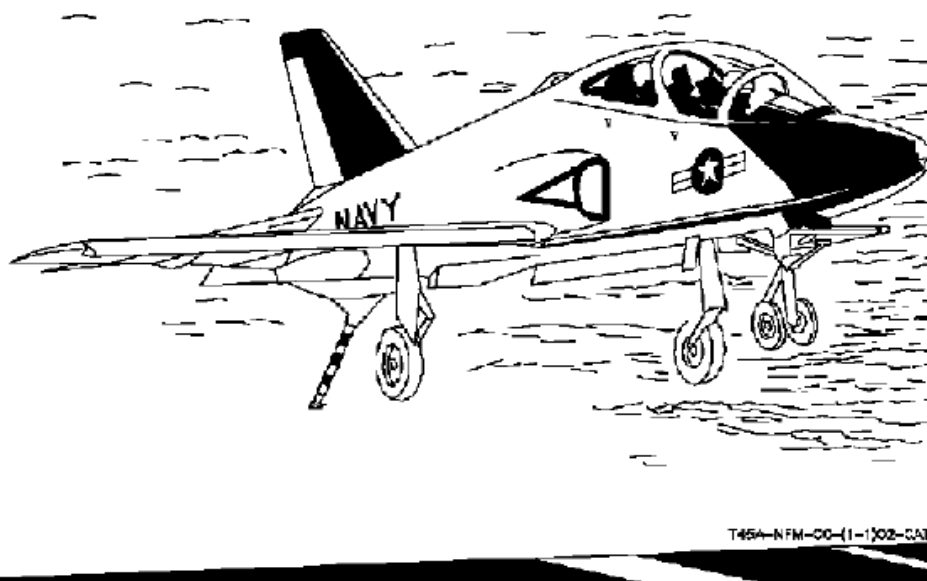




**VIRTUAL NATOPS FLIGHT MANUAL**  
**NAVY MODEL**  
**T-45C**  
**FOR MICROSOFT FLIGHT SIMULATOR X**



**DISTRIBUTION STATEMENT:** This document is part of the freeware T-45C Goshawk add-on package for Microsoft Flight Simulator X 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 T-45C Goshawk for Flight Simulator X, 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 T-45C Goshawk (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 jet training 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 T-45C Goshawk for Flight Simulator X 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  
A-COLL Anti-Collision  
A/C Aircraft  
A/G Air-to-Ground  
AC INV Alternating Current Inverter  
ACFT Aircraft  
ADC Air Data Computer  
ADI Attitude Director Indicator  
ADR Airborne Data Recorder  
ADR Airborne Data Recording System  
AGL Above Ground Level  
ALT Altitude  
AMP Amplifier  
AOA Angle of Attack  
ARI Aileron Rudder Interconnect  
ATC Air Traffic Control  
ATS Air Turbine Starter  
AV Avionics  
AZ Azimuth (DEP Entry)

## B

BARO Barometric  
BARO Barometric Delta (MFD)  
BATT Battery  
BD Baro Delta (DEP Entry)  
BF BINGO Fuel Setting (DEP Entry)  
BIT Built-in-Test  
Bleed air High pressure and low pressure  
air tapped from the compressor  
sections of the engine  
BNGO BINGO  
BRC Base Recovery Course  
BRT Brightness  
BYP Bypass

## C

C AUG Control Augmentation (Caution  
Light)  
CAU Cold Air Unit  
CAUT Caution  
CBIT Continuous Built-in-Test  
CCA Carrier Controlled Approach  
CCIP Continuously Computed Impact  
Point  
CCW Counter Clockwise  
CDI Course Deviation Indication  
CDP Cross Deck Pendant  
CEU Camera Electronics Unit  
CG Center of Gravity  
CH Command Heading Setting (DEP  
Entry)  
CLR Clear  
CONTR  
AUG  
Control Augmentation  
CR Cruise Configuration  
CRS Course  
CS Command Course Setting (DEP  
Entry)  
CWSEU Caution Warning System Electronic  
Unit

## D

DCL Declutter  
DEGD Degraded  
DEP Data Entry Panel (also called DP)  
DEU Display Electronics Unit  
DGRO Directional Gyro Mode (GINA)  
DIL Displayed Impact Line

DME Distance Measuring Equipment  
DN Down  
DSL Depressed Sight Line  
DSPY Display  
DT GINA Date (DEP Entry)

## E

EAT Estimated Arrival Time  
EBC External Baggage Container  
ECA Engine Control Amplifier  
ECS Environmental Control System  
EDP Engine Driven Pump  
EGT Exhaust Gas Temperature  
EHDG Entered Heading  
EL Elevation (DEP Entry)  
EHPE Estimated Horizontal Position  
Error (GPS)  
ELEV Elevation  
EMER Emergency  
ENG Engine  
ENT Enter  
EPR Engine Pressure Ratio  
ERU Ejection Release Unit  
EVPE Estimated Vertical Position Error  
(GPS)  
EXT PWR External Power

## F

F PRES Fuel Pressure (Caution Light)  
FCLP Field Carrier Landing Practice  
FCOC Fuel Cooled Oil Cooler  
FCU Fuel Control Unit  
FF Fuel Flow  
FFAR Folding Fin Aircraft Rocket  
FH Field Height  
FL Flight Level  
FOD Foreign Object Damage  
FOV Field of View  
FPM Feet Per Minute  
FPS Feet Per Second  
FQTY Fuel Quantity  
FREQ Frequency  
FRZ Freeze  
FSII Fuel System Icing Inhibitor  
FSLG Fuselage  
FSX Microsoft Flight Simulator X simulation videogame  
FTI Flight Training Instruction  
FWD Forward. Identifies controls and  
indicators available only in the  
forward cockpit

## G

g/G Force of gravity or load factor /  
Guard channel  
GCA Ground Controlled Approach  
GEN Generator  
GINA GPS/Inertial Navigation Assembly  
GND PWR Ground Power  
GND SPD Ground Speed  
GPS Global Positioning System  
GS Glideslope  
GSE Ground Support Equipment  
GTS Gas Turbine Starter

## H

HD Entered Heading (DEP Entry)  
HDG Heading  
HEFOE Hydraulic, Electrical, Fuel, Oxygen,  
Engine Systems  
Hg Inches of Mercury  
HP High Pressure

HPC PRESS High Pressure Compressor Pressure (Discharge)  
 HSI Horizontal Situation Indicator  
 HUD Head-Up Display  
 HYBD Hybrid Mode (GINA)  
 HYD Hydraulic  
**I**  
 IBIT Initiated Built-In-Test  
 ICAO International Civil Aviation Organization  
 ICS Intercom System  
 IFA In-Flight Alignment  
 IFF Identification, Friend or Foe  
 IFOV Instantaneous Field of View. The area which the pilot can see from the design eye point position  
 IFT Instrument Flight Trainer  
 ILS Instrument Landing System  
 IMC Instrument Meteorological Conditions  
 IMN Indicated Mach Number  
 INIT Initiator  
 INOP Inoperative  
 INS Inertial Navigation System  
 INTR LT Interior Lighting  
 IP Identification Point  
 IPRSOV Inducer Pressure Regulating And Shutoff Valve  
**J**  
 JETT Jettison  
**L**  
 L BAR Launch Bar  
 LAC Lead Angle Computing  
 LAFT Left Aft (Instrument)  
 LAT Latitude  
 LAW Low Altitude Warning  
 LBA Limit(s) of Basic Aircraft  
 LDG Landing  
 LFWD Left Forward (Instrument)  
 LH Left Hand  
 LOC Localizer  
 LONG Longitude  
 LP Low Pressure  
 LP PMP Low Pressure Pump  
 LPU Life Preserver Unit  
 LSO Landing Signal Officer  
 LVDT Linear Variable Differential Transducer  
 LW Low Altitude Warning Setting (DEP Entry)  
**M**  
 M FUEL Manual Fuel Control  
 MAC Mean Aerodynamic Chord  
 MAINT Maintenance  
 MAN Manual  
 MANT Maintenance Display  
 MB Marker Beacon  
 MBIT Manual BIT  
 MDA McDonnell Douglas Aerospace  
 MDC Mild Detonating Cord  
 MDL Mission Data Loader  
 MFD Multi Function Display (also called DU)  
 MHz Megahertz  
 MIC Microphone  
 Mil Milliradian  
 MIP Main Instrument Panel  
 Mk Mark. Navy designation for model  
 MKR Marker Beacon  
 MLG Main Landing Gear  
 Mod Navy designation for modification  
 MPRSOV Main Pressure Regulating and

Shutoff Valve  
 MRT Maximum Rated Thrust  
 MSL Mean Sea Level  
 MSTR Master  
 MV or  
 MVAR  
 Magnetic Variation  
**N**  
 N1 Engine Low Pressure (Speed) Compressor Spool  
 N2 Engine High Pressure (Speed) Compressor Spool  
 NACES Navy Aircrew Common Ejection Seat  
 NAV Navigation  
 NLG Nose Landing Gear  
 NM Nautical Miles  
 NWS Nose Wheel Steering  
 NZ Vertical Acceleration  
**O**  
 O/S BRG Offset Bearing (Waypoint)  
 O/S ELEV Offset Elevation (Waypoint)  
 O/S RNG Offset Range (Waypoint)  
 OAT Outside Air Temperature  
 OB Offset Bearing (DEP Entry)  
 OBOGS On-Board Oxygen Generating System  
 OE Offset Elevation (DEP Entry)  
 OFP Operational Flight Program  
 OFT Operational Flight Trainer  
 OILS Waypoint Offset/ ILS Steering  
 OR Offset Range (DEP Entry)  
 OVRHT Overheat  
**P**  
 PA Powered Approach Configuration  
 PBIT Power-Up BIT  
 PCU Power Control Unit  
 PD Pressure Datum  
 PDU Pilot's Display Unit  
 PFCU Power Flight Control Unit  
 PIO Pilot Induced Oscillation  
 PLA Power Lever Angle  
 PLAN Planimetric mode  
 PLF Post Landing Fall  
 PMBR Practice Multiple Bomb Rack  
 POM Polarographic Oxygen Monitor  
 PPH Pounds Per Hour  
 PRES or  
 PRESS  
 Pressure  
 PRSOV Pressure Regulating and Shutoff Valve  
 PSG Post Stall Gyration  
 PT Pitch Trim (MFD ADI Display)  
 PW Password  
**Q**  
 QUAL Quality (Alignment)  
**R**  
 RAD Radian  
 RAFT Right Aft (Instrument)  
 RALT Radar Altimeter  
 RAT Ram Air Turbine  
 RCDR Recorder  
 RCR Runway Condition Reading  
 RCVR Receiver  
 RDO Runway Duty Officer  
 REJ Reject  
 RF Radio Frequency  
 RFWD Right Forward (Instrument)  
 RKT Rocket

RL HUD Roll Correction  
Rmax Maximum Range  
Rmin Minimum Range

RPM Revolutions Per Minute  
RPPL Ripple  
RPTR Repeater  
RST Restart  
RTB Return To Base  
RTCL Reticle  
RTGS Real Time Gunsight  
RVDT Rotary Variable Differential  
Transducer

## **S**

SADS Stability Augmentation Data Sensor  
(also called ADC)  
SAR Search And Rescue  
SAT Satellite  
SBI Speed Brake Interconnect  
SCL Scale  
SEAWARS Seawater Activated Release System  
SEQ Sequential (Waypoint Steering)  
SET DEP Set Depression  
SIF Selective Identification Feature  
SIFCU Sub Idle Fuel Control Unit  
SIM Simulator  
SLV Slave Mode  
SMDC Shielded Mild Detonating Cord  
SP Wingspan (DEP Entry)  
SP BRK Speed Brake (Advisory Light)  
SPX Waypoint String Point (DEP Entry)  
SQ Squelch  
SSOM Solid State Oxygen Monitor  
STA Station  
STAB Stabilator  
STBY Standby  
STRS Stores (Display)  
SVM Sealed Video Module

## **T**

T6 °C Engine Temperature - Station 6

(EGT)  
TAT Total Air Temperature  
TBD To be determined  
TFOV Total Field Of View. The HUD  
IFOV plus the area not visible  
from the design eye point position.  
TH Target Height (DEP Entry)  
THGT Target Height  
TILS TACAN/ILS Steering  
TM GINA Time (DEP ENTRY)  
TP Tailpipe  
TRNG Training  
TO Takeoff Configuration

## **U**

UTC Universal Time Coordinated  
(GINA)

## **V**

VAC Volts Alternating Current  
VCR Video Cassette Recorder  
VDC Volts Direct Current  
VMC Visual Meteorological Conditions  
VREC Video Record  
VSI Vertical Speed Indicator

## **W**

WD Wind Direction (DEP Entry)  
WILS Waypoint/ILS Steering  
WO/S Waypoint Offset  
WS Wind Span (DEP Entry)  
WSPN Wingspan  
WYPT Waypoint

## **X**

XFR or  
XFER  
Transfer

## **Y**

YDA Yaw Damper Actuator  
YDC Yaw Damper Controller  
YDS Yaw Damper System

## **Z**

ZPL Zero Pitch Line

# **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**

# CHAPTER 1

## General Characteristics

**1.1 Description.** The Navy model T-45C Goshawk, manufactured by McDonnell Douglas Aerospace is a two place, light weight, high performance, fully carrier capable, digital cockpit version of the British Aerospace Hawk. It is powered by a single Rolls Royce F405-RR-401 turbofan engine, producing a sea level, installed, static thrust of 5,527 pounds. A pair of 24 volt rechargeable batteries and a Gas Turbine Starter (GTS) system provide the necessary electrical power and high pressure air required for starting on the ground and during assisted airstarts airborne.

The T-45C wing is mounted low on a conventionally structured fuselage. The wing is a moderately swept, laminar flow design exhibiting a 2 degree dihedral, full span leading edge slats, double slotted trailing edge flaps, and an integral fuel tank. The intakes are positioned on the fuselage directly above the wing, slightly forward of the leading edge, and on either side of the fuselage bag type fuel cell. The single vertical stabilizer, mounted slightly forward on the empennage, and the stabilator are of swept design. The vertical stabilizer integrates a mechanically powered rudder and a control augmentation system for all speed flight. The stabilator exhibits a 10 degree anhedral. The speed brakes are mounted on the sides of the aft fuselage forward of the stabilator. All control surfaces, with exception of the rudder, are hydraulically powered. A Ram Air Turbine (RAT) provides emergency hydraulic power to the flight controls in cases of engine or hydraulic pump failure.

The main landing gear use conventional shock struts on a trailing arm layout. A single high pressure tire and a fully powered anti-skid brake system completes the main gear assemblies. The nose landing gear utilizes a conventional shock strut and mounts the nose tow launch bar and nose wheel steering systems.

Two wing pylons permit carriage and delivery of a variety of training weapons. A centerline store station provides nonjettisonable carriage of an external baggage container. The aircraft general arrangement and principal dimensions are presented in Figures 1-1 and 1-2, respectively.

**1.2 Cockpits.** The air conditioned, pressurized cockpit accommodates two aircrew in a tandem seating arrangement. It is enclosed by a single,

side hinged, manually operated canopy and a one piece windscreen. Each cockpit is fitted with the Martin-Baker Navy Aircrew Common Ejection Seat (NACES) affording safe escape from zero airspeed and zero altitude.

Aircrew supplemental oxygen is supplied to the pilot's chest mounted regulator from the On-Board Oxygen Generating System (OBOGS).

The forward and aft cockpits are identical with the exception of the following equipment, and switches.

*NOTE: In this Flight Simulator X rendition, only the front cockpit is modeled, also some controls and functions have been changed. See cockpit layout diagram for actual in-game layout.*

### 1.2.1 Forward Cockpit Only

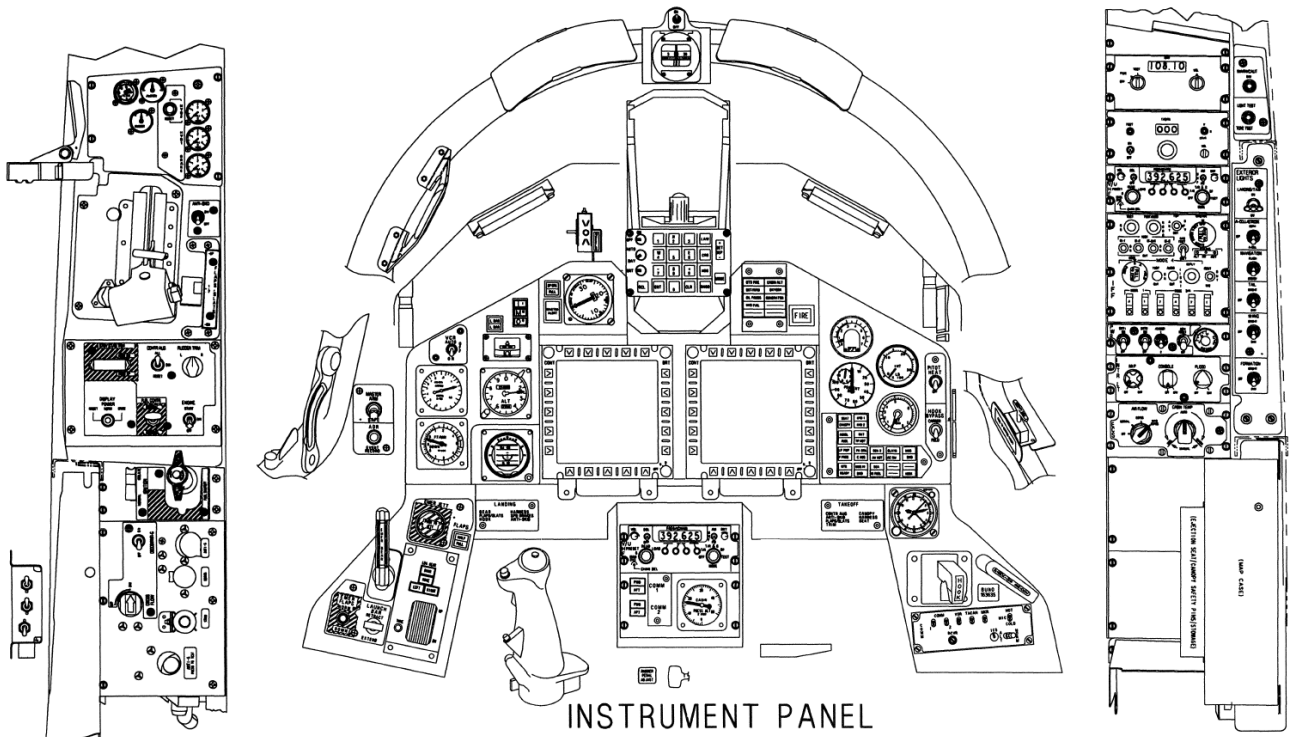
EXT PWR MONITOR Switch  
GND PWR Switches  
On-Board Oxygen Generating System Monitor  
OBOGS/ANTI-G Switch  
FUEL SHUTOFF Handle  
IGNITION Switch  
DISPLAY POWER Switch  
CONTR AUG Switch  
Throttle Friction Knob  
External Lights Master Switch  
Catapult Handgrip  
Head-Up Display (HUD)  
VCR Control Switch  
MASTER ARM Control Switch  
LAUNCH BAR Switch  
PARKING BRAKE Handle  
PITOT HEAT Switch  
IFF Control Panel  
ECS Control Panel  
BATT 1 and BATT 2 Switches  
Exterior Lights Switches  
HOOK BYPASS Switch  
Rudder Lock Lever (Gust Lock)

### 1.2.2 Aft Cockpit Only

RTCL Light Switch  
Command Ejection Selector  
Ejection SEAT LIGHT Switch  
MASTER ARM Override Switch  
Instrument Training Hood  
VCR  
Mission Data Loader  
Solo Checklist

**1.3 Aircraft weight and airspeeds.** The zero fuel or operating weight of the aircraft without pylons is approximately 10,560 pounds (which includes trapped fuel, oil, and two aircrew). Gross weights for different combinations of armaments, racks, and equipment can be determined from the applicable Handbook of Weight and Balance (NAVAIR 01-1B-40) for the aircraft. The aircraft is capable of achieving an airspeed of 0.85 Mach at 30,000 feet in level flight.

**1.4 Mission.** The primary mission of the T-45C is to provide Navy strike flight training. The aircraft provides the capability to train student naval aviators for high performance jet aircraft and to qualify students for a standard instrument rating and initial carrier qualification. In addition, the aircraft supports training in fundamental tactical skills, emphasizing the development of habit patterns, self confidence, and judgement required for safe and efficient transition to fleet aircraft with advanced technology weapon systems.





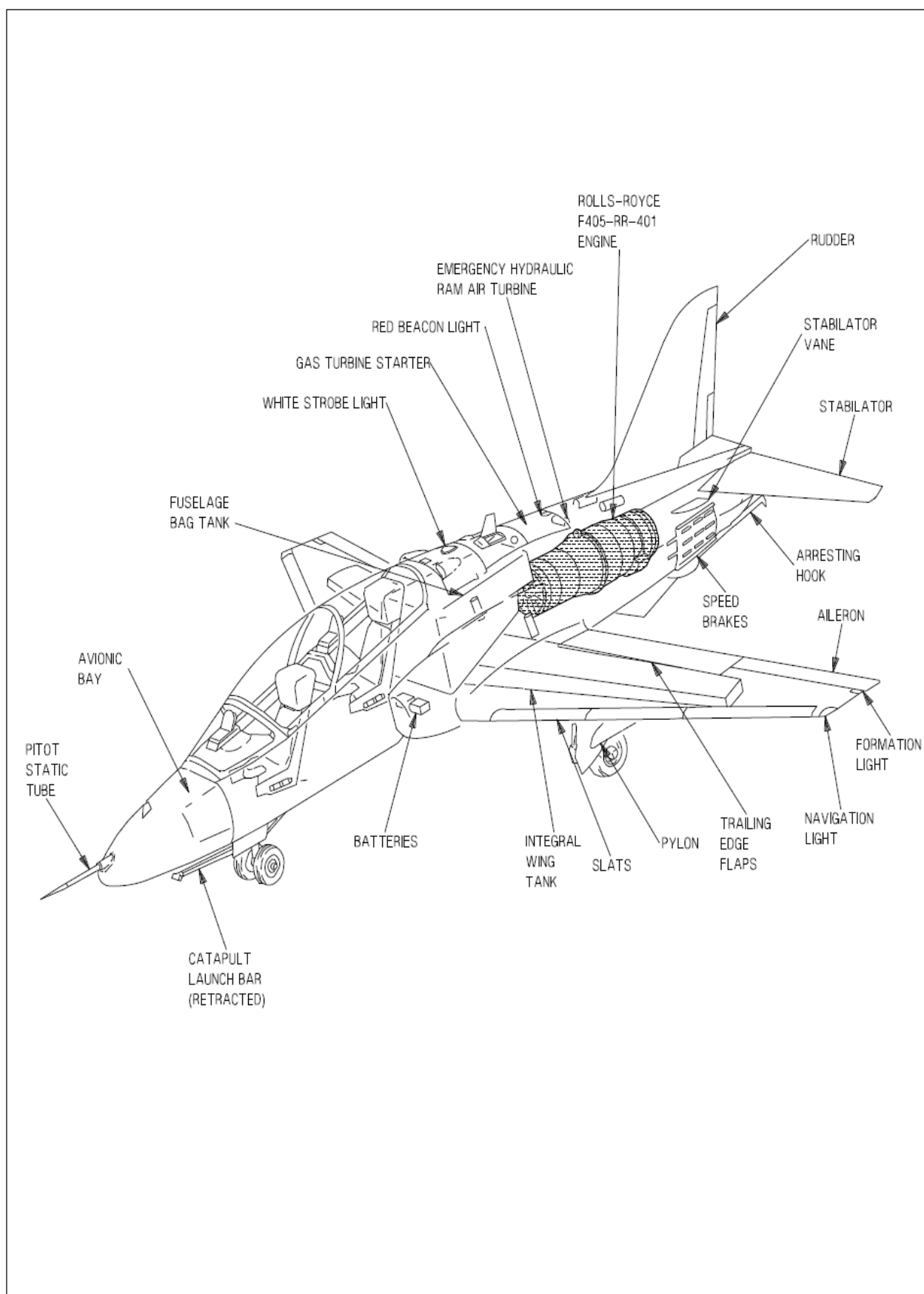
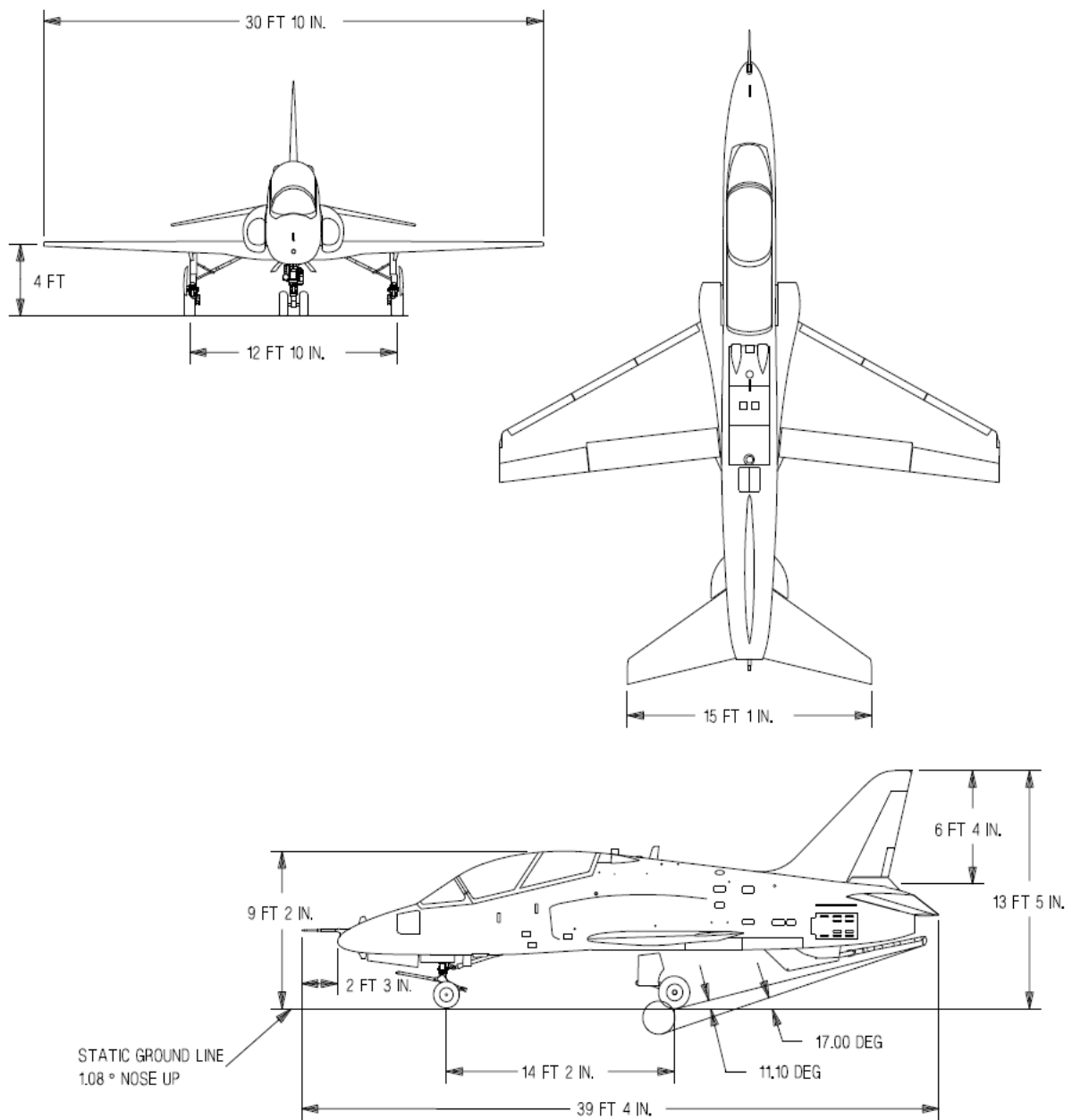


Figure 1-1 Aircraft General Arrangement



### OTHER DIMENSIONS

	WING	STABILATOR	VERTICAL STABILIZER
AREA	190.0 SQ FT	47.6 SQ FT	27.9 SQ FT
ASPECT RATIO	5.0	4.8	1.4
SWEEP 1/4 CHORD	23.7 °	30.1 °	39.5 °
DIHEDRAL	2 °	-10 °	0
INCIDENCE			
ROOT	0.6 °		
MAC	-0.1 °		
TIP	-2.7 °		

Figure 1-2 Aircraft Principal Dimensions

# CHAPTER 2

## System Descriptions

### 2. ENGINE SYSTEM

**2.1.1 Description.** The aircraft is powered by a single, non-afterburning twin-spool turbofan engine. A two-stage low pressure (N1) compressor is driven by a single-stage low pressure turbine. A five-stage high pressure (N2) compressor is driven by a single-stage high pressure turbine. The N1 and N2 shafts are concentric and each assembly rotates independently in a clockwise direction when viewed from the front of the aircraft. The engine develops an installed static sea level thrust of approximately 5,527 pounds.

**2.1.1.1 Internal Airflow.** Air entering the engine passes directly to the first stage of N1; there are no inlet guide vanes. Leaving N1, the air is divided into two streams. One stream passes through N2, the combustion system, and turbines; the other stream flows through an annular bypass duct into an exhaust mixer section where the two air streams mix. The mixed stream flows through the tailpipe and is discharged through a fixed geometry, converging nozzle.

**2.1.1.2 Bleed Valve.** A bleed valve is fitted to the N2 casing at the final stage to prevent stalling of N2 during starting. Bleed valve operation is automatic.

**2.1.1.3 Bleed System.** Bleed air from the N1 and N2 compressors is used to seal the compressor and turbine bearing compartments as well as providing cooling for the turbine assemblies. The N2 compressor (5th stage) also supplies bleed air for the environmental and OBOGS/Anti-G systems, and the fuel tank pressurization system.

A steam ingestion bleed valve is added in the N2 bleed line to increase bleed air flow and provide additional surge protection from catapult steam ingestion during launch. The valve is opened when the the launch bar is not retracted and all of the following are fulfilled:

1. Weight-on-wheels
2. N2 RPM above 70%

**2.1.1.4 Anti-Ice.** A small flow of bleed air is continuously ducted forward through the N1 shaft and through the fan spinner to provide

heat for anti-icing. The air is discharged through an annular slot in the spinner assembly and reenters the compressor.

**2.1.1.5 Engine Accessory Gear Box.** An external gearbox, driven from the N2 shaft, is mounted beneath the engine at the front end.

Drives are provided for:

Hydraulic pumps

Dc generator

Low pressure (LP) fuel pump

High pressure (HP) fuel pump

Engine oil pumps

N2 RPM tach-generator

During engine start, the drive from the air turbine starter is transmitted through the external gear box to rotate the N2 shaft.

**2.1.1.6 Engine Fuel Control System.** The engine fuel system consists of a LP fuel pump, fuel cooled oil cooler, low pressure fuel filter, HP fuel pump, fuel control unit (FCU), and 18 fuel spray nozzles in the engine combustion chamber. The LP fuel pump provides fuel at the proper pressure for the HP fuel pump.

The engine fuel control is equipped with a main and a back-up (manual) mode. Either mode can be selected by the FUEL CONTR switch located on the left console panel in both cockpits. The main fuel control system is activated by placing the FUEL CONTR switch to the NORMAL position. The system is a flow scheduling type with acceleration control. The FCU schedules fuel flow according to the selected throttle position and compensates the flow for changes in altitude and airspeed.

The engine accelerates more slowly as altitude increases.

**2.1.1.7 Engine Control Amplifier.** The engine control amplifier (ECA) automatically prevents overspeed and overtemp conditions under normal operation. The ECA monitors N1 shaft speed and two sets of thermocouples located behind the N1 turbine sections. The EGT/RPM warning light on the warning lights panel in each cockpit will illuminate whenever the exhaust gas temperature exceeds 650.

**2.1.1.8 Engine Oil System.** The engine oil system provides pressure lubrication to engine bearings and accessory gearboxes. The oil tank

is located under the aft end of the bypass duct and is replenished through pressure or gravity filling connections.

**2.1.2 Engine Operation.** Control of the engine consists essentially of selecting throttle positions. If the ECA and main fuel control system are functioning normally, fuel flow for any thrust setting will be correctly scheduled to prevent exceeding limits.

Sustained engine operation at less than 70% N2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout. If engine flameout occurs, perform an airstart.

#### **2.1.2.2 Engine Starting System**

**2.1.2.2.1 Gas Turbine Starter.** The GTS (or air producer) is a self-contained unit complete with ignition system, fuel pump, fuel control, lubrication system, and a dc starter motor. The GTS provides air to start the engine on the ground, and can also be used in flight to assist during an airstart. The GTS is mounted above the engine bay and consists of a compressor driven by a two-stage turbine. It supplies compressed air to an air turbine starter (ATS) motor mounted on the engine accessory gearbox.

*NOTE: GTS operation not properly simulated in the Flight Simulator X videogame. Information about GTS and operation is provided for educational purposes only and is may not be applicable to the game.*

**2.1.2.2.2. Air Turbine Starter.** The air turbine starter consists of a turbine driven by air ducted from the GTS. The ATS drives the engine N2 shaft through the accessory gearbox and provides assistance until approximately 45% N2 PRM has been achieved whereupon the starting system is automatically shut down.

*NOTE: the ATS system is not simulated in Microsoft Flight Simulator game. User may have to release the starter switch manually after the engine is on.*

#### **2.1.2.3 Engine Starting Operation.**

**CAUTION: Real world engine starting procedure differs significantly from this rendition of the T-45C Goshawk in Flight Simulator X. Specifically, GTS and ATS are not simulated. This section provides information on the real world engine start**

**operation for educational purposes only. Refer to FSX checklist for actual in-game engine operation.**

With the BATT switches ON, the throttle at OFF, both ENGINE switches at ON and the IGNITION switch at NORMAL, the GTS is started by momentarily pressing the GTS start button. The GTS accelerates to idle and the GTS advisory light illuminates.

If GTS start attempts are longer than the acceptable start times of the GTS START ENVELOPE, subsequent in-flight start attempts may exceed the GTS auto shutdown limit.

When the GTS light illuminates, momentarily placing the ENGINE switch to START accelerates the GTS to full power, the start valve opens and admits air to the ATS after which the dump valve closes. The ATS drives the engine N2 shaft which induces an airflow through the engine to rotate the N1 shaft. When N1 shaft speed reaches 100 RPM in the correct direction of rotation, a relay in the ECA closes to illuminate the READY advisory light. If the READY advisory light does not illuminate within 15 seconds, discontinue start attempt, otherwise mechanical damage may result from an overheat condition. A tail wind may cause the N1 compressor to rotate backward. When the READY advisory light is on and 15% to 20% N2 RPM is indicated, placing the throttle to the IDLE position supplies fuel, scheduled by the SIFCU to the spray nozzles in the combustion chamber. Engine light-off must occur within 15 seconds of IDLE being selected, or the start must be discontinued. At GTS cutout speed (45% N2 RPM) the fuel to the GTS is cut off and it will shut down; simultaneously the GTS and READY advisory lights are extinguished and the ignition units are deenergized. The engine continues to accelerate and should stabilize at approximately 52% N2 RPM within approximately 30 seconds of selecting IDLE. If 45% N2 RPM is not attained within 45 seconds from release of the start switch, the GTS will decelerate to idle. Engine starts with the throttle above the ground idle position may cause engine surge/over-temperature.

Engine EGT will not normally rise above 420° C on ground start.

After the RPM has stabilized the throttle should be advanced slowly to accelerate the engine through approximately 61% to close the bleed valve, after which the throttle should be returned to IDLE. The engine idle RPM should be approximately 3% higher and the EGT

approximately 50° C lower with the bleed valve closed than when idling with the bleed valve open. However, the idle speed may vary depending on engine loading, air bleeds and ambient conditions. As the engine stabilizes, the idle RPM should be 55 ±2% at sea level, (standard day), increasing 1% per 1,500 feet of altitude. During engine start, the start cycle can be interrupted by placing the throttle to OFF; the GTS will continue running and may be used to motor the engine. If it is intended to stop the GTS, the ENGINE switch must be placed to OFF; subsequently a 3-minute interval must be observed before a further start is attempted.

**2.1.2.4 Windmill.** The engine may be motored by following a procedure similar to that for a normal ground start except that the IGNITION switch must be placed to ISOLATE before the ENGINE switch is set momentarily to START. The throttle should be retained at OFF. The GTS automatically reverts to idle after 45 seconds.

### **2.1.3 Engine Cockpit Controls And Indicators.**

**2.1.3.1 Throttle.** The throttle is located on the left console and controls the engine thrust in response to the throttle movement. Full Forward Operates engine at Maximum Rated Thrust (MRT)

**2.1.3.2 ENGINE Switch.** The ENGINE switch is located on the left console. The switch has the following positions:  
**START** This momentary position accelerates the GTS to full power, then automatically opens the start valve to admit air to the ATS, starting the engine.  
**ON** Energizes the start control unit and permits fuel boost pump number 2 operation if all other parameters are met.  
**OFF** Manually shuts down the GTS operation and deenergizes the start control unit and, after 30seconds, shuts the fuel boost pump number 2 OFF. (NOTE: This position is not available in the FSX rendition. Engine should be shutdown by closing the FUEL SHUTOFF VALVE when the ENGINE SWITCH IS on the ON position)

**2.1.3.3 IGNITION Switch.** The IGNITION switch is located in the front cockpit on the left console, and has the following positions:  
**ISOLATE** Deenergizes engine and GTS ignition systems.  
**NORMAL** The switch is normally in this

position and is protected by a guard. In this position power is supplied to the ignition system.

*NOTE: The ignition switch is not simulated in this FSX rendition and has no function in the game.*

**2.1.3.4 FUEL CONTR Switch.** The FUEL CONTR switch is located on the left console. The switch has the following positions:  
**NORMAL** The switch is normally in this position. In this position the mainfuel control system is selected.  
**MANUAL** Selects the manual fuel control system.

*NOTE: in this FSX rendition, the fuel control is always in NORMAL mode. Switch actuation has no effect on the simulation apart from turning on the proper advisory light.*

**2.1.3.5 GTS Start Button.** The GTS start button is located on the front face of the throttle grip. Momentarily pressing the button starts theGTS and energizes the engine igniters, when the IGNITION switch is in NORMAL.

*NOTE: The GTS switch is not properly simulated in this FSX rendition. GTS switch is linked to the ENGINE switch and has the same function.*

**2.1.3.6 RPM Indicator.** The RPM indicator is located on the upper right corner of the main instrument panel, below the fuel flow indicator and indicates N2 RPM in percent.

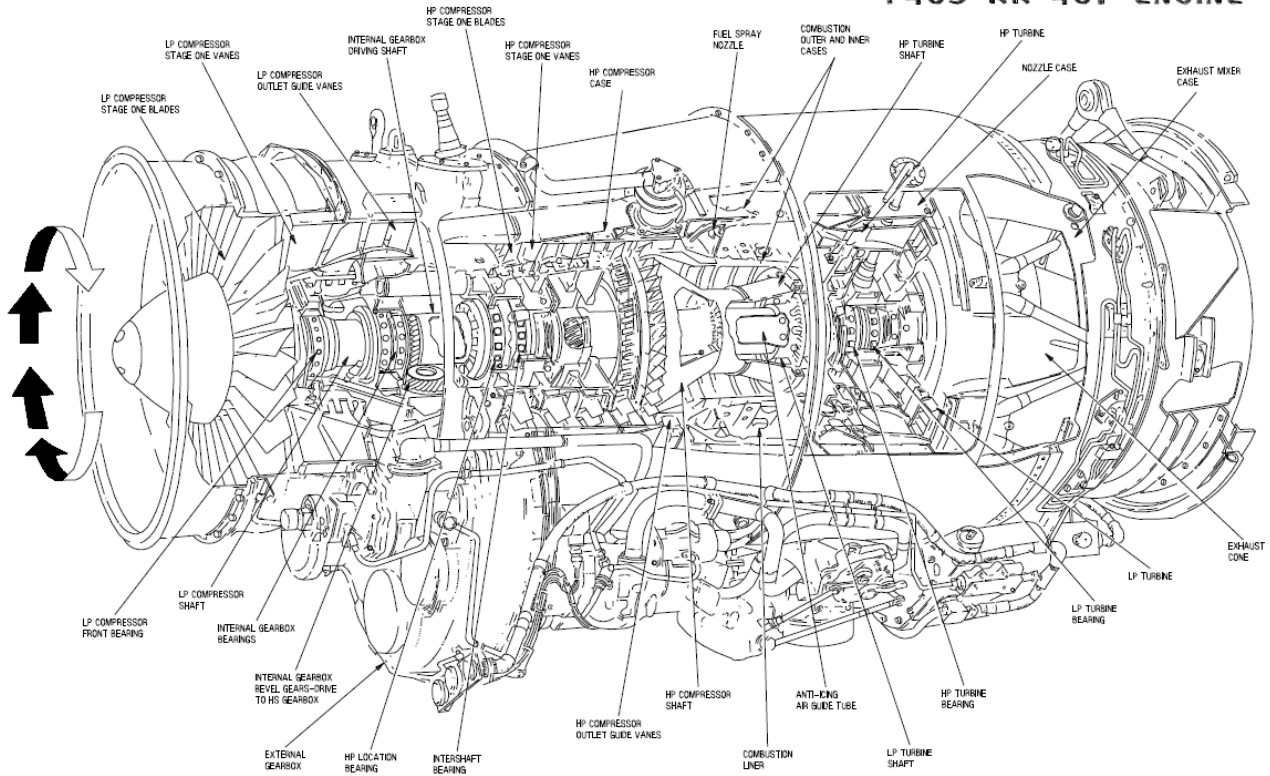
**2.1.3.7 EGT Indicator.** The EGT indicator is located on the upper right corner of the main instrument panel, and below the fuel quantity indicator. The indicator indicates EGT in °C.

**2.1.3.8 FUEL FLOW Indicator.** The FUEL FLOW indicator is located on the upper right corner of the main instrument panel, above the RPM indicator, and indicates the rate of fuel flow to the engine combustion chamber inPounds Per Hour (pph).

**2.1.4 ENG (Engine) Display.** The ENG display may be selected on either MFD by selecting the MENU option then the ENG option. . If any parameter is invalid or a sensor fails that information will be blank on the display.

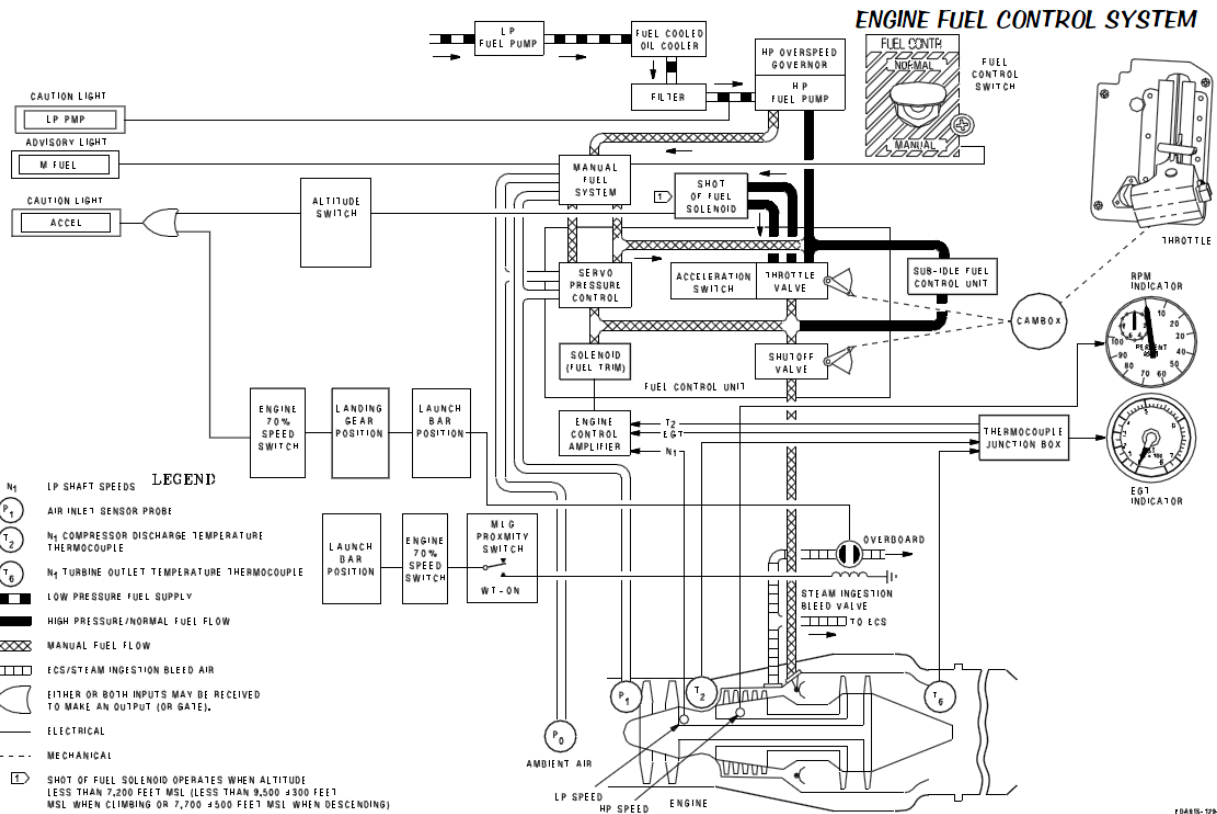
*NOTE: This FSX rendition uses the default avionics for F/A-18 Hornet, hence the display will show two columns, one for the left and one for the right engine. T-45C engine data is displayed as left engine data and may be incorrect.*

# F405-RR-401 ENGINE



F405-RR-401 Engine

DIAGN-603-1-003



Engine Fuel Control System

DIAGN-603-1-01

## 2. FUEL SYSTEM

**2.2.1 Fuel System Description.** The internal fuel supply is carried in two tanks, a fuselage tank and an integral wing tank, containing a total of 427 gallons of usable fuel. The center section of the wing tank forms a collector tank, the forward part of which is a negative g compartment containing two boost pumps. The internal tanks are pressurized with engine bleed air to keep the collector tank full until all other fuel is exhausted. In the event that pressurization is lost, fuel gravity feeds to the negative g compartment. The unusable or trapped fuel in the system is approximately 11 gallons. Provision is made for pressure or gravity refueling, and for gravity or suction defueling.

A precheck system allows the refueling operator to detect a failure in the fuel shutoff system during refueling.

### NOTE

**The aircraft has no capability to dump fuel.**

**2.2.1.1 Fuel Tanks.** The fuselage tank is located between the engine air intakes just aft of the aft cockpit. The wing tank extends between the front and rear spars on each side of the centerline.

**2.2.1.2 Boost Pumps.** Two boost pumps are installed in the negative g compartment. The boost pumps ensure uninterrupted engine fuel supply under normal and negative g conditions. The F PRES caution light on the warning/caution/advisory lights panel illuminates when there is an insufficient pressure differential across either pump.

The boost pumps are installed on a manifold. A full flow check valve is installed in each of the manifold's fuel pump inlets to prevent backflow of fuel into a failed pump. A bypass valve is installed on the manifold which allows the engine-driven pump to draw fuel directly from the bottom of the negative g compartment if the boost pumps fail.

The boost pumps are each driven by an ac motor with power supplied through a dedicated static inverter. The inverters and fuel boost pumps automatically turn on: (1) during GTS operation, or (2) when the engine speed is greater than 42 percent, the aircraft generator is ON and the ENGINE switches are set to ON. A time delay relay keeps the fuel boost pumps operating for 30

seconds after loss of any of the signals. For example, with the GTS off, 30 seconds after

losing engine speed, or generator voltage indication, both boost pumps shut down to conserve battery power. With the GTS off, if the ENGINE switch is selected to OFF for more than 30 seconds, fuel boost pump number 2 shuts down and a F PRES caution light is illuminated. After an airstart, if the generator is not reset, and the ENGINE switches are not returned to ON, within 30 seconds the F PRES caution light illuminates.

### NOTE

After an airstart, if the generator is not reset within 30 seconds the F PRES caution light will illuminate when a fuel boost pump's static inverter automatically switches back to the Generator Bus.

**2.2.1.3 Fuel Shutoff Valve.** The low pressure fuel shutoff valve enables the pilot to isolate the aircraft fuel system from the engine and GTS systems. The shutoff valve is operated by a T-handle control located only in the forward cockpit. The valve is normally left open (down position) and closed only during an emergency. The valve is closed (pulled up) during an emergency or after reaching zero RPM on engine shutdown.

**2.2.1.4 Fuel Flow Transmitter.** The fuel flow transmitter in the engine fuel supply line provides a rate of flow signal to the fuel flow indicator in the forward cockpit, which in turn provides a signal to the indicator in the aft cockpit and the airborne data recorder (ADR). The ADR then provides the digital value of the fuel flow to the display electronics unit (DEU) via the mux bus for presentation on the ENG display, see Figure 2-2. The fuel flow transmitter is powered by the 28 VDC Essential Services Bus.

**2.2.2 BINGO Advisory.** A BINGO advisory is displayed in the MFD advisory windows when the fuel quantity is less than or equal to the BINGO setting. The BINGO advisory is accompanied by CAUTION being displayed on the HUD and by flashing of the BINGO setting and BNGO option legends. The BINGO advisory and the HUD CAUTION will remain displayed until rejected. The BINGO setting and BNGO option legend will continue to flash after the advisory is rejected as a reminder, until the setting is reset below the aircraft's fuel quantity.

*NOTE: In this FSX rendition, BINGO advisory will*

only show in the HUD. Also, BINGO values shown in the MFD FUEL page may be incorrect.

## 2.2.5 Fuel System Controls and Indicators.

**2.2.5.1 FUEL SHUTOFF Handle.** The FUEL SHUTOFF handle is located on the left console, in the front cockpit. The T-shaped handle contains a release button in the top of the handle to unlock it from the down position. Down Permits fuel flow to the engine and GTS. Up Isolates aircraft fuel system from the engine and GTS.

**2.2.5.2 Fuel Quantity Indicator.** The fuel quantity indicator is located on the right side of the instrument panel. The indicator indicates internal fuel remaining in 100 pound increments.

**2.2.5.3 BNGO Option (ADI Display).** The BNGO option is located on the ADI display.

**NOTE:** In this FSX rendition, BINGO values shall be read and entered only through the HUD scratchpad.

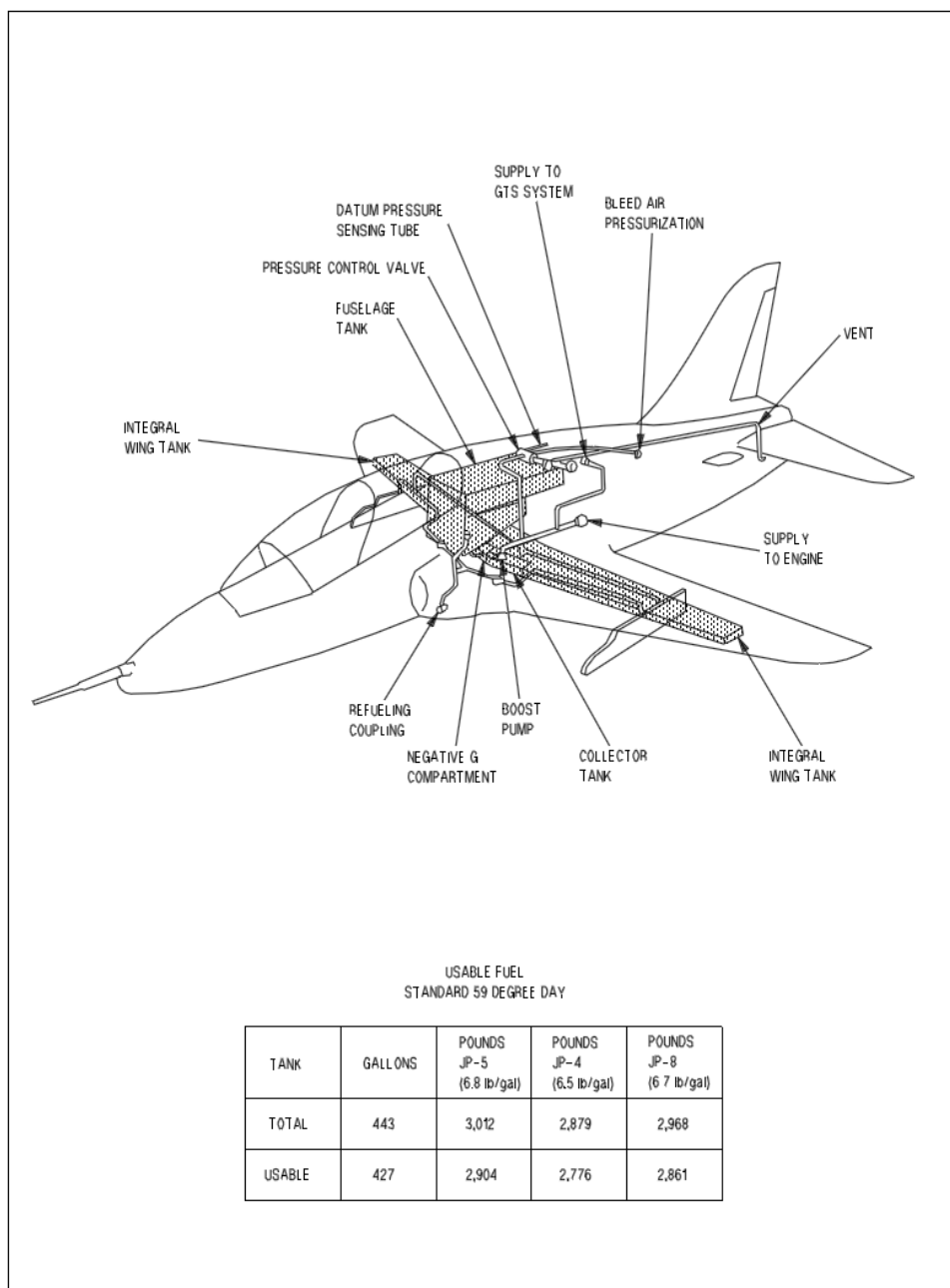


Figure 2-3. Fuel Tank Locations and Capacities



## 2.3 ELECTRICAL SYSTEM

Primary dc power is provided by an engine driven 9 kw dc generator which supplies 28 volts to the 28 VDC Generator Bus. Ac power is provided by two static inverters which are connected in parallel supplying the ac buses. The inverters are powered from the 28 VDC Essential Services Bus and each supplies 115 volts, 400 Hz to the 115 vac buses, and 26 volts, 400 Hz to the 26 vac buses. Warnings of generator and inverter failure are given on the warning/ caution/ advisory lights panel. Two 24 volt dc batteries provide power for the engine starting system and, following generator failure, for services which are essential for the operation of the aircraft. The batteries are connected to the 28 VDC Essential Services Bus. External dc power may be connected and used for ground servicing and for charging the batteries.

### CAUTION:

*The electrical system simulation in this flight simulator X rendition is approximate. Many functions are not implemented, such as generator reset and ground power switching. Most of the information in this section is given for educational purposes only and may not have effect in Flight Simulator X.*

### 2.3.1 Dc System Operation

**2.3.1.1 Dc Generator.** The 9 kw 28 volt dc generator, located below the forward end of the engine, is driven by the engine external gearbox. Generator output is supplied to the 28 VDC Generator Bus which is connected, through diodes, to the 28 VDC Essential Services Bus. During ground starts, the GENERATOR warning light extinguishes when a suitable dc output is obtained. On the initial start the GENERATOR warning light may not extinguish at idle RPM until the bleed valve is closed, resulting in increased engine idle RPM. While performing an airstart, the generator is automatically deenergized to reduce engine loads. The generator must then be manually reset as in a generator failure.

**2.3.1.2 Generator Failure Warning.** An undervoltage sensing unit is connected to the 28 VDC Generator Bus. When an undervoltage condition (25 volts dc or less) is sensed, the sensing unit is deenergized and the GENERATOR warning light is illuminated. In the deenergized state, the undervoltage unit also disables one of the inverters which then illuminates the AC INV (inverter) caution light (aircraft 165080 THRU 165092).

This is accomplished automatically to conserve battery life. If one inverter subsequently fails, the second inverter reenergizes and powers the various ac essential buses. This is accomplished through a series of relays.

The maximum voltage output of the generator is controlled by an overvoltage unit. The overvoltage unit takes the generator off line if the voltage exceeds 30.2 volts. When the overvoltage unit trips the generator off line the undervoltage sensing unit illuminates the GENERATOR warning light.

If the overvoltage condition clears, the generator can be brought back on line by placing the generator switch to RESET.

If the generator is taken off line, the 28 VDC Generator Bus voltage falls below 25 volts, causing the undervoltage unit to activate the GENERATOR warning light. The 28 VDC Essential Services Bus then receives power from the batteries.

A 2 minute timer provides battery power to the DEU, both left MFDs, stability augmentation data sensor (SADS) and the VCR/camera electronics unit (CEU) for up to 2 minutes whenever the generator is taken off line for either an overvoltage or undervoltage condition. If the generator remains off line for more than 2 minutes, the timer will time out and remove power from the DEU, MFDs, SADS, and VCR/CEU. Should power be restored before or after the 2 minutes, power will continue/be restored to the equipment from the 28 VDC Generator Bus.

**2.3.2 Batteries.** The two 24 volt 18 amperehour sealed lead acid batteries are located in the main equipment bay. The batteries are controlled from the forward cockpit by the individual switches, BATT 1 and BATT 2. Setting a battery switch to ON connects that battery to the 28 VDC Essential Services Bus. In this condition the battery is charged by the generator; if, however, the generator is off line, the battery supplies power to the 28 VDC Essential Services Bus. A single fully charged battery should supply the 28 VDC Essential Services Bus loads for approximately 12 minutes (both batteries should supply the loads for approximately 27 minutes).

If the generator fails, the services supplied by the 28 VDC Generator Bus (ac and dc nonessential loads) are lost; however, those services connected to the 28 VDC Essential Services Bus (including 115 ac, 26 vac, and 6 vac essential

loads) continue to operate from the batteries provided the battery switches are set to ON. See Part V, Emergency Procedures, for inoperative/operative equipment when the generator fails.

**2.3.3 External Power Supply. On the real aircraft** external power may be connected and used for ground servicing and for charging the batteries. External power units should supply 28 vdc at 300 amps. This function is not implemented in FSX.

### **2.3.4 Ac System Operation**

**2.3.4.1 Ac Supplies. 115/26 vac, 400 Hz, single phase** is provided by two static inverters which are supplied with dc power from the 28 VDC Essential Services Bus. Both inverters operate in parallel in the normal mode providing power to both the essential and nonessential ac busses. For flight safety during a generator failure, nonessential ac loads are automatically removed to maximize battery endurance time. Each inverter has voltage and frequency regulation and protection circuits. The inverters are interconnected for phase control, and the first inverter to sense a satisfactory dc input assumes a master control function over both inverters. With a satisfactory dc input and ac output, the inverters are brought on line automatically.

**2.3.4.2 Inverter Control.** The inverter protection circuits trip an inverter off line when certain fault conditions are detected. The fault conditions are grouped in two types, those associated with the input to an inverter and those associated with the output of an inverter. When an input fault condition has cleared the inverter is automatically reset but after an output fault has cleared the inverter must be reset manually. Manual resetting of both inverters is controlled by the AC RESET switch.

**2.3.4.3 Inverter Failure.** An indication that an inverter has failed or is off line is indicated by illumination of the AC INV caution light

**2.3.4.4 Ac Failure.** If both inverters fail and will not reset, the analog GPS/inertial navigation assembly (GINA) pitch, roll, and heading information provided to the ADR, yaw damper

controller(YDC), and VOR/ ILS/MB receiver will be unreliable due to the loss of the ac power. The attitude information display on the HUD and ADI displays will not be affected. The standby attitude indicator does not depend on ac power and will continue to operate with from the 28 VDC Essential Services Bus.

### **2.3.5 Electrical System Controls and Indicators.**

**2.3.5.1 Battery Switches.** Two battery switches, labeled BATT 1 and BATT 2, are located on the PWR panel on the right console in the front cockpit, and have the following positions:

ON Connects the corresponding battery to the 28 VDC Essential Services Bus.

OFF Disconnects the battery from the 28 VDC Essential Services Bus.

**2.3.7.2 AC RESET Switch.** The AC RESET switch is located on the PWR panel, on the right console and is a three position toggle switch, spring loaded to the center. This switch has no function in Flight Simulator X game.

**2.3.7.3 GEN Switch.** The GEN switch is located on the PWR panel, on the right console and is a three position toggle switch, spring loaded to the ON position. The switch has the following positions:

ON Generator is on, excitation power is supplied from the 28 VDC Essential Services Bus.

OFF Excitation power is removed, turning off the generator.

RESET Resets the generator voltage regulator. This function is not implemented in FSX and generator cannot be reset.

**2.3.7.4 EXT PWR MONITOR Switch.** The EXT PWR MONITOR switch is located on the external power monitor and controls the operation of the ground power panel. This switch has no function in Flight Simulator X.

## 2.4 AVIONICS SYSTEM

The avionics system provides a highly integrated digital cockpit which significantly improves the effectiveness of aircrew training. The heart of the avionics system is the display electronics unit (DEU).

*NOTE: This FSX rendition uses the default avionics for F/A-18 Hornet, hence the functions of the MFD and HUD display will differ from the ones in the real T-45C Goshawk. Some controls act differently and some functions are may be missing or may be working only partially. Also, the real Goshawk has no radar and no radar functionality – although radar simulators are being developed. Although ENG and FUEL pages may appear functional, their values may be incorrect. Only analogue gauges shall be trusted for engine and fuel readings.*

**2.4.1 Display Electronics Unit.** Upon aircraft power up, power is supplied to the DEU and normal operation begins.

The DEU acts both as a mission computer and display computer. As a mission computer it computes navigation and weapon delivery solutions.

It also controls the dual redundant MIL-STD-1553 multiplex data bus (mux bus) which interfaces with the airborne data recorder (ADR), mission data loader (MDL), and global positioning system (GPS)/ inertial navigation assembly (GINA). The DEU also has hardware interfaces with the TACAN and VOR/ILS for navigation data, the stability augmentation data sensor (SADS) for air data, selected aircraft equipment for BIT functions, and other miscellaneous signals.

As a display computer the DEU interprets aircrew commands from the four multi-function displays (MFD) and two data entry panels (DEP) to generate the appropriate response/ display on the head-up display (HUD) and MFDs. If any one source of data is invalid, the related information shall be blanked.

**2.4.2 Master Modes.** The real HUD has three master modes of operation: navigation (NAV), air to air (A/A), and air to ground (A/G). Master mode selection is mutually exclusive, selecting a different master mode automatically deselects the current master mode. The controls, displays, and avionics equipment operation are tailored as a function of pilot selected master mode.

*NOTE: Complete master mode selection is not available in this Flight Simulator X rendition.*

*However, pressing the MODE button in the Data Entry Panel switches the HUD into Air-to-Air gun simulation mode.*

**2.4.3 Cockpit Controls And Displays.** Cockpit controls and displays consist of four MFDs (two in each cockpit), two DEPs (one in each cockpit), the HUD (front cockpit) and a DISPLAY POWER switch (front cockpit).

**2.4.3.1 Multi Function Displays.** The four MFDs operate independent of one another. This provides the ability to display the desired information on any MFD. In the NAV master mode the left MFD is usually used to display the ADI and the right MFD is used to display the HSI.

**2.4.3.1.1 CONT (Contrast) Knob.** This knob varies the contrast between the symbology and the dark background on any level of brightness.

**2.4.3.1.2 BRT (Brightness) Knob.** This knob varies the intensity of the presentation.

**2.4.3.1.3 OFF/N (Night)/D (Day) Knob.** Placing the knob to OFF removes power from the MFD. Placing the knob to N provides a lower brightness control range. When selected, D provides a higher brightness control range.

**2.4.3.1.4 Option Buttons.** Each MFD has 20 buttons around the periphery of the MFD with an adjacent legend on the selected display. Actuation of a button with a legend (option) displayed next to the button will perform the desired function.

**2.4.3.6 Data Entry Panel.** The DEP is used to control the HUD, enter mission data and perform other operations.

Data entry (into the DEU) is accomplished using the DEP. The numeric characters will be displayed in the HUD scratchpad. The scratchpad display is removed or a new parameter is sequentially displayed if the value is valid as it is entered (ENT pressed).

If the entered value is not valid, it flashes until the CLR is pressed, then the new value should be entered.

*NOTE: In this Flight Simulator X rendition DEP is only partially functional, and some of its controls have been modified or may be not working.*

**2.4.3.6.1 HUD Power Knob.** The ON position turns the HUD on. The OFF position turns the

HUD off.

**2.4.3.6.2 AUTO/DAY Knob.** In the real aircraft the DAY position provides manual adjustments of HUD brightness.

In this Flight Simulator X rendition, this knob controls allows the user to switch the color of the HUD from green to cyan.

**2.4.3.6.3 BRT (Brightness) Knob.** Allows adjustment of HUD brightness with the AUTO/DAY knob in the DAY position. In FSX this knob is used to CAGE/UNCAGE the HUD.

**2.4.3.6.4 DCL (Declutter) Button.** The DCL option controls the amount of symbology rejection on the HUD. The system initializes with the normal declutter level selected. Successive actuations of the DCL button will cycle through the declutter levels of: declutter 1, declutter 2, and back to normal.

**2.4.3.6.5 Data Entry Buttons.** In the real aircraft, in all master modes these buttons are used to enter the LAW, CRS, HDG, BNGO, or waypoint data. In the A/A master mode they are used to enter wingspan data. In the A/G master mode they are used to enter target height, continuously computed impact point (CCIP) mode. When the data is entered it appears on the HUD and MFD scratchpads.

*NOTE: In this Flight Simulator X rendition, these buttons, as the ENT and CLR buttons, can be used only in BNGO, CRS, LAW and HDG modes.*

**2.4.3.6.6 ENT (Enter) Button.** After the data has been entered using the data entry buttons, the ENT button is actuated to enter the data in the DEU and remove the scratchpads. If the entered data is invalid, it will flash until the data is cleared.

**2.4.3.6.7 CLR (Clear) Button.** When invalid data is entered or a change to the scratchpad data is needed, the CLR button is used to clear (erase) the data from the scratchpad. The data can then be entered.

**2.4.3.6.8 LAW Button.** The LAW button is used to set the DEP in the Low Altitude Warning mode. Desired LAW shall be entered via the scratchpad.

**2.4.3.6.9 CRS Button.** This button sets the DEP

in CouRSe setting mode. Desired course setting for NAV1 shall be entered using the scratchpad.

**2.4.3.6.10 HDG Button.** This button sets the DEP in autopilot HeadInG setting mode. Desired heading shall be entered using the scratchpad.

**2.4.3.6.11 BNGO Button.** This button sets the DEP in the BINGO setting mode. Desired BINGO setting shall be entered. NOTE: the BINGO value in the MFD FUEL page is incorrect and will not change.

**2.4.3.6.12 SET DEP (Depression) Rocker Switch.** In the real aircraft this switch is used to adjust (increase/decrease) the depressed sight line (DSL) aiming reticle (mil depression) on the HUD. In this Flight Simulator X rendition, this rocker switch acts as the AUTOPILOT MASTER switch.

**2.4.3.6.13 MODE Button.** In the real aircraft this button is used to select the desired master mode. Successive actuations of this button will cycle through the master modes of NAV, A/A, and A/G. In this Flight Simulator X rendition, pressing the button switches the HUD to Air to Air, gun simulation mode.

**2.4.3.7 DISPLAY POWER Switch.** The DISPLAY POWER switch is a three position switch located on the miscellaneous switch panel. In real life, the switch has the following positions:

RESET Momentarily interrupts power to the DEU and commands DEU to perform a restart. Hold switch in position for a minimum of 5 seconds before releasing.

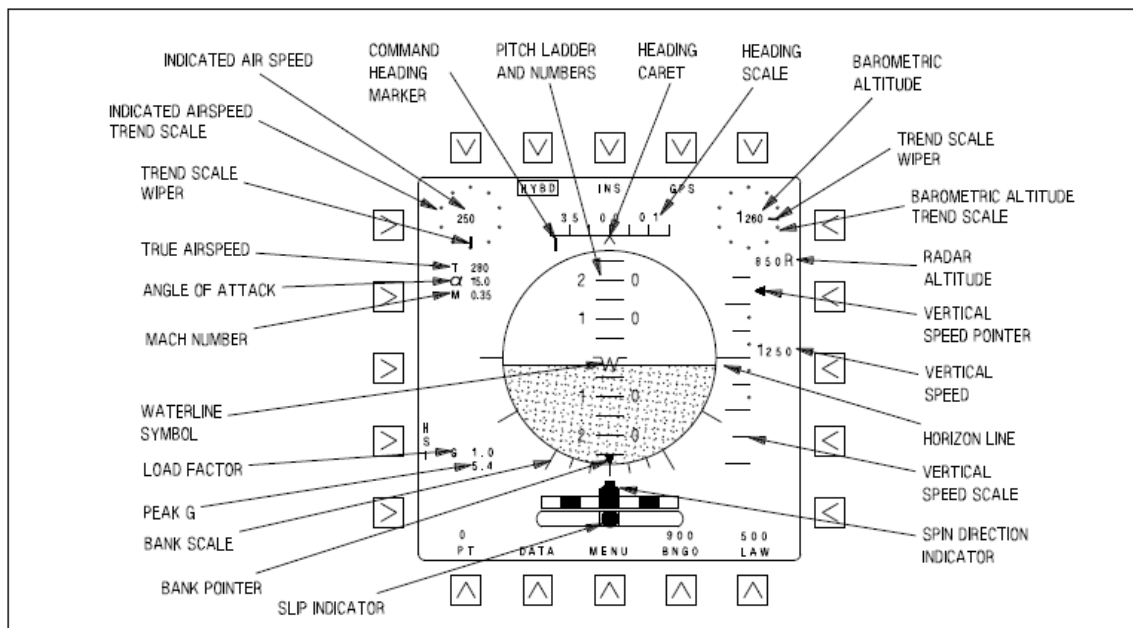
NORMAL The DEU, both left MFDs, SADS, and VCR/CEU are powered for 2 minutes following a 28 VDC Generator Bus undervoltage/generator failure.

ORIDE Overrides 2 minute relay and the DEU, both left MFDs, SADS, and the VCR/CEU will remain powered by the 28 VDC Essential services Bus.

In Flight Simulator X this switch has no function.

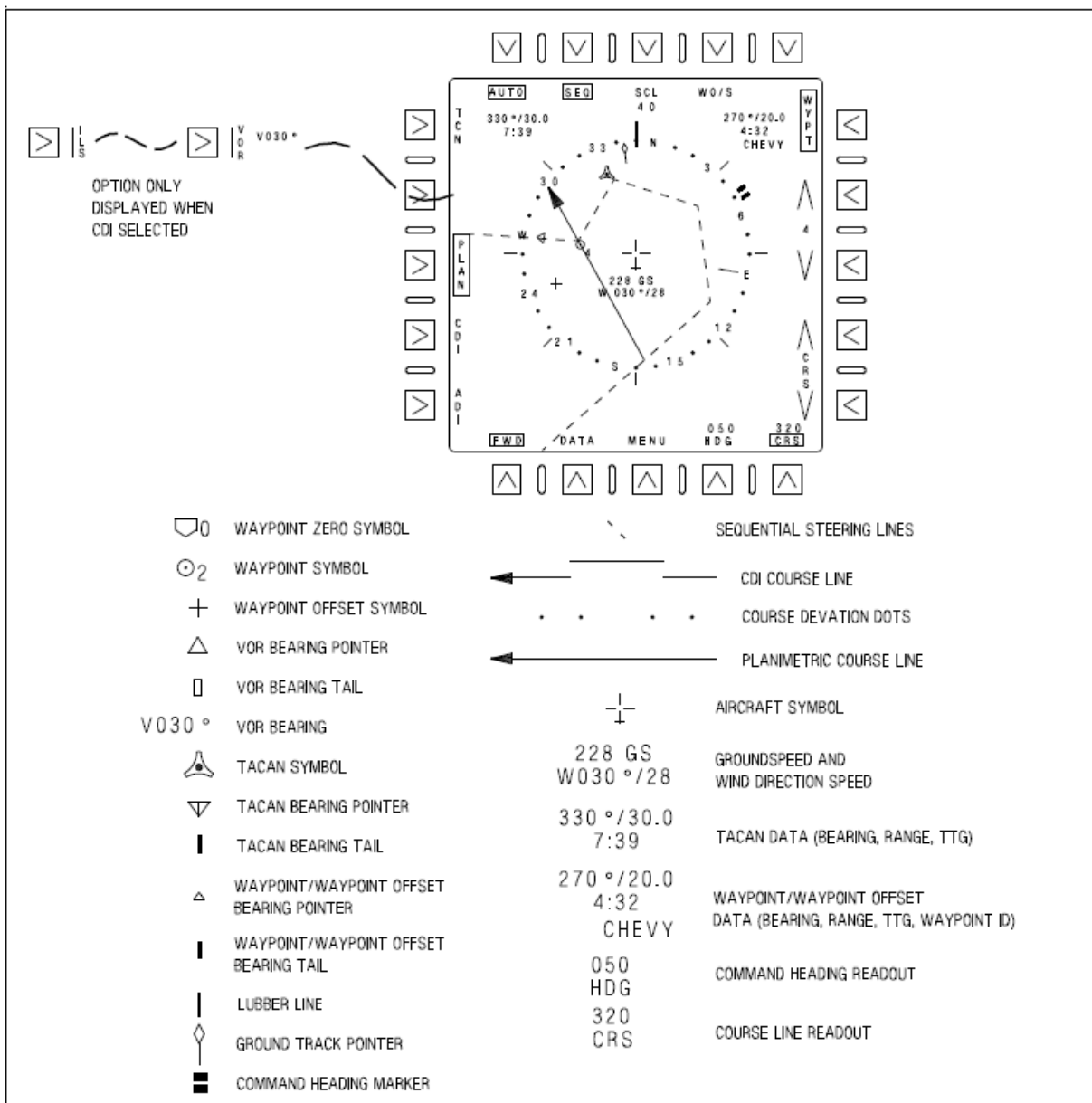
**NOTE**

Leaving the DISPLAY POWER switch in the ORIDE position with loss of 28 vdc generator will greatly reduce battery life in real life aircraft.



ADI Symbology

EDA815-12-1-003



HSI Symbology

EDA815-13-1-01

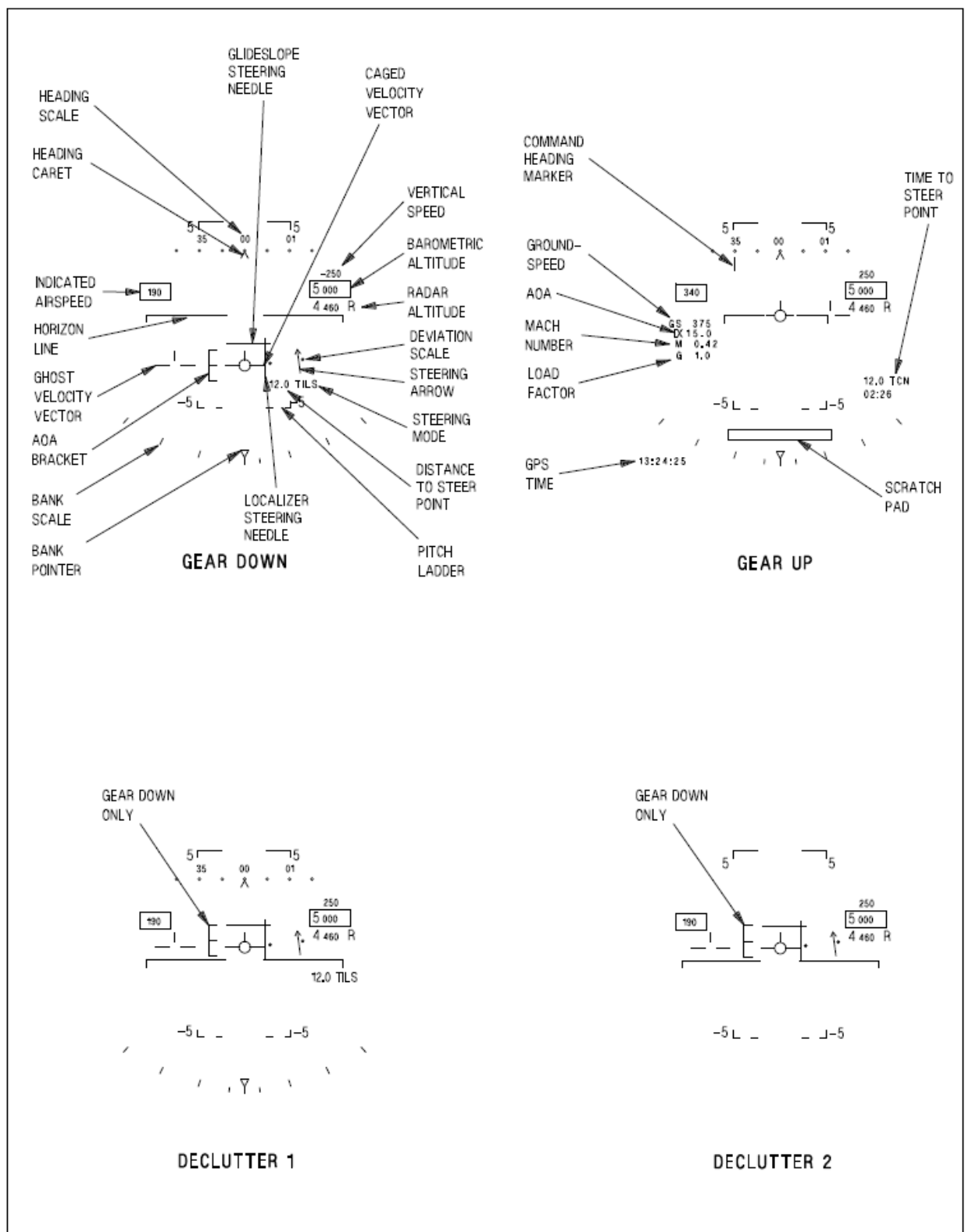


Figure 2-12. HUD Symbology

## 2.5 HYDRAULIC SYSTEM

Two hydraulic systems provide pressure for operating the flight controls and general services. The number 1 hydraulic system (HYD 1) provides power for flight control surfaces (ailerons and stabilator), and general services (flaps, slats, speed brakes, landing gear, nose wheel steering, wheel brakes, arresting hook, and launch bar). A hand pump is provided for ground testing the general services and for charging the wheel brake/emergency flap accumulator. The hydraulic hand pump is located behind an access panel on the right engine air intake, see Figure 3-3. The number 2 hydraulic system (HYD 2) provides power for aileron and stabilator controls, and is interconnected with the RAT system. Primary flight control actuators are designed so that either of the two main hydraulic systems can provide sufficient power for normal operation. See the Hydraulic System foldout, FO-17. Power for the two independent hydraulic systems is provided by two identical engine driven pumps. The pumps are constant pressure, variable displacement types and maintain each system at an operating pressure of 3,000 psi. Nitrogen pressurized reservoirs ensure adequate base pressure to resist pump cavitation under all flight conditions. The residual pressure also energizes component seals during system shut down to minimize fluid leakage. Two nitrogen pressurized accumulators, one for each HYD system, provide back up power sources for the primary flight controls during periods of high demands. A separate accumulator provides emergency power to the wheel brakes and flaps in case of pump failure or during operations without engine power. Indicators in each cockpit indicate hydraulic system pressure for each system.

**2.5.1 HYD 1 Normal Operation.** Hydraulic fluid is supplied under low pressure from the reservoir to the engine-driven pump (EDP). With the engine running, the EDP builds up pressure to 3,000 psi and discharges pressure to the power supply package before reaching the flight controls and general services. System pressure is sensed by a pressure transducer and indicated by the HYD 1 pressure indicators in both cockpits. A pressure switch connected to the power supply package illuminates the HYD 1 caution light in both cockpits if the pressure falls to 600 +/- 50 psi. As the pressure increases to 725 psi the caution light extinguishes. The power supply package consists of check valves, a pressure relief valve, and a priority

valve. If the pressure exceeds 3,600 psi, the pressure relief valve opens to direct excess pressure to the return line. If the pressure falls to below 1,500 psi, the priority valve closes to isolate general services from the system to maintain supply to the flight controls. As the pressure increases above 1,600 psi the valve reopens to provide power for general services. Return fluid from the flight controls and general services is directed back to the reservoir through the filter and check valves. Connection for replenishment of reservoir fluid is made at an external self-sealing coupling. In the event of reservoir over pressurization, a pressure relief valve in the reservoir line bleeds fluid overboard. A hand pump circuit is connected to the HYD 1 general service line. The circuit consists of a hand pump, a pressure relief valve, a check valve and connecting tubing. With the engine running, the check valve prevents fluid from returning to the reservoir through the hand pump circuit.

**2.5.2 HYD 2 Normal Operation.** Hydraulic fluid is supplied under low pressure from the reservoir to the EDP. The EDP builds up pressure to 3,000 psi and discharges the pressure to the flight controls and emergency package assembly through one-way check valves. Excess pressure from the pump is returned to the suction side of the system through a pressure relief valve. A bypass valve is energized open to return pump pressure when the engine RPM is below 42 percent to reduce engine loads during engine start.

System pressure is sensed by a pressure transducer and indicated by the HYD 2 pressure indicator in both cockpits. A pressure switch operates to illuminate the HYD 2 caution light in both cockpits if the pressure falls to 1,660 +/- 110 psi.

As pressure increases to 2,000 psi, the caution light will extinguish.

Return fluid from the flight controls is directed back to the reservoir through the filter. Excess pressure from the reservoir can be exhausted to atmosphere through the low pressure relief valve. Connection for replenishment of reservoir fluid is made at an external self-sealing coupling.

### 2.5.3 Emergency Hydraulic System

**Description.** In the real aircraft a RAT is provided as an emergency source of hydraulic

power to the stabilator and ailerons. Indications of RAT operation are the illumination of the RAT caution light and a cycling of the HYD 2 pressure indicator between 2,500 to 3,000 psi as control stick demands are made. The RAT is located in a bay on the top of the aft fuselage. .

The RAT has demonstrated, in flight test, a capability to provide sufficient hydraulic power for controllable flight during a total hydraulic pressure loss from the engine-driven pumps.

*NOTE: RAT is not available in this Flight Simulator X rendition.*

## **2.5.5 Hydraulic System Cockpit Controls and Indicators.**

**2.5.5.1 HYD 2 RESET Button.** The HYD 2 RESET button is located on the left console, forward of the throttle. Pressing the button with the engine above 45 percent N2 RPM or HYD 2 pressure above 1,800 psi, closes the HYD 2 system bypass valve after engine start and retracts the RAT if deployed. This button has no function in Flight Simulator X.

**2.5.5.2 HYD 2 Pressure Indicator.** The HYD 2 pressure indicator is located on the left console, forward of the throttle. The indicator indicates HYD 2 pressure in psi.

**2.5.5.3 HYD 1 Pressure Indicator.** The HYD 1 pressure indicator is located on the left console, below the HYD 2 pressure indicator. The indicator indicates HYD 1 pressure in psi.

**2.5.5.4 Brake Pressure Indicator.** The brake pressure indicator is located on the left console below the HYD 1 pressure indicator. The gauge indicates hydraulic pressure in the emergency brake/ flap accumulator.

## **2.6 FLIGHT CONTROLS AND TRIM SYSTEMS**

The aircraft is controlled in flight by tandem hydraulically actuated stabilator and ailerons, and a conventional unpowered rudder. A conventional control stick and rudder pedals are provided in each cockpit.

The stabilator provides both longitudinal trim and primary pitch control. The ailerons are outboard of the flaps at the trailing edge of the wing and provide primary roll control and lateral trim.

The rudder provides primary directional control. Yaw damping, turn coordination, and directional trim are accomplished by electrical commands sent to an electromechanical actuator which

moves the rudder and rudder tab at a fixed mechanical ratio. The rudder tab, located at the trailing edge of the rudder, is used to reduce the force required of the electromechanical actuator to overcome rudder aerodynamic loads.

Control inputs are transmitted directly to the rudder and to the hydraulic actuators for the stabilator and ailerons through push-pull rods, mechanical links and levers. The hydraulic actuators used in the stabilator and aileron systems are of tandem design. One cylinder in each tandem actuator is connected to the HYD 1 system and the other to the HYD 2 system.

Rudder pedals are adjustable fore and aft and include toe brakes for operation of the wheel brakes. The rudder may be mechanically locked for protection during strong winds when parked. The electrically operated rudder pedal shaker is attached to the left rudder pedal in the forward cockpit. The shaker and an aural tone are actuated by the stall warning feature of the angle-of attack (AOA) system, providing stall warning in both cockpits.

## **2.6.1 Flight Controls and Trim Operation.**

### **2.6.1.1 Longitudinal Control System.**

Longitudinal control is provided by a stabilator which is moved by a tandem hydraulic actuator. Artificial feel is provided by a spring cartridge in conjunction with an inertia weight and two viscous dampers while longitudinal trim is achieved with an electrically operated actuator. When a control stick is pushed full forward, the stabilator leading edge rotates up 6.6 degrees. When a control stick is pulled full aft, the stabilator leading edge rotates down 15 degrees. Non-linear gearing is provided in the longitudinal control system that increases the ratio of stabilator deflection per control stick deflection with increased displacement of the control stick away from neutral.

**2.6.1.1.1 Stabilator.** Power to operate the stabilator is obtained through a hydraulic actuator mounted horizontally above the engine tailpipe. The actuator is supplied with power from the two independent hydraulic systems, such that the integrity of the system is not affected by the failure of either half of the unit, or either hydraulic system.

A one-way check valve is in each of the HYD 1 and HYD 2 pressure lines to the stabilator actuator.

These check valves act to cause a hydraulic lock and prevent uncommanded pitchdown if



total hydraulic failure occurs in extreme conditions of stabilator loading.

**2.6.1.1.2 Stabilator Trim.** The stabilator trim actuator consists of a main and a standby motor. The main motor is operated by a four way trim switch located on each control stick. The standby motor is operated by a guarded standby stabilator trim switch on the left console in each cockpit. Power is provided to the main stabilator trim system from the 28 VDC Essential Services Bus and the standby stabilator trim system from the 28 VDC Generator Bus.

The control system is such that trim selections may be made from either the forward or aft cockpit. Similarly, standby selection may be made from either cockpit and will override main selection. The trim system provides a range of 3 degrees stabilator leading edge up to 8 degrees stabilator leading edge down. The rate of manual trim from either main or standby control is approximately 2 degrees/second. A stabilator position indicator is provided in each cockpit.

#### CAUTION

The stabilator position indicator will move as pitch commands or trim inputs are made. The indicator will only depict trim position with no forces on the stick. While setting trim for takeoff or catapult launch, it is important that both pilots not exert longitudinal forces on the stick.

**2.6.1.2 Lateral Control System.** Lateral control is provided by conventional ailerons. Artificial feel is provided by a spring cartridge while lateral trim is achieved by an electrically operated actuator. Aileron trim position is provided by aileron trim indicators, one in each cockpit. The control stick controls aileron deflection through a total range of 12.5 degrees to either side of neutral, landing gear up, or 15.5 degrees with landing gear down. This is accomplished through an aileron ratio changer that increases aileron deflection when the landing gear is down. Although the maximum lateral control stick travel is reduced when the landing gear is down, because of the ratio change, the maximum deflection of the ailerons is increased.

**2.6.1.2.1 Aileron.** Each aileron is powered by a tandem hydraulic actuator mounted underneath the wing and enclosed by fairings. Each actuator is supplied with power from the two independent hydraulic systems such that control

integrity is not affected by the failure of either half of a unit or either hydraulic system.

**2.6.1.2.2 Lateral Feel System.** The lateral feel system consists of a nonlinear spring cartridge feel system that varies with stick deflection.

**2.6.1.2.3 Aileron Trim System.** Aileron trim is applied by the electrically operated actuator and is controlled by the four-way trim switch located on each control stick. During trim checks on deck the stick moves with aileron trim inputs and no pressure on the stick. Trim authority is increased from 6 degrees gear up to 9 degrees with gear down. The rate of trim is approximately 2 degrees/second. An aileron trim indicator is provided in each cockpit. The indicators are driven by a transmitter mounted on the trim actuator. Power to the aileron trim controls is provided by the 28 VDC generator bus.

#### **2.6.1.3 Directional Control System.**

Directional control is provided by a conventional unpowered rudder operated by rudder pedals in both cockpits. Rudder trim is provided through an electrical trim motor that operates in conjunction with the yaw damper controller (YDC).

Power to the rudder trim is provided by the 28 VDC generator bus. Pilot actuation in either cockpit of the rudder trim knob repositions the rudder and trailing edge tab. A rudder trim indicator in both cockpits displays commanded trim position. Actual trim may be less at high airspeeds. Rudder trim is not available with the control augmentation system deactivated, as indicated by the trim needle pointing to the six o'clock position. Rudder centering is provided by a spring cartridge. A mechanical no-float mechanism in the rudder system prevents both aerodynamic loads on the rudder and movement of the yaw damper actuator from back driving the pedals when the pedals are centered. The rudder toe pedals operate independent hydraulic wheel brakes for ground roll braking and supplemental directional control on the ground. The rudder pedals can be adjusted fore and aft by using the pedal adjust knob located below the center pedestal in each cockpit.

**2.6.2 Control Augmentation System.** The control augmentation system (CONTR AUG) performs four functions: yaw damping, turn coordination, speed brake-to-stabilator interconnect (SBI), and rudder trim. This system is not implemented in this Flight Simulator X rendition.

## 2.6.3 Flight Controls and Trim Systems Controls and Indicators.

**2.6.3.1 CONTR AUG Switch.** The CONTR AUG switch is located on the left console of the front cockpit. This switch has no function in Flight Simulator X. In the real aircraft the switch is a three position switch with the following:

### ALL

Provides yaw damping, turn coordination through the aileronrudder-interconnect (ARI), rudder trim, and SBI capabilities. IBIT is initiated by momentarily pressing the paddle switch followed by setting the CONTR AUG switch momentarily to RESET, and then switching from SBI to ALL with weight-on-wheels, airspeed less than 80 knots, and the FLAPS/SLATS switch UP.

### SBI

Provides rudder trim and speed brake-to-stabilator interconnect capabilities.

### RESET

Momentary position which resets the CONTR AUG, neutralizing the rudder and SBI actuator, if the paddle switch was previously utilized. RESET position is spring loaded to SBI position.

**2.6.3.2 Roll and Pitch Trim Switch.** The roll and pitch trim switch is located on the front face of the stick grip near the top. Moving the switch left or right, adds corresponding aileron trim. Moving the switch forward adds nosedown pitch trim and moving it aft adds noseup trim.

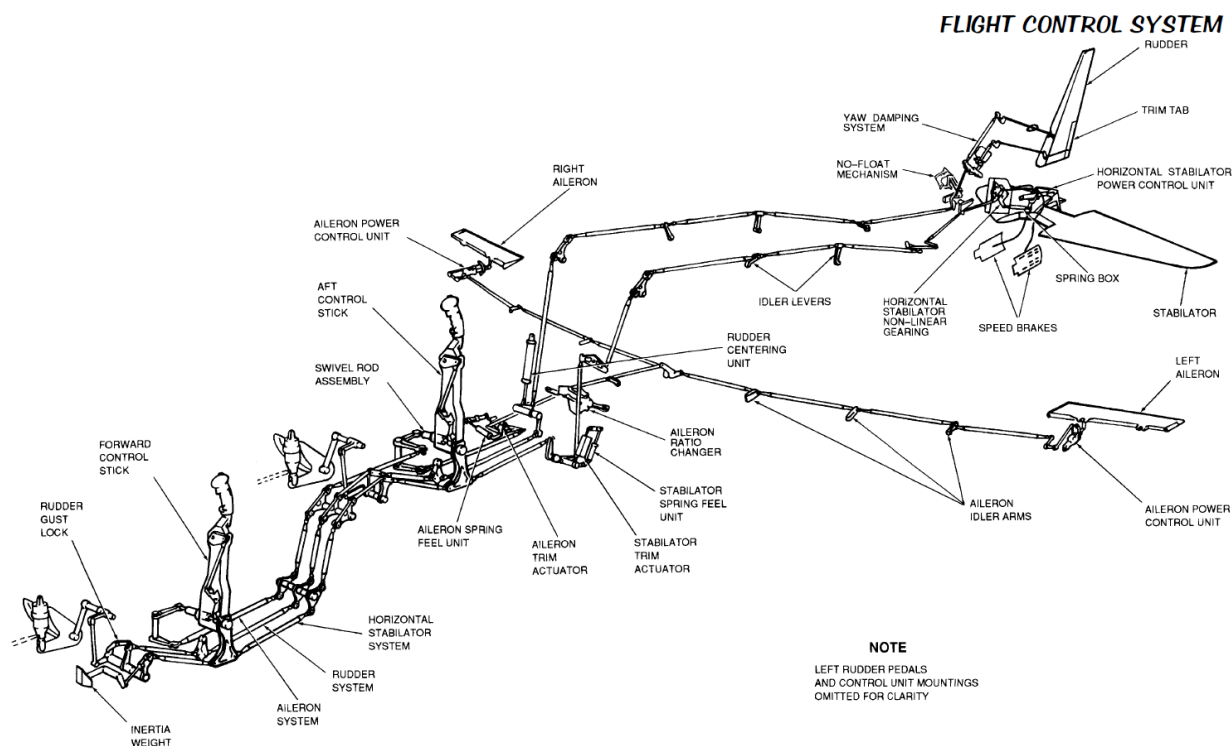
**2.6.3.3 STBY STAB TRIM Switch.** The STBY STAB TRIM switch is located on the left console, aft of the throttle.

**2.6.3.4 RUDDER TRIM Knob.** The RUDDER TRIM knob is located on the left console and aft of the throttle. Rotating the knob left or right adds the corresponding rudder trim.

**2.6.3.5 Rudder Trim Indicator.** The rudder trim indicator is located forward of the throttle and indicates rudder trim position.

**2.6.3.6 Stabilator Position Indicator.** The stabilator position indicator is located forward of the throttle and indicates stabilator position in degrees.

**2.6.3.7 Aileron Trim Indicator.** The aileron trim indicator is located forward of the throttle and indicates aileron trim position.



## 2.7 FLAP/SLAT SYSTEM

**2.7.1 Flap System Description.** Two double slotted trailing edge flaps, which are pivoted below the lower surface of the wing, span from the fuselage root fairings to the ailerons. Normal flap operating pressure is provided by the HYD 1 system. The flaps are raised and lowered by a single actuator via a series of push-pull control rods and bellcrank levers. Operation is controlled by a three position lever (UP, 1/2, DN) located on the left console in both cockpits. Selections made on the levers position a switch located inside the forward cockpit left console, and connect electrical power to energize either the up or down solenoid of the selector valve. Pressure from the selector valve is used to position the flaps to the up, 1/2 (partially extended to a nominal position of approximately 25 degrees), or the down (approximately 50 degrees) position. The flaps are held in the up or down position by hydraulic pressure and are hydraulically locked in the 1/2 position. Pressure and thermal relief valves, rate control restrictors and check valves protect and ensure correct functioning of the system. However, the flaps will not blow back if an overspeed occurs.

The FLAPS/SLATS levers are mechanically linked together by a cable. The levers position a switch located inside the forward cockpit left console. Flap position is displayed on the flap position indicator in both cockpits. The flaps can also be extended with pressure from the wheel brake/emergency flap accumulator. Emergency extension is controlled by an EMER FLAP switch located on the lower left side of the instrument panel. This function is not implemented in this Flight Simulator X rendition.

**2.7.1.1 Normal Flap Operation.** Hydraulic fluid directed to and from the flap actuator is controlled by two solenoid operated valves and a slide valve. With both solenoid valves deenergized and hydraulic pressure applied, the slide valve is held in the neutral position isolating the service pressure and return ports. Normal operation of the flaps is accomplished by selecting the desired position on the FLAPS/SLATS lever.

When the lever or switch is changed, an electrical signal is sent to either the up or down solenoid of the flap selector valve, porting hydraulic fluid to move the slide valve to the appropriate position.

Hydraulic fluid from the HYD 1 system passes through the slide valve and is directed to either the UP or DOWN side of the flap actuator. Positioning the FLAPS/SLATS lever to the 1/2 position causes the flap selector to port hydraulic fluid as necessary to drive the flaps toward the 1/2 position. When the flaps reach the 1/2 position, a rotary flap position switch interrupts the electrical signal to the solenoid valves moving the slide valve and closing the pressure and return ports. This action positively holds the flaps at 1/2.

**2.7.2 Emergency Flap Operation.** Emergency flap operation is not simulated in this Flight Simulator X rendition.

**2.7.3 Slat System Description.** Leading edge slats, when extended, decrease aircraft stall speed and increase aircraft control and stability during takeoff and landing, providing an increased safety margin. Three segmented slats are mounted on the leading edge of each wing. Selection is controlled through the FLAPS/SLATS lever located in both cockpits. The slat system is powered by HYD 1.

Each slat assembly consists of three slat segments, mounted on tracks and mechanically linked as a unit, which extend and retract through a series of push-pull rods and bellcranks.

The FLAPS/SLATS levers are mechanically connected by a cable and position a switch located inside the forward cockpit left console. Each lever moves in unison with the other. The only slat cockpit indication is the SLAT caution light.

The slat drive actuators extend or retract to reposition the control rod and bellcrank system which extends or retracts the slats. The slats on each wing are locked in the fully extended and fully retracted positions by overcenter links attached to each main bell crank. This ensures the slat remains locked in the selected position. Each overcenter lock is opened and closed by a hydraulic lock actuator.

**2.7.4 Slat System Operation.** Positioning the FLAPS/SLATS lever to either 1/2 or DOWN causes the slat selector valve to port hydraulic fluid to both lock actuators moving the overcenter links from the lock position. At the same time hydraulic fluid is also ported to each slat actuator extending the slat assembly. Once the slat is fully extended the lock actuators reposition the overcenter link in the locked position.

The overcenter lock insures that any loss of hydraulic pressure or electrical power will not allow the slats to drift from the selected position. Positioning of the FLAPS/SLATS lever to UP retracts the slats using the same sequence as to extend. Synchronous operation of the slats between each wing is achieved hydraulically. In the event of a normal system failure, symmetry is provided by a synchro cable which maintains one slat drive actuator position within 2 degrees of the other. Airspeed must be below 217 knots for the slats to extend.

### **2.7.5 Flaps and Slats Controls and Indicators.**

**2.7.5.1 FLAPS/SLATS Lever.** The FLAPS/SLATS lever is located on the left console, inboard of the throttle. The levers in the forward and aft cockpits are mechanically connected and move together when positioned from either cockpit.

The lever has positive detents for each of the following three positions:

UP Selects the flaps up and the slats retracted.

1/2 Selects half flaps and the slats extended.

DN Selects full flaps and the slats extended.

**2.7.5.2 EMER FLAPS Switch.** The EMER FLAPS switch is located on the left vertical console. The switch has no function in Flight Simulator X.

### **2.7.6 Flaps Position Lights**

**2.7.6.1 HALF Position Light.** The HALF position light is located on the left vertical console next to the EMER JETT button. The light illuminates when the flaps are in the 1/2 position.

**2.7.6.2 FULL Position light.** The FULL position light is located just below the HALF position light and illuminates when the flaps are in the full position.

### **2.7.7 Flaps and Slats Warning, Caution, and Advisory Lights.**

**2.7.7.1 SLATS Caution Light.** The SLATS caution light is located on the caution/warning panel. This light is inoperative in Flight Simulator.

## **2.8 SPEED BRAKE SYSTEM**

The speed brakes are located on each side of the aft fuselage just forward of the stabilator. The speed brakes are hydraulically operated and electrically controlled from either cockpit by a three position speed brake switch, spring loaded to center, located on the inboard side of the throttle grip. A SP BRK advisory light illuminates whenever the speed brakes are not fully retracted. The speed brakes are mechanically interconnected to the stabilator through the SBI system. The speed brakes may not extend fully above 340 knots. A safety feature allows the speed brakes to blow back to an unspecified position when the airload against them causes the hydraulic pressure in the actuating cylinder to exceed the pressure at which the pressure relief valve opens. The speed brakes begin to blow back at an airspeed of approximately 380 knots and will extend fully if the airspeed subsequently decreases to 340 knots. With a C AUG caution light illuminated, SBI is not available and the speed brakes should not be used in close formation flight.

**2.8.1 Speed Brake System Operation.** Speed brake operation is initiated by actuation of the speed brake switch. Hydraulic fluid from the HYD 1 system passes through a slide valve and is directed to either the extend or retract sides of the speed brakes actuators.

### **2.8.3 Speed Brake System Warning, Caution, and Advisory Lights.**

**2.8.3.1 SP BRK Advisory Light.** The SP BRK advisory light is located on the main instrument panel next to the AOA indicator. The light illuminates anytime the speed brakes are not fully retracted.

**2.8.3.2 SP BRK FULL Advisory Light.** The SP BRK FULL advisory light is located on the main instrument panel next to the AOA indicator. The light illuminates anytime the speed brakes are in the fully extended position.

## **2.9 LANDING GEAR SYSTEM**

The aircraft is equipped with a retractable tricycle landing gear, consisting of a dual wheel nose gear and two main gear with conventional split half-hub wheels. The nose gear retracts forward and the main gear retract inboard.

The main landing gear are wing mounted, trailing arm suspension type units. Lateral bracing of the gear is achieved by a folding side brace

mechanism. Lock links support the apex of the side brace to mechanically lock the gear in the down position. The dual wheel nose gear is a conventional forward retracting cantilevered shock strut type.

Normal retraction and extension of the main landing gear is provided by dedicated hydraulic actuators powered by the HYD 1 system. When retracted, each main gear is supported in that position by a mechanical uplock mechanism. Emergency extension is accomplished via gravity using the EMER GEAR handle.

Each main gear retracts inboard into a bay in the inner wing. Upon retraction, each main gear bay is totally enclosed by a door system. The door system consists of an inner door panel, a fixed strut door panel, a trunnion door, and a panel attached to the trailing arm. The inner door panel, which encloses the wheel bay, is operated by a direct acting linear actuator. Operation is controlled by a hydro-mechanical sequencing system such that the door closes when the gear has reached the down and locked position. Closing the doors ensures clearance of field or shipboard arresting cables. The fixed strut door panel operates with the strut, the trunnion door is mechanically positioned by gear motion, and the trailing arm door moves with the trailing arm. The nose gear retracts into a bay forward of, and partially beneath, the forward pilot position and when retracted is totally enclosed by forward and aft pairs of doors. When retracted, the nose gear is supported in that position by a mechanical uplock mechanism. The larger forward doors are operated by direct acting linear actuators controlled by a hydro-mechanical sequencing system such that the doors close when the gear has reached a down and locked position. The smaller aft pair of doors are hinged on eachside of the shock strut. The doors are operated directly from the strut by fixed length connecting rods. This pair of doors remains open when the gear is down and locked. A fixed panel rigidly attached to the outer cylinder of the drag brace acts as a fairing for the drag brace when the gear is retracted.

The landing gear is controlled by a two position pull to operate handle on the lower left side of the instrument panel. The handle includes a solenoid that locks in both the UP and DN positions. Moving the handle up (with weight-off-wheels) raises the gear. Moving it down lowers the gear. On the ground (weight-on-wheels), inadvertent movement of the handle from DN to UP is prevented by a detent. The gear handles are mechanically linked and operate the landing gear hydraulic valves via an electric switch.

#### **NOTE**

If the LDG GEAR handle is set to UP with weight-on-wheels, the gear will not retract.

Three green landing gear position indicator lights and one amber gear door indicator light are located above the landing gear handle in each cockpit. Each green indicator light is illuminated only when its respective landing gear is down and locked. The DOOR light is illuminated whenever the landing gear doors are not up and locked.

A WHEELS warning light, located on the glareshield in both cockpits flashes and a "GEAR" audio warning tone sounds if the LDG GEAR handle is not set to DN, the throttle is below 95 percent N2 RPM position and either of the following conditions exists:

1. Altitude is less than 7,200 feetMSL and the airspeed is less than 170 knots (less than 9,500 —300 feet MSL when climbing or 7,700-500feet MSL when descending)

or

2. The SLATS/FLAPS levers are not in the UP position.

NOTE: In Flight Simulator X, only condition 2 is checked.

#### **2.9.1 Landing Gear System Operation.**

Normal landing gear operation is initiated by pulling and positioning the LDG GEAR handle to the UP or DN position. With the gear down and locked and aircraft weight is off all wheels, selecting the UP position energizes the UP solenoid of the selector valve. HYD 1 pressure at 3,000 psi is directed to the nose and main gear doors and the actuators of the gear uplock, door uplock, gear downlock and gear retract. The gear doors open in approximately 1 second. During each door opening, the mechanically operated sequence valve prevents pressure from reaching the gear retract actuator. This prevents retracting the gear until the respective gear door reaches its fully open position. As each door reaches its open position, the sequence valve is repositioned allowing gear up pressure to be supplied to its respective gear retract actuator. At this point in the cycle, each gear begins to retract. When each gear reaches the up and locked position, it mechanically actuates the respective changeover valve to direct pressure to

close and lock its own door in the up position. Total gear retraction time is approximately 10 seconds. Up pressure is supplied to the gear doors, and door latches until gear down is selected.

With the landing gear up and locked, the DN position on the LDG GEAR handle energizes the DOWN solenoid of the gear selector valve. HYD 1 pressure at 3,000 psi is directed to unlock the gear and door uplocks and open the gear doors. The doors open in approximately 1 second. During each door opening, the sequence valve for each gear prevents hydraulic fluid from entering or leaving the retract actuator. This prevents the gear from extending until the respective gear door reaches its fully open position. When each gear reaches the down and locked position, it mechanically actuates a respective changeover valve to direct pressure to close and lock its door in the up and locked position. Total gear extension time is approximately 15 seconds. The main gear is locked in the down position by the hydraulic down-lock actuators and springs acting on the overcenter lock links attached to the side brace. The nose gear is locked down by an internal lock ring within the drag brace. A colored indicator protrudes on each gear drag brace showing the locked condition.

### **2.9.2 Landing Gear System Emergency**

**Operation.** In the event of a HYD 1 failure, or a failure of the landing gear to extend normally, the gear may be lowered manually by pulling the EMER GEAR handle. The handle is outboard of the normal gear handle in each cockpit and must be rotated clockwise and pulled approximately six inches to release the gear and door latches. Handle actuation allows the gear to free-fall to the down and locked position regardless of the position of the normal gear handle. When the EMER GEAR handle is pulled and the nose landing gear free falls past the forward doors, electrical power from the 28 VDC Essential Services Bus is supplied to an emergency nose landing gear door actuator. The actuator retracts the nose landing gear forward doors to a near closed position. Prior to applying electrical power on deck, ensure personnel are clear of the NLG forward doors. With the NLG door ground safety pin removed and the EMER GEAR handle not fully stowed the NLG doors will close when electrical power is applied. With the main gear doors open, door damage may result from arresting gear strikes.

### **2.9.3 Landing Gear System Controls and Indicators.**

**2.9.3.1 LDG GEAR Handle.** The LDG GEAR handle is located on the left vertical console. UP With the aircraft weight off all wheels, raises the landing gear. DN Lowers the landing gear.

**2.9.3.2 EMER GEAR Handle.** The EMER GEAR handle is located on the left vertical console. Rotating the handle clockwise and then pulling opens the landing gear doors and extends all the landing gear by gravity.

**2.9.3.3 TONE Button.** The TONE button is located on the landing gear control panel, on the left vertical console. Momentarily pressing the button silences the "GEAR" warning tone.

### **2.9.4 Landing Gear Warning, Caution, and Advisory Lights.**

**2.9.4.1 LDG GEAR Handle Warning Light.** The LDG GEAR handle warning light is located in the LDG GEAR handle and illuminates when:

1. One landing gear differs from the handle position.
2. When one landing gear is not down and locked with the LDG GEAR handle set to DN.
3. When the gear doors are not up and locked with the gear handle up.

**2.9.4.2 WHEELS Warning Light.** The WHEELS warning light is located on the right side of the AOA indexer. The light flashes and the tone pulses when the LDG GEAR handle is not set to DN, the throttle is below 95 percent N2 RPM position and either of the following conditions exists:

1. Altitude is less than 7,200 feetMSL and the airspeed is less than 170 knots (less than 9,500 —feet MSL when climbing or 7,700feet MSL when descending)
- or
2. The FLAPS/SLATS levers are not in the UP position.

### **2.9.4.3 Landing Gear Position Indicator**

**Lights.** The landing gear position lights are located on the landing gear control panel, above the LDG GEAR handle. The lights are green in color and are labeled: NOSE, LEFT, and RIGHT. The light illuminates when the corresponding gear is down and locked.

**2.9.4.4 DOOR Indicator Light.** The DOOR light is located on the landing gear panel, above the landing gear position indicator lights. The light illuminates when the gear doors are not up and locked.

## 2.10 NOSE WHEEL STEERING SYSTEM

The nose wheel steering system is a full time, dual gain system. The system is electrically controlled and hydraulically actuated through the landing gear hydraulics.

- Failure of weight off wheels circuits will prevent NWS activation or operation after landing, with no warning to the pilot.
- If the EMER GEAR handle is not fully stowed, nose wheel steering authority may be diminished.
- If the landing gear is emergency extended, hydraulic pressure will not be supplied to the nose wheel steering and the system will be inoperative.

The system includes a hydraulic motor and an electronic control box mounted on the nose strut.

Cockpit controls and indicators include an advisory light, a caution light, cockpit paddle switches, and cockpit steering button switches.

### 2.10.1 Nose Wheel Steering System

**Operation.** Hydraulic power is provided by the HYD 1 system to the nose wheel steering motor on the nose landing gear strut. Electrical power is supplied from the 28 VDC Essential Services Bus to the nose wheel steering control electronic set. Nose wheel steering is automatically engaged in the low gain mode during initial engine start and automatically disengaged with weight off both main landing gear after takeoff.

During landing, nose wheel steering is automatically reengaged in the low gain mode with weight on one main landing gear and a momentary weight on the nose landing gear. The nose wheel steering will remain engaged with weight on only one main landing gear. In the real aircraft, the steering may also be disengaged by momentarily pressing the nose wheel steering button on the control stick.

*NOTE: In Flight Simulator X the NWS is completely automatic, also low gain and high gain modes are not implemented. NWS HI will light whenever the steer angle is above 30 degrees.*

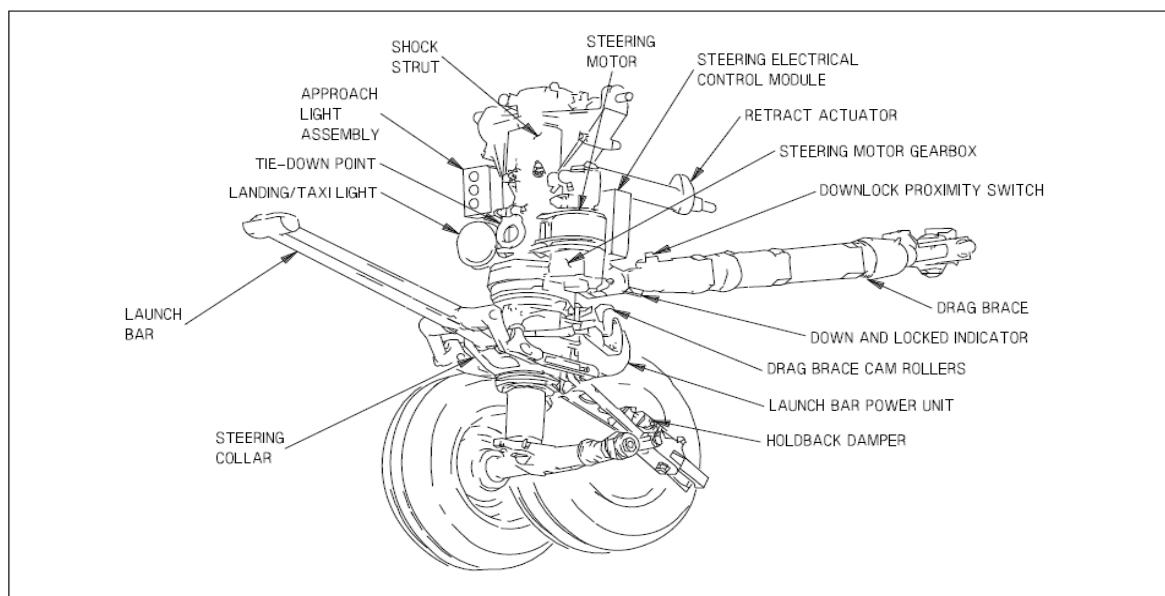
With the LAUNCH BAR switch set to EXTEND, nose wheel steering is disengaged.

After takeoff, when the nose landing gear strut extends, the nose gear is mechanically driven to center by a centering cam. No landing gear will retract until the nose gear is centered. Steering via the rudder pedal is disabled any time the aircraft is airborne.

### 2.10.2 Nose Wheel Steering System Controls and Indicators.

**2.10.2.1 Nose Wheel Steering Button.** The nose wheel steering button is located on the front side of the stick grip. This button has no function in Flight Simulator X.

**2.10.2.2 Paddle Switch.** The paddle switch is located at the base of the forward and aft cockpit control stick grips. This button has no function in Flight Simulator X.



**Nose Landing Gear and Launch Bar**

## 2.11 WHEEL BRAKES/ANTI-SKID SYSTEM

The wheel brakes are powered by a conventional hydro-mechanical system. Pilot brake input is accomplished via rudder pedal mounted hydraulic master cylinders. The braking system incorporates a fully modulated adaptive type antiskid system, with touchdown protection, to achieve maximum braking efficiency. Braking priority goes to the cockpit with the greatest brake pressure applied.

**2.11.1 Normal Brake Operation.** With antiskid inactive, normal braking is obtained from either cockpit by pressing the top of the rudder pedals. When a rudder pedal tip is pressed, it repositions a brake control valve in proportion to tip deflection. HYD 1 pressure is applied through a check valve and a filter to the brake control valve. The check valve maintains hydraulic pressure in the wheel brake/emergency flap accumulator for ground servicing and emergency braking in the event of HYD 1 failure. Hydraulic pressure passes through the anti-skid valve and the wheel brake hydraulic fuse to the wheel brake cylinders. The wheel brake fuse (fluid quantity limiter) is designed to pass a predetermined quantity of hydraulic fluid to the wheel brake cylinders. Each fuse provides dual flow lines for normal operation. A bypass valve and check valves are provided to allow continued operation of one brake line in the event a failure occurs in the other line. The pressure moves each piston against a pressure plate. This causes the brake linings of stationary brake disks to be forced against the surfaces of disks which are rotating with the wheels. The resulting friction supplies the braking force. When the rudder pedal is released, the brake control valve releases pressure from the brake cylinders, allowing the pressure to be ported into the HYD 1 return line.

The de-spin actuator interfaces with the brake control valve and the parking brake lever to stop wheel rotation after takeoff. When the landing gear is retracted, landing gear door open pressure is applied to the de-spin cylinder, which in turn, applies force to the parking brake lever to actuate the brake control valve. As soon as the door closed pressure is applied, the de-spin cylinder retracts and releases the brake pressure.

The outer half of each main landing gear wheel has three fusible plugs designed to prevent personnel injury and aircraft damage due to the heat and pressure buildup following excessive braking. The plugs release nitrogen pressure from the tire when the temperature reaches

324 °F or above.

**2.11.2 Emergency Brake Operation.** With a HYD 1 system loss, a priority valve disables emergency flap operation from the wheel brake/emergency flap accumulator at 2,200 psi. Due to the nitrogen preload of 1,300 psi, no fluid remains for brake operation when the accumulator pressure reads 1,300 psi. Pumping the brakes rapidly will deplete accumulator pressure; a smooth steady application is recommended. The system will provide a minimum of 10 full applications of the brakes before being fully depleted.

**2.11.3 Anti-Skid System.** The wheel brakes are equipped with an electrically controlled antiskid system. Use of anti-skid minimizes tire skid damage, and stopping distances are reduced under all runway surface conditions.

The system consists of a control unit, a wheel speed sensor on each main wheel, and a dual anti-skid/shutoff valve. Cockpit controls and indicators include an anti-skid switch located on the left console and the SKID caution and advisory lights in both cockpits.

*NOTE: Anti-Skid system is not functional in this Flight Simulator X rendition, and the switch has no function, although the advisory light turns on properly.*

**2.11.4 Parking Brake System.** A parking brake is provided on the forward cockpit right vertical console. The parking brake is engaged by pulling the PARKING BRAKE handle until fully extended and rotating it clockwise. After the parking brake is set, the PK BRK caution light will illuminate if the throttle is advanced beyond the intermediate position. The parking brake can be used in an emergency, but braking pressure rapidly goes to maximum with very little movement.

### NOTE

Applying the parking brake with antiskid energized and the engine not running will eventually deplete brake accumulator pressure due to anti-skid valve leakage.

## 2.12 LAUNCH BAR SYSTEM

The launch bar system consists of the launch bar, redundant launch bar drive linkage systems, power unit assembly, launch bar proximity switch, and retract cam roller assembly. The power unit assembly interfaces with the nose landing gear weight-on-wheels switch, gear



position switch, and a steering position indicator switch.

The bar is mounted on the forward side of the steering collar and is connected through a linkage system to the power unit mounted on the aft side of the steering collar. The bar has three positions: taxi (retracted position), launch (deck position), and stowed (gear retracted). In the launch position, the bar transmits launch loads from the catapult shuttle to the aircraft structure.

### **2.12.1 Launch Bar Operation.**

The position of the launch bar is controlled by the LAUNCH BAR switch on the left vertical console panel outboard of the LDG GEAR handle. There are two launch bar indicator lights on the main instrument panel, outboard of the marker beacon lights. A green L BAR light indicates the launch bar is extended with the switch set to EXTEND, and a red L BAR light indicates the launch bar is not retracted when airborne and the gear is down and locked. After a 10 second delay following launch, if the launch bar fails to retract the red L BAR light annunciate the malfunctions condition.

*NOTE: The launch bar will not retract automatically in this Flight Simulator X rendition, and should be retracted manually once the airborne. It is not possible to retract the landing gear if the launch bar is extended.*

### **2.12.2 Launch Bar System Controls and Indicators.**

**2.12.2.1 LAUNCH BAR Switch.** The LAUNCH BAR switch is a two position switch, spring loaded to the RETRACT position and magnetically held in the EXTEND position with weight-on-wheels. It is located on the left vertical console panel outboard of the LDG GEAR handle.

RETRACT Retracts the launch bar.

EXTEND Extends the launch bar.

### **2.12.3 Launch Bar System Warning, Caution, and Advisory Lights.**

**2.12.3.1 L BAR Warning Light.** The red L BAR warning light is located on the instrument panel, outboard of the marker beacon lights. The light comes on when the launch bar is not retracted, all landing gear is down and locked and weight is off wheels for ten seconds.

**2.12.3.2 L BAR Advisory Light.** The green L BAR advisory light is located below the red L BAR warning light. The light illuminates when the launch bar is extended with the switch set to EXTEND.

When the launch bar is extended and the aircraft is on the ground and the engine RPM is above 95% the LBAR light turns off to achieve a "no light" launch condition.

### **2.13 ARRESTING HOOK SYSTEM**

The arresting hook system consists of the hook shank, pivot assembly, replaceable hook point, hydraulic actuator/damper, manual up latch assembly, hydraulic selector valve, compensator/check valve, arresting HOOK handles and HOOK warning light. The pivot assembly allows both vertical and lateral movement of the arresting hook. The actuator/damper is a piston assembly with HYD 1 pressure on one side, nitrogen preload pressure of 950 +/- 50 psi at 70 °F on the other side, and a relief valve assembly in the middle to control the movement of the piston. The manual up latch assembly mechanically locks the arresting hook in the up position, and prevents the hook from extending when hydraulic pressure is removed from the actuator/damper during a hydraulic failure or engine shut down. Two arresting hook bumpers are located on the lower surface of the tail. The bumpers protect the lower tail surfaces and tail pipe from possible damage from arresting hook slap should the hook slip off the cable during arrestment.

Cockpit controls and indicators include an arresting HOOK handle and a red HOOK warning light in both cockpits. An electrical sensing switch located in the forward cockpit HOOK handle illuminates the red HOOK warning light in both cockpits when the HOOK handle does not correspond to the actual hook position.

**2.13.1 Arresting Hook Operation.** The arresting hook is operated by moving the HOOK handle in either cockpit. The handles are mechanically connected. Lowering either handle pulls a control cable that releases the manual up latch assembly and switches a hydraulic selector valve to remove HYD 1 pressure from the arresting hook actuator/damper. This allows the hook to gravity free fall, assisted by the nitrogen snubber pressure in the actuator/damper. The HOOK warning light illuminates for approximately 1.5 seconds while the hook is in transit and extinguishes when the hook reaches the full down position. With the hook extended, lateral hook movement is dampened by a centering

spring/damper in the hook shank, and vertical hook motion is dampened by the actuator/damper.

The hook is retracted by moving either arresting HOOK handle to the up position. The control cable then switches the hydraulic selector valve to allow positive hydraulic pressure to flow to the actuator/damper forcing the hook to retract to the up/latched position.

The arresting hook system employs a fail-safe feature which allows the hook to be extended in the event of an uplatch assembly, HYD 1, or control cable malfunction.

### 2.13.2 Arresting Hook Controls and Indicators.

**2.13.2.1 HOOK Handle.** The HOOK handle is located on the right vertical console panel. Up Retracts the arresting hook.  
Down Extends the arresting hook.

### 2.13.3 Arresting Hook Warning, Caution, and Advisory Lights.

**2.13.3.1 HOOK Warning Light.** The HOOK warning light is located on the warning/caution/advisory light panel. The light comes on when the hook position does not agree with the handle position.

## 2.14 BOARDING SYSTEM

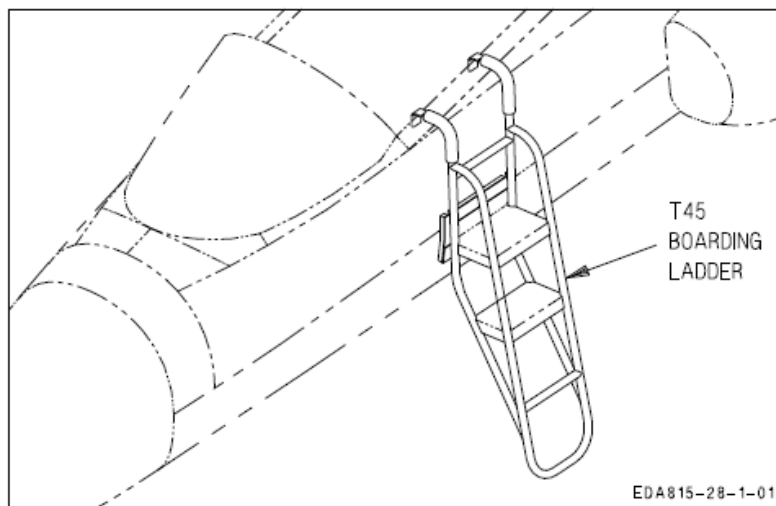
The T-45C aircraft boarding ladder or aircraft boarding system is used to board the aircraft. The aircraft boarding system consists of a retractable footstep, a toe-in step, two pull-out footsteps, and a nonskid footstep on top of the engine air intake are provided on the left side of the fuselage. Two handholds are provided; one

located on the cross-ship structure between the two cockpits, the other on the left hand side of the aft glareshield.

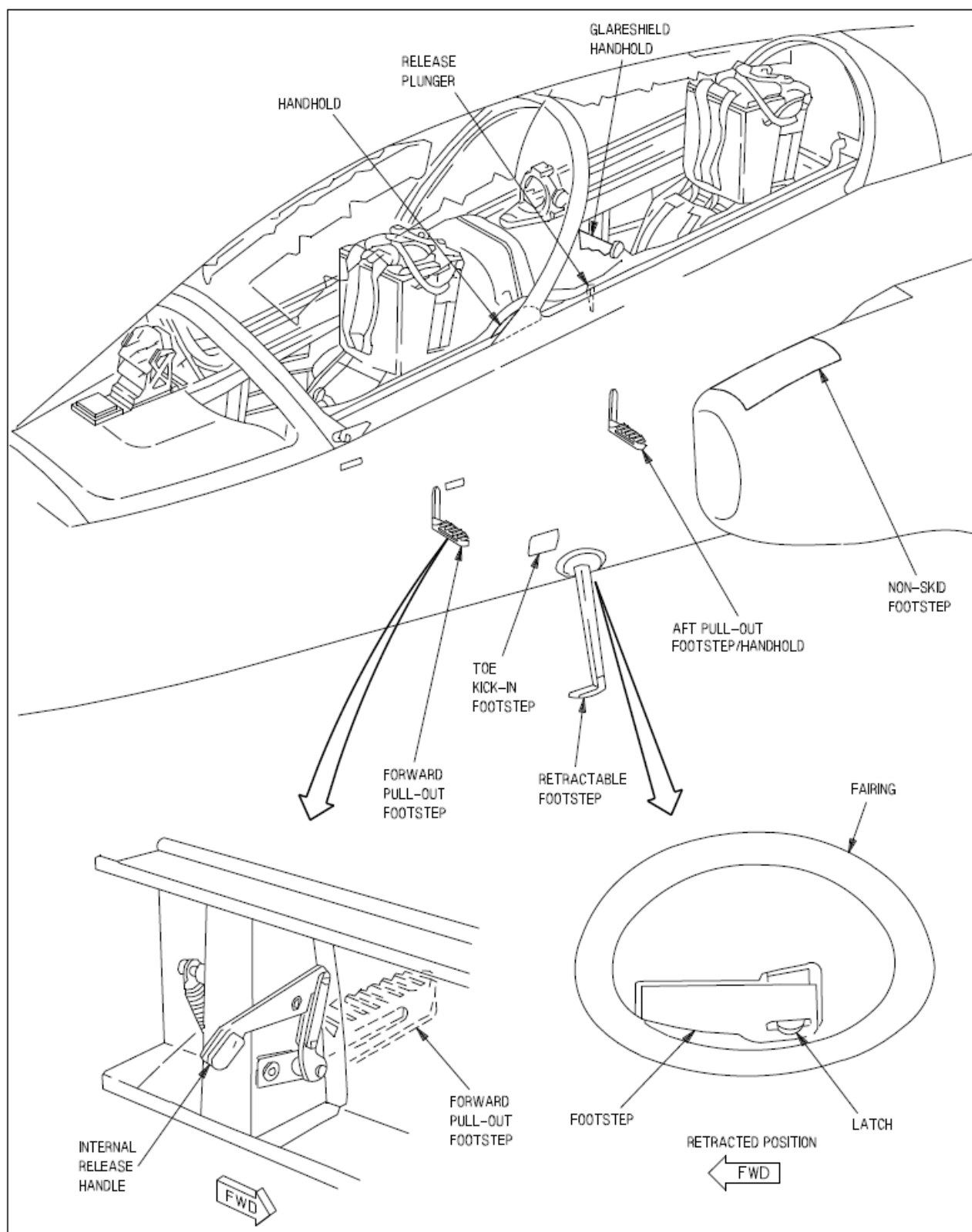
*NOTE: The boarding system has obviously no function in FSX, although it is represented in the exterior model and is activated when the secondary exit opens (SHIFT+E followed by 2).*

**2.14.1 Boarding System Operation.** The retractable footstep can only be lowered from outside the cockpit by moving the latch outboard and pulling the step down to its full extended position. With the canopy open, the footstep is locked at its full extended position and it will be automatically retracted when the canopy is closed. With the canopy closed, it is not possible to lock the footstep down. To retract the footstep with canopy open, the release plunger must be pressed manually. A spring catch on the footstep engages with a latch on the fuselage structure to prevent the footstep from extending in flight. The toe-in step, which is a backplate with a door hinged along the upper edge and spring loaded to the closed position, is located above the retractable footstep. Two pull-out footsteps, located above the toe-in step, are used for entrance/exit to/from the cockpits.

The forward footstep is used for the forward cockpit; the aft footstep is used for the aft cockpit. In addition, the aft footstep is also used as a hand hold. The forward footstep is operated either from inside the cockpit by internal release handle mounted on the left fuselage structure, or from outside of the cockpit by finger grips. The aft footstep can only be deployed or stowed from outside of the cockpit. Overcenter springs firmly keep the footsteps either in the retracted or extended positions.



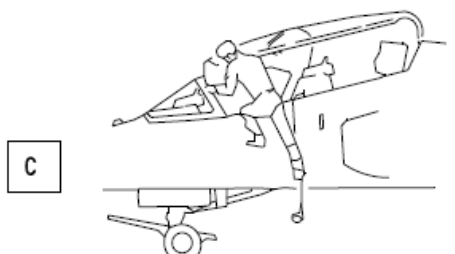
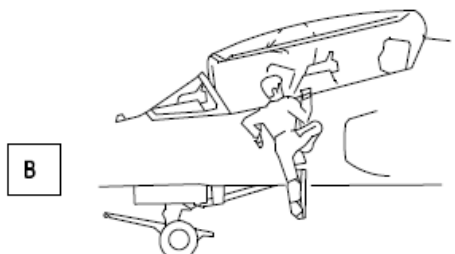
**T-45C Aircraft Boarding Ladder**



**Footsteps**

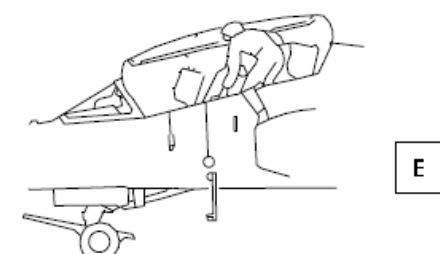
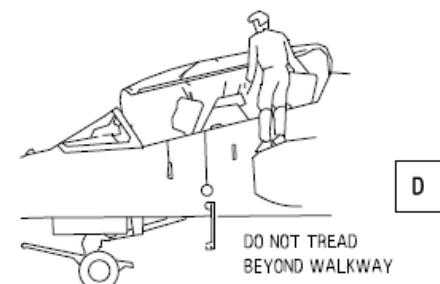
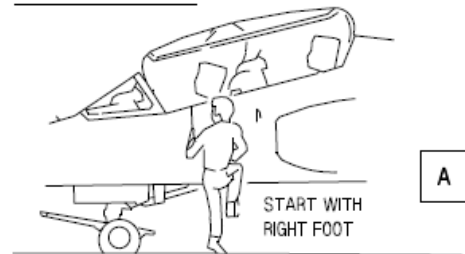
EDA815-29-1-001

## FORWARD COCKPIT



**NOTE:**  
WHEN LEAVING  
START WITH  
LEFT FOOT  
REVERSING THE  
INGRESS  
PROCEDURE.

## AFT COCKPIT



## Cockpits Entrance/Exit

## 2.15 CANOPY SYSTEM

The cockpit enclosure consists of a forward windscreen and a one-piece canopy. When the canopy is closed the cockpit is divided into forward and aft sections by an integral windscreen.

When closed and locked, the canopy provides a pressurized enclosure to ensure proper environmental conditions during flight. The sideways opening canopy operates about four hinges on its right side. The canopy is manually operated and its weight is counterbalanced by a torsion bar system. A combined pneumatic damper/locking strut controls the rate at which the canopy can be opened or closed and enables the canopy to be locked in the open position. The damper/locking strut, which can secure the canopy in any desired position is controlled by the canopy operating levers. The strut is located in the forward cockpit and is secured to the cockpit floor.

**2.15.1 Canopy Operation.** The interconnected internal canopy control lever is located on the left canopy rail in both cockpits. The lever is spring-loaded to the forward position. The canopy is locked when the lever is fully forward and unlocked when the lever is moved aft. A thumb operated spring-loaded safety catch prevents inadvertent movement of the levers from the canopy locked position. The safety catch is interconnected with the external/unlock handle.

When either the forward or aft safety catch is pressed outboard, both levers are free to move. When opening or closing the canopy in wind exceeding 20 knots, it is recommended that the nose of the aircraft be pointed into the wind if at all possible. Difficulty in opening/closing the canopy increases in high wind conditions. Outside assistance would be helpful, if not required, during these conditions. The canopy should not be operated, or allowed to remain open, in side winds exceeding 45 knots.

A lock/unlock external handle, labeled PRESS & TURN, is located on the forward left side of the canopy. When the push-button on the handle is pressed, the safety catch in the cockpit moves outboard to free the canopy internal operating lever and to permit the handle to be turned clockwise to its limit, thus unlocking the canopy and allowing it to partially open. The canopy can then be manually positioned provided that the handle is held at its clockwise limit. The canopy is held in the selected position when the handle is released.

To prevent injury to personnel or damage to the damper/locking strut and possible canopy collapse, canopy shall be full open prior to entering cockpit. The canopy is closed from outside the cockpit by pressing the push-button on the external handle and rotating the handle fully clockwise, pulling the canopy down, then releasing the handle to engage the canopy locks.

**2.15.2 Mild Detonating Cord.** A mild detonating cord (MDC) system is installed on the canopy. The MDC is a linear explosive charge, which when activated, shatters the canopy. The forward and aft sections of the canopy each have a separate, patterned MDC circuit which is bonded to the canopy in a continuous run around the periphery and over the inner top surface. The MDC system is automatically activated by seat ejection or manually activated by pulling the MDC firing handle in either cockpit. During seat ejection, the MDC circuit is individually detonated by the ballistic signal transmission system of the appropriate ejection seat.

*NOTE: The MDC is not functional in Flight Simulator X.*

### 2.15.3 Canopy Controls and Indicators.

**2.15.3.1 Canopy Control Lever.** The canopy control lever is located on the left canopy rail. Full forward Engages the canopy lock and safety catch to close and lock the canopy. Full aft Allows the canopy to be manually positioned.

**2.15.3.2 Canopy External Handle.** The canopy external handle is located on the left forward side of the canopy. The handle contains a lock and a push-button to disengage the lock. When the push-button is pressed, the handle can be rotated clockwise to disengage the safety catch and open the canopy.

This handle has no function and it is not accessible in Flight Simulator X, but it is represented in the graphic model and will operate automatically on canopy opening/closing commands.

**2.15.3.3 MDC Firing Handle.** The MDC firing handle is located on the right canopy rail in both cockpits. Pulling either handle will shatter the canopy in both cockpits. The handle travels approximately 4 inches when pulled. Only the last inch initiates firing. This handle has no function in Flight Simulator X.

## 2.16 EJECTION SEAT SYSTEM

The aircraft is equipped with the Martin Baker NACES. The SJU-17(V)5/A seat is installed in the forward cockpit and the SJU-17(V)6/A seat is installed in the aft cockpit.

*NOTE: The ejection seat system has no function in this Flight Simulator X rendition. The only switch that can be operated is the ARM switch that toggles the proper advisory light. The information in this section is given for educational purposes only.*

The seats consists of five main assemblies:

1. Catapult
2. Main beams
3. Seat bucket
4. Parachute
5. Survival kit.

The catapult assembly secures the seat to the aircraft structure and provides the initial power for ejection.

The main beam assembly consists of the following:

1. Left and right main beams
2. Upper and lower crossbeams
3. Shoulder harness retraction unit
4. Parachute deployment rocket
5. Electronic sequencer
6. Barostatic release unit
7. Drogue deployment catapult
8. Rocket initiators
9. Pitot assemblies
10. Ballistic manifolds
11. Thermal batteries.

The seat bucket assembly includes:

1. Rocket motor
2. Leg restraint system
3. Ejection handle
4. SAFE/ARMED handle
5. Emergency restraint release
6. Shoulder harness lock lever
7. Inertial reel
8. Seat height adjustment switch
9. Trombone tubes
10. Pin puller
11. Lower harness release.

The parachute assembly includes:

1. Parachute and ribbon drogue inside the headbox
2. Headpad
3. Parachute risers and retention straps
4. Harness release fittings and SEAWARS.

The seat survival kit includes:

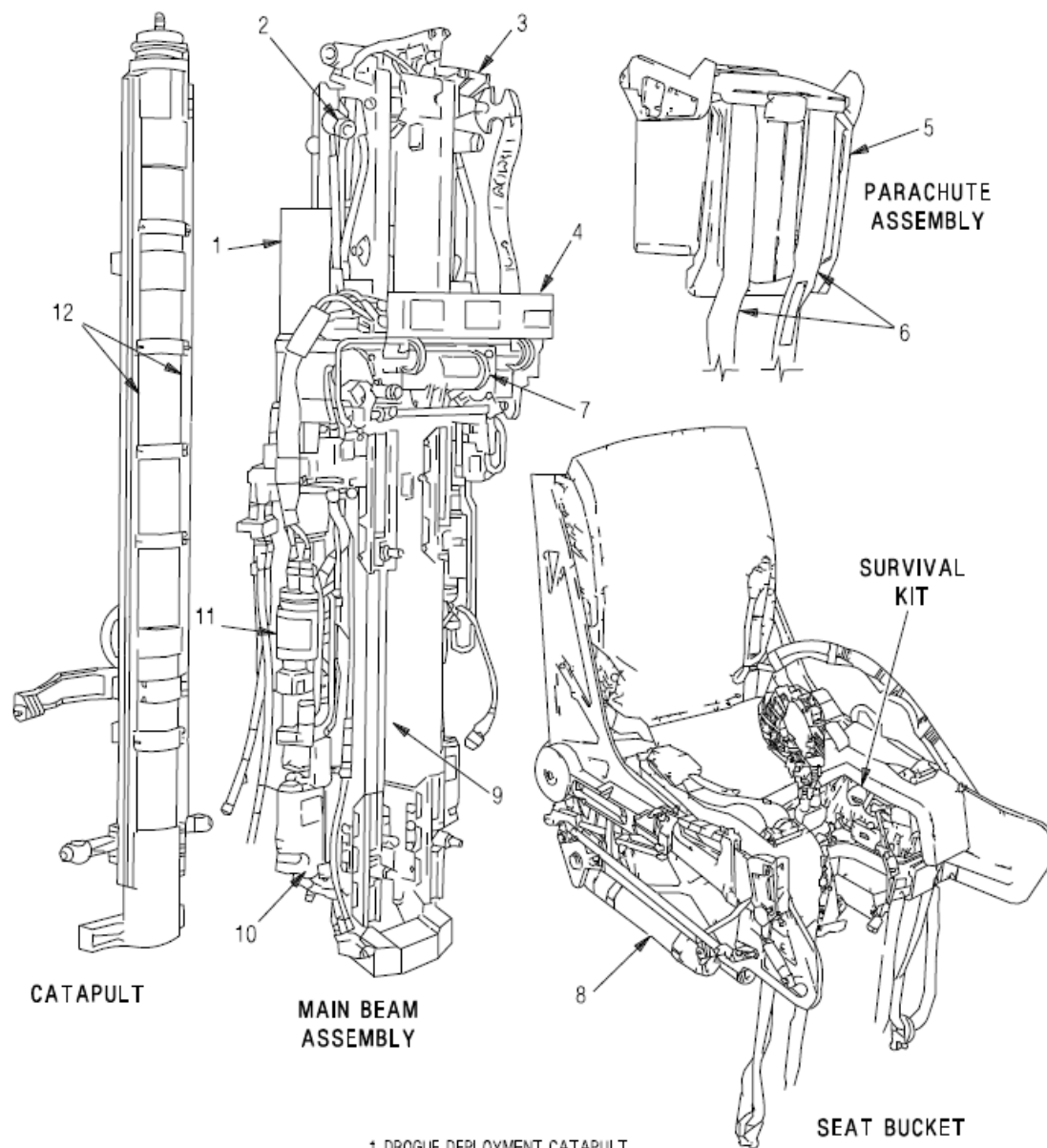
1. Emergency oxygen system
2. Life raft
3. Survival aids
4. Lap belt and release fittings.

The seats provide ejection capability at zero airspeed, zero altitude, and throughout the flight envelope. The seats are cartridge operated, rocket assisted, and incorporate fully automatic electronic sequencing.

Ejection is initiated by pulling the seat ejection handle located on the forward center of the seat bucket. The parachute container incorporates two canopy breakers which allow ejection through the canopy if the canopy fracturing system fails. Each seat is ejected by gas pressure developed within a telescopic catapult when the cartridges are fired. A rocket motor, located under the seat bucket, is fired at the end of the catapult stroke to sustain catapult thrust and propel the seat to an altitude sufficient for parachute deployment even when ejection is initiated at zero airspeed and zero altitude in a nearly level attitude. Timing of all events after rocket motor initiation is controlled by an on-board electronic sequencer which utilizes altitude and airspeed information to select the correct mode of operation. Should there be a total or partial failure of the electronic sequencer a barostatic release unit activates the parachute and emergency restraint release.

There are two differences between the forward and aft seats. The forward seat has a 0.5 second delay initiator (as backup for 0.4 second interseat sequencing system delay) incorporated in the seat firing circuit.

There is a ballistic gas line disconnect assembly at shoulder height on the right side of each seat. The forward seat has two gas lines entering the assembly from the bottom (again for the 0.5 second delay and interseat sequencing system) while the aft seat has only one.



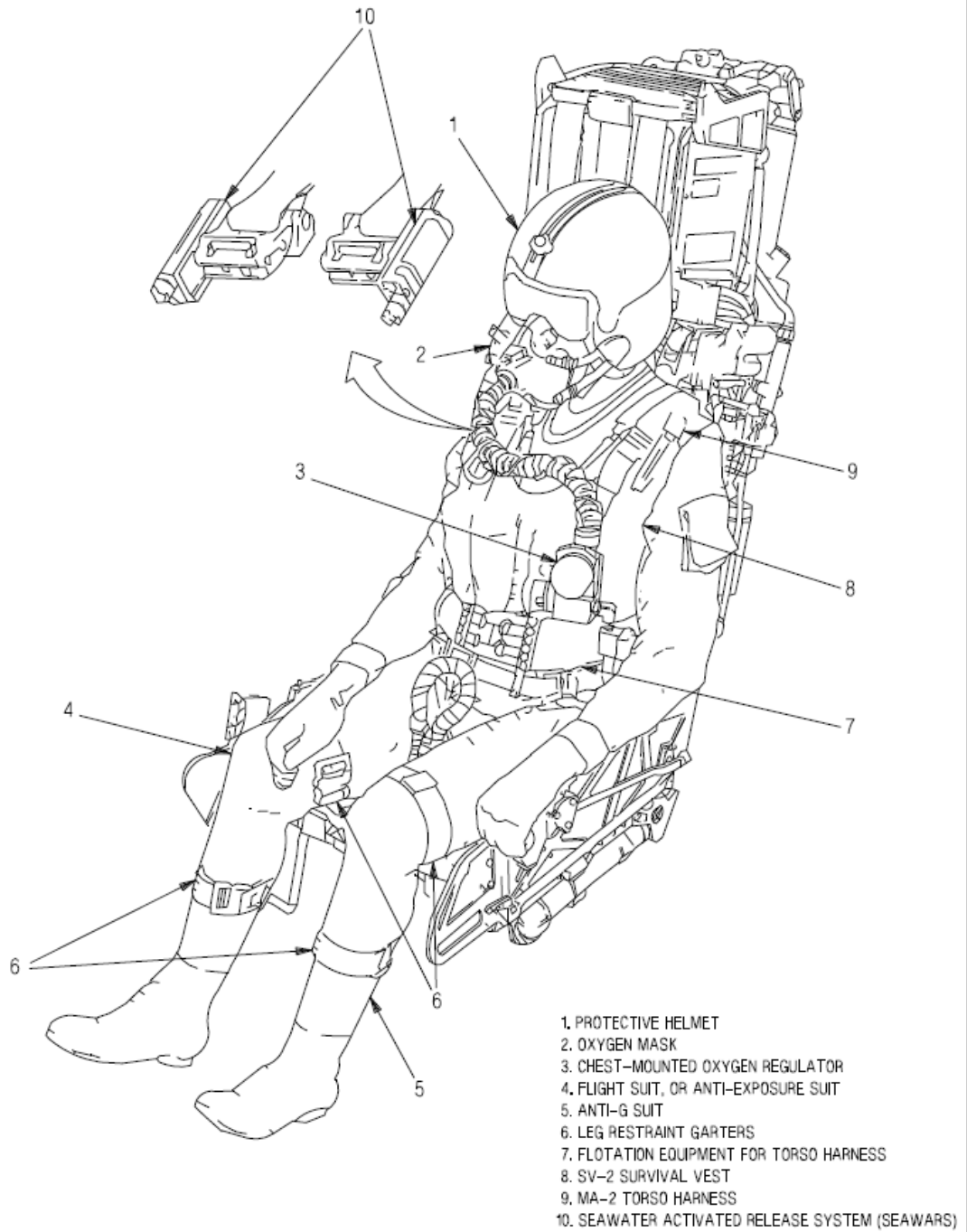
1. DROGUE DEPLOYMENT CATAPULT
2. PITOT HEAD
3. PARACHUTE DEPLOYMENT ROCKET STIRRUP
4. ELECTRONIC SEQUENCER
5. PARACHUTE CONTAINER
6. PARACHUTE RISERS
7. HARNESS RETRACTION UNIT
8. ROCKET MOTOR
9. MAIN BEAM STRUCTURE
10. START SWITCH, ROCKET INITIATOR  
AND LOWER BRIDLE RELEASE UNIT (2)
11. BAROSTATIC RELEASE UNIT
12. GUIDE RAILS

## Ejection Seat - Main Assemblies

EDA815-31-1-01



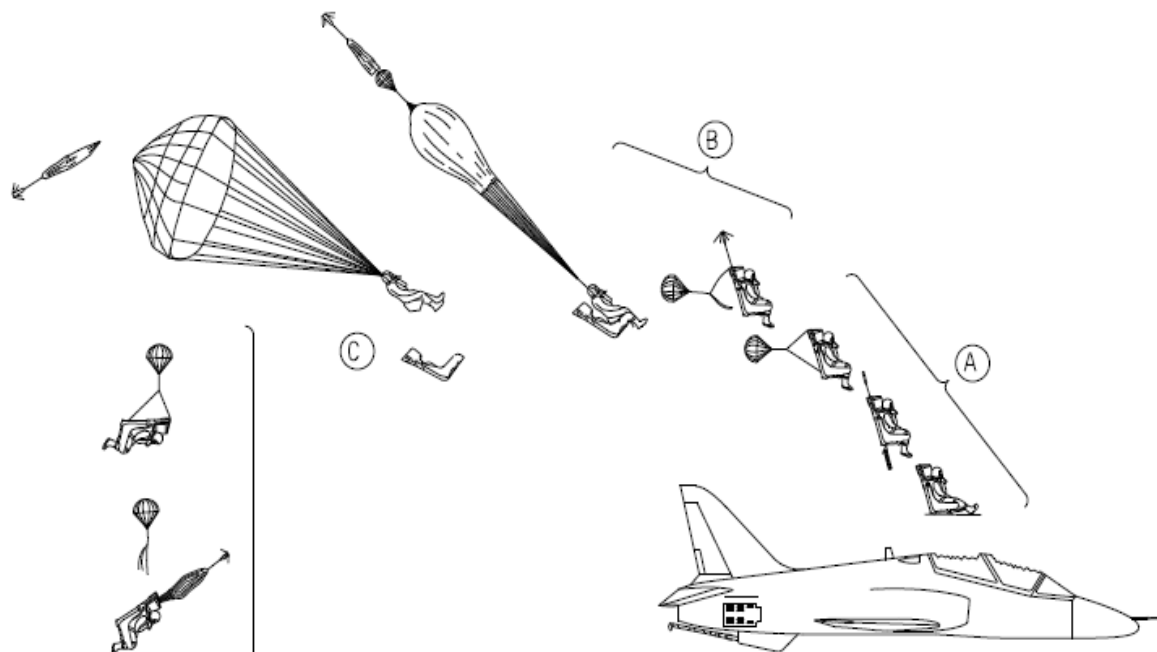
# SJU-17(V)5/A AND SJU-17(V)6/A NACES



EOA615-32-1-01

## Pilot's Equipment





#### ALL EJECTION SEQUENCES

- After pulling the ejection control handle, the IFF is actuated, the inertial reel positions the occupant, and the canopy fractures.

A Catapult fires and seat is propelled up guide rail. Occupant's legs are restrained. Emergency oxygen and radio beacon are actuated. The rocket pack fires near the end of the catapult stroke. Drogue catapult fires. Drogue is deployed to stabilize and decelerate seat.

#### LOW/MEDIUM ALTITUDE SEQUENCE (Below 18,000 feet MSL)

- B Drogue releases from seat. Parachute deployment rocket fires to extract and deploy main parachute. Harness and leg restraint lines released. Drogue release and parachute deployment time are dependent on airspeed and altitude.
- C The opening shock of the parachute separates occupant from the seat allowing normal descent.

#### HIGH ALTITUDE SEQUENCE (Above 18,000 feet MSL)

- D Drogue remains connected to seat until below 18,000 feet MSL, where drogue release, parachute deployment, harness and leg restraint release occurs.
- E The opening shock of the parachute separates occupant from the seat allowing normal descent.

#### WARNING

If high terrain is not a factor, do not use manual seat/man separation until below 14,000 feet MSL.

## **2.17 FIRE DETECTION AND OVERHEAT INDICATING SYSTEM**

The fire detection and overheat indicating system detects and gives warning of fire or overheating in the engine bay, the GTS bay, and of overheating in the tailpipe bay. A fireproof bulkhead separates the engine bay from the tailpipe bay. A FIRE warning light is on the upper right instrument panel of each cockpit.

## **2.18 ENVIRONMENTAL CONTROL SYSTEM**

The environmental control system (ECS) consists of the air conditioning system, the cockpit pressurization system, and avionic equipment cooling system. Air for the cockpit air conditioning and pressurization system is tapped from a port on the final (fifth) stage of the engine compressor. This bleed air is used solely for the environmental control system (temperature control, cockpit pressurization, ram air control, canopy seal, and heat exchanger inducers). Conditioned air is used to cool avionics equipment prior to being vented overboard.

*NOTE: The ECS has no function in Flight Simulator X.*

## **19 ON-BOARD OXYGEN GENERATING SYSTEM**

The OBOGS provides a continuously available supply of breathing air for the crew while the aircraft engine is operating. The OBOGS system consists of the bleed air shutoff valve, heat exchanger, concentrator, solid state oxygen monitor (SSOM), and chest mounted regulator.

*NOTE: The ECS has no function in Flight Simulator X.*

## **2.20 FLIGHT INSTRUMENTS**

**2.20.1 Pitot Static System.** The standby pitotstatic instruments are driven from a heated, aerodynamically compensated pitot-static probe mounted on the nose of the aircraft. This source drives the standby barometric altimeter, standby Mach/ airspeed indicator, standby vertical speed indicator, SADS, and other miscellaneous equipment. This information is then provided by the SADS to the DEU. The DEU will in turn use the information for the displays and provide it to the ADR via the mux bus.

**2.20.1.1 PITOT HEAT Switch.** The PITOT HEAT switch is a two position toggle switch located on right side of the main instrument panel.

HEAT Probe heater is on. 28VDC Essential Services Bus power is provided to heat the probe.

**2.20.2 Standby Barometric Altimeter.** The standby barometric altimeter is a counter drum pointer type. The counter drum indicates altitude in thousands of feet from 00 to 99. The long pointer indicates altitude in 50 foot increments with one full revolution each 1,000 feet. A knob and window permit setting the altimeter to the desired barometric pressure setting.

**2.20.3 Standby Airspeed Indicator.** The standby airspeed indicator displays airspeed from 60 to 850 knots indicated airspeed. It operates directly off the pitot/static system.

**2.20.4 Standby Vertical Speed Indicator.** The AVU-29/A vertical speed indicator senses rates of change in the static atmospheric pressure to give a visual presentation of ascent or descent from 0 to 6,000 feet per minute.

**2.20.5 Standby Attitude Indicator.** The standby attitude indicator is a self-contained electrically driven gyro-horizon type instrument. The gyro is powered by the 28VDC Essential Services Bus. The gyro cages to 0 degrees pitch and roll regardless of aircraft attitude. Power should be applied for at least 1 minute before caging. The indicator displays roll through 360 degrees. The caging knob on the lower right hand corner, besides being pulled for caging, is used to adjust the pitch of the miniature aircraft.

**2.20.6 Standby Turn and Slip Indicator.** The turn and slip indicator contains a scale, turn pointer, power warning flag and inclinometer ball.

**2.20.7 Standby Magnetic Compass.** The AQU-14/A standby magnetic compass is a conventional, self contained unit mounted on the canopy bow.

**2.20.8 Clock.** A standard eight day clock is installed in each cockpit, next to the takeoff checklist.

## **2.21 ANGLE-OF-ATTACK SYSTEM**

The angle-of-attack (AOA) system consists of an AOA indicator and indexer lights in each cockpit, an AOA transmitter, and a three colored external approach lights assembly. The rudder

pedal shakers and stall warning tone operate at 21.5 units AOA to provide artificial warning of stall AOA.

**2.21.1 AOA System Operation.** The transmitter probe, extending outboard on the left side of the forward fuselage, senses the attitude of the aircraft in relation to the relative wind and transmits the angle of the probe to the ADR, AOA indicators, and the YDC. The ADR then transmits the AOA via the mux bus to the DEU for MFD and HUD display. AOA indexers and approach lights are routed through all three landing gear down proximity switches. When the landing gear is down and locked and the NLG weight-off-wheels, AOA discrete signals are provided from the forward indicator to illuminate the indexer and approach lights. For protection against icing and moisture control, the transmitter probe, and its case are electrically heated with weight-off-wheels. An upper and lower slot on the probe are plumbed to an internal chamber separated by a vane. The vane rotates with the probe to equalize the pressures in the internal chambers and orient the slots equally into the airstream. The resulting probe angle is transmitted to the HUD (via the ADR/DEU) and AOA indicators. The servo driven pointer on the indicator displays aircraft AOA in units and drives the AOA indexer lights as well as the external approach lights. The AOA probe and indicator are powered from the 28 VDC Essential Services Bus.

## **2.21.2 AOA Controls and Indicators.**

**2.21.2.1 AOA Indicator.** The AOA indicator functions throughout the entire flight regime to display AOA information. The indicator registers units of AOA to the relative airstream, from 0 to 30 units. The indicator is set with the optimum unit setting at the 3 o'clock position. Both cockpit AOA indicators independently receive their input from the AOA probe.

**2.21.2.2 AOA Indexer.** The AOA indexer, located on the glareshield in both cockpits, consists of three indexer lights; the upper chevron is green and indicates a high AOA, the center donut (O) is amber and indicates the optimum AOA, and the lower chevron is red and indicates a low AOA. Two intermediate conditions are also indicated by illuminations of the donut with the upper or lower chevron. Dimming control of the indexer lights is achieved by a four position lever mounted next to the lights. Moving

the lever up brightens the lights. The indexer includes press-to-test light capability.

NOT AoA indexer dim and press-to test functions are not implemented in Flight Simulator X.

Both cockpit indexers receive their input from the forward cockpit AOA indicator. The indexers provide the principal reference for controlling airspeed during landing approaches.

### **NOTE**

The lack of AOA indexers and approach lights with the LDG GEAR handle down may indicate one or more landing gear not down and locked.

**2.21.2.3 Approach Lights.** The external approach lights assembly is located on the nose gear strut. The assembly provides the LSO with an indication of AOA and consists of three separate lights covered by red, amber, and green lenses. The corresponding AOA conditions are shown to the LSO as green for too high an AOA, amber for optimum AOA, and red for too low an AOA. The lights are controlled by the AOA system and function when the landing gear is down and locked in flight and extinguish upon landing. The lights are controlled by the HOOK BYP (bypass) switch in the forward cockpit. Placing the switch to CARRIER position causes the lights to flash if the arresting hook is not down. With the switch in FIELD, the lights remain steady regardless of arresting hook position.

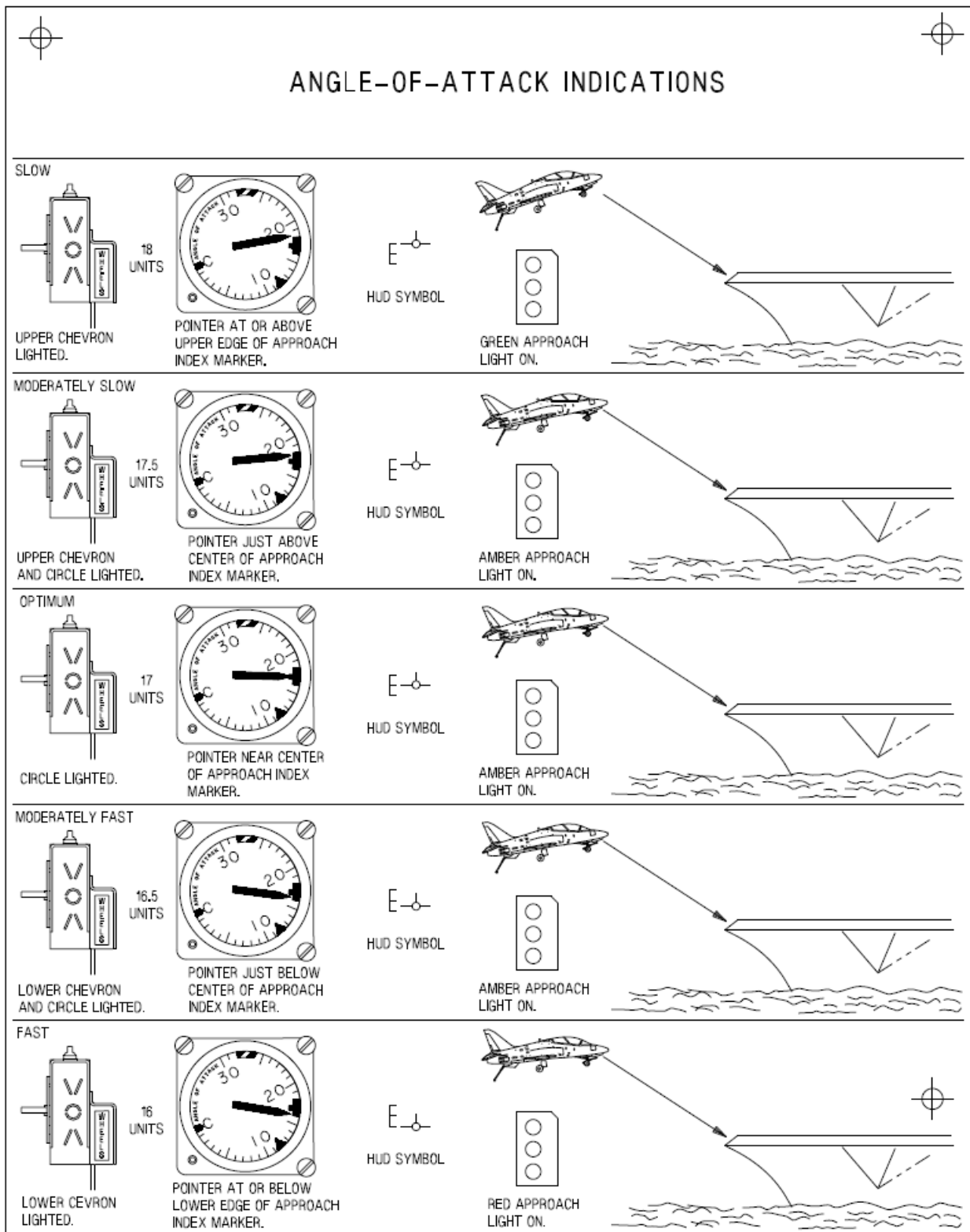
Day or night operation is selected by the PANEL light switch in the forward cockpit. Placing the switch to the OFF position selects day (bright) illumination. With the switch at PANEL, night (dim) illumination is selected.

**2.21.2.4 HOOK BYP Switch.** The two position toggle HOOK BYP switch is located in the front cockpit, on the right side of the main instrument panel. The switch has the following positions:

CARRIER Approach light/AOA indexers flash if the landing gear is down and locked and the arresting hook is not down.

FIELD Approach lights/AOA indexers operate steady regardless of the arresting hook position.

NOTE: HOOK BYP Switch is not operational in this Flight Simulator X rendition.



EDA815-24-1-01

### AOA System Indications

**NOTE:** The image above shows the correct Angle of Attack indication for the real plane. Angle of attack values in Fight Simulator X may differ substantially from the ones shown in this image.

## 2.22 RADAR ALTIMETER

The radar altimeter (RALT) system consists of a receiver-transmitter, and two antennas.

The RALT employs the pulse radar technique to provide instantaneous AGL information from 0 to 5,000, feet in 10 foot increments, at aircraft attitudes of 40 degree or less angle of bank or pitch. Aircraft height above ground is determined by measuring the elapsed transit time of a radar pulse, which is converted to feet. Audio and visual warnings are activated when the aircraft is at or below the selected low altitude limit (LAW setting). The system provides the radar altitude to the ADR which in turn forwards the altitude to the DEU for display on the MFDs and HUD. The DEU commands the HUD to display radar altitude below the altitude box and MFDs (ADI display) to display the radar altitude below the barometric altitude scale. The letter R will be displayed to the right of the altitude to indicate radar altitude.

will continue to flash after the advisory and tone are rejected as a reminder until either the LAW setting is reset to below the aircraft's altitude, the aircraft climbs above the LAW setting, or the aircraft transitions to weight-on-wheels. Flashing of the LAW setting and option are not affected by the landing gear position.

## 2.23 CENTRALIZED WARNING SYSTEM

The centralized warning system provides visual and aural indications of normal aircraft operation and system malfunctions affecting safe operation of the aircraft. The lights are on various system instruments and control panels in the cockpit. The red warning lights indicate system malfunctions requiring immediate action. Amber caution lights indicate malfunctions requiring attention but not immediate action. After the malfunction has been corrected, warning and caution lights go out. Advisory lights, green or white, indicate safe or normal conditions and supply information for routine purposes.

## 2.24 INTERIOR LIGHTING SYSTEM

The interior lighting system consists of four types of lighting: primary, secondary, emergency, and warning/ caution/advisory.

## 2.25 EXTERIOR LIGHTING SYSTEM

The exterior lights consist of a landing/ taxi light, approach lights, formation lights, navigation lights, anticollision lights.

All external lights, except the approach lights, are controlled by dedicated manual switches located on the exterior lights control panel in the forward cockpit. In addition, an external lights

master switch is provided on the throttle (forward cockpit only) to allow the pilot to select the navigation lights on or off.

**2.25.1 Landing/Taxi Light.** A combination landing and taxi light is located on the nose gear strut. The light is illuminated when the LAND/ TAXI light switch is set to ON and will automatically extinguish when the landing gear are retracted.

**2.25.2 Navigation Lights.** The navigation lights consist of a single light in the leading edge of the left and right wingtips, and a single light on the aft end of the tail cone.

**2.25.3 Formation Lights.** Amber formation lights are installed in each wingtip. The lights are controlled by the formation light switch and the exterior lights master switch.

**2.25.4 Approach Lights.** The external approach lights assembly is located on the nose gear strut. The assembly consists of three separate lights covered by red, amber, and green lenses. The lights are controlled by the AOA system and function when the landing gear is down and locked in flight.

**2.25.5 Anti-collision/Strobe Lights.** The lights consist of two red beacons and a white strobe. The red rotating lights are located on the top of the aft fuselage and on the underside of the fuselage below the aft cockpit. The white strobe light is located on the top of the fuselage aft of the aft cockpit. The lights are controlled by the A-COLL/STROBE switch located on the lower right instrument panel in the forward cockpit. The lower red anticollision light is turned off when the landing gear is down and locked.

## 2.26 BIT SYSTEM.

The BIT mechanization provided within the avionic subsystems/equipment forms the basis for fault isolation. This provides both the pilot and maintenance personnel with the status of the avionic equipment. The BIT system provides the pilot with simple displays of system status without interfering with other essential functions. The DEU displays the subsystems/ equipment BIT results on the MFD BIT display. An avionic BIT (AV BIT) advisory is displayed on all MFDs to indicate a failure has been reported to the DEU and is identified on the BIT display. During simulated failures, the AV BIT advisory will be displayed and the associated

subsystem will report degraded (DEGD) in the opposite cockpit, however, the initiating crew station shall display the correct status. The AV BIT advisory is removed by selecting the BIT display. The advisory will not be redisplayed unless another BIT failure is detected or simulated.

## 2.27 MISCELLANEOUS EQUIPMENT

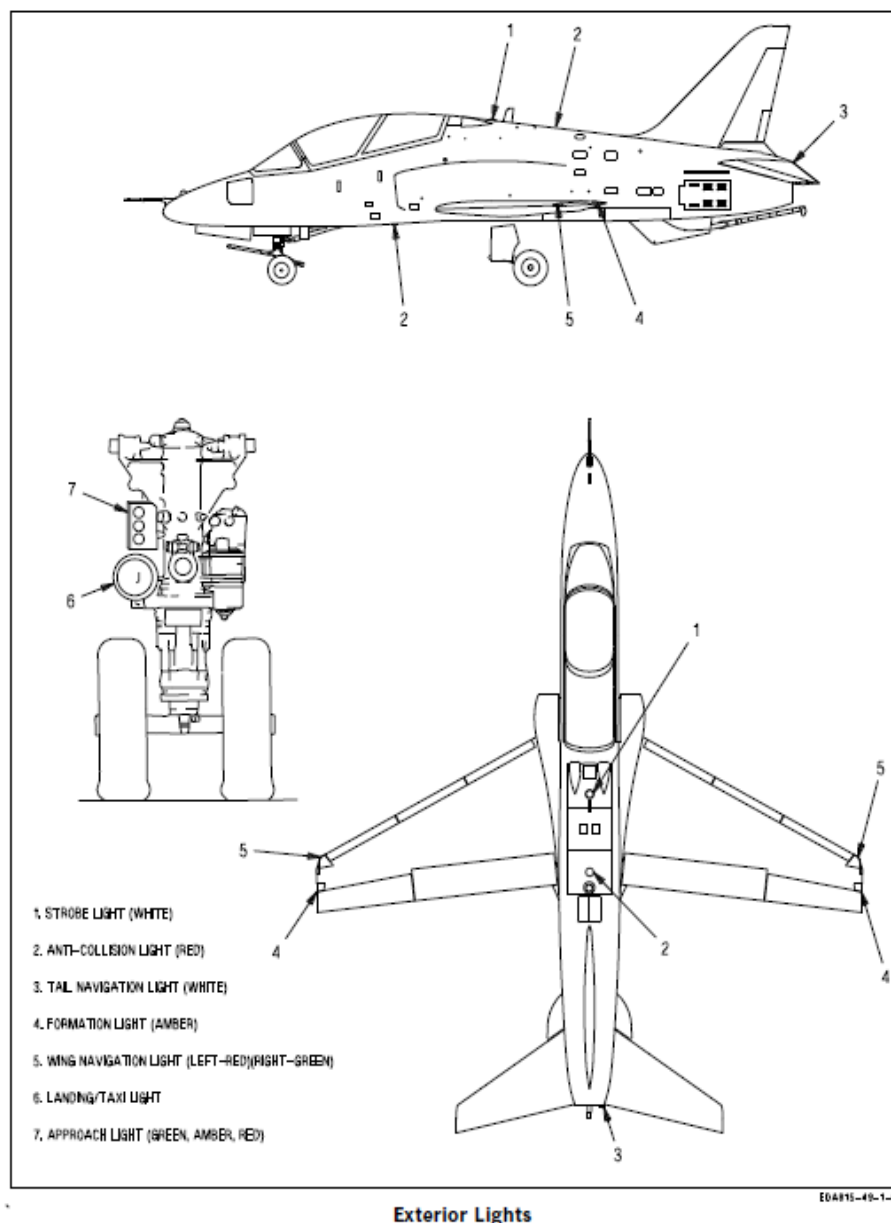
**2.27.1 Map Container.** A stowage pouch for maps is at the aft outboard end of the right console in both cockpits. A stowage pouch for the ejection seat/ canopy safety pins/ streamers is located on the inboard side of each map container.

**2.27.2 Rear View Mirrors.** Each cockpit has a pair of adjustable rear view mirrors, one pair on

the forward canopy arch and the other pair on the aft windscreen arch.

**2.27.3 Instrument Training Hood.** An instrument hood is stored on the aft cockpit glareshield, held in place by two velcro straps. To install the hood release the straps, unfold and attach the two locking stays to the grommets on the peak of the canopy. The stays lock into place with a quarter turn in a clockwise direction. The edges of the hood are held in place with velcro against the sides of canopy, canopy rail and top of glareshield.

**2.27.4 External Baggage Container.** The baggage pod is approximately 10 cubic feet in volume. The pod is for land based use only and can not be jettisoned in flight.

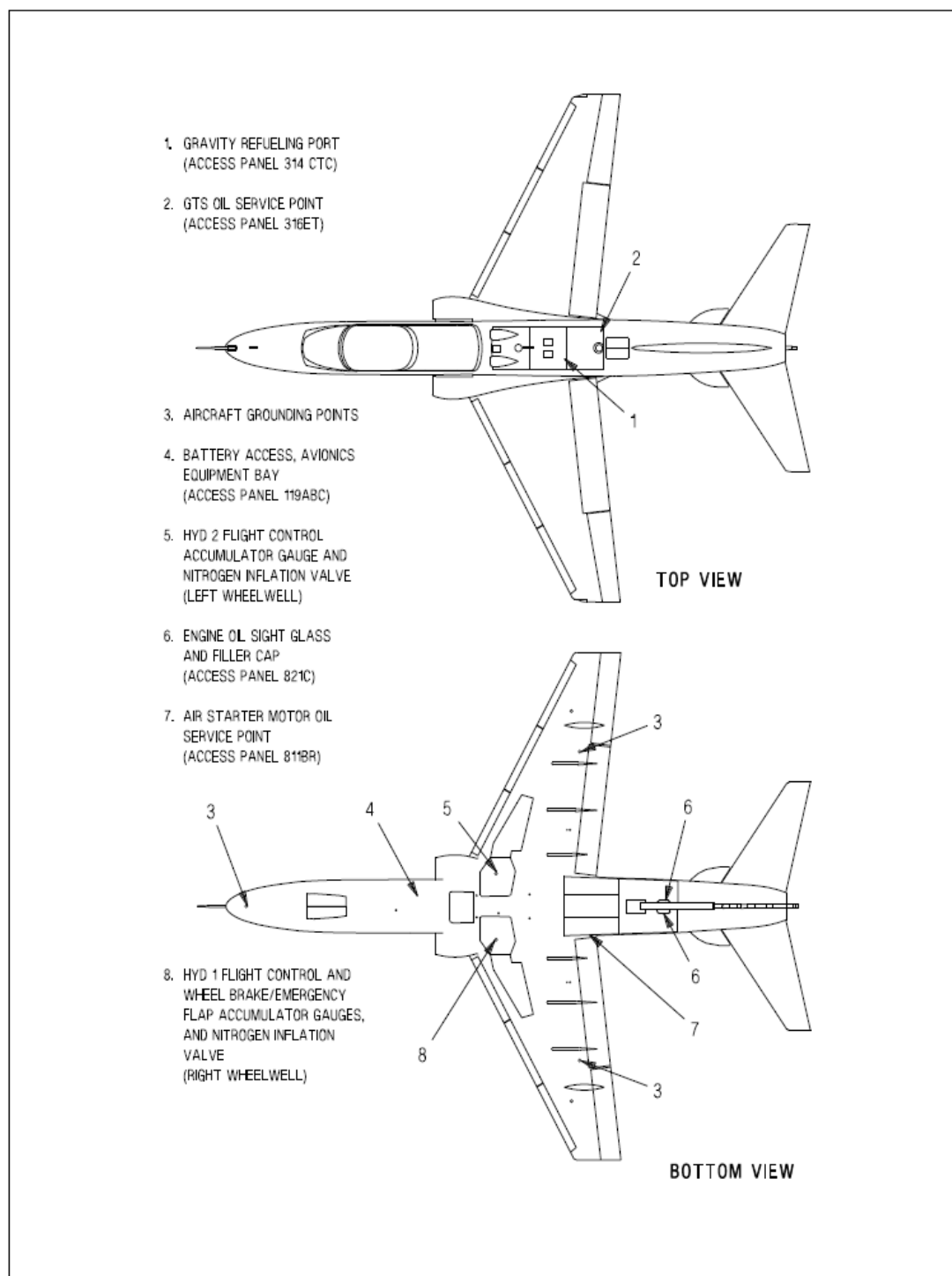


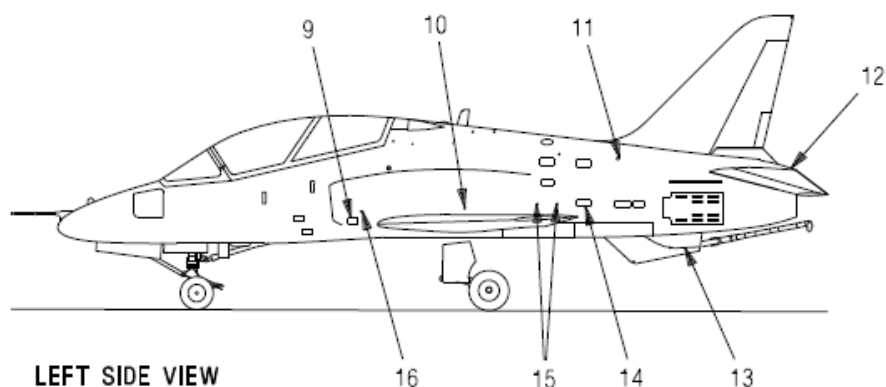
# CHAPTER 3

## Servicing and Handling

### 3.1 GENERAL

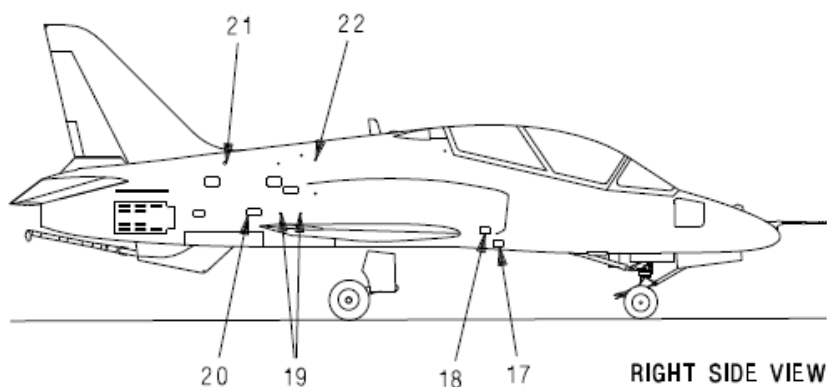
Servicing information is presented for educational purposes only and has no function in Flight Simulator X.





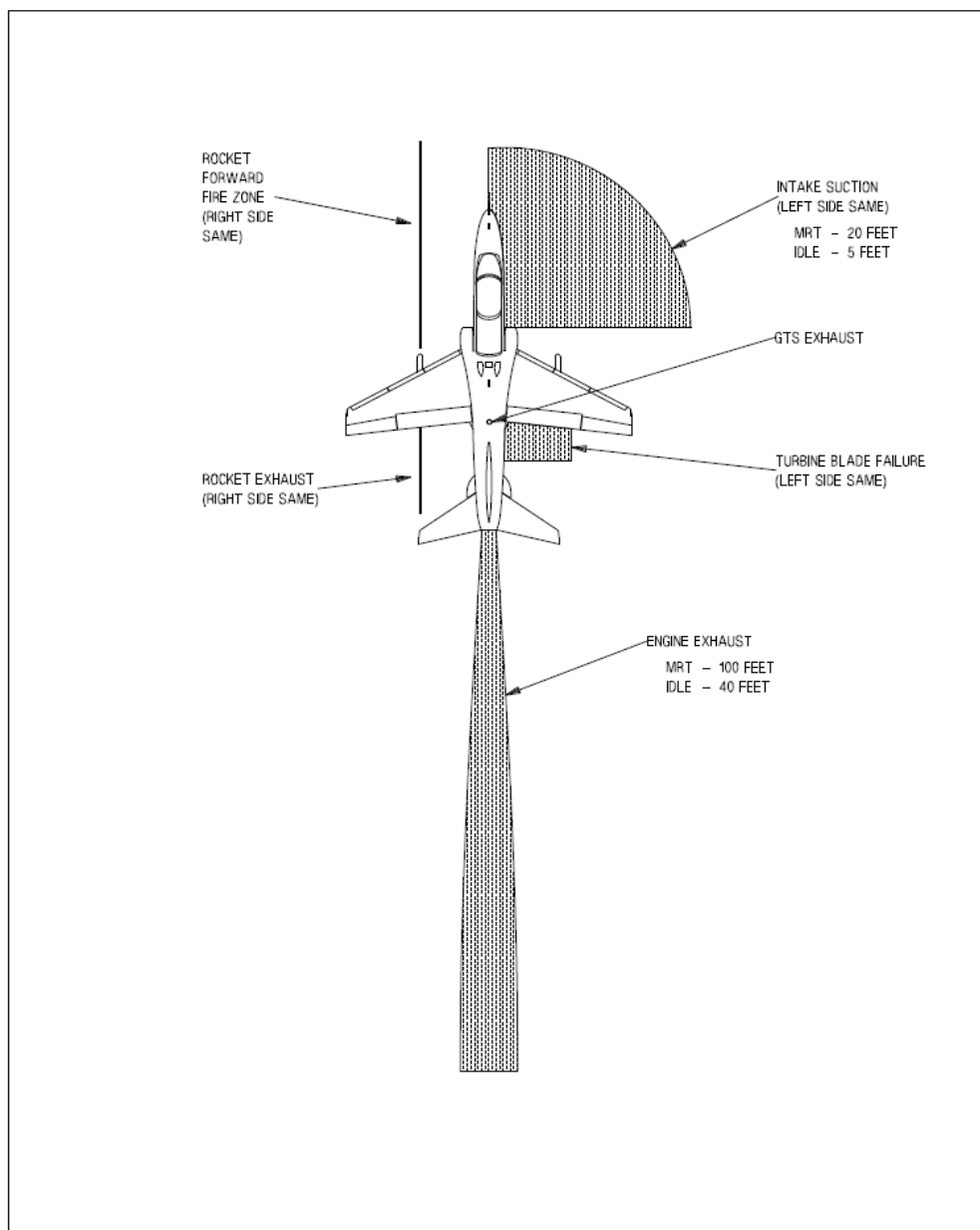
**LEFT SIDE VIEW**

- |  |  |
|--|--|
| 9. PRESSURE REFUELING/<br>DEFUELING COUPLING<br>AND CONTROL PANEL<br>(ACCESS DOOR 311EL) | 17. EXTERNAL ELECTRICAL<br>POWER RECEPTACLE<br>(ACCESS DOOR 310CR) |
| 10. DEFUEL VALVE KEYHOLD   | 18. HYD 1 HAND PUMP<br>(ACCESS DOOR 310ER)                         |
| 11. HYD 2 RESERVOIR GAUGE  | 19. HYD 1 FILTER INDICATORS  |
| 12. FUEL VENT  | 20. HYD 1 EXTERNAL<br>CHARGING PANEL<br>(ACCESS DOOR 3188R)        |
| 13. ARRESTING HOOK DAMPER<br>PRESSURE GAUGE AND<br>SERVICE POINT                         | 21. HYD 1 RESERVOIR GAUGE  |
| 14. HYD 2 EXTERNAL<br>CHARGING PANEL<br>(ACCESS DOOR 319BL)                              | 22. GTS OIL QUANTITY GAUGE   |
| 15. HYD 2 FILTER INDICATORS  |  |
| 16. AIRCRAFT GROUNDING POINT   |  |



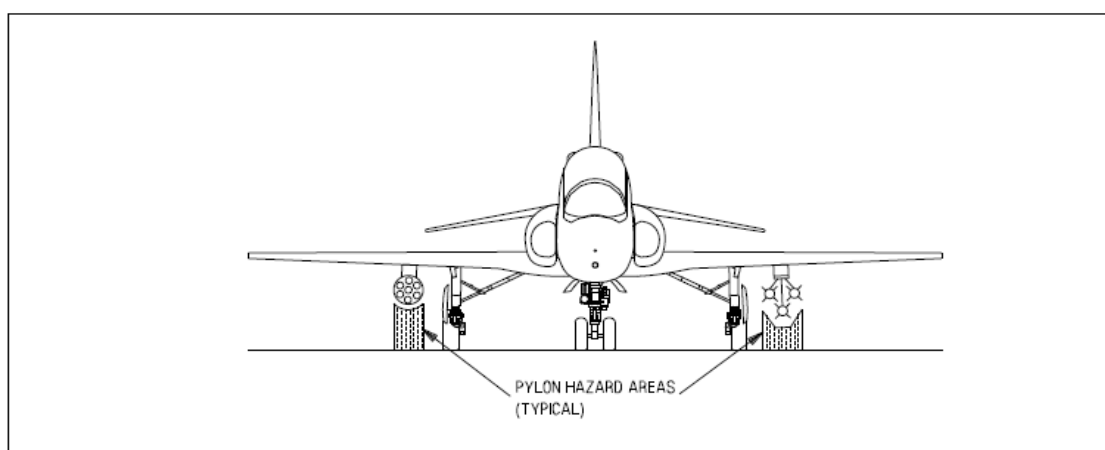
**RIGHT SIDE VIEW**





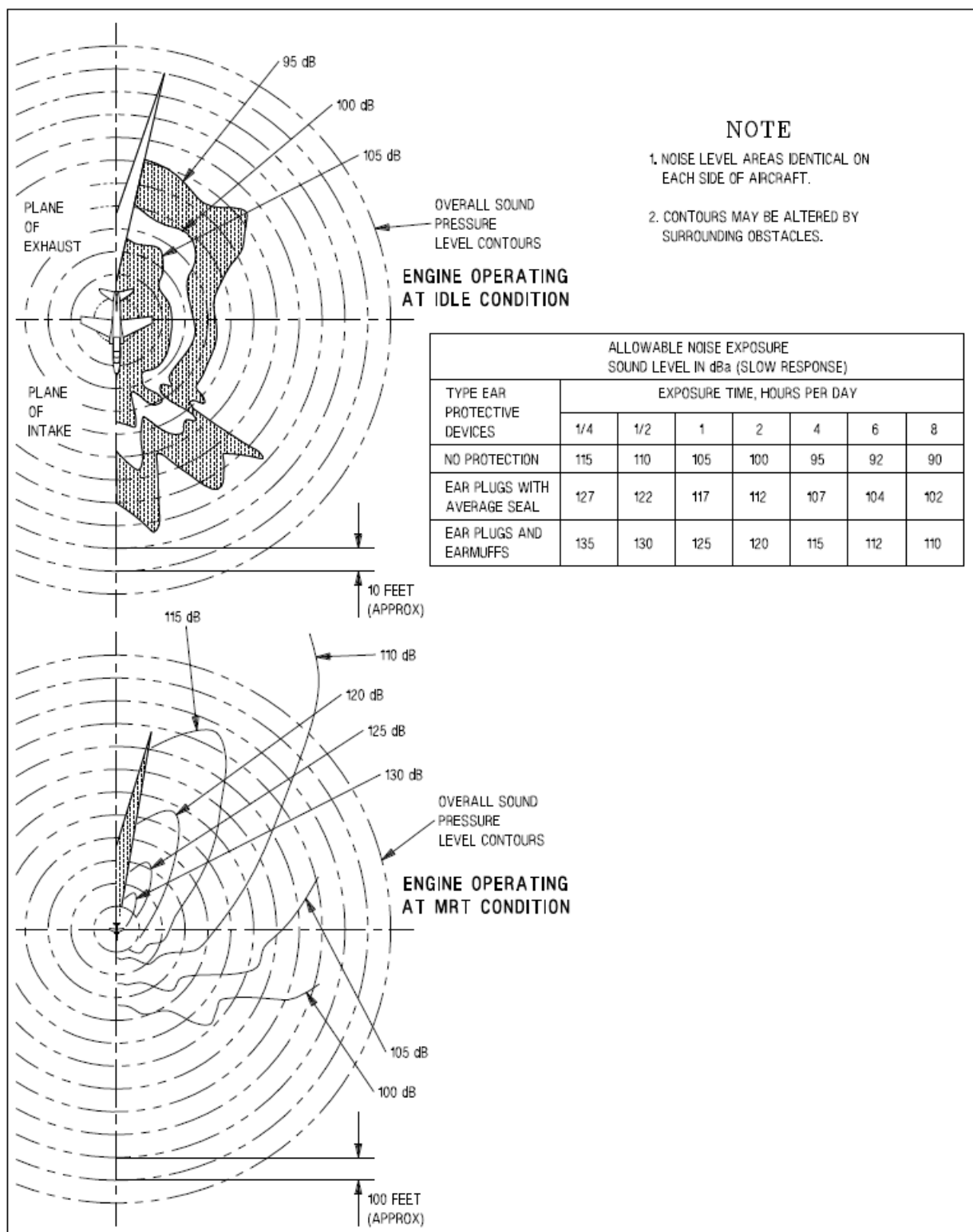
Danger Areas (Sheet 1 of 2)

EDA815-66-1-01

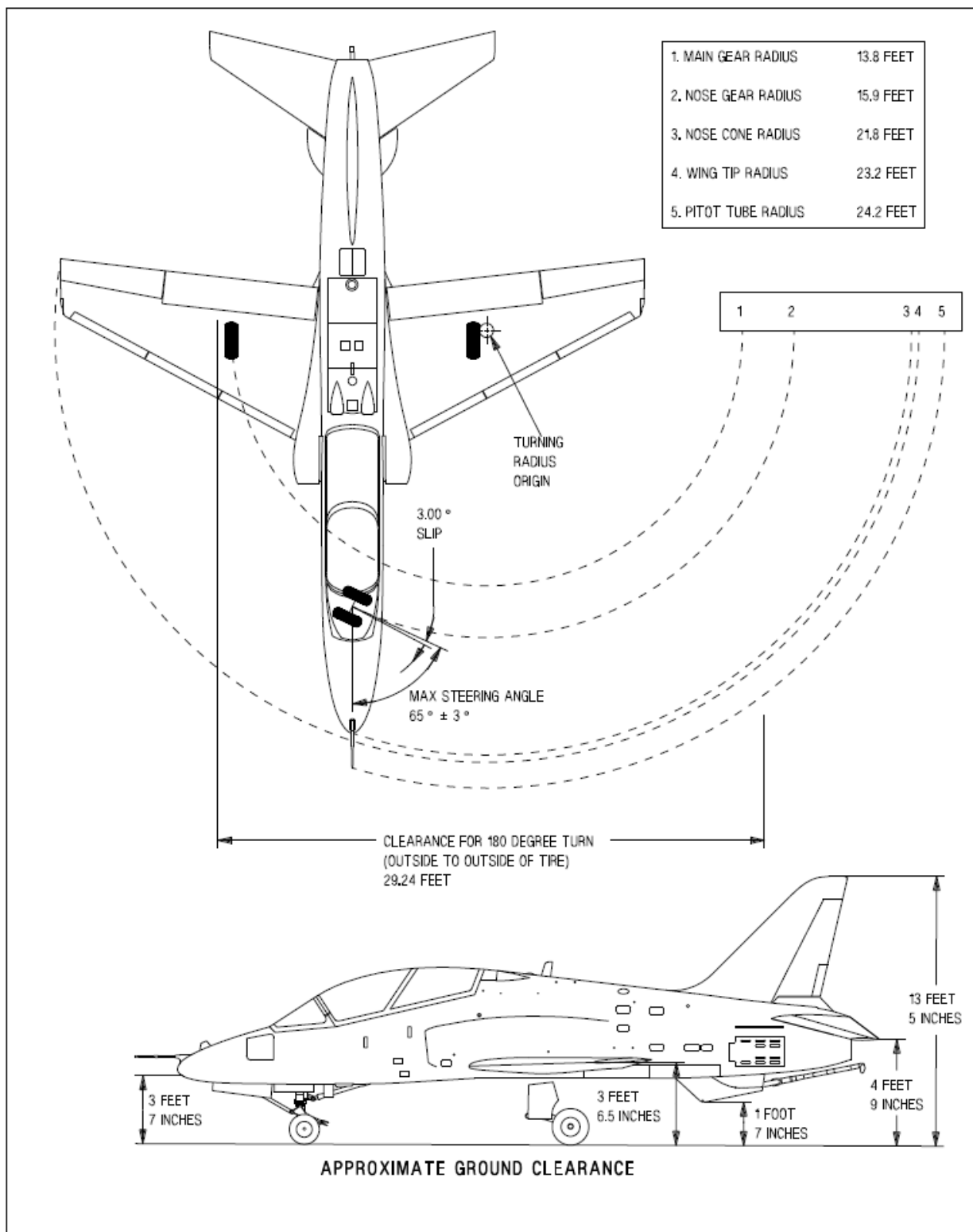


Danger Areas (Sheet 2 of 2)

EDA815-66-2-01

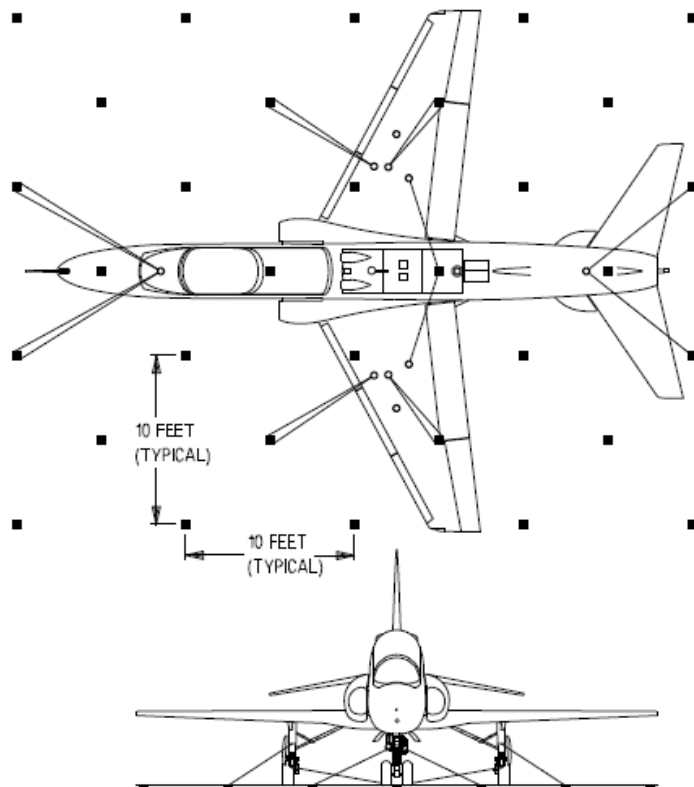
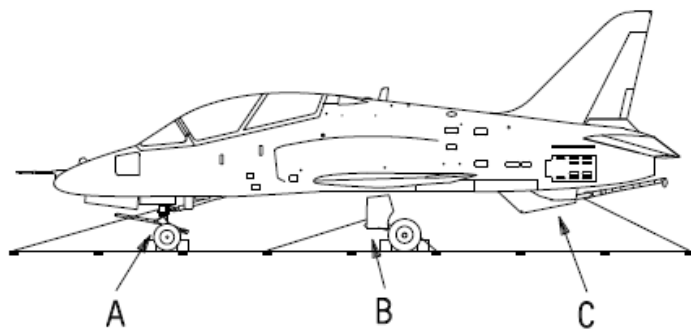


**Noise Danger Areas**



EDA815-68-1-001

**Minimum Turning Circle/Ground Clearance**

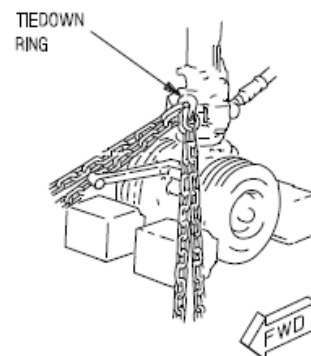


#### LEGEND

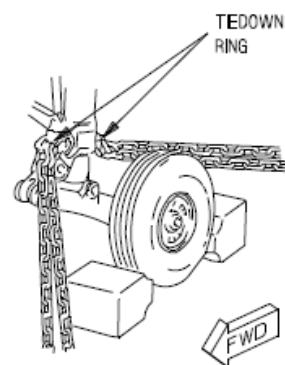
- AIRCRAFT FITTING
- DECK FITTING

#### NOTE

1. NOSE GEAR FORWARD TIEDOWN CHAIN NOT REQUIRED WHEN GROSS WEIGHT IS LESS THAN 15,600 POUNDS AND AIRCRAFT IS SPOTTED IN FORE AND AFT DIRECTION ON CARRIER.
2. MAXIMUM CARRIER GROSS WEIGHT 20,600 POUNDS FOR MODERATE WEATHER TIEDOWN.
3. MAXIMUM CARRIER GROSS WEIGHT 15,600 POUNDS FOR HEAVY WEATHER TIEDOWN.
4. TIEDOWN CHAIN OR EQUIVALENT 10,000-POUND WORKING LOAD.

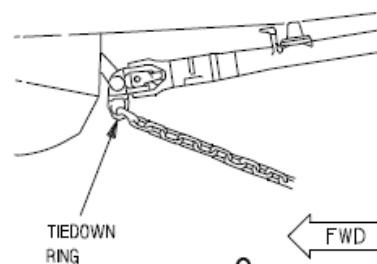


DETAIL A



MLG DOOR REMOVED FOR CLARITY

DETAIL B



DETAIL C

# CHAPTER 4

## Operating Limitations

### 4.1 INTRODUCTION

The following limitations apply to the T-45C.

**4.1.1 Solo Flying.** Solo flying shall be conducted only from the forward cockpit.

**4.1.2 Altitude Limits.** Maximum altitude is 41,000 feet MSL.

#### 4.1.3 Icing.

1. Prolonged flight in icing conditions shall be avoided.
2. When airframe icing is visible, intentional stalls or use of full flaps is not authorized.

### 4.2 ENGINE HANDLING LIMITATIONS:

*NOTE: These limitations may not apply to Flight Simulator X*

1. Throttle shall be at idle for:
  - a. Abrupt (0.5 seconds or less from neutral to full back stick) pulls to full back stick.
  - b. Abrupt full lateral stick inputs at full back stick.
  - c. Airspeeds less than 85 KIAS at altitudes above 15,000 feet MSL.
2. For airspeeds 85 to 150 KIAS at altitudes above 35,000 feet MSL; slow throttle movements.
3. Except in an emergency, engine shall be stabilized at idle for at least 30 seconds prior to shutdown.
4. Sustained engine operation at less than 70% N2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout.

### 4.3 GTS LIMITATIONS

GTS system is not simulated in this Flight Simulator X rendition.

### 4.4 FUEL LIMITATIONS

Operations with Jet A, Jet A-1, or Jet B are not authorized. These fuels do not normally contain the additives Fuel System Icing Inhibitor (FSII) or Corrosion Inhibitor/Lubricity Improver. These limitations do not apply in this Flight Simulator X.

### 4.5 AIRSPEED LIMITATIONS

Maximum permissible airspeeds in the clean configuration and limitations due to specific aircraft systems are shown in figures in these pages.

### 4.6 ANGLE-OF-ATTACK LIMITATIONS

MAX AOA for the emergency configuration of flaps half or full with slats up (flaps extended by the EMER FLAPS switch in the DOWN position) is AOA for pedal shaker/stall warning tone.

### 4.7 SIDESLIP LIMITATIONS

To prevent damage to nose gear doors and NLG strut door, minimize sideslip with landing gear in transition or extended position above 150 knots.

### 4.8 ROLL LIMITATIONS

1. For all configurations/store loadings:
  - a. Do not use large lateral inputs at less than 8 units AOA.
2. Cruise configuration:
  - a. For 1g rolls maximum bank angle change is 360 degrees.
  - b. For rolls at greater than or less than approximately 1g maximum bank angle change is 180 degrees.
3. Gear and/or flaps/ slats down:
  - a. Maximum bank angle is 90 degrees.

### 4.9 TAKEOFF/LANDING LIMITATIONS

1. Maximum 90 degree crosswind component:
  - a. Single Aircraft (dry runway) 20 knots
  - b. Single Aircraft (wet runway) 15 knots
  - c. Section Takeoff 10 knots
  - d. Banner Tow 10 knots
  - e. NWS Off/Failed 15 knots
2. FCLP landings are authorized only with the following configurations:
  - a. Clean loading and full flaps.
  - b. Pylons alone or pylons with empty PMBR's, and full flaps.
3. For landings in a configuration other than those described above, sink rate shall not exceed 600 fpm.

#### 4.10 BANNER TOWING

Banner towing is not implemented in this Flight Simulator X rendition.

#### 4.11 PROHIBITED MANEUVERS

1. Intentional spins or tailslides.
2. Rolling cross-control maneuvers of more than 60 degrees bank angle change.
3. Intentional departures except for:
  - a. Erect rolling departure entered with full aft stick/ full lateral stick.
  - b. Erect rudder-induced departure entered with full aft stick/ full rudder.
4. Sustained zero or negative g flight for more than 30 seconds.
5. Less than 30 seconds between negative g or zero g maneuvers.
6. Rolls at less than:
  - a. Negative 1.0g at less than 260 KIAS.
  - b. Negative 0.2g at or greater than 260 KIAS, but less than 0.80 Mach.
  - c. Approximately positive 1.0g at or greater than 0.80 Mach.
7. Lateral/directional inputs below 3 units AOA.
8. Intentional departures with greater than 1,000 foot-pounds asymmetry.
9. Operations with EMER FLAPS selected, when normal HYD 1 power is available, is restricted to 30 seconds with engine RPM less than or equal to 90% . Except in an actual emergency, use of EMER FLAPS is restricted to FCF profiles.
10. Intentional accelerated stalls with landing

gear extended while carrying stores.

#### 4.12 CENTER OF GRAVITY (CG) LIMITATIONS

1. Forward CG limit (gear up and down) is:
  - a. 14 percent mean aerodynamic chord (MAC) for gross weights up to 12,000 pounds.
  - b. 15.5 percent MAC above a gross weight of 12,760 pounds.
  - c. Linear variation between (a) and (b)
2. Aft CG limit is:
  - a. Gear Up:  
21 percent MAC for greater than 0.80 Mach.  
23 percent MAC for less than or equal to 0.80 Mach.
  - b. Gear Down:  
25 percent MAC with gear extended.

#### 4.13 WEIGHT LIMITATIONS

1. Field Takeoff 14,500 pounds
2. Catapult 14,200 pounds
3. Field Landing 13,360 pounds
4. FCLP 13,360 pounds
5. Carrier Landing 13,360 pounds

#### 4.14 ACCELERATION LIMITATIONS

1. Normal acceleration limits during landing gear transition or extended and/or with flaps half or full are 0.0 to +2.0 g symmetrical and +1.0 to +1.5 g unsymmetrical.
2. Normal acceleration limits in the cruise configuration (gear/ flaps retracted) with and without stores are shown in Figure 4-5.

#### 4.15 CARRIER OPERATIONS LIMITATIONS

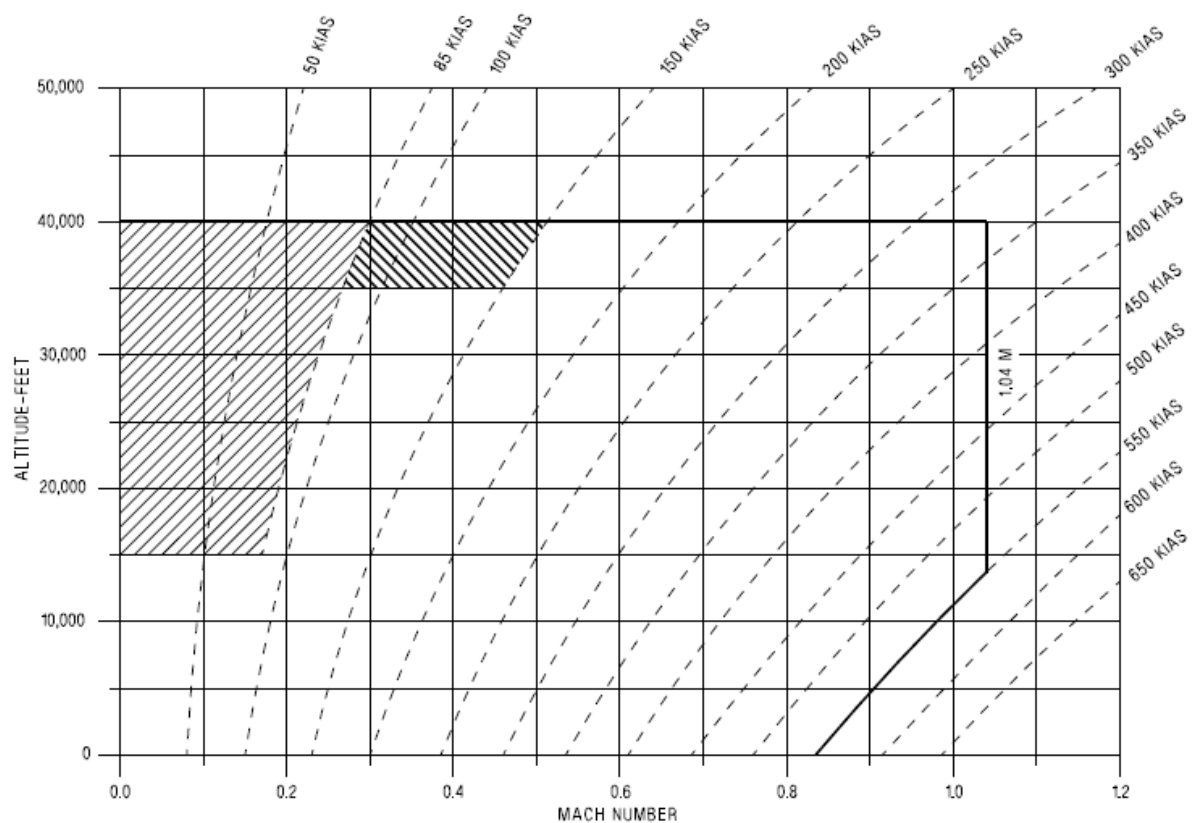
1. No external stores or pylons.

#### 4.16 EXTERNAL STORES LIMITATIONS



External stores are not implemented in this Flight Simulator X rendition.

SYSTEM	CONFIGURATION	LIMITATION
Landing Gear	Transition/extended	≤ 200 KIAS
Flaps/Slats	Transition/extended	≤ 200 KIAS
Arresting Hook	Transition/extended	≤ 450 KIAS
Canopy	Stationary and towing with canopy full open	Prevailing wind speed ≤ 32 knots
	Locking canopy in intermediate position	Permitted only for ingress and egress. Towing/taxiing not permitted.
	Taxi with canopy full open	Prevailing wind speed ≤ 20 knots
Tires	On deck	≤ 176 knots groundspeed
Nose Wheel Steering	On deck	≤ 176 knots groundspeed
Fuel System	Hot refueling	Fuel level ≤ 2,800 pounds

System Operation Limitations



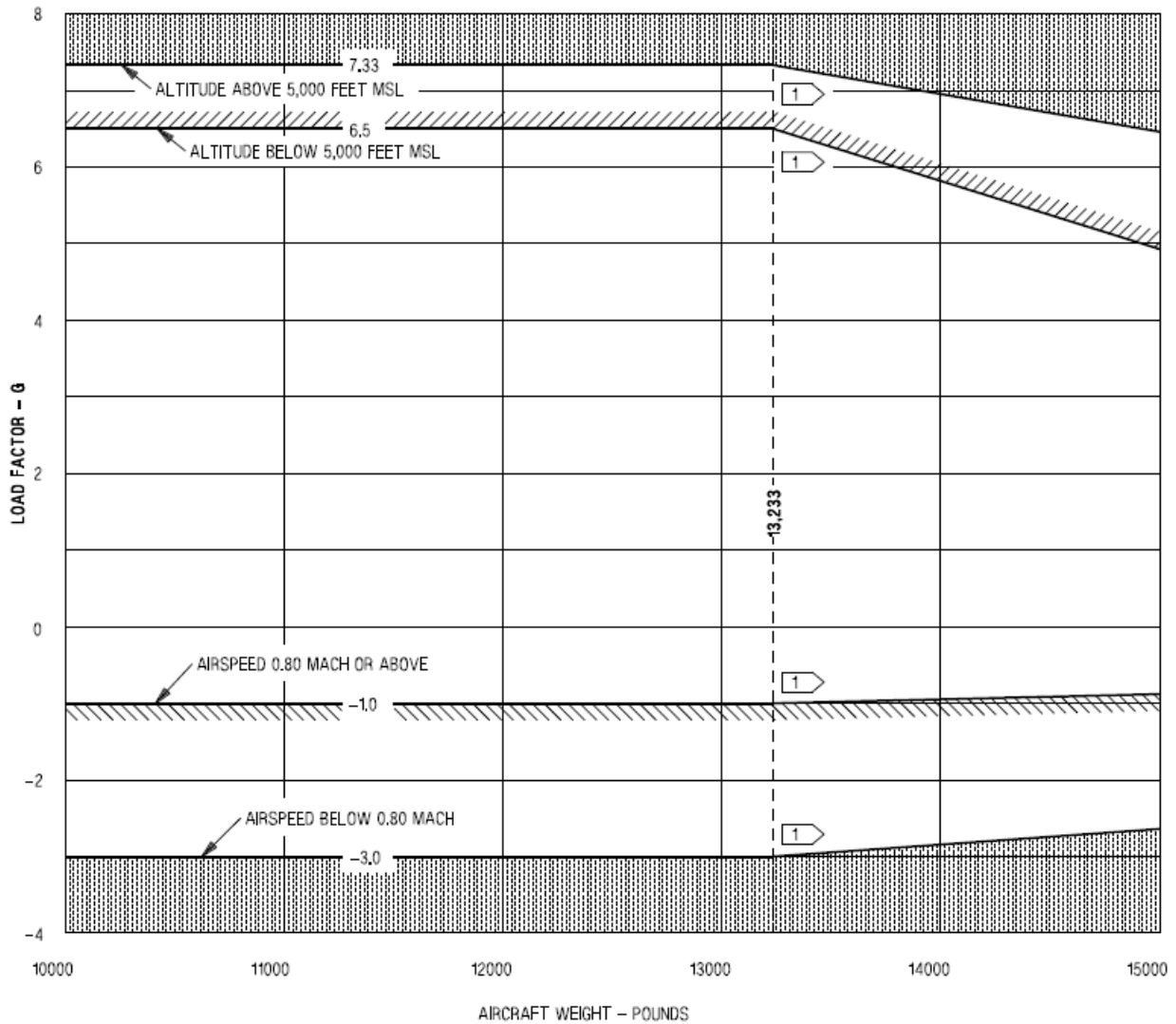
#### LEGEND

-  THROTTLE AT IDLE.
-  SLOW THROTTLE MOVEMENTS.

**T-45C Operating Envelope**

EDA815-76-1-003

## SYMMETRICAL MANEUVERING



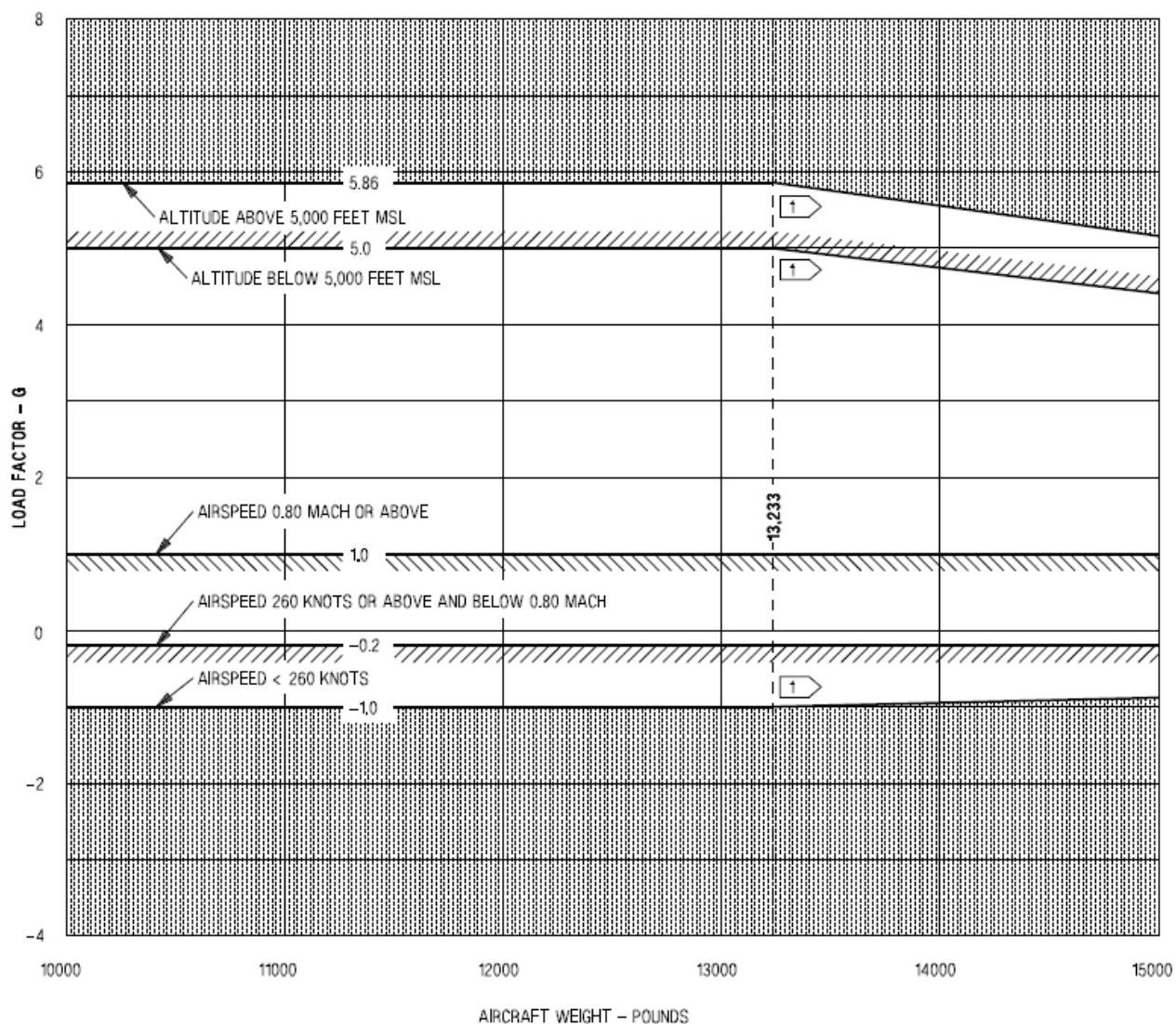
### LEGEND

- 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.

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



## 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.*

This section establishes minimum requirements for training, initial qualification, and currency in specified areas. A complete NATOPS evaluation must have been successfully completed within the preceding 12 months to be qualified as pilot in command.

### 5.2 GROUND TRAINING SYLLABUS

The ground training syllabus sets forth the minimum ground training which shall be satisfactorily completed prior to operating the T-45C. The ground training syllabus for each activity will vary according to local conditions, field facilities, requirement from higher authority, and the immediate unit commander's estimate of the squadron's readiness. The minimum ground training syllabus for the pilot is set forth below.

#### 5.2.1 Minimum Ground Training

Requirements. The minimum ground training requirements for the T-45C pilot shall be successfully completed prior to flight as follows:

1. Currently qualified to fly in accordance with OPNAVINST 3710 series.
2. Familiarization
  - a. Engineering Systems
  - b. Emergency Procedures
  - c. Normal Operating Procedures
  - d. Flight Characteristics
3. Safety and Survival
4. Weapon System Training (if applicable)
5. Weapons Delivery (if applicable)

### 5.3 FLIGHT TRAINING SYLLABUS

Initial flight training, up to and including first solo shall, be conducted in accordance with the unit commander approved syllabus. Follow-on flight training should include aircraft and weapon systems instruction, normal and emergency procedures, simulators (if available), open and closed book NATOPS tests, and evaluation of pilot performance. Local command requirements, squadron mission, and other

factors will influence the actual flight training syllabus and the sequence in which it is completed.

### 5.4 PERSONAL FLYING EQUIPMENT

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

1. Protective helmet
2. Oxygen mask and regulator
3. Anti-g suit
4. Fire retardant flight suit
5. Steel toed flight safety boots
6. Inflatable life preserver
7. Integrated torso harness
8. Leg restraints
9. Flight gloves
10. Identification tags
11. Survival radio
12. Survival knife and sheath
13. Signal devices
14. Flashlight (for all night flights)
15. Personal survival kit appropriate to the area of operations
16. Anti-exposure suit in accordance with OPNAVINST 3710.7
17. Other survival equipment appropriate to the climate of the area
18. Pocket checklist

### 5.5 QUALIFICATIONS AND CURRENCY REQUIREMENTS

5.5.1 Minimum Flight Qualifications. When recent pilot experience warrants, unit commanding

officers may waive flight training requirements for basic qualifications.

5.5.2 Minimum Currency Requirement.

1. Successfully completed a NATOPS evaluation in the last 12 months.
2. Holds a current instrument rating.
3. Any other requirements in accordance with OPNAVINST 3710 series.

# CHAPTER 6

## Flight Preparation

### 6.1 FLIGHT BRIEFING

The flight leader or pilot in command is responsible for ensuring that all flight or crew members are properly briefed on the operation and conduct of the mission. A briefing guide and the appropriate mission card will be used by the flight leader. Any format which is complete, concise, and orderly, and can readily be used by the flight leader as a briefing guide is suitable. Each pilot in the flight should be prepared to assume the flight lead and continue the mission to a successful completion should it become necessary.

The briefing guide will include the following items, when applicable.

#### 6.1.1 General.

1. Aircraft assigned, call signs, and event number
2. Fuel load, stores, and aircraft gross weight
3. Engine start, taxi, and takeoff times
4. Line and taxi procedures
5. Takeoff distance and speed, rendezvous instructions, and visual signals

#### 6.1.2 Mission Planning.

1. Primary
2. Secondary
3. Operating area
4. Formation procedures
5. Time on station or over target

#### 6.1.3 Communications.

1. Frequencies
2. Controlling agencies
3. Radio procedures and discipline
4. Navigational aids
5. IFF/SIF procedures

#### 6.1.4 Navigation and Flight Planning.

1. Duty runway
2. Takeoff
3. Climbout
4. Mission route including planned use of all navigation systems
5. Fuel management including bingo fuel
6. Marshall/holding
7. Instrument approach procedures
8. Radar altimeter procedures
9. Recovery

#### 6.1.5 Weapons.

1. Type/quantity
2. Preflight

3. Special routes with ordnance aboard
4. Pattern including airspeeds and altitudes
5. Armament switches/arming
6. Minimum release/pullout altitude
7. Hung ordnance, dearming, and jettison procedures
8. HUD programming

#### 6.1.6 Weather.

1. Local, enroute, and destination (existing and forecast)
2. Alternate and divert
3. Winds and jet streams

#### 6.1.7 Emergencies.

1. Takeoff aborts
2. Radio failure
3. System failures
4. Loss of NAVAIDS
5. Midair collisions
6. Ejection
7. Search and rescue (SAR)
8. Lost plane procedures

#### 6.1.8 Crew Coordination.

1. Shifting control of aircraft
2. Communications
3. NAVAIDS/RALT
4. Emergencies

**6.1.9 Operating Area Briefing.** Prior to operating in a new area, a mandatory briefing covering (but not limited to) the following items should be given.

##### 6.1.9.1 Bingo Fields.

1. Instrument approach facilities
2. Runway length and arresting gear
3. Local terrain and obstructions

##### 6.1.9.2 Emergency Fields.

1. Fields suitable for landing but without required support equipment
2. Instrument approach facilities
3. Runway length and arresting gear
4. Terrain and obstructions

### 6.2 DEBRIEFING

Each flight shall be followed as soon as possible by a thorough debriefing conducted and supervised by the flight leader/pilot in command. The debriefing shall cover the following:

1. General discussion of the flight with particular attention to those areas where difficulty may have been encountered and to the effectiveness of any tactics employed or weapons expended.

2. Operational and tactical information that can be given to squadron operations for relay to flight leaders of subsequent flights, such as weather.

The importance of the postflight debriefing and critique cannot be stressed too highly. To derive maximum benefit, constructive criticism and suggested improvements to doctrine, tactics, and techniques should be given and received with frankness and purpose and in the spirit of improving the proficiency of the unit as well as the individual pilot.

# CHAPTER 7

## Shore-Based Procedures

**NOTE: REAL WORLD CHECKLIST 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**

### 7.1 LINE OPERATIONS

The aircraft inspection and acceptance record must be checked for flight status, configuration, armament loading, and servicing prior to manning the aircraft. Weight and Balance clearance is the responsibility of the maintenance department.

### 7.2 PREFLIGHT INSPECTION

The pilot in command is responsible for a proper preflight inspection as follows. Approaching the aircraft look for chocks in place, tiedowns removed, and overall aircraft condition.

**7.2.1 Exterior Inspection.** The exterior inspection is divided into 13 areas.

The inspection begins at the left fuselage and continues around the aircraft in a clockwise direction. Check doors secure and be alert for loose fasteners, cracks, dents, leaks, and other general discrepancies.

- If the inner gear doors are open, ensure the gear door pins are inserted prior to entering the closing path of the doors. Failure to mechanically safe the doors will result in injury to personnel in the closure path, if the engine is started or hydraulic pressure applied.

- If the NLG forward doors are open ensure the safety pin is installed in the NLG door mechanism prior to entering the closing path of the doors. Failure to safety the doors may result in injury to personnel in the closure path, if electrical power is applied and the EMER GEAR handle is not fully stowed.

1. Left forward fuselage
  - a. Engine intake/duct - CLEAR
  - b. Marker beacon antenna - CONDITION
  - c. UHF/VHF No. 2 antenna - CONDITION

- d. AOA probe - CONDITION
- e. Windscreen/canopy - CONDITION

#### 2. Nose section

- a. Left avionics access door - SECURED
- b. Ram air inlet - CONDITION
- c. IFF antenna - CONDITION
- d. TACAN antenna - CONDITION
- e. Pitot static tube - CONDITION

Ensure the pitot switch is OFF prior to touching the pitot tube. The power to the pitot heater is not routed through the aircraft weight-on-wheels switch. Touching the pitot tube may cause burns.

- f. Right avionics access door - SECURED
- g. Total temperature probe - CONDITION

#### 3. Nose landing gear and wheelwell

- a. Gear doors and linkages - CONDITION
- b. NLG door safety pin - PULLED AND STOWED
- c. Tires, wheels, strut - INFLATION, CONDITION, TREAD WEAR NOT WORN BELOW GROOVE AT ANY SPOT ON TIRE
- d. Strut pressure - CHECK FOR APPROXIMATELY 3.25 INCHES OF EXPOSED CHROME
- e. Launch bar - CONDITION
- f. Nose wheel steering assembly - CONDITION
- g. Launch bar retract proximity switch - CONDITION
- h. Taxi/ landing light - CONDITION
- i. Approach light - CONDITION
- j. Pitot-static drain caps - CHECK
- k. Nosewheel weight on wheels proximity switch - CONDITION
- l. NLG external down and locked indicator - CHECK PROPER INDICATION
- m. Holdback - CONDITION
- n. Drag brace - SAFETY PIN PULLED AND STOWED

#### 4. Right forward fuselage

- a. Windscreen/ canopy - CONDITION
- b. Avionics bay and access doors - SECURED
- c. Lower anti-collision beacon - CONDITION
- d. Engine intake/duct - CLEAR

#### 5. Right main landing gear and wheelwell

- a. Gear doors and linkages - CONDITION
- b. HYD 1 flight control accumulator pressure gauge - CHECK (1,100 —50 psi)
- c. Wheel brakes/emergency flap accumulator pressure gauge - CHECK (1,300 psi or greater)
- d. Landing gear downlock and retract actuators - CONDITION
- e. Gear safety pin - PULLED AND STOWED
- f. Wheel strut - CHECK FOR 7/8 TO 1-7/8 INCH OF EXPOSED CHROME
- g. Tire - INFLATION, TREAD WEAR NOT WORN BELOW GROOVE AT ANY SPOT ON TIRE
- h. Brake wear indicators (2) - CHECK INDICATORS PROTRUDING BEYOND RECESSES IN TOP AND BOTTOM OF BRAKE HOUSING.
- i. Tiedown rings and springs - CONDITION
- j. Weight on wheels proximity switch - CONDITION

#### 6. Right wing

- a. Pylon and external stores - PREFLIGHT
- b. Slat - CONDITION
- c. Stall strip - CONDITION
- d. Vortex generators - CONDITION
- e. Navigation light - CONDITION
- f. Glideslope antenna - CONDITION
- g. Formation light - CONDITION
- h. Aileron and flap - CONDITION
- i. Flap-access panels - CHECK SCREWS TIGHT

If flap access panel screws are not secure, it is possible for the panel to raise up in flight causing the aircraft to lose lateral stability.

#### 7. Aft fuselage (right side)

- a. GTS oil reservoir indicator - CHECK
- b. HYD 1 filter indicators (2) - FLUSH
- c. Engine access doors - SECURED
- d. RAT doors - NO DISCOLORATION/ WARPAGE
- e. HYD 1 reservoir quantity - VERIFY (See Figure 3-10)

#### **NOTE**

The aircraft hydraulic fluid temperature should be stabilized to ambient air temperature prior to checking reservoir levels. If sufficient time has not elapsed for the stabilization to occur, an appropriate volume change can be anticipated.

#### 8. Tail section (right side)

- a. Speed brake - CONDITION
- b. Stabilator vane - CONDITION

- c. Stabilator - CONDITION
- d. Vertical stabilizer, rudder, rudder tab, buzz strips - CONDITION
- e. Tailpipe/ turbine blades - CONDITION (Check tailpipe sleeve travel and security - pull to full aft travel)
- f. Navigation light - CONDITION
- g. IFF antenna - CONDITION
- h. (T-45A) TACAN antenna - CONDITION
- i. Fuel vent – CONDITION/ UNOBSTRUCTED

#### 9. Tail section (left side)

- a. Vertical stabilizer, rudder, buzz strips - CONDITION
- b. Stabilator - CONDITION
- c. Stabilator vane - CONDITION
- d. Speed brake - CONDITION
- e. Arresting hook bumpers (2) - CONDITION
- f. Arresting hook – RETRACTED, SAFETY PIN REMOVED AND STOWED
- g. Hook actuator/damper pressure - CHECK (approximately 950 psi)

#### 10. Aft fuselage (underside)

- a. Radar altimeter antennas - CONDITION
  - b. Engine access doors - SECURED
  - c. Engine oil - WITHIN 2 LITERS OF FULL
- NOTE:** Checking or filling the engine oil system should be accomplished in a minimum of 5 minutes and a maximum of 30 minutes after engine shutdown.
- d. Engine and GTS fuel drains – CONDITION/UNOBSTRUCTED

#### 11. Aft fuselage (left side)

- a. HYD 2 filter indicators (2) - FLUSH
- b. HYD 2 reservoir quantity - VERIFY (See Figure 3-11)

**NOTE:** The aircraft hydraulic fluid temperature should be stabilized to ambient air temperature prior to checking reservoir levels. If sufficient time has not elapsed for the stabilization to occur, an appropriate volume change can be anticipated.

#### 12. Left wing

- a. Flap-access panels - CHECK SCREWS TIGHT

If flap access panel screws are not secure, it is possible for the panel to raise up in flight causing the aircraft to lose lateral stability.

- b. Flap and aileron - CONDITION
- c. Formation light - CONDITION
- d. VOR/LOC antenna - CONDITION
- e. Navigation light - CONDITION
- f. Vortex generators - CONDITION
- f. Stall strip - CONDITION

- g. Slat - CONDITION
- h. Pylon and external stores – PRE FLIGHT

13. Left main landing gear and wheelwell

- a. Tiedown rings and springs - CONDITION
- b. Weight on wheels proximity switch - CONDITION

- c. Brake wear indicators (2) - CHECK INDICATORS PROTRUDING BEYOND RECESSES IN TOP AND BOTTOM OF BRAKE HOUSING.

- d. Tire - INFLATION, TREAD WEAR NOT WORN

BELOW GROOVE AT ANY SPOT ON TIRE

- e. Wheel strut - CHECK FOR 7/8 TO 1-7/8 INCHES OF EXPOSED CHROME

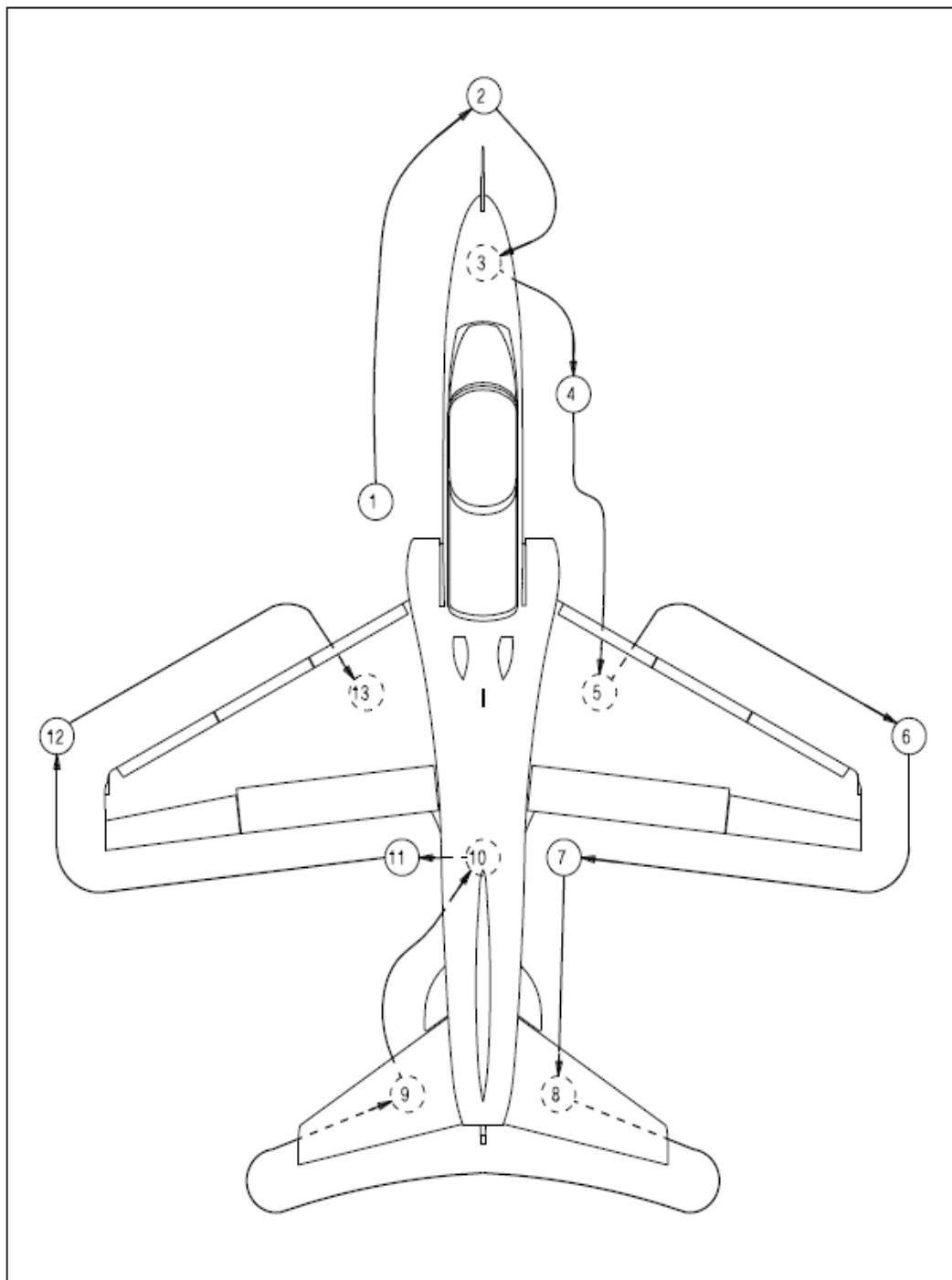
- f. Gear safety pin - PULLED AND STOWED

- g. Landing gear downlock and retract actuators - CONDITION

- h. Fuel door panel - SECURED

- i. HYD 2 flight control accumulator pressure gauge - CHECK (1,100 —50 psi)

- j. Gear doors and linkages - CONDITION



## 7.3 ENTERING COCKPIT

**7.3.1 Cockpits.** The following items shall be checked prior to entering the cockpit:

To prevent injury to personnel or damage to the damper/ locking strut and possible canopy collapse, canopy shall be full open prior to entering cockpit.

To prevent damage to the gunsight reticle, avoid grabbing/holding the gunsight or resting personal equipment on or near the gunsight during cockpit ingress/egress.

### 1. Cockpit area

- a. Windscreen/ canopy – CHECK SECURED, NO DEEP SCRATCHES, NO DELAMINATION, SEALS GOOD
  - b. MDC firing handle safety pin - REMOVED AND STOWED
  - c. Ejection seat safety pin – REMOVED AND STOWED
  - d. Rudder lock lever – RELEASE, STOWED
  - e. Ejection seat - INSPECT
    - (1) Ejection seat SAFE/ARMED handle - SAFE
    - (2) Emergency restraint release - FULLY DOWN AND LOCKED
    - (3) Ejection control handle safety pin - REMOVED AND STOWED
    - (4) Emergency oxygen actuator - OFF
    - (5) Emergency oxygen gauge - 1,800 TO 2,500 PSI
    - (6) Leg restraint cables - CONDITION/ PROPERLY ROUTED
    - (7) Emergency locator transmitter and oxygen lanyards - CONNECTED
    - (8) Catapult manifold valve - SECURED, HOSE CONNECTED AND RETAINING PIN INSTALLED
    - (9) Top latch mechanism – SPIGOT INDICATOR IS FLUSH WITH END OF TOP LATCH PLUNGERIf top latch mechanism does not meet outlined requirements, seat could rise up catapult guide rail during aircraft maneuvers.
  - (10) Electronic sequencer - CHECK INDICATOR FOR BLACK
  - (11) Parachute withdrawal line - CORRECTLY SECURED TO PARACHUTE DEPLOYMENT ROCKET STIRRUP
- To prevent SEAWARS/ trombone damage, do not adjust seat prior to strapping in.

### 2. Aft cockpit (solo flight)

- a. Command ejection selector - SECURED IN SOLO POSITION, COLLAR INSTALLED
- b. SEAT LIGHT switch - PINNED IN SOLO
- c. OBOGS FLOW selector - OFF

- d. ENGINE switch - ON
- e. FUEL CONTR switch - NORMAL
- f. STBY STAB TRIM switch - GUARDED
- g. RUDDER TRIM switch - NEUTRAL
- h. ANTI-SKID switch - ON
- i. EMER FLAP switch - NORM
- j. EMER GEAR handle - STOWED
- k. MASTER ARM override switch - (T-45A) NORMAL/(T-45C) FORWARD
- l. RTCL light switch - OFF
- m. MFDs - OFF
- n. COMM/NAV - AS DESIRED
- o. Interior lights - OFF
- p. Ejection seat SAFE/ARMED handle - SET TO SAFE
- q. Ejection control handle safety pin - INSTALLED
- r. MDC firing handle safety pin - INSTALLED
- s. Ensure MDC and ejection seat safety pin streamer is routed beneath right side lap belt. Failure to route integrated streamer beneath right side lap belt when ejection seat is set for solo flight may allow streamer assembly to foul the aft cockpit control stick.
- t. VCR switch - OFF
- u. VCR - LOAD
- v. VCR module - FULLY SEATED, LOCKING BAR SECURE, AND WHITE TAPE NOT VISIBLE
- w. MDL cartridge - LOAD
- x. All loose items including harness - SECURE
- y. Ejection seat - LOWER TO FULLDOWN POSITION (battery power required)

### 7.3.2 In The Cockpit.

**NOTE:** Do not place any items on glareshield to avoid scratching windscreen.

1. Throttle - OFF
2. LDG GEAR handle - DOWN
3. Parking brake - SET
4. Rudder pedals - ADJUST, ENSURE NO BINDING OR INTERFERENCE
5. Oxygen and g-suit leads - CONNECT
6. Harness and leg restraints
  - a. Leg restraints - FASTEN AND SECURE LEG RESTRAINT GARTERS.

Check garters buckled and properly adjusted with hardware on inboard side of the legs. Check that the leg restraint lines are secured to seat and floor and not twisted. Check that leg restraint lines are routed through the quick release buckles first and then connected to the garters.

- The leg restraint lines must be attached to the ejection seat at all times during flight to ensure that the legs will be pulled back upon ejection. This will enhance seat stability and will prevent



leg injury by keeping the legs from flailing following ejection.

- Failure to route the restraint lines properly through the garters could cause serious injury during ejection/emergency egress.
- b. Lap belt - CONNECT AND ADJUST
- c. Parachute release fittings - CONNECT
- d. Shoulder harness lock lever - CHECK FOR PROPER OPERATION

**NOTE: FROM THIS POINT ON, REAL WORLD CHECKLISTS HAVE BEEN EXTENSIVELY MODIFIED FOR USE IN FLIGHT SIMULATOR X. CHECKLIST ITEMS WRITTEN IN *ITALIC* AND IDENTIFIED AS N/A (NOT APPLICABLE) HAVE NO FUNCTION IN FSX EVEN IF THE RELEVANT COCKPIT ITEM IS CLICKABLE.**

#### 7.4 INTERIOR CHECK

1. *OBOGS FLOW selector* – OFF (N/A)
2. *OBOGS/ANTI-G switch* – OFF (N/A)
3. *FUEL SHUTOFF handle* – LOCKED (DOWN)
4. *IGNITION switch* – NORMAL (GUARDED, N/A)
5. *DISPLAY POWER switch* – NORM (N/A)
6. *FUEL CONTRL switch* – NORMAL (N/A)
7. ENGINE switch - ON
8. RUDDER TRIM knob - NEUTRAL
9. *CONTR AUG switch* – SBI (N/A)
10. STBY STAB TRIM switch – NEUTRAL
11. *Throttle friction* – OFF (N/A)
12. Throttle - OFF
13. EXTERIOR LIGHTS master switch - AS REQUIRED
14. FLAPS/SLATS lever – UP
15. *ANTI-SKID switch* – ON (N/A)
16. *EMER FLAP switch* – NORM (N/A)
17. LAUNCH BAR switch - RETRACT
18. EMER GEAR handle - IN
19. LDG GEAR handle - DOWN
20. *MASTER ARM switch* – SAFE (N/A)
21. *VCR switch* – OFF (N/A)
22. Flight instruments - SET/CHECK
  - a. Standby VSI - ZERO (note any error)
  - b. *Standby attitude indicator* - OFF FLAG VISIBLE (N/A OFF FLAG INOP IN FSX)
  - c. *Standby barometric altimeter* – SET BAROMETRIC PRESSURE (N/A)
  - d. Standby airspeed indicator - CHECK
  - e. Standby turn and slip indicator - CENTERED
  - f. *AOA indexer/ indicator* - CHECK OFF/ FLAG IN VIEW (N/A OFF FLAG INOP IN FSX)
  - g. HUD - OFF
  - h. MFDs - OFF
  - i. *CABIN pressure altimeter* – CHECK (N/A)
23. UHF/VHF No. 1 radio - OFF

24. PITOT HEAT switch - OFF
25. *HOOK BYP switch* - AS REQUIRED (N/A)
26. Clock - SET
27. HOOK handle - CORRESPONDS TO HOOK POSITION
28. COMM control panel - AS DESIRED
29. VOR/ ILS - OFF
30. TACAN - OFF
31. UHF/VHF No. 2 radio - OFF
32. IFF - OFF
33. BATT switches - OFF
34. *AC RESET switch* – CENTERED (N/A)
35. GEN switch - ON
36. **(T-45A)** Navigation TRNG switches - NORMAL
37. **(T-45A)** HOOK BYPASS switch - AS REQUIRED
38. Interior lights - AS DESIRED
39. *Cockpit air conditioning* - NORMAL/AS DESIRED (N/A)
40. *Exterior lights* - AS REQUIRED (N/A)
41. A-COLL/STROBE light switch - A-COLL

#### 7.5 PRESTART CHECKS

1. Battery switches
  - a. BATT 1 and BATT 2 – ON

### CAUTION!

Prior to applying electrical power on deck, ensure personnel are clear of the NLG forward doors. With the NLG door ground safety pin removed and the EMER GEAR handle not fully stowed the NLG doors will close when electrical power is applied.

- b. *Alternately select each battery OFF to check individual voltage; 24 to 29 volts (N/A – IN FSX BATTERY SWITCHES ARE LINKED)*
- c. BATT 1 and BATT 2 - CHECK ON
2. *Seat* – ADJUST (N/A)
3. *ICS* – CHECK (N/A)
4. Fuel quantity - CHECK
5. MASTER ALERT light - OUT
6. *Advisory panel lights* - ENSURE ANTISKID ON (N/A)
7. FIRE light - OUT
8. Warning/caution panel lights- ENSURE THE FOLLOWING ON:  
Warning - GENERATOR, OIL PRESS, HYD FAIL, OXYGEN  
Caution - HYD 1, HYD 2, LP PMP, CANOPY (if open), AC INV (aircraft 165080 THRU 165092), F PRES
9. *LT/TONE TEST switch* - CHECK LAMPS/TONE/AOA INDEXER (N/A)
10. HYD 1 and HYD 2 pressure indicators -

ZERO

11. BRAKE pressure indicator - 1,250 PSI  
MINIMUM

12. FLAP position lights - MATCH FLAP  
POSITION

13. Landing gear position indicator lights -  
ON (GREEN)

14. COMM/NAV transfer buttons - AS  
DESIRED

15. AOA - NO OFF FLAG (N/A)

16. Canopy - AS DESIRED

## CAUTION!

Actuation of the MDC inadvertently or through the ejection process with the helmet visor up could result in severe eye injury.

## 7. STARTING ENGINE

### CAUTION!

Make certain that the area forward and aft of the aircraft is clear of personnel and FOD hazards. Make certain that fire fighting equipment is available and manned. Advise aft cockpit before engine start.

1. GTS start button - PRESS  
*MOMENTARILY GTS advisory light should illuminate within 20 seconds.*  
*If GTS start attempts are longer than the acceptable start time of the GTS START ENVELOPE, subsequent in-flight start attempts may exceed the GTS auto shutdown limit. (N/A – GTS SYSTEM IS NOT SIMULATED IN FSX)*

2. ENGINE switch - START  
READY advisory light illuminates within 15 seconds.

3. Throttle - IDLE WHEN RPM BETWEEN 15 TO 20%

a. Monitor engine instruments for normal engine start while engine stabilizes at idle with the OIL PRESS warning light out.

Engine starts with the throttle above the ground idle position may cause engine surge/over-temperature.

- Advancing throttle to IDLE before READY advisory light illuminates may cause damage to the engine from overheat.

- Light-off must occur within 15 seconds after advancing throttle to IDLE.

- Secure engine if start EGT limit is rapidly approached and appears likely to be exceeded.

4. Voltmeter - CHECK (27 to 29 volts)

5. (T-45A) SAHRS mode selector - SLV

6. HUD - ON

7. (T-45A) Radar altimeter - ON/SET BUG

8. MFDs - ON

9. UHF/VHF radios - ON

10. VOR/ILS - AS DESIRED

11. TACAN - ON

12. IFF – STANDBY (N/A)

13. OBOGS/ANTI-G switch - ON

## 7.7 POSTSTART

1. Throttle - ADVANCE SLOWLY TO 70% RPM

Following start, do not advance the throttle rapidly before the bleed valve closes, as there is a possibility that the engine will overheat. Once the bleed valve is closed there are no restrictions on the rate of throttle movement.

2. FUEL CONTR switch – MANUAL M FUEL advisory light illuminates. Note engine RPM may decrease by up to 6 percent. (N/A MANUAL FUEL CONTROL SYSTEM IS NOT SIMULATED IN FSX)

3. FUEL CONTR switch – NORMAL (N/A)  
M FUEL advisory light goes out and ensure previous RPM is achieved.

4. HYD 2 RESET button – PRESS (N/A)  
Check that HYD 2 caution light is out and hydraulic pressure indicates in normal range

5. Hydraulic pressures - 3,000 PSI

6. Throttle - IDLE, CHECK EGT AND RPM, ENSURE BLEED VALVE CLOSED AND RPM +/-2 PERCENT IDLE RPM .

### NOTE

Bleed valve closure can be confirmed by noting RPM increases approximately 3 percent and EGT decreases by 50° C from previous indications. (BLEED VALVE IS NOT SIMULATED IN FSX)

7. HUD - ON/SET BRIGHTNESS

8. MFDs - ON/SET BRIGHTNESS AND CONTRAST

9. Aircraft exceedance - CHECK

a. MENU/BIT/MANT options - SELECT

b. Verify no A/C exceedance

### NOTE

If an exceedance indication is present, shut down aircraft and report the exceedance to maintenance.

10. Alignment progress - CHECK

a. MENU/DATA/ACFT options - SELECT

b. Verify GPS is tracking four satellites and QUAL is decremting (if alignment completes QUAL will be removed and velocity vector displayed)

**If alignment QUAL is not decremting -**

c. Verify aircraft's present position agrees with waypoint zero. If not, correct waypoint zero.

d. Waypoint zero – CHECK

e. After 50 seconds verify QUAL begins to

decrement

**If alignment QUAL is decrementing and GPS tracking four satellites – (N/A GPS QUAL IS NOT SIMULATED IN FSX)**

11. CONTR AUG IBIT - PERFORM

**NOTE**

Ensure GINA is valid. (GINA heading and attitudes are available.)

a. Paddle switch - MOMENTARILY PRESS

C AUG caution light illuminates.

b. CONTR AUG switch - MOMENTARILY RESET C AUG caution light extinguishes.

c. CONTR AUG switch - SBI TO ALL C AUG caution light illuminates for a maximum of 120 seconds and then extinguishes. (N/A)

12. Stabilator trim:

a. Pitch trim - CHECK BOTH DIRECTIONS (-3° to +8°)

b. STBY STAB TRIM switch - LIFT GUARD COVER AND CHECK NORMAL TRIM STOPS. CHECK BOTH DIRECTIONS, CLOSE GUARD (N/A)

c. Pitch trim - SET FOR TAKEOFF/ CATAPULT

13. Aileron trim - CHECK BOTH DIRECTIONS AND SET AT NEUTRAL

14. Rudder trim - CHECK BOTH DIRECTIONS AND SET AT NEUTRAL. DO NOT COMMENCE UNTIL CONTR AUG IBIT IS COMPLETE

15. Standby attitude indicator - PUSH TO ERECT (N/A)

16. LAW - SET

17. BINGO - SET

18. ADI display - COMPARE WITH STANDBY INSTRUMENTS

19. BIT display - NOTE DEGD

IFF, YDS and VCR display DEGD when set to OFF or STBY. (N/A)

20. Waypoints – PROGRAM (N/A – IN FSX WAYPOINTS CAN BE PROGRAMMED DURING FLIGHT PLANNING)

21. Navigation source - SET

22. OBOGS pneumatic BIT button - PRESS Hold until OXYGEN warning light illuminates. Ensure light goes out 1 minute after releasing button. (N/A)

23. Oxygen mask - ON/CONFIRM FLOW (N/A)

24. ANTI-G test button – PRESS (N/A)

25. RADALT - BIT CHECK/SET

**7.7.1 Plane Captain.**

**After plane captain signals -**

1. Flight controls - FREE, FULL TRAVEL AND PROPER MOVEMENT.

2. Nose wheel steering – ENGAGE (N/A)

3. Speed brakes, flaps/slats, hook, and launch

bar - EXTEND, FULL/DOWN, DOWN, EXTEND

4. Check for the following -

SP BRK advisory light - ON

SP BRK FULL advisory light - ON

Flaps HALF position light - OFF

Flaps FULL position light - ON

HOOK warning light - ON

L BAR advisory light - ON

**After plane captain makes check and signals -**

5. Speed brakes, flaps/slats, hook, and launch bar - RETRACT, 1/2 / DOWN, UP, RETRACT

6. Check for the following indications -

SP BRK advisory light - OFF

SP BRK FULL advisory light - OFF

Flaps HALF position light - ON

Flaps FULL position light - OFF

HOOK warning light - OFF WITHIN 6 SECONDS

L BAR advisory light - OFF

Ensure ground personnel are clear of aircraft

before actuating flight controls, flaps/ slats, speed brakes, arresting hook, and gear doors.

**7.8 TAXI**

**CAUTION!**

To prevent injury to personnel or damage to the damper/ locking strut and possible canopy collapse, do not taxi with canopy in other than full open or full closed position. Intermediate canopy position is not authorized during taxi.

**NOTE**

At gross weights greater than 13,500 pounds, avoid hard differential braking and sharp turns during taxi.

1. Parking brake - RELEASE

When ready to taxi, signal the plane captain to remove chocks.

Advance throttle to about 70% RPM. Release brakes and perform brakes check. Use caution in confined or restricted areas.

2. Wheel brakes - CHECK

3. Nose wheel steering - CHECK

If the EMER GEAR handle is not fully stowed, nosewheel steering authority may be diminished.

4. Flight instruments - CHECK, SET AS REQUIRED

5. PITOT HEAT switch - AS REQUIRED

**7.9 TAKEOFF CHECKLIST**

1. CONTR AUG switch – ALL (N/A)

2. ANTI-SKID switch – ON (N/A)

3. Flaps/ slats - 1/2

4. Trim:

a. Rudder/Aileron - 0 DEGREES

b. Stabilator - 2 TO 3 DEGREES NOSEUP

5. Canopy - CLOSED, LOCKED, LIGHT OUT
6. Harness - CONNECTED
7. Ejection seat – ARMED

## 7.10 TAKEOFF

*After completion of the Takeoff checklist and upon clearance from the tower, taxi the aircraft onto the runway. Select IFF to NORMAL with the appropriate squawk and turn the strobe light on. Advance the throttle to MRT, check EGT/ RPM are within limits, check all warning/ caution lights are out, and check controls are free and clear. See Figure for typical field takeoff. With carrier pressurized tires, static MRT checks may cause the tires to skid, possibly resulting in breach of the tire carcasses (N/A)*

### NOTE

*Static runups with carrier pressurized tires should be accomplished at or below 90% N2, with MRT limiters being checked after brake release (N/A)*

OAT° F	N <sub>2</sub> RPM (minimum)
Above 50° F	97 percent
37 to 50° F	96 percent
21 to 36° F	95 percent
9 to 20° F	94 percent
-5 to +8° F	93 percent
-15 to -6° F	92 percent

Use brakes and/or NWS to maintain directional control. Check the predicted line speed at the selected distance marker. Five knots prior to predicted liftoff speed, raise the nose to a takeoff attitude (approximately 10 degrees noseup) and allow the aircraft to fly off the deck.

### NOTE

For full flap takeoffs with aircraft gross weights less than 12,000 pounds, begin rotation 8 knots prior to liftoff speed.

1. After comfortably airborne place gear handle up.
2. Push handle up and in to ensure handle is seated.

**Once gear indicated up and locked, (less than 200 KIAS) check gear handle for proper**

### operation -

3. Lightly (less than 6 lbs. of force) try to move the gear handle directly down, (do not pull out)

- Landing gear and flaps/slats should be fully retracted before reaching limit speed of 200 knots.
- The gear uplock mechanism can be overridden with 20-50 lbs. of force applied to the gear handle.

### If gear handle moved down with light pressure -

4. Remain below 200 KIAS
5. Abort mission
6. Gear handle - DOWN
7. Land as soon as practical

## 7.11 CLIMB, CRUISE

7.11.1 10,000 Foot Checklist/15 Minute Report.

1. Check all instruments for normal operation.
2. Verify proper cabin pressurization
3. Fuel state – CHECK

## 7.12 DESCENT/PENETRATION

*Before descent, the windshield and canopy should be preheated by increasing the air flow and temperature. The maximum cockpit temperature should be maintained to aid in defogging the windshield and canopy. The following should be considered to determine the preheating required: OAT, humidity, rate of descent, power setting, and cockpit temperature. Should fogging occur with the AIR FLOW knob set to MAX DEFOG and the CABIN TEMP knob set to maximum AUTO heat setting, consider use of manual mode and maximum heat with MAX DEFOG selected until fogging clears or temperature becomes excessive. (N/A)*

**1. Canopy defog and cockpit temperature - AS REQUIRED BEFORE THROTTLE REDUCTION (N/A)**

2. MASTER ARM switch – SAFE (N/A)
3. CONTR AUG switch – ALL (N/A)
4. Weather/ field conditions - CHECKED
5. NAVAIDS - TUNED/IDENTIFIED
6. (T-45A) SAHRS – CHECK/ALIGN (N/A)
7. Standby attitude indicator - ERECT
8. Standby barometric altimeter – SET BAROMETRIC PRESSURE
9. (T-45A) Radar altimeter - SET
10. LAW - SET
11. MFDs/HUD - COMPARE DISPLAYS (ADI, HSI, and HUD) WITH STANDBY INSTRUMENTS
12. Fuel - CHECK

Sustained engine operation at less than 70% N2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout. If engine flameout occurs, perform an airstart.

## 7.13 LANDING

### 7.13.1 Landing Checklist.

1. Gear - DOWN
2. Flaps/ slats - AS REQUIRED
3. Hook - AS REQUIRED
4. *Harness - AS REQUIRED (N/A)*
5. Speed brakes - AS REQUIRED
6. *Anti-skid - AS REQUIRED (N/A)*

### 7.13.2 Approach.

Enter the pattern as prescribed by local course rules. At the break, reduce thrust as required and extend the speed brakes. As the airspeed decreases through 200KIAS, lower the landing gear and flaps/slats. Decelerate to on-speed, and perform an angle of attack check (airspeed at 17 units AOA).

GROSS WT. (Pounds)	FULL FLAPS (KIAS)	HALF FLAPS (KIAS)	ZERO FLAPS (KIAS)	EMERG FLAPS (KIAS)
11,000	114	132	151	114
12,000	119	138	157	119
13,000	124	143	164	124
14,000	128	149	170	128
15,000	133	154	176	133

Complete the landing checklist prior to reaching the abeam position. Continue past the abeam to the 180 degree position, then commence the approach turn using approximately 27 to 30 degrees angle of bank. Control the rate of descent to reach 450 feet AGL at approximately the 90 degree position. At the 45 degree position, altitude should be 350 to 375 feet AGL, intercept the glideslope and fly optimum AOA to touchdown.

Slow engine response may preclude recovery from high rates of descent in close, which may occur during rates of descent in excess of 600 feet per minute at touchdown.

### 7.13.3 Normal Field Landing.

At touchdown retard the throttle to IDLE. Maintain back pressure on throttle until ground idle is achieved.

Failure to retard the throttle from approach idle to idle after landing could result in hot brakes during subsequent ground operations.

#### NOTE

*When the ANTI-SKID switch is set to ON, the*

*approach idle stop retracts immediately with weight-on-wheels (N/A)*

Braking or a combination of braking and NWS inputs may result in PIO. If PIO about the runway centerline occurs, discontinue braking and use low gain NWS to accomplish a straight track down the runway. Once a straight track is accomplished, resume normal braking. Slight pumping of the brakes prior to normal brake application may preclude additional PIO. See figure for a typical field landing.

Improper braking and NWS technique may result in exaggerated PIO.

### 7.13.4 Crosswind Landing.

**7.13.4.1 General.** The aircraft is easily controllable in cross wind landings. Full flaps are recommended for crosswind landings. The approach and rollout characteristics with half flaps and slats are similar except for the airspeeds.

Landings without flaps and slats will exhibit decreased lateral and directional stability in the approach since the ARI and bank angle feedback are turned off with flaps and slats up at less than 217 KIAS. The optimum approach technique is the wings level crab. A wing down top rudder approach is not recommended because the yaw damper opposes rudder pedal input. Furthermore, there is insufficient rudder authority to track straight in crosswinds above 15 knots. The recommended procedures follow.

1. Use a wings level crabbed approach to the runway.
2. Just prior to touchdown, smoothly take out the crab with rudder. As rudder is going in, use opposite aileron to maintain wings level with the goal of touching down wings level with the nose of the airplane aligned with the runway heading. If the crab is taken out too early, continue into a wing down top rudder approach to stop any drift.
3. On main gear touchdown, immediately apply full aileron into the wind and neutralize the rudder prior to nose wheel touchdown. Maintain longitudinal stick where trimmed for the approach or slightly forward. If less aileron is required to maintain wings level later in the rollout then take out aileron if desired. Full aileron should be held to taxi speed for crosswinds above 20 knots.
4. Throttle to idle.
5. Use NWS to maintain or attain desired ground track.
6. Apply brakes to slow the airplane when desired or required. Differential braking may also be used, and is effective in directional control.

**7.13.4.2 Touchdown** The exact timing of the

kick out is not critical. When the nose wheels contact the surface with rudder pedals applied a moderate swerve that is easily corrected with NWS will occur. Some oscillations may occur until the ground track is stabilized.

**7.13.4.3 Landing Rollout.** The upwind wing has a definite tendency to rise during the rollout and it is essential that full aileron into the wind be applied at touchdown. If full aileron is not applied until the upwind wing has risen, it may take up to 10 seconds for the angle of bank to reduce to comfortable levels. Generally, full aileron is required to hold wings level in crosswinds up to 23 knots. Even with full aileron, with crosswinds above 23 knots the upwind wing will rise and may be as high as 6 degrees with 30 knots of crosswind. If the ground track is straight, the aircraft appears as if it is rolling out in a crabbed attitude. Even with 6 degrees angle of bank at the highest crosswinds, the lateral drift rate during the rollout is slow and easily controlled with NWS. Generally a little upwind NWS is required to track straight.

**7.13.4.4 Rudder Pedal Feel.** Due to the manual rudder and no-float configuration, rudder pedal feel in strong crosswinds differs significantly between upwind and downwind pedals. When making a downwind NWS correction, 6 to 8 pounds of force is required to break out of the no-float, but then the wind pushes the rudder causing additional uncommanded input. Therefore, NWS inputs downwind tend to overshoot and have to be immediately countered. Corrections into the wind require high forces on the upwind rudder pedal. A smoother rollout is achieved by accepting a little drift and making fewer corrections rather than trying to tightly track the centerline.

**7.13.5 Wet Runway Landing.** Use anti-skid to minimize landing roll. Operations on wet or flooded runway may produce hydroplaning throughout the landing speed range. Consider an arrested landing. If directional control problems occur after touchdown, execute go-around and make an arrested landing.

**7.13.6 Flaps/Slats Up Landing.** Fly optimum AOA approach (approximately 42 to 49 KIAS above full flaps/slats airspeed). Ensure maximum wheel speed is not exceeded at touchdown.  
NOTE

With flaps up and gear down, minimize sideslip excursions. Sideslip angles of 8 degrees or greater may cause structural damage to the nose/tailpipe fire.

landing gear doors.

#### **7.14 WAVEOFF/MISSED APPROACH**

To execute a waveoff, immediately add full power, retract speed brakes, maintain landing attitude (not to exceed optimum AOA) and establish a safe rate of climb. If desired, with a positive rate of climb, raise the landing gear and flaps/ slats above 140 KIAS. Transition from full flaps to 1/2 flaps may be accomplished above 125 KIAS.

#### **7.15 AFTER LANDING (CLEAR OF RUNWAY)**

1. Ejection seat SAFE/ARMED handle - SAFE (N/A)

2. Speed brakes - RETRACT

3. Flaps/ slats - UP

4. Trim - SET TO ZERO

5. NAV equipment/IFF - OFF

6. HUD - OFF

7. PITOT HEAT switch - OFF

8. Strobe light - OFF

9. VCR switch - OFF

Allow 10 seconds before engine shutdown to ensure tape unthreads.

#### **7.16 BEFORE ENGINE SHUTDOWN**

*The GINA should not be turned off before electrical power is removed. The DEU retains the last position information it receives from the GINA upon electrical shutdown as waypoint 0. (N/A)*

1. Parking brake - SET

2. BIT status - RECORD

3. Perform IBIT on DEGD equipment

4. IBIT results - RECORD

5. MANT display - CHECK

6. Aircraft exceedance - CHECK

NOTE Report all A/C exceedance and/or ADR memory overflow indications to maintenance.

7. GINA power - OFF (in chocks) (N/A)

8. MFDs - OFF

9. UHF/VHF radios - OFF

10. VCR switch - OFF

11. OBOGS FLOW selector - OFF

12. OBOGS/ANTI-G switch - OFF

13. Idle RPM - ENSURE WITHIN  $\pm 2\%$  OF IDLE RPM.

#### **7.17 Engine Shutdown.**

Before shutting down the engine, ensure that throttle has been at IDLE for at least 30 seconds to cool the engine.

1. Throttle - OFF

Bumping the throttle out of the OFF position during shutdown may lead to rising EGT and

The engine should not be shut down from a high power setting except in an emergency condition. (NOTE: IN FSX ENGINE SHUTDOWN IS ACHIEVED BY PULLING THE FUEL SHUT OFF HANDLE – FUEL SHUT OFF HANDLE SHOULD BE PULLED AT THIS )

2. Canopy - AS DESIRED

45 seconds after setting throttle to off -

3. BATT 1 and BATT 2 switches - OFF

4. All remaining switches - OFF

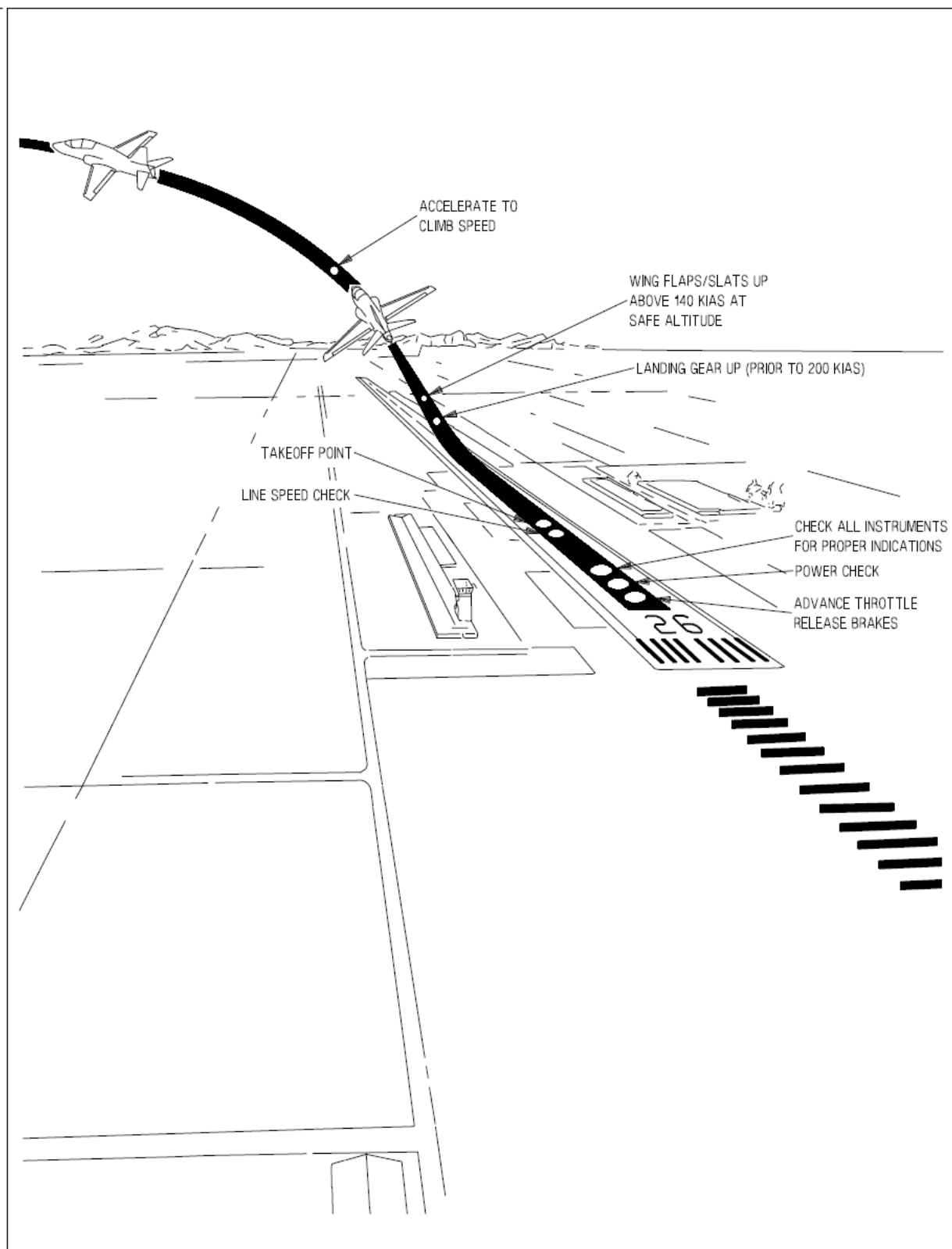
5. *Engine switch - OFF (front cockpit only) (N/A)*

6. Fuel shutoff handle – PULL (N/A – SEE HANDLE – FUEL SHUT OFF HANDLE SHOULD ABOVE)

7. *MDL cartridge – REMOVE (N/A)*

8. *VCR - REMOVE, IF REQUIRED (N/A)*



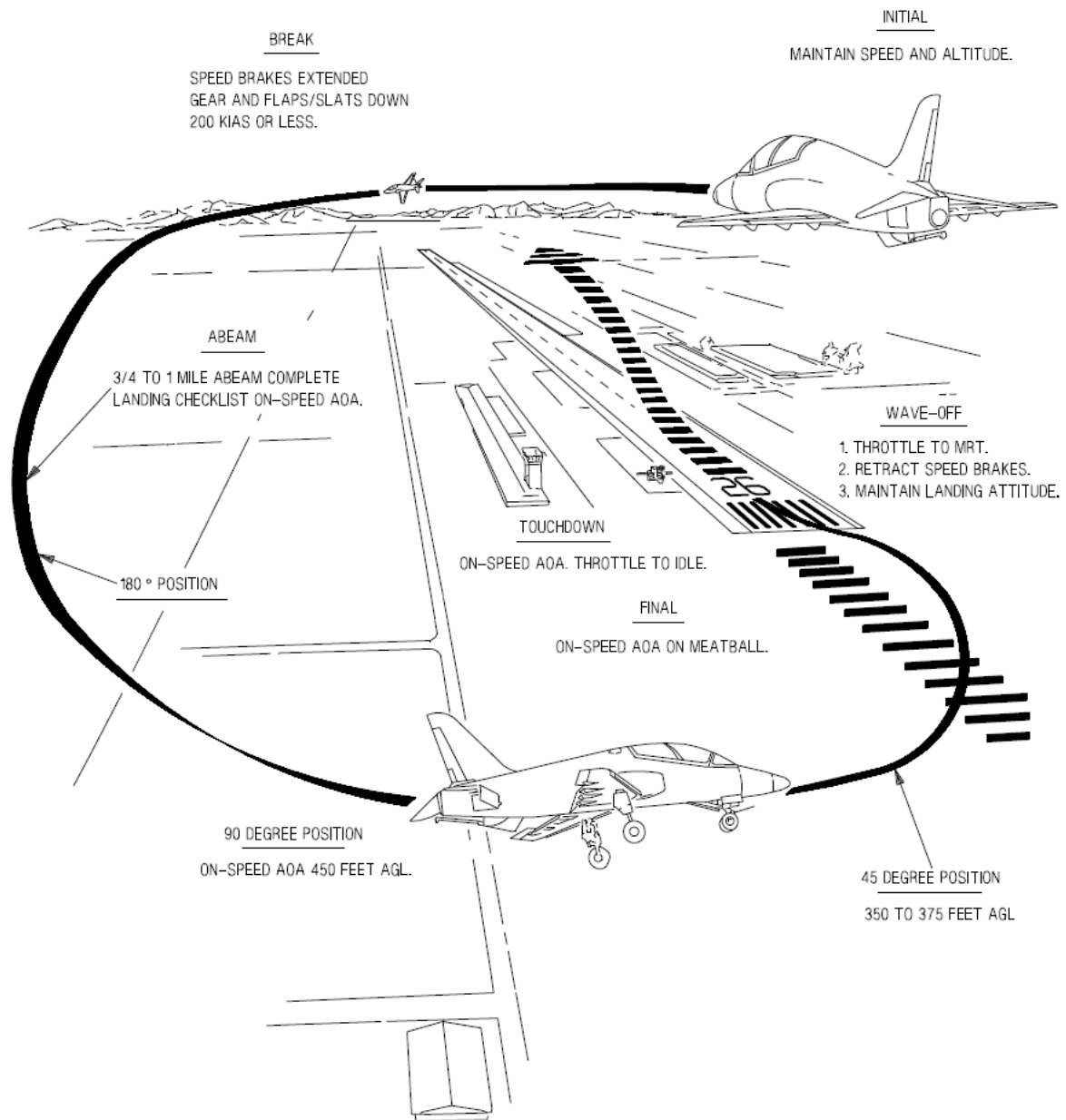


**Field Takeoff (Typical)**



**NOTE:**

SEE LANDING DISTANCE CHARTS IN PART XI  
FOR FINAL APPROACH AND TOUCHDOWN SPEEDS.



**Field Landing Pattern (Typical)**

E0A815-82-1-003

# CHAPTER 8

## Carrier-Based Procedures

### 8.1 GENERAL

The CV and LSO NATOPS Manuals are the governing publications for the carrier-based operations and procedures. All flight crewmembers shall be familiar with CV NATOPS procedures and Aircraft Launch/Recovery Bulletins prior to carrier operations.

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

**NOTE: SECTIONS 8.2, 8.3, 8.9, 8.10, 8.11 HAVE NO USE IN FLIGHT SIMULATOR X AND HAVE BEEN INCLUDED WITHOUT SPECIFIC MODIFICATIONS. THESE SECTION HAVE BEEN INCLUDED FOR INFORMATION ONLY**

**NOTE: CATAPULT HOOKUP AND LAUNCH PROCEDURES SHALL THE SAME AS THE DEFAULT PROCEDURES FOR FLIGHT SIMULATOR X: ACCELERATION**

#### CAUTION!

**Anti-skid shall be off for all carrier operations (N/A)**

### 8.2 HANGAR DECK OPERATION

Occasionally the assigned aircraft is manned on the hangar deck. If the aircraft is not already on the elevator, it is towed or pushed with the pilot in the cockpit onto the elevator, chocked and chained.

#### NOTE

Ensure adequate emergency brake pressure prior to manning aircraft. The director signals for braking by either a hand signal, whistle blast, or both. Leave the canopy open and helmet off to facilitate hearing the directors whistle. Prior to breaking down the chocks and chains at the flight deck level, close the canopy, set the parking brake, and arm the ejection seat.

Do not arm ejection seat until elevator is at flight deck level.

### 8.3 PREFLIGHT

Conduct a normal preflight, paying particular attention to the condition of the landing gear, struts, tires, arresting hook, launch bar and the underside of the fuselage for evidence of arresting cable damage. Note the relationship of the arresting hook to the deck edge.

**NOTE: FROM THIS POINT ON, REAL WORLD CHECKLISTS HAVE BEEN EXTENSIVELY MODIFIED FOR USE IN FLIGHT SIMULATOR X. CHECKLIST ITEMS WRITTEN IN *ITALIC* AND IDENTIFIED AS N/A (NOT APPLICABLE) HAVE NO FUNCTION IN FSX EVEN IF THE RELEVANT COCKPIT ITEM IS CLICKABLE.**

### 8.4 ENGINE START

Ensure the canopy is closed and locked prior to GTS lightoff. Proceed with a normal start, paying particular attention to EGT especially if the aircraft is spotted in the vicinity of jet exhaust from other aircraft.

### 8.5 POSTSTART

Conduct the systems checks outlined in the normal procedures. Oxygen masks shall be on, canopy down and locked, and ejection seat armed prior to removing the chocks and chains. Hold the brakes when the tiedowns and chocks are removed.

Do not lower the hook during post start checks unless the hook point will drop on the flight deck.

### 8.6 PRIOR TO TAXI

1. *CONTR AUG – ALL (N/A)*
2. *ANTI-SKID switch – OFF (N/A)*
3. Controls - WIPEOUT
4. Trim - SET
  - a. Rudder and aileron - ZERO
  - b. Stabilator - 3.5 DEGREES NOSEUP
5. Controls - WIPEOUT
6. Verify trim settings
7. Canopy - CLOSED, LOCKED, LIGHT OUT
8. *Harness – CONNECTED (N/A)*
9. Ejection seat - ARMED
10. Ejection seat handle - CLEAR OF CONTROL STICK
11. Parking brake – DESELECT

### 8.7 TAXI

Taxiing aboard ship is much the same as ashore, but increased awareness of jet exhaust and aircraft directors is mandatory. Nose wheel steering is used for directional control aboard ship. Higher than normal power settings may be needed while taxiing on the flight deck due to ship motion, wind over the deck, jet blast, or any combination of these effects.

Taxi speed should be kept under control at all times. The canopy shall be down and locked,

oxygen mask on, and the ejection seat armed during taxi. Increasing power slightly prior to hot gas ingestion increases air flow for engine cooling. Monitor EGT; if temperature exceeds limits, engine shut down should be considered. Whenever hot jet exhausts from other aircraft are directed toward the intake, a potential for overtemp exists.

### 8.8 BEFORE CATAPULT HOOK-UP

Before taxi onto the catapult, complete the takeoff checklist and ensure the heading is aligned with the base recovery course (BRC). With flaps set to FULL, set takeoff trim to 3.5 degrees noseup. For normal operation, 15 KIAS endspeed above the minimum endspeed is recommended.

NOTE: THIS T-45C PACKAGE FOR FLIGHT SIMULATOR X USES DEFAULT CATAPULT LAUNCH ENDSPEED. THIS RESULTS IN ENDSPEED HIGHER THAN 200 Kts – THAT WOULD BE ABOVE THE MAXIMUM GEAR DOWN SPEED OF THE REAL AIRCRAFT.

Takeoff trim setting is only valid with hands off the control stick. Care should be taken to ensure that proper trim setting is set prior to launch.

#### NOTE

System alignment in the directional gyro (DGRO) mode requires correct heading information to be manually entered prior to launch.

1. *CONTR AUG switch – ALL (N/A)*
2. *ANTI-SKID switch – OFF (N/A)*
3. *Flaps/Slats – FULL (N/A)*
4. Trim:
  - a. Rudder and aileron - ZERO
  - b. Stabilator - 3.5 DEGREES NOSE-UP
5. Canopy - CLOSED, LOCKED and LIGHT OUT
6. *Harness – CONNECTED (N/A)*
7. *Ejection Seat – ARMED (N/A)*

Correct stabilator trim is critical to obtaining adequate catapult fly-away performance.

Stabilator trim affects initial pitch rate and fly-away AOA. A low stabilator trim setting lowers the initial pitch rate and fly-away AOA, resulting in a flatter fly-away attitude and possible sink off bow.

### 8.9 CATAPULT HOOK-UP

Before taxiing past the shuttle, verify the aircraft gross weight and complete the takeoff checklist. Approach the catapult track slowly while lightly riding the brakes. Use minimum power required

to keep the aircraft rolling. Close attention to plane director's signals is required to align the aircraft with the catapult track wye entry. When aligned, the plane director will signal the pilot to lower the launch bar. Place the LAUNCH BAR switch to EXTEND. The green launch bar advisory light will illuminate and the NWS will disengage. The low mode of the NWS may be engaged with the launch bar down by pressing and holding the NWS button. This should only be done on signal from the director since catapult personnel may be in close proximity to the launch bar. Do not use NWS once the launch bar enters the track. The catapult crew will install the holdback bar. Taxi forward slowly, following the signals of the plane director. When the launch bar drops over the shuttle spreader, the aircraft will be stopped by the holdback bar engaging the catapult buffer.

#### NOTE

An intermittent ACCEL light may occur while taxiing into the catapult shuttle at varying power settings (65 to 75% RPM) with the LAUNCH BAR switch in the EXTEND position (ambiguous indication – timing sequence).

### 8.10 AIRCRAFT OR CATAPULT MALFUNCTION

If a malfunction is detected after the aircraft is in tension, initiate suspend procedures. Do not reduce power until directed by the catapult officer.

### 8.11 CATAPULT SUSPEND

If you want to suspend the launch while tensioned on the catapult, signal by shaking the head from side to side. Transmit to Pri-Fly, "SUSPEND (catapult number)" on land/ launch frequency. Never raise a hand into the catapult officer's view to give a thumbs down signal or any hand signal that may be interpreted as a salute.

The catapult officer will reply with a "SUSPEND" signal followed by an "UNTENSION AIRPLANE ON CATAPULT" signal. The shuttle spreader will be moved aft and the launch bar will automatically raise to clear the shuttle spreader. Maintain power at MRT until the catapult officer steps in front of the aircraft and signals "THROTTLE BACK". Then, and only then, reduce the throttle from military to idle. The same signals will be used when a catapult malfunction exists.

### 8.12 CATAPULT LAUNCH

Upon receipt of the "TENSION UP AND

RELEASE BRAKES " signal, advance the throttle to military, throttle friction as desired, and check all engine and flight instruments for normal indications and operation. Upon signal from the catapult director and after feeling the aircraft take tension (aircraft squats), place the LAUNCH BAR switch to RETRACT and perform a smooth, but rapid cycle of flight controls ensuring full deflection in all axes.

Selecting launch bar RETRACT before receiving the retract signal from the aircraft director may raise the launch bar before it is properly seated in the shuttle spreader assembly, resulting in a mispositioned launch bar.

After successful completion of the flight control wipeout, place feet in the catapult position (tip of boot under rudder pedal toe guide) and visually verify feet are correctly positioned.

The toe guide serves only as a reminder to the pilot of correct foot positioning for catapult launches. Failure to maintain correct foot position throughout the catapult stroke may result in a blown tire due to inadvertent brake application. Ensure the ejection seat handle is clear of the control stick and recheck launch trim. If dual, ensure HOT mic is selected and rear seat pilot is ready, place your head against the headrest and render an exaggerated hand salute with your right hand to the Catapult Officer. There will be a 2 to 4 second delay before catapult firing due to sequence followed by the catapult crew.

Catapult launches should be planned for a 15 KIAS excess end airspeed. Excess end airspeed is an additional safety factor added to the minimum airspeed required to effect a safe, but not optimum, catapult launch. The minimum airspeed was determined during shipboard carrier suitability trials and is applicable for specific gross weights and ambient temperature conditions.

Grip the control stick lightly and allow it to move aft during the launch as it is affected by the catapult acceleration. It should be noted that the control stick moves laterally to the left if not restrained during the launch, resulting in a slight left wing down condition after launch which can be easily controlled with lateral stick following launch.

After leaving the catapult, the elevator trim setting causes the aircraft to rotate to the pitch attitude of 8 to 10 degrees. The resulting climbing attitude is the optimum for aircraft weight and, once attained, should be maintained with stick positioning and trim. The AOA indicator should indicate approximately 19 units. After launch, maintain optimum AOA and pitch angle, and monitor the airspeed and altimeter for increasing values. Instrument scan after launch should include all flight instruments. Initial pitch attitude and wing position is immediately indicated on the ADI. Airspeed information is available and can be monitored during the catapult stroke. Vertical speed lags slightly but may be used after leaving the catapult. The altimeter, like the VSI, lags and accurate information is not available for use immediately after launch. It must be emphasized that the most important requirement after catapult launch is the necessity to climb.

### 8.13 CARRIER LANDING

Enter the carrier landing pattern with the hook down. Make a level break from a course parallel to the BRC, close aboard the starboard side of the ship. Below 200 KIAS lower the gear and flaps/ slats. Descend to 600 feet when established downwind. Complete the landing checklist and cross-check AOA and airspeed prior to the 180 degree position.

With a 25 knot wind over the deck begin the 180 degree turn to the final approach when approximately abeam the LSO platform. When the meatball is expected to be acquired, transmit call sign, Goshawk, Ball or Clara and fuel state (nearest 100 pounds). Fly the aircraft at optimum angle of attack from the 180 degree position to touchdown.

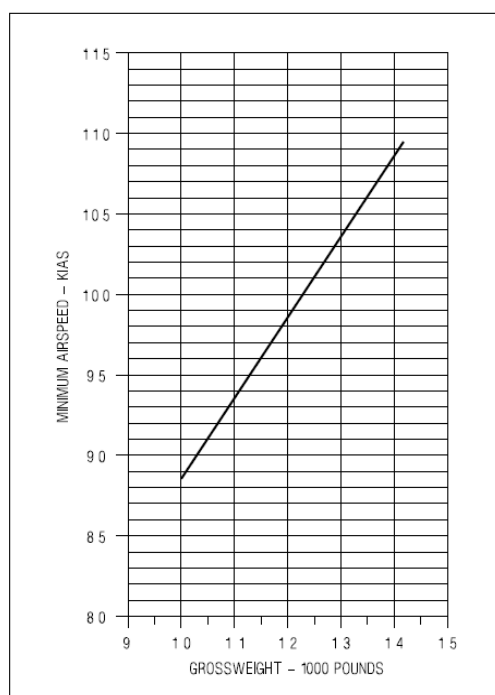


Figure 8-1. Catapult Launch Minimum Endspeed

## 8.14 ARRESTMENT AND EXIT FROM THE LANDING AREA

Upon touchdown, add power to MRT and retract the speed brakes. When forward motion has stopped, reduce power to IDLE and allow the aircraft to roll back a short distance. Hold the brakes and raise the hook on signal from the taxi director. Use high gain NWS and approximately 70 percent power to expedite exit from the landing area.

### NOTE

Utilize a combination of power and brakes to stop the rearward motion caused by the roll back. Extreme use of the brakes to halt this motion may cause the aircraft to tip back excessively.

## 8.15 WAVEOFF TECHNIQUE

To execute a waveoff, immediately add power to MRT, retract the speed brakes, and smoothly adjust the nose of the aircraft to maintain landing attitude (not to exceed 17 units AOA) and establish a safe rate of climb. Waveoff should be up the angled deck.

Over rotation on a waveoff can place the aircraft on the back side of the power required curve, where sufficient power is not available to stop the descent.

Exceeding optimum angle of attack on a waveoff lowers the hook to ramp clearance and can result in an in-flight engagement. The resulting arrestment can cause damage to the aircraft. After a waveoff or a bolter, establish a positive rate of climb. At the bow, turn to parallel the BRC. Do not cross the bow while flying upwind.

## 8.16 POST LANDING PROCEDURES

The canopy should remain closed until after engine shutdown. Do not release brakes until the aircraft has at least an initial three-point tiedown. If the aircraft is towed or pushed, be alert for hand signals from aircraft handling personnel. Set parking brake and execute a normal shutdown when the cut signal is received. If the aircraft is to be spotted on the hangar deck, safe the seat, unstrap, remove helmet and open the canopy after the aircraft is chocked and

chained on the elevator. Hold the brakes after being spotted in the hangar bay until the required number of tiedowns have been attached.

### 8.16.1 Hot Refueling

1. Pilot signal for cutoff at 2,800 pounds.

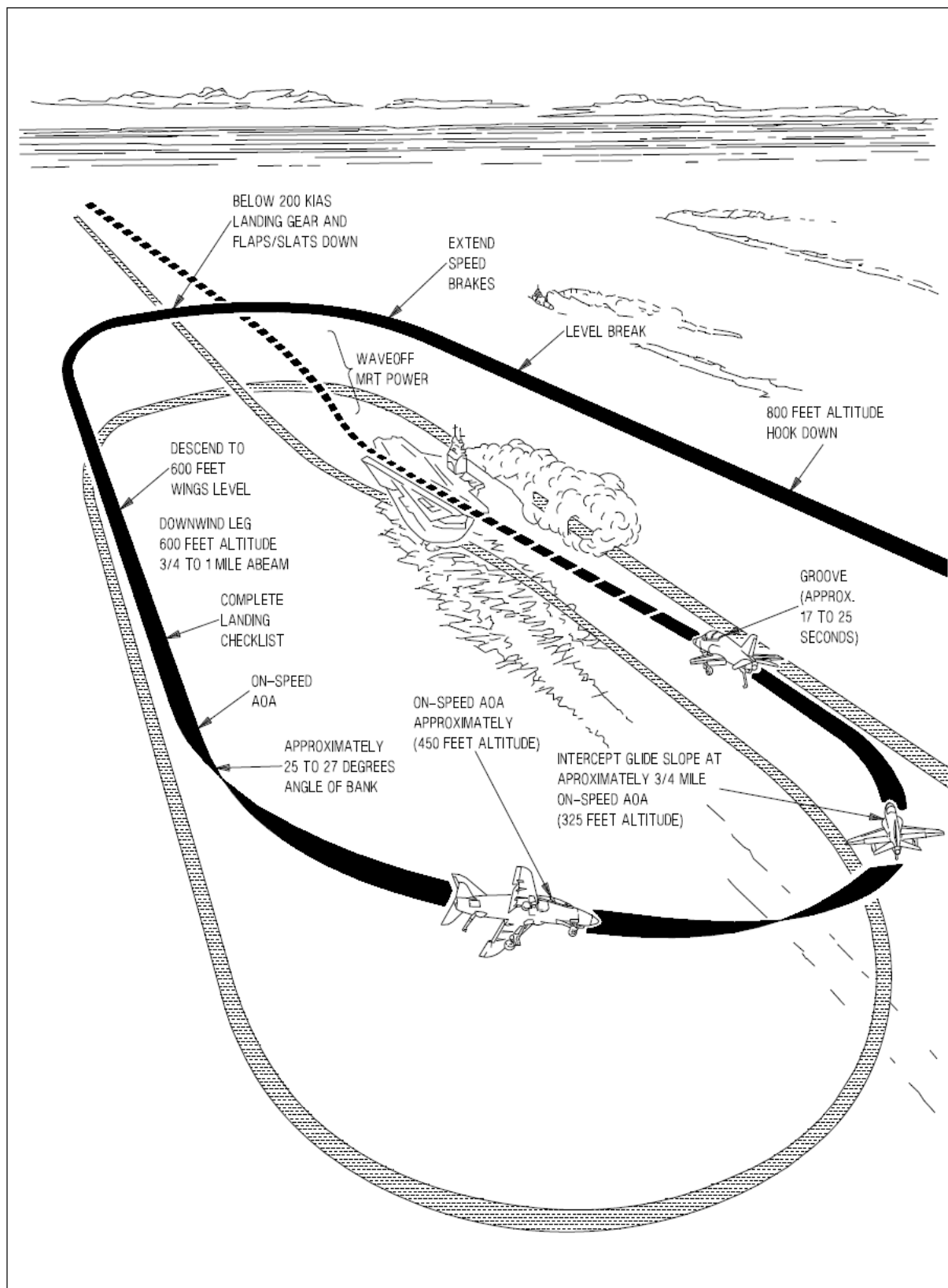
## 8.17 CARRIER CONTROLLED APPROACH (CCA)

**8.17.1 General.** The pattern procedures and terms used for carrier controlled approaches shall be in accordance with the CV NATOPS manual.

**8.17.2 Procedures.** Lower the hook entering the holding pattern and maintain maximum endurance airspeed. Arrive at the marshal point at your estimated arrival time (EAT). Commence the penetration at 250 KIAS, 4,000 fpm rate of descent, with speed brakes extended, and power as required. At 5,000 feet (platform), the rate of descent is reduced to 2,000 fpm, and speed is maintained at 250 KIAS to the 10-mile gate. At this point, slow to 150 KIAS. Lower the landing gear and place the flaps/slats to down as airspeed drops below 200 KIAS. Retract speed brakes and adjust power to maintain 150 KIAS. At 6 nm, in the landing configuration, slow to optimum AOA. Unless otherwise directed, maintain 1,200 feet and optimum approach speed until directed to commence descent at about 3 miles. Then, extend speed brakes and maintain optimum AOA/airspeed.

After transition is made to the landing configuration, all turns should be standard rate in pattern and 1/2 standard rate on final. Do not exceed 30 degrees angle of bank at any time.

**8.17.3 Carrier Emergency Signals.** Refer to CV NATOPS manual for emergency signals from carrier to aircraft.

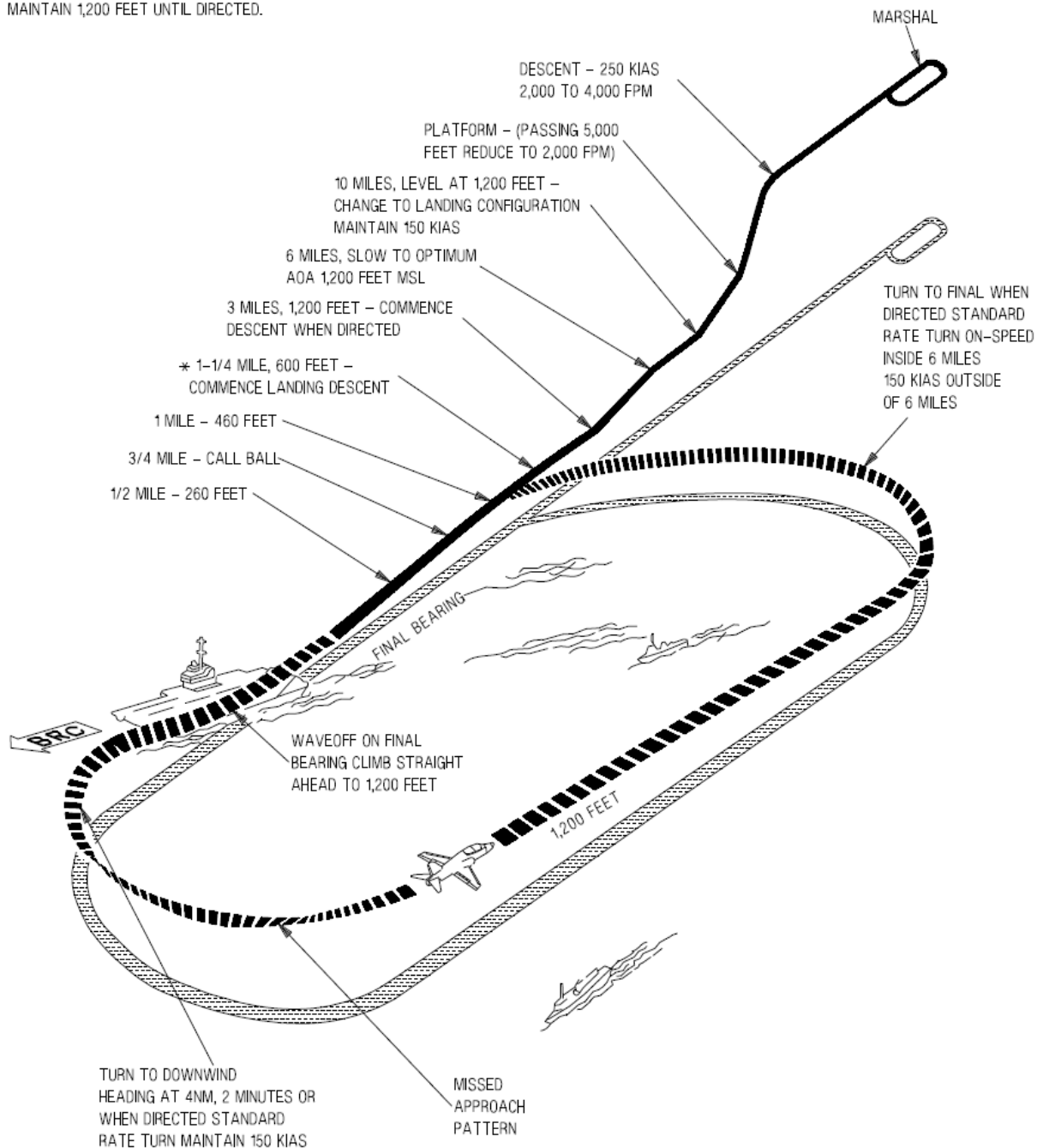


EOA615-84-1-003

**Carrier Landing Pattern (Typical)**

# VOICE REPORTS

- ENTERING HOLDING "SIDE NUMBER, ESTABLISHED, ANGELS \_\_\_\_\_".
- DEPARTING MARSHAL "SIDE NUMBER, COMMENCING, STATE \_\_\_\_\_, ALTIMETER \_\_\_\_\_".
- 5,000 FEET - "SIDE NUMBER, PLATFORM".
- 10 MILES - "SIDE NUMBER, 10 MILES".
- BALL CALL - "SIDE NUMBER, GOSHAWK, BALL OR CLARA, FUEL STATE".
- \* NON-PRECISION (ASR) APPROACH ONLY, FOR PRECISION (PAR) APPROACH, MAINTAIN 1,200 FEET UNTIL DIRECTED.



Carrier Controlled Approach (CCA) (Typical)

# CHAPTER 9

## Special Procedures

### 9.1 FORMATION FLIGHT

**9.1.1 Formation Taxi/Takeoff.** During taxi, a 150-foot interval should be maintained. For formation takeoff, all aspects of the takeoff must be prebriefed by the flight leader. This includes:

1. Flap settings
2. Use of nose wheel steering
3. Power changes
4. Power settings
5. Signals for actuation of landing gear and flaps/slats.

The leader takes position on the downwind side of the runway with other aircraft in tactical order, maintaining briefed alignment. After takeoff checks are completed and the flight is in position, each pilot looks over the next aircraft to ensure:

1. Speed brakes are retracted
2. Flaps/ slats are set for takeoff
3. All panels are closed
4. No fluids are leaking
5. Nose wheel is straight
6. Launch bar is up.

Beginning with the last aircraft in the flight, a “thumbs up” is passed toward the lead to indicate “ready for takeoff”. See figure for typical formation takeoff runway alignment.

**9.1.2 Section Takeoff.** After completion of engine run up checks, lead should reduce power by approximately 2 percent RPM, but not less than 95 percent. On signal from the leader, brakes are released. Normal takeoff techniques should be used by the leader, with the wingman striving to match the lead aircraft's attitude as well as maintaining a position on the parade bearing with wingtip separation. The gear and flaps/slats are retracted on signal. No turn into the wingman will be made at an altitude less than 500 feet above ground level.

**9.1.3 Parade.** The bearing in parade formation is maintained by sighting along the leading edge of the lead's wing line. This positions the aircraft on a bearing approximately 30 degrees aft of the lead. The proper step-down (approximately 5 feet) is achieved by being able to see equal portions of the top and bottom of the lead's wing. Parade turns are either standard visual meteorological conditions (VMC) or instrument

meteorological conditions (IMC) turns. During day VMC conditions, turns away from the wingman are standard turns. To execute, when lead turns away the wingmen roll their aircraft about their own axis and increase power slightly to maintain rate of turn with the leader. Step-down is maintained by keeping the lead's fuselage on the horizon.

Day VMC turns into the wingman and all IMC or night turns in a parade formation are instrument turns. During instrument turns, wingmen roll their aircraft about the lead's axis. After initially joining up in echelon, three and four aircraft formations normally use balanced parade formation.

**9.1.4 Cruise Formation.** The cruise formation is a more open formation which allows the wingmen more time for visual lookout. Cruise formation provides the wingmen with a cone behind the leader in which to maneuver. This allows the wingman to make turns by pulling inside the leader and requires little throttle change.

The cruise position is defined by a line from the lead's wingtip navigation light with the lower UHF/VHF antenna, with 20 feet of nose to tail separation. The wingmen are free to maneuver within the cone established by the bearing line (approximately 45 degrees) on either side of the lead. In a division formation, dash 3 should fly the bearing line, but always leave adequate room for dash 2 and lead. Dash 4 flies cruise about dash 3.

**9.1.5 Section Approach/Landing.** During section approaches all turns are instrument turns about the leader. When a penetration is commenced the leader retards power to 80 percent RPM, extends speed brakes and descends at 250 KIAS (4,000 to 6,000 fpm). Approximately 5 miles from the final approach fix or ground controlled approach (GCA) pickup, the lead gives the signal for gear and flap/slat extension.

### 9.2 GUN BANNER TOW PROCEDURES

NOTE: GUN BANNER TOW IS NOT IMPLEMENTED IN THIS FSX RENDITION. THIS PARAGRAPH IS INCLUDED FOR



## INFORMATION ONLY.

**9.2.1 Runway Hookup.** Taxi to the upwind side of the runway near the hookup point of the cable, approximately 1,000 feet from the approach end.

- Ensure the short field arresting gear has been derigged.

- Banner crosswind limit is 10 knots. Following banner hookup, test the banner release mechanism. The banner is then reattached, and the crew leader indicates completion with a thumbs-up.

**9.2.2 Takeoff/Departure.** Takeoff performance is not affected by tow banner. After liftoff, rotate to optimum AOA, retract the landing gear as soon as the aircraft is airborne, and climb to ensure the banner clears the long field gear. Maintain 140 KIAS climb profile (approximately 12 to 15 degrees nose up) to 500 feet AGL. Above 500 feet AGL continue climb to altitude at MRT power and 200 KIAS.

**9.2.3 Enroute.** Optimum climb/cruise airspeed is 200 KIAS, not to exceed 200 KIAS. The maximum AOA while turning is optimum units.

**9.2.4 Banner Drop.** Normal banner drop is done from an altitude of 500 feet AGL and 200

KIAS. Lowering the hook will release the banner.

**9.2.4.3 Emergency Banner Drop.**

1. Drop the banner in a designated area clear of population and buildings.

2. Note the position for subsequent recovery/safety reports.

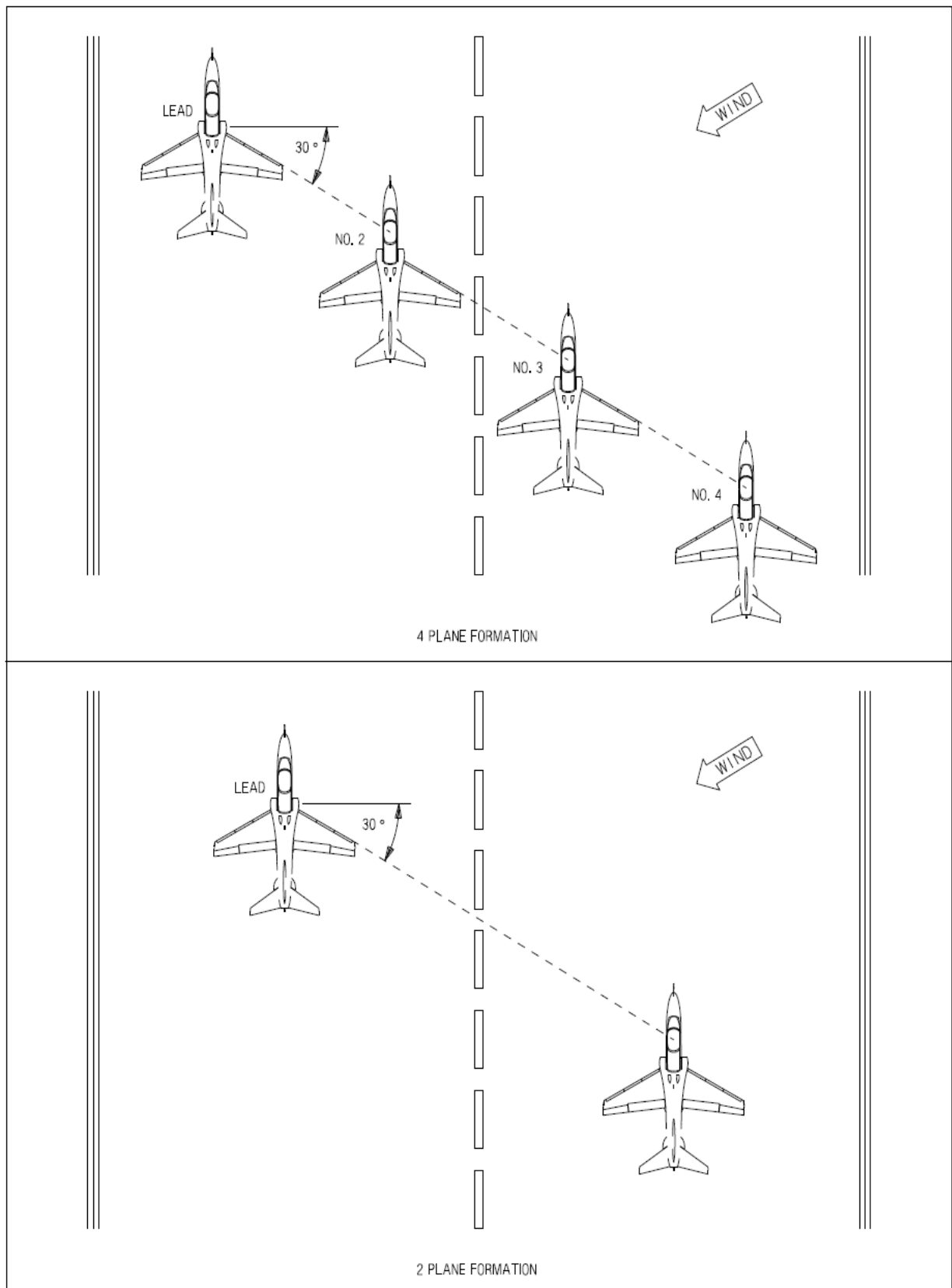
**9.2.4.4 Landing With A Banner.** Execute a VFR straight-in or GCA approach to land on the designated runway. Ensure the short field arresting gear is derigged. Maintain at least 500 feet AGL and between 130 and 150 KIAS until inside the airport boundary and then descend to 300 feet AGL until the banner is clear of the runway threshold. Use the long field arresting gear if required. The ground crew will manually disconnect the cable.

- Watch for excessive rate of descent due to the added drag of the banner.

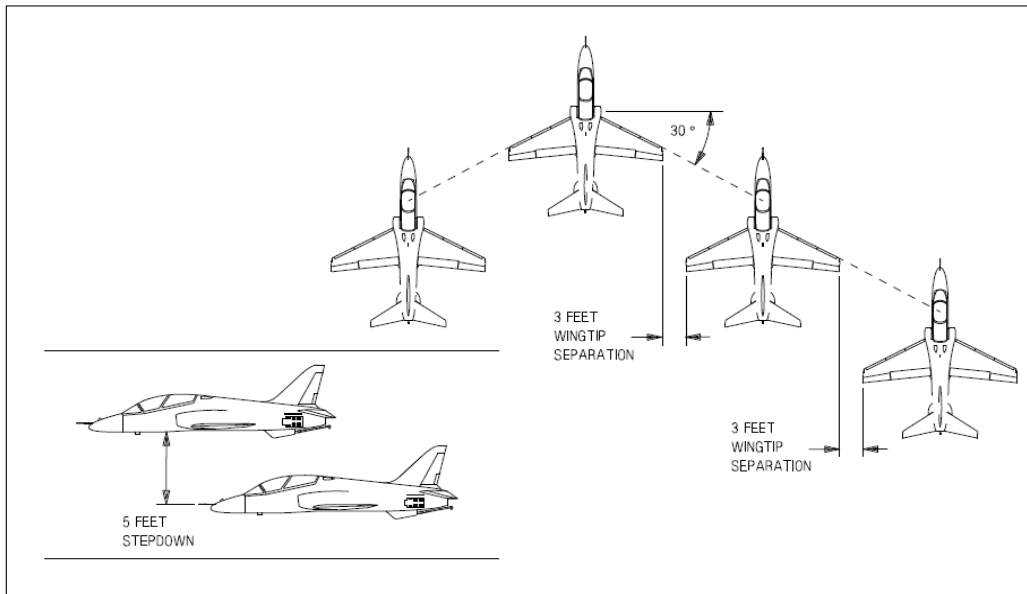
- At 200 KIAS, the banner sags approximately 100 feet.

- At 150 KIAS, the banner sags approximately 200 feet.

- At 120 KIAS, the banner sags approximately 300 feet.

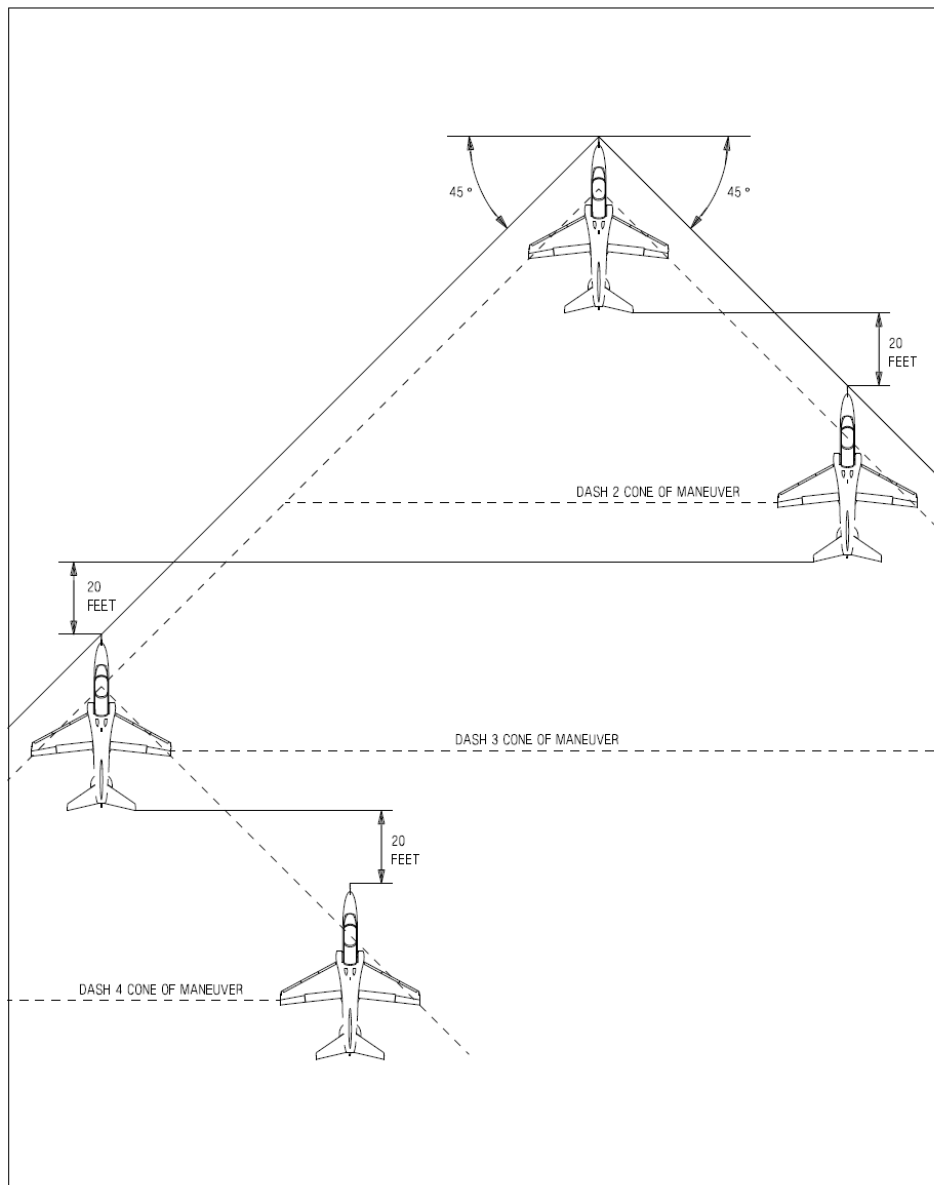


## Formation Takeoff Runway Alignments



EDA815-87-1-01

**Parade Formation**



EDA815-88-1-01

**Cruise Formation**

# CHAPTER 10

## Flight Characteristics

### 10.1 INTRODUCTION

The flight characteristics of the aircraft described in this section are based on flight test information unless otherwise noted.

**NOTE: ALBEIT THIS CHAPTER HAS BEEN HIGHLY MODIFIED FROM THE ORIGINAL FLIGHT MANUAL, IT DEPICTS THE FLIGHT CHARACTERISTICS OF THE REAL T-45. FLIGHT CHARACTERISTICS OF THE VIRTUAL GOSHAWK IN FLIGHT SIMULATOR X MAY DIFFER SIGNIFICANTLY.**

### 10.2 FLIGHT CONTROLS

The flight control forces are generally light to moderate. The aircraft is quite responsive throughout most of the flight envelope.

#### 10.2.1 Ailerons.

**10.2.1.1 Cruise Configuration.** Roll control is good throughout most of the flight envelope and aileron forces are independent of airspeed. The aircraft responds quickly to roll initiation. Typically maximum roll rates are 160 to 170 degrees/second and are obtained from 350 to 400 KIAS below 0.85 Mach, however, roll rates up to 270 degrees/second can be experienced with large lateral inputs at 0.82 to 0.84 Mach.

**10.2.1.2 Landing Configuration.** Roll response is crisp and predictable below 21 units AOA. With the CONTR AUG in ALL, there is very little adverse yaw, even with large aileron inputs. Above 21 units AOA, the roll rate decreases and adverse yaw increases as AOA increases.

**10.2.2 Stabilator.** Pitch control is generally very crisp and responsive. The stick force required for any maneuver depends on the control stick displacement from the trimmed position and to some extent, upon the quickness of the input. Throughout the heart of the envelope from 0.5 to 0.85 Mach, maneuvering stick forces are relatively moderate and the aircraft response is predictable. In the transonic region from 0.86 to 0.99 Mach, the stick forces are light and g's should be applied more judiciously and at a slower rate to avoid overstress. When large stabilator deflections are required, as at low airspeed or above 1.0 Mach, the stick forces are heavy.

**10.2.3 Rudder.** The rudder system is reversible, except that it contains a no-float rudder

lock. Aerodynamic forces are fed back through the rudder pedals whenever the rudder is outside the breakout band for the no-float rudder lock. The rudder pedal forces are light at low airspeeds and become progressively heavier as airspeed increases. The rudder is not very effective in rolling the aircraft at any speed. Above 400 KIAS, very little yaw can be generated with the rudder due to aerodynamic hinge moments holding rudder deflection to a minimum. Below 0.85 Mach, the aircraft rolls slightly in the direction of the applied rudder, while above 0.85 Mach the roll is away from the applied rudder.

#### 10.2.4 Control Augmentation Off or Failed.

Control Augmentation is not simulated in this FSX rendition, and should be considered "always on".

**10.2.5 Speed Brakes.** The speed brakes are operable throughout the flight envelope; however, full extension of the speed brakes occurs only at 340 KIAS or less. If full extension exists, it is available up to 380 KIAS, where blowback begins. Extension above 340 KIAS results in partial deflection, but full deflection becomes available once the airspeed has decreased to 340 KIAS. (NOTE: this limitation does not apply to Flight Simulator X and speed brakes can be fully deflected at all speeds)

**10.2.6 Trim.** Longitudinal, lateral, and directional trim is capable of reducing control forces in all axes to zero for all stabilized level flight conditions. As airspeed increases to approximately 300 KIAS, nosedown trimming is required to maintain level flight. From 300 to 450 KIAS, trim changes are minimal. When accelerating above 0.85 Mach, slight noseup trim is required. During deceleration the required trim changes are reversed, becoming more pronounced in the low airspeed range. Above 0.9 Mach, establishing a trimmed constant Mach dive is difficult and trimming is not recommended, as control forces become more sensitive.

**10.2.6.1 Trim Changes Due To Speed Brakes.** The trim change due to speed brake extension/retraction is noticeable, especially in formation flight. At Mach numbers below 0.8, the aircraft trim change with speed brake extension is slightly noseup and requires a small push force to counteract. At Mach numbers

above 0.8, the aircraft trim change is nosedown and requires a slight pull force. The opposite occurs upon retraction. The trim change due to speed brake extension in the landing/approach configuration is negligible.

#### NOTE

During speed brake extension/ retraction, expect aircraft pitch attitude change of up to  $\pm 2$  degrees, respectively.

#### 10.2.6.2 Trim Changes Due To Wing Flaps

**/Slats And Landing Gear.** Extension of the flaps/ slats requires a moderate push force (3 to 4 pounds) to prevent an increase in altitude, often described as a balloon response. As the flaps/ slats reach full down, up to one third aft stick is required to prevent a large settle in altitude.

Stick forces are greatest at 200 KIAS and are reduced at lower airspeeds. Stick forces during flap/slat retraction are opposite in direction and equal in magnitude. Extension/retraction of the landing gear requires a lower magnitude trim change in the direction opposite the flap/slat trim change. Small, uncommanded yaw excursions may be experienced during landing gear transition.

**10.2.7 Emergency Gear.** Extending gear by the emergency method produces a reduction in directional stability due to the main landing gear doors remaining fully open and the nose landing gear forward doors being actuated up to within 10 degrees of fully closed by an electrical actuator.

In this configuration, the aircraft is less stable directionally and the pilot needs to use coordinated stick and rudder during approach to landing to control the slight yaw excursions which may be encountered.

**10.2.8 Emergency Flaps.** Emergency flap extension is not available in this Flight Simulator X rendition.

### 10.3 GENERAL FLIGHT CHARACTERISTICS

**10.3.1 Level Flight.** At full power, the maximum airspeed obtainable in level flight is approximately 0.83 Mach. The aircraft is essentially buffet-free in level flight, but there is a slight nosedown pitch change above about 0.8 Mach. At low altitudes (below 5,000 feet MSL) and airspeeds above 450 KIAS, longitudinal control becomes sensitive.

#### 10.3.2 Maneuvering Flight.

**10.3.2.1 Longitudinal.** Below 0.85 Mach the aircraft is highly maneuverable with predictable longitudinal flying qualities. Stick forces are moderate and provide good feedback. Above 0.84 Mach the stick forces become noticeably more sensitive.

**10.3.2.2 Roll Performance.** At Mach numbers up to 0.9, aircraft response to both small and full lateral inputs in 1g flight is crisp and predictable. Roll rates of up to 180 degrees per second can be achieved between 0.7 to 0.9Mach. During loaded rolls, the aircraft exhibits a tendency to unload, losing up to 2gfs at higher entry load factors.

During loaded rolls at high subsonic Mach numbers (greater than 0.8Mach), roll response can be unpredictable. Loaded aileron rolls in the low transonic region (0.8 to 0.9 Mach) can produce large roll rates in excess of 260 degrees per second due to reduced roll damping at AOA near stall.

**10.3.2.3 High Speed Dive.** The aircraft is capable of attaining approximately 1.04 Mach with no external stores. The aircraft should be trimmed at 0.7 to 0.75 Mach and the trim maintained throughout the dive. High speed dives are not recommended past 15,000 feet MSL due to pull out altitude requirements for safe recovery. Characteristics in a transonic dive are:

#### CAUTION!

A region of reduced longitudinal stability exists within the trim AOA band at approximately 0.87 trueMach number. The pilot perceives this as stick force lightening or pitch-up. Less than 3 pounds of stick force can result in g excursions of +1 to +3g. Excursions are highest at aft CG. Use caution during high speed dive recoveries to avoid overstress in this pitchup region.

1. As airspeed increases past 0.9 Mach, slight buffeting is felt that may increase slightly as Mach increases. At approximately 0.92 Mach, either wing may become heavy and begin a slow roll. Up to 3/4 lateral stick may be required to maintain wings level. Above 0.92 Mach there is a marked reduction in aileron effectiveness. Roll rate degrades rapidly with increasing Mach. Roll rates as low as 27 degrees per second at 0.95 Mach were observed in flight test using full lateral stick.

Above 0.95 Mach the wing heaviness disappears and the aileron effectiveness returns.

Slight pitch oscillations may be evident as the center of pressure shifts aft. Some random motion due to shock wave formation may be noticeable. It is very difficult to stabilize on a Mach number or an exact dive angle in this region.

2. As airspeed increases past 1.0 Mach, the slight pitch oscillations diminish. Pitch changes require higher stick forces due to the aft shift in center of pressure. The aircraft is very stable directionally and full stick aileron rolls can generate roll rates of approximately 120 degrees per second.

3. The dive recovery should be initiated by pulling no more than 4.0gfs to prevent excessive g overshoot. Shortly into the recovery at 0.99 Mach, a sharp pitchup occurs and must be countered by quickly easing aft stick to maintain 4.0gfs. A rapid g jump of over 2gfs may occur if not countered with forward stick. This pitchup is due to the sudden shift in the center of pressure as the aircraft shifts from supersonic to subsonic speeds. No more than 4gfs should be maintained following the first pitchup because it is shortly followed by a second pitchup during deceleration somewhere between 0.95 to 0.85 Mach as AOA reaches 10 to 11 units. Once the second pitchup has occurred, the longitudinal characteristics become predictable and g can be increased as desired.

## **10.4 TAKEOFF AND LANDING CHARACTERISTICS**

**10.4.1 Takeoff.** Takeoffs are easily accomplished in all loading configurations. However, with a large asymmetry (i.e., LAU-68 with rockets or PMBR with practice bombs), the pilot notes some roll and yaw on lift off, unless rudder and aileron trim has been pre-positioned to prevent it. Rotation with takeoff trim set at 3 degrees noseup requires about 8 to 12 pounds longitudinal stick force and allows smooth, precise longitudinal control.

**10.4.2 Landing Rollout.** The aircraft shows some directional sensitivity during landing rollout due to combined effects of aerodynamics, landing gear dynamics, braking and nose wheel steering inputs. Upon touchdown, the aircraft may swerve, requiring pilot action to maintain a straight track. As the pilot applies braking and nose wheel steering inputs a tendency for directional

oscillations is noticeable. During these oscillations, minimize control inputs and allow the aircraft to stabilize before reapplying controls.

**10.4.2.1 Crosswind Landing Rollout.** During crosswind landing rollouts, the rudder tends to align itself with the relative wind, and this is fed back into the pedals. The pilot perceives it as uneven pedal forces required to make corrections during the rollout, which may be disconcerting.

Also, the upwind wing has a definite tendency to rise during rollout and it is essential that full aileron into the wind be applied at touchdown. If full aileron is not applied until the upwind wing has risen, it may take up to 10 seconds for the bank angle to reduce to comfortable levels. Full aileron is usually required to hold wings level in crosswinds up to 20 knots, and some residual bank angle (1 to 2 degrees) remains at the highest crosswinds.

## **10.5 FLIGHT CHARACTERISTICS WITH EXTERNAL STORES**

External stores may be not available and will have no effect in this Flight Simulator X rendition.

## **10.6 HIGH ANGLE OF ATTACK CHARACTERISTICS**

### **WARNING!**

Maneuvering within 20 degrees of vertical pitch attitude at airspeeds less than 100 KIAS could result in departure and inverted spin entry.

### **CAUTION!**

. Abrupt stick inputs to or near full back stick with the throttle above idle may result in engine surge, overtemperature and/or damage due to rapid changes in AOA and/or sideslip.

. Avoid abrupt forward stick inputs due to the possibility of encountering a forward stick departure.

. Risk of engine stall increases when maneuvering at high angles of attack and/or above heavy buffet, when the engine is accelerating from low power settings or at high power settings.

### **NOTE**

. Rapid engine acceleration from low power settings can increase engine stall sensitivity and decrease engine stall margin.

. Engine stall characteristics vary depending on power setting, engine acceleration, and maneuver severity. Self-recovering pop stalls are sometimes indicated by an audible bang or pop with correct engine operation being immediately restored with no pilot action.

Locked-in stalls at low power settings are characterized by a slow EGT rise (approximately 12°C per second) and a gradual decay in RPM, with no audible cue to the pilot. EGT rise during a low power stall accelerates rapidly if the throttle is advanced. Locked-in stalls at high power settings are sometimes indicated by an audible bang or pop and are characterized by a very rapid temperature rise. A locked-in stall can sometimes be cleared by positioning the throttle to idle. If the stall remains locked in, the engine must be shut down to clear it.

**10.6.1 Stall Characteristics.** In all configurations, stalls are defined initially by wing roll off and an associated pitch break. The amount of wing roll off is highly variable, particularly in configurations with the slats retracted. The aircraft provides very little natural stall warning, leaving rudder shakers and AOA warning tone the best indication of impending stall.

**10.6.1.1 Cruise Configuration.** In the cruise configuration, there is little or no aerodynamic stall warning such as buffet or wing rock until immediately prior (1 to 2 knots) to stall. In power on (thrust for level flight) stalls, the high pitch attitude (approximately 20 degrees) is a good secondary indication of impending stall. With idle power, the pitch attitude is significantly less and might not be noticeable.

**10.6.1.2 Power Approach (PA)/Takeoff (TO) Configuration.** With gear down and flaps/slats HALF or FULL, there is no noticeable increase in buffet during the approach to stall until immediately prior to the stall. In power on stalls, the high pitch attitude (about 20 degrees) is a good secondary indication of impending stall. With power off the pitch attitude is significantly less and may not be noticeable. With gear down and flaps/slats full (PA), the first indication of impending stall is a slight longitudinal instability and wing rock at about 28 units AOA. This is followed, at about 29 to 30 units AOA, by a noticeable increase in buffet and closely precedes an uncommanded wing drop of about 15 to 20 degrees and pitch break which define stall. Speed brake position has no effect on stall characteristics. In all configurations, stall

recovery is immediate upon release of aft stick. Altitude loss can be minimized by application of MRT power and capturing 24 units AOA.

#### **10.6.1.4 Accelerated Stalls - Cruise**

**Configuration.** The amount of pre-stall buffet warning in maneuvers varies with airspeed and altitude. At higher altitudes the buffet starts as mild buffet and builds to heavy buffet at the stall. As altitude decreases and airspeed increases, the buffet band compresses, moves closer to the stall, and the magnitude of the initial buffet increases. Stall AOA decreases as Mach increases. The stall itself is primarily a pitch oscillation (bucking motion) accompanied by wing rock at all airspeeds and altitudes. This pitch bucking motion is noticeable at AOA anywhere between buffet onset, which is essentially where maximum lift occurs, and full aft stick. Easing aft stick is all that is required to recover.

#### **10.6.1.6 Accelerated Stalls - PA/TO**

**Configuration.** It is difficult to obtain an accelerated stall in the takeoff or landing configuration (gear down/ flaps HALF or FULL/SLATS OUT), especially with power on. Because full (or nearly full) aft stick is required to stall, stick forces are high (18 to 20 pounds). At approximately 24 units AOA buffet begins and the level increases significantly, giving a good indication of impending stall. At approximately 27 units AOA, a rapid, uncommanded increase in pitch rate occurs, immediately followed by the pitch rate decreasing. In most cases this occurs with full aft stick. If aft stick is held, aircraft AOA oscillates about 30 units and the aircraft becomes less stable laterally, giving the impression of wallowing. Ailerons are less effective, but are adequate for roll control during recovery. If the stall is held, the pilot can get out of phase with the roll and get into a mild wing rock. Recovery is immediate with relaxation of aft stick. Some small roll and yaw oscillations may be present during recovery. Rudder is effective in controlling the roll/yaw oscillations following the stall.

**10.6.2 Lateral Stick Rolls.** During lateral stick rolls above buffet onset, the aircraft rolls in the direction of the applied lateral stick. However, an abrupt pitchup due to inertial coupling, or mild roll oscillations may be experienced during the roll. During maneuvers near full aft stick, a large amount of sideslip is usually present as the lateral stick is neutralized following bank angle changes near 180 degrees. This sideslip

generally results in an additional uncommanded roll in the direction of the original roll command as much as 180 degrees due to strong lateral stability.

However, depending on control input timing, the aircraft could experience no additional roll or a slight nosedown motion or unload. If controls are neutralized, all rates will return to zero following the uncommanded roll.

Peak roll rate increases with increasing Mach number. Roll rates in excess of 250 degrees/second may be encountered in the 0.8 Mach number region when using large lateral inputs. The magnitude and frequency of the roll rate oscillations also increase with increasing Mach number. If aggravated controls are maintained, the roll oscillations can diverge and couple the aircraft into a pitchdown departure.

**10.6.3 Coordinated Lateral Stick And Pedal Rolls.** Rolling with coordinated lateral stick and rudder will always produce a faster roll rate than when rolling with lateral stick alone or rudder alone. However, at high speeds, the additional increase in roll rate due to the rudder is very small due to the small rudder deflection angles which can be generated.

**10.6.4 Rudder Rolls.** When the aircraft is rolled at high angles of attack using the rudder only, it rolls in the direction of the applied rudder. The roll rate achieved is a function of Mach number and angle of attack. Due to increasing rudder hinge moments as airspeed increases, the pilot commands less rudder pedal deflection for a constant rudder pedal force at high speeds as compared to low speeds.

**10.6.5 Departures.** During all departures, failure to forcefully center the rudder pedals in combination with inadvertent lateral control inputs aggravates aircraft motion and can result in large yaw excursions or additional roll oscillations, both of which can prolong the out-of-control flight condition and possibly result in inverted spin entry.

The pilot must assess aircraft status, determining whether the aircraft has truly departed controlled flight, is in a post-stall gyration, or is in a developed spin. The rudder pedals must be forcefully centered and the control stick must be held neutral to recover from a departure. The rudder must be neutralized and this may take considerable rudder pedal force (in excess of 250 pounds). Relaxing the rudder pedal force, or putting feet on the floor, does not command a neutral rudder position in the presence of high

sideslip angles because the rudder control system is reversible and rudder blowout may occur, causing the rudder to be deflected fully in the direction of the turn needle.

**10.6.6 Vertical Maneuvering.** Up to approximately 70 degrees pitch attitude at any airspeed, even below 100 KIAS, the aircraft recovers easily from a near vertical maneuver with use of neutral controls and any power setting. Recovery response is a ballistic flight path with the nose seeking the nearest horizon (assuming no gross mis-trimming of the aircraft). During flight testing, no departures or incipient spins were encountered when the above recovery technique was used at pitch attitudes of less than 70 degrees. Near zero indicated airspeed may be encountered during this recovery maneuver. The pilot must be aware that above 70 degrees pitch attitude, the airspeed decays very rapidly. Control inputs made at 100 KIAS or below and less than about 70 degrees pitch attitude produce a very slow aircraft response but can assist in reducing pitch attitude. All control inputs should be neutralized as the nose approaches the horizon and the aircraft should be allowed to recover to a nose low, increasing airspeed condition.

**10.6.7 Spins.** The aircraft is highly resistant to upright and inverted spins. While upright spins have been achieved in flight test, they are unstable and tend to oscillate out of the spin. During departure and spin testing, no upright spins were achieved with pedals centered and lateral and longitudinal stick neutralized. Stabilized inverted spins are possible and have been entered from pure vertical maneuvers (tailslides) or by timed control inputs from pitchdown departures. The pilot should neutralize lateral stick and forcefully center the rudder pedals until it can be determined whether the out-of-control motion is a PSG or a spin, then apply recovery controls as necessary. AOA, airspeed, and turn needle should be used to determine the nature of the out-of-control motion. If AOA is positive for any length of time, the aircraft is upright. If AOA is at or fluctuating near zero, the aircraft is probably inverted. If the turn needle is changing significantly, the aircraft is probably not in a spin, but is in a PSG.

Pegged AOA, airspeed oscillating between 50 and 160 KIAS and pegged turn needle verify a fully developed spin. AOA pegged at 0 units indicates an inverted spin, while AOA above 28 units indicates an upright spin. Due to the disorienting nature of spins, particularly inverted,



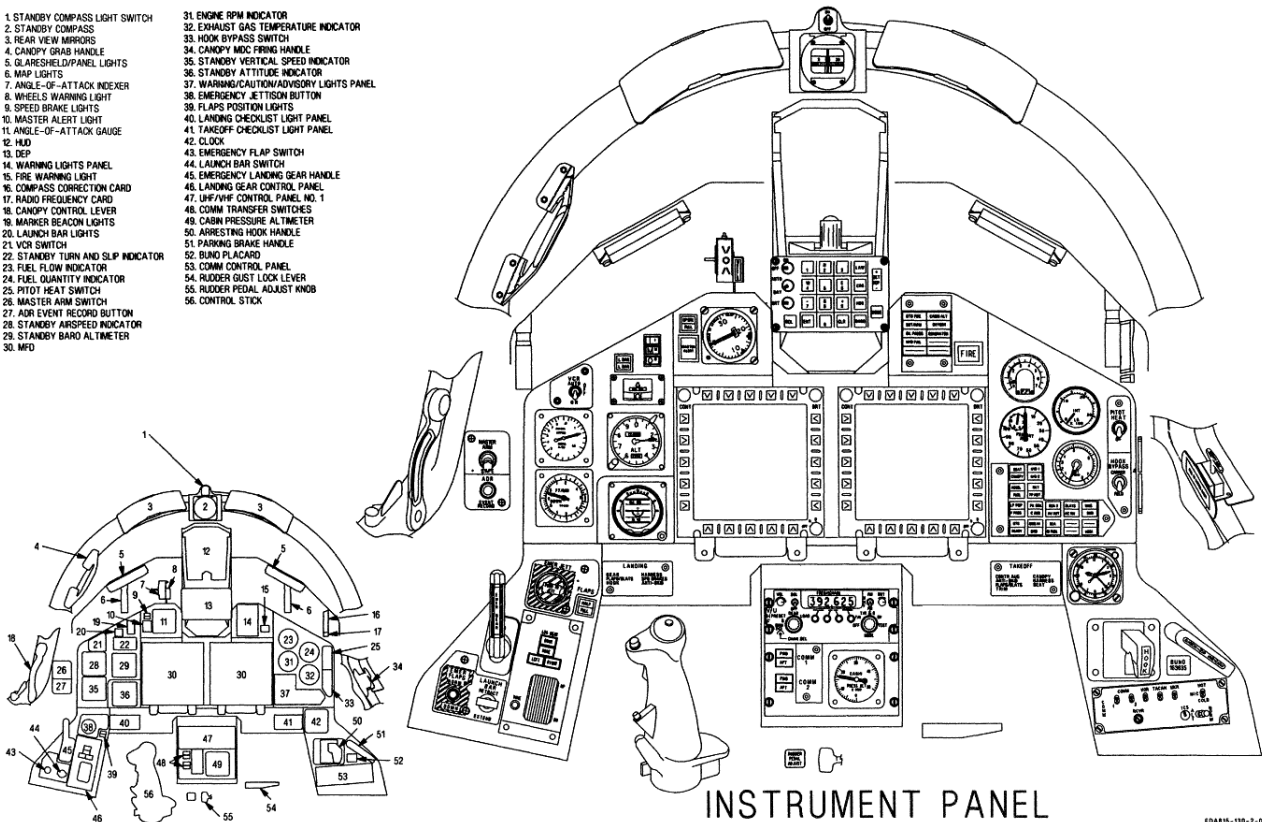
the turn needle must be referenced to determine spin direction. Turn needle to the right indicates a right spin, while turn needle to the left indicates a left spin. After determining spin mode and direction the appropriate recovery controls can be applied.

and spins. Engine EGT and RPM should be monitored after departure/spin recovery to determine engine status. An inverted spin will likely result in either a flameout or surge, regardless of power setting.

An engine anomaly will likely occur during PSGs

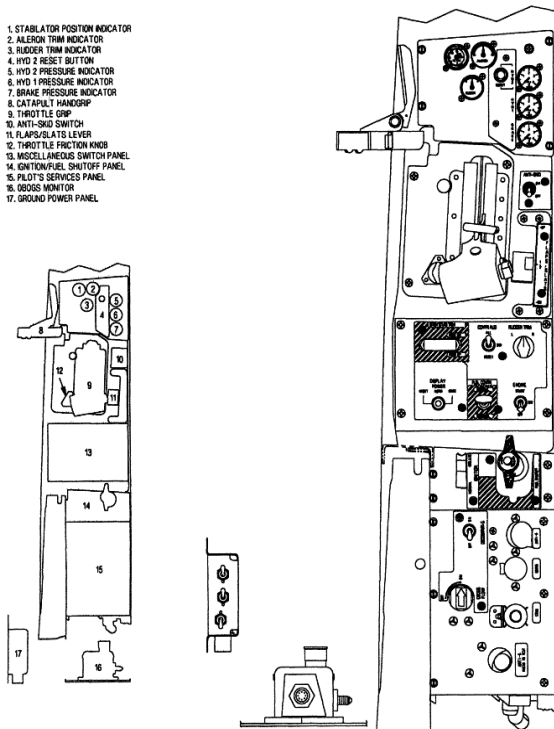
# APPENDIX A – FORWARD COCKPIT LAYOUT

1. STANDBY COMPASS LIGHT SWITCH
2. STANDBY COMPASS
3. REAR VIEW MIRROR
4. CANOPY GRAB HANDLE
5. GLARESHIELD/PANEL LIGHTS
6. MAP LIGHTS
7. ANGLE-OF-ATTACK INDEXER
8. WHEELS WARNING LIGHT
9. SPEED BRAKE LIGHTS
10. MASTER ALERT LIGHT
11. ANGLE-OF-ATTACK GAUGE
12. HUD
13. DEP
14. WARNING LIGHTS PANEL
15. PRE WARNING LIGHT
16. COMPASS CORRECTION CARD
17. RADIO FREQUENCY CARD
18. CANOPY CONTROL LEVER
19. MARKER BEACON LIGHTS
20. LAUNCH BAR LIGHTS
21. VCR SWITCH
22. STANDBY TURN AND SLIP INDICATOR
23. FUEL FLOW INDICATOR
24. FUEL QUANTITY INDICATOR
25. PITOT HEAT SWITCH
26. MASTER ARM SWITCH
27. ADR EVENT RECORD BUTTON
28. STANDBY AIRSPEED INDICATOR
29. STANDBY BARO ALTIMETER
30. MFD
31. ENGINE RPM INDICATOR
32. EXHAUST GAS TEMPERATURE INDICATOR
33. HOOK BYPASS SWITCH
34. CANOPY MDC FRRING HANDLE
35. STANDBY VERTICAL SPEED INDICATOR
36. STANDBY ATTITUDE INDICATOR
37. WARNING/CUTION/ADVISORY LIGHTS PANEL
38. EMERGENCY JETTISON BUTTON
39. FLAPS POSITION LIGHTS
40. LANDING CHECKLIST LIGHT PANEL
41. TAKEOFF CHECKLIST LIGHT PANEL
42. CLOCK
43. EMERGENCY FLAP SWITCH
44. LAUNCH BAR SWITCH
45. EMERGENCY LANDING GEAR HANDLE
46. LANDING GEAR CONTROL PANEL
47. UHF/VHF CONTROL PANEL NO. 1
48. COMM TRANSFER SWITCHES
49. CABIN PRESSURE ALTIMETER
50. ARRESTING HOOK HANDLE
51. PARKING BRAKE HANDLE
52. BUNG PLACARD
53. COMM CONTROL PANEL
54. RUDDER GUST LOCK LEVER
55. RUDDER PEDAL ADJUST KNOB
56. CONTROL STICK



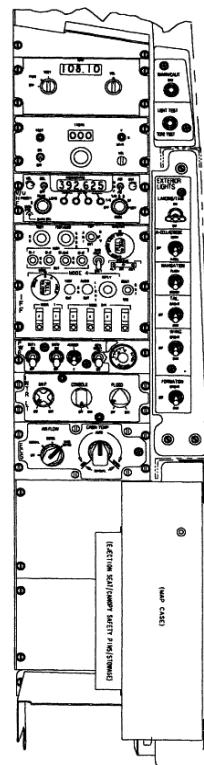
ED815-120-2-01

1. STABILATOR POSITION INDICATOR
2. ALERON TRIM INDICATOR
3. RUDDER TRIM INDICATOR
4. HYD 1 RESET BUTTON
5. HYD 2 PRESSURE INDICATOR
6. HYD 1 PRESSURE INDICATOR
7. BRAKE PRESSURE INDICATOR
8. CATALYTIC HANDGrip
9. THROTTLE GUP
10. ANTI-SKO SWITCH
11. FLAPS/SLATS LEVER
12. THROTTLE FRICTION KNOB
13. MISCELLANEOUS SWITCH PANEL
14. KONTON/FUEL SHUTOFF PANEL
15. PILOT'S SERVICES PANEL
16. OBOSS MONITOR
17. GROUND POWER PANEL



LEFT CONSOLE

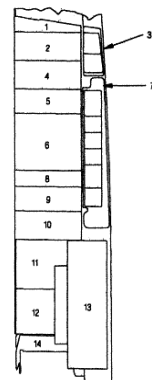
ED815-120-1-01



RIGHT CONSOLE

ED815-120-3-01

1. BLANK PANEL
2. VOR/DLS CONTROL PANEL
3. ANNUNCIATOR DM/TEST PANEL
4. TACAN CONTROL PANEL
5. UHF/VHF CONTROL PANEL NO. 2
6. HF CONTROL PANEL
7. EXTERIOR LIGHTS SWITCH PANEL
8. ELECTRICAL POWER CONTROL PANEL
9. INTERIOR LIGHTS CONTROL PANEL
10. ENVIRONMENTAL CONTROL SYSTEM PANEL
11. BLANK PANEL
12. BLANK PANEL
13. MAP CONTAINER
14. COVER PANEL



## APPENDIX B – DECK / GROUND HANDLING SIGNALS



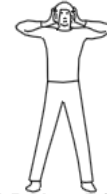
### ACKNOWLEDGEMENT

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.