or further up with each decrease in speed.

Trimming the aircraft laterally/directionally may be required to compensate for lateral asymmetry resulting from either asymmetric stores, wing fuel imbalance, or control surface rigging tolerances. Lateral trim requirements will result in a stick displacement and a corresponding differential tail split that will reduce the amount of effective differential tail authority in the direction of trim and increase the amount of effective differential tail authority opposite trim. As a result, aircraft response will be reduced for lateral stick deflections in the direction of trim and increased for lateral stick deflections opposite the direction of trim. The combined effects of lateral trim and any CG displacement associated with the asymmetry may result in increased departure susceptibility and severity. In addition, excessive lateral trim requirements will result in increased roll rates and structural loads during rolling maneuvers opposite the direction of trim. This is particularly evident at transonic and supersonic flight conditions. For this reason, lateral/directional trim requirements should be managed primarily via directional yaw trim first then followed by lateral stick roll trim.

WARNING!

Excessive lateral trim requirements will result in increased roll rates and structural loads during rolling maneuvers opposite the

direction of trim. This is particularly evident at transonic and supersonic flight conditions.

For this reason, trim yaw first, then roll.

10.4.1.1 Gross Weight

Heavier gross weights require higher thrust settings to maintain level flight and, therefore, larger control deflections to counter the greater

Changes in thrust settings normally require a trim asymmetric thrust.

change, particularly in the approach

configurations. A reduction in power causes a slight nosedown pitch.

In the landing configuration, the DFCS includes a roll rate command function. Pilot lateral stick deflection commands a desired roll rate, which is provided through differential tail and spoiler inputs. Once this commanded roll rate is achieved, ROLL SAS inputs will stabilize the aircraft at the commanded rate. Likewise, any roll rate not commanded by lateral stick deflection (gust, turbulence, lateral asymmetry, etc.) is sensed as a roll rate error. The ROLL SAS will automatically provide inputs through the roll series servos to stop this uncommanded rate. Sufficient gain exists in this control function to essentially provide an "auto-trim" capability in the roll axis for many lateral asymmetry situations. Because of this characteristic, precise lateral trim may be slightly more difficult to achieve in the landing configuration. In some cases, it may be possible to slowly move lateral stick trim from left to right with no appreciable change in aircraft bank angle or roll rate. Because much of the lateral trim is now being provided through biasing of the roll series servos in one direction, the aircraft may subsequently exhibit an asymmetric roll rate in response to pilot lateral stick inputs. Should this bias become objectionable, the aircraft can be trimmed both laterally and directionally with the ROLL SAS OFF, reselecting ROLL SAS ON once trim is established. This action should eliminate any bias present in the roll series servos and provide symmetric roll response.

10.4 ASYMMETRIC THRUST FLIGHT CHARACTERISTICS IN COMBAT AND CRUISE CONFIGURATION

10.4.1 General

With one engine inoperative, flight characteristics are considerably affected by the thrust asymmetry generated by the operating engine. The distance of the engines from the aircraft centerline produces flight control requirements and flying qualities not present in centerline thrust aircraft. Flight control requirements are a function of the thrust setting on the operating engine. The thrust required to maintain flight, and therefore the magnitude of the thrust asymmetry, is a function of the following.

10.4.1.2 Configuration

Aircraft configuration varies the amount of thrust required at a particular flight condition. At cruise configuration airspeeds, control requirements will be significantly reduced compared to landing configurations, which will require significantly higher thrust settings and in turn larger control forces to maintain desired flight path.

10.4.1.3 Airspeed

At maximum endurance airspeeds, minimum thrust is required to maintain level flight; therefore, the smallest asymmetric moment is produced. Higher or lower airspeeds will require higher power settings and, therefore, increased control forces. At airspeeds above maximum endurance, the greater asymmetry will be offset largely by the additional control power available. Minimum control speed is reached at the point when maximum rudder deflection is no longer sufficient to maintain directional control.

10.4.1.4 Altitude

Net thrust is strongly dependent on altitude. For a constant throttle setting, the asymmetric thrust is considerably higher at sea level than at higher altitudes. The F110 produces considerably more thrust than the TF-30 powered F-14A. At maximum afterburner, the F110's thrust at 10,000 feet is equivalent to that of the TF-30 at sea level.

10.4.1.5 Bank Angle

Bank angle increases induced drag and, therefore, requires higher thrust settings to maintain level flight. The higher thrust setting demands increased rudder deflection in a turn compared to that required in level flight at the same airspeed. Turn direction into or away from the failed engine significantly affects rudder requirements. In straight-line flight, some amount of rudder deflection will be required to offset the yawing moment from asymmetric thrust at zero bank angle. A five degree bank angle into the good engine will introduce a side force component countering the thrust asymmetry and thereby reducing the rudder requirement.

10.5 ENGINE STALLS AND FLAMEOUT

The F110 engines demonstrate exceptional operability throughout the flight envelope. No

hung stalls" (similar to the classic TF-30 stall) have been observed in flight tests. Self-clearing pop" stalls, which may produce an audible bang," may occur above 35,000 feet when below 100 knots in MAX power and usually occur in conjunction with an afterburner blowout. To date these stalls have resulted in no engine damage, are self-clearing in approximately 1 second, and have required no pilot action for engine recovery.

However, throttles should be reduced to idle when subsonic (MIL when over 1.1 Mach) to minimize the possibility of engine damage during all engine stalls. A supersonic stall may cause inlet buzz resulting in a rough, bumpy ride (+2.5 to -1g at 6 cycles per second). Inlet buzz should subside when decelerating below 1.2 Mach. When supersonic, any wing drop tendencies should be controlled with lateral stick alone.

10.6 HIGH ANGLE OF ATTACK FLIGHT CHARACTERISTICS

Several characteristics of the F-14 affect its behavior in high AOA flight. Among these are directional stability, dihedral effect, stores loading, the stability augmentation system, and maneuver flaps/slats.

10.6.1 Directional Stability

Directional stability is the tendency of the aircraft to return to trimmed, zero sideslip when disturbed. At low AOA, the aircraft exhibits positive directional stability and, if sideslip is generated by a control input or turbulence, the aircraft will return to the trimmed, zero-sideslip condition.

As AOA increases, directional stability begins to drop and, for a clean aircraft, becomes negative at approximately 20 to 22 units AOA. At high AOA with negative directional stability, the aircraft becomes more difficult to fly because the pilot or stability augmentation system must control sideslip with rudder inputs.

10.6.2 Dihedral Effect

Dihedral effect is the tendency of the aircraft to roll in reaction to sideslip being generated. The F-14 exhibits positive dihedral effect throughout the positive-AOA envelope (tending to roll away from sideslip) but negative dihedral effect at negative AOA. This tendency is borne out by the aircraft response from a rudder input. When right rudder is applied from a straight-and-level flight condition, the aircraft sees sideslip from the left and so rolls to the right increases or away from the sideslip. Positive dihedral effect

is a stabilizing influence in the area of reduced directional stability (high-AOA flight). At negative AOA, dihedral effect is negative such that a right rudder input will produce a left roll. In the PA configuration, negative AOA can be encountered at 1 g flight at the higher limit airspeeds for the configuration.

10.6.3 Miscellaneous

Speedbrake position has no effect on high-AOA flight characteristics. Wing-sweep angles aft of the AUTO schedule reduce buffet intensity, but departure resistance is reduced and more altitude is required for dive pullout when recovering after a departure. Therefore, the AUTO sweep schedule is best for high-AOA maneuvering.

10.6.4 Stall Characteristics

The 1g level stall (maneuver flaps/slats retracted) is characterized by the onset of light airframe buffet at 12 to 13 units AOA. This increases to moderate intensity at 15 units AOA with essentially no change in intensity at AOA as high as 60. Buffet is not a satisfactory cue to determine airspeed or AOA during high-AOA maneuvering. If deceleration is continued to full aft stick deflection, AOA will stabilize at approximately 35° to 45° depending upon stores loading. The cockpit AOA indicator pegs at 30 units AOA, which is equivalent to approximately 25 true AOA. Pitch attitude at stall is between 10 to 20 above the horizon with no external stores and 10 to 15 below the horizon with maximum external load. Some longitudinal porpoising may occur at full aft stick.

Maneuver flaps and slats delay buffet onset to 13 to 14 units AOA and reduce the magnitude of buffet in high-AOA flight.

The clean stall is defined as the application of full aft stick combined with rates of descent up to 9,000 fpm. As much as 5,000 feet is required for recovery from the fully developed stall.

Satisfactory lateral and directional control is maintained beyond the AOA where the basic airframe directional stability becomes negative. Lateral stick and rudder inputs can be used to adjust and maintain desired bank angle throughout the stall. Control inputs are provided to suppress wing rock motion up to 30 units AOA, but some mild wing rock may still occur. Above 30 units AOA, the wing rock suppression feature is inhibited and rudder effectiveness decreases sharply. Large rudder or lateral stick inputs produce an increase in AOA as sideslip

10.6.5 Vertical Stalls

If the aircraft is allowed to decelerate to zero airspeed in a vertical or near vertical attitude, it will slide backwards momentarily, then pitch over (usually backwards) to a near vertical dive.

Aircraft motions during the initial fall will be predominantly inertial with random pitching and yawing as the aircraft accelerates. After the initial nosedown pitch, the aircraft may pass through the vertical to near level flight attitude, yaw in one direction, and then return to a vertical dive attitude. This may occur more than once. This tendency is more pronounced at aft wing sweeps, but can usually be controlled with longitudinal control inputs. Some recoveries may be accompanied by large random yawing and/or rolling motions that will generally dampen without pilot action as the aircraft accelerates.

CAUTION!

The use of lateral stick to offset the random yawing and/or rolling motion may generate enough adverse yaw to cause a yawing/rolling departure.

The controls should be released below 100 knots during the vertical stall to prevent inadvertent inputs that may lengthen recovery and/or cause a departure.

Control inputs should not be applied until the aircraft is nose down and accelerating through 100 knots. Rudder and lateral stick are also effective in damping oscillations once the aircraft is nose low and accelerating. The aircraft is very responsive to longitudinal stick inputs at all AOA's at speeds above 100 knots.

During flight tests, vertical stalls in maximum afterburner power sometimes resulted in afterburner blowouts on one or both engines possibly followed by pop stalls that may or may not be audible to the pilot. All the stalls were self clearing with no tendency for EGT to rise out of limits. As the aircraft recovered and airspeed increased, the afterburner relit if the throttle remained in the afterburner detent. When practicing vertical stalls, basic engine power settings are recommended to avoid inducing engine afterburner transients that have an unknown effect on engine life. Maximum engine stall margin for the F110 is obtained at IDLE power.

11.7 DEPARTURE FROM CONTROLLED FLIGHT

Although the F-14 is an honest aircraft with

moderate departure resistance, departures can be induced by large or sustained control inputs that generally feel unnatural to the pilot. Since the aircraft has an essentially unrecoverable flat-spin mode, yaw rate must be controlled before it can build and the aircraft transitions to the flat-spin mode. In general, departures are characterized by increasing yaw rate with oscillations in roll and yaw. Yaw rate is masked by the roll rate and is not evident to the pilot until approximately 90 per second yaw rate (2 "eyeball-out" g) is reached.

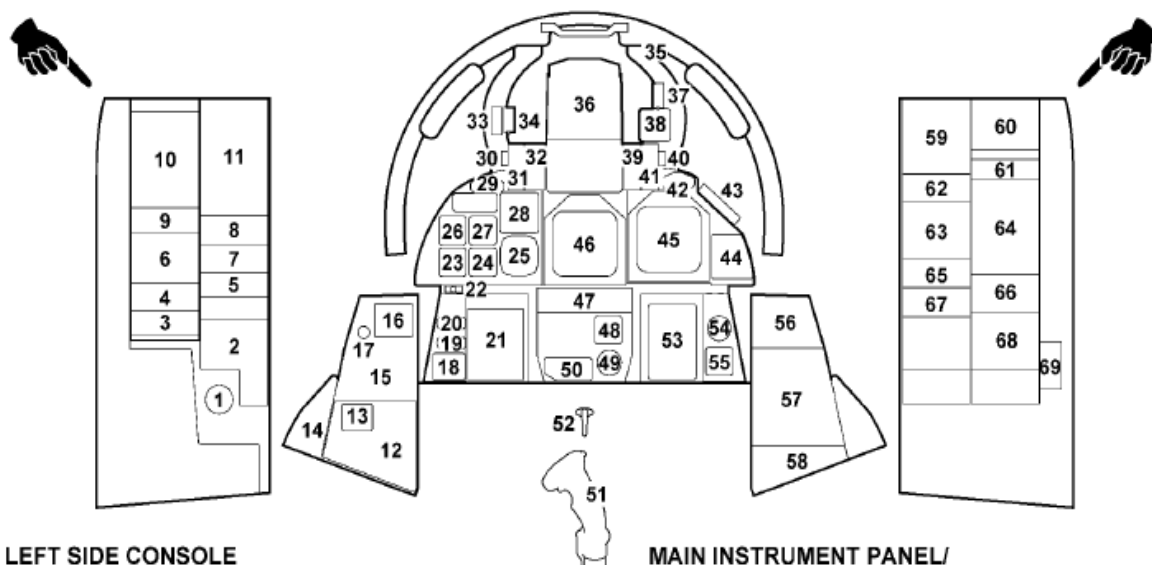
A predominant stability characteristic of the F-14 is positive dihedral effect, which is the tendency for the aircraft to roll to reduce sideslip. This effectively serves to delay yaw rate buildup associated with loss of directional stability at high AOA.

In an upright departure at approximately 50 per second yaw rate or less, if full forward stick is applied to reduce AOA, the aircraft will generally recover. At over 50 per second yaw rate, lateral/directional control inputs (rudder opposite yaw, lateral stick into yaw) are required to recover the aircraft. If these inputs are not made, the yaw rate will continue to build and the aircraft may enter the flat spin. DFCS will significantly enhance these recovery characteristics.

The time to reach 50 per second yaw rate after control input or engine failure is very critical. If 50 per second yaw rate is reached in 5 seconds or less, the pilot may not have enough time to neutralize, analyze, and apply recovery controls before the aircraft enters a flat spin depending on type and severity of departure, altitude and AOA at entry, and aircraft configuration.

Generally, the most severe departures are induced through the differential tail, which is commanded by lateral stick. Rudder inputs, asymmetric thrust, and inertia coupling can cause or contribute to the severity of departures. In addition to the enhanced departure resistance, the DFCS automatically provides anti-spin rudder and differential tail inputs to the maximum ROLL and YAW SAS authority limits as a function of yaw rate. This increases aircraft spin resistance. Flight tests indicate that the aircraft will recover from high yaw rates without pilot-commanded lateral/directional control inputs, due to these automatic rudder and differential tail inputs.

APPENDIX A – COCKPIT LAYOUT



LEFT SIDE CONSOLE

1. G VALVE PUSHBUTTON
2. OXYGEN/VENT AIRFLOW CONTROL PANEL
3. TONE VOLUME/TACAN COMMAND PANEL
4. ICS CONTROL PANEL
5. COMM/VOLUME/JTIDS SELECT PANEL
6. DFCS CONTROL PANEL
7. TACAN CONTROL PANEL
8. V/UHF CONTROL PANEL #1
9. ASYM LIMITER/ENGINE MODE SELECT PANEL
10. RAMPS/THROTTLE/RUDDER TRIM PANEL
11. THROTTLE QUADRANT

LEFT VERTICAL CONSOLE

12. FUEL/MASTER RESET/ANTI-SKID/SPOILER BRAKE PANEL
13. CONTROL SURFACE POSITION INDICATOR
14. LAUNCH BAR CONTROL PANEL
15. LANDING GEAR CONTROL PANEL
16. WHEELS/FLAPS/SPEED BRAKE POSITION INDICATOR
17. EMERGENCY STORES JETTISON BUTTON

LEFT KNEE PANEL

18. HYDRAULIC PRESSURE INDICATOR
19. OIL PRESSURE INDICATOR
20. NOZZLE POSITION INDICATORS
21. ENGINE INSTRUMENT GROUP
22. LOW ALTITUDE WARNING LIGHT

MAIN INSTRUMENT PANEL/WINDSHIELD FRAME

23. BAROMETRIC ALTIMETER
24. RADAR ALTIMETER
25. BEARING DISTANCE HEADING INDICATOR (BDHI)
26. VERTICAL VELOCITY INDICATOR
27. AIRSPEED INDICATOR
28. STANDBY ATTITUDE INDICATOR
29. LEFT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
30. LEFT FIRE WARNING LIGHT
31. ANGLE OF ATTACK INDICATOR
32. MASTER CAUTION/MASTER ARM PANEL
33. APPROACH INDEXER
34. LEFT LADDER LIGHTS: WHEELS, BRAKES, ACL/AP, NWS ENGS, AUTO THROT
35. SHOOT/LOCK LIGHTS
36. HEAD UP DISPLAY (HUD)/COCKPIT TV SENSOR (CCTVS)

MAIN INSTRUMENT PANEL/ WINDSHIELD FRAME (CONT.)

37. RIGHT LADDER LIGHTS: SAM, AAA, CW, AI
38. STANDBY COMPASS
39. ACM SHUTOFF/HOT TRIGGER LIGHT
40. RIGHT FIRE WARNING LIGHT
41. WING SWEEP INDICATOR
42. RIGHT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
43. CANOPY JETTISON HANDLE
44. RADIO FREQUENCY/CONTROL INDICATOR
45. MULTIFUNCTION DISPLAY No. 2
46. MULTIFUNCTION DISPLAY No. 1

CENTER PANEL

47. MULTISTATUS INDICATOR
48. CLOCK
49. BRAKE PRESSURE INDICATOR
50. COURSE/HEADING DISPLAY CONTROL
51. CONTROL STICK
52. RUDDER PEDAL ADJUST HANDLE

RIGHT KNEE PANEL

53. FUEL QUANTITY INDICATOR
54. OBOGS BACKUP OXYGEN PRESSURE INDICATOR
55. CABIN PRESSURE INDICATOR

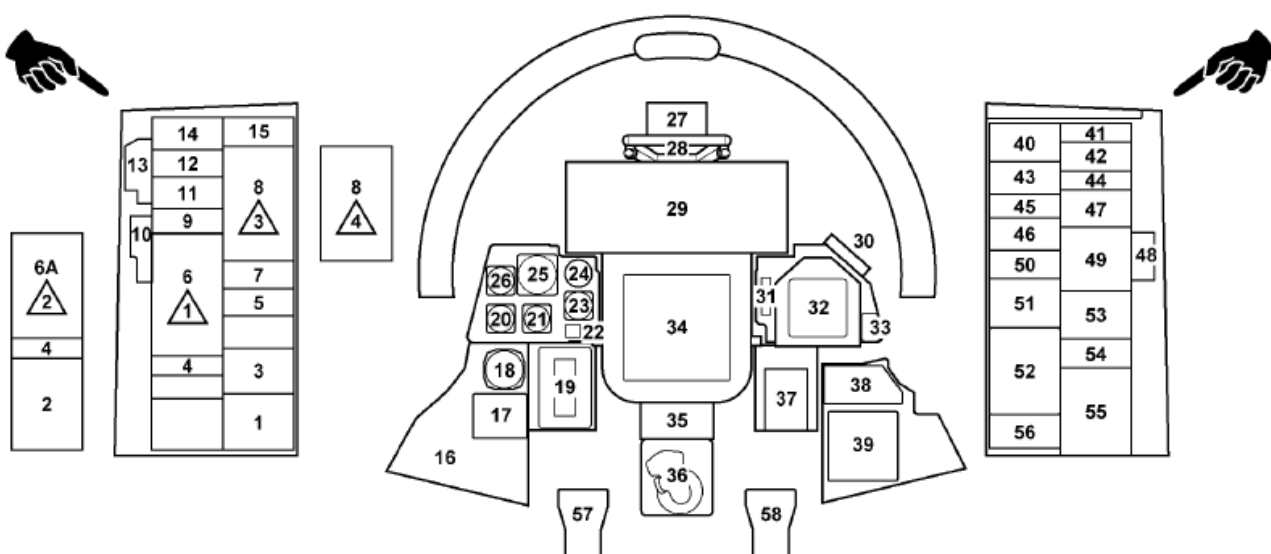
RIGHT VERTICAL CONSOLE

56. ARRESTING HOOK/GUN ROUNDS INDICATOR
57. DISPLAYS CONTROL PANEL
58. AUX WEAPONS CONTROL PANEL

RIGHT SIDE CONSOLE

59. CAUTION/ADVISORY INDICATOR
60. OXYGEN MONITOR PANEL
61. ARA-63 CONTROL PANEL
62. MASTER GENERATOR CONTROL PANEL
63. AIR CONDITIONING CONTROL PANEL
64. MASTER LIGHT CONTROL PANEL
65. EXTERNAL ENVIRONMENT CONTROL PANEL
66. MASTER TEST CONTROL PANEL
67. HYDRAULIC TRANSFER PUMP SWITCH
68. HUD VIDEO CONTROL
69. CANOPY DEFOG CONTROL LEVER

PILOT COCKPIT



LEFT SIDE CONSOLE

1. G VALVE PUSHBUTTON
2. DATA STOWAGE
3. OXYGEN/VENT AIRFLOW CONTROL PANEL
4. RADAR BEACON CONTROL PANEL
5. ANTENNA SELECT CONTROL PANEL
6. LANTIRN CONTROL PANEL
- 6A. RECON CONTROL PANEL
7. ICS CONTROL PANEL
8. SENSOR CONTROL PANEL
9. KY MODE/TACAN COMMAND PANEL
10. RADAR COOLING PANEL
11. JTIDS CONTROL PANEL
12. TACAN CONTROL PANEL
13. EJECT COMMAND LEVER
14. KY-58 CONTROL PANEL
15. V/UHF CONTROL PANEL #2

LEFT VERTICAL CONSOLE

16. ARMAMENT CONTROL PANEL
17. RADIO FREQUENCY/ CONTROL INDICATOR
18. BEARING/DISTANCE HEADING INDICATOR

LEFT KNEE PANEL

19. MISSION DATA LOADER

MAIN INSTRUMENT PANEL

20. AIRSPEED INDICATOR
21. BAROMETRIC ALTIMETER
22. MASTER CAUTION LIGHT
23. CLOCK
24. TOTAL FUEL INDICATOR
25. STANDBY ATTITUDE INDICATOR
26. VERTICAL VELOCITY INDICATOR
27. SENSOR SLAVING PANEL
28. COUNTERMEASURES DISPENSE SWITCHES
29. DIGITAL DISPLAY (DD)
30. CANOPY JETTISON HANDLE
31. LADDER LIGHTS: IFF, RCV, XMIT, SAM, CW, AI

32. MULTIFUNCTION DISPLAY No. 3
33. ECM OVERRIDE SWITCH

CENTER PANEL

34. PROGRAMMABLE TACTICAL INFORMATION DISPLAY (PTID)
35. SENSOR CONTROL PANEL
36. HAND CONTROL UNIT

RIGHT KNEE PANEL

37. CAUTION/ADVISORY INDICATOR

RIGHT VERTICAL PANEL

38. NAVIGATION MODE CONTROL PANEL
39. DATA ENTRY UNIT

RIGHT SIDE CONSOLE

40. RADAR WARNING RECEIVER CONTROL PANEL
41. DATA LINK CONTROL PANEL
42. DATA LINK REPLY/MODE/ADDRESS PANEL
43. ASPJ CONTROL PANEL
44. REMOTE CONTROL UNIT (RCU-403)
45. MULTIPLE FILTER ASSEMBLY PRIORITY CONTROL PANEL
46. AN/ALE-47 DCDU
47. INTERROGATOR CONTROL PANEL
48. CANOPY DEFOG/CABIN AIR LEVER
49. IFF ANTENNA CONTROL/TEST PANEL
50. AN/ALE-47 DIMMER/TEST PANEL
51. AN/ALE-47 PROGRAMMER PANEL
52. CAMERA STOWAGE
53. INTERIOR LIGHTS CONTROL PANEL
54. TEST/GROUND COOLING POWER PANEL
55. SYSTEM POWER/GROUND TEST PANEL
56. POWER SYSTEM TEST PANEL

LEFT AND RIGHT FOOT WELLS

57. ICS FOOT BUTTON
58. MIC FOOT BUTTON

RIO COCKPIT (TYPICAL) – NOTE: THE IN-GAME FSX RENDITION HAS A NON-TYPICAL RIO COCKPIT CONFIGURATION

APPENDIX B – DECK / GROUND HANDLING SIGNALS



ACKNOWLEDGEMENT

A CLENCHED FIST WITH THUMB POINTING STRAIGHT UP INDICATES SATISFACTORY COMPLETION OF A CHECK ITEM. A CLENCHED FIST WITH THUMB POINTING STRAIGHT DOWN INDICATES UNSATISFACTORY COMPLETION AND/OR DO NOT CONTINUE.



INSERT/PULL ELECTRICAL POWER

PILOT INSERTS/PULLS INDEX AND MIDDLE FINGER TO/FROM OPEN PALM. SIGNALMAN RESPONDS WITH SAME SIGNAL.



GROUND INTERCOM

CUP HANDS OVER EARS OR POINT WANDS TO EARS



START GTS

PILOT MOVES CLENCHED FIST IN CIRCULAR MOTION IN VIEW OF SIGNALMAN



START ENGINE

PILOT EXTENDS FINGERS TO INDICATE ENGINE IS READY FOR START IF ALL CLEAR. SIGNALMAN RESPONDS WITH SIMILAR GESTURE POINTING AT ENGINE WHILE ROTATING OTHER HAND OR WAND IN CLOCKWISE MOTION



ENGINE RUN-UP

PILOT MOVES INDEX FINGER IN CIRCULAR MOTION INDICATING HE IS READY TO RUN UP ENGINE. SIGNALMAN RESPONDS WITH SIMILAR SIGNAL WHEN ALL CLEAR.



START GTS

POINTS TO GTS EXHAUST WITH LEFT HAND INDEX FINGER. MOVES RIGHT HAND IN HORIZONTAL CIRCLE, INDEX AND MIDDLE FINGER POINTED DOWN. NIGHT: SAME AS DAY EXCEPT WITH WANDS MAKES THROAT CUTTING SIGNAL WITH LEFT HAND WHILE RIGHT HAND MAKES GTS SIGNAL TO SHUT DOWN GTS



PULL CHOCKS

PILOT MAKES SWEEPING MOTION OF FISTS WITH THUMBS EXTENDED OUTWARD. SIGNALMAN SWEEPS FISTS APART AT HIP LEVEL WITH THUMBS EXTENDED OUTWARD.



AM I CLEAR UNDERNEATH

WITH LEFT HAND OPEN, PALM OUT, PILOT MAKES SWEEPING MOTION ACROSS COCKPIT FROM RIGHT TO LEFT.



FLAPS FULL

HANDS FLAT TOGETHER, THEN OPENED WIDE FROM WRISTS. ARM IN CLOSE TO BODY.



FLAPS HALF

FLAPS FULL SIGNAL FOLLOWED BY CROSSED INDEX FINGERS



COME AHEAD

HANDS AT EYE LEVEL, EXECUTE MOTION: RATE OF MOTIONS INDICATES DESIRED SPEED OF AIRCRAFT. FOR NIGHT OPERATION, WAVE WANDS SIDE TO SIDE.



RIGHT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.



LEFT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.



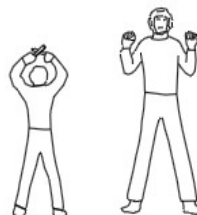
TURNOVER OF COMMAND

BOTH HANDS POINTED AT NEXT SUCCEEDING TAXI SIGNALMAN.



SLOW DOWN

DOWNWARD PATTING MOTION, HANDS OUT AT WAIST LEVEL



STOP

ARMS UPRAISED, FISTS CLENCHED AND HELD IN SIMPLE "POLICEMEN'S STOP".



EMERGENCY STOP

ARMS CROSSED ABOVE HEAD FISTS CLENCHED.



HOT BRAKES

MAKE RAPID FANNING MOTION WITH ONE HAND IN FRONT OF THE FACE. POINT TO WHEEL WITH OTHER HAND.



ENGINE FIRE

DESCRIBE A LARGE FIGURE EIGHT WITH ONE HAND AND POINT TO THE FIRE AREA WITH THE OTHER HAND.



CUT ENGINE

HAND DRAWN ACROSS NECK IN "THROAT CUTTING" MOTION.



FINAL READY

TWO FINGERS IN CIRCULAR MOTION



GROUND REFUELING INTERNAL TANKS NO INTERNAL POWER

CIRCULAR MOTION WITH THE PALM OF HAND TOWARD STOMACH (AS RUBBING STOMACH) FOLLOWED BY A DRINKING MOTION (THUMB TO MOUTH)

REFER TO CV NATOPS MANUAL FOR NIGHT SIGNALS AND FLIGHT DECK JERSEY COLOR CODING



EXTEND LAUNCH BAR
DOUBLE RIGHT ARM THEN
DROP FOREARM.



RAISE LAUNCH BAR
RAISE RIGHT FOREARM
TO DOUBLE POSITION



SPEED BRAKE
EXTEND ARMS AT WAIST
WITH PALMS TOGETHER.
KEEP WRISTS TOGETHER
AND OPEN PALMS.



HOOK UP
RIGHT THUMB JERKED UP
TO MEET HORIZONTAL
LEFT HAND



HOOK DOWN
LOWER RIGHT FIST SUDDENLY,
THUMB EXTENDED DOWNWARD,
TO MEET HORIZONTAL PALM OF
LEFT HAND HELD IN FRONT
OF BODY.



STABILATOR CHECK
STICK AFT
LEADING EDGE DOWN



STICK FWD
LEADING EDGE UP



RUDDER CHECK
LEFT RUDDER IN
RUDDER SWINGS LEFT



RIGHT RUDDER IN
RUDDER SWINGS RIGHT



AILERON CHECK
SWING FOREARM
LEFT THEN RIGHT



WIPEOUT CHECK
SWING FOREARM
CIRCULAR MOTION



**ENGAGE NOSE
GEAR STEERING**
POINT TO NOSE WITH
INDEX FINGER WHILE
INDICATING DIRECTION
OF TURN WITH OTHER
INDEX FINGER.



EXTERIOR LIGHTS
HOLD THE INDEX AND
MIDDLE FINGER IN A "V"
SIGNAL POINTING TOWARDS
THE EYES.

APPENDIX C – EJECTION SEAT

