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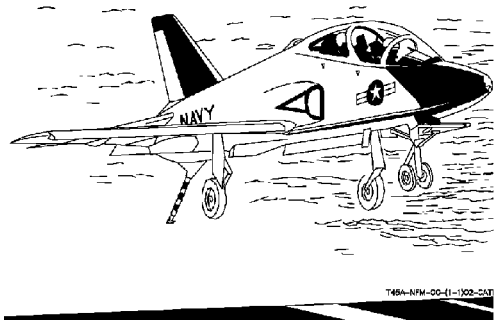

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DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap rate. Standardization, based on professional knowledge and experience, provides the basis for development of an efficient and sound operational procedure. The standardization program is not planned to stifle individual initiative, but rather to aid the commanding officer in increasing the unit's combat potential without reducing command prestige or responsibility.

2. This manual standardizes ground and flight procedures but does not include tactical doctrine. Compliance with the stipulated manual requirements and procedures is mandatory except as authorized herein. In order to remain effective, NATOPS must be dynamic and stimulate rather suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein, in accordance with the waiver provisions established by OPNAVINST 3710.7, for the purpose of assessing new ideas prior to initiating recommendations for permanent changes. This manual is prepared and kept current by the users in order to achieve maximum readiness and safety in the most efficient and economical manner. Should conflict exist between the training and operational procedures found in this manual and those found in other publications, this manual will govern.

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and carried for use in naval aircraft.

DENNIS V. McGINN
Rear Admiral, U.S. Navy
Director, Air Warfare

NATOPS Flight Manual

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RECORD OF CHANGES

Change No. and Date of Change	Date of Entry	Page Count Verified by (Signature)

INTERIM CHANGE SUMMARY

The following Interim Changes have been cancelled or previously incorporated in this manual:

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 thru 6	Previously incorporated

The following Interim Changes have been incorporated in this Change/Revision:

INTERIM CHANGE NUMBER	REMARKS/PURPOSE
7	AIRCRAFT EXCEEDANCE CHECK - POSTSTART CHECKLIST

Interim Changes Outstanding - To be maintained by the custodian of this manual:

INTERIM CHANGE NUMBER	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

PTTUZYUW RUCOMCB3794 1462046-UUUU--RUENNSN.
ZNR UUUUU ZUI RULSABU8410 1462006
RUHBANB T CG FIRST MAW
RUCCNOQ T CG FOURTH MAW
RUCKFCO T CG SECOND MAW
RUWIKBC T CG THIRD MAW
RUHEHMS T COMMARFORPAC
RUNGAAA T EODMU FIVE
RUFRJCS T USS JOHN C STENNIS
RHRCEXJ T USNS NIAGARA FALLS
RUHPABE T USS ABRAHAM LINCOLN
RUHPCVV T USS CARL VINSON
RUHPNUL T USS CONSTELLATION
RUHPYKC T USS CROMMELIN
RUFRIKE T USS DWIGHT D EISENHOWER
RULYNGW T USS GEORGE WASHINGTON
RHFJJFK T USS JOHN F KENNEDY
RUHPZFF T USS KITTY HAWK
RULYMTZ T USS NIMITZ
RULYNTR T USS THEODORE ROOSEVELT
RUFREST T USS WASP
RUCTPIM T PRECOMUNIT IWO JIMA
RUFRIKE T HELANTISUBRON FIVE
RUFRBHR T HMM ONE SIX SIX
RUWDHFY T AIRTEVRON NINE
RULSABQ T AIRTEVRON ONE
P 252006Z MAY 00 ZYB
FM COMNAVAIRSYSCOM PATUXENT RIVER MD //4.3P//
TO AIG 165//
AIG 11183//
RUWHTXF/CNATRA CORPUS CHRISTI TX//N3144/N34/511/N421//
INFO RHMFIUU/CNO WASHINGTON DC//N889//
RUENAAA/CNO WASHINGTON DC//N889//
RUCTPOA/CNET PENSACOLA FL//JJJ//
RULSFAO/PEOASWASM PATUXENT RIVER MD//PMA273//
RUCKFDA/NAVAVNDEPOT CHERRY PT NC//JJJ//
RHFJJBF/NAVAVNDEPOT JACKSONVILLE FL//JJJ//
RUDJABF/NAVWARCOL NEWPORT RI//213//
RUCTPOH/NAVOPMEDINST PENSACOLA FL//060//
BT
UNCLAS //N03711//
MSGID/GENADMIN/COMNAVAIRSYSCOM/4.3P//
SUBJ/INTERIM CHANGES (IC'S) TO T-45 AIRCRAFT NATOPS PUBLICATIONS//
REF/A/DOC/NAVAIR/01SEP99//
REF/B/DOC/NAVAIR/01SEP99//
REF/C/DOC/NAVAIR/01SEP99//
PAGE 02 RUCOMCB3794 UNCLAS
REF/D/DOC/NAVAIR/01SEP99//
NARR/REF A IS NAVAIR A1-T45AB-NFM-000 (T-45A NATOPS FLIGHT MANUAL
(NFM)) DTD 15JAN97 W/CHG-2 01SEP99.
REF B IS NAVAIR A1-T45AC-NFM-000
(T-45C PRELIMINARY NATOPS FLIGHT MANUAL (NFM)) DTD 15AUG97 W/CHG-3
01SEP99.
REF C IS NAVAIR A1-T45AB NFM-500 (T-45A PRELIMINARY NATOPS
PILOT'S CHECKLIST (PCL) W/CHG-2 01SEP99.

REF D IS NAVAIR A1-T45AC NFM-500 (T-45C PCL) W/CHG-3 01SEP99.//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 21 TO REF A (T-45A NFM), INTERIM CHANGE NUMBER 10 TO REF B (T-45C PRELIM NFM), INTERIM CHANGE NUMBER 19 TO REF C (T-45A PCL) AND INTERIM CHANGE NUMBER 9 TO REF D (T-45C PRELIM PCL).
2. SUMMARY. THIS MSG ADDS BDU-33 PRACTICE BOMBS TO EXTERNAL STORES LIMITATIONS FOR THE T-45A AND T-45C AIRCRAFT IN REFS A THROUGH D.
3. CHANGE REFS A (T-45A NFM), AND B (T-45C PRELIM NFM), PAGES I-4-10 AND I-4-11, FIGURE 4-6 EXTERNAL STORES LIMITATIONS (SHEET 1 OF 2 AND SHEET 2 OF 2), AS FOLLOWS:
A. UNDER STORE COLUMN:
   (1) DELETE: PMBR WITH 0 TO 6 MK-76 BOMBS
PAGE 03 RUCOMCB3794 UNCLAS
   (2) ADD: PMBR WITH 0 TO 6 MK-76 OR BDU-33 BOMBS
   (3) DELETE: MIXED LOAD LAU-68 WITH 0 TO 7 2.75 INCH FFAR AND PMBR WITH 0 TO 6 MK-76 BOMBS
   (4) ADD: MIXED LOAD LAU-68 WITH 0 TO 7 2.75 INCH FFAR AND PMBR WITH 0 TO 6 MK-76 OR BDU-33 BOMBS
   (5) DELETE: SINGLE PMBR WITH 0 TO 6 MK-76 BOMBS
   (6) ADD: SINGLE PMBR WITH 0 TO 6 MK-76 OR BDU-33 BOMBS
B. FOR SAME STORES, UNDER CONFIGURATION WEIGHTS (LBS) COLUMN:
   (1) DELETE: PMBR/87 MK76/25 EACH
   (2) ADD: PMBR/87 MK76/25 OR BDU33/25 EACH
   (3) DELETE: PMBR/87 MK76/25 EACH LAU-68/85 FFAR/23 EACH
   (4) ADD: PMBR/87 MK76/25 OR BDU33/25 EACH LAU-68/85 FFAR/23 EACH
   (5) DELETE: PMBR/87 MK 76/25 EACH
   (6) ADD: PMBR/87 MK76/25 OR BDU33/25 EACH
C. FOR SAME STORES, UNDER APPLICABLE NOTES COLUMN:
   (1) DELETE: NA
   (2) ADD: 7
D. IN NOTES SECTION AT BOTTOM OF SHEET 2 OF 2:
   (1) DELETE: NA
PAGE 04 RUCOMCB3794 UNCLAS
   (2) ADD: 7. MIXED BDU33/MK76 AUTHORIZED
5. FOR NATOPS MODEL MANAGER ACTION: DURING NEXT ROUTINE CHANGE REVISION TO NATOPS PUBLICATIONS, REFLECT MK76/BDU33 IN PLACE OF MK76 FOR FLIGHT CHARA SECTION, STUCK THROTTLE APPROACH SECTION, ARMAMENT SYSTEM GENERAL SECTION AND T-45 DELIVERY DATA TABLES.
6. FOR TECHNICAL ISSUES CONTACT AIR-4.1.1.3, CDR TOM GARRISON, T-45 CLASS DESK, PHN 301-757-5178, OR E-MAIL GARRISONTP@NAVAIR.NAVY.MIL.//
BT

ADMINISTRATIVE MESSAGE

PRIORITY

P 012000Z MAR 00 ZYB

FM COMNAVAIRSYSCOM PATUXENT RIVER MD//4.3P//

TO CNATRA CORPUS CHRISTI TX//N3144/N34/511/N421//
ALL GOSHAWK AIRCRAFT ACTIVITIES//

INFO CNO WASHINGTON DC//N889//
CNET PENSACOLA FL//JJJ//
PEOASWASM PATUXENT RIVER MD//PMA273//
NAVAVNDEPOT CHERRY PT NC//JJJ//
NAVAVNDEPOT JACKSONVILLE FL//JJJ//
NAVWARCOL NEWPORT RI//213//
NAVOPMEDINST PENSACOLA FL//060//

UNCLAS //N03711//

MSGID/GENADMIN/COMNAVAIRSYSCOM/4.3P//

SUBJ/INTERIM CHANGES (IC'S) TO T-45 AIRCRAFT NATOPS PUBLICATIONS//

REF/A/DOC/NAVAIR/01SEP99//

REF/B/DOC/NAVAIR/01SEP99//

REF/C/DOC/NAVAIR/01SEP99//

REF/D/DOC/NAVAIR/01SEP99//

NARR/REF A IS NAVAIR A1-T45AB-NFM-000 (T-45A NATOPS FLIGHT MANUAL (NFM)) DTD 15JAN97 W/CHG-2 01SEP99.
REF B IS NAVAIR A1-T45AC-NFM-000 (T-45C PRELIMINARY NATOPS FLIGHT MANUAL (NFM)) DTD 15AUG97 W/CHG-3 01SEP99.
REF C IS NAVAIR A1-T45AB-NFM-500 (T-45A NATOPS PILOT'S POCKET CHECKLIST (PCL)) DTD 15JAN97 W/CHG-2 01SEP99.
REF D IS NAVAIR A1-T45AC-NFM-500 (T-45C PRELIMINARY NATOPS PILOT'S POCKET CHECKLIST (PCL)) DTD 15AUG97 W/CHG-3 01SEP99.//

RMKS/1. THIS IS INTERIM CHANGE NUMBER 20 TO REF A (T-45A NFM), INTERIM CHANGE NUMBER 9 TO REF B (T-45C PRELIM NFM), INTERIM CHANGE NUMBER 18 TO REF C (T-45A PCL) AND INTERIM CHANGE NUMBER 8 TO REF D (T-45C PRELIM PCL).

2. SUMMARY. THIS MSG REVISES ROLL ENVELOPE LIMITATIONS FOR THE T-45A AND T-45C AIRCRAFT IN REFS A THROUGH D.

3. CHANGE REFS A (T-45A NFM), AND B (T-45C PRELIM NFM), AS FOLLOWS:

A. T-45A NFM AND T-45C PRELIM NFM, PAGES I-4-4, PARAGRAPH 4.8 ROLL LIMITATIONS, SUBPARAGRAPH 2 CRUISE CONFIGURATION:
   (1) DELETE SUBPARAGRAPHS 2.A AND 2.B.
   (2) ADD SUBPARAGRAPHS 2.A THROUGH 2.C:
       A. FOR AIRSPEEDS 0 TO 260 KIAS:

FROM MINUS 1 TO PLUS 1.25 G -- MAXIMUM BANK ANGLE CHANGE IS 360 DEG.
FROM PLUS 1.25 TO PLUS 4 G -- MAXIMUM BANK ANGLE CHANGE IS 180 DEG, OR 360 DEG LIMITED TO HALF LATERAL STICK AND HALF RUDDER PEDAL INPUTS.
FROM PLUS 4 G TO G-LIMIT -- MAXIMUM BANK ANGLE CHANGE IS 180 DEG.

B. FOR AIRSPEEDS GREATER THAN 260 KIAS TO 0.8 MACH:
FROM MINUS 0.2 TO PLUS 1.25 G -- MAXIMUM BANK ANGLE CHANGE IS 360 DEG.
FROM PLUS 1.25 TO PLUS 4 G -- MAXIMUM BANK ANGLE CHANGE IS 180 DEG, OR 360 DEG LIMITED TO HALF LATERAL STICK AND HALF RUDDER PEDAL INPUTS.
FROM PLUS 4 G TO G-LIMIT -- MAXIMUM BANK ANGLE CHANGE IS 180 DEG.

C. FOR AIRSPEEDS GREATER THAN 0.8 MACH TO AIRSPEED LIMIT:
FROM PLUS .75 TO PLUS 1.25 G -- MAXIMUM BANK ANGLE CHANGE
?? IS 360 DEG.
FROM PLUS 1.25 G TO G-LIMIT -- MAXIMUM BANK ANGLE CHANGE IS 180 DEG.

B. PAGE I-4-7, AFTER FIGURE 4-4 T-45 OPERATING ENVELOPE:
(1) DELETE: NA
(2) ADD (INSERT) NEW FIGURE 4-4A T-45 ROLL LIMITATIONS. (SEE PARAGRAPH 5 BELOW).

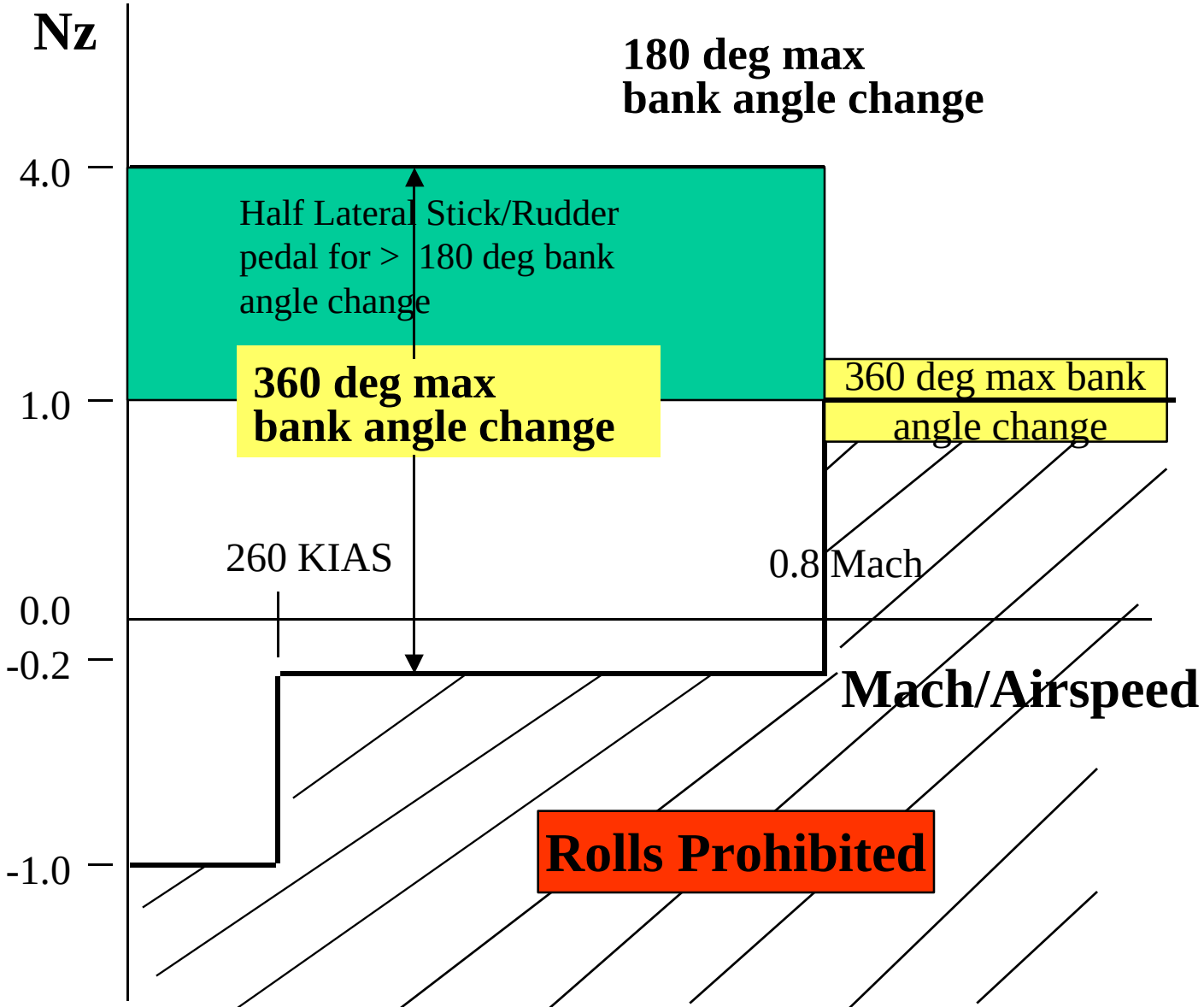
4. CHANGE REFS C (T-45A PCL), AND D (T-45C PRELIM PCL), AS FOLLOWS:

A. T-45A PCL PAGE 115 AND T-45C PRELIM PCL PAGE 114, AFTER FIGURE 3 T-45 OPERATING ENVELOPE:
(1) DELETE: NA
(2) ADD (INSERT) NEW FIGURE 3A T-45 ROLL LIMITATIONS. (SEE PARAGRAPH 5 BELOW).

B. CHANGE T-45A PCL PAGE 117 AND T-45C PRELIM PCL PAGE 116, ROLL LIMITATIONS, SUBPARAGRAPH 2 CRUISE CONFIGURATION AS IN PARAGRAPHS 3.A(1) AND 3.A(2) ABOVE.

5. REFS A AND B FIGURES 4-4A AND REFS C AND D FIGURES 3A HAVE BEEN PROMULGATED VIA THE T-45 GOSNET WEBSITE (HTTPS:(FORWARD SLASH FORWARD SLASH)T45INT.NADJX.NAVY.MIL OR HTTPS:(FORWARD SLASH FORWARD SLASH)GOSNET.NADJX.NAVY.MIL) FOR T-45 NATOPS ADVISORY GROUP MEMBERS, AIRWINGS AND SQUADRONS AS SEPCOR, AND ARE ALSO AVAILABLE IN MS-POWERPOINT. IF COPIES OF THE NEW FIGURES ARE REQUIRED AND/OR FOR TECHNICAL ISSUES CONTACT AIR-4.1.1.3, CDR TOM GARRISON, T-45 CLASS DESK, PHN 301-757-5178, DSN 757-5178 OR E-MAIL GARRISONTP@NAVAIR.NAVY.MIL.//

BT



ROLL LIMITATIONS, G VERSUS SPEED

ADMINISTRATIVE MESSAGE

PRIORITY

P 262001Z JAN 00 ZYB PSN 303216M15

FM COMNAVAIRSYSCOM PATUXENT RIVER MD //4.3P//

TO CNATRA CORPUS CHRISTI TX//N3144/N34/511/N421//
ALL GOSHAWK AIRCRAFT ACTIVITIES//

INFO CNO WASHINGTON DC//N889//
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NAVWARCOL NEWPORT RI//213//
NAVOPMEDINST PENSACOLA FL//060//

UNCLAS //N03711//

MSGID/GENADMIN/COMNAVAIRSYSCOM/4.3P//

SUBJ/INTERIM CHANGES (IC'S) TO T-45 AIRCRAFT NATOPS PUBLICATIONS//

REF/A/DOC/NAVAIR/15AUG98//

REF/B/DOC/NAVAIR/15AUG97//

REF/C/DOC/NAVAIR/15AUG98//

REF/D/DOC/NAVAIR/15AUG97//

REF/E/MSG/NAVAIR/182000ZMAY99//

REF/F/MSG/NAVAIR/292001ZJUL99//

NARR/REF A IS NAVAIR A1-T45AB-NFM-000 (T-45A NATOPS FLIGHT MANUAL (NFM)) DTD 15JAN97 W/CHG-1 15AUG98. REF B IS NAVAIR A1-T45AC-NFM-000 (T-45C PRELIMINARY NATOPS FLIGHT MANUAL (NFM)). REF C IS NAVAIR A1-T45AB-NFM-500 (T-45A NATOPS PILOT'S POCKET CHECKLIST (PCL)) DTD 15JAN97 W/CHG-1 15AUG98. REF D IS NAVAIR A1-T45AC-NFM-000 (T-45C PRELIMINARY NATOPS PILOT'S POCKET CHECKLIST (PCL). REF E ISSUED IC 18 TO REF A. REF F ISSUED IC 6 TO REF B, IC 16 TO REF C, AND IC 5 TO

RMKS/1. THIS IS INTERIM CHANGE NUMBER 19 TO REF A (T-45A NFM), INTERIM CHANGE NUMBER 8 TO REF B (T-45C PRELIM NFM), INTERIM CHANGE NUMBER 17 TO REF C (T-45A PCL) AND INTERIM CHANGE NUMBER 7 TO REF D (T-45C PRELIM PCL).

2. SUMMARY. THIS MSG REVISES EXTERNAL STORES LIMITATIONS FOR THE BAGGAGE POD IN REFS A THROUGH D.

3. CHANGE REFS A (T-45A NFM), AND B (T-45C PRELIM NFM), WITH REFS E AND F IC'S INCORPORATED, CHAPTER 4, AS FOLLOWS:

A. T-45A NFM AND T-45C PRELIM NFM, PAGES I-4-6, PARAGRAPH 4.16 EXTERNAL STORES LIMITATIONS, T-45A NFM SUBPARAGRAPH 7 AND T-45C NFM SUBPARAGRAPH 9:
   (1) DELETE: 10 KNOTS
   (2) ADD "15 KNOTS", SO SUBPARAGRAPH READS:
       MAXIMUM CROSSWIND COMPONENT WITH CARRIAGE OF BAGGAGE POD IS 15 KNOTS.
B. PAGE I-4-11, FIGURE 4-6 EXTERNAL STORES LIMITATIONS (SHEET 2 OF 2), BAGGAGE POD STORE:
   (1) UNDER COLUMN TITLED "AIRSPEED - MAXIMUM AIRSPEED OR MACH WHICHEVER IS LESS, CARRIAGE KIAS":
       (A) DELETE: 300/0.70
       (B) ADD: 380/0.80
   (2) UNDER COLUMN TITLED "ACCELERATION - G, CARRIAGE, SYM":
       (A) DELETE: GR UP, FLP UP, 0 TO 3.0
       (B) ADD: GR UP, FLP UP, 0 TO 4.0
   (3) UNDER COLUMN TITLED "ACCELERATION - G, CARRIAGE, UNSYM":
       (A) DELETE: GR UP, FLP UP, 1.0 TO 2.0
       (B) ADD: GR UP, FLP UP, 1.0 TO 3.0

4. CHANGE REFS C (T-45A PCL) AND D (T-45C PRELIM PCL) WITH REF F INCORPORATED, AS FOLLOWS:
A. CHANGE T-45A PCL PAGE 123 AND T-45C PRELIM PCL PAGE 122, EXTERNAL STORES LIMITATIONS, T-45A PCL SUBPARAGRAPH 7 AND T-45C PRELIM PCL SUBPARAGRAPH 9 AS FOLLOWS:
   (1) DELETE: 10 KNOTS
   (2) ADD "15 KNOTS", SO SUBPARAGRAPH READS:
       MAXIMUM CROSSWIND COMPONENT WITH CARRIAGE OF BAGGAGE POD IS 15 KNOTS.
B. CHANGE T-45A PCL PAGE 126 AND T-45C PRELIM PCL PAGE 125, FIGURE 6 EXTERNAL STORES LIMITATIONS (SHEET 2 OF 2), BAGGAGE POD STORE AS IN PARAGRAPHS 3.B(1) THROUGH 3.B(3) ABOVE.

5. FOR TECHNICAL ISSUES CONTACT CDR TOM GARRISON, T-45 CLASS DESK, AIR-4.1.1.3, PHN 301-757-5180.//

BT

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

Information relating to the following recent technical directives has been incorporated in this manual.

Change Number	ECP Number	Description	Visual Identification	Effectivity

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
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
H_g	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

N_1	Engine Low Pressure (Speed) Compressor Spool
N_2	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
N_Z	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

Preface

SCOPE

The NATOPS flight manual is issued by the authority of the Chief of Naval Operations and under the direction of the Commander, Naval Air System Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) program. This manual contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operation. However, it is not a substitute for sound judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

A1-T45AB-NFM-300 (Supplemental Flight Manual)

A1-T45AC-NFM-500 (Pilot's Pocket Checklist)

A1-T45AC-NFM-600 (Servicing Checklist)

A1-T45AC-NFM-700 (Functional Check Flight Checklist)

HOW TO GET COPIES

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UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with OPNAVINST 3710.7.

CHANGE RECOMMENDATIONS

Recommended changes to this manual or other NATOPS publications may be submitted by anyone in accordance with OPNAVINST 3710.7.

Routine change recommendations are submitted directly to the model manager on OPNAV Form 3500-22 shown herein. The address of the model manager of this aircraft is:

Commander Training Air Wing Two
ATTN: NATOPS Model Manager
205 Mitscher Ave.
Suite 101
Kingsville, TX 78363-5008

Change recommendations dealing with Cockpit 21 specific information should be addressed to:

Commander Training Air Wing One
Attn: VT-7 NATOPS Model Manager
101 Fuller Rd., Suite 270
Meridian, MS 39309-5406

_ **

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV/FORM 3710/6(4-90) S/N 0107-LF-009-7900 DATE

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

FROM (originator)	Unit
TO (Model Manager)	Unit

Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit of Command

TO BE FILLED IN BY MODEL MANAGER (Return to Originator)

FROM	Date

TO

Reference
(a) Your change Recommendation Dated _____

Your change recommendation dated _____ is acknowledged. It will be held for action of the review conference planned for _____ to be held at _____

Your change recommendation is reclassified URGENT and forwarded for approval to _____ by my DTG _____

/S/_____ MODEL MANAGER | _____ AIRCRAFT

Change recommendations of an URGENT nature (safety of flight, etc.) should be submitted directly to the NATOPS advisory group member in the chain of command by priority message.

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NATOPS flight manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate, at once.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight manual interim changes are changes or corrections to the NATOPS flight manuals promulgated by CNO or NAVAIRSYSCOM. Interim changes are issued either as printed pages or as a naval message. The interim change summary is provided as a record of all interim changes. Upon receipt of a change or revision, the custodian of the manual should check the updated interim change summary to ascertain that all outstanding interim changes have been either incorporated or cancelled: those not incorporated shall be recorded as outstanding in the section provided.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be material added or information restated. A change symbol in the margin by the chapter number and title indicates a new or completely revised chapter.

WARNING, CAUTIONS AND NOTES

The following definitions apply to "WARNINGS", "CAUTIONS", and "NOTES" found throughout the manual.

WARNING

Any operating procedure, practice, or condition, etc., which may result in injury or death if not carefully observed or followed.

CAUTION

An operating procedure, practice, or condition, etc., which may result in damage to equipment if not carefully observed or followed.

NOTE

An operating procedure, practice, or condition, etc., which is essential to emphasize.

WORDING

The concept of word usage and intended meaning which has been adhered to in preparing this manual is as follows:

"Shall" has been used only when application of a procedure is mandatory.

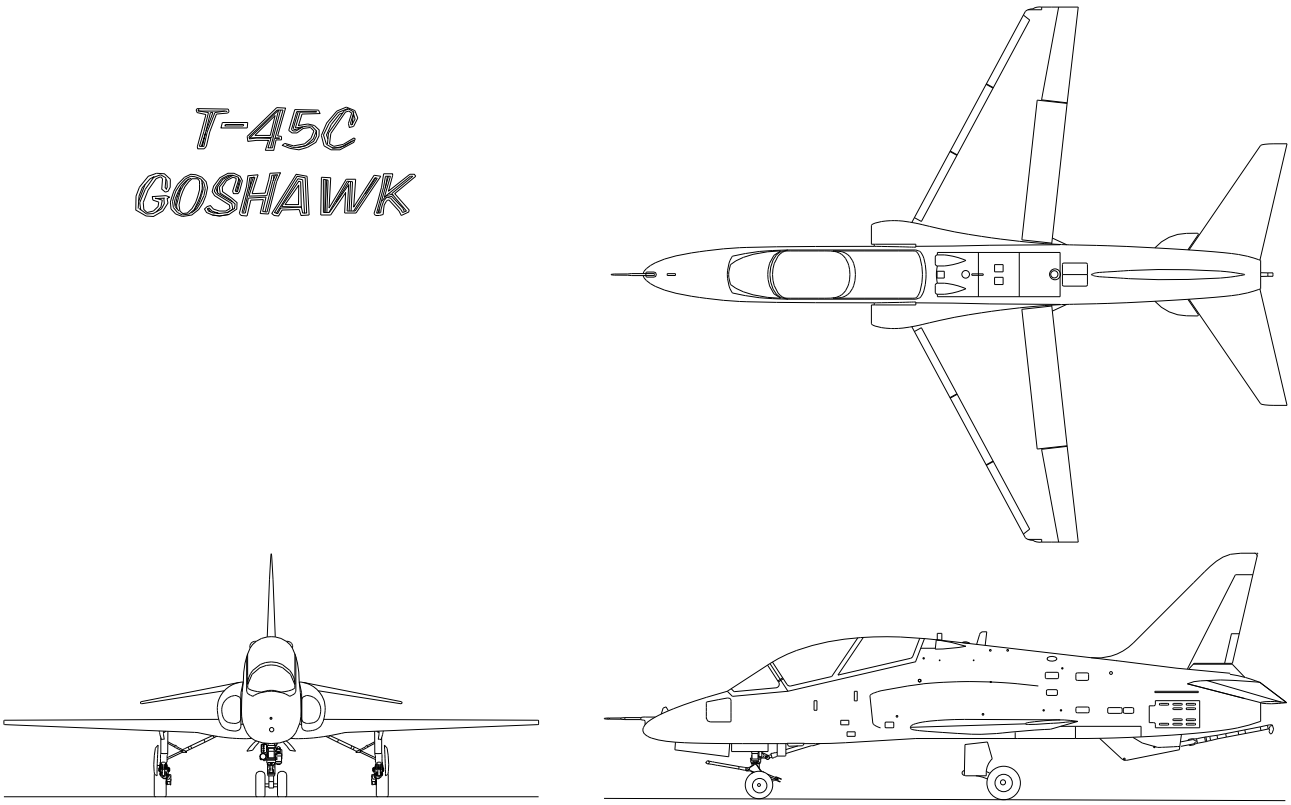
"Should" has been used only when application of a procedures is recommended.

"May" and "need not" have been used only when application of a procedure is optional.

"Will" has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

Unless otherwise specified all airspeeds are indicated airspeed and headings are magnetic.

T-45C GOSHAWK



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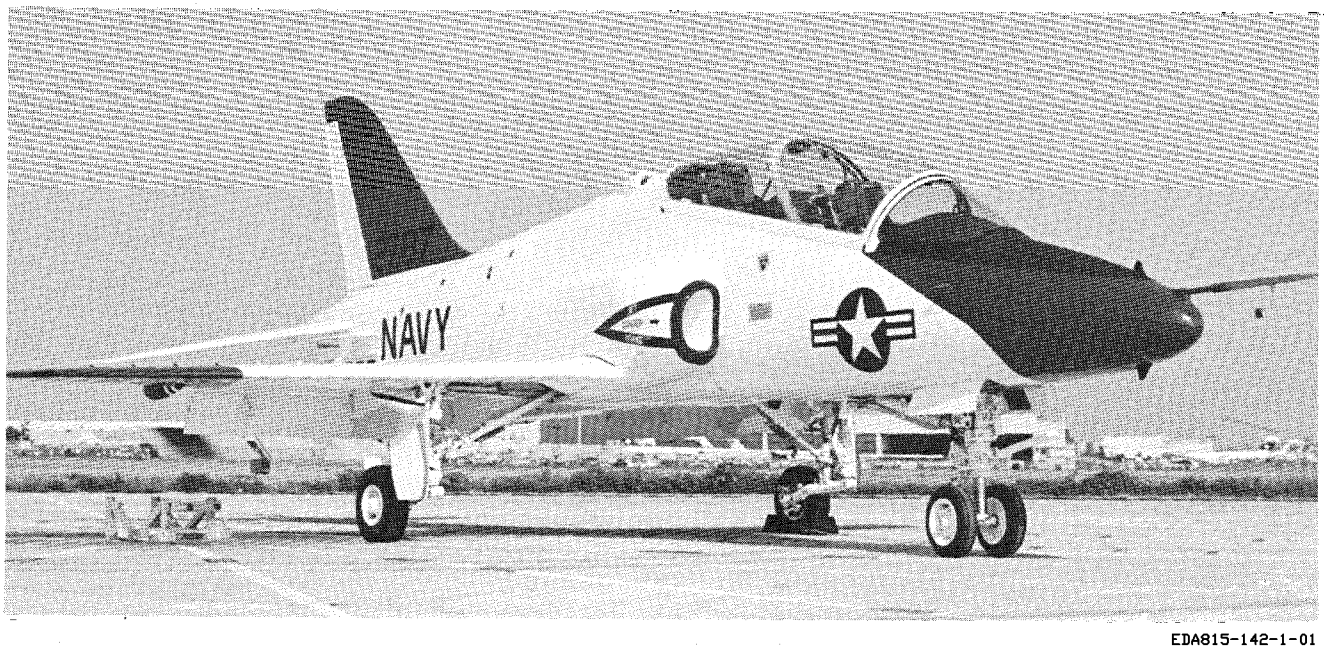

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PART I

THE AIRCRAFT

Chapter 1 - General Characteristics

Chapter 2 - System Descriptions

Chapter 3 - Servicing and Handling

Chapter 4 - Operating Limitations

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

See Forward Cockpit foldout, FO-3 and Aft Cockpit foldout, FO-5. 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, controls, and switches.

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 (6)
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.

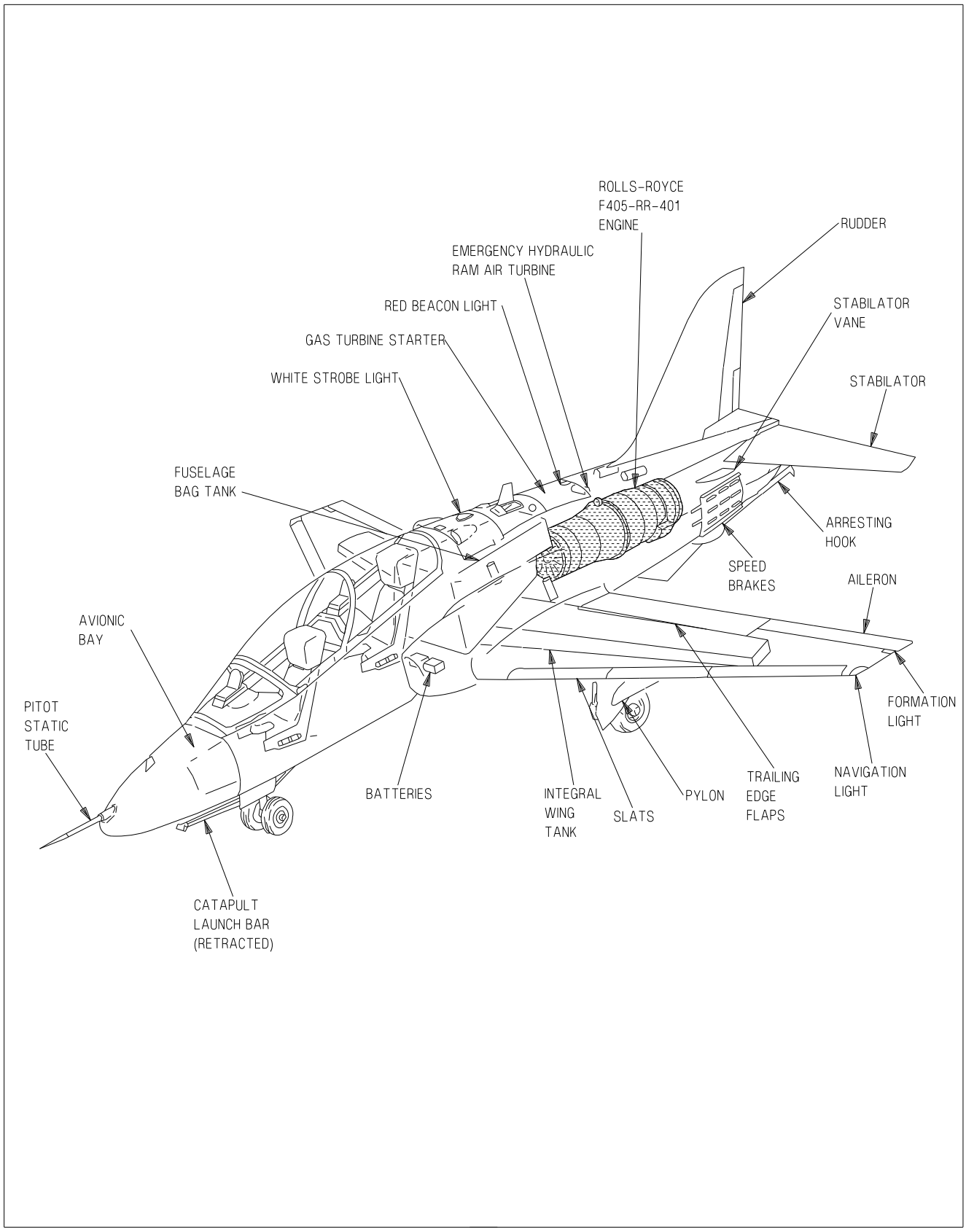
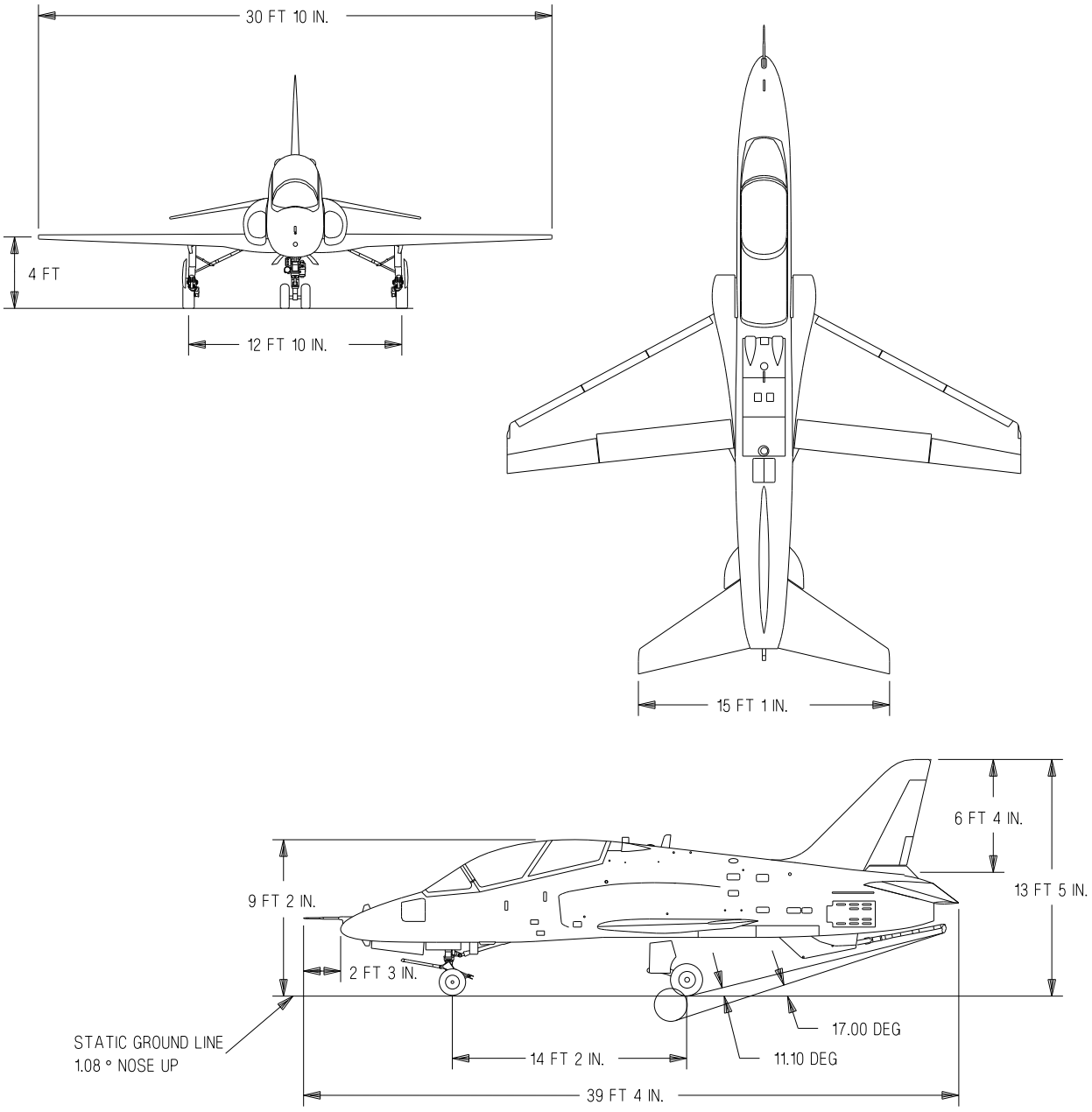


Figure 1-1. Aircraft General Arrangement



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 °		

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Figure 1-2. Principal Dimensions

CHAPTER 2

System Descriptions

2.1 ENGINE SYSTEM

2.1.1 Description. The aircraft is powered by a single, non-afterburning twin-spool turbofan engine. A two-stage low pressure (N_1) compressor is driven by a single-stage low pressure turbine. A five-stage high pressure (N_2) compressor is driven by a single-stage high pressure turbine. The N_1 and N_2 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. 100% N_2 RPM is 15,512 pounds.

2.1.1.1 Internal Airflow. Air entering the engine passes directly to the first stage of N_1; there are no inlet guide vanes. Leaving N_1, the air is divided into two streams. One stream passes through N_2, 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 N_2 casing at the final stage to prevent stalling of N_2 during starting. Bleed valve operation is automatic. The valve is open for starting and closes at 61 ±4% during the initial engine acceleration. Closure is indicated by an increase in N_2 idle RPM of approximately 3% and a decrease in EGT of approximately 50° C. When the valve is closed it remains so until N_2 RPM falls to approximately 45% during engine shutdown.

When the engine is operating under manual fuel control the bleed valve remains closed at all engine speeds, except during an airstart when it is opened by pressing the GTS start button. The bleed valve remains open for 60 seconds after button release. This is automatic and is a feature which facilitates air starting. The bleed valve opens upon a switch over from manual fuel control to the main fuel control if N_2 is below 61 ±4%.

2.1.1.3 Bleed System. Bleed air from the N_1 and N_2 compressors is used to seal the compressor and turbine bearing compartments as well as providing cooling for the turbine assemblies. The N_2 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 N_2 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. N_2 RPM above 70% (the 70% N_2 switch provides the switching).

A latching relay permits the LAUNCH BAR switch to be set to RETRACT, after the circuit is completed, to establish a lights out cockpit for launch without closing the valve. The valve automatically closes when any of the other conditions required to open the valve are not true. The ACCEL caution light illuminates when the valve position does not match the commanded position. A 2 second delay prevents transitory light indications.

2.1.1.4 Anti-Ice. A small flow of bleed air is continuously ducted forward through the N_1 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 N_2 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
N_2 RPM tach-generator

During engine start, the drive from the air turbine starter is transmitted through the external gear box to rotate the N_2 shaft.

2.1.1.6 Engine Fuel Control System. See Engine Fuel Control System foldout, FO-7. 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 LP PMP caution light illuminates when fuel pressure drops below 35 psi.

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.

2.1.1.6.1 Main Fuel Control System. 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. Engine acceleration is controlled by a 75 gallons per hour (gph) shot of fuel solenoid and a throttle valve dashpot in conjunction with a hydromechanical acceleration switch. The two position shot of fuel solenoid is opened whenever the aircraft is below 7,200 feet MSL.

NOTE

The shot of fuel solenoid is open on the ground and remains open until climbing thru 9,500 ±300 feet MSL. The solenoid reopens when descending thru 7,700 ±500 feet MSL.

The two position shot of fuel solenoid is actuated to the approach mode when the aircraft is below 6,500 feet (may occur as high as 10,000 feet).

When the shot of fuel solenoid is activated it provides increased fuel flow to reduce engine acceleration time and provide improved engine surge control. The dashpot ensures that the throttle valve opens at a rate to give the maximum stall free acceleration regardless of the rate of throttle movement. The acceleration switch modulates the action of the dashpot by permitting an increased rate of throttle valve movement at a scheduled N_2 RPM during acceleration. The engine accelerates more slowly as altitude increases.

2.1.1.6.2 Manual Fuel Control System. The manual fuel control system is activated by placing the FUEL CONTR switch to the MANUAL position. The system bypasses the control elements downstream of the HP pump outlet. There is no automatic control of N_1 RPM, N_2 RPM or EGT. All fuel metering to the engine is accomplished by direct movement of the throttle; therefore, all power changes must be made with care to prevent exceeding RPM and EGT limits.

Selection of manual fuel control may be made at any engine speed throughout the flight envelope.

CAUTION

Selecting manual fuel at high RPM may result in exceeding RPM or EGT limits.

Engine operation is similar to that of main fuel system with the exception of the following:

- Airstarts may require throttle modulation due to bypassing of the sub idle fuel control unit (SIFCU).
- Retarding the throttle to IDLE results in a lower than normal idle N_2 RPM (up to 5%) due to the absence of the fuel flow contributed by SIFCU.

NOTE

If practical, throttle should be positioned so N_2 RPM is above 70% to prevent possible sub idle operation.

- As the dashpot acceleration switch is inoperative, engine acceleration times at lower altitude are significantly slower than normal. At higher altitudes (above 20,000 feet), a slightly faster engine acceleration may be noticed.
- The bleed valve remains closed at all engine speeds except during airstart when it is held open with a 60 second timer circuit.
- To maintain N_1 RPM within limits, N_2 RPM should not exceed 95% below 20,000 feet MSL, or 90% above 20,000 feet MSL.

Starting the engine on the ground with manual fuel control is not permitted.

NOTE

Complete loss of electrical power precludes switching the fuel control from the position selected.

Restoration to main fuel control system from manual fuel control while the engine is producing high thrust can cause a transient deceleration and immediate acceleration as the ECA trim control is restored. The bleed valve may open until the hydro-mechanical governor speed signal is reestablished. If the engine is running below 61 ±4% N_2 RPM the bleed valve remains open until the engine is accelerated above this speed.

2.1.1.6.3 Sub Idle Fuel Control Unit. The sub idle fuel control unit meters a fuel supply to the fuel spray nozzles during the starting cycle. The SIFCU consists of a body housing a sleeve and metering piston which is actuated by a spring-loaded diaphragm assembly. A fuel pressure signal from the HP fuel pump hydro-mechanical governor is fed to one side of the diaphragm and a continuous reference pressure signal (LP fuel pressure) is fed to the other side. The resultant signal (pressure difference) moves the diaphragm causing the metering piston to move in the profiled sleeve which meters the fuel flow in accordance with N_2 speed during acceleration up to ground idle conditions.

2.1.1.7 Engine Control Amplifier. The engine control amplifier (ECA) automatically prevents overspeed and overtemp conditions under normal operation. The ECA monitors N_1 shaft speed and two sets of thermocouples located behind the N_1 turbine sections. The EGT/RPM warning light on the warning lights panel in each cockpit will illuminate whenever the exhaust gas temperature exceeds 650 ±8° C or N_1 RPM exceeds 112.4 ±1.0%.

The ECA controls fuel flow to maintain EGT and N_1 RPM within limits. The ECA contains two separate identical electrical circuits, lane 1 and lane 2, and a circuit that monitors and compares the operation of the two lanes. The lane that indicates the lowest fuel flow setting has priority. If a malfunction occurs to one of the lanes, the other lane takes priority and the ECA advisory light illuminates in both cockpits. If a malfunction occurs to both lanes, the ECA advisory and ECA caution lights will illuminate in both cockpits.

During engine start the ECA provides a signal of correct N_1 rotation to the starting system. When N_1 reaches 100 RPM in the correct direction of rotation, a signal is sent to the starting system

which energizes the ignition system and illuminates the READY advisory light in each cockpit. The ignition system is deenergized and the READY advisory light is extinguished when the engine reaches 45% RPM.

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. Oil quantity is indicated on a sight glass at the rear of the tank. The total capacity of the tank and system is 25.2 U.S. pints. The unusable or trapped oil is 9.6 U.S. pints. Maximum consumption rate is 0.8 U.S. pint per hour.

2.1.1.8.1 Oil Circulation. An engine driven, variable speed, positive displacement pressure pump draws oil from the tank and supplies oil through a fuel cooled oil cooler (FCOC) and a filter, to an oil feed transfer housing (distribution block). A pressure relief valve protects the system, and a FCOC bypass valve ensures the circulation of an adequate supply of oil at low temperature or if the FCOC is blocked. From the transfer housing, pressure oil is supplied to the internal gearbox and compressor bearings, turbine bearings, and external high speed gearbox. Three scavenge pumps, located on a shaft common with the pressure pump, return the scavenge oil through associate filters to the tank.

2.1.1.8.2 Oil Low Pressure Warning. A differential pressure switch monitors the differential pressure between feed oil pressure and the scavenge oil pressure at the internal gearbox. If the differential pressure decreases below 10 psi, the OIL PRESS warning light will illuminate in both cockpits. To eliminate transient warning caused by negative g maneuvers, the warning is delayed for approximately 10 seconds. Momentary illumination of the OIL PRESS warning light is acceptable under positive g flight conditions following a period of zero or negative g. This is caused by system pressure recovery; which may take up to six seconds.

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.

CAUTION

Sustained engine operation at less than 70% N_2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout. If engine flameout occurs, perform an airstart.

If the ECA automatic controls fail to keep the N_1 RPM and EGT within limits, the ECA caution and/or EGT/RPM warning lights will illuminate. If the engine can not be adequately controlled after a dual lane failure, manual fuel control should be selected.

NOTE

- If an ECA lane failure indicated by the ECA advisory light occurs, a momentary thrust fluctuation may be experienced. With a dual lane failure indicated by the ECA 2 caution light; engine EGT, fuel flow, and N_2 should be monitored and the throttle carefully controlled.
- If the main fuel control system fails, incorrect or uncommanded engine response will be experienced. This may be accompanied by N_1 RPM, EGT, and N_2 RPM exceedance, and/or engine stall. If main fuel control system failure occurs, fuel control should be switched to manual.
- Engine EGT and N_2 RPM should be monitored and the throttle carefully controlled.

2.1.2.1 Ignition. Two 12 joule dc ignition units are mounted above the engine bay, each energizes an engine igniter. Both igniters operate

during ground and air starting. Ignition is controlled by the ECA and starter control unit.

2.1.2.1.1 Weight-On-Wheels. With weight-on-wheels engine ignition is provided when:

1. The GTS start button is pressed, ignition ceases immediately when the button is released.

2. The ENGINE switch is set to START and the READY advisory light is on. Ignition is continuous until the engine reaches 45% RPM or after 45 seconds when ignition is automatically terminated and the GTS returns to idle.

2.1.2.1.2 Airborne. When the aircraft is airborne (weight-off-wheels) engine ignition is provided when:

1. The GTS start button is pressed and continues for 30 seconds after the button is released.

2. The ENGINE switch is set to START and the READY advisory light is on. Ignition is continuous until the engine reaches 45% RPM or after 45 seconds when ignition is automatically terminated and the GTS returns to idle.

2.1.2.2 Engine Starting System

2.1.2.2.1 Gas Turbine Starter. See GTS System foldout, FO-9. 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.

GTS operation is initiated by activating the GTS start button located on the front of the throttle grip. The turbine is rotated to a self-sustaining speed by a dc motor. A dc powered fuel/oil pump draws fuel from the aircraft tanks and supplies it to nozzles in a combustion chamber containing two ignition plugs. Power for the dc motor and the ignition plugs is taken from the 28 VDC Essential Services Bus. Air is drawn into the compressor through a grill on top of the fuselage. When the GTS is first started, the resulting compressed air is exhausted overboard through a dump valve. Once the GTS is at idle, the green GTS advisory light illuminates. When the ENGINE switch is momentarily selected to START, the GTS accelerates, the start valve is opened, the dump valve closes and the GTS supplies compressed air to the engine ATS. The ATS drives the N_2 shaft through the accessory gearbox. To prevent shock loading of the ATS clutch, a speed switch inhibits operation of the start valve when N_2 RPM is above 20%. The GTS will automatically shut down when N_2 RPM reaches 45%. When GTS shutdown occurs, the GTS advisory light will go out.

CAUTION

Minimum interval between each GTS start attempt is 3 minutes. After three consecutive GTS start attempts, a minimum interval of 30 minutes is required before further start attempts. Additional start attempts after an unsuccessful start are prohibited until the GTS exhaust duct and combustor section are inspected and any residual fuel is removed and the RAT doors are inspected for discoloration and warpage.

NOTE

Protection circuits within the starting system automatically shut down the GTS if GTS idle speed is not achieved within 30 seconds after the GTS start button has been pressed.

2.1.2.2.2 Air Turbine Starter. The ATS consists of a turbine driven by air ducted from the GTS. The ATS drives the engine N_2 shaft through the accessory gearbox and provides assistance until approximately 45% N_2 RPM has

been achieved whereupon the starting system is automatically shut down.

2.1.2.3 Engine Starting 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. (Maximum acceptable time between pressing the GTS start button until GTS advisory light illuminates is 20 seconds at sea level and 28 seconds in flight as depicted in Figure 35-3, A1-T45AB-NFM-300.)

CAUTION

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 N_2 shaft which induces an airflow through the engine to rotate the N_1 shaft. When N_1 shaft speed reaches 100 RPM in the correct direction of rotation, a relay in the ECA closes to illuminate the READY advisory light.

CAUTION

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 N_1 compressor to rotate backward.

When the READY advisory light is on and 15% to 20% N_2 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% N_2 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% N_2 RPM within approximately 30 seconds of selecting IDLE. If 45% N_2 RPM is not attained within 45 seconds from release of the start switch, the GTS will decelerate to idle.

WARNING

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. Conditions may arise which will cause EGT to approach the maximum permissible temperature of 550° C. Under these conditions, the EGT rate of increase will be a better indication of proper engine operation than will the actual value attained. Thus, a ground starting EGT that is rising rapidly should concern a pilot more than a start where the EGT slowly peaks out at 550° C. The cause of the rapidly rising EGT (extremely high ambient temperatures, starting a hot engine, high wind up the tailpipe, etc.) should always be determined, since it may be indicative of some engine malfunction.

After the RPM has stabilized the throttle should be advanced slowly to accelerate the engine through approximately 61 ±4% 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 the 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. See Figure 2-1.

Full Forward	Operates engine at Maximum Rated Thrust (MRT)
APPROACH IDLE	With landing gear down and aircraft weight-off-wheels, maintains minimum RPM at approximately 72%. With the ANTI-SKID switch set to ON the approach idle stop retracts immediately with weight-on-wheels, or 2 seconds after weight-on-wheels with the ANTI-SKID switch set to OFF. Inflight, the approach idle stop is automatically retracted when the GTS start button is pressed. The generator must be reset to restore normal operation.
IDLE	Opens fuel shutoff valve to direct fuel to fuel spray nozzles.
OFF	Interrupts or prevents fuel flow to engine.

2.1.3.2 Throttle Friction Knob. The throttle friction knob is located in the front cockpit, on the left console, and aft of the throttle. Rotating the knob clockwise increases the throttle friction.

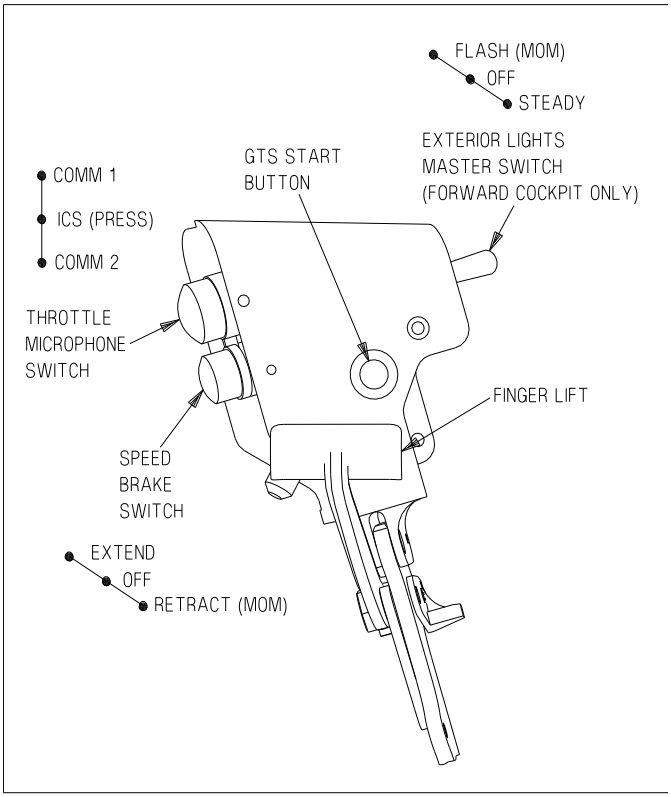


Figure 2-1. Throttle Grip

2.1.3.3 Finger Lift. The finger lift is located on the front side of the throttle, just below the throttle grip. Raising the finger lift permits the throttle to be moved past the approach idle stop, when engaged, or past the IDLE stop into OFF. A safety stop prevents inadvertent movement of the throttle lever to OFF should the pilot accidentally actuate the finger lift during normal throttle retraction. If an engine shutdown is required, the finger lift must not be lifted until the throttle is in either the approach idle position or the ground idle position.

WARNING

To prevent inadvertent engine shut down, use of the finger lifts shall be avoided unless shutting down the engine is the desired intent.

NOTE

The PLA display on the multi function display (MFD) is not the same degrees reported via ADRS data.

2.1.3.4 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 30 seconds, shuts the fuel boost pump number 2 OFF.

2.1.3.5 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.

2.1.3.6 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 main fuel control system is selected.
MANUAL	Selects the manual fuel control system.

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

2.1.3.8 RPM Indicator. The RPM indicator is located on the upper right corner of the main instrument panel, below the fuel flow indicator and indicates N_2 RPM in percent.

2.1.3.9 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.

2.1.3.10 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 in Pounds 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, see Figure 2-2 for a typical ENG display. The display presents information in three data blocks. The first provides back-up data for the primary instruments, the second provides supplementary data, and the third provides information useful for maintenance and is available only with weight-on-wheels. If any parameter is invalid or a sensor fails that information will be blank on the display.

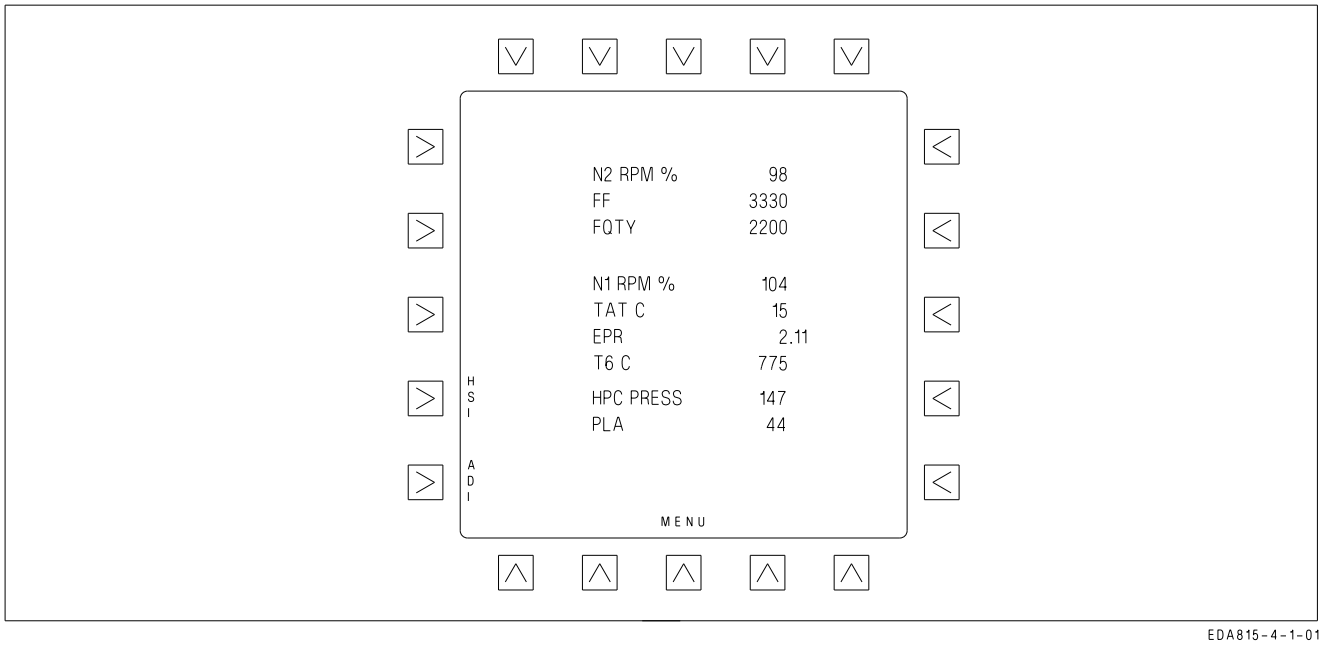


Figure 2-2. ENG Display

N2 RPM % — Displays engine N_2 compressor RPM. Range is from 0 to 115% RPM in 1% increments.

FF — Displays engine fuel flow. Range is from 0 to 7,000 pph in 1 pph increments.

FQTY — Displays internal fuel quantity remaining. Range is from 0 to 3,306 pounds, in 1 pound increments.

N1 RPM % — Displays engine N_1 compressor RPM. Range is from 0 to 120% RPM in 1% increments.

TAT C — Displays total air temperature. Provides indication of icing conditions. Range is from -60° to +99° C in 1° C increments.

EPR — Displays the engine pressure ratio (EPR). Engine pressure ratio is calculated by dividing the engine exhaust pressure (PS16) by the atmospheric pressure (furnished by the forward BARO altimeter). Range is from 0 to 9.99 in 0.01 increments. This data is provided as information only at this time.

T6 C — Displays engine turbine EGT directly from the ADR.

NOTE

The ENG display T6° C temperature does not include the engine trim corrections made to the primary EGT indicator and, therefore, will not match the EGT indicator indication. Range is from 0 to +1,000° C in 1° C increments.

HPC PRESS	Displays N_2 compressor discharge pressure (P3) in psi. Range is from 0 to 250 psi in 1 psi increments. Available only with weight-on-wheels.
PLA	Represents the throttle position in degrees. Range is from 0 to 48 degree in 1 degree increments. Available only with weight-on-wheels .

2.1.5 Engine Warning, Caution, and Advisory Lights.

2.1.5.1 FIRE Warning Light. The FIRE warning light is located on the upper right side of the instrument panel. When excessive temperature is detected in the engine bay, the FIRE warning light illuminates, and is followed by a MASTER ALERT light and warning audio tone.

2.1.5.2 GTS FIRE Warning Light. The GTS FIRE warning light is located on the warning lights panel, on the main instrument panel. When excessive temperature is detected in the GTS bay, the GTS FIRE light illuminates.

2.1.5.3 EGT/RPM Warning Light. The EGT/RPM warning light is located on the warning lights panel, on the main instrument panel. The light illuminates when either the EGT exceeds 650 ±8° C or N_1 RPM exceeds 112.4 ±1.0%.

NOTE

An "A/C Exceedance" from the ADR on the MANT page of the MFD is initiated when N_1 RPM exceeds 108 ± .5%.

2.1.5.4 OIL PRESS Warning Light. The OIL PRESS warning light is located on the warning lights panel, on the instrument panel. The light illuminates when the oil pressure differential is low for more than 10 seconds. Momentary illumination of the OIL PRESS warning light is acceptable under positive g flight conditions following a period of zero or negative g. This is caused by system pressure recovery; which may take up to six seconds.

2.1.5.5 TP (TAILPIPE) HOT Caution Light. The TP HOT caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light comes on when excessive temperature in the tailpipe bay is detected.

2.1.5.6 ECA 2 Caution Light. The ECA 2 caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when a total (both lanes) engine control amplifier failure is detected.

2.1.5.7 LP PMP (PUMP) Caution Light. The LP PMP caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light comes on when LP pump output pressure is low or the low pressure fuel filter is clogged.

2.1.5.8 ACCEL Caution Light. The ACCEL caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when either the shot of fuel solenoid valve or the steam ingestion bleed valve is not in the proper position with respect to aircraft configuration.

2.1.5.9 GTS Advisory Light. The GTS advisory light is located on the warning/caution/advisory lights panel, on the right side of the instrument panel. The light illuminates when the GTS has reached idle speed and is available for engine start.

2.1.5.10 READY Advisory Light. The READY advisory light is located on the warning/caution/advisory lights panel, on the right side of the instrument panel. The light illuminates when N_1 reaches 100 RPM or greater, rotation is in the correct direction, and the igniters are energized.

2.1.5.11 ECA Advisory Light. The ECA advisory light is located on the warning/caution/advisory lights panel, on the right side of the instrument panel. The light illuminates when a single lane ECA failure is detected.

2.1.5.12 M (Manual) FUEL Advisory Light. The M FUEL advisory light is located on the warning/caution/advisory lights panel, on the

right side of the instrument panel. The light illuminates when the manual fuel control system is selected.

2.2 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.

The aircraft fuel system is illustrated in the Fuel System foldout, FO-11. See Figure 2-3 for fuel tank locations and capacities.

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.

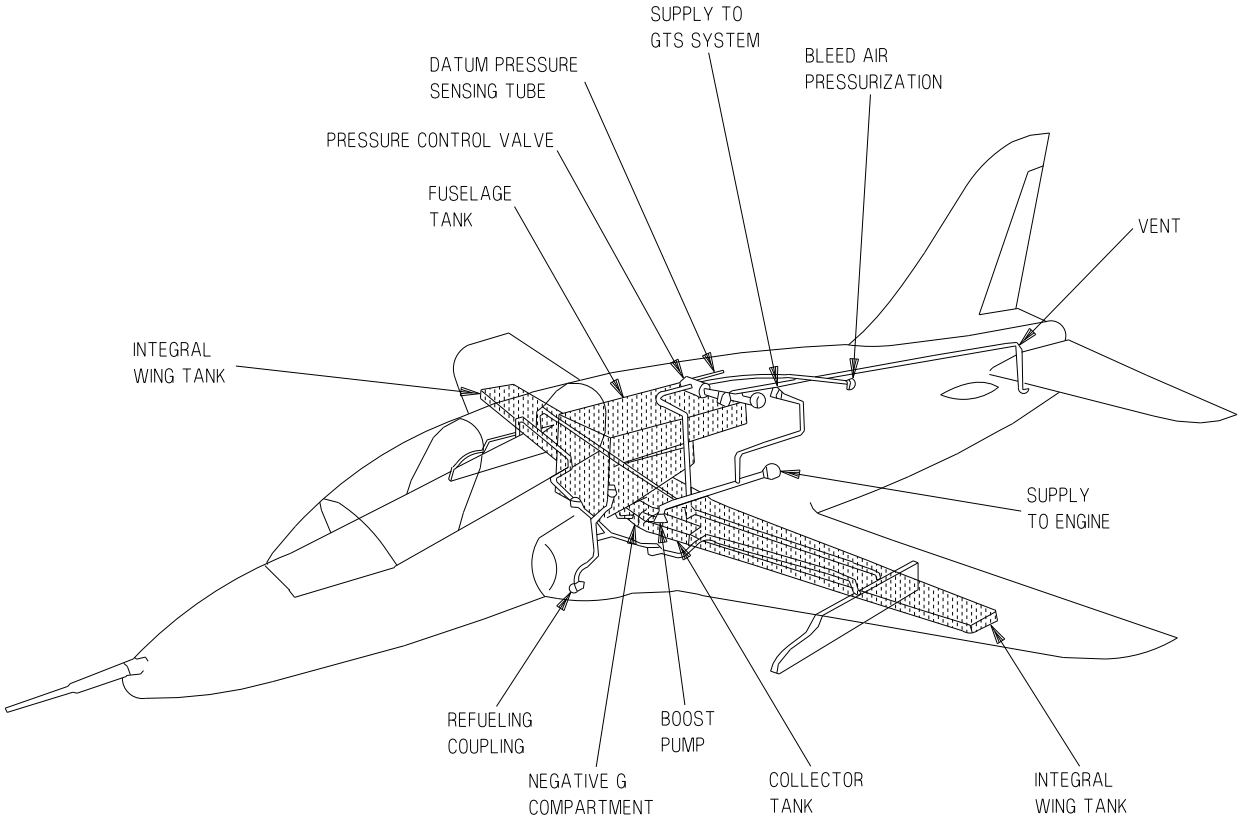
The boost pumps are each driven by an ac motor with power supplied through a dedicated static inverter. The inverters and fuel boost pumps automatically turn on: (1) during GTS operation, or (2) when the engine speed is greater than 42 percent, the aircraft generator is ON and the ENGINE switches are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



USABLE FUEL
STANDARD 59 DEGREE DAY

TANK	GALLONS	POUNDS JP-5 (6.8 lb/gal)	POUNDS JP-4 (6.5 lb/gal)	POUNDS JP-8 (6.7 lb/gal)
TOTAL	443	3,012	2,879	2,968
USABLE	427	2,904	2,776	2,861

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Figure 2-3. Fuel Tank Locations and Capacities

2.2.1.5 Fuel Quantity Indicating System. The fuel quantity indicating system consists of capacitance-type fuel quantity probes, fuel quantity indicators, a Fuel Quantity (FQTY) readout on the ENG display (see Figure 2-2), a BINGO advisory on the MFDs, and a FUEL caution light.

The fuel quantity indicator located on the instrument panel, is the primary fuel quantity indication and provides the total fuel available in pounds multiplied by 100. The range of indication is from 0 to 3,300 pounds.

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, see Figure 2-4. 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 aircrafts fuel quantity.

2.2.2.1 BINGO Setting. The BINGO setting readout is located on the MFD attitude display indicator (ADI) display above the BNGO option. On power up, the BINGO setting defaults to 900 pounds with a minimum setting of 0 pounds and a maximum of 3,000 pounds. The setting may be entered using either the ADI display or the data entry panel (DEP) in 100 pound increments.

2.2.2.1.1 ADI Entry. Successive actuation of the ADI BNGO option selects/deselects (boxes/unboxes) the option. Selection of the low altitude warning (LAW) or pitch trim (PT) option will deselect (unbox) BNGO. When the ADI BNGO option is selected, the BINGO increment and decrement options are displayed. Selecting either increment/decrement option changes the BINGO setting accordingly in 100 pound increments. Pressing and holding the increment/decrement option initially changes the BINGO setting in fine adjustments and rapidly accelerates the longer it is selected. If the minimum or maximum setting is reached the value will wrap around past 0 and continue to increment/decrement.

2.2.2.1.2 DEP Entry. The BINGO setting is controlled from the DEP by pressing the BNGO button. When the button is pressed the scratchpads will be displayed, and the DEP is enabled. The current BINGO setting will be displayed in each scratchpad proceeded by the BINGO identifier (BF). The BINGO setting can now be entered in 100 pound increments using the DEP entry buttons. When the setting is entered, pressing the DEP ENT button will store the new setting in the DEU, update the ADI BINGO setting, and remove the scratchpads.

2.2.3 Fuel System Operation.

2.2.3.1 Fuel Transfer Sequence. Fuel is transferred from the outer sections of the wing tank into the collector tank through a flap type non-return valve on each side of the collector tank. Fuel is then transferred from the collector tank to the negative g compartment through flap type non-return valves in the rear wall of the compartment. The flap type non-return valves prevent fuel from flowing out of the negative g compartment to the rear part of the collector tank in noseup attitudes and/or during acceleration at low fuel states. This ensures that fuel is available at the boost pumps for delivery to the engine.

2.2.3.2 Fuel Tank Pressurization. The fuel tanks are pressurized by bleed air from the engine HP compressor. The air enters the system through a filter, and a pressure control valve.

The pressure control valve provides air to the fuel tanks at a pressure of 6 psig above datum pressure. The pressurized air flows through the transfer valves and pressure refueling valve to the fuselage tank. The ram/datum pressure is ambient pressure or slightly above and is fed to a low air pressure switch and two inward relief valves in addition to the pressure control valve. The low air pressure switch senses ram/datum pressure on one side and control valve outlet pressure on the other; if the outlet pressure falls below 3 psig above datum pressure the F PRES caution light illuminates. The F PRES caution

light is also connected to each boost pump's pressure switch. A loss of tank pressurization or loss of either boost pump pressure illuminates the F PRES light. If fuel tank pressurization is lost, the two inward relief valves allow ram/datum air to enter the tanks. The inward relief valves also act as a non-return valve to prevent air/vapor or fuel venting to the atmosphere through the ram/datum air inlet.

2.2.3.3 Fuel Tank Venting. The fuel tanks are vented to the atmosphere through a dual datum relief valve and a bleed orifice arranged in parallel and connected to a vent pipe terminating at the aft end of the fuselage adjacent to the tailpipe.

The dual datum relief valve provides a means of venting fuel if the pressure refueling system fails to shut off fuel flow when the tanks are full, and also controls tank pressure. The valve relieves at 9.5 psig during normal flight and 4 psig during pressure refueling or when the arresting hook is down; relieving some tank pressure prior to carrier landing.

The bleed orifice provides a controlled bleed of pressure that bypasses the dual datum relief valve to vent the tanks after the engine is shut down or after refueling.

Air and fuel vapor from the collector tank is piped to a vent tank. A vapor release valve in the vent tank discharges the vapor through a non-return valve into the fuel tank vent pipe. The vapor release valve is float controlled, but under negative g conditions it is held closed by a weighted arm to prevent fuel loss. Vapor from the outer sections of the wing tanks is vented through the fuselage tank.

2.2.3.4 Fuel Feed. Fuel is supplied to the engine by a pair of electrical motor (ac) driven boost pumps located in the negative g compartment. The fuel supply line is fitted with a manually controlled fuel shutoff valve and a fuel flow transmitter. A branch pipe supplies fuel to the GTS.

2.2.3.5 Low Fuel Caution. A low internal fuel state is indicated by the illumination of the FUEL caution light on the warning/caution/advisory lights panel in both cockpits. The caution light is triggered by a float switch in the negative g compartment which closes when the usable fuel falls below approximately 350 pounds. The amount of fuel indicated when the float switch closes depends on the type fuel, its temperature and the aircraft attitude.

When the low level float switch closes, activation of the FUEL caution light is delayed for 10 seconds to minimize nuisance flickering caused by sloshing fuel.

2.2.4 Refueling. A pressure refuel/defuel coupling is located on the fueling control panel behind access door 311EL in the engine left air intake fairing. Refueling is accomplished through a solenoid operated pressure refueling valve located at the bottom of the fuselage tank. When the access door is opened, the main refueling switch is automatically set to REFUEL, which powers the refuel panel for refueling. When the door is closed, the main refueling switch is automatically set to the FLIGHT position.

For refueling, dc power from the No. 1 battery/Ground Service Bus is routed through the the main refueling switch to a reed switch in the refueling valve. When fuel pressure is applied to the refuel/defuel coupling the reed switch is closed and power is supplied by the fuselage tank high level float switch to energize a solenoid which opens the pressure refueling valve. When the fuselage tank is full a FULL FUEL indicator light on the fueling control panel illuminates after electrical power is removed from the valve (closes valve) and the no flow refuel pressure (above 17 psi) closes the flow limiting valve which closes the reed switch. The light will extinguish when the refuel pressure is removed from the refuel nozzle. If the pressure refueling valve fails to close when the fuselage tank is full, fuel is vented overboard through the fuselage tank relief valve. The fuselage tank and wing tank can be refueled by gravity through a capped filler at the top of the fuselage tank.

The precheck system allows the refueling operator to detect a failure in the fuel shutoff system

during refueling. The system includes a precheck solenoid valve, a precheck tank (which encloses the high level float switch) and associated plumbing. After refueling flow is initiated, actuation of the momentary precheck switch on the fueling control panel opens the precheck solenoid valve; filling the precheck tank, raising the high level float switch, and closing the refueling valve. If the high level float switch and the refueling valve function normally, refueling reduces to 5 gpm or less in 10 seconds. The FULL FUEL light illuminates when the pressure refueling valve closes.

NOTE

When the refueling door is open the transfer valves are commanded closed and the XFR CLOSED light illuminates. If the XFR CLOSED light does not illuminate, the problem must be fixed prior to refueling.

2.2.4.1 Defueling. When the main refueling switch is set to DEFUEL the internal tanks can be defueled by suction through the refuel/defuel coupling. A manually operated defueling valve, on the left side of the fuselage above the midpoint of the wing root fairing, must be opened with a special key to facilitate this process. The key cannot be removed when the defueling valve is in the open position. The fuselage tank and wing tank defueling rate is approximately 24 gpm (160 ppm) with a suction of 11 psi.

During suction defueling, fuel is drawn from the collector tank through the boost pump bypass valve, the defueling valve and refuel/defuel coupling. As fuel is withdrawn from the system, suction relief is provided by inward venting of air through the inward relief valves in the ram/datum air supply line. Defueling using suction alone leaves some trapped fuel in the outer portions of the wing tank. The amount of trapped fuel in the outer portions of the wing can be reduced by defueling with the fuel tanks pressurized through the ram/datum air scoop.

NOTE

Pressurizing through the external air pressurization port will not assist in defueling as the transfer valves close and prevents this pressure from reaching the tanks.

2.2.4.2 Draining. The fuel system may be drained by gravity down to the residual fuel level by opening a wing tank drain valve in the left wheel well. The residual fuel in the fuselage tank and wing tank may be removed by opening two water drain valves in the collector tank; the valve's operating positions and discharge points are in underwing fairings on each side of the aircraft centerline. Draining without tank pressurization leaves some trapped fuel in the outer portion of the wing tank. The amount of trapped fuel in the outer portion of the wing tank can be reduced by draining with the fuel tanks pressurized through the ram (datum) air scoop or through the external air pressurization port.

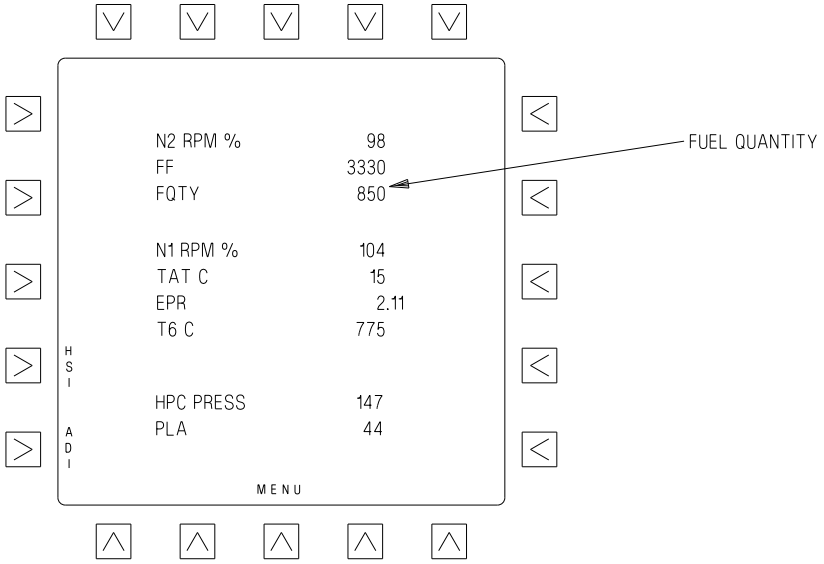
2.2.5 Fuel System Controls and Indicators.

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.

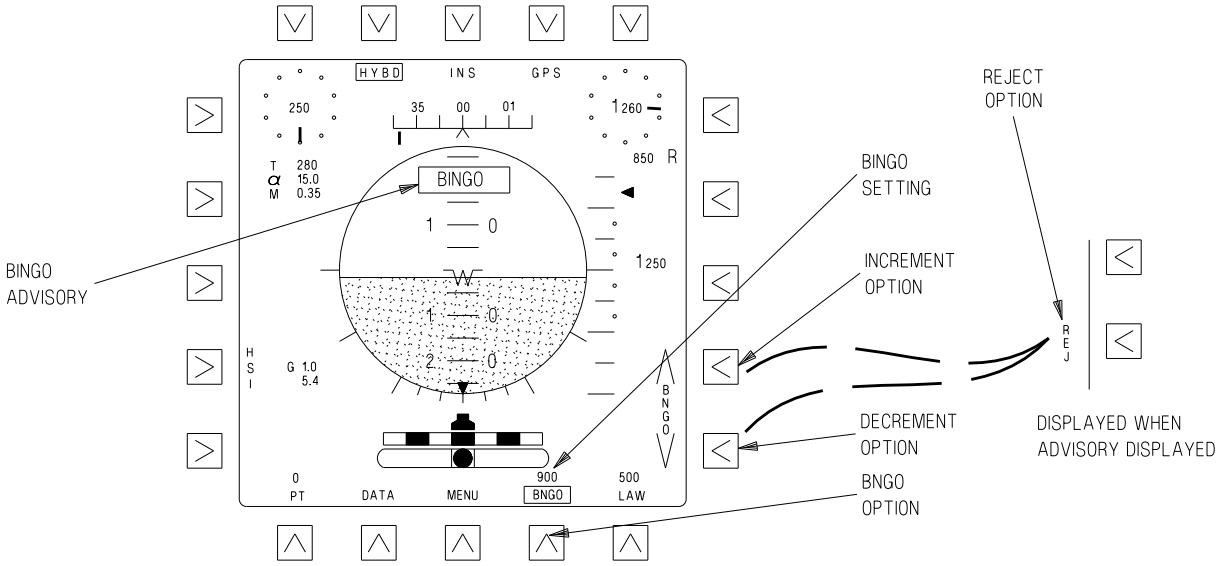
Down	Permits fuel flow to the engine and GTS.
Up	Isolates aircraft fuel system from the engine and GTS.

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. Pressing the option alternately selects/deselects (boxes/unboxes) the BNGO option, enabling/disabling the BNGO increment/decrement options. The option is also boxed when the DEP is enabled for entry of the BINGO setting.



ENGINE FORMAT



MFD

- BINGO SET WITH MFD BNGO OPTION SELECTED

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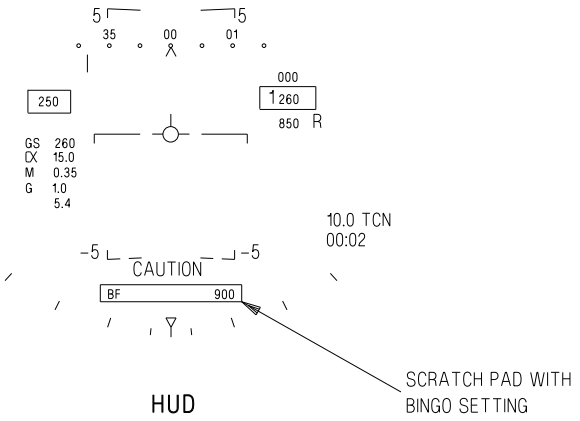
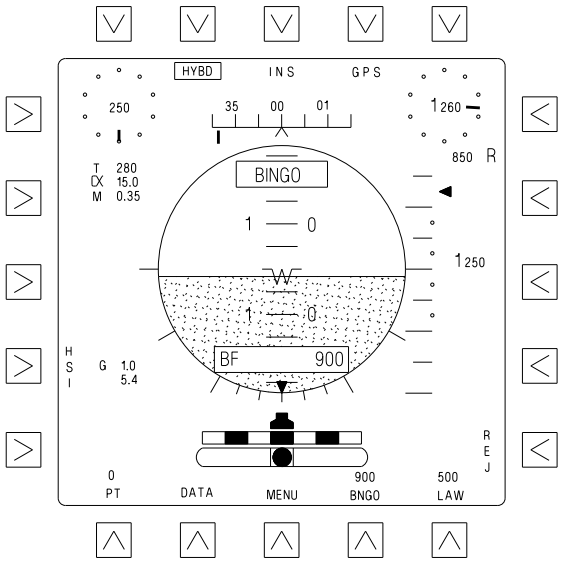
Figure 2-4. Fuel System Displays (Sheet 1 of 2)



HUD



MFD

● BINGO SET WITH DEP
BNGO BUTTON SELECTED

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Figure 2-4. Fuel System Displays (Sheet 2 of 2)

2.2.5.4 BNGO Button (DEP). Pressing the button enables the DEP for entry of the BINGO setting and displays the scratchpads.

2.2.5.5 BINGO Setting. The BINGO setting is located above the ADI BNGO option and provides a readout of the BINGO setting from 0 to 3,000 pounds in 100 pound increments.

2.2.5.6 ADI BNGO Increment/Decrement Options. The ADI BNGO increment/decrement (∧/∨) options correspondingly increase/decrease the BINGO setting in 100 pound increments.

2.2.6 Fuel Warning, Caution, and Advisory Lights.

2.2.6.1 FUEL Caution Light. The FUEL caution light is located on the warning/caution/advisory lights panel. The light illuminates when usable fuel remaining is less than approximately 350 pounds.

2.2.6.2 F PRES Caution Light. The F PRES caution light is located on the warning/caution/advisory lights panel. The light is illuminated when a loss of fuel tank pressure is detected or an insufficient pressure differential exists across either boost pump.

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. The electrical system is illustrated in the Electrical System foldout, FO-13. See Figure 2-6 for electrical load distribution.

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 and is shown in FO-13. On aircraft 165093 AND UP, both ac inverters continue to operate and share the essential ac bus load when a generator undervoltage condition is sensed by the undervoltage unit. The undervoltage sensing unit incorporates a 1.5 second time delay to prevent operation by undervoltage transients.

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 and the AC INV caution light (aircraft 165080 THRU 165092). On aircraft 165093 AND UP, the AC INV light does not illuminate. 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 and the AC INV caution light (aircraft 165080 THRU 165092). On aircraft 165093 AND UP, the AC INV light does not illuminate. 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 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 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 ampere-hour 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. 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. Suitable power units are listed in Chapter 3, Servicing. The external power supply receptacle is located behind an access panel aft of the right engine air intake. As engine RPM exceeds 45 percent N_2, the external power is automatically cut off.

2.3.4 External Power Monitor. Before being supplied to the aircraft electrical buses, external power is sampled by the external power monitor for proper voltage. If the monitor senses any quality problems it will disconnect or inhibit external power from the buses. Operation of the external power monitor is controlled by the EXT PWR MONITOR switch. Starting the GTS on external power is not permitted. To start the GTS, external power must be disconnected by setting the EXT PWR MONITOR switch to OFF. The external power monitor switch is located in the front cockpit on the left side wall, aft of the pilot services panel on the ground power panel.

2.3.5 Ground Power Switching. Two ground power switches are located in the front cockpit on the ground power panel. These switches control external electrical power to a group of aircraft systems/equipment and are used to apply power on the ground only to the necessary systems/equipment during maintenance. During an engine start or anytime both ENGINE start switches are set to ON, ground power switching is disabled.

2.3.6 Ac System Operation

2.3.6.1 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.

2.3.6.2 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.

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

2.3.6.4 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.

2.3.7 Electrical System Controls and Indicators. See Figure 2-5.

2.3.7.1 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. The switch has the following positions:

1	Resets number 1 inverter.
Center	Normal position.
2	Resets number 2 inverter.

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:

RESET	Resets the generator voltage regulator.
ON	Generator is on, excitation power is supplied from the 28 VDC Essential Services Bus.
OFF	Excitation power is removed, turning off the generator.

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.

OFF	The external power is disconnected from the aircraft electrical system. Before starting the GTS this position should be selected.

NORMAL	Allows the aircraft electrical system to be energized by external electrical power if the generator is not running and the external power is of the proper quality.
RESET	Switch must be positioned to RESET before external power can be applied to the aircraft electrical system. The RESET position is spring loaded to NORMAL.

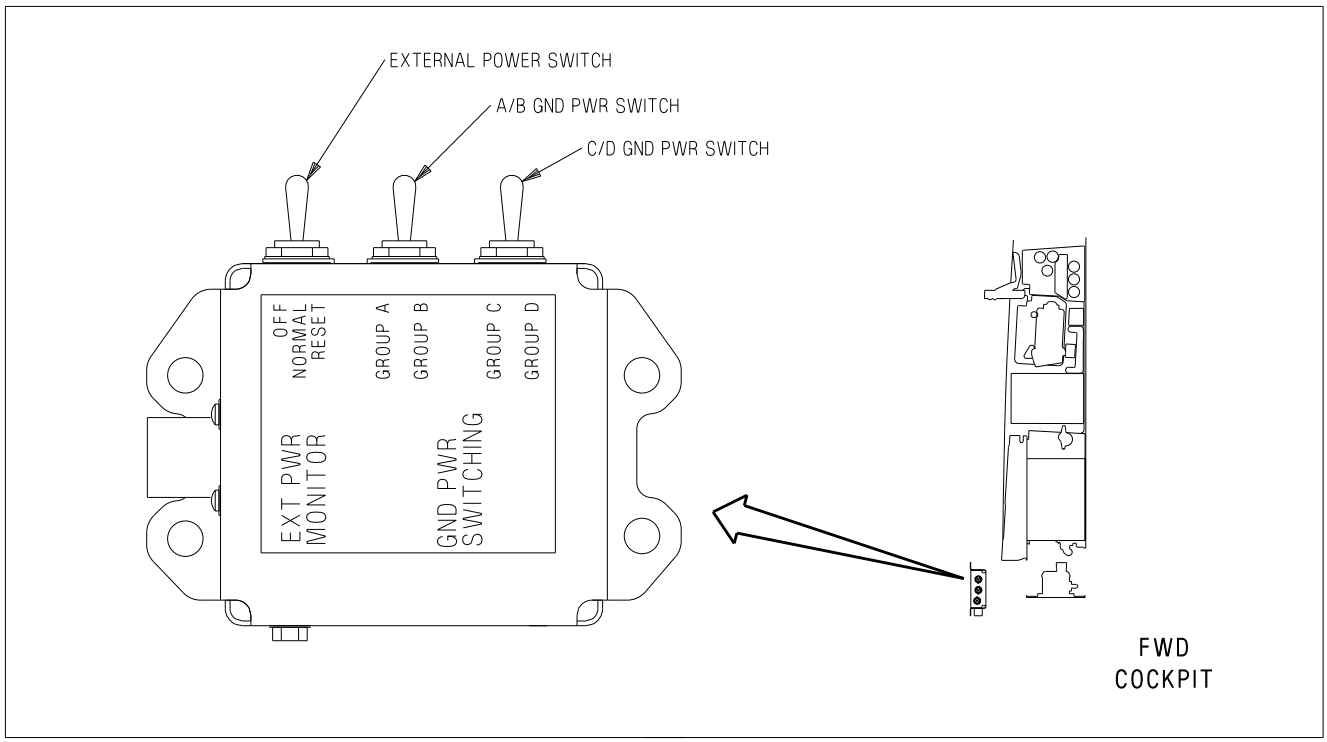

Figure 2-5. External Power Monitor/Ground Power Switching Controls

2.3.7.5 A/B GND PWR Switch. The A/B GND PWR switch controls external electrical power to the various systems/equipment as listed below:

GROUP A	DEU, ADR, HUD camera, SADS, forward left MFD.
GROUP B	Same as GROUP A plus the remaining three MFDs.

2.3.7.6 C/D GND PWR Switch. The C/D GND PWR switch controls external electrical power to the various systems/equipment as listed below:

GROUP C	YDC and GINA.
GROUP D	Same as GROUP C plus the radar altimeter.

2.3.7.7 Voltmeter. A dc voltmeter in each cockpit is connected to the 28 VDC Essential Services Bus. It indicates generator voltage with the generator on and battery voltage with the generator off. The scale of the voltmeter ranges from 21 to 29 volts and is graduated in 2-volt increments. Concentric with the graduated scale is a colored scale which is orange from 21 to 24 volts (indicating battery power only) and is green from 24 to 29 volts (indicating generator or external power).

2.3.8 Electrical Warning, Caution, and Advisory Lights.

2.3.8.1 GENERATOR Warning Light. When an undervoltage condition is sensed, the warning light is illuminated.

2.3.8.2 AC INV (INVERTER) Caution Light. When a generator bus undervoltage is sensed, disabling one inverter, or an inverter fails, the AC INV caution light is illuminated (aircraft 165080 THRU 165092). On aircraft 165093 AND UP, the AC INV caution light illuminates only when one or both inverters fail.

28VDC - GENERATOR BUS			
AC Isolation Relay	Stby Baro Altimeter Vibrator [3]	Master Arm	Rudder Trim Control
ADRS Total Air Temp Htr Pwr	Bombs Release	MDL Power	Stabilator Position Indicator
Aileron Trim Control	Cabin Pressure Control 2	MFDs, Right (Both Cockpits)	Stabilator Trim Standby
Aileron Trim Position Indicator	Comm Control Power B	OBOGS Heat	UHF/VHF 2
Angle-of-Attack Heat	DEP, Fwd	Overvoltage Unit	Undervoltage Sensing
Anti-collison Lights	Flood Lighting	Reticle Light	Voltage Regulator
	GTS Drain Valve	Rockets Release	VOR/ILS Control
	Landing/Taxi light		Yaw Damper

28VDC - ESSENTIAL SERVICES BUS			
Accel/Bleed Valve Control	Ejection Enable Switch (IFF)	Fuel System Quantity Indicator	Navigation Light, Tail
Accel/Bleed Valve Indicator	Emergency Jettison (Wing Station Only)	Generator Off-Load	Nose Wheel Steering
ADI, Standby	Emergency Lighting	Generator Undervoltage	OBOGS Monitor
ADRS	Emergency NLG Door Actuation Control	GINA	OBOGS Shutoff Valve
Angle-of-Attack Indicator	Engine Bleed Valve	GTS Fuel/Oil Pump	Pitot Probe Heat
Annunciator Lights	Engine Control & EGT Indicator Pwr	HYD 1, 2, & Brake Transducer	Press To Test
Anti-Skid Control	Engine Vibration and Pressure Monitor	Hydraulic 2 Bypass	Ram Air Turbine Reset
Approach Idle Stop	External Power	IFF Control	Rudder Pedal Shaker Motor
Arresting Hook	Fire Detection	IFF RCVR/XMTR	SADS [2]
Cabin Pressure Control 1	Flaps Control (Emer)	Ignitors	Seat Position
Cabin Pressure Warning	Flaps Control Main	Inverters Protection	Slats Position Indicator
Cabin Temperature Control	Flaps Position Indicator	Landing Gear Control	Speedbrake Control
Caution Warning System	Fuel Boost Pump Inverters [1]	Landing Gear Selector Valve	Speedbrake Position Indication
Comm Control Pwr A	Fuel Boost Pumps Control [1]	Launch Bar	Stabilator Trim Main
DC Power External Supply	Fuel Flow Indicator	Manual Fuel Sys Bleed Valve Time Delay	TACAN
DC Power Generator Reset	Fuel System Control	Manual Fuel System Control	Throttle Proximity Switches
DC Power Voltmeters-DEU [2]	Fuel System Low Level Warning	Master Start 1 & 2	Turn/Slip Indicator
		Master Switch Batt 2	UHF/VHF 1
		MFD, Left (Both Cockpits) [2]	VCR/CEU [2]
			Weight-on-Wheels Control

115 VAC BUSES		26 VAC BUSES	
ESSENTIAL	**NON-ESSENTIAL**	**ESSENTIAL**	**NON-ESSENTIAL**
Annunciator Lights (Night)	DEU Cooling Fan	TACAN	DEU
Emergency NLG Door Act (Pwr)	Radar Altimeter	ADR	VOR/ILS/MB
GINA (Synchro. Signal)			Yaw Damper

6 VAC BUSES		5 VAC NON-ESSENTIAL BUS
ESSENTIAL	**NON-ESSENTIAL**	
NAV Lights, Wing	Formation Lights	MIP Cockpit Lights
28 VAC NON-ESSENTIAL BUS		
Console Lights		

LEGEND

[1] Operate for 30 seconds after loss of generator bus.
[2] Operate for 2 minutes after loss of generator bus.
[3] Standby Baro Altimeter continues to operate with a 28VDC generator bus failure, but the vibrator becomes inoperative.

Figure 2-6. Electrical Load Distribution

2.4 AVIONICS SYSTEM

The avionic 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). The Avionic System foldout, FO-15, presents a block diagram of the system.

2.4.1 Display Electronics Unit. Upon aircraft power up, power is supplied to the DEU and normal operation begins. Refer to the BIT System, paragraph 2.26, for a description of DEU BIT. 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, see Figure 2-7.

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. Anytime a 28 VDC Generator Bus undervoltage is sensed, both right MFDs and the HUD drop off line. The DEU, both left MFDs, and SADS will remain powered by the 28 VDC Essential Services Bus for 2 minutes without generator power. If the 28 VDC Generator Bus undervoltage occurs while airborne the DEU automatically deselects all training failures and switches both left MFDs to the ADI display. A DISPLAY POWER switch on the miscellaneous switch panel allows the pilot to override the 2 minute relay and maintain power to the DEU, left MFDs, and SADS by selecting ORIDE. The DISPLAY POWER switch also allows the pilot to reset the DEU by momentarily interrupting power to the DEU. When a GTS start is initiated while airborne, the DEU and all MFDs immediately drop off line. Once the generator is restored and reset following a 28 VDC Generator Bus undervoltage or GTS start, the DEU, all MFDs, and the HUD will be restored to their last pilot selected mode/display.

2.4.2 Master Modes. There are 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 avionic equipment operation are tailored as a function of pilot selected master mode. This section will only address the NAV master mode, refer to Chapter 22 for a description of the A/A and A/G master modes.

2.4.2.1 Navigation Master Mode. The NAV master mode optimizes HUD symbology with navigation type data, see paragraph 2.4.3.5.1 HUD Symbology. The NAV master mode can be selected in several different ways:

1. Automatically at power up with weight-on-wheels.

2. Selecting (boxing) the NAV option on the stores display, see Figure 2-8.

3. Actuating the MODE button on the DEP to cycle to the NAV master mode, refer to the MODE button description, paragraph 2.4.3.6.14.

Selection of the NAV master mode can be determined by the HUD display, see Figure 2-12 for HUD symbology in the NAV master mode. Master mode can also be determined from the stores display.

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

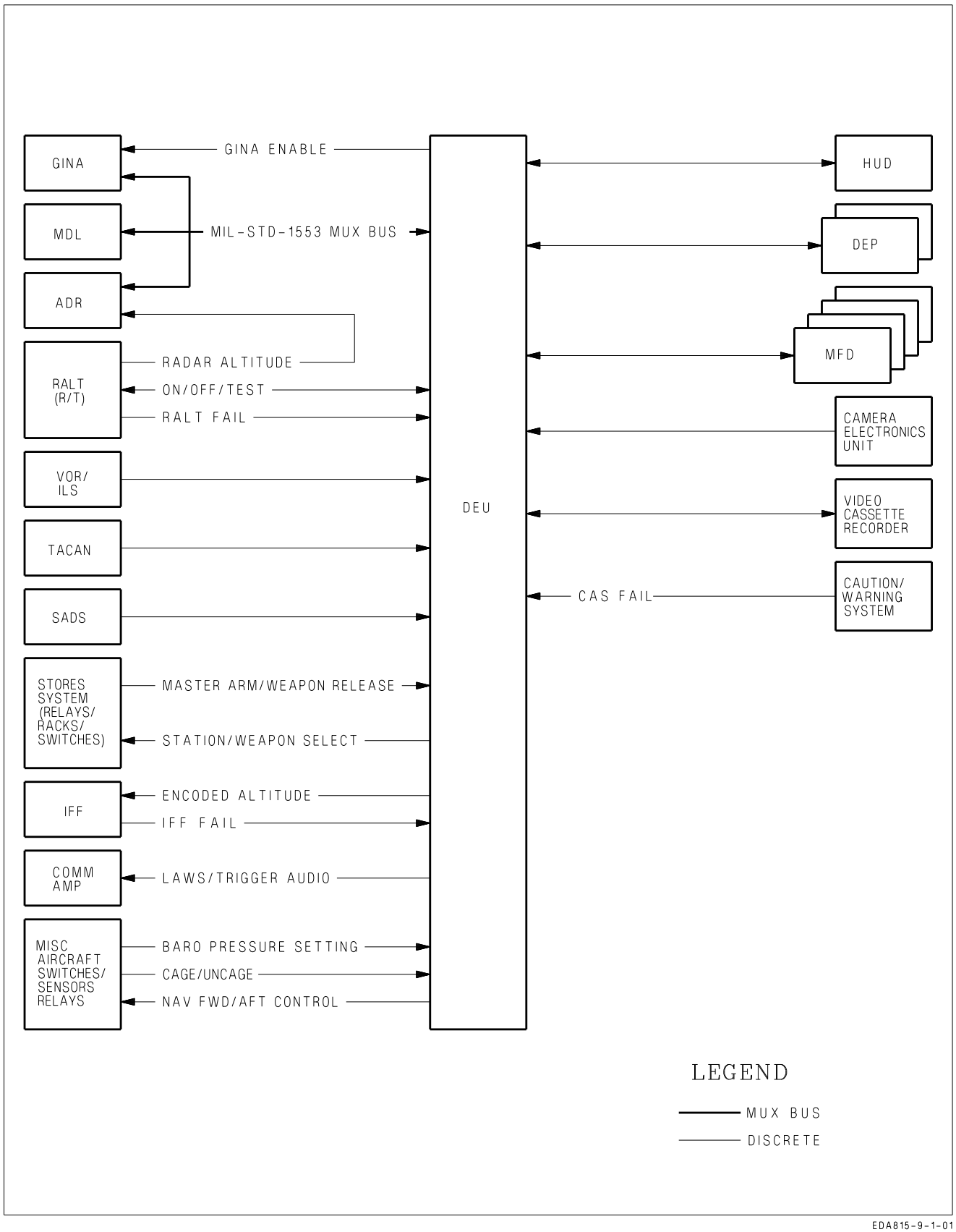

Figure 2-7. DEU Interface Diagram

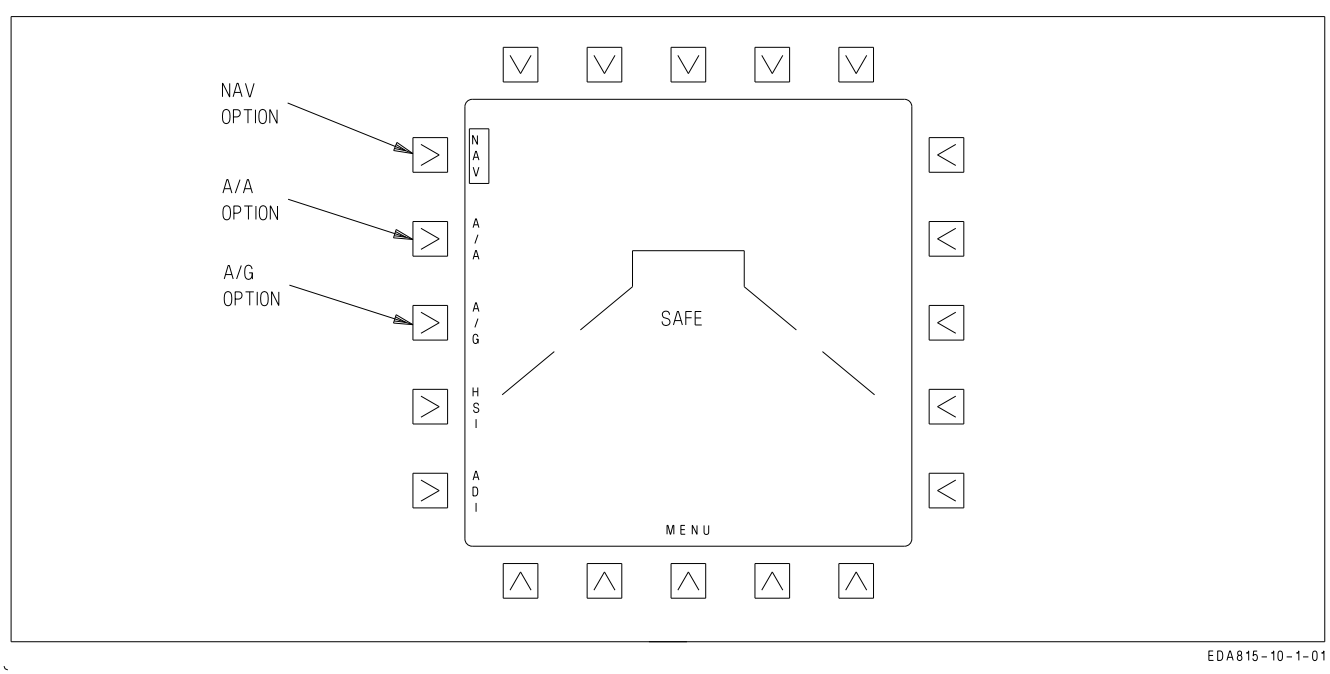

Figure 2-8. Master Mode Selection

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. Refer to the BIT System, paragraph 2.23 and subsequent, for a description of the MFD BIT.

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.

2.4.3.2 MENU Display. The MENU display provides access to all top level displays by pressing (selecting) the adjacent button, see Figure 2-9. Upon aircraft power up with weight-on-wheels each MFD initializes with the MENU display. With weight-off-wheels, the MFDs will revert to the display, option selections, and master mode selected prior to the power interruption. The MENU option appears next to the bottom center button on all formats and provides the ability to return to a known point and access another format. Functions provided by the MENU options are discussed in the section where that system is described.

2.4.3.3 Attitude Director Indicator (ADI). The ADI display is selected by actuating the ADI option. The ADI is an electronic display that replicates a standard electro-mechanical ADI, but provides more flight information, see Figure 2-10. Aircraft navigation data is derived from the GINA and/or ILS then is sent to the DEU which in turn provides the corresponding ADI display. Refer to Chapter 21 for a description of how the ADI is integrated with the navigation system.

The ADI ball indicates aircraft pitch and roll angle in a standardized format compatible with

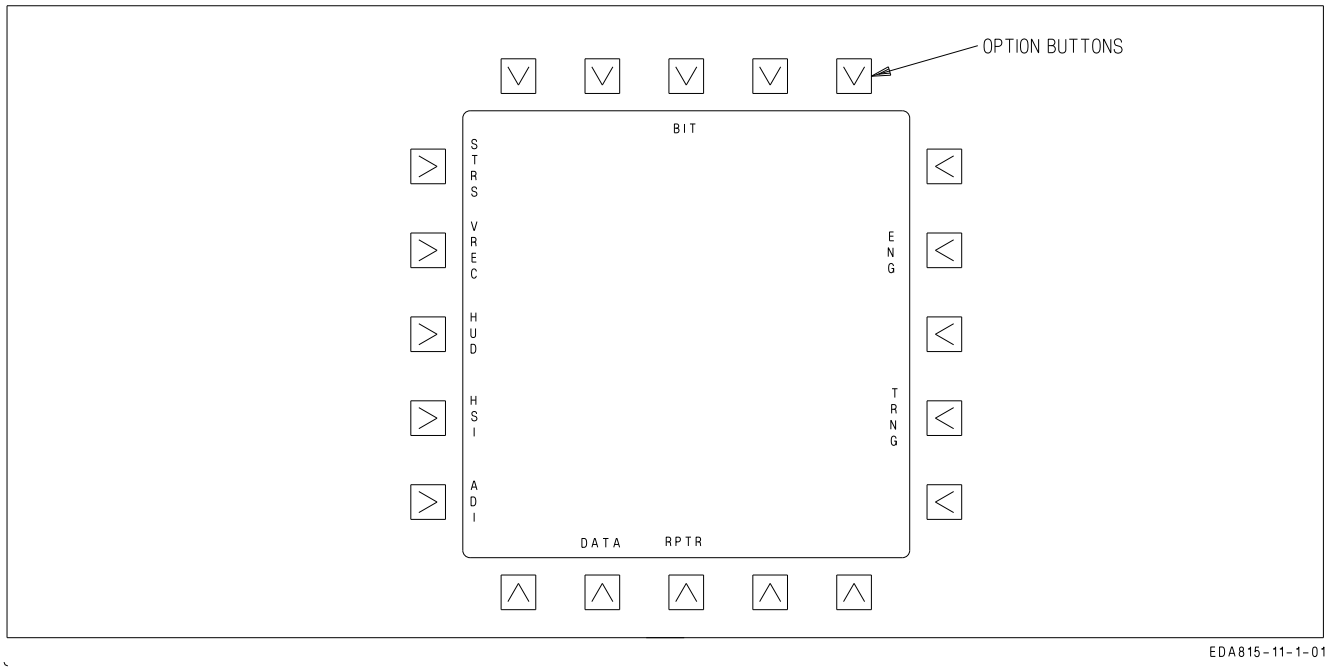

Figure 2-9. MENU Display

previous training. On the ADI the sky is represented in green and the earth in dark.

2.4.3.3.1 ADI Symbology. The pitch ladder, horizon line, waterline symbol, bank pointer and scale, spin direction indicator, slip indicator, indicated airspeed, barometric altitude, and vertical speed are unique ADI symbology and are described below:

1. Pitch Ladder and Horizon Line. Indicates the pitch angle of the aircraft by the position of the waterline symbol (‾W‾) relative to the pitch ladder. The ladder consists of rungs every 5 degrees and the pitch angle readout every 10 degrees. At +90 degrees a circle appears indicating the zenith and at -90 degrees a circle with a cross appears indicating the nadir. The pitch ladder pivots about the waterline symbol and appears in all master modes. The horizon is indicated by a solid line extending across the ADI ball and is restricted to the confines of the ball. The area above the horizon (sky) is illuminated in green, while the area below (ground) is dark. The horizon line will be limited when it is within approximately 10 percent of the edge of ball to show the nearest horizon. The pitch ladder will continue to move in relation to the waterline symbol, displaying the actual pitch attitude.

2. Bank Pointer and Scale. Bank angle is indicated by a solid pointer moving inside a fixed scale at the bottom of the ADI ball. Tic marks are provided at 0, 10, 20, 30, 60 and 90 degrees angles of bank. When the bank angle exceeds 90 degrees the bank pointer will not be displayed.

3. Spin Direction Indicator. Indicates direction and magnitude of aircraft yaw rate. Used to determine direction of aircraft spin in both upright and inverted spins. A yaw rate of 3 degrees per second is indicated when the indicator is limited above 6 degrees per second.

NOTE

This indicator does not provide standard and half-standard rate turn information.

4. Slip Indicator. Indicates aircraft slip or skid when the ball is not centered. The ball is

limited when lateral acceleration , slip or skid, is 0.15g or above.

5. Vertical Speed. Vertical speed is displayed to the right of the ADI ball in two formats: digital and analog. The digital readout displays the vertical speed in 10 feet per per minute (fpm) increments with a minus sign for descents. The vertical speed is automatically set to zero with weight-on-wheels. The analog display provides trend information using a trend scale, located in the upper right portion of the ADI display. The digital readout displays altitude in feet, based upon the barometric pressure setting set on the standby altimeter. The altitude is flashed for 5 seconds when ascending or descending through 18,000 feet. The trend scale consists of a circle of 10 evenly spaced dots, each representing 100 feet, and a marker which moves around the circle in 20 foot increments. Multiples of 1,000 feet are

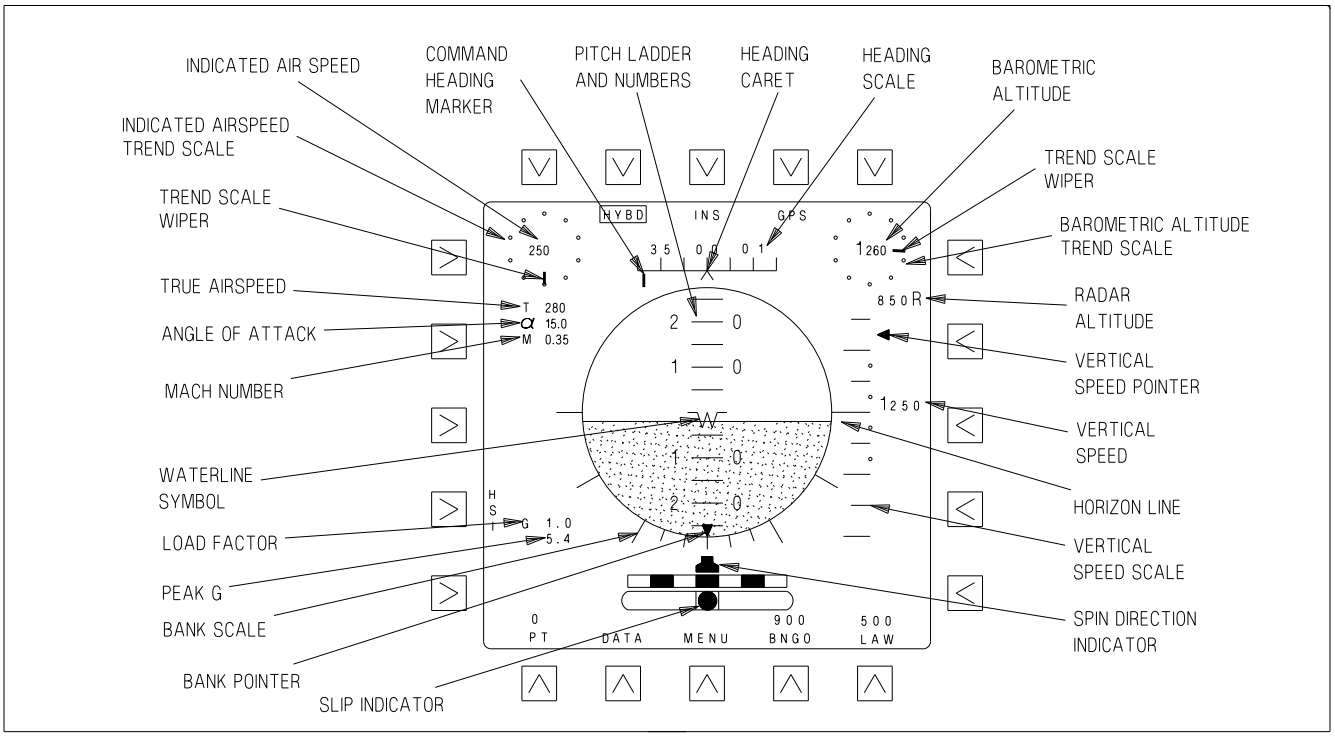

Figure 2-10. ADI Symbology

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fixed scale and a solid caret which moves up and down the scale. The 0 fpm line is an extension of the 90 degree angle of bank marker. Dashes are provided at the -2,000, -1,000, and +1,000 fpm locations. Tic marks are provided at the -1,500, -500, +500, +1,500 fpm locations. Dots are provided at the -750, -250, +250, and +750 fpm locations. The caret position is based upon the digital readout. The caret is limited when the rate of descent exceeds -2,100 fpm or the rate of climb exceeds 1,600 fpm. When limited the indicator is displayed as an open caret.

6. Barometric Altitude. The barometric altitude readout is displayed in the center of a represented at the 12 o'clock position. Increasing altitude is indicated by clockwise rotation of the marker.

7. Indicated Airspeed. Indicated airspeed digital readout range is from 50 to 570 knots and is displayed in the center of a trend scale, located in the upper left portion of the ADI display. The airspeed readout appears in all master modes and will be removed if the DEU or SADS degrades. The airspeed trend scale consists of a circle of 10 dots, each representing 10 knots, and a marker which moves around the circle in 1 knot increments. Multiples of 100 knots are represented at the 12 o'clock position.

Refer to HUD Symbology paragraph for a description of: peak G, load factor, Mach number, angle-of-attack (AOA), true airspeed, heading scale, heading caret, command heading marker, and radar altitude.

2.4.3.3.2 PT Option. The PT (ADI pitch trim) option allows the pilot to adjust the ADI ball pitch position (horizon line, pitch ladder, and numerics) in relation to the waterline symbol. Upon initial power up the setting defaults to 0, with a maximum adjustment of ±5 degrees. Pressing the option alternately selects/deselects (boxes/unboxes) the PT option, enabling/disabling the PT increment/decrement options. Selection of either the ADI LAW or BNGO options will automatically deselect (unbox) the PT option. Pressing the increment option will increase the pitch attitude by rotating the ADI ball downward. Selecting the decrement option will decrease the pitch attitude. The increment or decrement option is not displayed when the maximum adjustment is reached. Changing the pitch trim in either cockpit changes the pitch trim for the other cockpit.

2.4.3.4 Horizontal Situation Indicator (HSI). The HSI display is selected by actuating the HSI option. The HSI display is an electronic display that replicates a standard electro-mechanical HSI, but provides enhanced capabilities, see Figure 2-11. Aircraft navigation data is derived from the GINA, TACAN, VOR, ILS, or MDL then is sent to the DEU which in turn provides the corresponding HSI display. The HSI display provides aircrew selectable course deviation indication (CDI) or planimetric (PLAN) steering modes. Refer to Chapter 21 for a description of how the HSI is integrated with the navigation system.

NOTE

Only one cockpit can have command of the HSI display, refer to Chapter 21.

2.4.3.4.1 HSI Symbology. The compass rose rotates about the aircraft symbol according to the aircraft heading, referenced to the lubber line. Benchmarks are provided around the periphery of the compass rose in 45 degree increments from the lubber line. HSI symbology is described below:

1. Waypoint Zero. Indicates the position of waypoint zero relative to the aircraft symbol. It appears as a home plate symbol with a zero next to it and is displayed only when inside the compass rose.

2. Waypoint Symbol. Indicates the position of the selected waypoint relative to the aircraft symbol. It appears as a small circle with dot in the center and the waypoint number to the right of the symbol. The symbol is only displayed when inside the compass rose.

3. Waypoint Offset Symbol. Indicates the position of the offset for the selected waypoint relative to the waypoint and the aircraft symbol. It appears as a plus symbol and is displayed only when within the compass rose.

4. VOR Bearing Pointer/Tail. Displayed only in CDI mode, with a valid VOR signal, when VOR steering is selected and indicates the bearing to the VOR station. The pointer appears as an open triangle and the tail appears as an open rectangle; both located inside the compass rose.

5. VOR Bearing. Displayed only in the CDI mode with a valid VOR signal and indicates bearing to the VOR station digitally.

6. TACAN Symbol. Displayed when receiving a valid TACAN signal. The TACAN symbol indicates the position of the TACAN station relative to the aircraft symbol. It appears as a highly modified triangle shape with a dot in the center.

7. TACAN Bearing Pointer/Tail. Displayed when TCN steering is selected and indicates bearing to the selected TACAN station. The pointer appears as a triangle with a line inside it and the tail appears as a solid rectangle, both located outside the compass rose.

8. Waypoint/Waypoint Offset Bearing Pointer/Tail. Indicates the bearing to the

selected waypoint or waypoint offset. The pointer appears as a small triangle and the tail appears as a solid rectangle; both located inside the compass rose. The pointer is displayed when WYPT or WO/S steering is selected.

9. Lubber Line. Indicates aircraft heading on the compass rose.

10. Ground Track Pointer. Indicates the aircraft actual ground track heading. It appears as a diamond with attached tail.

11. Command Heading Marker. Indicates the selected command heading. Appears as a split rectangle along the outside of the compass rose.

12. Sequential Steering Lines. The lines are displayed when a waypoint sequence string is entered and the SEQ option is selected. The SEQ option is available regardless of the steering mode selected. The sequential steering lines are displayed as dashed lines connecting the waypoints entered into the sequencestring. A minimum of two waypoints must be entered before the SEQ option is displayed.

13. CDI Course Line. Indicates the selected course/deviation to/from the waypoint/ waypoint offset/TACAN/VOR course or ILS localizer. It appears as a segmented line with the pointer and tail centered on the aircraft symbol pointing towards the selected course on the compass rose. The center segment is displayed parallel to the head and tail but offset by course deviation. The CDI course line is only displayed when the CDI mode is selected.

14. Course Deviation Dots. Indicates the amount of deviation from the selected course. The four dots are centered on the aircraft symbol and are perpendicular to the CDI course line. Appears only in the CDI steering mode with CRS selected. Refer to Chapter 21 for descriptions of the various CDI steering modes and a detailed explanation of the course deviation dots.

15. Planimetric Course Line. Indicates the selected course to the selected waypoint, waypoint offset, or TACAN station. It appears as a solid line centered on the waypoint/ waypoint offset/TACAN symbol and appears only in the planimetric steering mode with CRS selected.

16. Aircraft Symbol. Indicates a plan view of the aircraft relative to the selected steering mode. It appears fixed in the center of the display, heading upward. The aircraft symbol will occlude all other symbols when they overlap.

17. Groundspeed and True Wind Direction/ Speed. Appears below the aircraft symbol when the aircraft is weight-off-wheels. The maximum value that can be displayed for wind speed is 99 knots.

18. TACAN Data. Indicates bearing, range, and time to go, to the selected TACAN station. It appears in the upper left corner of the display. The data is removed if it is invalid.

19. Waypoint/Waypoint Offset Data. Indicates the applicable magnetic bearing, range, time to go, and waypoint name for the selected waypoint or waypoint offset. It appears in the upper right corner of the display.

20. Command Heading Readout. Indicates the selected heading. Appears as a digital readout above the HDG option.

21. Course Line Readout. Indicates the heading of the selected course line in CDI or PLAN steering modes.

2.4.3.5 Head-Up Display. The HUD is only available in the forward cockpit. It is an electro-optical device that projects flight and weapon delivery information in symbolic form into the pilots field of view on a combining glass, see Figure 2-12. The HUD is directly controlled by the DEU which receives inputs from various on board systems. The DEU then converts these inputs and displays the appropriate symbology.

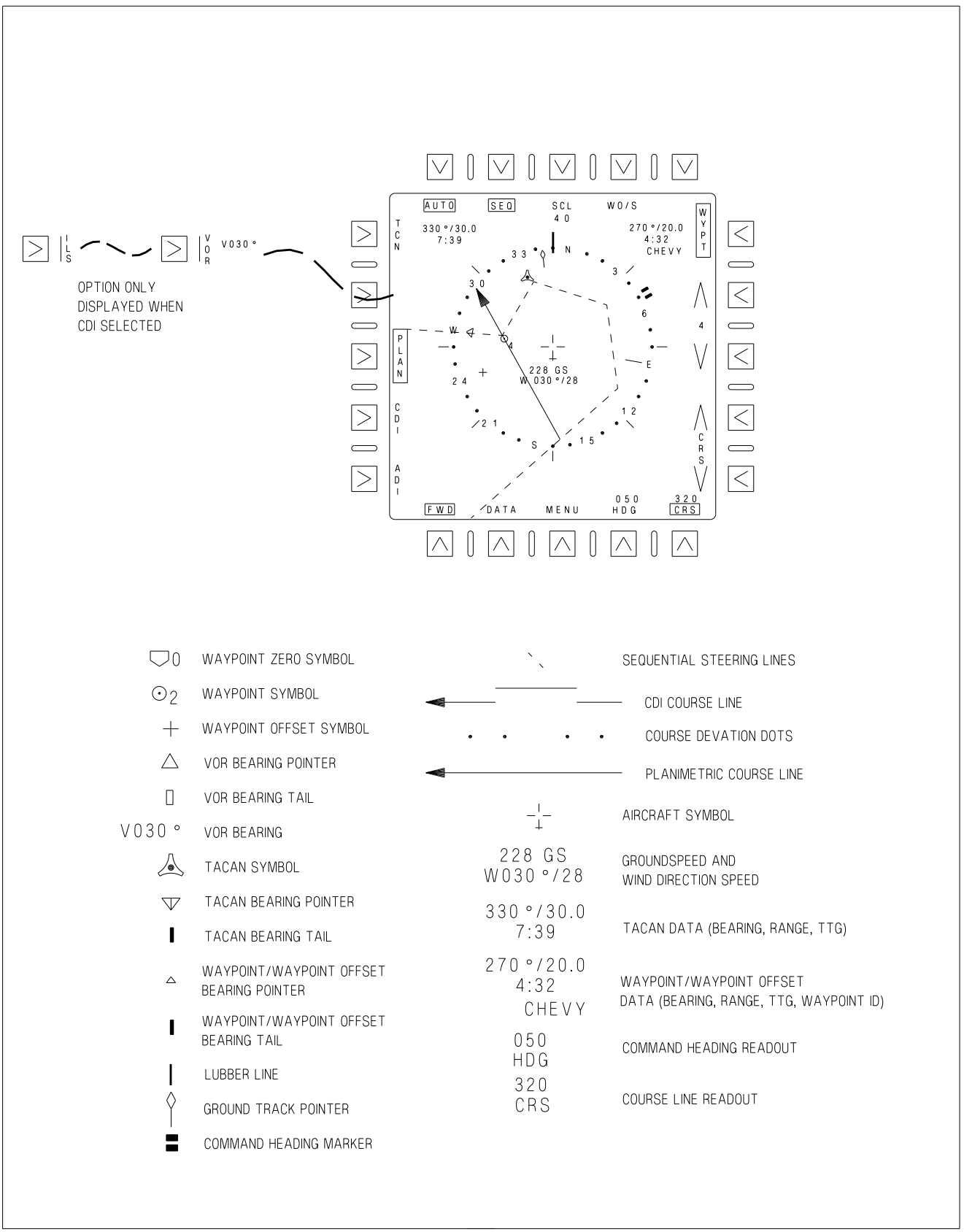

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Figure 2-11. HSI Symbology

These inputs to the DEU can be received automatically or manually from the aircrew. Aircrew inputs are entered via the DEP, or an appropriate MFD display. Refer to the BIT System, paragraph 2.26 and subsequent, for a description of HUD BIT.

WARNING

The HUD shall not be used as a primary flight instrument.

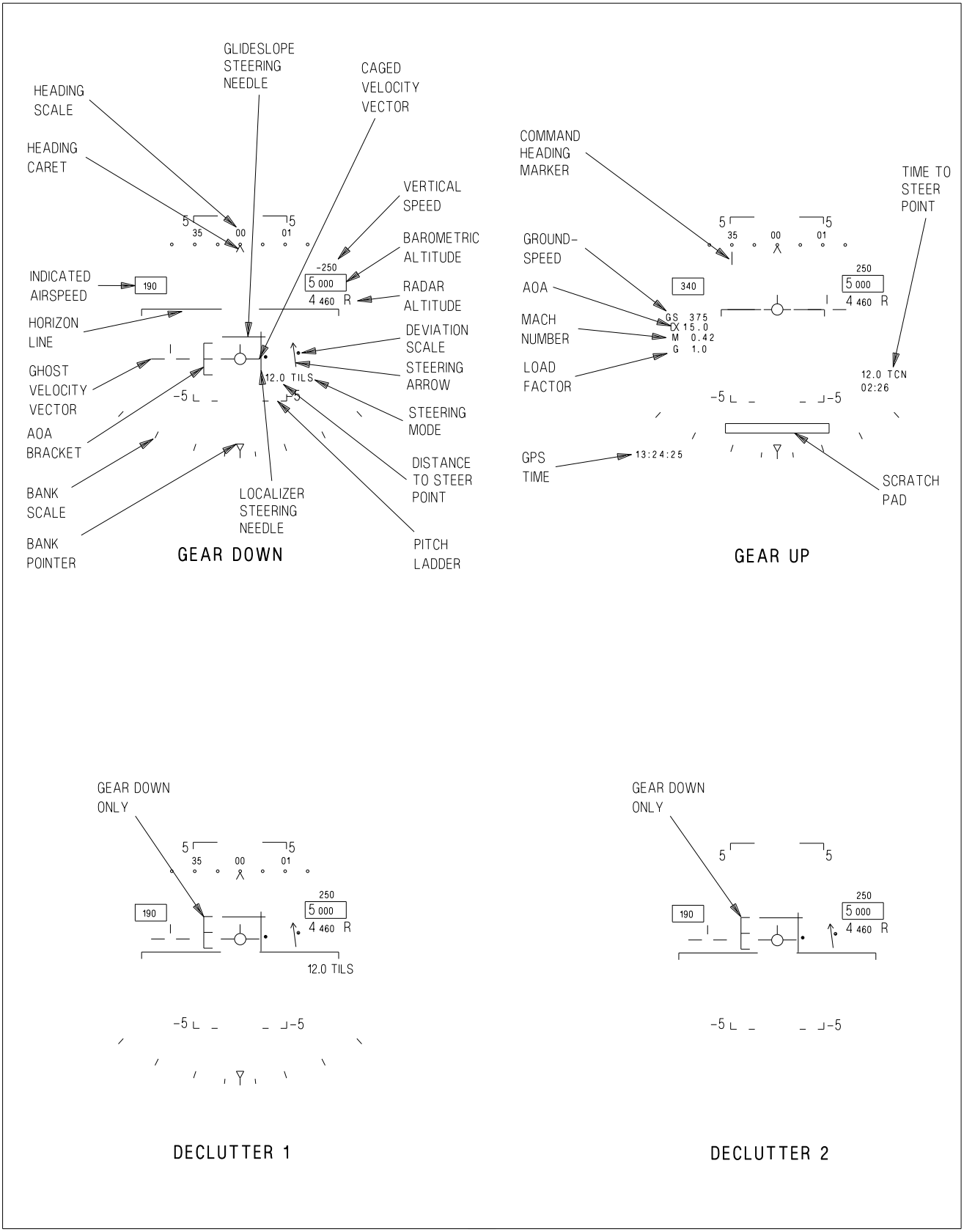

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Figure 2-12. HUD Symbology

2.4.3.5.1 HUD Symbology. HUD symbology is a function of the selected master mode. This section will only discuss HUD symbology as it relates to the NAV master mode, see Figure 2-12. Refer to Chapter 22 for a description of A/A and A/G HUD symbology. HUD symbology is described below:

1. Waterline Symbol. When displayed the waterline symbol (‾W‾) is fixed at a position in line with the top of the airspeed and barometric altitude boxes. The pitch ladder is referenced to the waterline symbol to provide pitch attitude indications. The waterline symbol is removed following a successful alignment.

2. Velocity Vector. The velocity vector (-O-) provides the pilot with an outside world reference with regard to actual aircraft flight path. The velocity vector represents the point towards which the aircraft is flying (actual aircraft flight path). The position of the velocity vector is limited to 7 degrees laterally and +3 to -11 degress vertically from the waterline position (top of the airspeed and barometric altitude boxes). As long as AOA is valid, the velocity vector may be caged to restrict its movement closer to the center of the HUD. The pitch ladder is referenced to the velocity vector in either the caged or uncaged mode to provide flight path angle. If the velocity vector exceeds its limits in the uncaged mode it will begin to flash, indicating it no longer accurately represents the aircraft's flight path as viewed through the HUD combiner glass. The pitch ladder in this case will continue to accurately display actual aircraft flight path angle, however, the pilot will not be able to determine pitch attitude. In the caged mode when the aircraft flight path exceeds the caged velocity vector limits a ghost velocity vector is displayed at the actual aircraft flight path. The caged velocity vector is surrounded by an occluded zone and the ghost velocity vector will appear to slide out from behind the caged velocity vector. The ghost velocity vector movement has the same restrictions as the uncaged velocity vector and will flash when those limits are exceeded. If AOA becomes unreliable the velocity vector will automatically uncage. If INS data becomes invalid the velocity vector is removed.

3. Pitch Ladder. With a velocity vector displayed, the vertical flight path angle of the aircraft is indicated by the position of the velocity vector relative to the pitch ladder. With a waterline symbol displayed, the aircraft's pitch attitude is indicated by the position of the waterline symbol relative to the pitch ladder. Positive pitch lines are solid and are above the horizon. Negative pitch lines are dashed and are below the horizon. The outer segments of the lines point toward the horizon. Each line is numbered and the numbers rotate so that inverted flight can easily be determined. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at half of the indicated pitch angle. In level flight the pitch lines are not angled. The zenith is represented by a plus and the nadir by a circle with an X. The pitch ladder is referenced to the velocity vector as described in the velocity vector description. If INS attitudes are invalid the pitch ladder is referenced to and pivots about the waterline symbol. The pitch ladder appears in all master modes.

4. Horizon Line. Provides a horizon reference with the pitch ladder. The horizon line is displayed as a solid line. The horizon line appears in all master modes. The width of the horizon line is extended in the approach mode (landing gear down)

5. Bank Pointer and Scale. Bank angle is indicated by a pointer moving inside a fixed scale at the bottom of the display. Tic marks are provided at 0, 5, 15, 30, and 45 degrees angle of bank. When the bank angle exceeds 47.5 degrees. The bank pointer is limited and will flash, the bank pointer and scale only appear in the NAV master mode.

6. AOA Bracket. The AOA bracket moves with respect to the velocity vector and shows a range of AOA from 16 to 18 units, with the center of the bracket indicating the on speed approach AOA. The AOA bracket is only displayed in the NAV master mode with the gear

down. When the velocity vector is outside the AOA bracket digital AOA is displayed.

7. Indicated Airspeed. Indicated airspeed appears in all master modes.

8. Heading Scale/Heading Caret. The heading caret indicates compass heading on the heading scale. The heading scale is a 30 degree moving scale with a digital reading every 10 degrees, that provides trend data during turns. For example, as the aircraft turns right, the scale moves from right to left.

9. Command Heading Marker. If ILS is selected or when no steering is selected (i.e., TACAN, waypoint, waypoint offset, VOR) the marker indicates the selected heading set using the Command Heading Setting function, refer to Chapter 21. This symbol only appears in the NAV and A/G master modes. This symbol also appears on the ADI as a vertical line and on the HSI as a split rectangle (command heading marker). On the HUD and ADI, the marker will move slightly past the heading scale before being limited. If no steering is selected the marker will indicate the shortest turn to the command heading. If VOR is selected its location is based upon VOR bearing. If TACAN, waypoint, or waypoint offset steering is selected it indicates great circle steering to the NAVAID position. The command heading marker is removed whenever the steering arrow is displayed.

10. Vertical Speed. Indicates aircraft instantaneous vertical speed in fpm. Descent is indicated with a minus sign. This value only appears in the NAV master mode. The vertical speed indication range is from -9990 to +9990 fpm. Vertical speed is set to 0 fpm with weight-on-wheels.

11. Barometric Altitude. The barometric altitude is presented in the box on the right side of the HUD in 20 foot increments, based on the pressure setting dialed in the standby altimeter. The altitude is flashed for 5 seconds when ascending or descending through 18,000 feet. Barometric altitude appears in all master modes.

12. Radar Altitude. Radar altitude is displayed below the barometric altitude box, in 10 foot increments from 0 to 5000 feet (AGL), and in all master modes. The letter R will be displayed to the right of the altitude to indicate radar altitude. If the radar altitude is invalid or the aircraft exceeds 5000 feet AGL, the radar altitude will be removed, however, the R will remain displayed. The R will only be removed when the radar altimeter power is turned off.

13. Ground Speed. Indicates aircraft ground speed. Ground speed only appears in the NAV (gear up) master mode. Displayed ground speed changes to true airspeed in the A/G mode. The ADI always displays true airspeed. All are displayed in 1 knot increments.

14. AOA. Indicates aircraft angle-of-attack. Digital AOA appears in all master modes except NAV (gear down). In the NAV mode (gear down) the AOA digital value is displayed when the AOA bracket is limited.

15. Mach Number. Indicates aircraft Mach. Mach appears in all master modes except NAV (gear down) and is displayed in 0.01 increments.

16. Load Factor (g). Indicates aircraft acceleration between ±9.8g's and is displayed in 0.1 increments. Load factor (g) appears in all master modes except NAV (gear down).

17. Peak G. A positive peak g indication is displayed on the HUD anytime the aircraft exceeds a threshold of 4.0g's with the aircraft weight-off-wheels. The peak g indication can be removed/reset by selecting declutter level 1 from normal. The peak g display range is a positive 4.0 to 9.8g's and is displayed in 0.1 increments. The peak g indication is cleared upon aircraft electrical power-up with weight-on-wheels.

18. GPS Time. Indicates coordinated Universal Time in hours, minutes, and seconds (hh:mm:ss). If GPS time is not available, elapsed time starting at DEU power up is

displayed. GPS time is displayed in NAV (gear up) and A/G modes.

19. ILS steering Needles. The ILS steering needles are referenced to the velocity vector or waterline symbol, whichever is displayed, and are displayed whenever selected on the HSI and valid signal received. The maximum travel is the width of the other needle. The needles are removed when invalid, and flash when limited.

20. Steering Arrow and Deviation Scale. The steering arrow and deviation scale are referenced to the velocity vector or waterline symbol, whichever is displayed. The steering arrow provides ground track deviation when TACAN, waypoint, or waypoint offset steering is selected and the CRS option is selected on the HSI display. The dots are only displayed on the side of the course deviation. The arrow and deviation scale will be removed when the course deviation is within 1 degree for TACAN, 0.4 nm for waypoint/waypoint offset steering with landing gear up, or 0.03 NM for waypoint/waypoint offset steering with the landing gear down.

21. Steering Mode. The currently selected steering mode is displayed on the right side of the HUD. The following may be displayed: TCN - TACAN, W - waypoint, O - waypoint offset, VOR - VOR, ILS - ILS, TILS - TACAN & ILS, WILS - waypoint & ILS, OILS - waypoint offset & ILS.

22. Distance To Steer Point. The distance to the selected steering point is displayed when an applicable steering mode is selected. The distance is the same as presented on the HSI display.

23. Time To Steer Point. The time to the selected steering point is displayed when an applicable steering mode is selected. The time is displayed below the distance to the steering point with a maximum reading of 99 minutes and 59 seconds. The time is the same as presented on the HSI display.

24. Scratchpad. When the scratchpad is displayed, it is also displayed on all four MFDs. The existing setting/value for the selected data appears in the scratchpad when it is initially displayed. As data is entered via the DEP, the initial setting/value is removed and the new data is displayed on the right and moves to the left as additional characters are entered (leading zeros are not required). If an invalid setting/value is entered the scratchpad will flash until it is cleared. If data entry is interrupted for more than 1 minute, the scratchpad will be cleared and removed. Identifiers are displayed on the left side of the scratchpad to identify the data being entered. The following is a list of the data identifiers:

AZ	PDU Boresite Azimuth Correction or GINA Boresight Yaw
BD	Barometric Delta Altitude
BF	BINGO Fuel Setting
CH	Command Heading Setting
CS	Command Course Setting
DT	GINA Date
EL	Waypoint Elevation or PDU Boresite Elevation Correction or GINA Boresite Pitch
HD	Entered Heading
LW	Low Altitude Warning Setting
MV	Magnetic Variation
OB	Offset Bearing
OE	Offset Elevation
OR	Offset Range
PW	Password
RL	GINA Boresight Roll

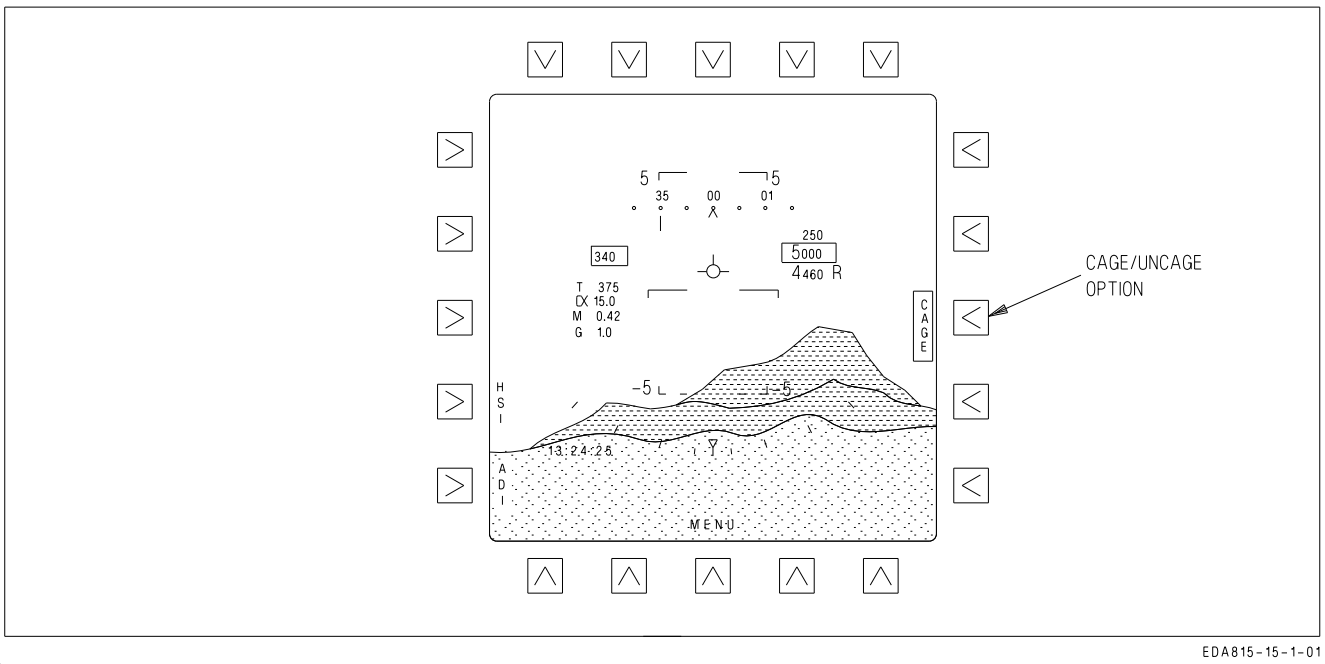


Figure 2-13. MFD HUD Display

SPX	Waypoint String Point (X is waypoint number 1 through 10)
TH	Target Height
TM	GINA Time
WS	Wing Span

25. CAUTION Indication. Indicates illumination of a caution light or the BINGO advisory and the MASTER ALERT light. The flashing CAUTION indication appears on the bottom center of the HUD. Actuation of the MASTER ALERT light removes the CAUTION indication unless displayed because of BINGO condition which requires selection of REJ option.

26. Warning Indication. Indicates illumination of a warning light or the LAW advisory and the MASTER ALERT light. The warning indication appears as large W in the center of the HUD. Actuation of the MASTER ALERT light removes the warning indication LAW.

2.4.3.5.2 HUD Video - MFD. Actual HUD video with associated symbology may be selected to appear on any MFD by actuating the HUD option on the MENU display. The velocity vector may be caged/uncaged by selecting/deselecting (box/unbox) the CAGE option on the display (Figure 2-13) or pressing the cage/uncage button on the stick grip (Figure 2-22).

2.4.3.6 Data Entry Panel. The DEP is used to control the HUD, enter mission data, and select master mode, see Figure 2-14. Refer to the BIT System, paragraph 2.26 and subsequent, for a description of the DEP BIT.

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.

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

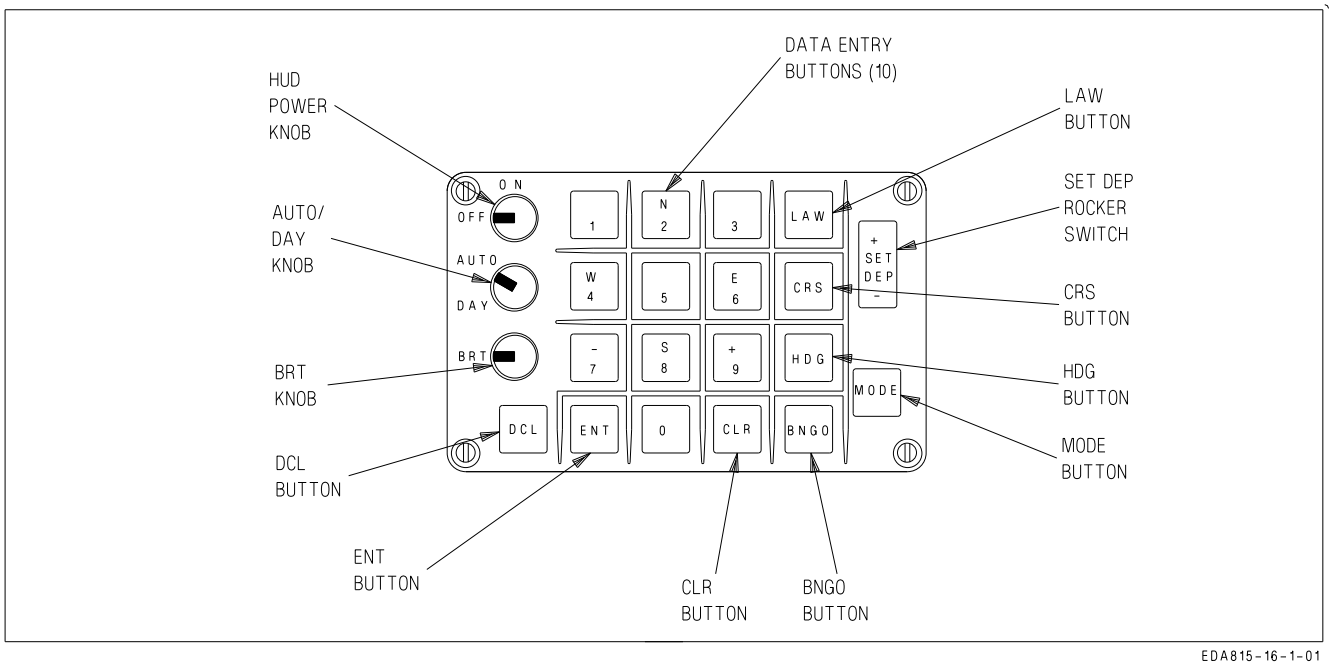


Figure 2-14. Data Entry Panel

2.4.3.6.2 AUTO/DAY Knob. The DAY position provides manual adjustments of HUD brightness. The AUTO position adjusts the HUD automatically as a function of ambient light levels.

2.4.3.6.3 BRT (Brightness) Knob. Allows adjustment of HUD brightness with the AUTO/DAY knob in the DAY position.

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: decluter 1, declutter 2, and back to normal. Refer to Figures 2-12 and 2-15 to determine which symbology and values are removed when the different declutter levels are selected.

2.4.3.6.5 Data Entry Buttons. 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.

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. Selection of the LAW button enables the scratchpads and the DEP for entry of the LAW setting.

2.4.3.6.9 CRS Button. Selection of the CRS button enables the scratchpads and the DEP for entry of the course setting.

2.4.3.6.10 HDG Button. Selection of the HDG button enables the scratchpads and the DEP for entry of the command heading setting.

2.4.3.6.11 BNGO Button. Selection of the BNGO button enables the scratchpads and the DEP for entry of the BINGO setting.

	NAV (Gear Up)	NAV (Gear Down)	A/A	A/G
DCL1	AOA, Mach #, Load Factor, Groundspeed	(No Change)	AOA, Mach #, Load Factor	AOA, Mach #, Load Factor
DCL2	AOA, Mach #, Load Factor, Heading Scale, Heading Caret, Command Heading Marker, Bank Scale, and Bank Pointer	Heading Scale, Heading Caret, Command Heading Marker, Bank Scale, Bank Pointer	AOA, Mach #, Load Factor, Heading Scale, Heading Caret, and Command Heading Marker	AOA, Mach #, Load Factor, True Airspeed, Heading Scale, Heading Caret, Command Heading Marker

Figure 2-15. HUD Declutter Levels

2.4.3.6.12 SET DEP (Depression) Rocker Switch. This switch is used to adjust (increase/decrease) the depressed sight line (DSL) aiming reticle (mil depression) on the HUD. The default setting is 140 mils and can be adjusted from 0 to 270 mils. Refer to Chapter 22.

2.4.3.6.13 MODE Button. 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. The system initializes to NAV at power up with weight-on-wheels. The selected master mode can be determined from the stores display or HUD symbology. See Figure 2-12 for HUD symbology in the NAV master. Refer to Chapter 22 for the A/A and A/G master modes.

2.4.3.7 DISPLAY POWER Switch. The DISPLAY POWER switch is a three position switch located on the miscellaneous switch panel. 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.

NOTE

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

2.4.4 Airborne Data Recorder (ADR). The ADR provides the combined functions of flight incident recording, structural monitoring, engine monitoring, and digitizing data for transmission to the DEU over the mux bus. The ADR system consists of the ADR recorder, an ADR button in each cockpit, and aircraft system sensors.

The flight incident function provides sufficient recorded data of engine and flight parameters to aid in the investigation of a mishap or flight incident. The ADR records all incident data of the last 15 minutes of flight. To detect any trends in aircraft or engine performance that may have begun earlier in the flight, data is retained at a lesser rate for the earlier part of flight.

The structural fatigue monitoring function provides aircraft performance data for tracking of fatigue life consumption and periodically summarizing the condition of each aircraft. In addition, the function provides a rational basis for

fleet employment and replacement, and additional data for future design. Stress on both wings, vertical stabilizer, stabilator, forward and aft fuselage, and vertical and roll accelerations are monitored in-flight. When vertical acceleration or a hard landing reaches a predetermined value, an X appears on the maintenance display following the A/C Exceedance legend, see Figure 2-52.

The engine monitoring function provides engine component life usage tracking. The recorded engine data enables the prediction of life expectancies of selected engine modules. The four categories of monitoring are: low cycle fatigue calculations, thermal fatigue and creep calculations, and incidents involving engine parameter exceedance. An engine exceedance results when any one of the parameters exceeds a predetermined value. An X will appear on the maintenance display following the A/C Exceedance legend, see Figure 2-52.

When exceedance values are set or when the 80% storage capacity of the ADR is reached, the ADR notifies the DEU over the mux bus. The DEU provides notice/flags, which are available for display on the MAINT display, see Figure 2-52. The ADR has the capacity to store data from multiple flights. Operation of the ADR is automatically initiated at engine start. Refer to the BIT System, paragraph 2-26 and subsequent, for a description of ADR BIT.

WARNING

The ADR is used to assist engine starting by dumping HYD 2 pump pressure to return line and reducing engine loads when N_2 is below 42 percent. An ADR failure may cause it to energize the HYD 2 pump bypass valve and reduce pump output pressure. The HYD 2 caution light illuminates if pressure drops below 1600 psi, and the RAT extends if pressure drops below 1500 PSI. Additionally fuel boost pumps are lost and F PRES illuminates.

CAUTION

An ADR failure causes blanking of the following HUD/MFD display parameters:

HSI display	wind speed/direction
DATA display	wind speed/direction
ADI display	TAS, AOA, RALT
HUD nav modes	AOA, RALT
HUD A/A mode	aiming reticle
HUD A/G mode	CCIP marker, bomb fall line, breakaway cross, AOA, RALT
Engine page	N_2 RPM , FF, FQTY, N_1 RPM, TAT C, EPR, T6 C, HPC PRESS, and PLA

2.4.4.1 ADR Button. The ADR button is located on the upper left portion of the main instrument panel in both cockpits, and is placarded ADR EVENT RECORD. This button should be actuated when the aircrew notices unusual aircraft behavior. When pressed, the ADR retains all flight incident and engine parameters from five seconds before selection to five seconds after selection.

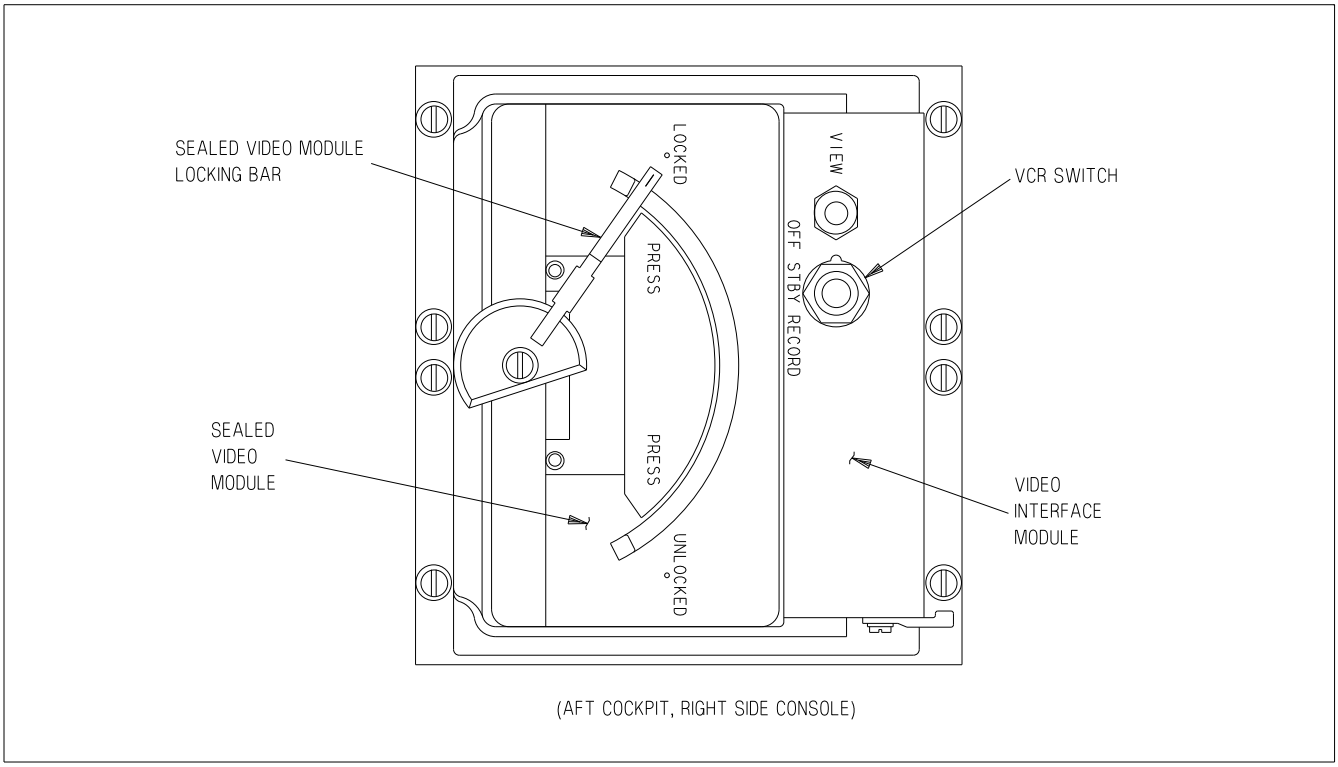


Figure 2-16. VCR Sealed Video Module and Video Interface Module

2.4.5 Mission Data Loader (MDL). The MDL receptacle is located in the aft cockpit along the right console, see FO-5 for the exact location. The MDL is used to transfer GPS waypoints to the DEU, magnetic variation coefficients, and GPS almanac data to the GINA, refer to Chapter 21.

Prior to flight, place the MDL in the MDL receptacle. Communication of the MDL on the mux and proper operation can be verified on the BIT display, refer to the BIT System description, paragraph 2.26. After shutdown, actuate the button to the left to release the MDL cartridge. No pilot action during flight is required.

2.4.6 Instructional Aids. Instructional aids consist of the video cassette recorder (VCR), the TRNG (training) display, and the RPTR (repeater) display.

2.4.6.1 Video Cassette Recorder. The VCR provides video and audio recording with a removable tape system. Any one of the four MFDs or HUD can be selected for video recording, see paragraph 2.4.7.1.3. The system also records intercom/audio any time the VCR system is turned on. Refer to the BIT System description, paragraph 2.26, for a description of VCR BIT status.

The system consists of a video camera, sealed video module (SVM), and a video interface module (VIM). HUD video is derived using a video interface from the HUD to the DEU to VCR. MFD video is derived using a video interface from the MFD to the DEU to the VCR. The VIM is located in the aft cockpit on the right console, providing a housing for the SVM, see Figure 2-16. The SVM is a removable sealed unit containing recording heads, capstans, and accepts one 2 hour 8mm cassette tape.

Forward cockpit control of the VCR is accomplished using the VCR switch and the MASTER ARM switch. Aft cockpit control of the VCR is done using the VCR switch. Selection of the desired HUD or MFD for video recording is provided using the VREC display (available in either cockpit).

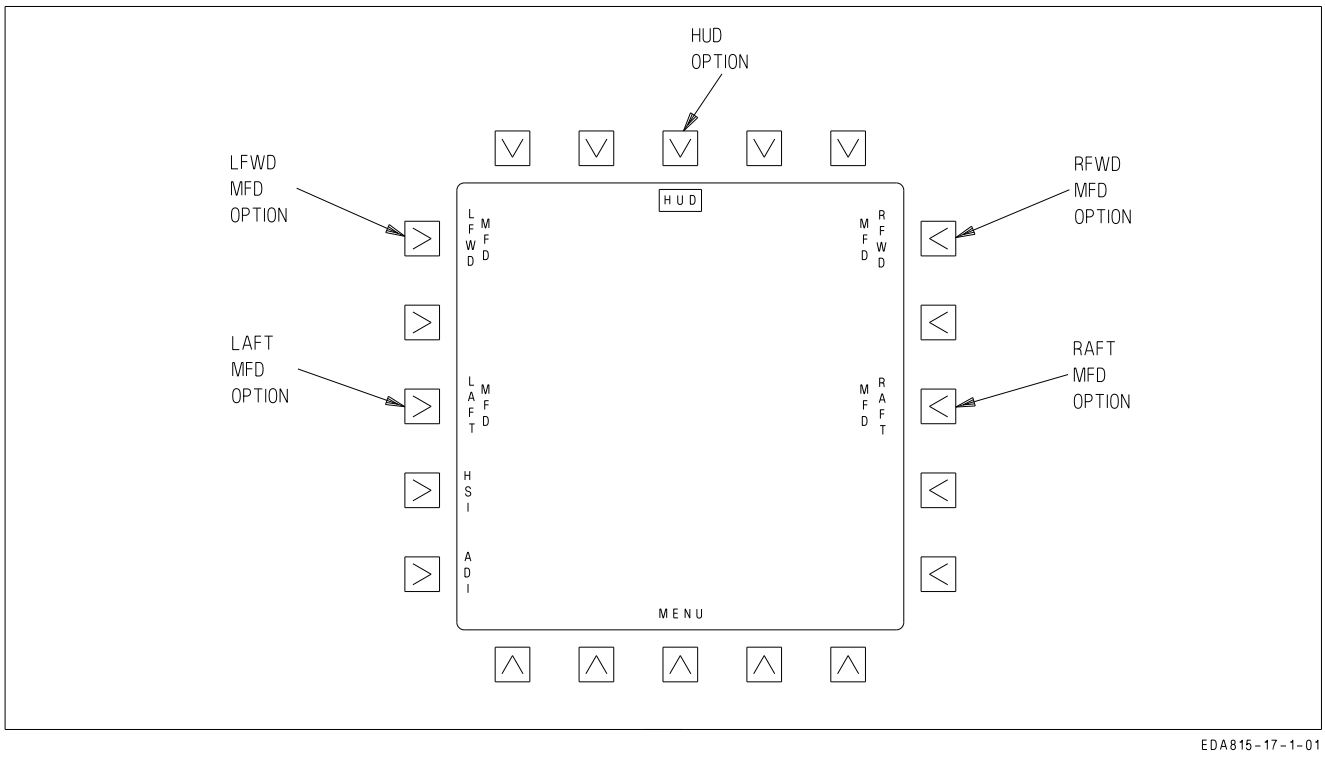


Figure 2-17. VCR Source Display

The VCR system should be turned off 20 seconds prior to aircraft shutdown, allowing the tape to unwind from the recording head. This action will allow for later removal of the cassette tape from the SVM. The removal of the tape from the SVM should be accomplished in an air-conditioned environment to preclude dust from entering the SVM.

2.4.6.1.1 VCR Switch (FWD Cockpit). The VCR switch has positions of AUTO, OFF, and ON.

AUTO	Defers control of the VCR through the master arm switch. See Master Arm Switch.
OFF	VCR deactivated.
ON	Records MFD display as selected on the VREC format.

2.4.6.1.2 MASTER ARM Switch (FWD Cockpit). The master arm switch has positions of ARM and SAFE.

ARM	With the VCR switch in AUTO, VCR recording is activated. The VREC display is used to select the desired format for recording.
OFF	With the VCR switch in AUTO, disables VCR recording.

Refer Chapter 22 for a description of the MASTER ARM switch and armament system.

2.4.6.1.3 VCR Source Display. The VCR source display is accessed by selecting the VREC option on the MENU display. This display (Figure 2-17) allows selection of the HUD or any MFD for video recording. To record a display, actuate the desired option: LAFT MFD (left aft MFD), LFWD MFD (left forward MFD), HUD, RFWD MFD (right forward MFD), and RAFT MFD (right aft MFD). When an option is selected it is boxed. The system initializes with the HUD selected.

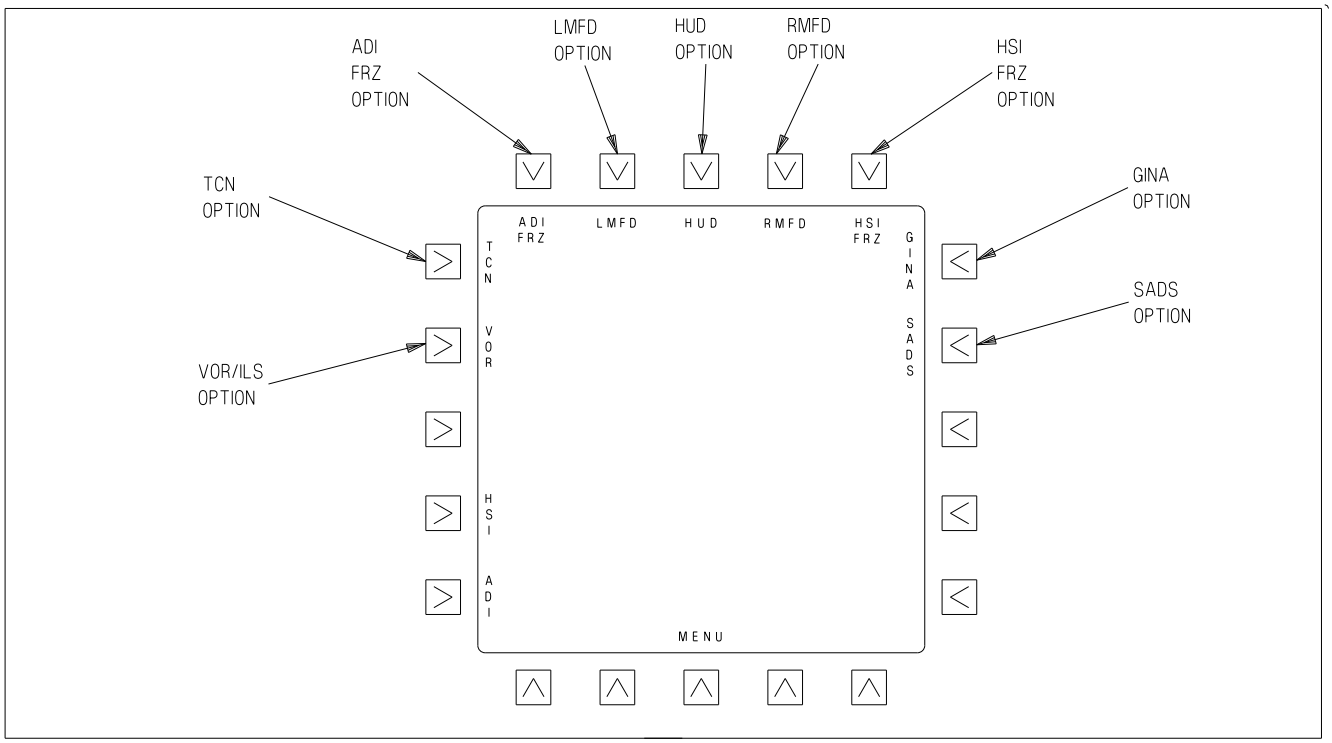


Figure 2-18. Training Display

2.4.6.1.4 VCR Switch (Aft Cockpit). This switch has positions of OFF, STBY, and RECORD.

OFF	VCR is deactivated.
STBY	Pre-threads film through VCR. (Forward cockpit VCR switch set to OFF).
RECORD	Records MFD display as selected on VREC format.

2.4.6.2 Training Mode. The training mode is a means by which the instructor is able to selectively simulate system and display failures. When a failure is initiated, the instructor can monitor student reaction and assess the students knowledge of emergency and backup procedures.

The training display is accessed by selecting the TRNG option on the MENU display. Systems and displays available for simulated failure are selected on the training display, see Figure 2-18. The training format can be selected in either cockpit, however, if the training display is selected in one cockpit, the TRNG option will be unavailable in the opposite cockpit. A failure is selected/deselected (boxed/unboxed) by alternate actuations of the desired option. Multiple failures can be selected.

Selection of a VOR or ILS frequency on the NAV radio head, controls the display of the VOR or ILS option on the training format. If HUD failure is selected in the forward cockpit, it only affects the aft cockpit, if the HUD is selected for display on an MFD. Figure 2-19 identifies the impact of the selected failure on each cockpit.

When a system failure is selected, the opposite cockpit will display the AV BIT advisory and the BIT format will display DEGD for the applicable system. The initiating cockpit will continue to display the correct BIT status. All simulated failures are automatically deselected with the loss of the 28VDC Generator Bus.

2.4.6.3 Repeater Mode. The repeater mode is selected/deselected (boxed/unboxed) by alternate actuations of the RPTR option on the MENU display or selection of DSPY BIT. At power up the repeater mode initializes deselected (unboxed).

Selection of the repeater mode from a right MFD will link the right MFDs in both cockpits. Conversely, selection of the repeater mode from a left MFD will link the left MFDs in both cockpits. The MFD from which the repeater mode was selected immediately displays the format from the opposite MFD, however, display contrast and brightness are not repeated. When the repeater mode is commanded, selections made from either linked MFD are repeated on the opposite MFD. Selection of the repeater mode is indicated by a RPTR legend in the lower left corner of a repeated display and the boxed RPTR option on the MENU display. When deselected, the format that was displayed when RPTR was selected is returned.

SELECTED FAILURE (OPTION)	COCKPIT IMPACT
VOR (BOXED)	HUD SYMBOLOGY REMOVED: COMMAND HEADING BUG IF VOR SELECTED HSI SYMBOLOGY REMOVED: DIGITAL VOR BEARING, VOR BEARING POINTER/TAIL, & CDI DEVIATION LINE
ILS (BOXED)	HUD SYMBOLOGY REMOVED: GLIDESLOPE AND LOCALIZER STEERING NEEDLES ADI SYMBOLOGY REMOVED: GLIDESLOPE & LOCALIZER STEERING NEEDLES HSI SYMBOLOGY REMOVED: CDI DEVIATION LINE
TCN (BOXED)	HUD SYMBOLOGY REMOVED: DISTANCE TO STEER POINT, TIME TO STEER POINT, COURSE DEVIATION ARROW (IF TCN STEERING SELECTED), AND COMMAND HEADING BUG (IF DISPLACED FOR TCN STEERING) ADI SYMBOLOGY REMOVED: COMMAND HEADING BUG (IF DISPLAYED FOR TCN STEERING) HSI SYMBOLOGY REMOVED: TACAN SYMBOL, TACAN BEARING, TACAN DISTANCE, TACAN TIME TO GO, TACAN BEARING POINTER/TAIL, PLAN COURSE LINE, & CDI DEVIATION LINE

Figure 2-19. Training Mode - Failure Implications (Sheet 1 of 3)

SELECTED FAILURE (OPTION)	COCKPIT IMPACT
GINA (BOXED)	HUD SYMBOLOGY REMOVED: PITCH LADDER, HEADING SCALE & CARET, COMMAND HEADING MARKER, BANK POINTER, VERTICAL SPEED, G, GROUND SPEED, STEER POINT RANGE (WAYPOINT OR WAYPOINT OFFSET), TIME TO STEER POINT, STEERING ARROW, A/A & A/G RETICLES, & BOMB IMPACT LINE. REPLACED: VELOCITY VECTOR WITH WATERLINE SYMBOL & GPS TIME WITH ELAPSED TIME ADI SYMBOLOGY REMOVED: PITCH LADDER, SKY SHADING, HYBD/INS/GPS OPTIONS, HEADING SCALE & CARET, COMMAND HEADING MARKER, VERTICAL SPEED, G, BANK POINTER, SPIN DIRECTION INDICATOR, AND SLIP INDICATOR BALL HSI SYMBOLOGY REMOVED: COMPASS ROSE, BENCHMARKS, WAYPOINT/WAYPOINT OFFSET SYMBOL(S)/BEARING POINTER/BEARING/RANGE/TIME TO GO/ID, TACAN SYMBOL/RANGE/BEARING/TIME TO GO, VOR BEARING, COURSE LINE, GROUND TRACK POINTER, GROUNDSPEED, WIND DIRECTION/SPEED, & COMMAND HEADING MARKER. AIRCRAFT DATA REMOVED: LATITUDE, LONGITUDE, MAGNETIC VARIATION, HEADING, GROUND SPEED, WIND DIRECTION/SPEED, & GPS SATELLITES
SADS (BOXED)	HUD SYMBOLOGY REMOVED: INDICATED & TRUE AIRSPEED, BAROMETRIC ALTITUDE, MACH NO., A/A & A/G RETICLES, & BOMB IMPACT LINE ADI SYMBOLOGY REMOVED: INDICATED & TRUE AIRSPEED, BAROMETRIC ALTITUDE, AND MACH NO. HSI SYMBOLOGY REMOVED: WIND DIRECTION/SPEED AIRCRAFT DATA REMOVED: WIND DIRECTION/SPEED
LMFD (BOXED)	OPPOSITE COCKPIT LEFT MFD IS BLANKED
RMFD (BOXED)	OPPOSITE COCKPIT RIGHT MFD IS BLANKED

Figure 2-19. Training Mode - Failure implications (Sheet 2 of 3)

SELECTED FAILURE (OPTION)	COCKPIT IMPACT
HUD (BOXED)	SELECTED FROM FWD COCKPIT: AFT COCKPIT MFD HUD VIDEO REMOVED SELECTED FROM AFT COCKPIT: HUD SYMBOLOGY REMOVED: HUD AND MFD HUD DISPLAY
ADI FRZ (BOXED)	HUD SYMBOLOGY NO IMPACT ADI SYMBOLOGY FREEZES: ATTITUDE BALL, PITCH LADDER, HORIZON LINE, AND ANGLE OF BANK POINTER
HSI FRZ (BOXED)	HUD SYMBOLOGY NO IMPACT ADI SYMBOLOGY FREEZES: HEADING SCALE HSI SYMBOLOGY FREEZES: COMPASS ROSE

Figure 2-19. Training Mode - Failure implications (Sheet 3)

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. Following engine start, the bypass valve is reset by depressing the HYD 2 RESET pushbutton in either cockpit with engine RPM above 45 percent.

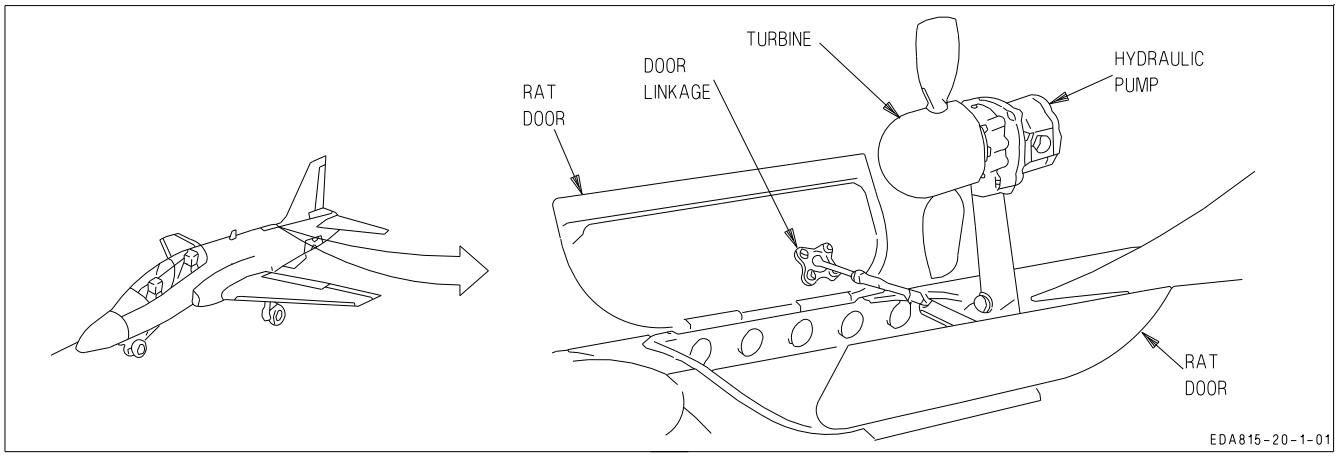


Figure 2-20. Hydraulic Ram Air Turbine

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. 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. See Figure 2-20.

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. This capability has been demonstrated in the cruise and emergency approach (emergency gear and emergency flaps) configurations from 20,000 to 10,000 feet MSL between 180 to 120 knots. Sufficient RAT hydraulic power was available to successfully fly simulated (10,000 feet) turbulent landings in the emergency approach configuration without exceeding RAT output capability. In general, sustained (15 seconds or more), high frequency (approximately one or more cycles per second), large amplitude (1/3 longitudinal stick combined with a small amount of lateral stick, or more) inputs were required to drive RAT output pressure below 2,500 psi. Although the engine was operating normally during flight testing, the hydraulic system was modified to provide RAT only (i.e., no engine assist) hydraulic pressure which simulated an engine accessory gearbox or dual EDP failure. In an engine flameout or failure emergency, engine RPM above approximately 8 percent N_2 would result in some engine-assisted hydraulic pressure above that supplied by the RAT. At no time were aircraft handling qualities or flight control system performance degraded.

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

2.5.4 Emergency Hydraulic System

Operation. Power to extend the RAT is provided by an isolated hydraulic circuit, using

HYD 2 fluid and a separate accumulator. Extension occurs automatically whenever HYD 2 pressure falls to approximately 1,500 psi. As the engine-driven hydraulic pump pressure falls, a check valve in the emergency system package assembly closes and pressure on the spool valve falls off in line with the engine-driven pump pressure. RAT accumulator pressure moves the spool valve. Movement of the spool valve connects the poppet valve side of the spool valve to the RAT actuator. The RAT accumulator pressure applied to the RAT actuator extends the actuator raising the RAT into the airstream. A shuttle valve allows the RAT to provide pressure to the stabilator and aileron actuators.

With the RAT extended, fluid from the HYD 2 reservoir system is supplied to the RAT pump through the RAT suction filter. The RAT pump supplies fluid at 3,000 psi to the emergency system package, and then through the HYD 2 system to the flight controls. The RAT emergency accumulator provides hydraulic pressure to keep the RAT actuator fully extended. Return fluid from the flight controls is directed back to the reservoir.

The RAT can be reset by pressing the HYD 2 RESET button in either cockpit. With the HYD 2 caution light off and HYD 2 pressure above 1,800 psi, sufficient HYD 2 pressure is available to reset the RAT shuttle valve, retract the RAT and restore normal HYD 2 operation. The RAT can be stowed at any airspeed.

CAUTION

Placing EMER FLAPS switch to the DOWN position when normal HYD 1 pressure is available will cause the hydraulic fluid to rapidly overheat, possibly causing a HYD 1 seal failure resulting in HYD 1 system failure.

NOTE

The HYD 2 RESET may also be used above 45 percent N_2 RPM to reset the HYD 2 pump bypass valve. During engine shutdown, the RAT extends as hydraulic pressure falls below 1,500 ±100 psi. As pressure dissipates further, the RAT is retracted automatically by spring pressure.

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 N_2 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.

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.

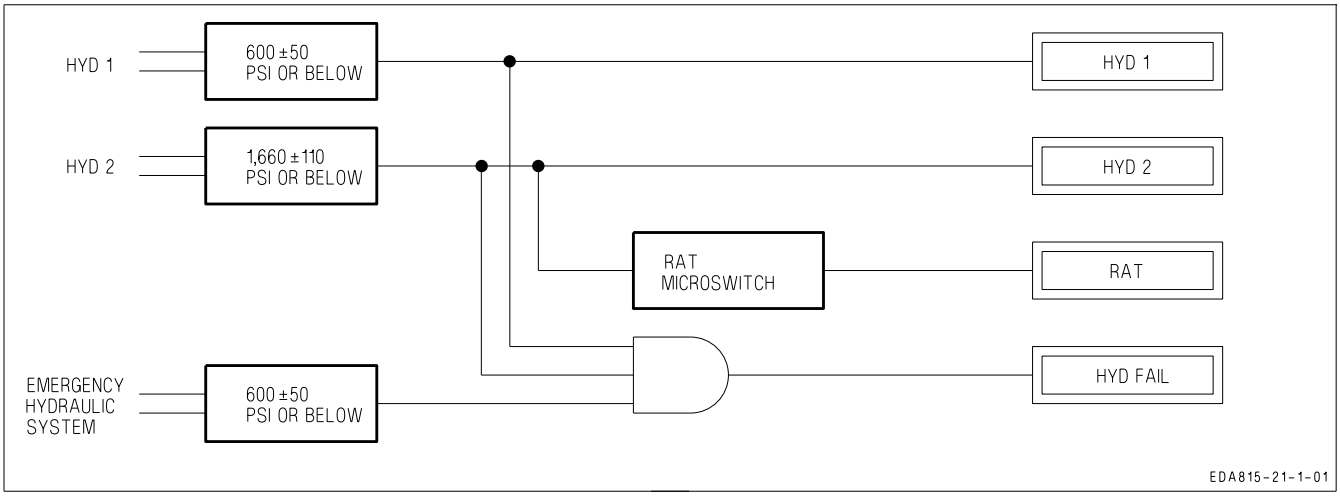


Figure 2-21. Hydraulic System Warning/Caution Light Logic Diagram

2.5.6 Hydraulic Warning, Caution, and Advisory Lights.

2.5.6.1 HYD FAIL Warning Light. The HYD FAIL warning lights located on the warning lights panel, will illuminate with HYD 1, HYD 2, and an emergency system failure. Figure 2-21 shows the logic circuit of the pressure switches required to illuminate the HYD FAIL warning light. HYD 1 pressure must be less than 600 ±50 psi, HYD 2 pressure must be less than 1660 ±110 psi in the EDP circuit and emergency system pressure must be less than 600 ±50 psi.

2.5.6.2 HYD 1 Caution Light. The HYD 1 caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when HYD 1 pressure drops below 600 ±50 psi.

2.5.6.3 HYD 2 Caution Light. The HYD 2 caution light is located on the warning/caution/advisory lights panel, on the main instrument panel. The light illuminates when HYD 2 pump output pressure drops below 1,660 ±110 psi. The caution light operation is not affected by the emergency system pressure.

2.5.6.4 RAT Caution Light. The RAT caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when the RAT is extended.

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. See the Flight Control System foldout, FO-19.

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. Yaw damping is available with weight-off-wheels and less than 217 knots airspeed. Turn coordination is available with weight-off-wheels, less than 217 knots airspeed, and the FLAPS/SLATS lever set to 1/2 or DOWN. The SBI and rudder trim are available with weight on or off wheels.

The YDC receives roll attitude from the GINA, aileron position from the right aileron position sensor flaps position from the FLAPS/SLATS lever, yaw rate from an internal gyro, indicated airspeed inputs from the SADS, and pilot inputs to the rudder trim system to compute the command to the yaw damper actuator. The electromechanical yaw damper actuator drives the rudder and rudder tab at a fixed mechanical ratio providing yaw dampening, turn coordination, and rudder trim.

The YDC receives a Mach number input from the SADS to compute the command to the SBI actuator. The function of the SBI is to reduce positive pitch transients between 0.2 to 0.7 Mach and to reduce negative pitch transients above 0.7 Mach during speed brake extension and retraction. The YDC has a Mach number dependent schedule which determines the SBI actuator position input into the longitudinal cambox. A mechanical linkage mounted to the longitudinal cambox transmits the resultant signal to the stabilator actuator driving the stabilator in the required direction. The pilot's control stick does not move during SBI operation.

2.6.2.1 Control Augmentation System Continuous Built-In-Test (CBIT). The CONTR AUG CBIT is an automatic continuous failure monitoring function of the YDC. CBIT operates continuously after YDC power-up, except during CONTR AUG Initiated Built-In-Test (IBIT).

The C AUG caution light illuminates if CBIT detects a system failure.

NOTE

The CONTR AUG IBIT is a more comprehensive test than CBIT and should be performed during Poststart procedures to determine the CONTR AUG system integrity. Inoperative yaw damping, turn coordination, rudder trim, and aircraft pitch transients during speed brake deployment may occur without a C AUG caution light generated by CBIT.

2.6.3 Flight Controls and Trim Systems Controls and Indicators. See Figure 2-22 for controls located on the stick grip.

2.6.3.1 CONTR AUG Switch. The CONTR AUG switch is located on the left console of the front cockpit. The switch is a three position switch with the following:

ALL	Provides yaw damping, turn coordination through the aileron-rudder-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.

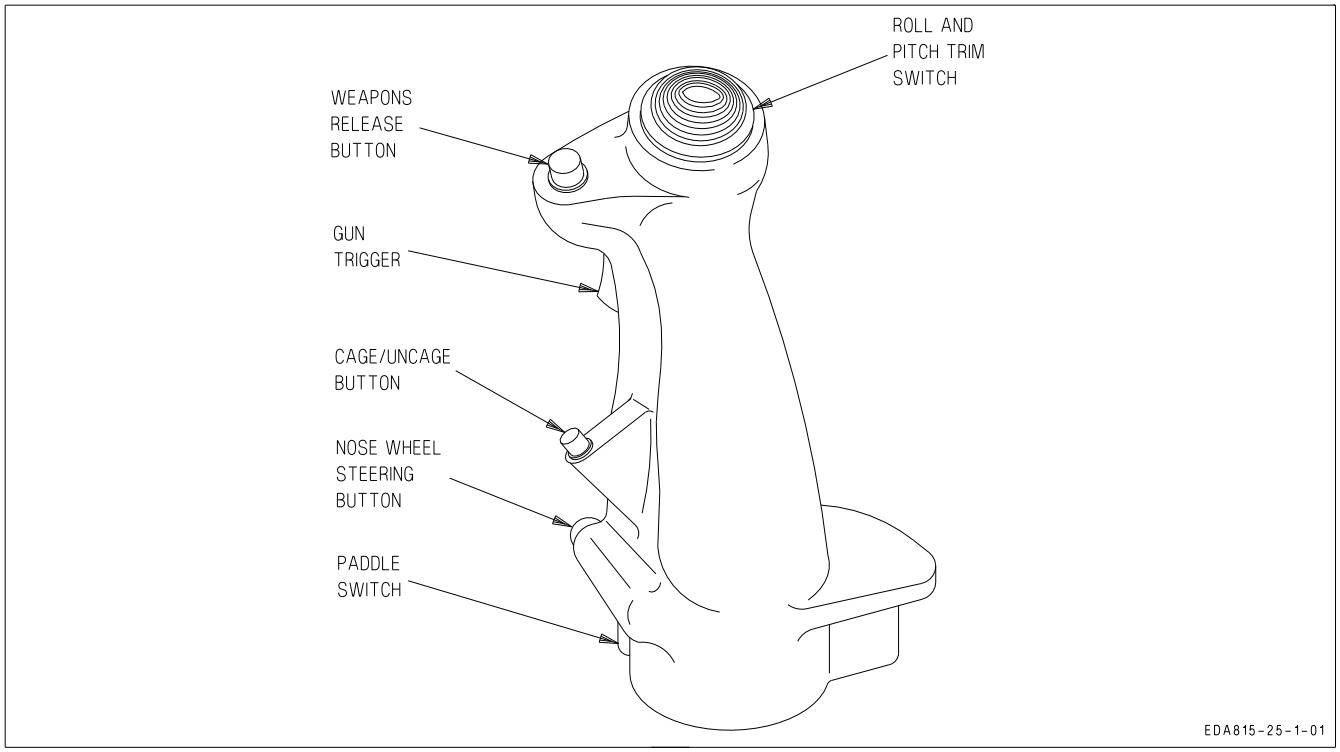


Figure 2-22. Stick Grip

2.6.3.2 Rudder Pedals. The rudder pedals control the rudder surface to a maximum deflection of 20 ±0.5 degrees to either side of neutral.

2.6.3.3 Rudder Pedal Adjust Knob. The RUDDER PEDAL ADJUST knob is located below the center pedestal. Pulling the knob unlocks the pedals and allows the crewmember to adjust the pedals. When the knob is pushed in the pedals are locked into position.

2.6.3.4 Rudder Lock Lever (Gust Lock). The rudder lock lever is located on the right side of the center pedestal, in the front cockpit. In the raised position the rudder is locked in the neutral position. Pushing the lever down unlocks the rudder.

2.6.3.5 Paddle Switch. The paddle switch is located at the base of the forward and aft cockpit control stick grips. Momentarily pressing the switch deactivates the CONTR AUG and illuminates the C AUG caution light, and disengages NWS, if engaged, illuminating the NWS caution light.

2.6.3.6 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.

2.6.3.7 STBY STAB TRIM Switch. The STBY STAB TRIM switch is located on the left console, aft of the throttle. The switch is a three position, guarded switch and is spring loaded to the center position.

NOSE DN	Momentarily setting the switch to this position adds the corresponding nosedown trim.
Center	The trim setting is held. The guard covers the switch in this position. If the guard is raised outboard, the main trim motor is disengaged.

NOSE UP	Momentarily setting the switch to this position adds the corresponding noseup trim.

2.6.3.8 RUDDER TRIM Knob. The RUDDER TRIM knob is located on the left console and aft of the throttle, and is spring loaded to the center, neutral position. Rotating the knob left or right adds the corresponding rudder trim.

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

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

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

2.6.4 Flight Controls Warning, Caution, and Advisory Lights.

2.6.4.1 C AUG Caution Light. The C AUG caution light is located on the forward and aft cockpit caution/warning panels and illuminates to indicate that the CONTR AUG has degraded, IBIT is in progress or the paddle switch has been pressed.

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 then 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. Use of the emergency flap extension system overrides the normal system and drives the flaps to full down.

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. In the event of a HYD 1 system failure, power to the flaps is available from the wheel brake/emergency flap accumulator. Placing the EMER FLAPS switch to the DOWN position provides power to the flap system. A solenoid operated emergency valve directs pressure to the down line and activates a dump valve on the up line to fully extend the flaps. A priority valve, set to 2,200 psi, ensures the integrity of the wheel brake system if the HYD 1 system failure is due to a leak in the flap circuit. The slats are not operated via the EMER FLAPS switch.

NOTE

With normal HYD 1 pressure, the flaps can be raised normally following emergency extension.

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 is a two position switch and has the following positions:

NORM	Normal flaps/slats operation.
DOWN	Extends the flaps via emergency accumulator. Does not affect slat position or indication.

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. The light illuminates when:

1. Slats not in selected position
2. Split slats
3. Slats are selected when the airspeed is above 217 knots (slats do not extend).

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.

Blowback is controlled by a pressure relief valve that prevents excess hydraulic pressure in the extend circuit caused by airload on the speed brakes. A thermal relief valve releases excess hydraulic pressure in the retract circuit caused by temperature rises. Pressure fluctuations are isolated by the check valves. There are no emergency speed brake extension/retraction controls.

2.8.2 Speed Brake System Controls and Indicators.

2.8.2.1 Speed Brake Switch. The speed brake switch is on the throttle grip and has three unmarked positions.

Forward	Retracts the speed brake to the full stowed position.
Center	Stops the speed brake in any position on extension.
Aft	Extends the speed brakes as long as the switch is held aft. Spring loaded to the center. Momentary selection will interrupt retraction.

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 each side 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 red warning light is provided integral to the landing gear handle. With the handle up, the red light is illuminated unless all landing gear are up and locked, and all landing gear doors are latched closed. With the handle down, the red

light is illuminated unless all landing gear are down and locked, regardless of landing gear door position.

A red 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 N_2 RPM position and either of the following conditions exists:

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

or

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

The gear warning tone can be canceled by momentarily pressing the tone button located next to the landing gear handle.

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.

WARNING

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.

CAUTION

With the main gear doors open, door damage may result from arresting gear strikes.

NOTE

- Emergency landing gear extension does not affect the position indication system logic. It is normal for the DOOR light to remain illuminated following emergency extension, since the main gear doors remain open.

- It is normal for the gear handle red light to remain illuminated following an emergency extension if the normal LDG GEAR handle is not set to the DN position.

- Recommend a short field arrestment due to loss of NWS.

If normal hydraulic pressure is regained or if the gear have been extended by the free fall method for test purpose, normal landing gear operation may be restored by returning the forward cockpit EMER GEAR handle to its stowed position.

CAUTION

In the event of an actual emergency gear extension, the normal landing gear handle should be placed in the DN position before pulling the EMER GEAR handle. When a safe gear indication is achieved the EMER GEAR handle should remain out and the aircraft should be landed as soon as practicable.

NOTE

If the aft cockpit EMER GEAR handle has been pulled, it may be restowed by first pulling out then pushing in the forward EMER GEAR handle. Both handles should then be locked in their normal positions.

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 N_2 RPM position and either of the following conditions exists:

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

CAUTION

- 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 (see Figure 2-22, Stick Grip).

2.10.1 Nose Wheel Steering System Operation.

Hydraulic failure 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. The steering may also be disengaged by momentarily pressing the nose wheel steering button on the control stick. Full rudder

pedal deflection turns the nose wheel 12 degrees either direction. Upon engagement, the nose wheel rotates to the position commanded by the rudder pedals. If the nose wheel steering is disengaged using the paddle switch, the amber NOSE WHL STR caution light will come on.

NOTE

- If the amber NWS caution light is on and the nose wheel steering button is pressed and held for 4 seconds or longer rather than a momentary press, the nose wheel steering system will enter a test routine and will not engage. If this occurs, to engage, momentarily press the nose wheel steering button to end the test routine and engage the nose wheel steering. The extinguishing of the NWS caution light identifies a successful engagement of the nose wheel steering.

- High gain nose wheel steering should be used for low speed taxi operations only, at less than 10 knots ground speed.

For taxiing, the high gain may be selected once the low gain is engaged, by pressing and holding the nose wheel steering button. Once engaged in the high gain the NWS HI advisory light will come on. When the nose wheel steering button is

released, nose wheel steering immediately reverts to the low gain and the advisory goes out. Full rudder pedal deflection in the high gain turns the nose wheel 65 degrees either direction.

With the LAUNCH BAR switch set to EXTEND, nose wheel steering is disengaged. Steering may be reengaged by pressing and holding the nose wheel steering button. In this gain, full deflection of the rudder pedal turns the nose wheel 20 degrees either direction.

When the NWS is disengaged the nose wheel is free to caster. Hydraulic fluid in the steering system provides rotational (shimmy) damping for the nose gear.

If the position of the nose wheel moves away from the commanded rudder pedal position for an extended period, or there is a discontinuity in either the input/feedback signals, or the solenoid wiring or the electronic control box fails internal self tests, the system will shut itself down and illuminate the amber NWS caution light.

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. Momentarily pressing the button when the nose wheel steering is disengaged engages the system in the low gain. Pressing and holding the button while the system is in low gain selects high gain until the button is released. If the LAUNCH BAR switch is set to EXTEND, pressing and holding the button engages steering as long as the button is pressed.

2.10.2.2 Paddle Switch. The paddle switch is located at the base of the forward and aft cockpit control stick grips. Momentarily pressing the paddle switch disengages the NWS and illuminates the NWS caution light and deactivates CONTR AUG, illuminating the C AUG caution light.

2.10.3 Nose Wheel Steering System Warning, Caution, and Advisory Lights.

2.10.3.1 NWS Caution Light. The NWS caution light is located on the warning/caution/advisory lights panel on the instrument panel. The light illuminates when a system failure has been detected or the system has been paddled off.

2.10.3.2 NWS HI Advisory Light. The NWS HI advisory light is located on the warning/caution/advisory lights panel, located on the left side of the instrument panel. The light illuminates when the high gain is engaged. The light extinguishes when low gain is selected or a system failure has been detected.

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 anti-skid system, with touchdown protection, to achieve maximum braking efficiency. Braking priority goes to the cockpit with the greatest brake pressure applied.

Differential braking may be used in the event of a steering system failure for all ground maneuvering. The aircraft is equipped with an emergency brake system utilizing a portion of the emergency flap accumulator which provides sufficient hydraulic pressure to bring the aircraft to a stop if the HYD 1 system fails.

Release brakes prior to deselecting anti-skid to avoid locking brakes and blowing tires when normal brakes engage.

2.11.1 Normal Brake Operation. With anti-skid 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 anti-skid 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.

2.11.3.1 Anti-Skid Operation. The system is selected by placing the ANTI-SKID switch in both cockpits in the ON position. This illuminates the SKID advisory light in each cockpit. The system is actuated when the landing gear is down, aircraft is weight-on-wheels and wheel speed is above 30 knots during acceleration, and above 10 to 13 knots during deceleration. When the wheel speed sensor senses speeds below these values, anti-skid is disabled and normal braking is in effect. The brakes operate in the normal manner with the anti-skid engaged; pressure at the wheel brakes is proportional to the pressure on the rudder pedal toe pads. When either or both wheel speed sensors detect excessive wheel deceleration indicating an impending skid, a signal is sent to the anti-skid control valve via the anti-skid control unit. The anti-skid valve directs pressure to the return lines, releasing both brakes. When wheel speed recovers, the control unit signals the anti-skid valve to reapply brake pressure to a level just below that which caused the skid. The pressure increases until the skid threshold is reached and the cycle starts over again until the optimum wheel deceleration is achieved.

Protection is provided against touchdown with locked brakes to allow wheel spin upon landing. The anti-skid valve releases brake pressure with

LDG GEAR control handle in the DN position, landing gear extended, and weight-off- wheels if brake pedal pressure occurs airborne.

CAUTION

Failure of weight off wheels circuits will prevent anti-skid activation on touchdown, with no indication to the pilot, and subsequent loss of brakes. Placing the ANTI-SKID switch to OFF will engage the normal (No Anti-Skid) brake system and restore braking authority.

2.11.4 Anti-Skid Malfunction. System malfunctions include short/open circuits in the system components, a prolonged full pressure dump lasting greater than 2 seconds, or no wheel spin up detected in 3 seconds after aircraft weight-on-wheels. In the event of anti-skid system failure, the SKID caution light illuminates accompanied by the caution tone. The SKID caution light will extinguish when the detected fault clears or when the ANTI-SKID switch is placed to OFF. When the switch is placed in the OFF position, the unit fail safe feature isolates the ANTI-SKID system, allowing full use of the normal brake system.

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

2.11.6 Wheel Brakes/Anti-Skid Controls and Indicators.

2.11.6.1 ANTI-SKID Switch. The ANTI-SKID switch is located on the left console, inboard of the throttle.

ON	Electrically energizes the anti-skid system to modulate brake pressure.
OFF	Selecting off from either cockpit reverts aircraft to normal braking. Braking will be without hydraulic pressure being controlled by the anti-skid electronic control unit.

2.11.6.2 PARKING BRAKE Handle. The J-shaped PARKING BRAKE handle is located on the right vertical console. Pulling and rotating the handle clockwise sets the parking brake. To release the parking brake rotate the handle counterclockwise and push in.

2.11.6.3 Rudder Pedals. Braking action is proportionate to toe pressure on the rudder pedals.

2.11.6.4 BRAKE Pressure Indicator. The BRAKE pressure indicator is located on the left console, forward and inboard of the throttle. The indicator indicates the pressure in the wheel brake/emergency flap accumulator in psi x 1,000.

2.11.7 Wheel Brakes/Anti-Skid Warning, Caution, and Advisory Lights.

2.11.7.1 SKID Caution Light. The SKID caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when an anti-skid system failure has been detected.

2.11.7.2 PK BRK Caution Light. The PK BRK caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light comes on when the parking brake is set and the throttle is advanced beyond the intermediate position (approximately 60 percent N_2 RPM).

2.11.7.3 SKID Advisory Light. The SKID advisory light is located on the warning/caution/ advisory lights panel, on the left side of the instrument panel. The light illuminates when both ANTI-SKID switches are ON and the landing gear are down.

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. At the completion of launching, the bar rapidly elevates to and is positioned and retained in the taxi position. During gear retraction, cams on the lower end of the drag brace contact the cam follower of the power unit to rotate the launch bar to the stowed position. See Figure 2-24 for nose landing gear and launch bar.

2.12.1 Launch Bar Operation. See Figure 2-23. 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 and warning tone annunciate the malfunction condition. This light remains illuminated until the pilot raises the LDG GEAR handle to retract the landing gear which suppresses the red L BAR light and warning tone. When the gear is subsequently extended and the launch bar remains extended, the red L BAR light and warning tone again annunciates the malfunction following a 10 second delay.

NOTE

- With a HYD 1 failure the launch bar fails to the retracted position.
- If the launch bar fails to retract it will mechanically stow when the NLG is retracted.
- The weight-on-wheels proximity switch inhibits the launch bar switch from remaining in the EXTEND position when airborne.

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, and the aircraft is on the deck.

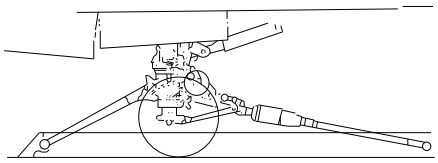
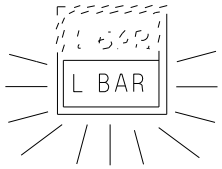
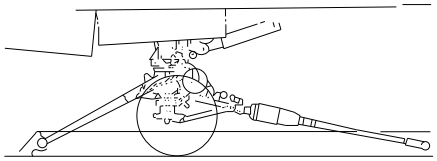
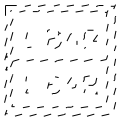
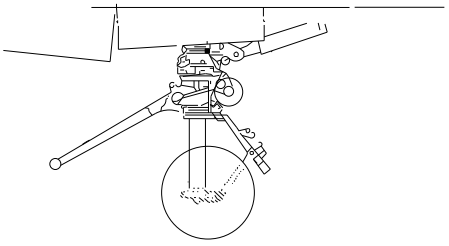
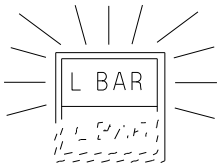
LAUNCH BAR POSITION	SWITCH POSITION	LIGHT	WARNING TONE
			NO
			NO
 AIRBORNE		 (AFTER 10 SECOND DELAY)	YES

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Figure 2-23. Launch Bar Operation

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.

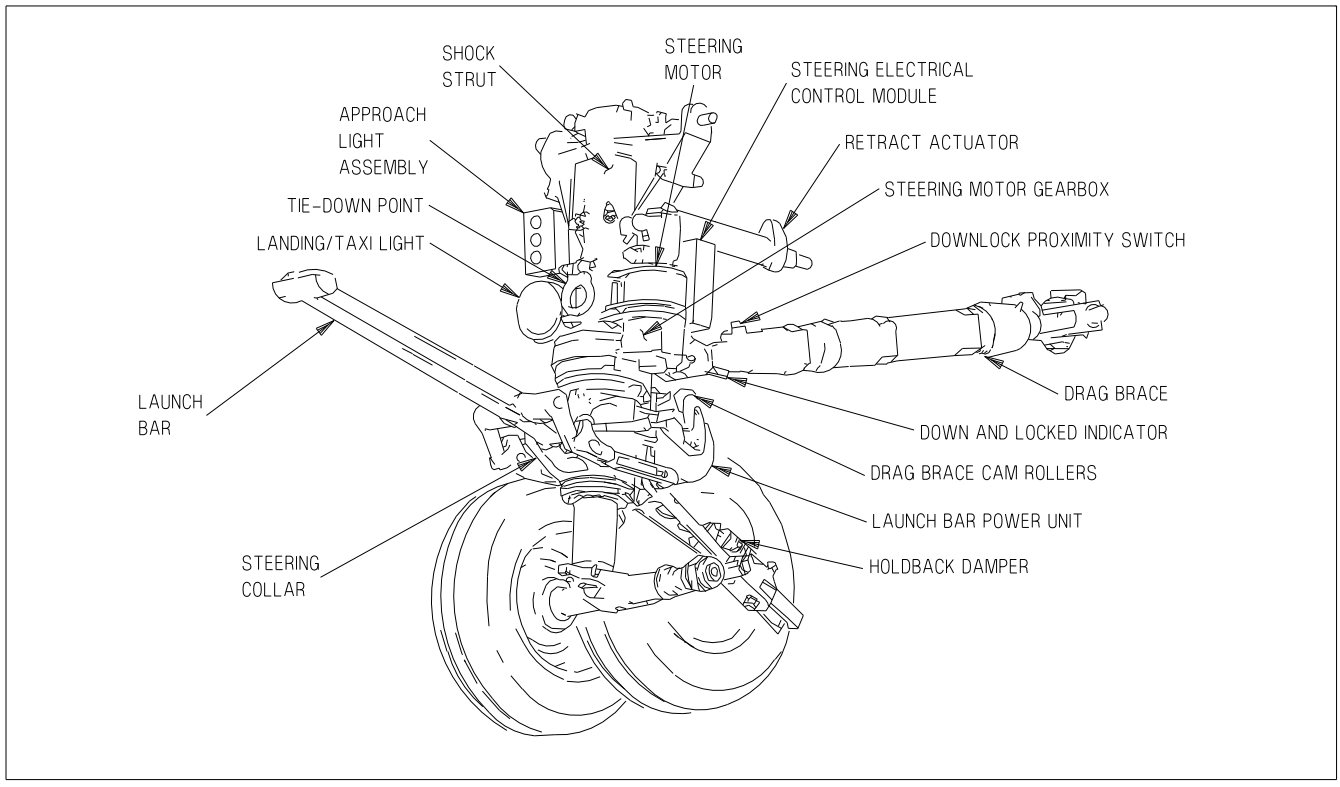

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Figure 2-24. Nose Landing Gear and Launch Bar

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.

NOTE

With weight-on-wheels, the hook cannot fully extend and the HOOK warning light will remain illuminated.

A compensator/check valve directs positive hydraulic pressure to the actuator/damper during vertical hook movements (hook bouncing on deck) to prevent possible cavitation in the return hydraulic line.

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 HOOK warning light will illuminate for approximately 6 seconds or less during retraction and will extinguish when the hook is up and latched. 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. The pilot cannot retract the hook without hydraulic pressure.

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. At airspeeds above 300 knots with the hook extended, air loads may raise the hook slightly causing the HOOK warning light to illuminate. Once the airspeed is below 300 knots the hook will fully extend and the HOOK warning light will extinguish.

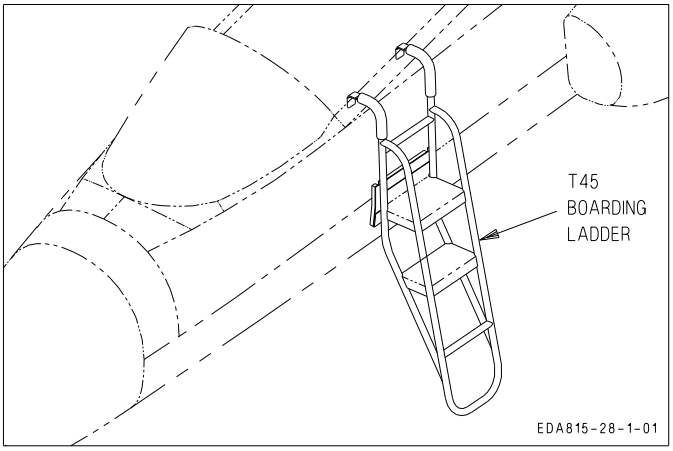

Figure 2-25. T-45C Aircraft Boarding Ladder

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. See Figure 2-25 for T-45C aircraft boarding ladder or Figure 2-26 for aircraft boarding system.

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. See Figure 2-27 for cockpits entrance/exit.

CAUTION

When entering or leaving the cockpit, do not grasp the canopy transparencies or use the forward glareshield as a handhold. In addition to the handholds provided, the canopy rail/ windscreen frame may also be used as a handhold. Do not use the bottom lip of the engine left air intake as a step.

NOTE

If the aft cockpit aircrew elects to use the aft pull-out footstep/handhold during egress, commence by stepping from the inlet duct position with the right foot instead of the left foot.

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. An UNLOCKED label in each cockpit is positioned such that when the canopy is locked each safety catch totally obscures the word UNLOCKED. If any part of the word is visible the canopy is not locked. When either lever is held fully aft, the canopy swings partially open and the damper/locking strut allows the canopy to be manually positioned. When the lever is released the strut holds the canopy in the selected position. 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

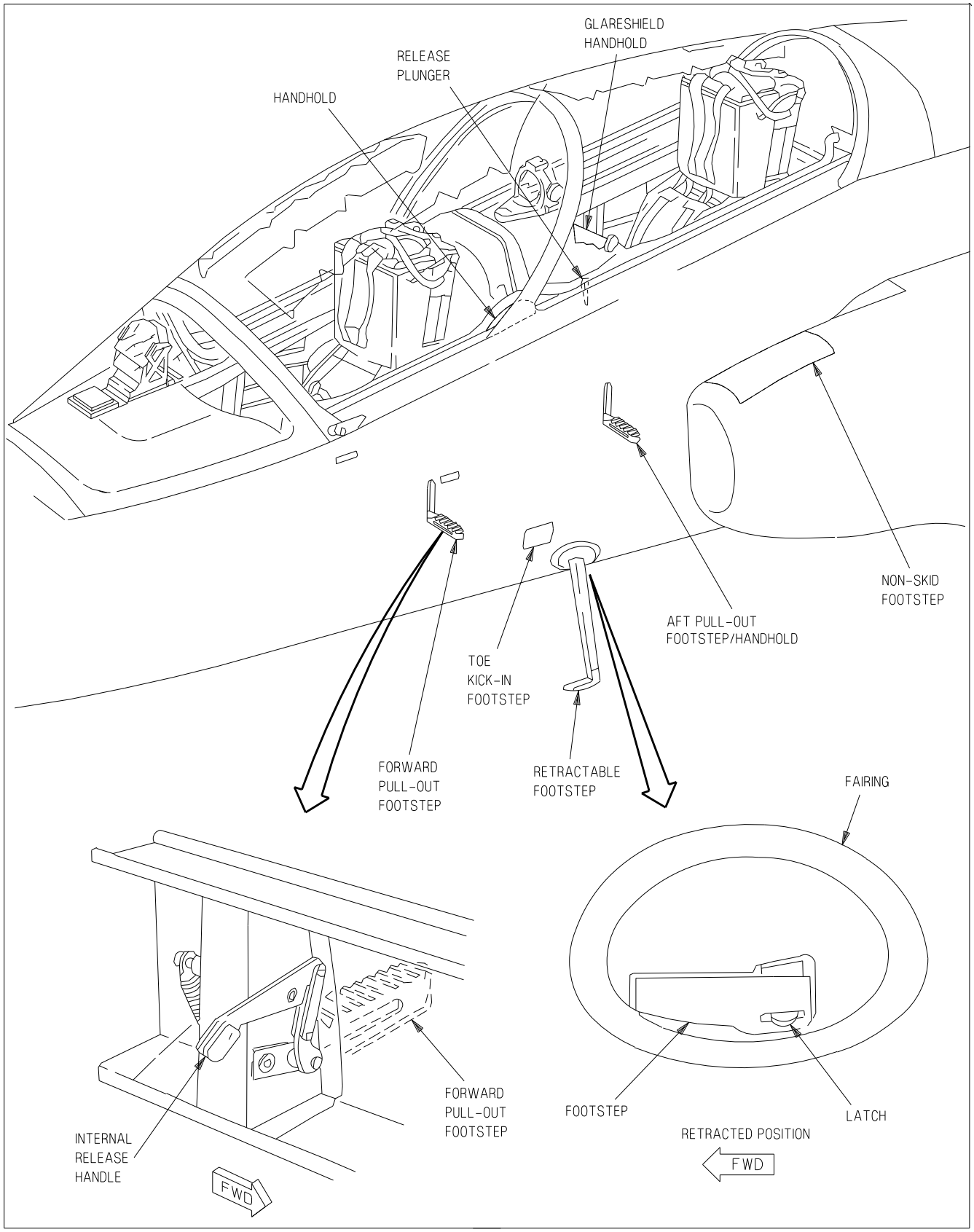

Figure 2-26. Footsteps

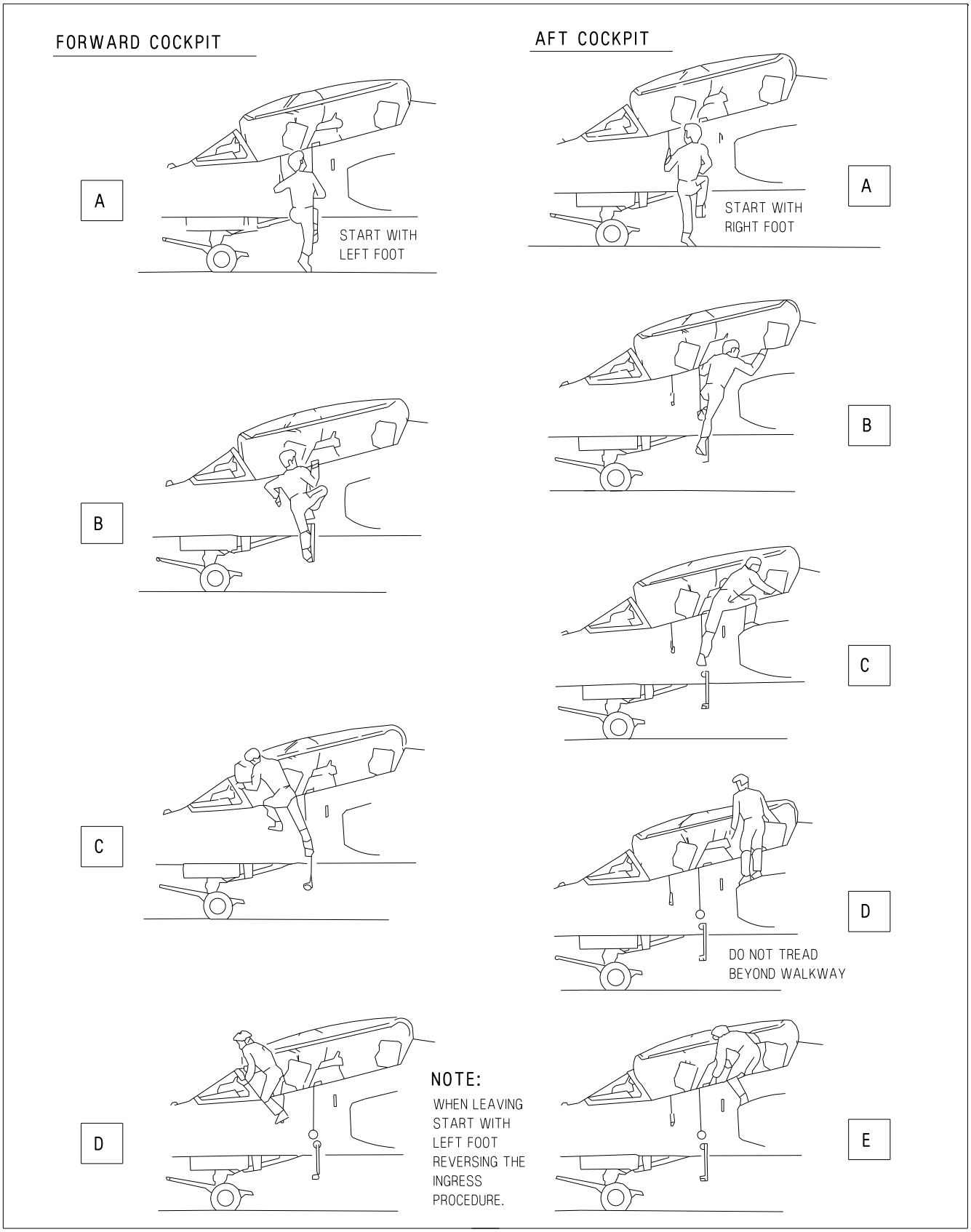

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Figure 2-27. Cockpits Entrance/Exit

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.

WARNING

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. Operation of the forward or aft cockpit MDC firing handle fires both circuits. The handle will travel approximately 4 inches when pulled to full extension. Only the last inch of travel initiates firing. Each MDC initiation manifold, when fired, initiates both ends of the MDC circuit; this ensures that the complete circuit is fired even if there is a break in the MDC. Each MDC firing handle has a safety pin which must be removed before flight.

WARNING

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

- Do not use the MDC firing handle or initiator cover as a handhold.

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.

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.

2.15.4 Canopy Warning, Caution, and Advisory Lights.

2.15.4.1 CANOPY Caution Light. The CANOPY caution light is located on the warning/caution/advisory lights panel, on the instrument panel. The light illuminates when the canopy is unlocked. If the throttle is advanced above the 95 percent N_2 RPM throttle position, the MASTER ALERT light and tone will come on.

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. The seats consists of five main assemblies (see Figure 2-28):

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.

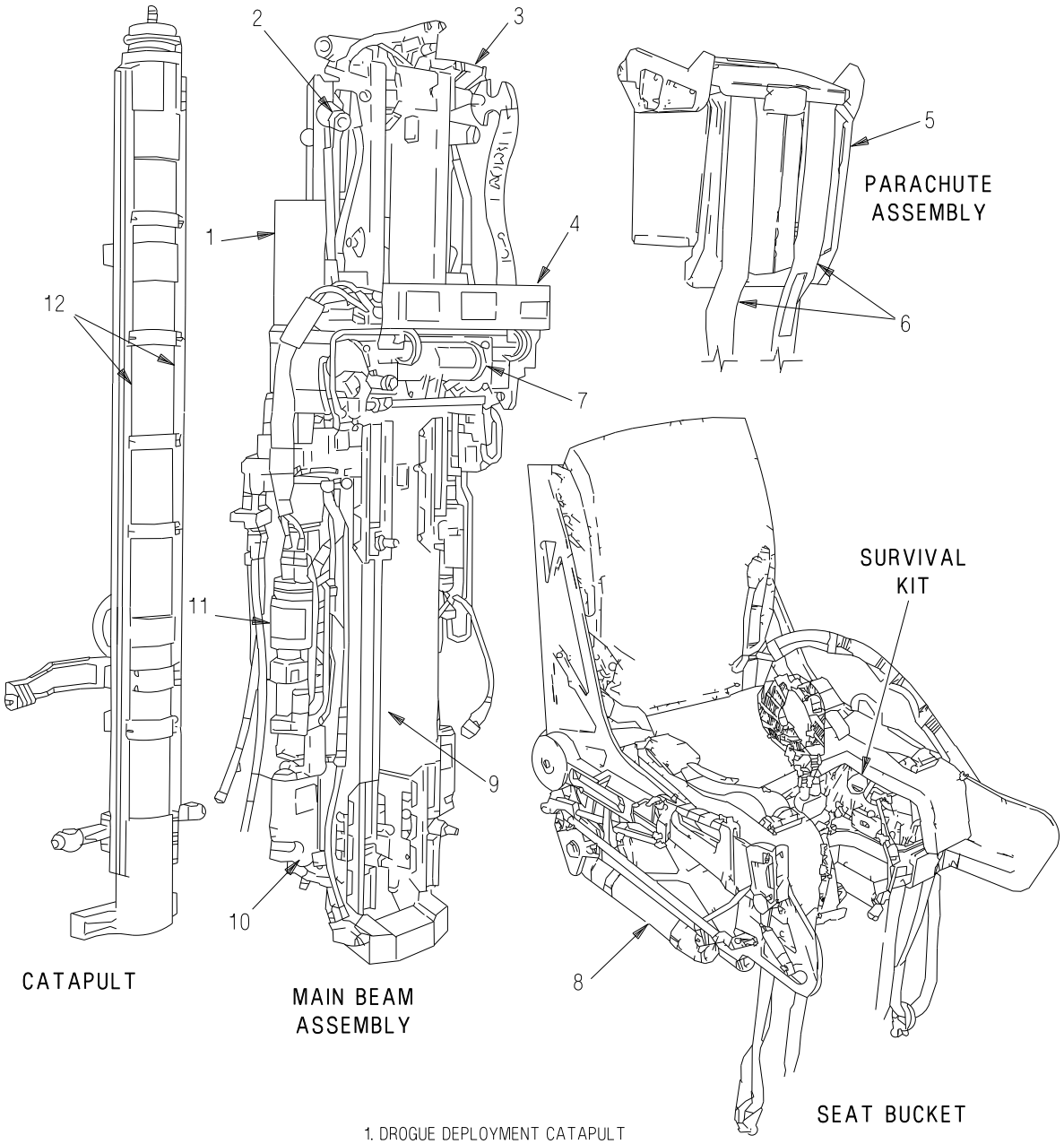
The seat survival kit includes:

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

See Ejection Seat foldout, FO-21. 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.

The pilot's equipment is illustrated in Figure 2-29.



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

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Figure 2-28. Ejection Seat - Main Assemblies

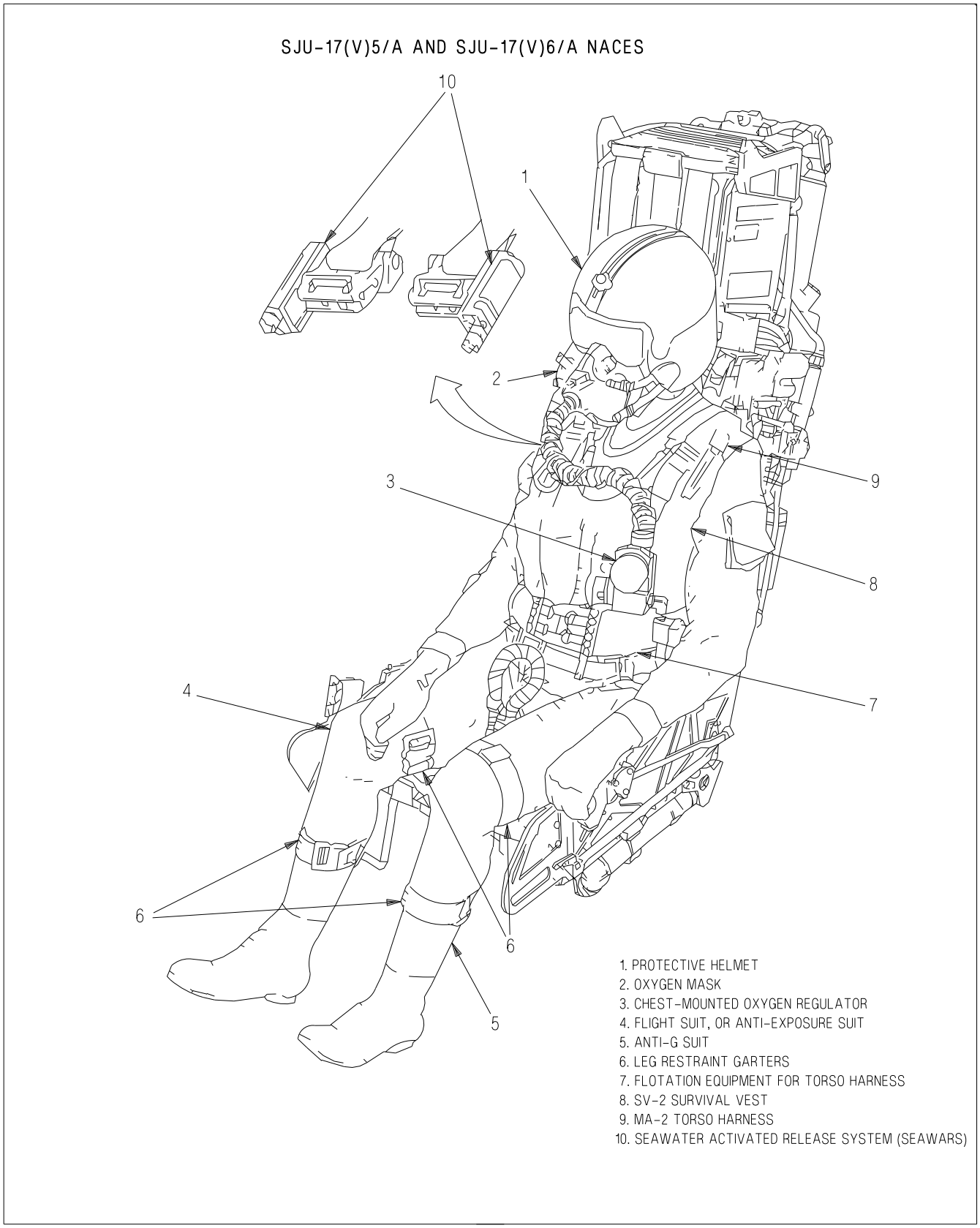

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Figure 2-29. Pilot's Equipment

A command ejection selector is located in the aft cockpit for the purpose of managing control of the command ejection sequence. A shielded mild detonating cord (SMDC) command ejection system is installed in the forward and aft cockpits and auxiliary bay. The SMDC is a linear charge, when activated, transfers an explosive signal to the canopy and appropriate seat based on the position of the mode selector. For solo flight, a seat light switch in the aft cockpit is used to disable the aft seat input to the SEAT caution light.

2.16.1 Leg Restraint System. The leg restraint system (Figure 2-32), located on the front of the seat, secures the pilot's legs during ejection. The system consists of two adjustable leg garters, a restraint line, a restraint line lock, and a snubbing unit for each leg. Each leg restraint line is made up of two lengths of blue nylon tubular braid joined together by a break ring. One end of each line is secured to the cockpit floor and the other, after being routed through the snubbing unit and both quick release buckles (D rings), is attached to a taper plug. The taper plug is fastened into the appropriate restraint line lock located on the inboard face of the seat bucket side plate. The leg restraint lines are adjusted to give the pilot more leg movement by pulling inboard on the snubbing unit release tab and simultaneously pulling the restraint lines forward through the snubbing units. Two leg restraint garters are worn on each leg; an upper garter on the thigh and a lower garter on the mid calf or boot top. A pendant strap, attached to the upper garter and worn at the back of the leg, terminates in a quick-release connector. The quick-release buckles, through which the leg restraint line is passed, are secured to the connectors. Operation of all four quick-release connectors allows the pilot to egress from the aircraft wearing both upper and lower garters.

During ejection the leg restraint lines are drawn through the snubbing units restraining the legs against the seat bucket. When the lines become taut and a predetermined load is attained, the break rings fail and release the lines from the cockpit floor. The leg restraint lines are restrained by the snubbing units and the legs secured until the taper plugs are released from their locks when seat/man separation occurs.

2.16.2 Survival Kit. A seat survival kit located in the seat bucket assembly, contains an emergency oxygen supply, oxygen pressure gauge, an inflatable life raft, an AN/URT-33 emergency locator beacon, an assortment of standard survival aids, and the lap belt and release fittings, see Figure 2-31. The emergency oxygen and beacon are automatically activated during seat ejection by a static line connected to the cockpit floor. Emergency oxygen can also be manually operated by pulling the green emergency oxygen actuator located on the left side of the seat cushion. The emergency oxygen bottle can be manually reset after activation. The survival kit may be deployed after seat/man separation by pulling the left or right raft release on the aft portion of the kit. As the kit falls away a lanyard attached to the life raft CO_2 bottle will discharge the bottle and inflate the raft.

2.16.3 Ejection Seat Operation. Seat ejection may be initiated from either the forward or aft cockpit by pulling upward on the ejection handle. The handle will travel approximately 3 inches when pulled to full extension. Only the last inch of travel initiates the ejection sequence. A pull force of 25 to 40 pounds is required to remove the ejection handle from its housing. A continued pull force of 30 to 60 pounds is required to initiate ejection. The sears are withdrawn from the seat initiator firing mechanisms and the two cartridges are fired. Gas from the right hand initiator cartridge is directed to the following:

1. Pin puller which withdraws a piston from engagement in the lower operating link of the restraint release mechanism.
2. Interseat sequencing system which operates the canopy MDC system and command ejection sequencing system.
3. Breech of the shoulder harness reel cartridge. The cartridge fires to operate the harness retraction unit which restrains the pilot for correct ejection posture.
4. Thermal batteries.

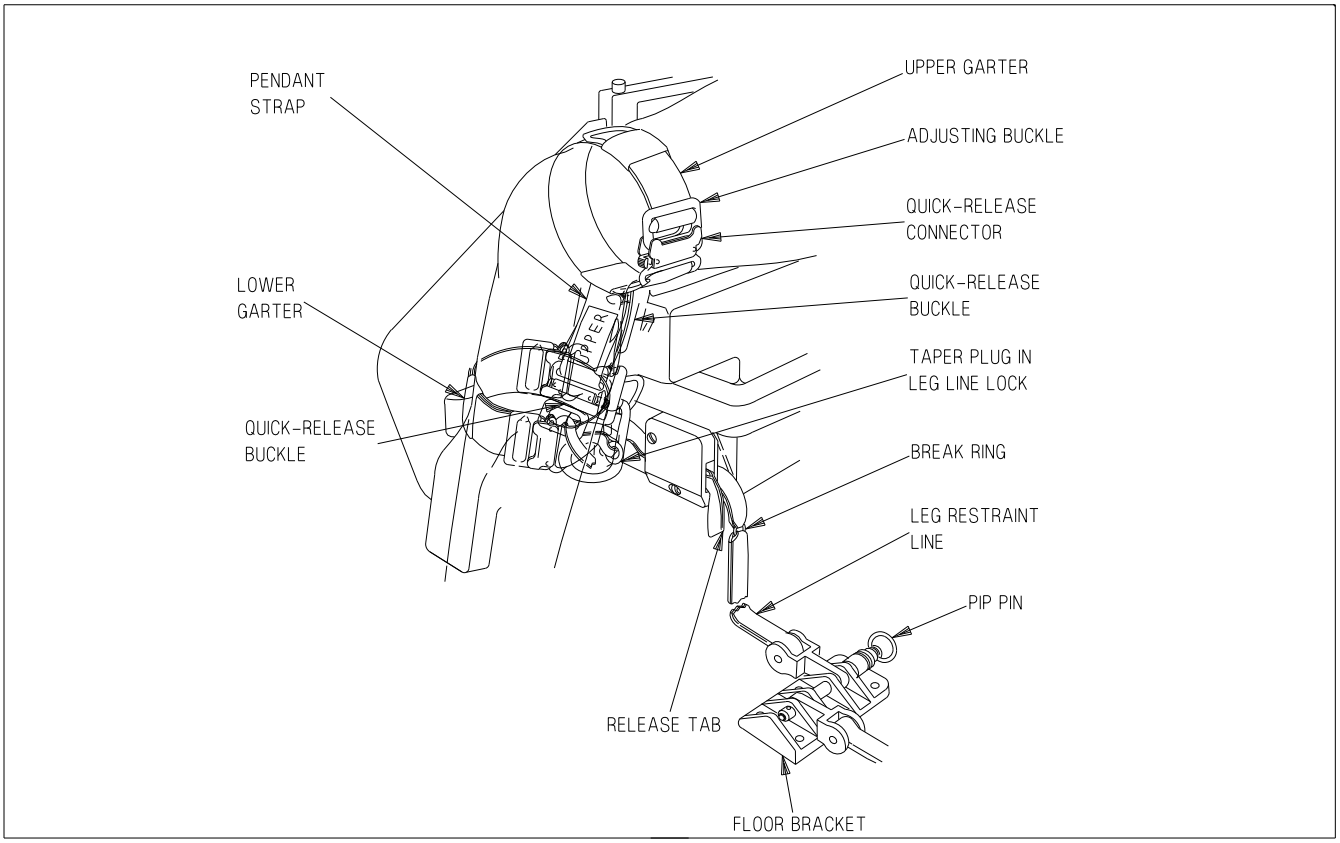

Figure 2-30. Leg Restraint System

5. Forward seat 0.5 second delay initiator, then to the left inlet of the catapult manifold to initiate the catapult cartridge.
6. Aft seat 0.0 second delay initiator, then to the right inlet of the catapult manifold to initiate the catapult cartridge. The right manifold initiator may not have enough gas output to operate the catapult initiator, therefore, a 0.0 second time delay (or gas generator) is used inline to boost the gas signal and operate the catapult initiator.

Gas from left hand initiator cartridge is directed to the following:

1. Thermal batteries.
2. 0.5 second delay cartridge if initiated by the forward seat, or left hand inlet of the catapult manifold valve if initiated by the aft seat.
3. Left hand inlet of the catapult manifold valve from the 0.5 second delay cartridge if initiated by the front seat only.

Gas pressure developed by the catapult initiator cartridge passes down the catapult to operate the ballistic latches, retaining the rocket initiator static line and fittings. As the pressure increases within the catapult, the catapult piston rises, releases the top latch and begins to move the seat upward. Further movement of the piston uncovers the catapult secondary cartridge which is fired by the heat and pressure of the first catapult cartridge gas. Staggered firing of the catapult cartridges provides a relatively even increase in gas pressure during catapult stroke to eliminate excessive g force during ejection. At catapult initiation and as the seat travels upward, the following occur:

1. Canopy fractures.
2. Thermal batteries are activated.
3. Harness retraction unit pulls shoulders against seat back.
4. Rocket initiator static lines begin to withdraw.
5. Ballistic and electrical quick-disconnects are separated.

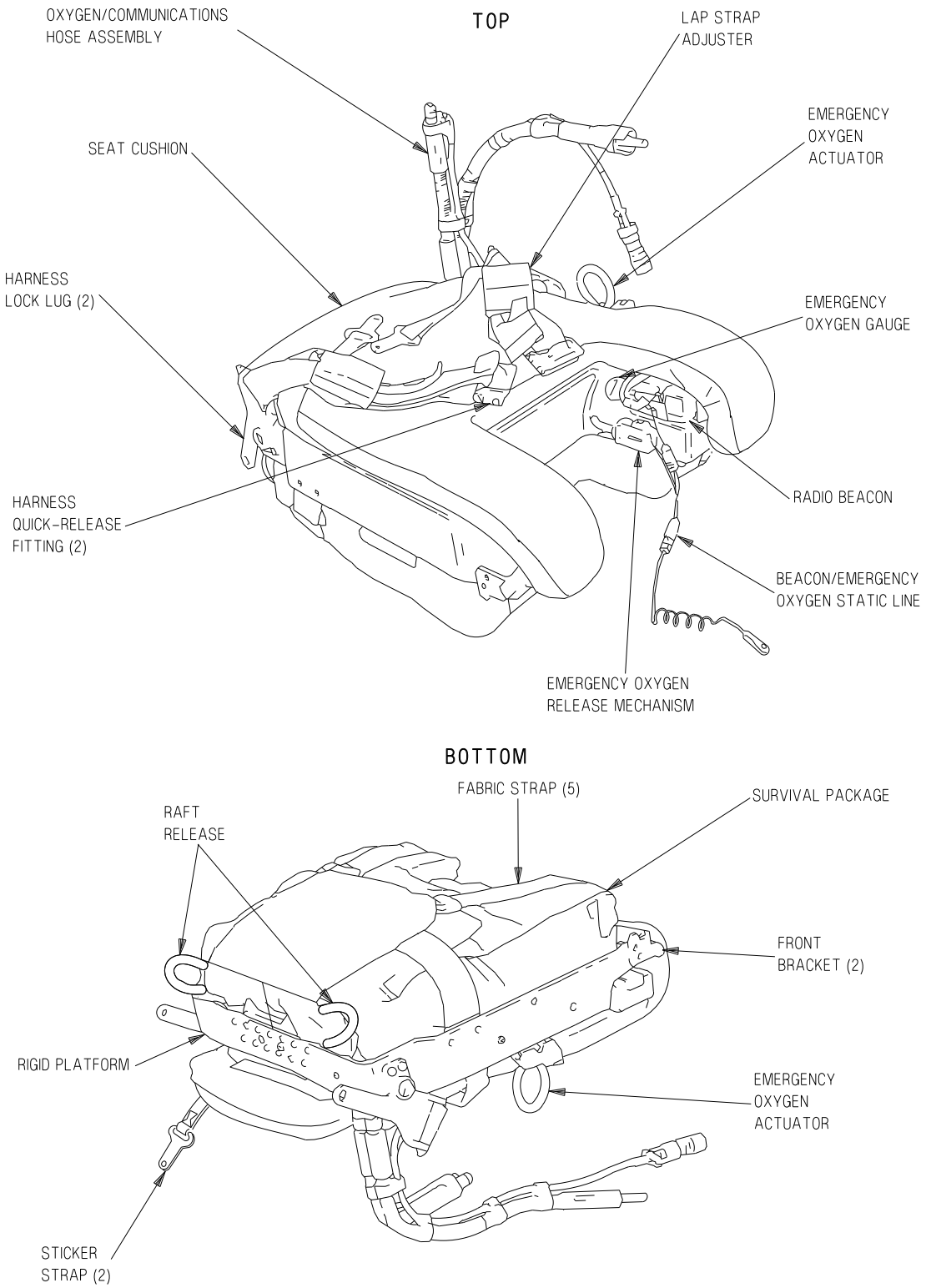

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Figure 2-31. Seat Survival Kit

6. Quick-disconnect fittings for pilot's services (oxygen, communication, g suit) are separated.
7. Emergency oxygen supply and radio beacon are activated.
8. Leg restraint system is activated.

Near the end of catapult stroke, the rocket initiator static lines become taut and withdraw the firing mechanism sears. Gas pressure from the rocket initiator cartridge is directed to the following:

1. Start switch plungers to commence sequencer timing.
2. Barostatic release unit.
3. Pitot mechanism to deploy pitot heads.
4. Underseat rocket motor which is fired to sustain catapult thrust to carry the seat clear of aircraft.

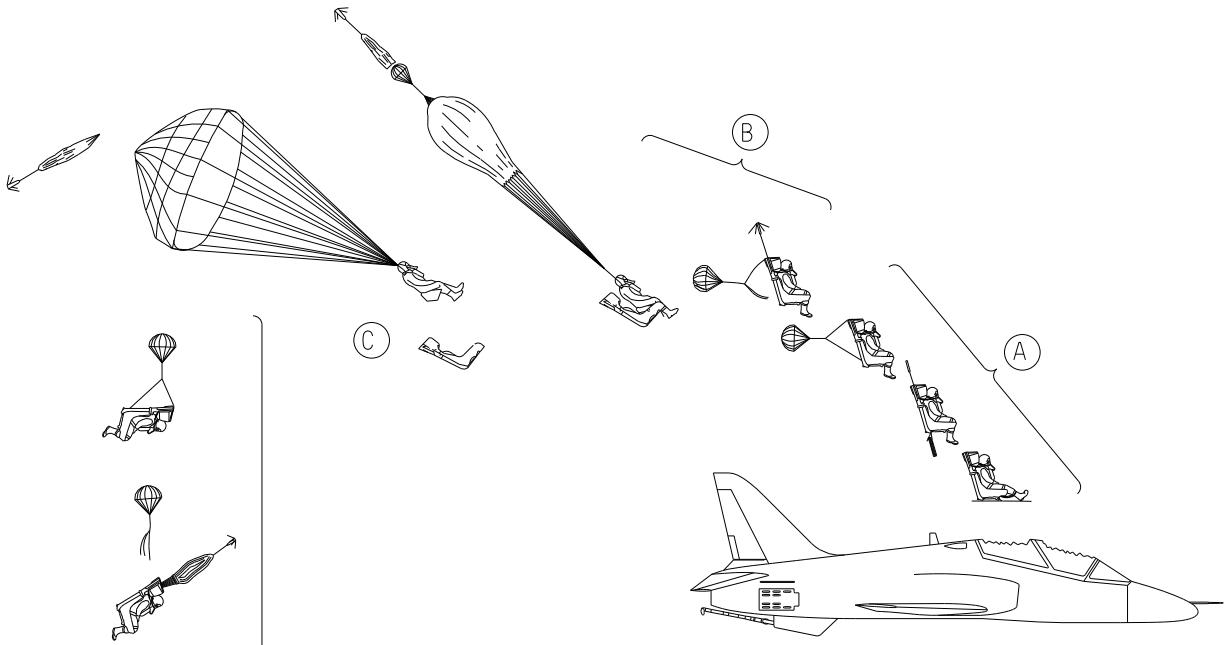
2.16.4 Ejection Mode Sequence. See Figure 2-32 for ejection mode sequence and Figure 2-33 for modes of operation.

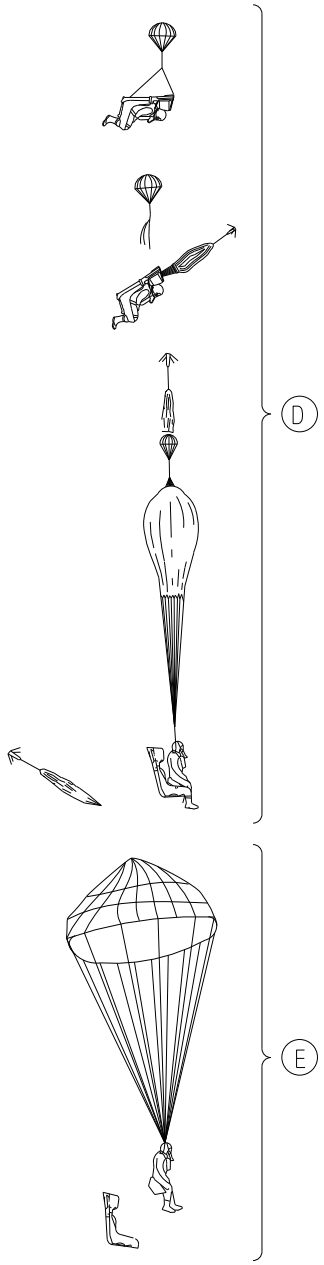
After the seat moves up approximately 39 inches, the seat electronic sequencer activates to select one of five operational modes, depending on altitude and airspeed parameters. To stabilize and decelerate the seat, the drogue deploys regardless of mode selected.

Mode 1	The drogue bridles are released 0.32 seconds after seat's first motion. The parachute deployment rocket fires to deploy parachute and the harness release system operates to free the pilot from the seat.
Modes 2, 3, and 4	The seat is decelerated by the drogue and after a time delay determined by the electronic sequencer the parachute deployment rocket fires to deploy the parachute before the drogue bridles are released. The harness release system operates to free the pilot from the seat.
Mode 5	The seat (with drogue bridles connected) descends to 18,000 feet, where the bridles are released. The parachute deployment rocket fires to deploy the parachute and the harness release system operates to free the pilot from the seat.

In all modes, the pilot is held momentarily in the seat bucket by sticker straps after the harness release system is operated. Seat/man separation occurs when the parachute is deployed, lifting the pilot with the survival kit from the seat and pulling the sticker straps from their clips.

2.16.5 Seat Emergency Operation. To ensure that the parachute is deployed and the harness locks are released, the barostatic release unit, consisting of a barostat and a cartridge, provides an independent automatic backup to the electronic sequencer. The cartridge is fired one of three ways: electronically by the sequencer at a preset altitude of 18,000 feet, mechanically by the barostatic release unit between 14,000 and 16,000 feet, or mechanically by gas pressure from a four second delay cartridge when the manual override handle is pulled. After the time delay, gas pressure is applied to the barostat cartridge firing mechanism. Above the barostat altitude setting, the mechanism is restricted from moving; at or below the altitude it is free to move and fire the cartridge if it has not already been fired electrically. When fired, the barostat cartridge





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.

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Figure 2-32. Ejection Mode Sequence

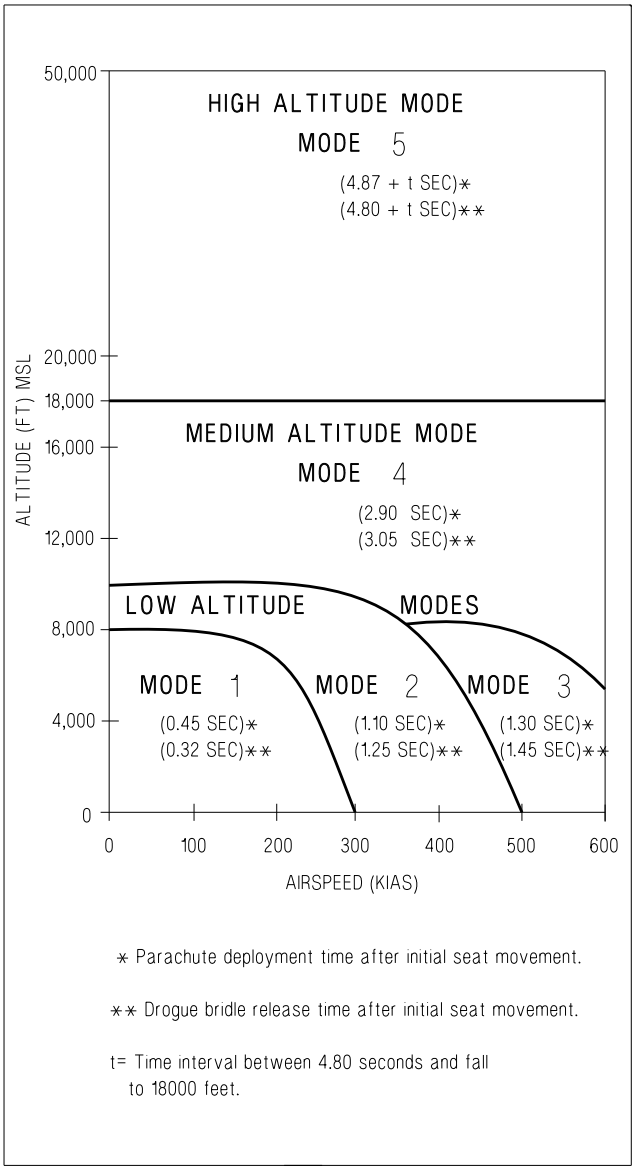

Figure 2-33. Modes of Operation

provides gas pressure to fire the parachute deployment rocket and operate the harness lock release.

In the unlikely event of a barostatic release unit failure in addition to sequencer failure, activation of the emergency restraint release fires the cartridge to free the pilot from the seat and deploy the parachute.

2.16.5.1 Ground Emergency Egress. Following ground emergencies or ditching, the pilot can egress with survival kit by activating the emergency restraint release.

Pulling the handle up safes the seat, releases the survival kit from the seat, leg restraint line locks and negative g strap locks. Full rotation of the handle is prevented by the pin puller engaging in the emergency restraint release operating link thereby inhibiting parachute deployment.

NOTE

After actuating emergency restraint release, upper Koch fittings must be released before pilot can ground egress without the survival kit.

2.16.6 Ejection Seat Controls and Indicators.

2.16.6.1 SAFE/ARMED Handle. The SAFE/ARMED handle is located on the right side of the seat.

SAFE (up)	Mechanically prevents activation of the ejection handle.

WARNING

With one seat armed and one seat safe, the armed seat can initiate ejection of both seats.

ARMED (down)	Allows seat ejection.

CAUTION

Ensure the SAFE/ARMED handle is in the SAFE or ARMED position. It is possible for the handle to be positioned between the SAFE and ARMED positions.

2.16.6.2 Emergency Restraint Release. The emergency restraint release is located on the right side of the seat. The two position handle is

black with yellow striping and has a thumb button. The thumb button must be pressed before the handle can be moved to the up position. When the handle is raised it simultaneously rotates the SAFE/ARMED handle to the SAFE position. Raising the handle performs the following:

Ground	Releases the survival kit and leg restraint lines to permit emergency ground egress with the survival kit.
	NOTE After actuating emergency restraint release, upper and lower Koch fittings must be released before pilot can ground egress without the survival kit.
During ejection	Fires the cartridge to activate seat/man separation and the parachute deployment rocket in the event of automatic sequence failure.

2.16.6.3 Ejection Handle. The ejection handle is located in front of the seat cushion. Pulling the handle fully upward initiates the ejection sequence.

2.16.6.4 Shoulder Harness Lock Lever. The two position shoulder harness lock lever is located on the left side of the seat.

Forward	Locks the shoulder harness inertia reel at any position to prevent forward movement of the pilot.
Aft	Unlocks the shoulder harness inertia reel and allows the pilot to lean forward. The inertia reel will automatically lock if subjected to a decelerating 0.7g longitudinal inertia load.

The shoulder harness lock lever and the FUEL CONTR switch are located in close proximity. Inadvertently switching the FUEL CONTR switch to MANUAL while operating the shoulder harness lock lever will cause engine damage at high power settings.

2.16.6.5 Seat Height Adjustment Switch. The seat height adjustment switch is located on the left side of the seat, forward of the shoulder harness lock lever. The switch is a three position switch and is spring-loaded to the center position.

Forward	Lowers the seat. Stops at the selected position when the switch is released.
Off	Seat remains at selected height. Spring-loaded to this position.
Aft	Raises the seat. Stops at the selected position when the switch is released.

2.16.6.6 SEAT LIGHT Switch. The SEAT LIGHT switch is located in the aft cockpit, on the left console command ejection panel. The switch is a two position toggle switch, spring loaded to the NORM position, and guarded to the SOLO position.

NORM	Permits SEAT caution light in both cockpits to illuminate with either seat safed.
SOLO	Overrides the aft seats ability to activate both cockpit SEAT caution lights when in SAFE condition.

2.16.6.7 Command Ejection Selector. The command ejection selector is located in the aft cockpit, on the left console command ejection panel.

BOTH	Actuation of the ejection handle from either cockpit immediately ejects the aft seat, followed 0.4 seconds later by the front seat.
SOLO	This position shall be selected with the selector collar installed when flying solo. The selector will not stay in the SOLO position without the collar installed. Actuation of the forward ejection handle ejects that seat only.
FWD-BOTH/ AFT-SELF	Actuation of the ejection handle from the forward cockpit immediately ejects the aft seat, followed 0.4 second later by the front seat. Actuation of the ejection handle from the aft cockpit ejects only the aft seat.

WARNING

In the FWD BOTH/AFT SELF mode, if the AFT crew member initiates ejection, followed by ejection initiation by the FWD seat, the FWD seat canopy will not automatically fracture prior to ejection. In this scenario, the MDC firing handle will function normally and should be used to fracture the FWD canopy prior to FWD seat ejection, if time permits.

2.16.7 Ejection Seat Warning, Caution, Advisory Lights.

2.16.7.1 SEAT Caution Light. The SEAT caution light is located on the warning/caution/ advisory lights panel on the right side of the instrument panel. The light illuminates with the seat light switch in the NORM position when either seat is SAFE and the throttle is advanced beyond the intermediate, approximately 60 percent N_2 RPM, position. With the SEAT LIGHT switch set to the SOLO position, the light illuminates only when the front seat is SAFE and the throttle is advanced beyond the intermediate position (approximately 60 percent N_2 RPM).

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. The GTS FIRE warning light is located on the warning lights panel, and TP HOT caution light is on the warning/caution/advisory lights panel.

2.17.1 Fire Detection and Overheat Indicating System Operation. The fire detection system consists of two sets of firewire elements of the automatic resetting type. Each set of elements forms a continuous loop which is connected to a control unit; one set of firewire elements encircles the engine bay and the other encircles the GTS bay. Power is supplied through the Essential Bus.

The firewire elements are temperature sensitive and their resistance decreases as temperature rises. If the engine firewire reaches 300 °C, current flow increases sufficiently to close a relay which supplies a dc signal to illuminate the FIRE warning light. If the GTS firewire is activated, a similar relay closes and the GTS FIRE warning light is illuminated. If the temperature in the affected bay falls below 300 °C, the warning lights go out and the detection system is automatically reset; resetting may take up to 45 seconds. The system is not designed to detect hot bleed air leaks; however, in the event a bleed air leak impinges directly on a firewire element, the FIRE warning light may illuminate.

The fire detection system self test is activated by placing and holding the LIGHT TEST/TONE TEST switch, located in both cockpits to the right of the caution/warning panels, in the LIGHT TEST position. The FIRE and GTS FIRE warning lights illuminate to indicate a properly functioning circuit. If the FIRE and GTS FIRE warning lights do not illuminate, system malfunctions are probably caused by short circuits, broken firewire elements or control unit failure.

The tailpipe bay has temperature sensors which activate the TP HOT caution light when bay temperature exceeds 150 °C. The caution light will extinguish when the temperature drops below 150 °C.

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.

2.18.1 ECS Operation. See Environmental Control System foldout, FO-23. The engine supplies bleed air to two solenoid operated pressure regulator valves simultaneously: the main pressure regulating and shutoff valve (MPRSOV), and the inducer pressure regulating and shutoff valve (IPRSOV). These valves are deenergized open so in the event of loss of all electrical power, the air conditioning and pressurization will remain on. Air from the inducers is used to increase the airflow through the heat exchangers when the landing gear are extended. Upstream of the MPRSOV, bleed air is passed to the canopy seal system and to the control chambers of the ram air inlet and outlet valves.

Air from the MPRSOV passes simultaneously to the primary heat exchanger, the temperature control valve, the max defog valve, and provides servo air to the changeover valve. After cooling in the primary heat exchanger, air is supplied to the compressor of the cold air unit (CAU), then to the secondary heat exchanger and finally, to the turbine of the CAU from where the cold air emerges. Leaving the cold air unit, air is ducted through a water separator and then to the cockpits. The hot air flow supply is primarily controlled by the temperature control valve which opens to allow hot bleed air to bypass the cooling system and to mix with the cold air from the

CAU before entering the water separator. The max defog valve directs a larger volume of the hot air to mix with the cold air before being supplied to both canopy and ventilation ducts.

In-flight, ram air is employed for cooling the engine bleed air passing through the heat exchangers. Cooling air enters the aircraft through two ram air scoops located behind the canopy. The scoops are built into a large door, through which access is gained to the heat exchanger/cold air unit assembly and fuselage fuel tank. The cooling air from the heat exchangers passes overboard through holes in the top of the aircraft forward of the GTS.

When the landing gear are extended, cooling air is induced through each heat exchanger by a cooling air jet pump. When either the landing gear is raised or the cockpit air conditioning system is switched off, the jet pumps will shut off. In the event of an electrical failure the jet pumps will operate normally.

Within the cockpit, air is distributed by means of two separate sets of ducts: ventilation and defog. The majority of supply air (approximately 60 percent) can be directed to either the ventilation or defog ducts. A changeover valve, located in the supply tube leading to the ventilation/defog ducts is used to control the proportion of the supply air. Changeover valve position is controlled through the AIR FLOW control knob, which in turn directs servo pressure to position the valve. Air pressure for the servos is supplied from a tap downstream of the MPRSOV.

The crew ventilation ducts are located under the left and right canopy rails and contain head, body (directionally adjustable), and foot louvers. The defog ducts are located at the left and right base of the windscreen and canopy, and are perforated with a series of spray holes.

Ram air inlet and outlet valves are positioned on the cockpit forward and aft bulkheads, respectively, to provide emergency ventilation in-flight when the cockpit air conditioning system is switched off. These valves allow fresh air to remove smoke or uncontrollable fogging from the cockpit. On the ground the valves remain open.

The cockpit air conditioning system is turned on by the AIR FLOW control knob in the forward cockpit. Placing the knob to NORMAL opens the MPRSOV and energizes the changeover valve to increase the air flow to the ventilation ducts (approximately 60 percent to ventilation and 40 percent to defog). Placing the knob at DEFOG or MAX DEFOG deenergizes the changeover valve to increase the air flow to the defog ducts (approximately 60 percent to defog and 40 percent to ventilation). In addition, when MAX DEFOG is selected the max defog valve is energized to fully open allowing more hot bleed air into the conditioned air flow, further increasing the flow/temperature of the DEFOG air and it's defog capability.

NOTE

During penetration cockpit fogging may occur. Use of the DEFOG or MAX DEFOG setting is recommended during descent/ penetration.

2.18.1.1 Temperature Control. The pilot can control the temperature in either the AUTO or MANUAL mode. The AUTO mode is provided as the normal operating mode and the MANUAL mode as a backup.

2.18.1.1.1 AUTO Mode. In the AUTO mode the cabin temperature is automatically regulated by the cabin temperature control. The control monitors cabin temperature and compares the temperature with the CABIN TEMP knob setting. If the temperature is incorrect, the control repositions the temperature control valve appropriately to correct the temperature and then automatically repositions the valve to maintain the temperature. The cabin temperature control also positions the temperature control valve to limit the supply duct air temperature (2.5 to 75 °C). The CABIN TEMP knob remains in the selected position.

2.18.1.1.2 MANUAL Mode. In the MANUAL mode cabin temperature is manually controlled by holding the CABIN TEMP knob to COOL or WARM. When the knob is set to either position a control signal is sent to the temperature control

valve to open or close the valve. The signal is applied to the valve as long as the knob is held in the COOL or WARM position. When the knob is released the knob will spring back to the center position, discontinuing the control signal to the temperature control valve. The control valve, however, will remain in the last selected position. Small changes should be made when adjusting the temperature, accompanied by a brief waiting period before making any further adjustments. The brief waiting period allows the ECS ducts to heat/cool and the discharge temperature to stabilize. In the MANUAL mode the temperature to the ventilation/defog ducts is not limited and must be manually controlled.

- Extended operation in MANUAL mode with very cool temperature selected may result in freeze-up condition of the water separator coalescer and premature failure of the internal coalescer bypass relief valve.

- Extended operation in the MANUAL mode with WARM selected may cause excessive temperatures resulting in weakening or damage of the windscreen.

2.18.2 Cockpit Pressurization System.

Cockpit pressurization is controlled by the pressure control valve and its slave discharge valve. These two servo controlled discharge valves restrict the discharge of air from the cockpit to maintain cockpit pressure at the required differential. Pressurization commences at 5,000 feet MSL and increases approximately linearly with altitude until the full differential pressure of 4 psi is attained at 40,000 feet MSL.

In the event of cockpit pressure control system failure, a safety relief valve ensures that cockpit differential pressure cannot exceed 4.8 psi. The safety valve also incorporates a negative pressure relief function to ensure that a negative cockpit differential pressure cannot exceed 0.5 psi; for example, during a rapid descent. If cockpit pressure is lost, the CABIN ALT warning light will illuminate when the cockpit altitude exceeds 24,500 ±500 feet. See Figure 2-34 for the cockpit pressurization schedule.

The pneumatically operated canopy seal has a control valve that is mechanically coupled into the canopy locking mechanism. Air for the seal is tapped from the bleed air supply upstream of the MPRSOV

2.18.3 Avionic Equipment Cooling System.

During flight, cockpit air exhausts through the cockpit pressure control valve and discharge valve. Some of this air passes through the avionics compartments on its way to being discharged aft of the air conditioning equipment bay.

The AV HOT caution light is only operative on the ground and will illuminate if the air temperature in the auxiliary equipment bay exceeds 67 °C.

ECS conditioned air flows to the cockpit ventilation ducts at all times during ground operation for pilot comfort.

2.18.4 ECS Controls and Indicators.

2.18.4.1 AIR FLOW Control Knob. The AIR FLOW control knob is located in the front cockpit, on the right console. The knob has the following positions:

OFF	Secures ECS. Opens ram air valves.
NORMAL	Directs approximately 60 percent of the total air flow to the crew ventilation ducts.
DEFOG	Directs approximately 60 percent of the total air flow to the windscreen and canopy defog ducts.
MAX DEFOG	Opens max defog valve to allow additional supply of hot air.

2.18.4.2 CABIN TEMP Control Knob. The CABIN TEMP control knob is located in the front cockpit, on the right console.

AUTO	Cockpit temperature is automatically controlled by positioning the knob toward COOL or WARM to maintain desired cockpit temperature setting.
MANUAL	Cockpit temperature is manually controlled. Positioning the knob toward COOL or WARM will move the temperature control valve in the appropriate direction until released. When released the knob will spring back to center and the temperature control valve will stay in the last commanded position.

NOTE

In the MANUAL mode should chunks of ice and/or snow be detected discharging from the cockpit ECS louvers, a higher cockpit air temperature should be selected to restore the system to normal operation. The ice/snow condition is caused by too cold a selection, resulting in a freeze-up of the water separator coalescer and operation of the internal coalescer bypass relief valve.

2.18.4.3 Canopy Control Lever Safety Catch. The canopy control lever safety catch is located at the base of the canopy control lever. Pressing outboard deflates the canopy seal and disengages the locking mechanism allowing the canopy control lever to be pulled aft.

2.18.4.4 CABIN Pressure Altimeter. The CABIN pressure altimeter is located on the left side of the pedestal. The altimeter indicates cabin pressure altitude in 1,000 foot increments.

2.18.5 ECS Warning, Caution, and Advisory Lights

2.18.5.1 CABIN ALT Warning Light. The CABIN ALT warning light is located on the warning lights panel, on the right side of the instrument panel. The light illuminates when any of the following occur:

1. An air conditioning system failure caused by overpressure to the CAU compressor.
2. CAU compressor outlet temperature above 500 °F (260 °C).
3. CAU turbine inlet temperature above 250 °F (121 °C).
4. Cockpit pressurization failure, only when the CABIN pressure altimeter indication exceeds 24,500 ±500 feet.

2.18.5.2 AV HOT Caution Light. The AV HOT caution light is located, on the warning/caution/advisory lights panel, on the right side of the instrument panel. The light illuminates when the air temperature in the auxiliary equipment bay exceeds approximately 67° C. The light only comes on when the aircraft is on the ground.

2.19 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. See On-Board Oxygen Generating System fold-out, FO-25.

A pneumatic BIT button, located on the bottom of the oxygen monitor, checks operation of the sensor and the OXYGEN warning light. An electronic BIT button is located on the front surface of the SSOM and is intended for maintenance purposes only.

The anti-g system allows air pressure to the anti-g suit proportional to the g force experienced. A button on the OBOGS control panel allows the pilot to manually inflate and test the anti-g suit. The system incorporates a safety pressure relief valve.

2.19.1 OBOGS Operation. The OBOGS uses engine fifth stage bleed air which is cooled through a heat exchanger then directed to the concentrator. The concentrator is powered by

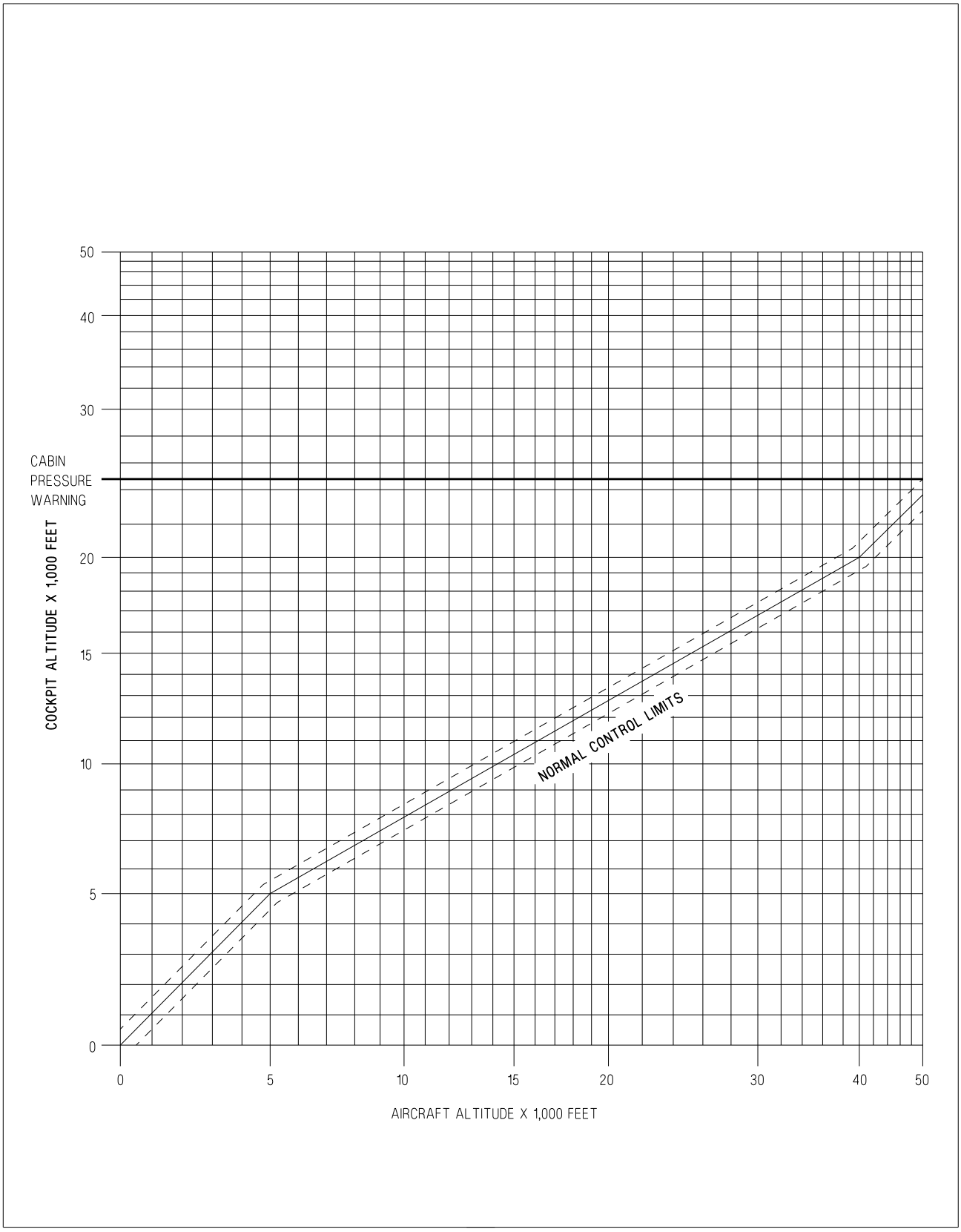

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Figure 2-34. Cockpit Pressurization Schedule

the 28 VDC Essential Services Bus and contains rotary valves and molecular sieves which remove most of the nitrogen, CO_2, and water. This oxygen enriched air is routed through the cockpit plenum to the pilot services panel.

The overheat temperature sensor is located in the ducting between the heat exchanger and the concentrator. This sensor illuminates the OXYGEN warning light whenever the bleed air temperature exceeds 250 °F (121 °C).

The oxygen monitor continuously samples oxygen enriched air for the proper concentration level. When the oxygen level drops below an acceptable level the oxygen monitor illuminates the OXYGEN warning light.

CAUTION

Should the OBOGS/ANTI-G switch return to the OFF position in-flight, for any unknown reason, do not attempt to reset more than once.

The regulator delivers the oxygen enriched air to the pilot at positive pressure. At cabin altitudes above 35,000 feet oxygen is automatically supplied to the pilot's mask at increased pressure to allow adequate oxygen absorption. Full pressure breathing is supplied at 42,000 feet cabin altitude.

The OBOGS is controlled by the OBOGS/ ANTI-G switch located on the pilot services panel in the front cockpit.

To accomplish OBOGS pneumatic BIT, press and hold the pneumatic BIT button located on the bottom of the oxygen monitor for up to 1 minute. This lets cockpit air to enter the oxygen monitor sensing chamber lowering the oxygen level, and causing the OXYGEN warning light to illuminate. Releasing the pneumatic BIT button allows oxygen enriched OBOGS air to enter the sensing chamber increasing the oxygen level and extinguishing the OXYGEN warning light indicating a satisfactory check of the system.

WARNING

Testing of the OBOGS above 9,000 feet shuts down the OBOGS system.

NOTE

When performing OBOGS BIT it is possible for the pilot to cover the OBOGS vent holes on the oxygen monitor causing an incorrect BIT check.

The SSOM automatically performs a power-up BIT, testing the monitors electronic components during the warm-up period. The OXYGEN warning light may illuminated momentarily during the power-up BIT. The monitor will then automatically perform a periodic BIT on 60 second intervals during normal operation. If a fault is detected the OXYGEN warning light will be illuminated.

The anti-g system for both cockpits is controlled by the OBOGS/ANTI-G toggle switch located on the pilots services panel in the forward cockpit. Each pilot can test their anti-g system with the ANTI-G press to test button located on the pilot services panel. Suit inflation commences at approximately 2g and the suit pressure rises linearly with increasing g reaching 6.5 psi at 6g. Air pressure for the anti-g system is tapped downstream from the OBOGS heat exchanger.

2.19.2 OBOGS Emergency Operation. An emergency supply of gaseous oxygen is contained in an emergency oxygen bottle located in the survival kit. A pressure gauge is mounted on the emergency oxygen bottle and is visible on the left inside portion of the seat pan. The gauge has a red refill sector from 0 to 1,800 psi and full sector from 1,800 to 2,500 psi. During emergency operation, emergency oxygen is routed through the pilot's regulator to the mask. This supply is actuated automatically with seat ejection. The emergency oxygen supply can be manually activated by pulling the emergency oxygen actuator located on the left side of the survival kit.

The emergency oxygen will last 4 to 20 minutes, depending on cabin altitude and breathing rate. The higher the altitude, the longer the duration. The actuator can be reset after actuation by pushing down on the handle.

2.19.3 OBOGS/Anti-G Controls and Indicators.

2.19.3.1 OBOGS/ANTI-G Switch.
The OBOGS/ANTI-G switch is a two position toggle switch, located in the forward cockpit on the left console pilots services panel.

ON	Turns on the OBOGS and anti-g systems. The switch must be set to ON for up to 20 seconds to reset the OBOGS.
OFF	Closes the bleed air shutoff valve to turn off the OBOGS and anti-g system.

2.19.3.2 OBOGS FLOW Selector. The OBOGS FLOW selector is located on the left console pilots services panel.

OFF	Shuts off the OBOGS flow from the pilots services panel.
ON	Open OBOGS flow from the pilots services panel.

2.19.3.3 OBOGS Pneumatic BIT Button. The OBOGS pneumatic BIT button is located on the bottom of the oxygen monitor, see Figure 2-35. Pressing and holding the button activates the BIT operation. Releasing the button deactivates the BIT.

The pneumatic BIT button can be rotated when pressed, locking the button in the pressed (BIT) position. To release the button, press, rotate the button in the opposite direction and release. The lock feature is intended to be used only during maintenance.

2.19.3.4 OBOGS Electronic BIT Button. The OBOGS electronic BIT button is located on the front side of the oxygen monitor, see Figure 2-35.

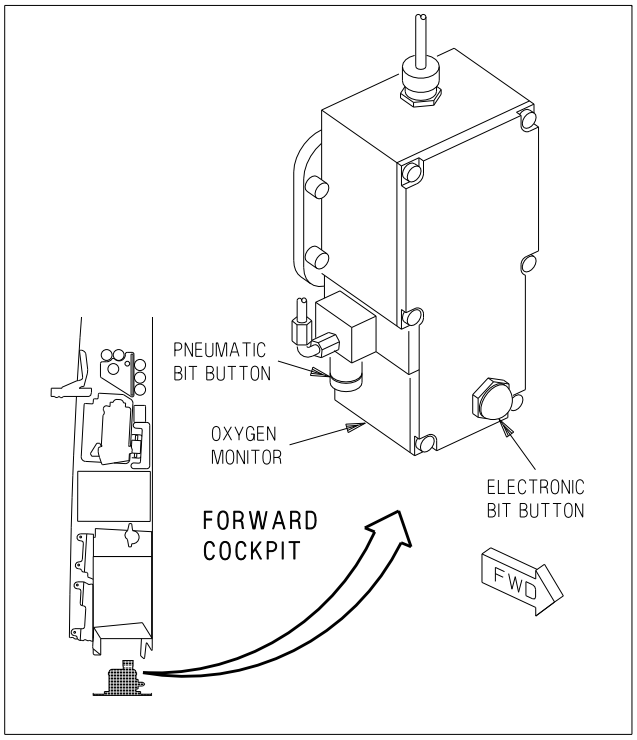

Figure 2-35. Oxygen Monitor

Pressing the button initiates an IBIT of the oxygen monitors electronic components. This button is intended for maintenance use only.

2.19.3.5 ANTI-G Press to Test Button. The ANTI-G press to test button is located on the left console pilots services panel. Pressing and holding the button directs air into the anti-g suit to check the anti-g system operation.

2.19.4 OBOGS/ANTI-G Warning, Caution, and Advisory Lights.

2.19.4.1 OXYGEN Warning Light. The OXYGEN warning light is located on the caution/ warning light panel. The light illuminates when an OBOGS failure is detected. Either low oxygen concentration from the concentrator or heat exchanger discharge air temperature exceeding 250 °F (121 °C) will indicate a system failure. The warning light also illuminates when the OBOGS/ANTI-G switch is in the OFF position.

2.20 FLIGHT INSTRUMENTS

2.20.1 Pitot Static System. The standby pitot-static instruments are driven from a heated,

aerodynamically compensated pitot-static probe mounted on the nose of the aircraft, refer to Figure 2-36. 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.
OFF	Probe heat is off.

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. The barometric setting set on the front cockpit standby barometric altimeter is sent to the DEU. The pressure setting is displayed on the MANT display, see Figure 2-52. The standby altimeter operates directly off the static pressure; however, the internal vibrator is powered by the 28 VDC generator bus.

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. A zero adjustment screw is accessible on the lower left corner of the instrument case.

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. An OFF flag appears whenever power is lost or the unit is caged. 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 pitch display is limited by mechanical stops at approximately 92 degree climb and 78 degree dive. The caging knob on the lower right hand corner, besides being pulled for caging, is used to adjust the pitch of the miniature aircraft. A pitch-trim scale measures displacement of the miniature aircraft. Pulling the caging knob and rotating fully clockwise to the detent locks the inner gimbal of the gyro. This position is for storage and transport, and should never be used during flight. A minimum of 9 minutes of reliable attitude information (error less than 6 degree) is available after power loss, even though the OFF flag is in view.

2.20.6 Standby Turn and Slip Indicator. The turn and slip indicator contains a scale, turn pointer, power warning flag and inclinometer ball. A 2 minute turn is indicated with the needle over the index to the left and right of center. A 4 minute turn is indicated with the needle half way between the center and the right or left index. The gyro is driven by an inverter, which is powered from the 28VDC Essential Services Bus. An OFF flag is provided to indicate loss of power.

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

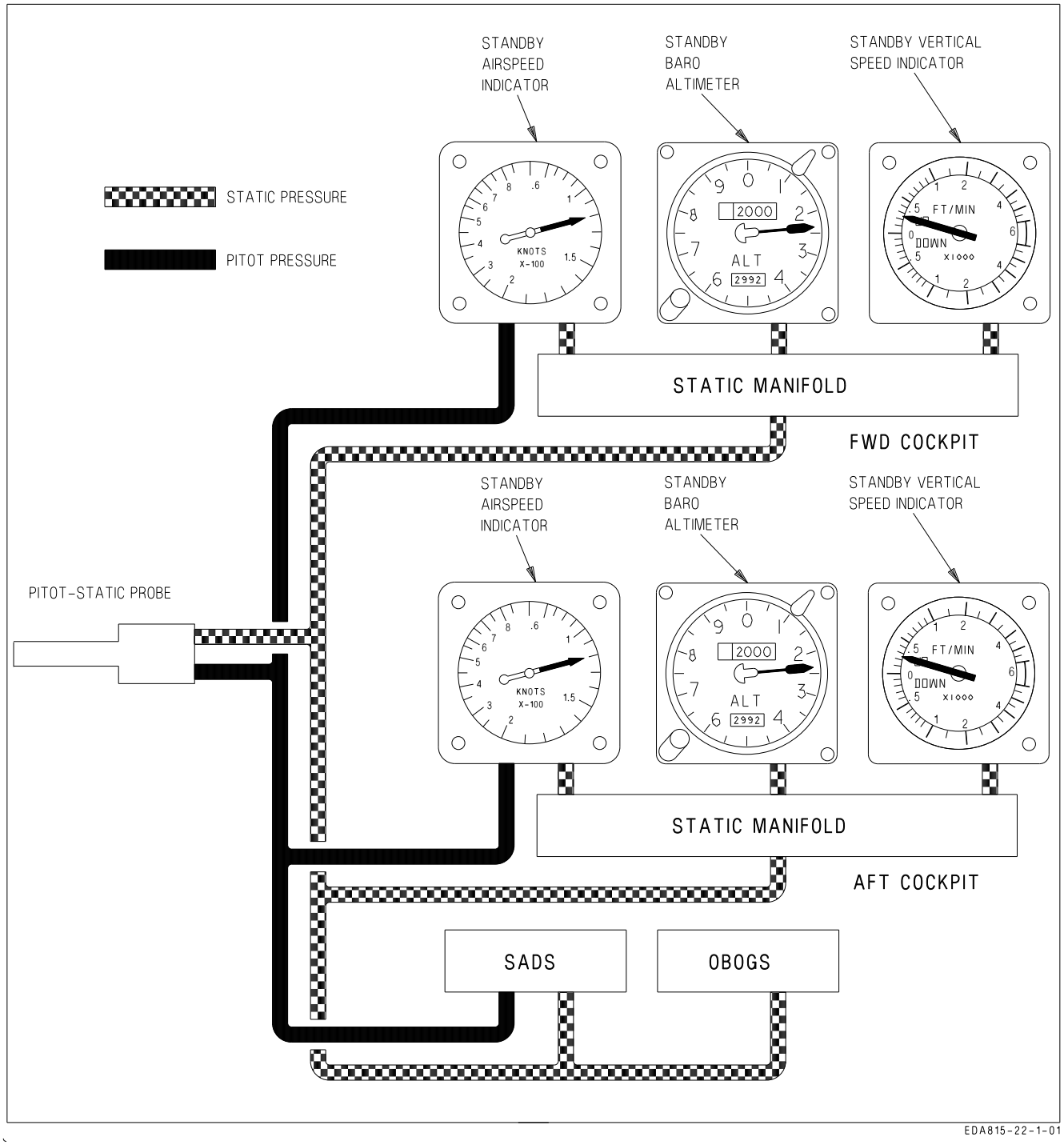

Figure 2-36. Pitot-Static System

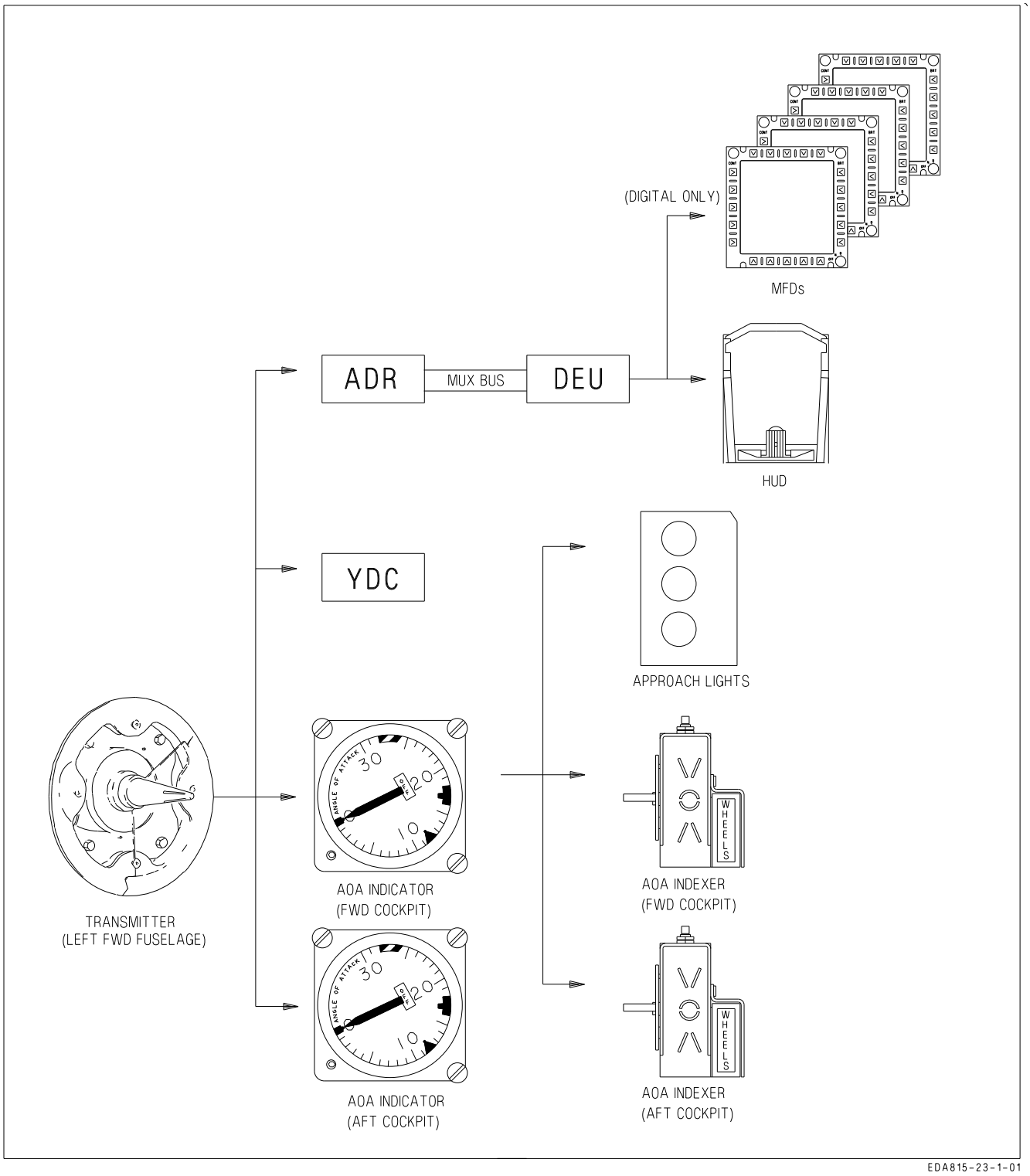

Figure 2-37. AOA System Diagram

pedal shakers and stall warning tone operate at 21.5 units AOA to provide artificial warning of stall AOA. See Figure 2-37.

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, see Figure 2-38. The indicator registers units of AOA to the relative airstream, from 0 to 30 units. An OFF flag is visible if electrical power is lost. 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 ($\vee$) is green and indicates a high ($\geq$18 units) AOA, the center donut (O) is amber and indicates the optimum (17 units) AOA, and the lower chevron ($\wedge$) is red and indicates a low ($\leq$16 units) AOA. Two intermediate conditions are also indicated by illuminations of the donut (O) 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. 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.

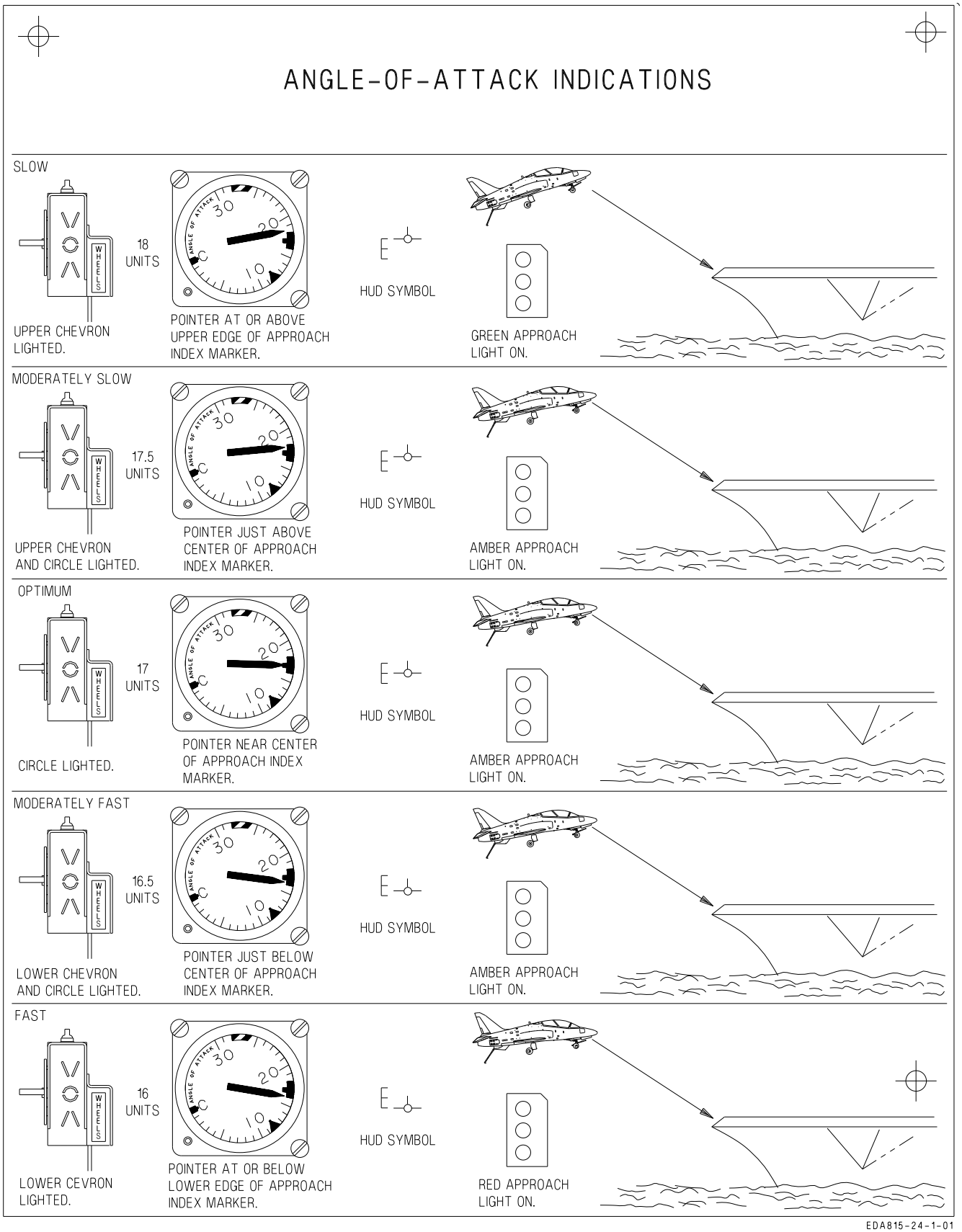

Figure 2-38. AOA System Indications

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.

2.22 RADAR ALTIMETER

The radar altimeter (RALT) system consists of a receiver-transmitter, and two antennas. Refer to the BIT System description, paragraph 2.26 and subsequent, for a description of the RALT BIT. 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. If the ADR or RALT signal is invalid, fails, or exceeds 5,000 feet the radar altitude will be removed and the letter R will remain displayed on the HUD and ADI display. After IBIT is performed on the ground, a RALT failure is reported by the message DEGD on the BIT display. On the ground (weight-on-wheels) the radar altitude defaults to 10 feet.

RALT power is controlled by the RALT PWR option on the BIT display. Successive actuation of the RALT PWR option turns on/turns off (boxes/unboxes) the RALT. Upon power up of the electrical system with weight-on-wheels, the RALT will default to the power on (boxed) state. If a power interruption occurs with weight-on-wheels the RALT will again default to the power on state regardless of the power state prior to the interruption. When airborne and a power interruption occurs, the RALT will return to the power state prior to the interruption.

2.22.1 Low Altitude Warning. The LAW consists of a LAW advisory displayed in the MFD advisory window, an audio warning tone, and flashing of the LAW setting and option accompanied by the HUD warning indication. The LAW is initiated when the aircraft descends to or below the LAW setting and continues until the aircraft ascends above the LAW setting, see Figure 2-39.

With the landing gear extended the LAW advisory/tone and HUD warning will be displayed/emitted for 3 seconds. With the landing gear retracted, the LAW advisory/tone and HUD warning will be displayed/emitted continuously until rejected. The LAW setting and option 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.

2.22.2 LAW Setting. The LAW setting is displayed on the ADI display above the LAW option. The setting may be set using either the ADI display or the DEP. Upon power up the LAW setting defaults to 500 feet.

2.22.2.1 ADI Entry. The LAW setting is controlled from the ADI display by selecting the LAW option and LAW increment/decrement options. Successive actuations of the LAW option selects/deselects (boxes/unboxes) the option. Selection of the BNGO or PT options will unbox the option. When the LAW option is selected, the LAW increment and decrement options are displayed. Selecting either option changes the LAW setting accordingly in 10 foot increments. Pressing and holding the increment/decrement option initially changes the LAW

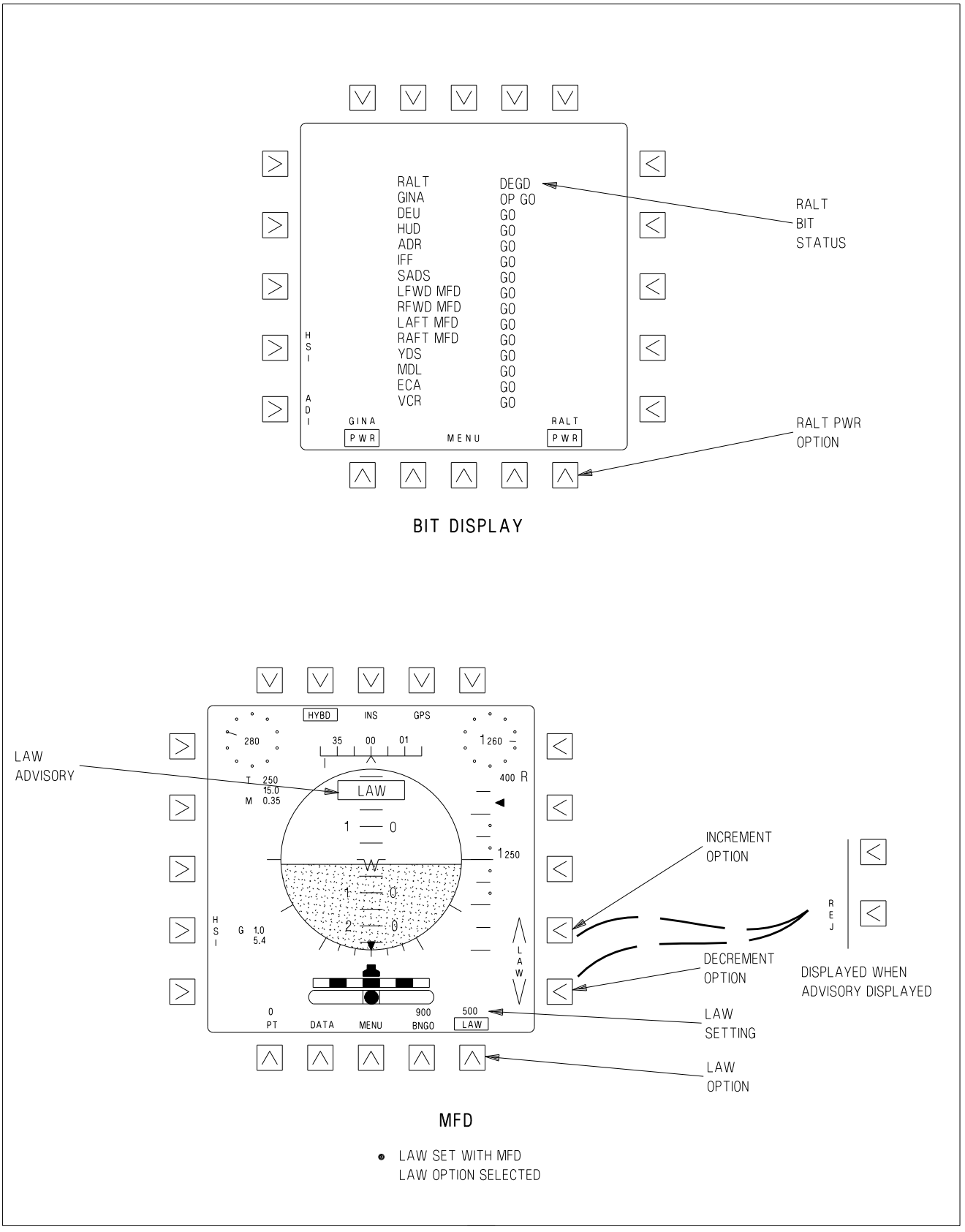

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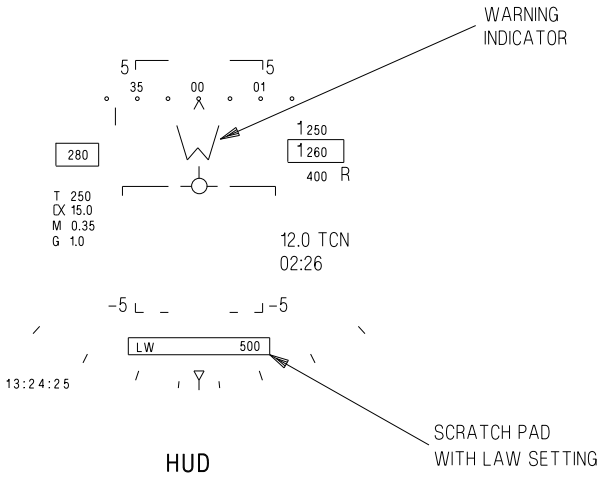
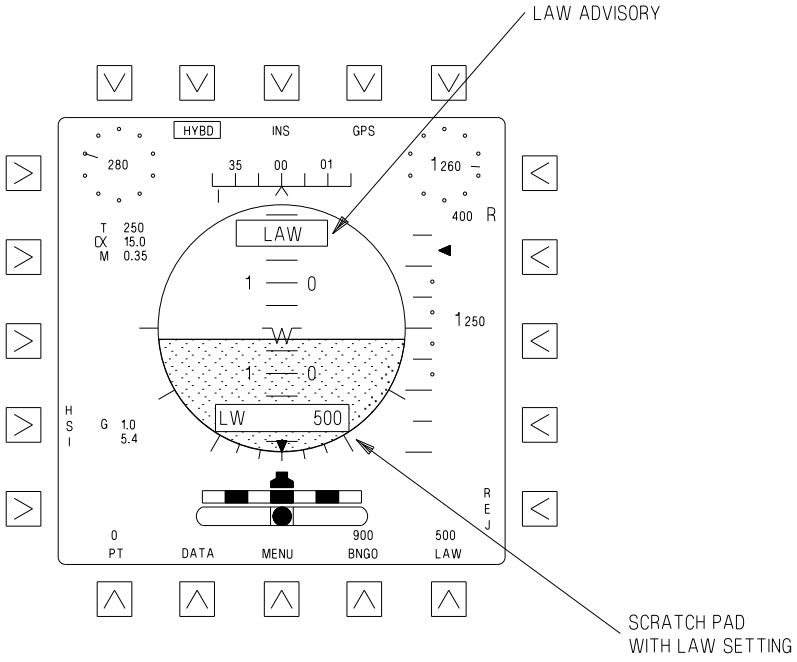
Figure 2-39. Radar Altimeter Controls and Indications (Sheet 1 of 2)



HUD



MFD

- LAW SET WITH DEP LAW BUTTON SELECTED

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Figure 2-39. Radar Altimeter Controls and Indications (Sheet 2 of 2)

setting in fine adjustments and rapidly accelerates the longer the option is selected. If the maximum or minimum setting is reached the setting will wrap around to the maximum or minimum setting and continue to increment or decrement.

2.22.2.2 DEP Entry. The LAW setting is controlled from the DEP by pressing the LAW button. When the button is pressed the scratchpads will be displayed, and the DEP is enabled. The current LAW setting will be displayed in each scratchpad with the LAW identifier (LW). The LAW setting can now be entered using the DEP data entry buttons. When the setting is entered, pressing the DEP ENT button will store the new setting in the DEU, update the ADI LAW setting, and remove the scratchpads.

2.22.3 Radar Altimeter Controls and Indicators. See Figure 2-39.

2.22.3.1 RALT PWR Option. The RALT PWR option is located on the BIT display in the lower right corner. Alternate selections of the option turn on (box), turn off (unbox) the RALT.

2.22.3.2 LAW Option (ADI Display). Pressing the option alternately selects/deselects (boxes/unboxes) the LAW option, enabling/disabling the LAW increment/decrement options.

2.22.3.3 LAW Button (DEP). Pressing the button enables the DEP for entry of the LAW setting, boxes the LAW option on the ADI display, and displays the scratchpads.

2.22.3.4 LAW Setting. The LAW setting is displayed above the LAW legend and provides a readout of LAW setting from 0 to 5,000 feet AGL. The setting will flash whenever the aircraft is below this altitude and weight-off-wheels. If the RALT power is turned off XXXX will be displayed and the R is removed from the HUD and ADI displays.

2.22.3.5 Increment/Decrement Options. The LAW increment/decrement (∧/∨) options correspondingly increase/decrease the LAW setting in 10 foot increments.

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.

2.23.1 MFD Advisories. The MFD advisories provide a visual display of system malfunctions affecting the safe operation of the aircraft. These advisories go beyond indications of the warning/caution/advisory lights. The advisories are displayed on the MFDs in an advisory window which is displayed over whatever display is selected on the individual MFD, including the HUD video display, see Figure 2-40. The advisory will continue to be displayed on the MFDs until the condition or malfunction is corrected or the REJ option is selected, except for the SIM MODE (simulator mode) advisory which is not rejectable. If the REJ option is selected that particular advisory will not be redisplayed until the condition or malfunction returns.

NOTE

The advisories are not displayed on the HUD.

If multiple advisories occur, only one advisory will be displayed. The advisory will remain until the condition is corrected or it is rejected and then the next advisory will be displayed. When multiple advisories occur they will be displayed in the following priority:

SIM MODE
LAW
BINGO
ATTITUDE
POSITION
CORRIDOR

ILS
GLIDESLOPE
LOCALIZER

The advisories are inhibited until communication is established between the appropriate equipment and the DEU. All advisories except the LAW advisory are inhibited during BIT.

illumination, audio tone, HUD warning indicator, and HUD CAUTION indicator can be canceled by pressing the MASTER ALERT light except for LAW or BINGO. In this case the REJ option must be selected. The warning or caution light remains illuminated until the failure is corrected. Dimming of the caution and advisory

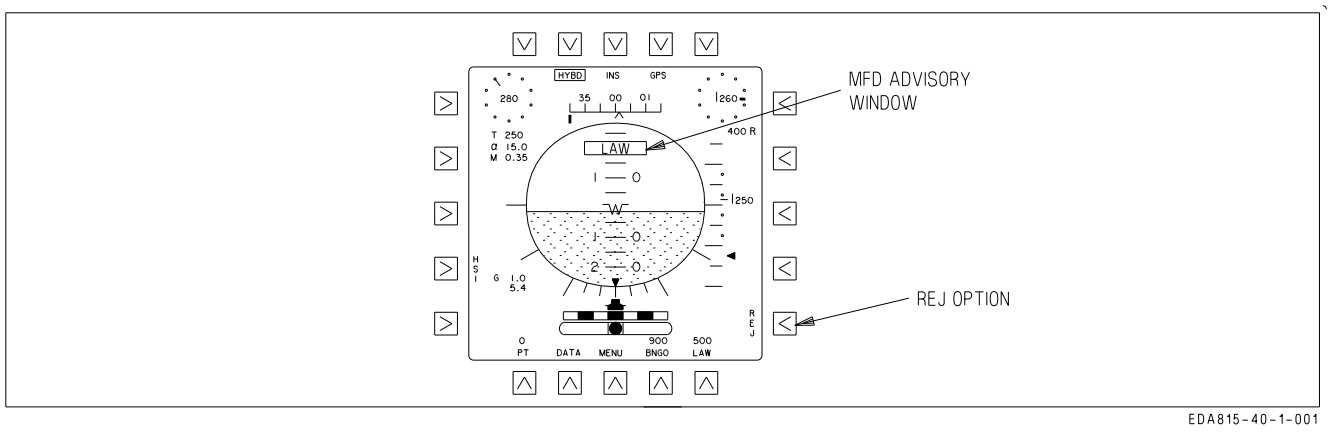

Figure 2-40. MFD Advisory Window

2.23.1.1 SIM MODE Advisory. The SIM MODE advisory is displayed when the DEU receives a discrete signal stating it is installed in the simulator and communication cannot be established with the simulator. The HUD and MFDs will be blanked except for the advisory on the MFDs. The DEU waits for 2 minutes after receiving the discrete signal before blanking the displays and displaying the advisory. Due to this delay, the HUD and MFDs may display aircraft information prior to being blanked and displaying the advisory. The advisory is not rejectable.

2.23.2 Warning/Caution/Advisory Light System Operation. Aircraft system failures are indicated in both cockpits by the illumination of red warning lights or amber caution lights, depending on the source of the failure input signal. This is accompanied by the flashing of the amber MASTER ALERT light and an audio tone in both cockpits. In addition, the HUD will display a warning indicator (W) when a warning light is illuminated or a CAUTION when a caution light is illuminated, see Figure 2-41. The warning indicator takes precedence if both occur simultaneously. The MASTER ALERT light

lights is obtained by setting the WARN/CAUT light switch to DIM.

System operation can be tested by placing the LIGHT TEST/TONE TEST switch in either the LIGHT TEST or TONE TEST position. Placing the switch to LIGHT TEST illuminates all the warning, caution, advisory lights and tests the fire warning system. Placing the switch at TONE TEST generates the four audio tones in the sequence of warning, caution, wheels up, and weapons release.

The centralized warning system is inhibited when the emergency fuel shutoff handle is in the up position (valve closed) and external electrical power is connected to the aircraft. However, the FIRE light, GTS FIRE light, MASTER ALERT lights, and audio tone channels still operate normally. The system is in the normal operating mode when the fuel shutoff handle is in the down position (valve open).

2.23.3 MASTER ALERT Light. The amber MASTER ALERT light is located in the upper left part of the instrument panel. The light flashes, accompanied by an audio warning/

caution tone whenever a warning or caution light is illuminated. Pressing the light:

1. Cancels the audio tone
2. Turns off the MASTER ALERT caution light
3. Resets the system.

The warning or caution light remains illuminated until the failure is corrected.

2.23.4 Audio Tones. An output to the communication control system to generate seven different audio tones. The seven audio tones are then sent from the communication control system to the headsets.

2.23.4.1 Warning Tone. A continuous warning tone is associated with illuminated red warning lights. The tone transmits once per second. Pressing the MASTER ALERT light cancels the tone.

2.23.4.2 Low Altitude Warning Tone. The low altitude warning tone is associated with MFD LAW advisory. The tone is a four to six burst tone.

2.23.4.3 Stall Warning Tone. The stall warning tone is associated with the rudder pedal shaker and comes on simultaneously with the pedal shaker at 21.5 units AOA. A 400 hertz pulsed, tone is repeated until AOA is decreased below the specified units.

2.23.4.4 Wheels Warning Tone. The wheels warning tone is associated with the WHEELS warning light. The tone is a 250 hertz pulsed tone. Pressing the TONE button on the LDG GEAR control panel cancels the tone.

2.23.4.5 Caution Tone. A 1-second caution tone is associated with illuminated amber caution lights. The tone alternates between two frequencies and stops after 1 second. If two cautions are triggered simultaneously, the duration of the caution tone will be shortened. If a sound is heard on the headset, a check of the caution lights should be performed to determine if cautions have occurred. Operation of the MASTER ALERT light, HUD caution indication, and caution lights are not affected.

NOTE

The abbreviated tone most commonly occurs when the parking brake is set, the throttle is above 60 percent RPM and either or both of the seats are in SAFE. This does not occur when only the rear seat is set to SAFE and the Command Ejector Selector handle is set to SOLO.

2.23.4.6 Weapon Release Tone. A constant 1,000 hertz weapon release tone is heard when the weapons release input (bomb pickle) is activated. The tone stops when the weapons release input is deactivated.

2.23.4.7 Gun Tone. The gun tone is a 67 hertz tone simulating a gun firing. The tone stops when the trigger is released.

2.23.5 Warning/Caution/Advisory Light Panels. The warning lights panel and the warning/caution/advisory lights panel is located on the right instrument panel in each cockpit. See Figure 2-42 for the Forward Cockpit and Figure 2-43 for the Aft Cockpit. The warning lights panel consists of 10 warning lights; all lights are warning indicators (see Figure 2-44). Each warning/caution/advisory panel consists of 28 lights. The top six rows contain 18 caution lights (see Figure 2-45). The bottom two rows contain nine advisory lights (see Figure 2-46) and one warning light (see Figure 2-44).

2.24 INTERIOR LIGHTING SYSTEM

The interior lighting system consists of four types of lighting: primary, secondary, emergency, and warning/caution/advisory. See Figure 2-47 for forward cockpit and Figure 2-48 for the aft cockpit. The individual types are comprised as follows:

Primary	Integral lights

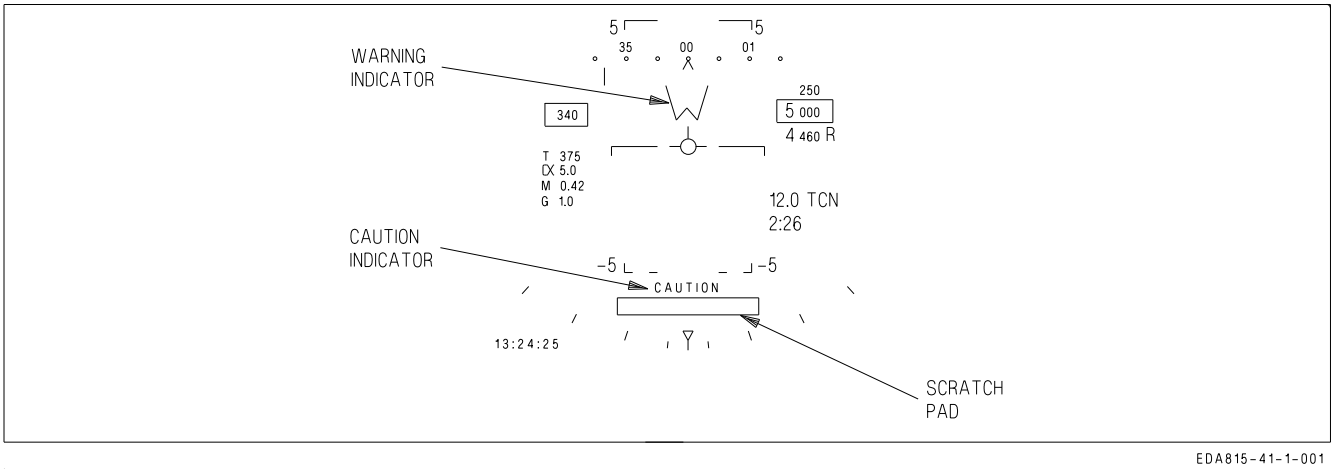

Figure 2-41. HUD Warning/Caution Indications

Secondary	Map lights (illuminated the kneeboard area) and strip floodlights mounted under the glareshield and above the consoles (for maximum lighting of the main instrument panel and consoles)
Emergency	One dedicated lamp in each strip floodlight. These lamps are not used during normal operation. The standby attitude indicator and compass emergency lighting is integral to the indicators.
Warning/ Caution/ Advisory	Individual lamp contained in each warning/caution/advisory light

The flood strip lighting assemblies consist of seven unfiltered white strips, located in each cockpit, to provide normal and emergency illumination.

The following buses provide electrical power to the interior lights:

26 VAC NON-ESS	Main instrument panel (MIP) primary
115 VAC NON-ESS	Console primary
28 VDC GEN	Secondary, less map
28 VDC ESS SERVICES	Emergency and map

2.24.1 Emergency Lighting Operation. The emergency flood lighting is automatically activated if the MIP and/or CONSOLE lighting control knob are out of the OFF position and any two of the lighting functions fail as follows:

MIP lighting and console lighting,
MIP lighting and flood lighting,
Console lighting and flood lighting.

2.24.2 Interior Lighting Controls. The lighting controls are located on the right console.

2.24.2.1 MIP Knob. The MIP knob is located on the INTR LT panel and controls the intensity of main instrument panel primary lighting.

2.24.2.2 CONSOLE Knob. The CONSOLE knob is located on the INTR LT panel and controls the intensity of the primary on both consoles.

2.24.2.3 FLOOD Knob. The FLOOD knob is located on the INTR LT panel and controls the intensity of all secondary lights with the exception of the map lights.

2.24.2.4 WARN/CAUT DIM Switch. The WARN/CAUT DIM switch is located on forward outboard side of the right console. Momentarily setting the switch to the DIM position dims all

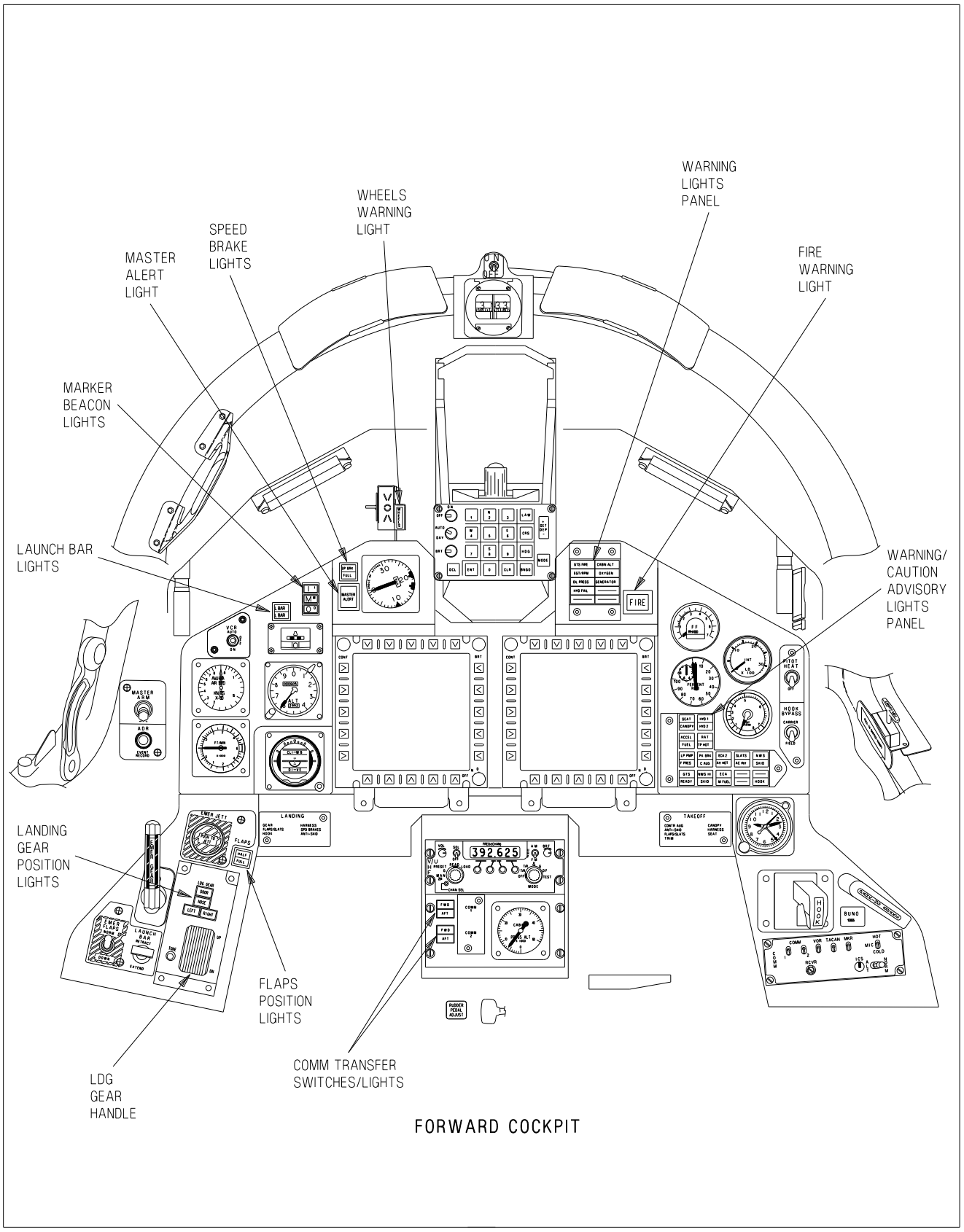

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Figure 2-42. Warning/Caution/Advisory Lights (Forward Cockpit)

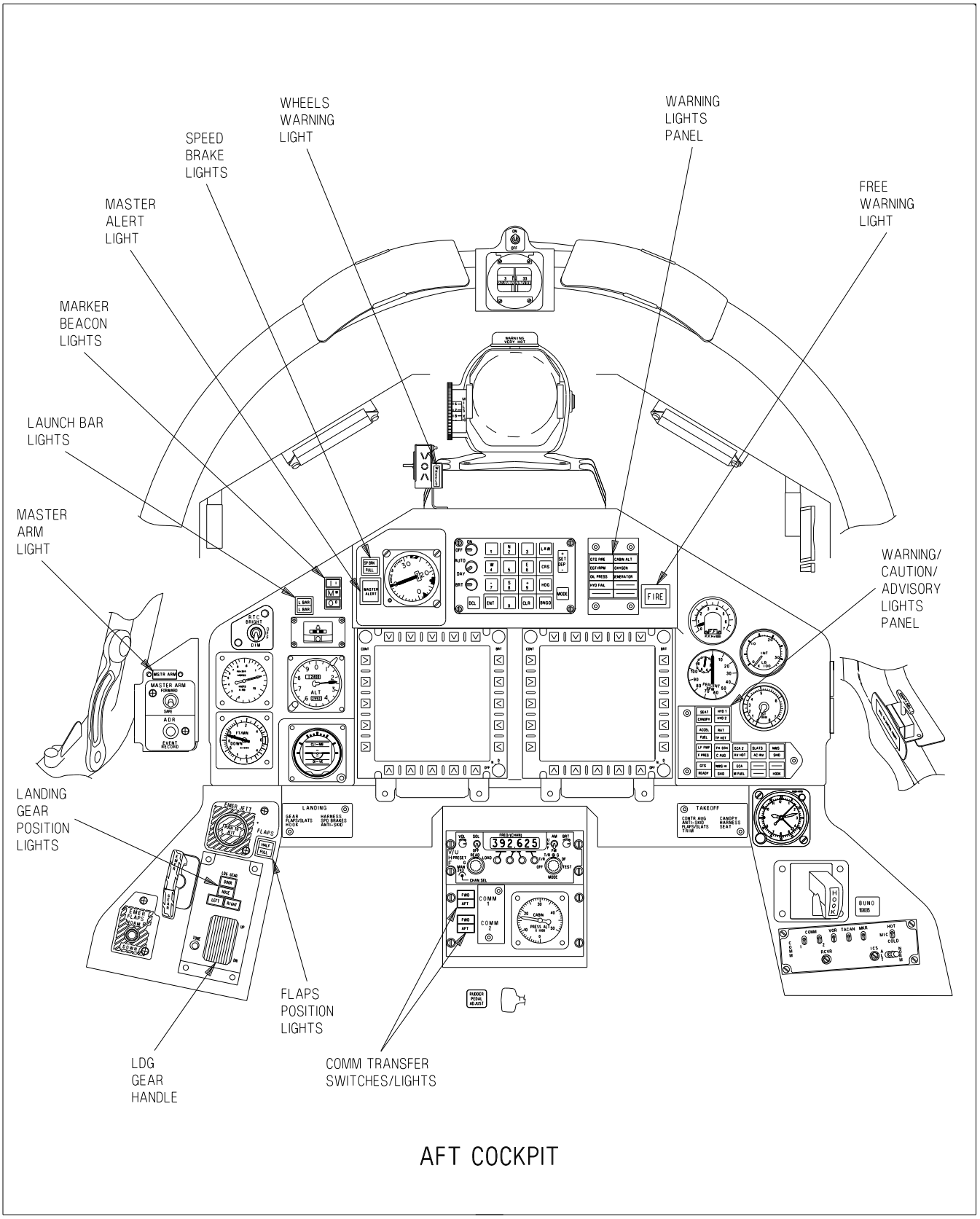

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Figure 2-43. Warning/Caution/Advisory Lights (Aft Cockpit)

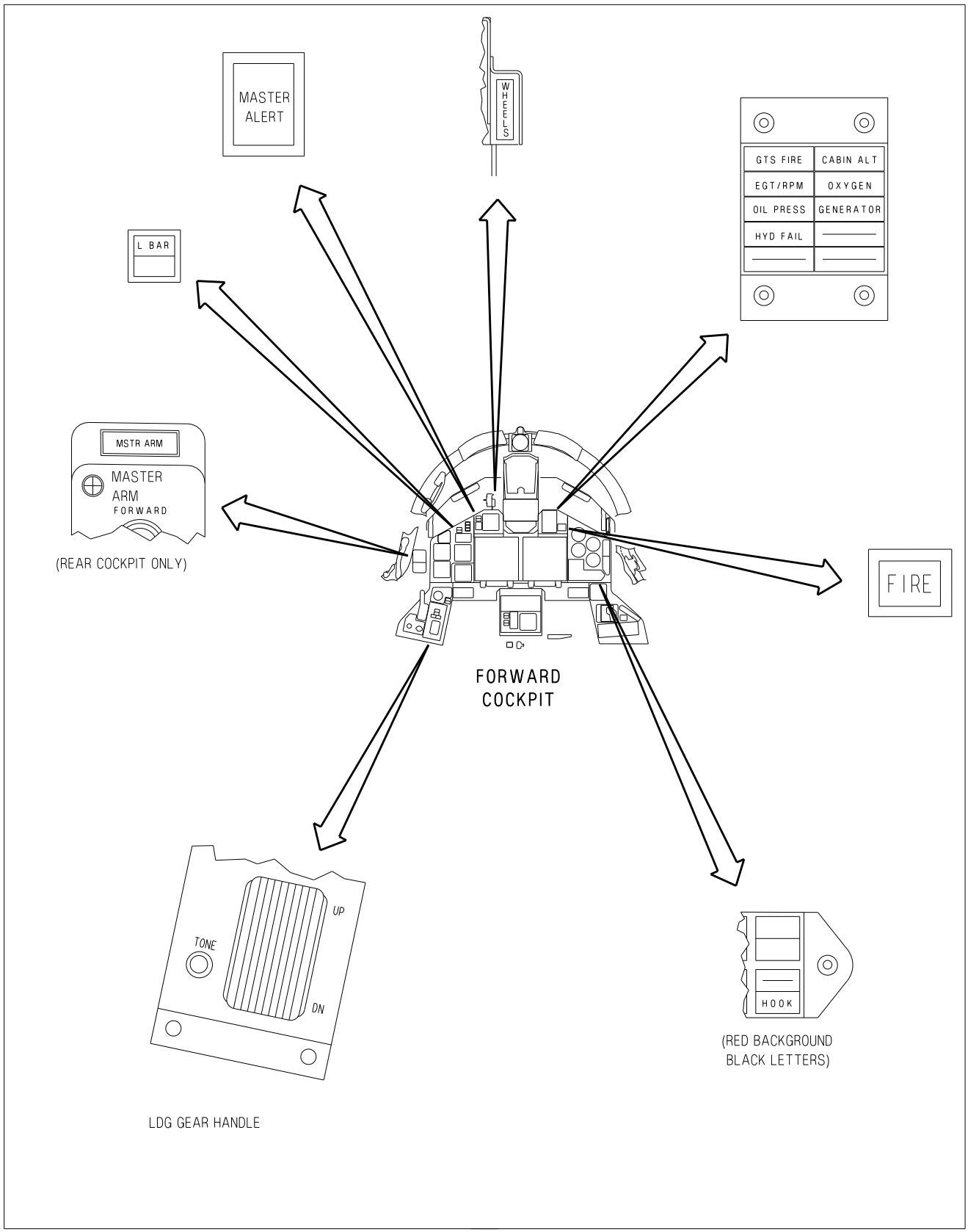

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Figure 2-44. Warning Lights

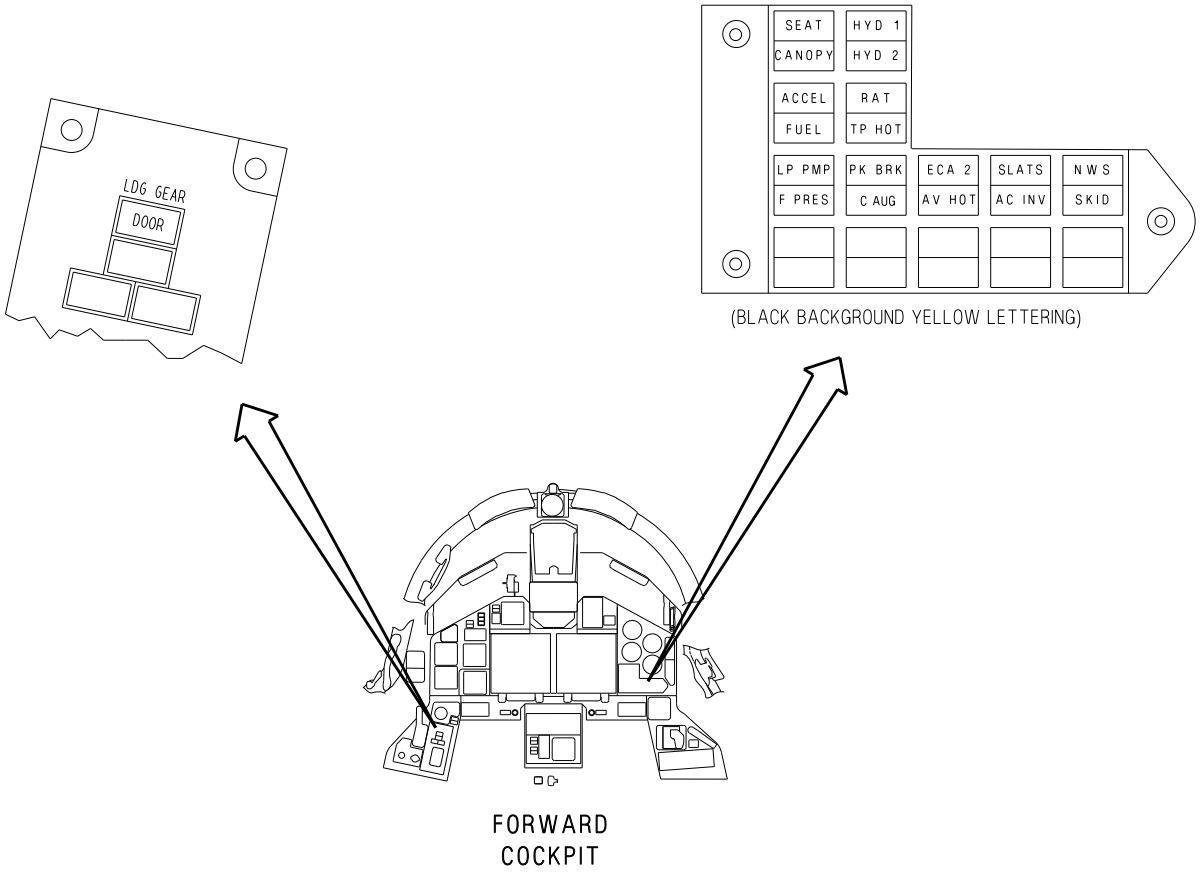

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Figure 2-45. Caution Lights

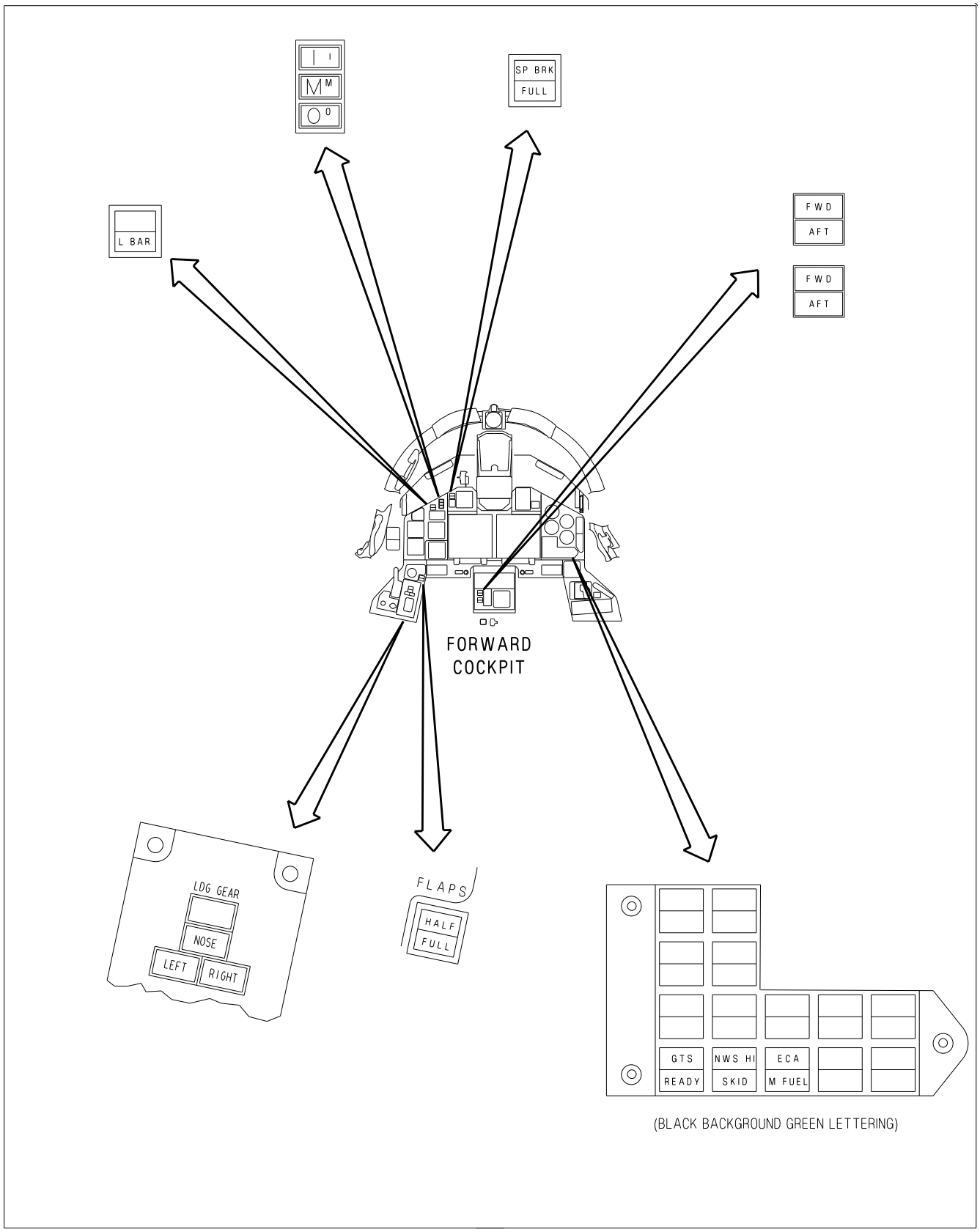

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Figure 2-46. Advisory Lights

warning, caution, and advisory lights. To reset the lights to day lighting, the MIP knob must be set to OFF.

2.24.2.5 Standby Compass Light Switch.

ON	Turns on standby compass integral light, if the PANEL light switch is on.
OFF	Turns off the standby compass integral light.

2.25 EXTERIOR LIGHTING SYSTEM

The exterior lights consist of a landing/taxi light, approach lights, formation lights, navigation lights, anticollision lights. See Figure 2-49.

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 tailcone. The lights are controlled by the WING, TAIL and NAV lights switches, and the External Lights Master Switch.

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. Day or night operation is selected by the MIP, OFF-BRT control knob in the forward cockpit. Placing the control knob in the detented OFF position selects day (bright illumination). With the control knob out of its detented OFF position and the WARN/CAUT DIM SELECT switch to DIM, night (dim) illumination is selected. In addition, the lights are also controlled by the HOOK BYP 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.

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.

2.25.6 Exterior Lights Controls and Indicators.

2.25.6.1 Exterior Lights Master Switch. The three position exterior lights master switch is located on the outboard side of the throttle grip.

On (forward)	Energizes all selected navigation and formation lights to on.
Off (center)	Deenergizes all navigation lights.
On (Aft)	Momentary. Turns on selected navigation lights as long as the switch is held in position. Is spring loaded to off from this position.

2.25.6.2 A-COLL/STROBE Switch. The A-COLL/STROBE switch is located in the front cockpit, on the INT/EXT LIGHTS switch panel.

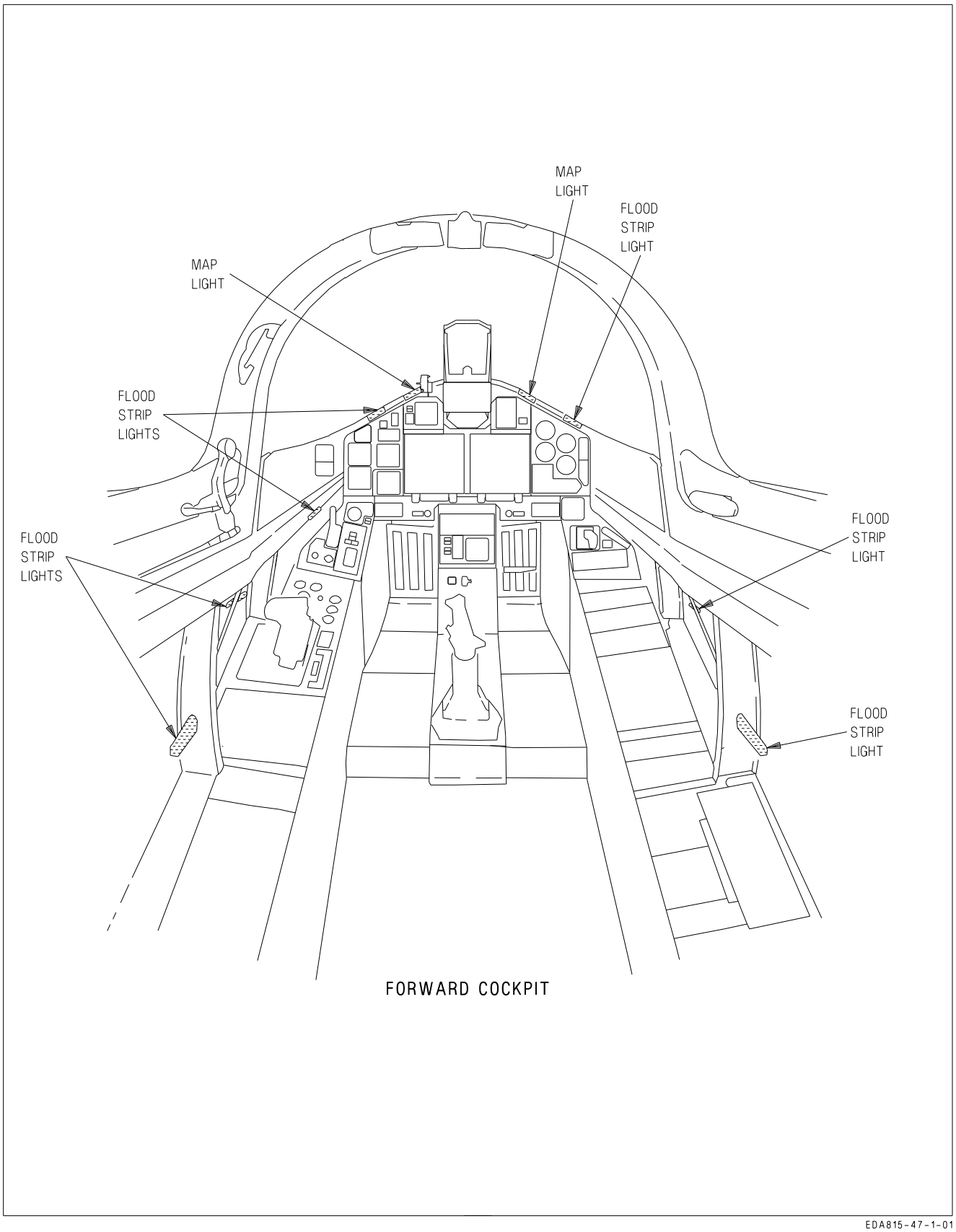


Figure 2-47. Interior Lights and Controls (Forward Cockpit)

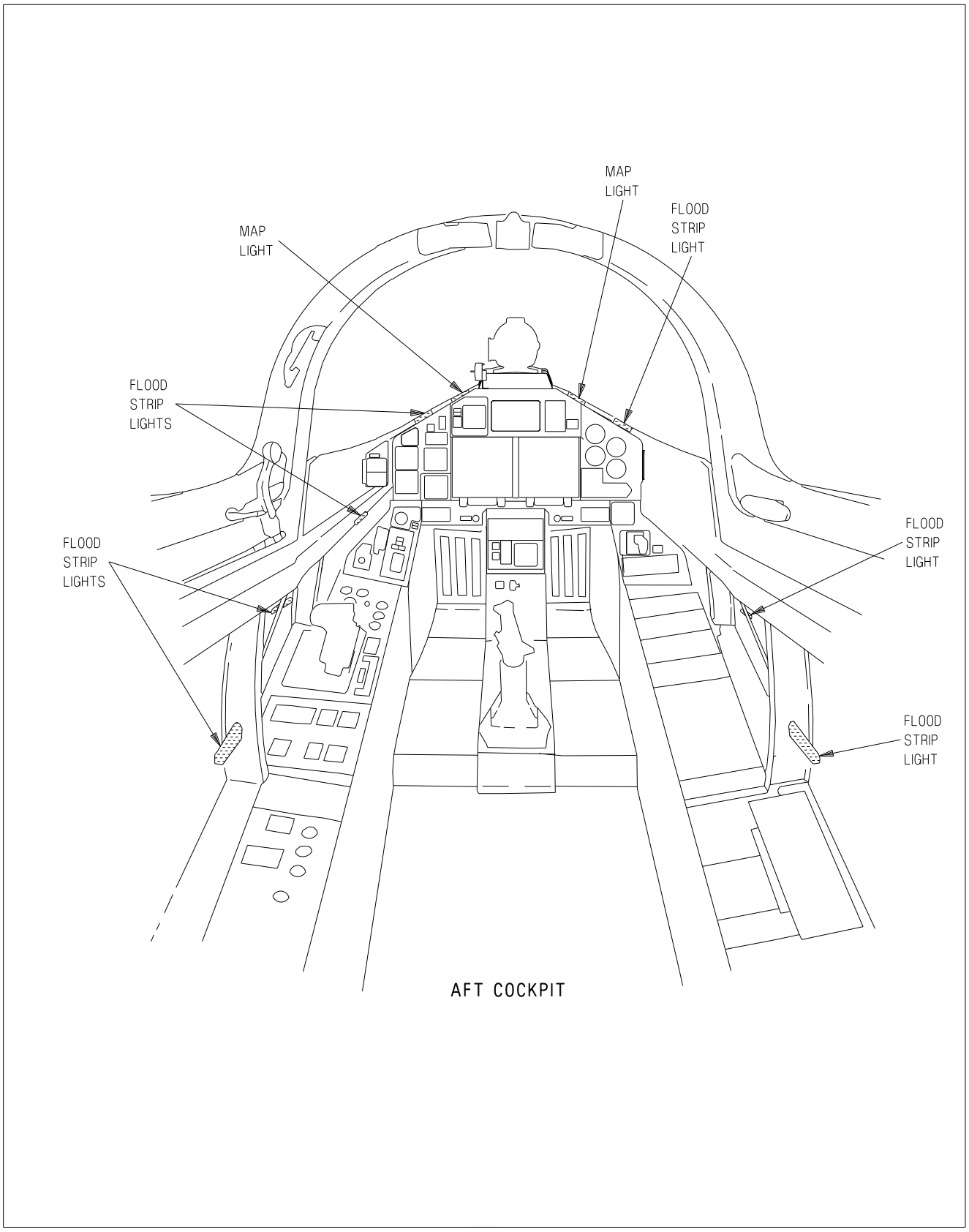


Figure 2-48. Interior Lights and Controls (Aft Cockpit)

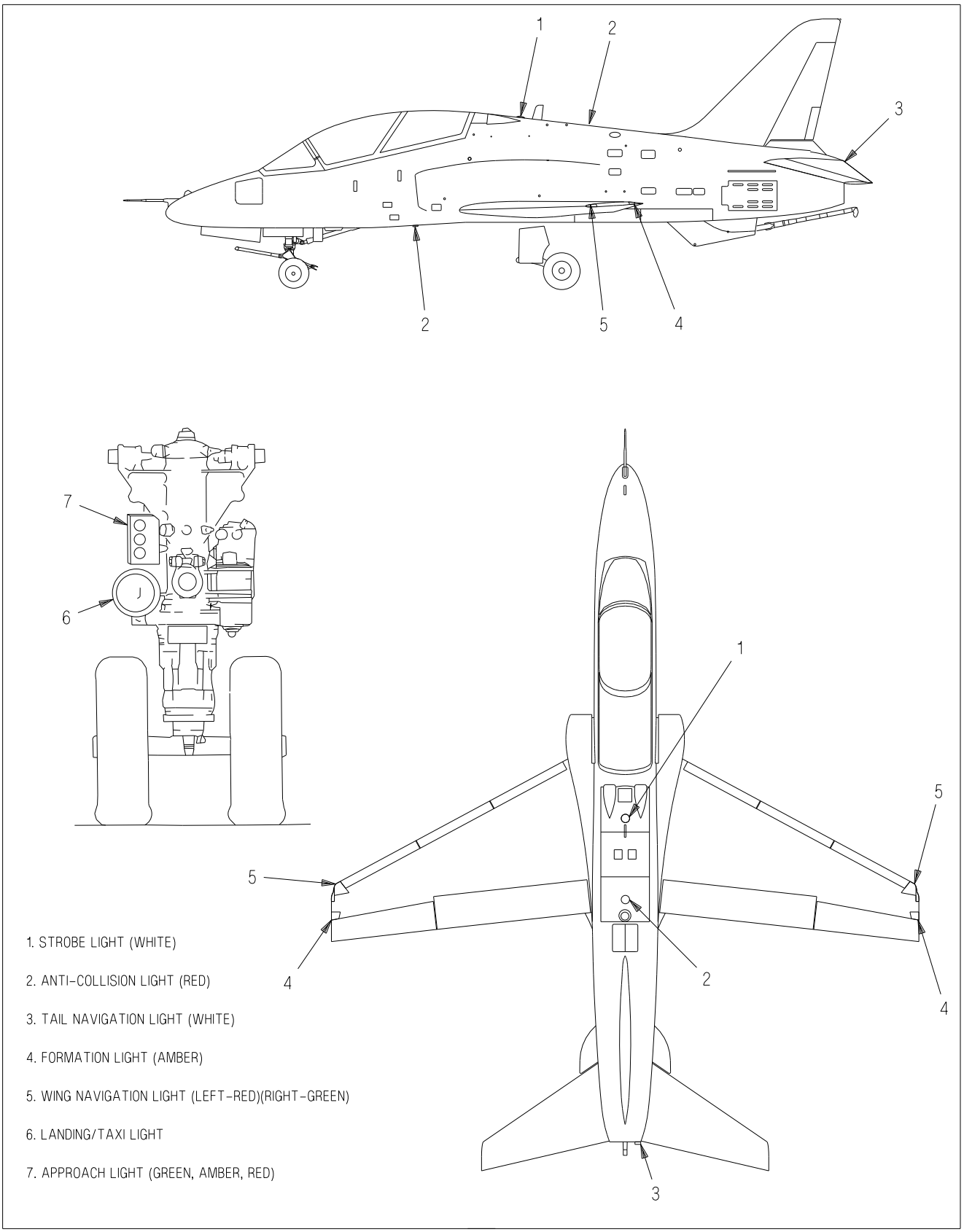


Figure 2-49. Exterior Lights

A-COLL/ STROBE	Turns on both red anti-collision lights and the white strobe light.
A-COLL	Turns on the red anticollision lights.
OFF	Turns off the anti-collision and strobe lights.

2.25.6.3 WING Lights Switch. The WING lights switch is located in the front cockpit, on the right console exterior light switch panel.

BRIGHT	Wing navigation lights operate at full brightness.
OFF	Turns off the wing navigation lights.
DIM	Wing navigation lights operate at reduced intensity.

2.25.6.4 TAIL Lights Switch. The TAIL lights switch is located in the front cockpit, on the right console exterior light switch panel.

BRIGHT	Tail navigation light operates at full brightness.
OFF	Turns off the tail navigation light.
DIM	Tail navigation light operates at reduced intensity.

2.25.6.5 FORMATION Light Switch. The FORMATION lights switch is located in the front cockpit, on the right console exterior light switch panel.

BRIGHT	Formation lights operate at full brightness.
OFF	Turns off the formation lights.
DIM	Formation lights operate at reduced intensity.

2.25.6.6 NAVIGATION Lights Switch. The NAVIGATION lights switch is located in the front cockpit, on the right console exterior light switch panel.

FLASH	Wing and/or tail navigation lights flash if selected.
STEADY	Wing and/or tail navigation lights operate steady if selected.

2.25.6.7 LANDING/TAXI Light Switch. The LANDING/TAXI light switch is located in the front cockpit, on the right console exterior light switch panel.

ON	Turns on the landing/taxi light if the LDG GEAR handle is in the DN position, and the landing gear is down and locked.
OFF	Turns off landing/taxi light.

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.

Four types of BIT are mechanized: power up BIT (PBIT), initiated BIT (IBIT), manual BIT (MBIT), and continuous BIT (CBIT). PBIT

provides the most extensive BIT and is automatically initiated following application of electrical power with weight-on-wheels. PBIT occurs prior to normal operation of the equipment with the status reported to the DEU. IBIT is similar to PBIT, but less extensive. IBIT requires initiation by the pilot and can only be performed with weight-on-wheels, since it interrupts the normal operation of the equipment. IBIT will reset previously stored failures. Those systems which have associated audio tones, the tones will be annunciated during IBIT. MBIT, utilized by some avionic equipment, interrupts normal operation and requires operator initiation and observation. The results requiring observation may not be reported on the BIT display. CBIT is the least extensive form of BIT, and is performed as background testing by the avionic equipment during normal operation. CBIT status is reported the same as IBIT. The following list identifies the types of BIT available for the various avionic equipment.

ADR	PBIT, IBIT, CBIT
DEP	MBIT (Part of display IBIT)
DEU	PBIT, IBIT (display IBIT)
ECA	CBIT
GINA	PBIT, IBIT, CBIT
HUD	MBIT (Part of display IBIT)
IFF	CBIT, MBIT
MDL	PBIT, IBIT, CBIT
MFD	CBIT, MBIT (Part of display IBIT)
RALT	IBIT
SADS	CBIT
TACAN	MBIT
UHF/VHF COMM	MBIT, CBIT
VOR/ILS	MBIT
YDS	CBIT, IBIT

2.26.1 BIT Display. The MENU selectable BIT display provides status of all avionic subsystems/equipment for which BIT status is available and options for: initiating BIT on the various avionic subsystems/equipment, stopping an initiated BIT, accessing the MANT (maintenance) display, and turning on/off power to the GINA and RALT, see Figure 2-50. The options for initiating and stopping BIT are only displayed when the aircraft is weight-on-wheels, and the subsystem/equipment is available for BIT (operating and communicating). In addition, the GINA option will not be displayed unless the parking brake is set, and the ADR IBIT is inhibited (option removed) if the engine is rotating. Status messages are displayed next to the avionic subsystem/equipment legend on the MFD. The status messages provide actual avionic status reporting (real time) as it is provided to the DEU from the avionic equipment. The failure status may be removed by performing an IBIT on the avionic equipment, this removes the stored failures, runs the IBIT, and reports the status from the IBIT. The following list identifies the messages used for each avionic equipment:

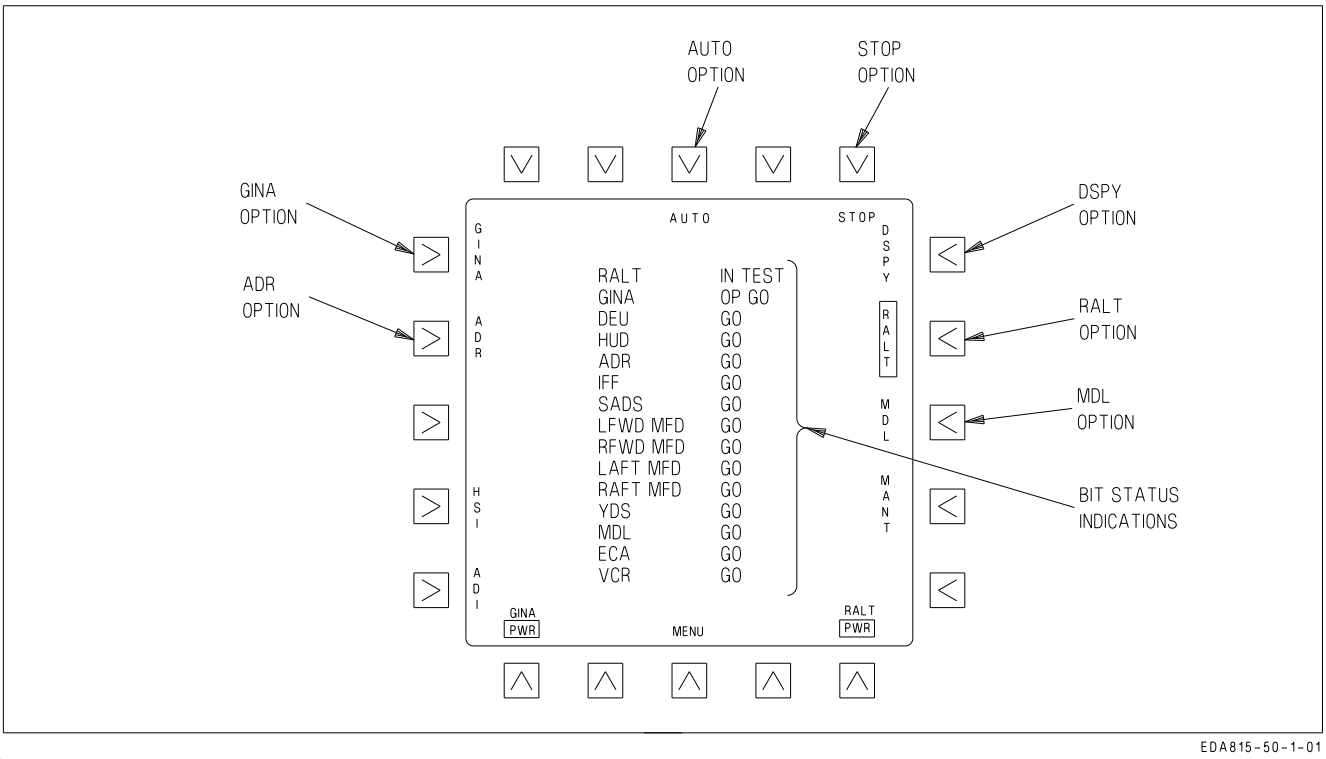


Figure 2-50. BIT Display

SUBSYSTEM/ EQUIPMENT	STATUS MESSAGE
RALT	GO, DEGD, IN TEST
GINA	GO, OPGO, DEGD, IN TEST
DEU	GO, DEGD, OVRHT
HUD	GO, DEGD
ADR	GO, OPGO, DEGD, IN TEST
IFF	GO, DEGD
SADS	GO, DEGD
LFMFD	GO DEGD
RFMFD	GO DEGD
LAMFD	GO, DEGD
RAMFD	GO, DEGD

SUBSYSTEM/ EQUIPMENT	STATUS MESSAGE
YDS	GO, DEGD
MDL	GO, OPGO, DEGD, IN TEST
ECA	GO, DEGD
VCR	GO, DEGD

The following list provides a description of the BIT status messages and lists them in order of their priority:

IN TEST	IBIT testing is in progress
OVRHT	DEU indicates an overheat condition
DEGD	Equipment indicates BIT failure, or equipment OFF or not installed, or no response on either mux bus channel

OPGO	Mux bus responding on only one mux bus channel, but no BIT failure indication
GO	Avionic equipment operating and no BIT failure indications on both mux bus channels

The AV BIT advisory will be displayed whenever an overheat (OVRHT) or DEGD status is reported. If the GINA, ADR, RALT, or MDL BIT option(s) is/are selected, the STOP option will be displayed. Selecting the STOP option terminates the selected BIT and unboxes that option.

2.26.2 AUTO IBIT. AUTO BIT permits the pilot to perform IBIT on several avionic systems without requiring selection of each IBIT separately. Upon selection of the AUTO option the option will be boxed and the DEU will enter IBIT. Upon successful completion of the DEU IBIT the ADR, GINA and MDL will enter IBIT simultaneously. The RALT will enter IBIT as soon as the ADR IBIT is complete. TEST will be displayed next to each legend when the AUTO is selected and as each IBIT is completed the status message will be updated.

NOTE

The ADR will not go into IBIT once the engine started, ADR IBIT option is blanked with RPM above 30% N_2 (it will not interrupt recording).

If an AUTO BIT is initiated the GINA will begin a realignment. Alignment will be complete 3 minutes after AUTO BIT is complete.

The AUTO option will be available only if there are initiated BIT options for DSPY, ADR, GINA, RALT, and MDL. If the engines are turning or the parking brake is not set, AUTO will not be displayed.

2.26.3 Display (DSPY) BIT. DSPY BIT is a combination of IBIT and MBIT. IBIT is performed on the DEU and upon completion of the DEU BIT the HUD and MFDs are commanded to display their respective test patterns. If the DEU fails BIT, DSPY BIT is halted and the MFDs will return to the BIT display. If the DEU passes BIT, from this point on the BIT is MBIT, requiring the pilot to observe the test pattern and manually press the buttons on each MFD. See Figure 2-51 for the HUD BIT TEST and MFD BIT TEST patterns. Display repeater mode is automatically deselected upon initiation of the DSPY BIT.

1. Ensure HUD power knob is set to ON.

2. Adjust the brightness of the HUD.

3. Select MENU, BIT, and then the DSPY option. The DEU will be commanded into BIT and the MFDs and HUD will be blanked.

4. DEU will complete BIT and the HUD and MFDs display their respective test patterns.

5. Adjust the MFD display

   a. Rotate the CONT knob to the minimum setting.

   b. Increase the brightness (BRT knob) until the display background begins to turn green

   c. Decrease the display brightness until the green is removed from the display background

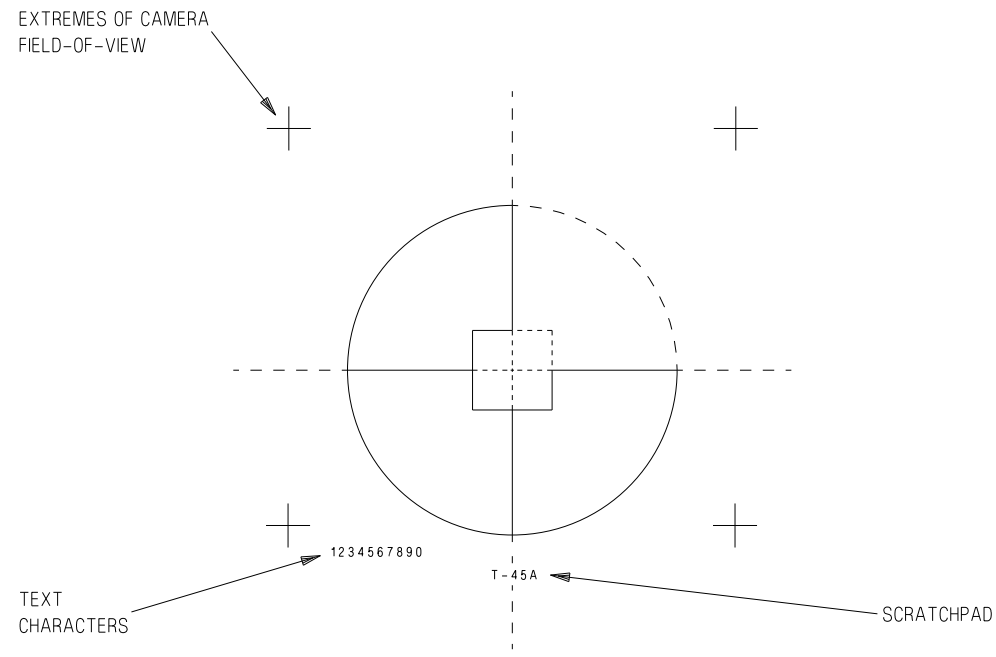
   d. Increase the contrast until 16 distinct shades of gray are visible on the gray scale.

6. Check HUD test pattern

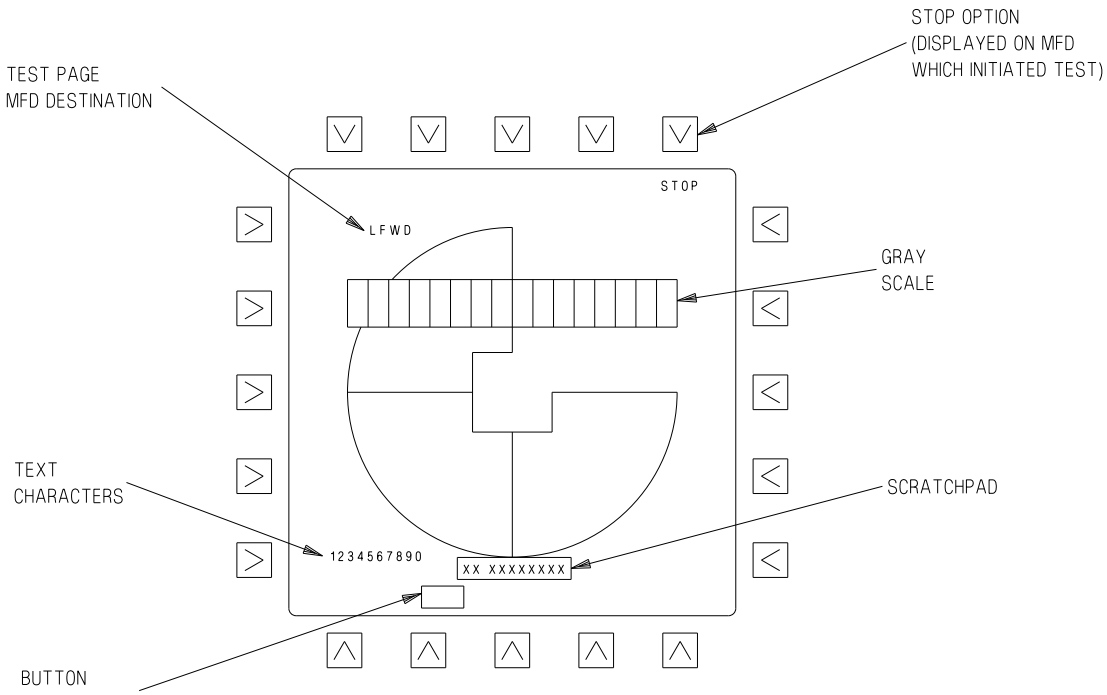
   a. Ensure the test pattern is steady, in focus, and centered horizontally on the HUD.

   b. Verify the display matches the test pattern in Figure 2-51.

   c. Ensure the scratchpad displays T-45A, the text characters are displayed and they are symmetrical and in focus.



HUD BIT TEST



MFD BIT TEST

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Figure 2-51. HUD/MFD BIT Test Displays

7. Check each MFD test pattern

   a. Ensure the test pattern is steady, in focus, and centered in the display.

   b. Ensure the test pattern matches the test pattern in Figure 2-51.

   c. Verify the gray scale and ensure the 16 blocks present a progressively lighter green than the previous block as checked left to right.

   d. Ensure the test page destination displayed matched the display location.

   e. Ensure the text characters are displayed, and are symmetrical and in focus.

If option buttons and DEP buttons test desired -

8. Perform the DSPY Interactive Test.

If option buttons and DEP test not desired -

7. Select the STOP option on the MFD or press the CLR button on the DEP.

8. Ensure HUD and each MFD displays GO.

2.26.3.1 DSPY Interactive Test (Optional).

1. Complete DSPY BIT.

2. Press and release each push button on the DEP.

3. Ensure the HUD scratchpad displays the correct DEP operation.

DEP BUTTONS	DISPLAY
1 thru 0	1 thru 0
DCL	DCL
ENT	ENT
LAW	T-45A
CRS	T-45A
HDG	T-45A
BNGO	T-45A
SET DEP +	SETDEP +
SET DEP -	SETDEP -

NOTE

Ensure you do not press the MODE or CLR buttons during the test. Selecting MODE will initiate boresight entry and selecting CLR will end the test.

4. Select each option button around each MFD. Ensure the button test symbol is displayed next to the option button selected.

5. Select the STOP option displayed on the MFD from which DSPY IBIT was initiated or press the CLR button on the DEP.

6. Ensure HUD and each MFD displays GO.

2.26.4 CONTR AUG BIT. The CONTR AUG BIT (IBIT) is a self test of the YDC to verify the proper operation of the rudder control system. The DEU provides YDS status based upon a discrete signal received from the caution warning system electronic unit (CWSEU). The CWSEU sends a signal to the DEU whenever it illuminates the C AUG caution light (YDS failure, OFF, or in BIT). The DEU then sets the YDS status to DEGD and displays the DEGD status. Since the DEU does not monitor the YDS directly or its operation mode (ON, OFF, or in BIT), the YDS status is based on the CWSEU C AUG caution light command. The CWSEU has a built in delay before it illuminates the C AUG caution light, however, it does not delay in reporting YDS status to the DEU. Therefore, the C AUG caution light must be used during BIT to determine the correct status of the YDS. After a successful completion of the YDS BIT, the AV BIT advisory may need to be cleared.

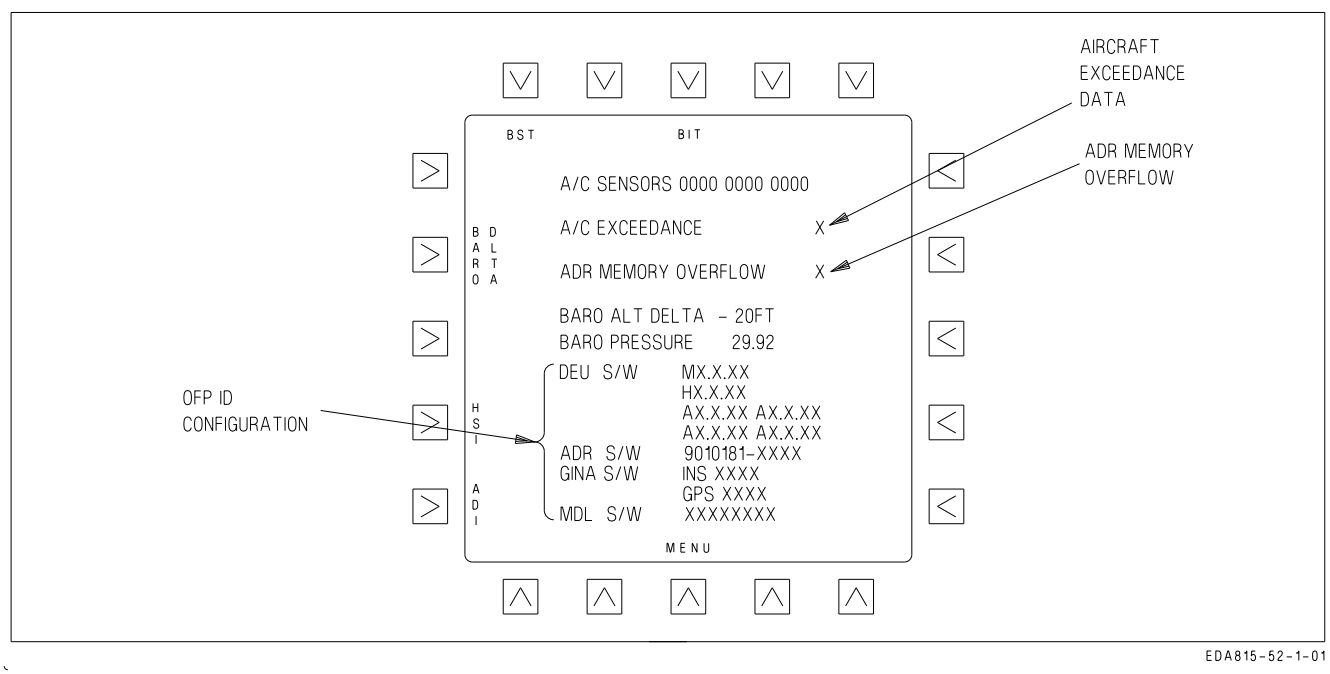

Figure 2-52. MAINT Display

The IBIT must be performed with weight-on-wheels, flaps up, and airspeed below 80 knots.

NOTE

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

1. Paddle switch - MOMENTARILY PRESS
   C AUG caution light illuminates.

2. FLAPS/SLATS lever - UP

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

4. CONTR AUG switch - SBI TO ALL
   C AUG caution light illuminates for maximum of 120 seconds then out.

5. YDS BIT status - DEGD THEN GO
   DEGD will be displayed while the C AUG caution light is illuminated, and will change to GO when the C AUG light is extinguished.

WARNING

Initiating the CONTR AUG cycles the rudder and rudder tab. Ensure the YDS BIT is complete prior to takeoff.

2.26.5 Software Configuration. The software configuration for the avionic equipment is controlled by assigning operational flight program (OFP) numbers to the software load of each individual piece of equipment. All subsequent releases (updates) to the software loads (OFP) will be assigned a new OFP number. The OFP numbers for the avionic equipment installed in the aircraft are displayed on the MANT display. Prior to flight the OFP numbers should be checked to verify that valid OFP are installed in

the aircraft and that they are compatible. See Figure 2-52.

2.26.6 MANT Display. The MANT (maintenance) display is selectable from the BIT display only with weight-on-wheels, see Figure 2-52. The display provides the following maintenance data: aircraft sensor health, aircraft exceedance, ADR memory overflow, barometric altitude delta (correction), barometric pressure setting, and avionic OFP identification. In addition, the display provides a BST option for entry of boresight data, and a BARO DLTA (barometric delta) option for entry of the barometric altitude correction factor. The BIT, HSI, and ADI options when pressed will select their respective displays. The BST and BARO DLTA options are provided for use by maintenance personnel and should require adjustment only after an air data system component (SADS, DEU, or static pressure plumbing) or GINA is replaced.

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. See Forward Cockpit foldout, FO-3 and Aft Cockpit foldout, FO-5.

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. See Forward Cockpit foldout, FO-3 and Aft Cockpit foldout, FO-5.

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. See Figure 2-53.

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. Loading is accomplished by unlatching the nose and tail cones and inserting baggage through the front or rear of the main body. See Figure 2-54.

CAUTION

To prevent damage to latches, the bottom latches should be unlocked first when opening the pod and the top latches should be secured first when closing the pod.

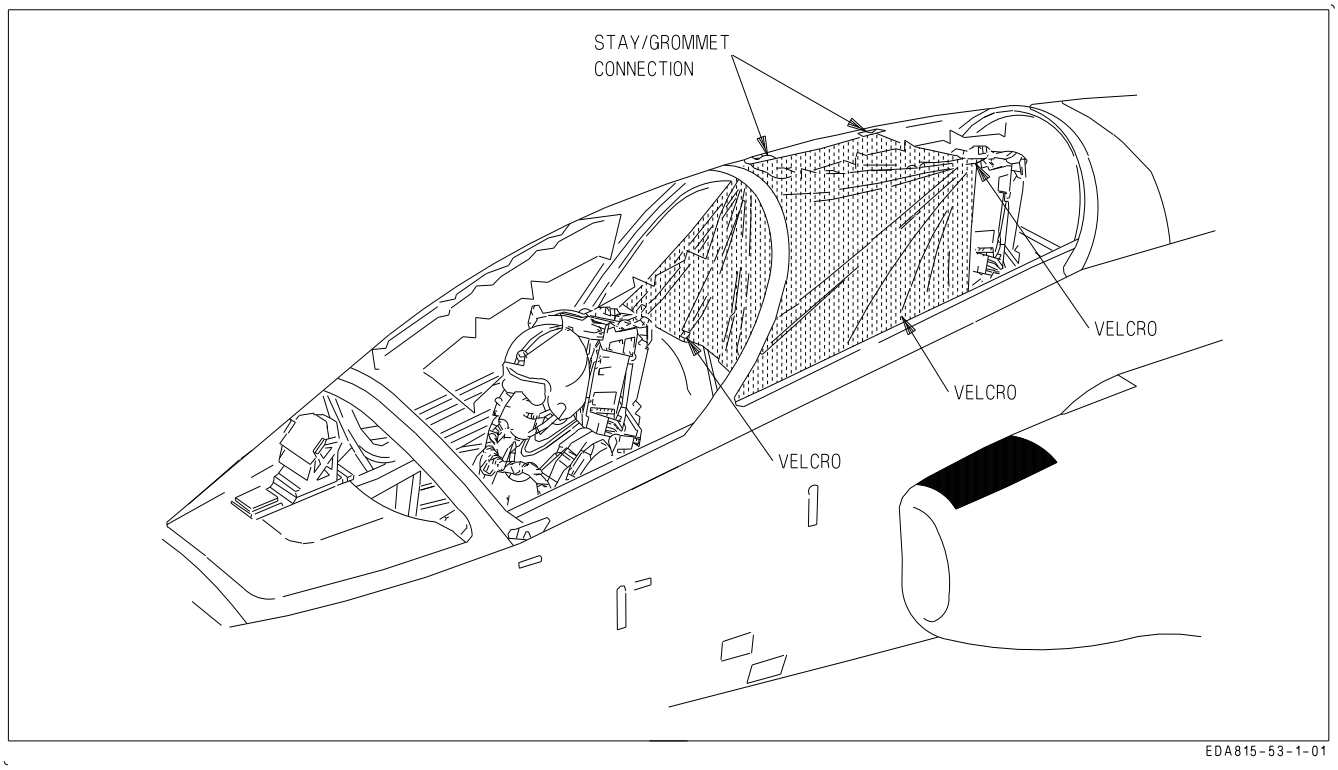

Figure 2-53. Instrument Training Hood

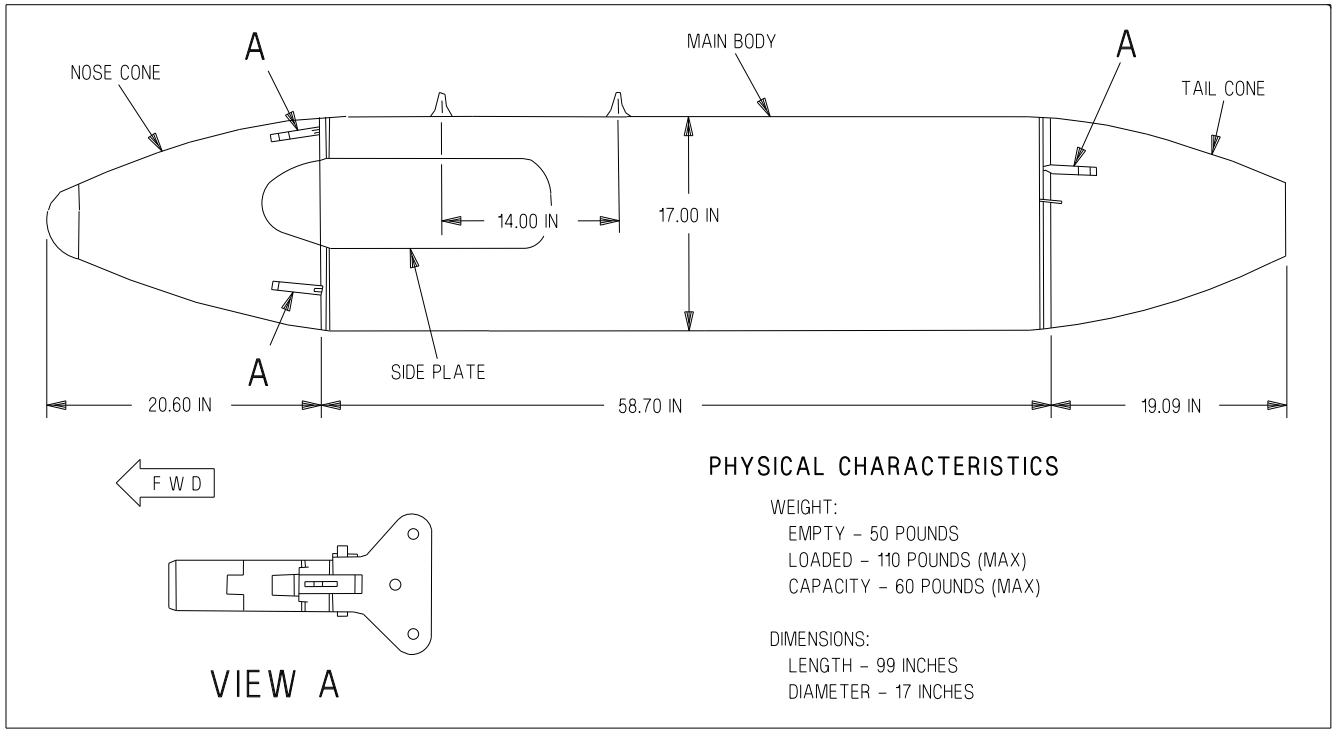

Figure 2-54. External Baggage Container

CHAPTER 3

Servicing and Handling

3.1 GENERAL

Servicing information is presented to cover operation at a strange field where ground personnel are unfamiliar with the aircraft. In such cases, the pilot may have to direct or assist personnel in accomplishing aircraft turnaround.

NOTE

The flight manual is not intended to be a maintenance manual. For detailed maintenance information, refer to the appropriate chapters of the organizational maintenance instructions manual.

UNIT	SPECIFICATION REQUIREMENT	COMMERCIAL (HOME BASE)	USN*	USAF*	NATO*
Electric Carts	28vdc/300 Amp	321105	NC-8 NC-10, N-12, NC-8A	NC-8A	NC-8A
Hydraulic Servicing Units		G8A5-J1000-1	XAS1832A	XAS1832A	XAS1832A
Oil Servicing Units		G1A108J1-1	PON6	PON6	PON6
Nitrogen Servicing Units		322AS100-1	NAN 3	NAN 3	NAN 3
Automatic Pressure Gauge		GA477A			
* These units are examples of support equipment that meet or exceed desired servicing specifications. Any unit that meets specification requirements can be used.					

Figure 3-1. Servicing Units

CONSUMABLE	FUEL TYPE	MILITARY	NATO	UK	COMMERCIAL	CAPACITY
FUEL:						
PRIMARY [2]	HIGH FLASH KEROSENE	MIL-T-5624 (JP-5)	F-44	AVCAT/FSII	NONE	2,904 LBS
	KEROSENE	MIL-T-83133 (JP-8) [4]	F-34 [1]	AVTUR/FSII	NONE	2,861 LBS
RESTRICTED	WIDECUT	MIL-T-5624 (JP-4) [4]	F-40 [1]	AVTAG/FSII	NONE	2,776 LBS
EMERGENCY [3]	KEROSENE	NONE	F-35 [1]	AVTUR	JET A-1	2,861 LBS
	KEROSENE	NONE	NONE	NONE	JET A [5]	2,861 LBS
	WIDECUT	NONE	NONE	AVTAG	JETB	2,776 LBS
OIL:						
ENGINE		MIL-L-23699 (MIL-L-7808)	0-156 (0-150)		MOBILE JET II (3 CST)	10 PINTS
GTS						3.55 PINTS
AIR TURBINE STARTER						1.75 PINTS
HYDRAULIC FLUID:		MIL-H-83282	H-537	OX-19	OX-19	
HYD 1						3.3 GAL
HYD 2						1 GAL

NOTES:

[1] Any aircraft scheduled for immediate sea duty shall be fueled with F-44 (JP-5) ONLY. WARNING: Turbine fuels other than F-44 (JP-5) present a greater fire risk to shipboard operations.

[2] Primary Fuels are those for which the aircraft and engine were designed to use on a continuous basis without any operational restrictions.

[3] Emergency Fuels are those which may cause airframe or engine components to malfunction. The fuels listed in this category are commercial jet fuels and the reason they are listed here is that they do not normally contain the following additives:

a. Fuel System Icing Inhibitor (FSII). This additive prevents the formation of water ice in the fuel which can block the engine fuel filter. It also acts as a biostat preventing the development of microbiological contamination in the aircraft fuel system during periods of inactivity.

b. Corrosion Inhibitor/Lubricity Improver. This additive improves the long term durability of the aircraft and engine fuel system by increasing the lubricity of the fuel.

Once these additives are injected into Jet A or Jet A-1 the resultant fuel is essentially identical to JP-8 and can be used without restrictions as a Primary Fuel. Since Jet B blended with these additives is essentially identical to JP-4, it may be used as a Restricted Fuel. Sometime the designations Jet A+, Jet A-1+ and Jet B+ are unofficially used to designate commercial jet fuels which have been treated with additives. The exact meaning of this designation must be confirmed with the fuel supplier.

[4] The basic physical and chemical properties of these military fuels are similar to those of the listed commercial fuels; however, the commercial fuels do not normally contain the necessary additives. See note 4 above.

[5] Jet A fuel will solidify if chilled to temperatures below -40 °C compared to -46 °C for JP-5 and -47 °C for JP-8.

Figure 3-2. Consumables

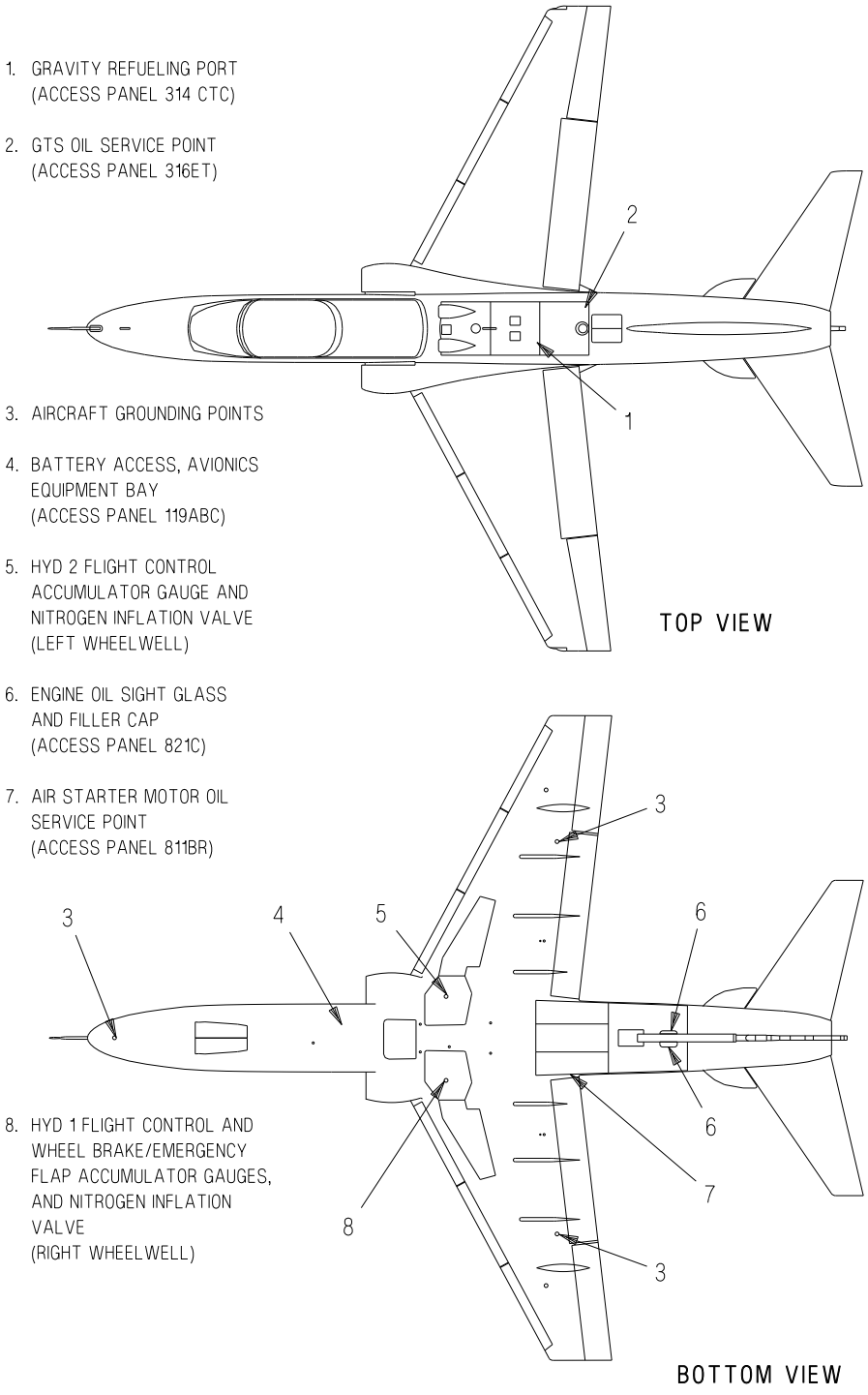

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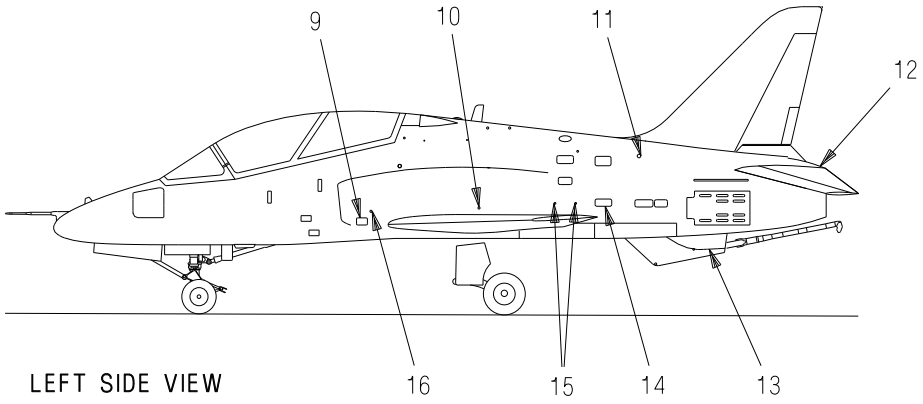
Figure 3-3. Servicing Points (Sheet 1 of 2)



9. PRESSURE REFUELING/ DEFUELING COUPLING AND CONTROL PANEL (ACCESS DOOR 311EL)
10. DEFUEL VALVE KEYHOLD
11. HYD 2 RESERVOIR GAUGE
12. FUEL VENT
13. ARRESTING HOOK DAMPER PRESSURE GAUGE AND SERVICE POINT
14. HYD 2 EXTERNAL CHARGING PANEL (ACCESS DOOR 319BL)
15. HYD 2 FILTER INDICATORS
16. AIRCRAFT GROUNDING POINT
17. EXTERNAL ELECTRICAL POWER RECEPTACLE (ACCESS DOOR 310CR)
18. HYD 1 HAND PUMP (ACCESS DOOR 310ER)
19. HYD 1 FILTER INDICATORS
20. HYD 1 EXTERNAL CHARGING PANEL (ACCESS DOOR 318BR)
21. HYD 1 RESERVOIR GAUGE
22. GTS OIL QUANTITY GAUGE

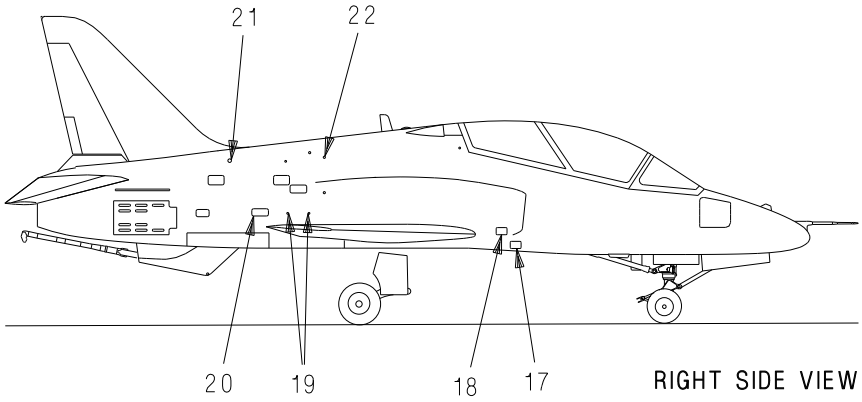


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Figure 3-3. Servicing Points (Sheet 2 of 2)

3.2 REFUELING

The aircraft may be serviced with approved fuel by either the pressure fueling method or the gravity fueling method.

WARNING

- Perform all fueling operations in a well ventilated area.
- Stop all maintenance on aircraft during fueling operations.
- Ensure adequate grounding of aircraft and fueling equipment.
- Ensure that no electrical or electronic equipment is operating in the area.
- Ensure that adequate fire fighting equipment is in the immediate area of the fueling operation.
- If fuel discharges from the fuel vent in the tail cone, stop fueling immediately.

NOTE

- The engine is capable of functioning normally with any mix of acceptable fuel grades with no engine adjustment.
- While there is a filter in the engine fuel system, there are no related system checks for the aircrew or turnaround crew to accomplish. A clogged filter will be bypassed by fuel system plumbing. Scheduled maintenance action is required to service the filter system.

3.2.1 Pressure Refueling. The pressure refuel/defuel coupling (single point refueling receptacle) permits single point pressure fueling or defueling of the aircraft. The refueling tanker can refuel at a rate of up to 180 US gpm with a pressure up to 50 psi. The fuel system may be defueled through either the drain valve in the left main landing gear wheel well or the refuel/defuel coupling at a suction pressure of 11 psi. See Figure 3-4. Perform the pressure fueling in the following sequence.

NOTE

Aircraft cannot be pressure fueled without electrical power available. If aircraft electrical power is not available, external power can be used.

1. Ensure that throttle is in the OFF position.
2. Ensure that defueling valve is in the CLOSED position and defueling key removed.
3. Open access door 311EL.
4. Test and record refueling tanker quantity gauge and set flowmeter to zero.
5. Connect tanker grounding cable to static grounding point and aircraft grounding points.
6. Remove blanking caps from refuel/defuel coupling.
7. Connect nozzle grounding jack to aircraft grounding receptacle. Attach nozzle to refuel/defuel coupling.
8. Ensure main refueling switch is set to REFUEL.

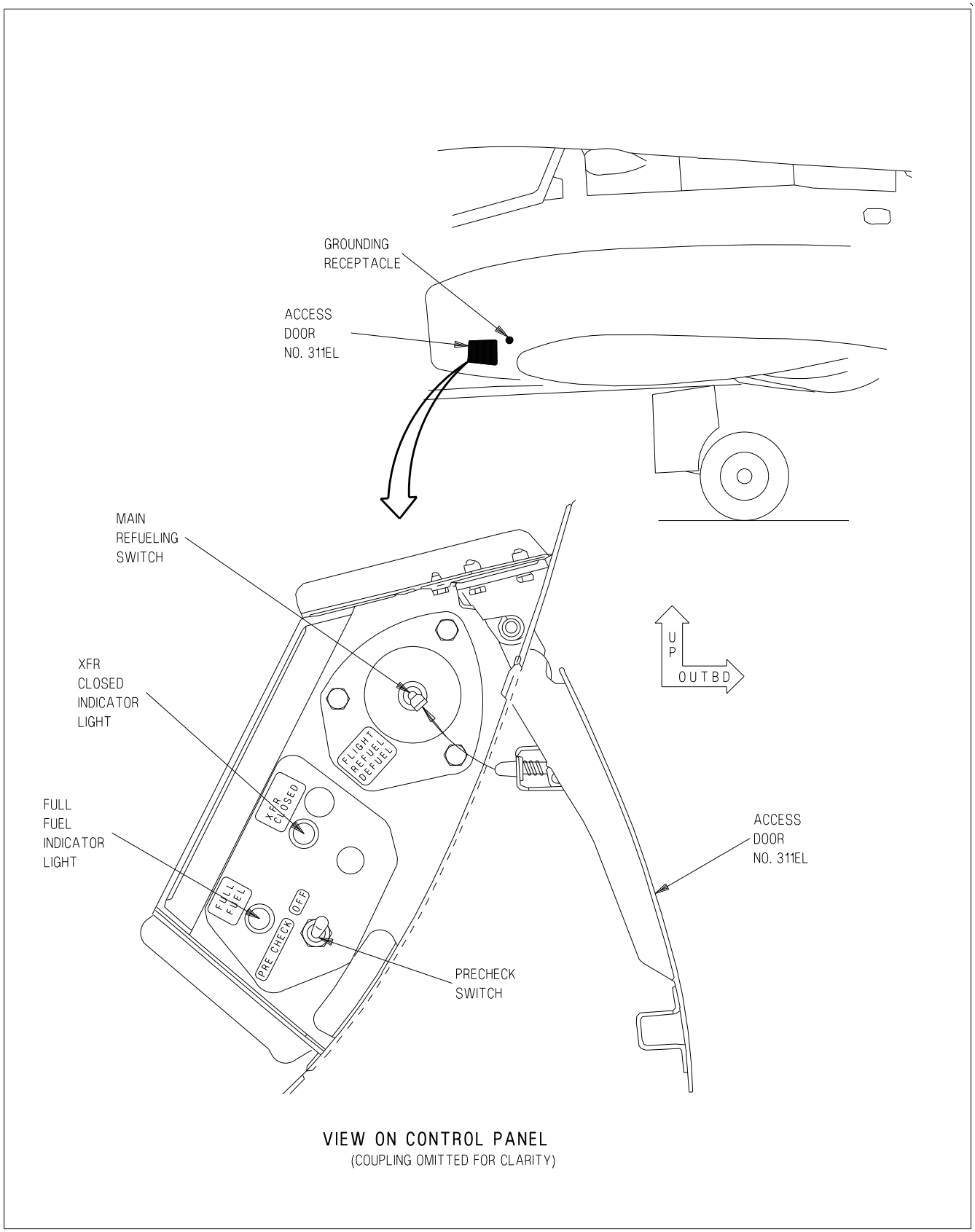

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Figure 3-4. Pressure Refueling

9. Verify the XFR CLOSED light illuminates within 2 seconds.

CAUTION

If the XFR CLOSED light does not illuminate, discontinue refueling procedure; one or both transfer valves may be open, resulting in a fuel spill.

10. Place tanker control in REFUEL position and start to pump fuel.

11. Press and hold PRE CHECK switch and verify the below:

    a. Fuel flow reduces to 5 gpm or less within 10 seconds.

    b. The FULL FUEL light illuminates when nozzle pressure increases above 17 psi.

    c. Release PRE CHECK switch.

    d. FULL FUEL light extinguishes and fuel flow returns to normal.

12. Verify that air is being exhausted from fuel vent on the tail cone. If fuel is discharged, discontinue refueling immediately.

13. Continue refueling until fuel flow automatically stops.

14. Verify FULL FUEL light is illuminated.

NOTE

The FULL FUEL light extinguishes when refueling pressure is removed from the aircraft.

15. Place tanker valve in OFF position. Remove nozzle and disconnect nozzle grounding jack from aircraft grounding receptacle. Install cap on refuel/defuel coupling and align yellow marks. Install sealing cover on nozzle.

16. Disconnect tanker grounding cable from aircraft grounding point and static grounding point.

17. Close and secure access door 311EL.

3.2.2 Hot Refueling. See Figure 3-5. Perform hot refueling in the following sequence.

CAUTION

- The aircraft shall not be hot refueled by the gravity fueling method.
- Due to the close proximity of the pressure refuel/defuel coupling to the left engine intake, ground crew shall remain clear and aft of engine intake during hot refueling operations.

1. Ensure that defueling valve is in the CLOSED position and defueling key removed.

2. Open access door 311EL.

3. Test and record refueling tanker quantity gage and set flowmeter to zero.

4. Connect tanker grounding cable to static grounding point and aircraft grounding points.

5. Remove blanking caps from refuel/defuel coupling and sealing cover from nozzle.

6. Connect nozzle grounding jack to aircraft grounding receptacle. Attach nozzle to refuel/defuel coupling.

7. Ensure main refueling switch is set to REFUEL.

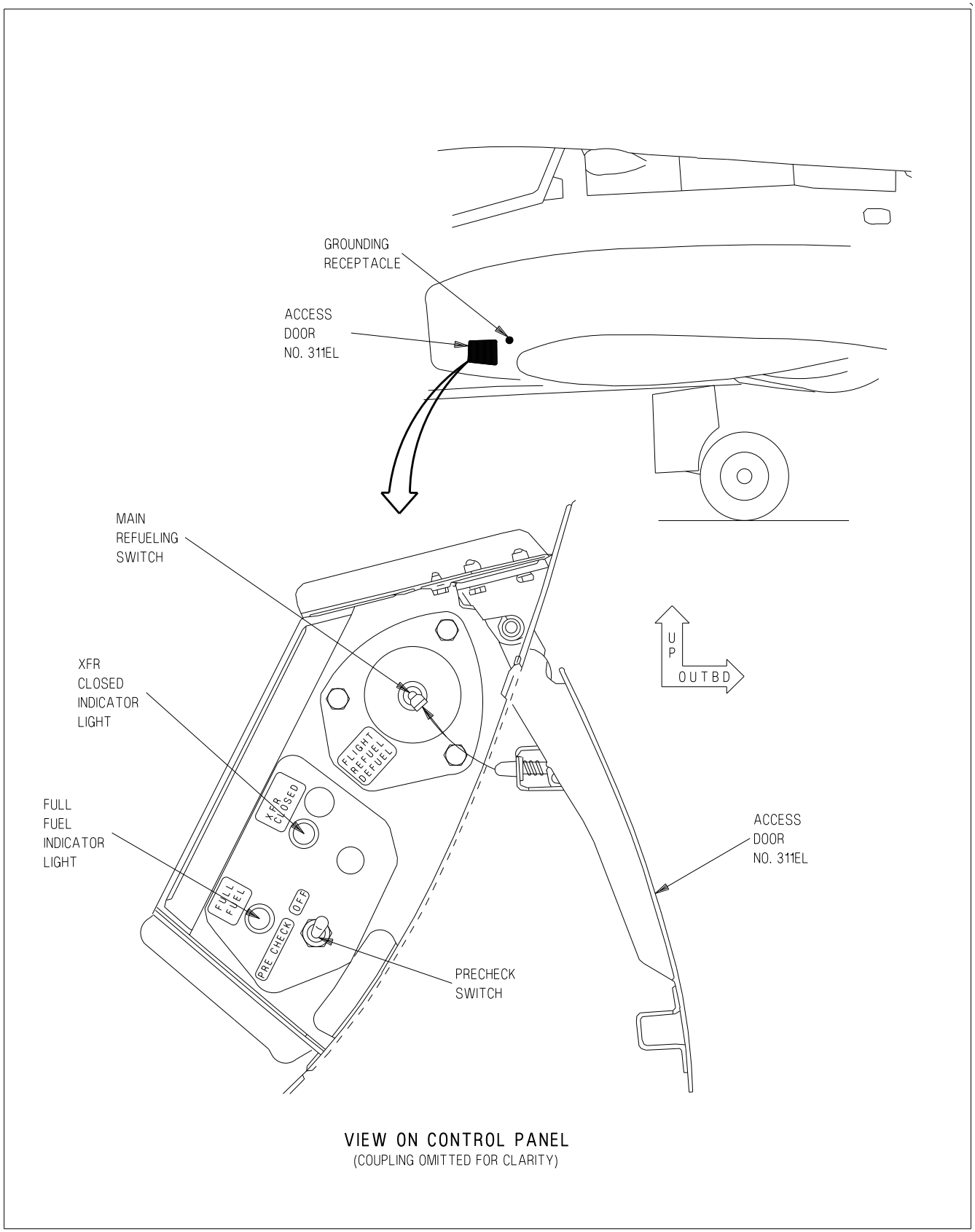

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Figure 3-5. Hot Refueling

8. Verify the XFR CLOSED light illuminates within 2 seconds.

CAUTION

If the XFR CLOSED light does not illuminate, discontinue refueling procedure; one or both transfer valves may be energized open resulting in a fuel spill.

9. Place tanker control in REFUEL position and start to pump fuel.

10. Press and hold PRE CHECK switch and verify the below:

    a. Fuel flow reduces to 5 gpm or less within 10 seconds.

    b. The FULL FUEL light illuminates when the nozzle pressure increases above 17 psi.

    c. Release PRE CHECK switch.

    d. The FULL FUEL light extinguishes and fuel flow returns to normal.

11. If fuel discharges from the fuel vent, stop refueling immediately.

12. Continue refueling until fuel flow automatically stops.

13. Verify FULL FUEL light is illuminated.

NOTE

The FULL FUEL light extinguishes when refueling pressure is removed from the aircraft.

14. Place tanker valve in OFF position. Remove nozzle and disconnect nozzle grounding jack from aircraft grounding receptacle. Install cap on fueling/defueling coupling and align yellow marks. Install sealing cover to nozzle.

15. Disconnect tanker grounding cable from aircraft grounding point and static grounding point.

16. Close and secure access door 311EL.

3.2.3 Gravity Refueling. Gravity refueling must be used when pressure refueling equipment or electrical power is not available. If electrical power is not used, delete items with asterisks (*). See Figure 3-6. Perform the gravity refueling in the following sequence.

NOTE

Care must be taken to ensure tank overflow at filler point does not occur.

*1. Place battery switches in the ON positions and record aircraft fuel quantity using cockpit fuel quantity indicator.

*2. Open access door 311EL.

*3. Ensure the main refueling switch is set to REFUEL.

4. Test and record refueling tanker quantity gage and set flowmeter to zero.

5. Connect tanker grounding cable to static grounding point and aircraft grounding points.

6. Open access panel 314CTC (gravity refueling access cover).

7. Lift handle of gravity filler cap, then turn handle to OPEN position to remove cap.

8. Connect refueling nozzle grounding jack to aircraft grounding receptacle.

*9. Verify that gravity refueling indicator light on side of fuselage, forward of fueling receptacle, is illuminated.

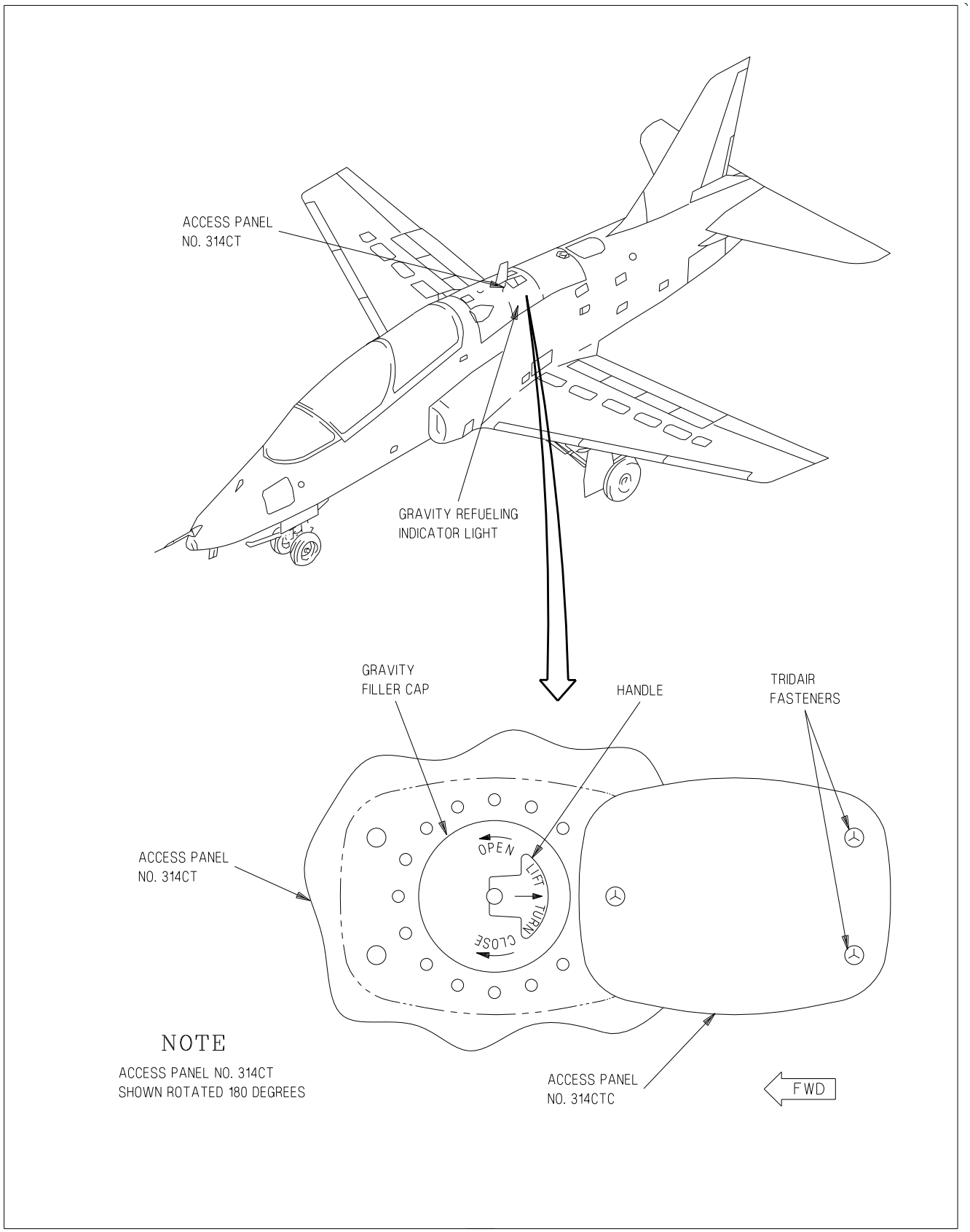

Figure 3-6. Gravity Refueling

10. Insert nozzle in gravity filler port.

NOTE

If electrical power is not used, visually monitor fuel level to preclude overflow.

*11. Start to pump fuel and stop refueling when the gravity refueling indicator light is extinguished.

12. Remove nozzle from gravity filler port and record reading on tanker flowmeter. Disconnect nozzle grounding jack from aircraft grounding receptacle.

13. Insert gravity filler cap and turn handle to CLOSE position. Push handle into recess.

14. Close and secure access panel 314CTC.

*15. Close and secure access door 311EL.

*16. Verify change in cockpit fuel quantity indicator agrees with the fuel quantity registered on tanker fuel quantity gage and flowmeter.

*17. Return battery switches to OFF positions or secure and disconnect external power.

3.3 ENGINE OIL SYSTEM SERVICING

Checking or filling the engine oil system should be accomplished a minimum of 5 minutes and a maximum of 30 minutes after engine shutdown. Oil level is checked by utilizing the sight glass accessible through access panel 821C. Oil servicing is required when the level reads 2 liters. See Figure 3-7. The oil tank is replenished by either pressure or gravity filling, however, gravity filling requires removal of equipment and will not be discussed here.

NOTE

- While it is recommended one type of oil be used, approved oils can be mixed with no danger of engine malfunction.
- There is no need to purge the system when oil types are mixed.
- Maximum consumption rate is 0.8 U.S. pints/hour (0.38 liters/hour).

3.3.1 Pressure Filling. Perform oil pressure filling in the following sequence.

1. Open access panel 821C.
2. Check oil level indicated on sight glass and note quantity required to fill.
3. Remove oil pressure filler blanking cap.
4. Ensure that pressure filler connection and pressure oiling unit hose are clean.
5. Pump oil until sight glass indicates FULL.
6. Disconnect hose from filler connection and ensure that check valve in filler is seating correctly.
7. Inspect filler blanking cap and install cap by pushing and turning clockwise to lock.
8. Close and secure access panel 821C.

3.4 ENGINE STARTING SYSTEM OIL SERVICING

The GTS (air producer) and the air starter motor are gravity replenished with oil MIL-L-23699 (NATO 0-156) or alternate oil MIL-L-7808 (NATO 0-150).

3.4.1 GTS Oil Filling. GTS usable oil capacity is 1.76 pints (0.22 gallon). When empty, the unit can be serviced with a maximum of 3.55 pints (0.44 gallon) of oil. The GTS filler cap is located

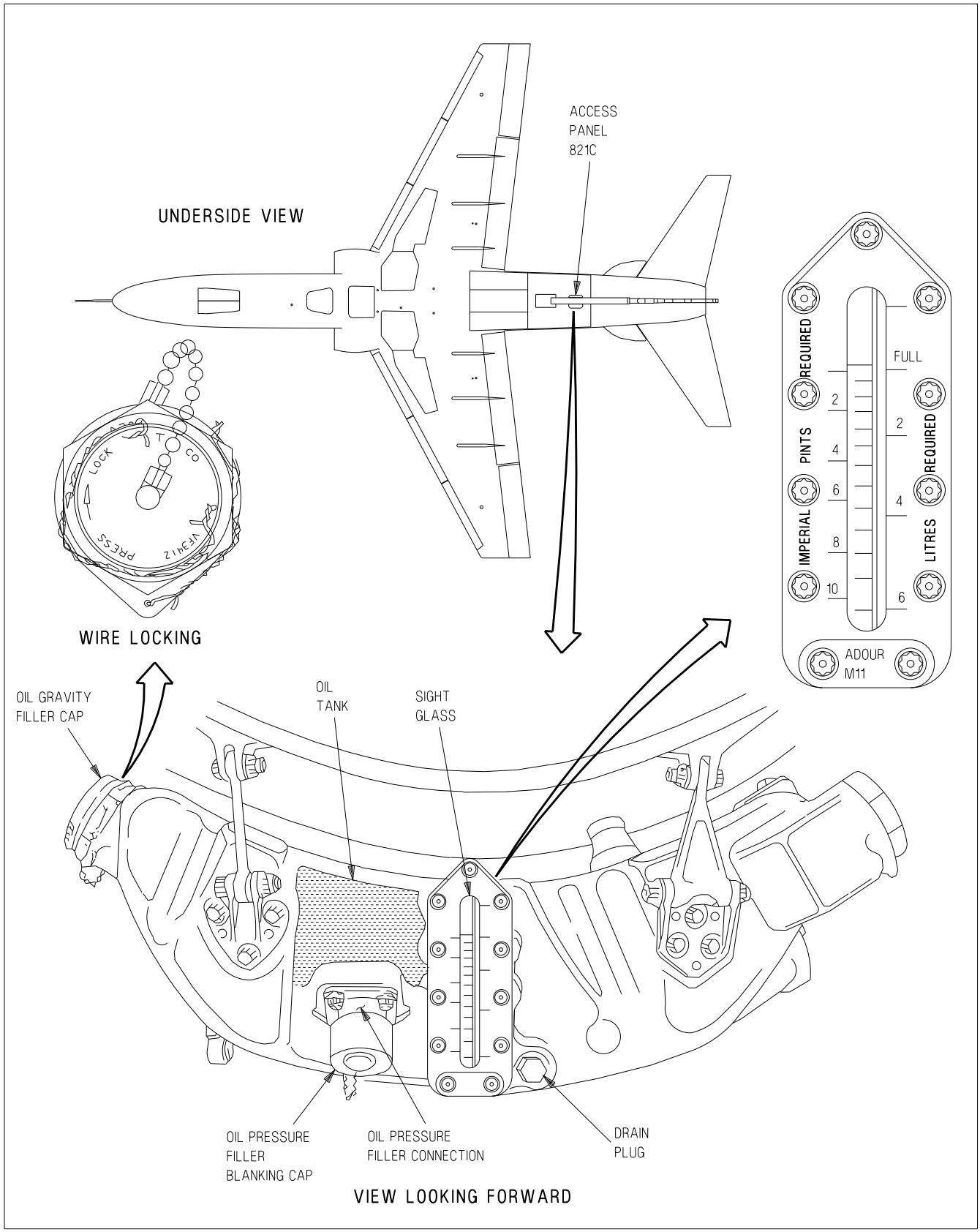

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Figure 3-7. Engine Oil Filling

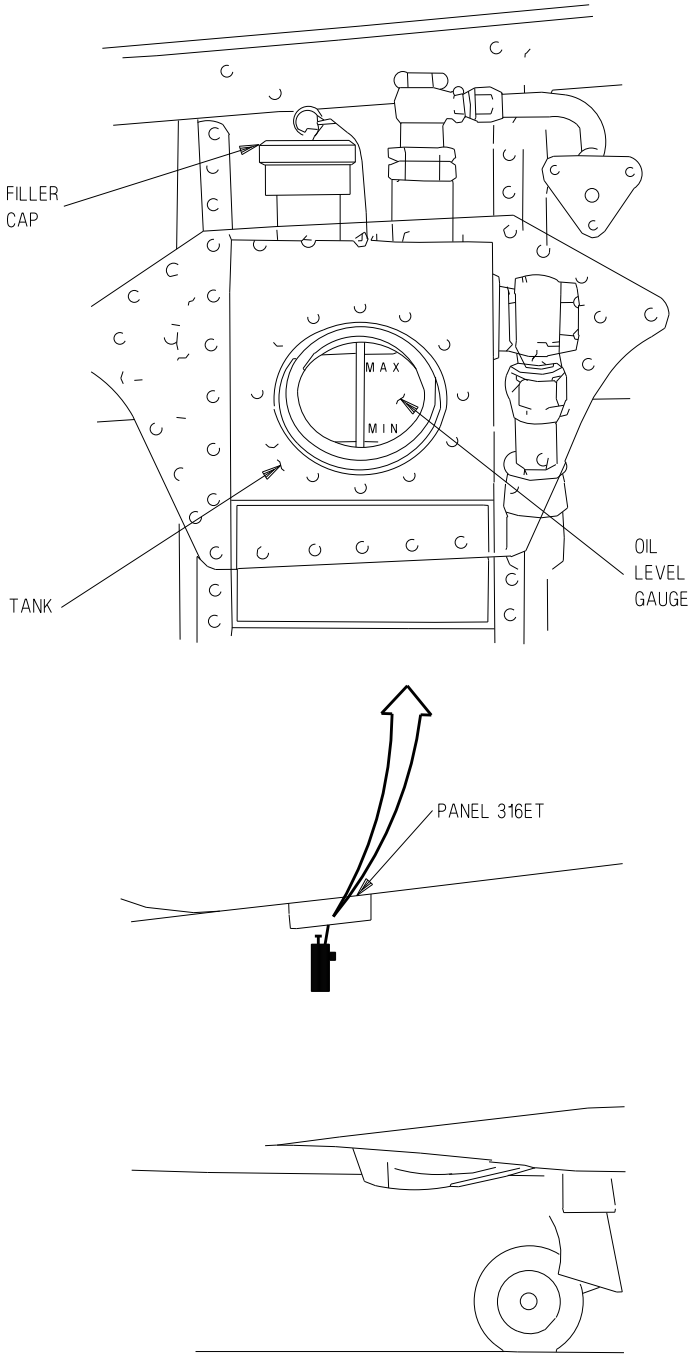

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Figure 3-8. GTS Oil Filling

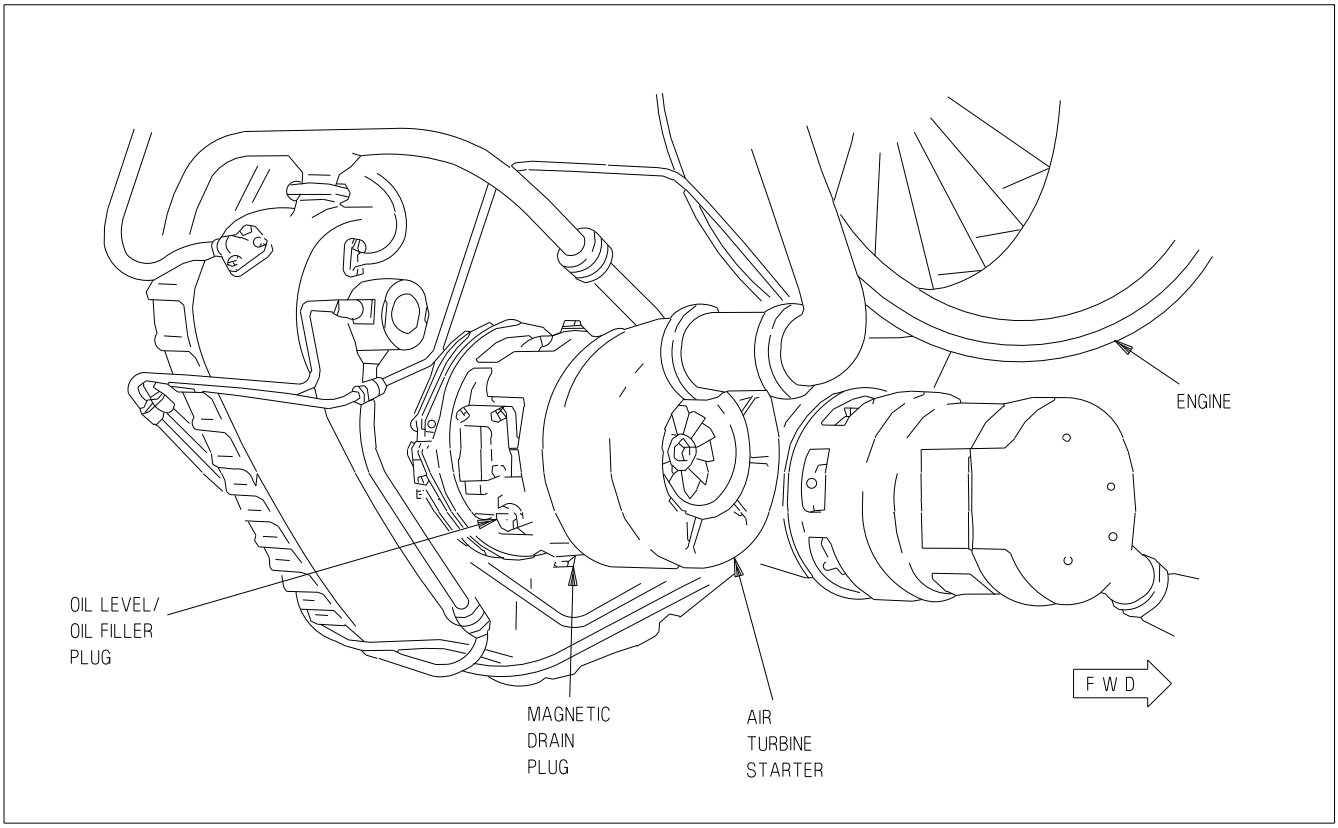

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Figure 3-9. Air Starter Motor Oil Filling

on top of the GTS oil tank. See Figure 3-8. Perform the following sequence.

NOTE

- GTS oil filter screen is internal to the unit and is not easily serviceable at remote sites.
- Ensure the use of uncontaminated containers/funnels.

1. Remove panel 316ET.
2. Remove safety lockwire and filler cap.
3. Fill oil tank utilizing Pon 6 until oil level on gauge indicates midway between the MAX and MIN lines.
4. Inspect filler cap gasket and install filler
5. Lockwire filler cap.
6. Reinstall panel 316ET

3.4.2 Air Turbine Starter Oil Filling. Air turbine starter oil level is checked by removing the oil level plug on right hand side of the sump. Max operating level is 1.75 pints and the minimum level is 0.97 pints. See Figure 3-9. Perform the following sequence.

1. Open access panel 811BR.
2. Remove safety lockwire from the air turbine starter oil level/filler plug.
3. Remove plug.
4. Insert oil through the oil level/filler plug fitting until oil overflows.
5. Reinstall oil level plug and tighten to 7.4 foot-pounds. Lockwire.
6. Reinstall and lockwire filler plug.

7. Close and secure access panel 811BR.

NOTE

There is no oil filter included in the air starter motor system.

3.5 HYDRAULIC SYSTEM SERVICING

Access to the charging valves is through access doors 319BL and 318BR. Reservoir fluid level and inflation pressure requirements are detailed on data labels located on the inside of the respective access doors. Prior to fluid replenishment, each reservoir should be bled to ensure that the contents do not include gas. The reservoirs of HYD 1 and HYD 2 systems are bled by allowing the system to settle for about 10 minutes and operating the appropriate bleed valve until fluid, free from air or nitrogen, emerges. A minimum of 0.67 US fluid ounces of fluid (the capacity of the tube) must be drawn off before the state of the fluid in the reservoir is revealed.

NOTE

Prior to servicing the hydraulic reservoirs, ensure the following:

Landing gear - DOWN
Speed brakes - IN
Flaps/Slats - UP

3.5.1 Reservoir Filling. See Figures 3-10 and 3-11. Perform the following sequence.

1. Open applicable access door 319BL or 318BR.

2. Remove protective cap from reservoir fill ground connection.

NOTE

During servicing, if air bubbles appear in the transparent hose or the pump sucks air, stop pumping to avoid introducing air into reservoir.

3. Prepare BOWSER. Insert clean suction tube into can of fluid, operate pump to prime the transparent outlet tube and connect to replenishment connection.

NOTE

In the event of overfilling, bleed through bleed valve and dispose of surplus fluid.

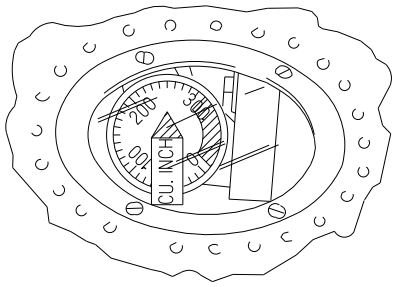
4. Operate BOWSER pump until the correct volume is indicated on the reservoir fluid gage.

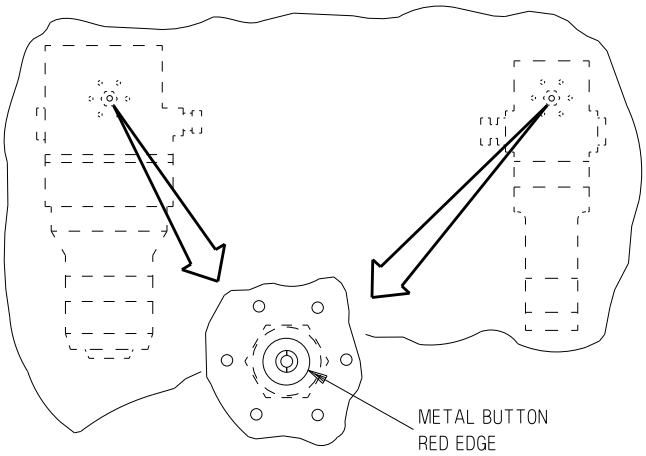
5. Bleed again through the bleed valve located adjacent to the reservoir nitrogen precharge valve and inspect the fluid.

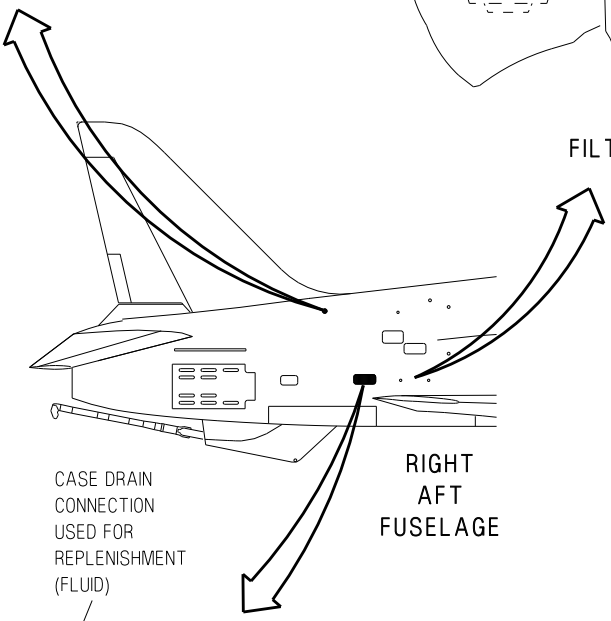
6. Remove equipment.

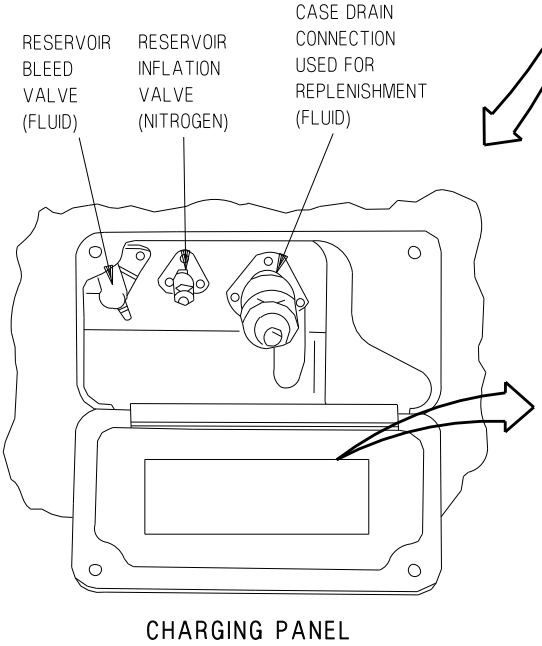
7. Reinstall protective cap.

8. Close and secure access door 319BL or 318BR.









T45A GOSHAWK – HYDRAULIC RESERVOIRS – INFLATION AND CHARGING DATA						
OIL TEMPERATURE RANGE	–15 TO 32 °F		32 TO 86 °F		86 TO 140 °F	
PRESSURE PSI G ±1.5 VOLUME CUBIC INs ±6.0	PRESSURE	VOL	PRESSURE	VOL	PRESSURE	VOL
NO.1 SYSTEM ALL ACCUM'RS DISCHARGED OF OIL	39	256	49	275	61	293
NO.1 SYSTEM WHEEL BRAKE ACCUM'RS ONLY CHARGED TO 3000 PSI	32	201	39	220	49	244

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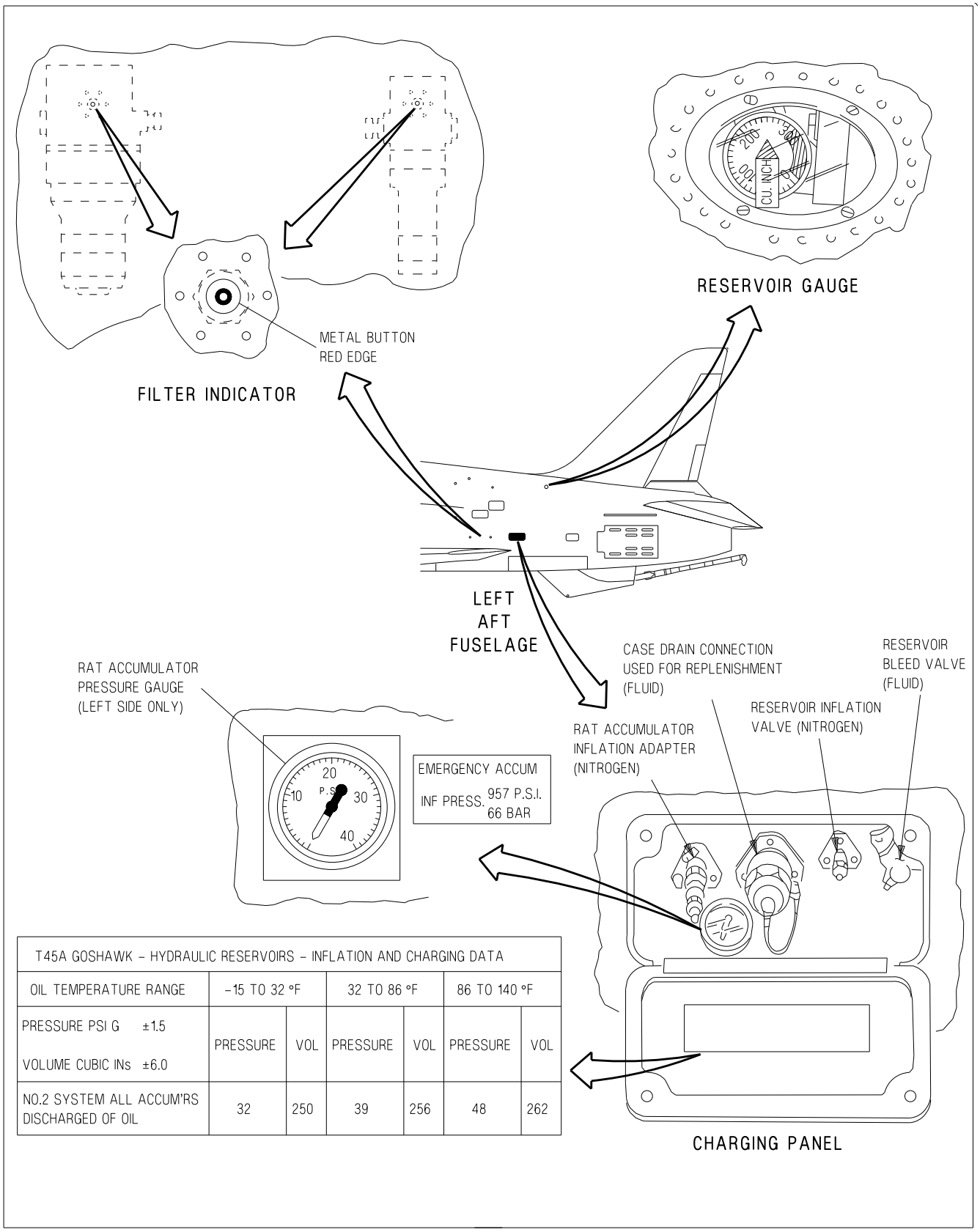
Figure 3-10. HYD 1 System Servicing



T45A GOSHAWK – HYDRAULIC RESERVOIRS – INFLATION AND CHARGING DATA						
OIL TEMPERATURE RANGE	-15 TO 32 °F		32 TO 86 °F		86 TO 140 °F	
PRESSURE PSI G ±1.5 VOLUME CUBIC INs ±6.0	PRESSURE	VOL	PRESSURE	VOL	PRESSURE	VOL
NO.2 SYSTEM ALL ACCUM'RS DISCHARGED OF OIL	32	250	39	256	48	262

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Figure 3-11. HYD 2 System Servicing

3.5.2 Reservoir Nitrogen Servicing. See Figures 3-10 and 3-11. Perform the following sequence.

CAUTION

Over inflation will damage the reservoir. The inflation pressure must only exceed the reservoir pressure by the minimum required for flow.

NOTE

The No. 1 and No. 2 hydraulic reservoirs require nitrogen servicing for the low pressure chamber of the reservoir. A part number KB132K0925-000 adapter is required for this effort to mate with the aircraft servicing valve and the nitrogen source due to the British Standard Pipe threads at the base of the aircraft servicing valve. Due to the non-availability of the KB132K0925-000 adapter, this work around procedure shall be utilized until the KB132K0925-000 adapter is received through supply.

1. Open access Door 319BL or 319BR as applicable to the reservoir to be serviced.
2. Remove the reservoir inflation valve cap.
3. Connect the GA477A Automatic Pressure Gauge to a low pressure nitrogen source.

WARNING

Make sure that the nitrogen source pressure is not regulated above 150 psi. Over pressurization could result in hose rupture, personnel injury and equipment damage.

4. Determine the required pressure from the aircraft placard. Adjust the nitrogen source to the pressure setting required.
5. Place the GA477A Automatic Pressure Gauge over the reservoir nitrogen servicing valve and press down on gauge handle to allow nitrogen flow into the valve. Monitor the gauge on the GA477A Automatic Pressure Gauge and release the gauge handle when the required pressure is reached.
6. Remove the GA477A Automatic Pressure Gauge and close the valve to the nitrogen servicing source.
7. Verify the correct servicing pressure.
8. Install the nitrogen servicing cap and close access Door 319BL or 319BR as applicable.
9. Relieve the remaining pressure between the GA477A Automatic Pressure Gauge and nitrogen source. Remove the automatic pressure gauge from the nitrogen source.

3.6 NITROGEN SYSTEM SERVICING

Pressure gages and inflating valves for HYD 1 and 2 flight control accumulators are located in the right and left wheel wells, respectively.

The pressure gage and inflating valve for wheel brakes/emergency flap accumulator are located in right landing gear wheel well.

The pressure gage and inflating valve for the RAT accumulator is located in the fuselage, accessible through access panel 319BL.

Accumulators must be charged at ambient temperature (see Figure 3-12). Prior to inflating accumulators, ensure that hydraulic system pressures are dissipated.

Pressurize the system using a replenishing cart and an inflation adapter. See Figures 3-12 and 3-13. Perform the following sequence.

1. Remove dust cap and connect adapter to inflating valve.
2. Connect cart hose to adapter.
3. Loosen swivel nut 1 to 2 turns counterclockwise.

4. Open cart valve slowly on adapter gage to inflate to the correct pressure.

5. Tighten the swivel nut clockwise to 50 to 70 foot-pounds torque.

6. Close cart valve, disconnect hose, remove adapter and reinstall dust cap.

AMBIENT TEMP (°F)	HYD 1 AND HYD 2 FLIGHT CONTROL ACCUMULATOR PRESSURE (PSI) ±50	RAT ACCUMULATOR PRESSURE (PSI) ±50	WHEEL BRAKE ACCUMULATOR PRESSURE (PSI) ±50	ARRESTING HOOK ACTUATOR/ DAMPER PRESSURE (PSI) ±50
-20	918	797	1,083	790
+32	1,027	892	1,211	880
+68	1,102	957	1,300	950
+100	1,169	1,015	1,379	1,010

Figure 3-12. Nitrogen Charging Temperature/Pressure Characteristics

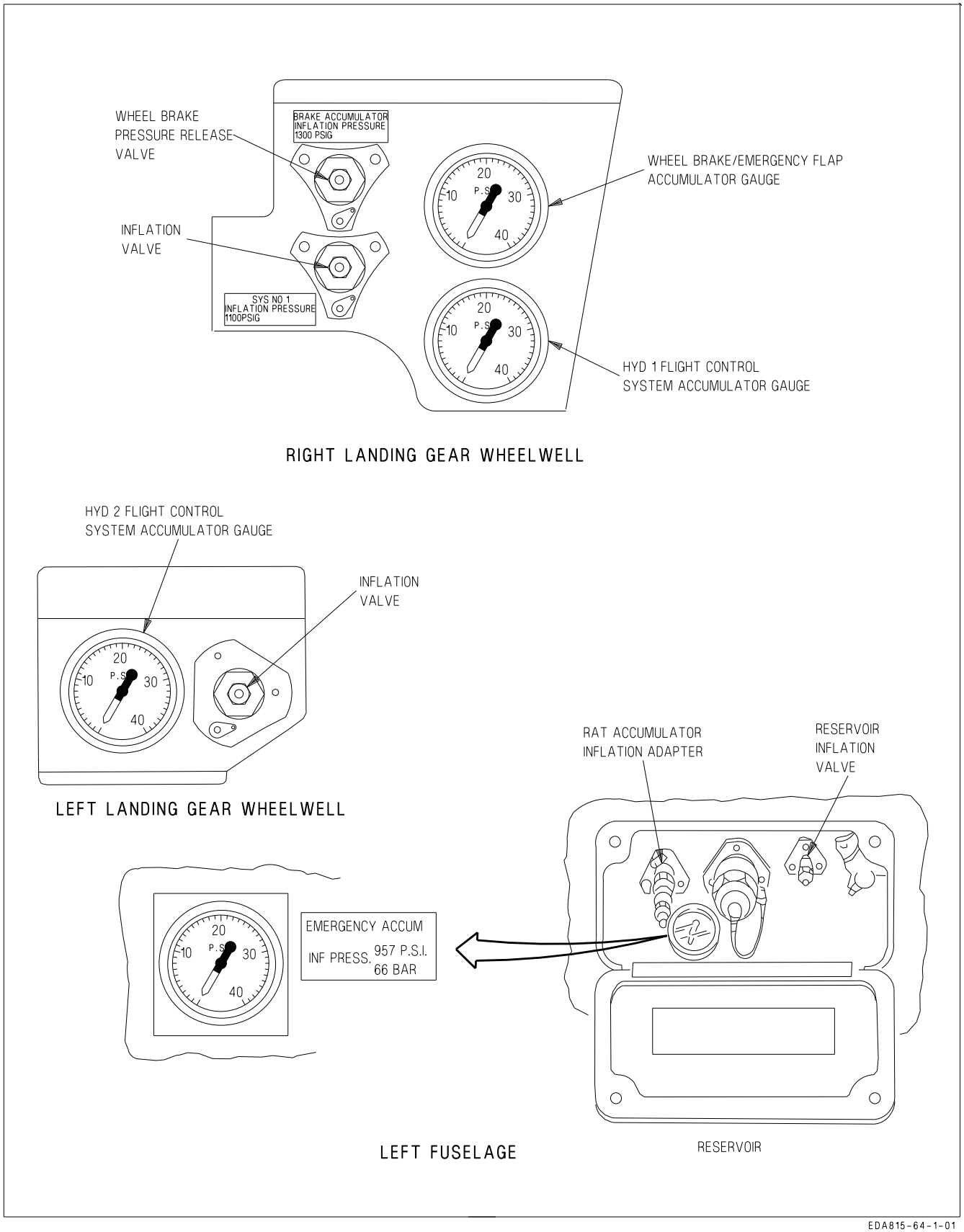


Figure 3-13. Nitrogen System Servicing

3.7 TIRES

Service with dry air or nitrogen as follows:

3.7.1 Main Gear (Size: 24″x7.7″-10″).

Land operation - 125 psi
Carrier operation - 350 psi

3.7.2 Nose Gear (Size: 19″x5.25″-10″).

Land operation - 125 psi
Carrier operation - 350 psi

3.8 AIRCRAFT JACKING FOR TIRE CHANGE

Jacking for removing a wheel or wheels should be carried out on level ground with the aircraft chocked forward and aft at the other wheels. Gear down lock pins should be installed and parking brake and rudder lock applied. A 5-ton axle jack with adapter head should be used. See Figure 3-14.

3.8.1 Main Wheel.

To jack up main wheel, perform the following sequence:

1. Position axle jack under main gear jacking pad.
2. Operate jack until wheel is clear of the ground.

3.8.2 Nose Wheel. To jack up nose wheel, perform the following sequence:

1. Position axle jack under nose gear jacking pad.
2. Chock forward and aft of the two main gear with enough space for a small amount of wheel rotation to accommodate movement due to the knee strut system.
3. Release parking brake to allow main wheels to rotate during jacking process.
4. Operate jack until nose wheels are clear of the ground.
5. Secure main gear chocks firmly.

3.9 EXTERNAL ELECTRICAL POWER REQUIREMENT

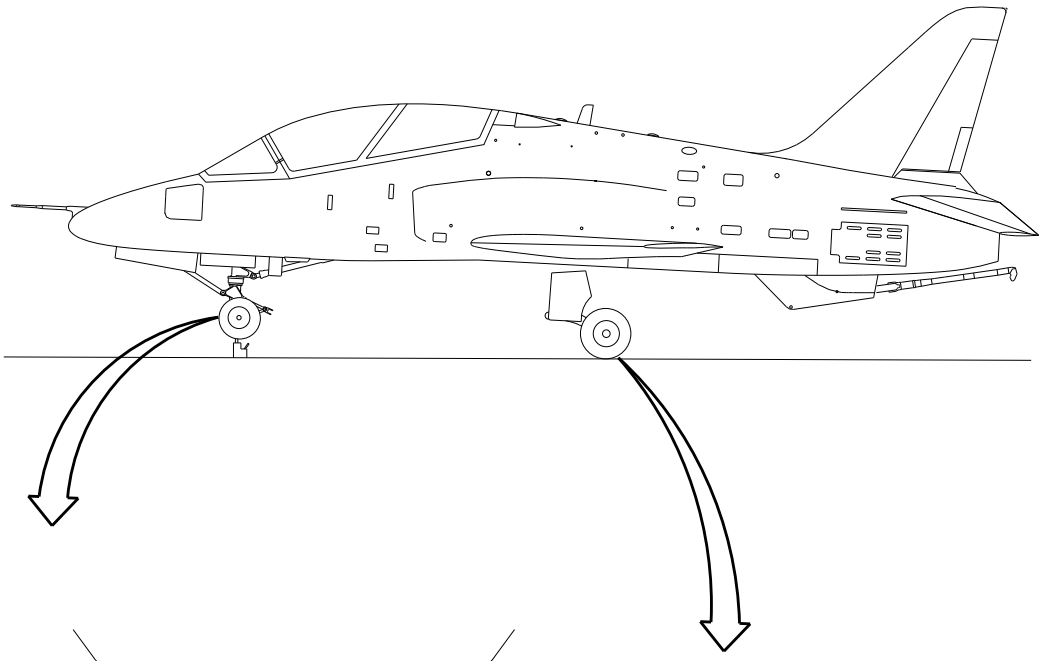
A 28 vdc, 300 amp power generating unit, providing up to 6,400 watts, can be connected to the external power receptacle to provide power to the aircraft on the ground. This power is sufficient to perform all ground electrical maintenance functions and provide necessary electrical power for engine start. The receptacle is accessible through access door 310CR, located on the forward fuselage below the right intake. Perform the following sequence for connecting and activating the external power supply:

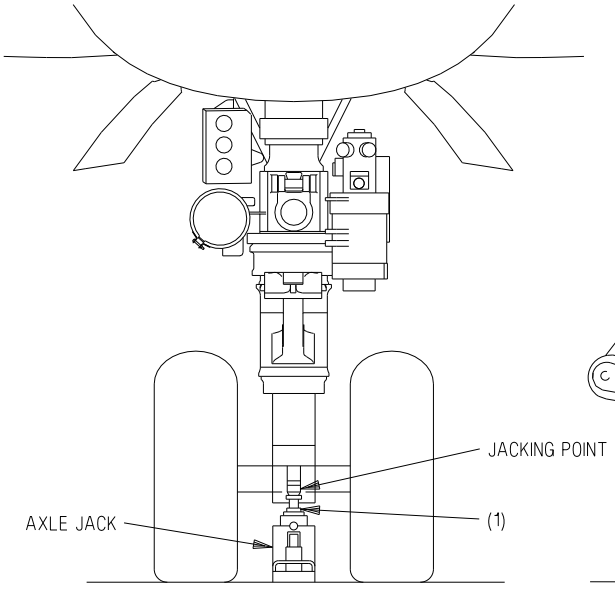
1. Ensure all forward and aft cockpits electronic gear is secured.
2. Place battery switches in OFF positions.
3. Place ENGINE switch in OFF position.
4. Place PITOT HEAT switch in OFF position.
5. Pull up FUEL SHUTOFF handle located on forward cockpit left console (if engine start is not desired).

NOTE

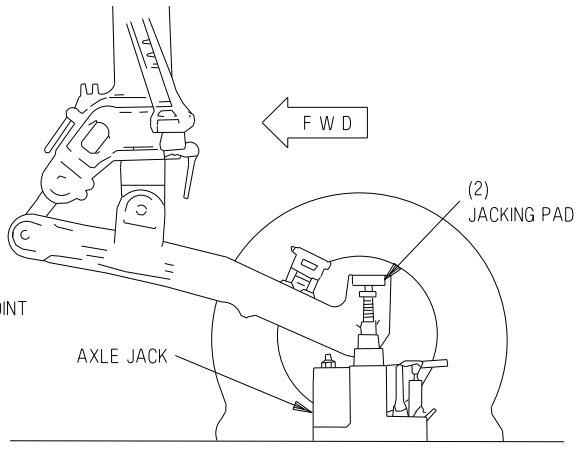
The caution/warning system is inhibited when the fuel shutoff handle is in the UP position. However, the FIRE, GTS FIRE and MASTER ALERT lights, and audio tones will still operate normally when the electrical power is connected to the aircraft.

6. Open access door 310CR.
7. Connect external power supply cable plug to receptacle.
8. Turn external power supply on.





VIEW LOOKING AFT



VIEW LOOKING OUTBOARD
ON RIGHT SIDE

NOTE:

(1) 12 INCHES MAXIMUM EXTENSION.

(2) THE MAIN GEAR JACKING PAD WILL CLEAR THE DECK BY NOT LESS THAN 9.20 INCHES (234 MM) WHEN TIRE IS FLAT.

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Figure 3-14. Aircraft Jacking

Perform the following sequence for disconnecting external power supply.

9. Turn external power supply off.
10. Disconnect external power supply cable
11. Close and secure access door 310CR.
12. Return fuel shutoff handle to DOWN position (stowed).

3.10 DANGER AREAS

See Danger Areas and Noise Danger Areas illustrations. See Figures 3-15 and 3-16.

3.11 MINIMUM TURNING RADIUS

See Minimum Turning Circle/Ground Clearance illustration. See Figure 3-17.

3.12 TOWING AIRCRAFT

The aircraft can be towed and positioned using the NT-4 tow bar. See Figure 3-18. Towing speed must not exceed 3 mph in the hangar and 5 mph on parking ramps. Prior to commencing operations, perform the following sequence.

1. Check for correct wheel brake accumulator pressure (2,800 ±200 psi, right landing gear wheel well).
2. Complete cockpit ground handling checklist.
3. Ensure the canopy is full open. If the crosswind component exceeds 20 knots, close the canopy until the crosswind component can be reduced below 20 knots.
4. Ensure that landing gear safety pins are installed.
5. Ensure that forward cockpit is occupied by a qualified brake rider.
6. Hook tow bar to nose landing gear and secure with chain.
7. Hook tow bar to tow tractor.
8. Ensure that all tie down chains, if installed, are removed.
9. Perform brake operational check.
10. Ensure that sharp turns are avoided.

3.13 TIEDOWN/SECURING AIRCRAFT

Aircraft tiedown requirements vary with expected weather condition/wind velocity. Correctly tensioned chain assemblies must be used to secure the aircraft. Tiedown chains required for different weather conditions are as follows:

1. Normal weather (windspeed up to 45 knots), 6 chains
2. Moderate weather (windspeed up to 60 knots), 12 chains
3. Heavy weather (windspeed up to 100 knots), 18 chains

Eight tiedown ring fittings are used to secure the aircraft. See Figure 3-19. Each ring has capability of accepting multiple chain end hooks of the standard TD-1A aircraft tiedown assembly.

3.13.1 Normal Weather Tiedown Procedures (Shore). See Figure 3-20. Perform the following sequence.

1. Install landing gear down lock pins.
2. If possible, spot aircraft on tiedown padeye pattern with nose pointing into the wind.
3. Align nose wheel fore and aft; secure nose and main gear wheels fore and aft with adjustable chocks.
4. Attach chain assemblies to tiedown points and tighten chains.
5. Tighten throttle friction knob.
6. Apply parking brake and rudder lock lever (gust lock).
7. Close and lock canopy.
8. Install external covers, if required.

3.13.2 Moderate/Heavy Weather Tiedown Procedures (Shore). See Figure 3-21. Perform the following sequence.

NOTE

The aircraft should be moved into hangar or flown out of storm area if possible.

1. Remove all armament stores from aircraft.
2. Fuel aircraft to maximum weight.
3. Perform steps 1 thru 8 under procedures for shore base tiedown in normal weather.

3.13.3 Carrier Operations. Initial tiedown and permanent and moderate/heavy weather tiedown methods are shown in Figures 3-22 and 3-23 respectively. However, refer to Aircraft Securing and Handling technical manual, NAVAIR 17-1-537, or CV NATOPS for tiedown requirements and detailed procedures.

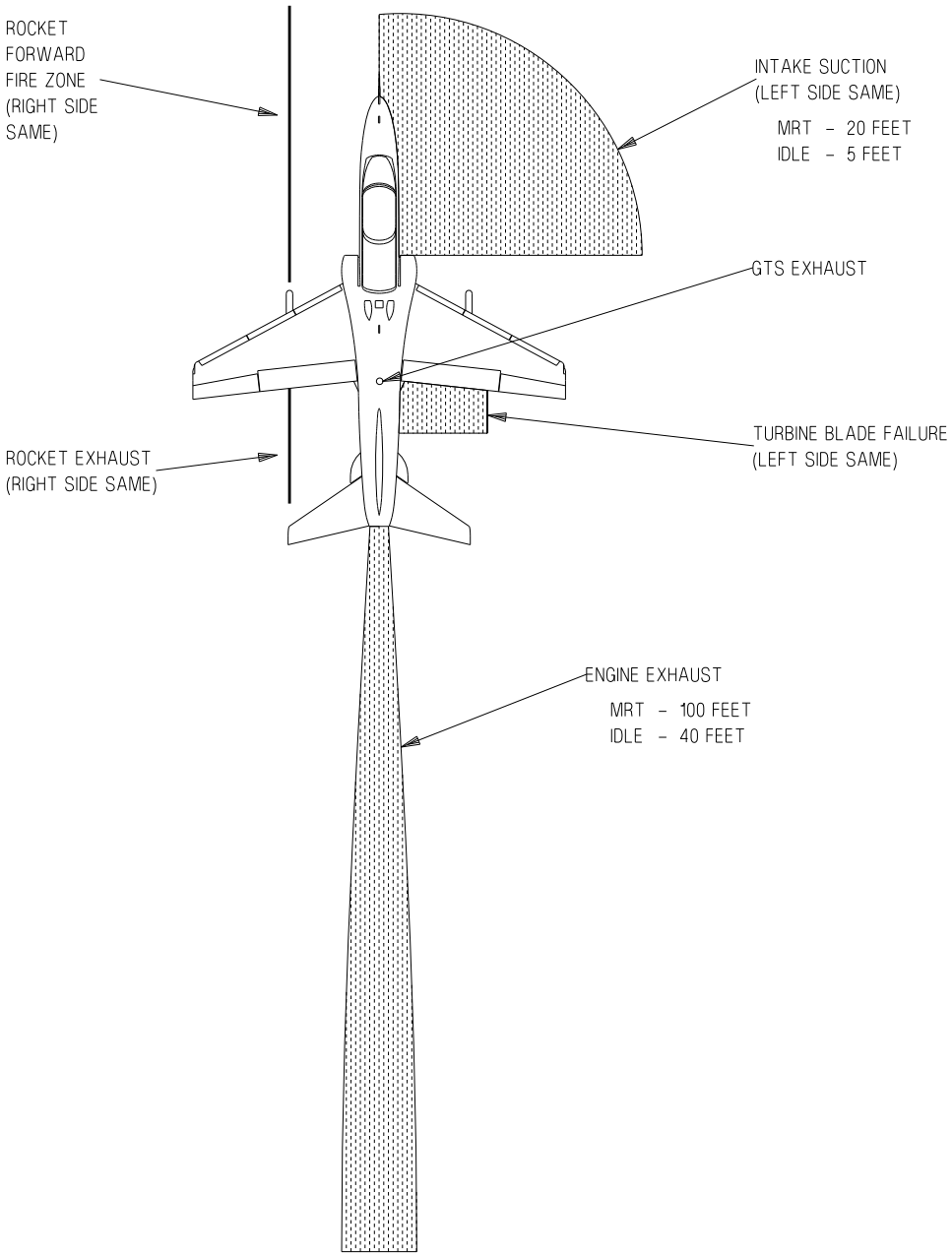

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Figure 3-15. Danger Areas (Sheet 1 of 2)

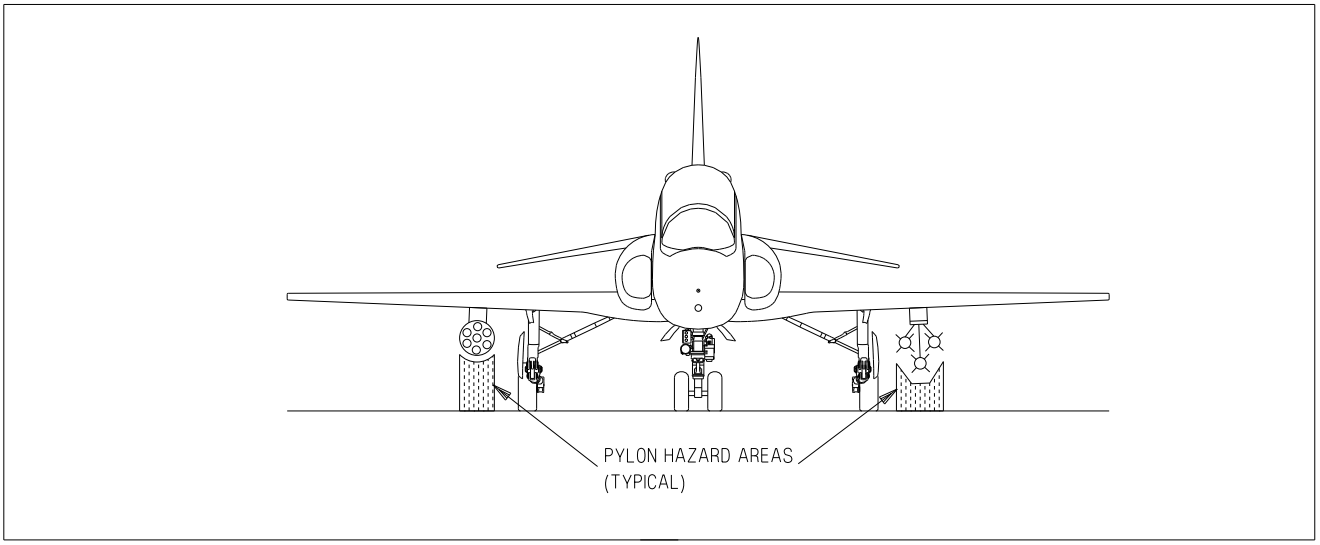
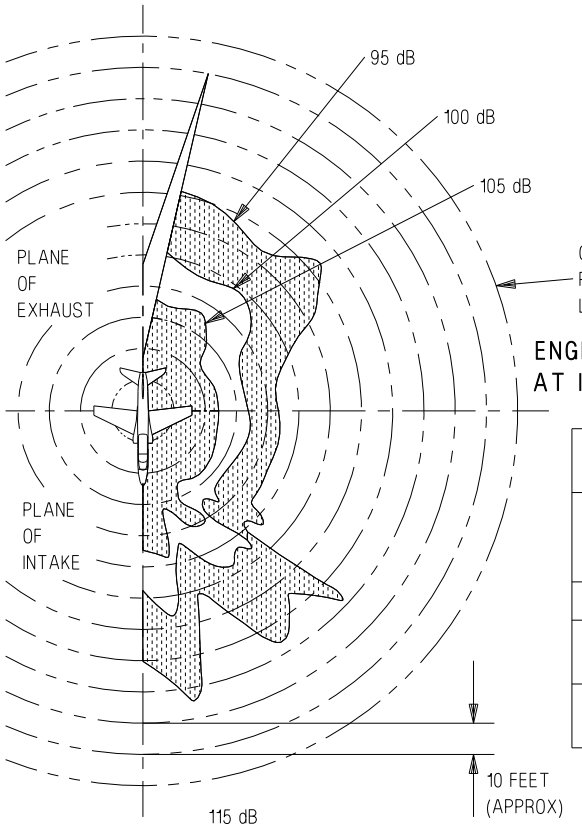


Figure 3-15. Danger Areas (Sheet 2 of 2)



NOTE

1. NOISE LEVEL AREAS IDENTICAL ON EACH SIDE OF AIRCRAFT.
2. CONTOURS MAY BE ALTERED BY SURROUNDING OBSTACLES.

ALLOWABLE NOISE EXPOSURE SOUND LEVEL IN dBa (SLOW RESPONSE)							
TYPE EAR PROTECTIVE DEVICES	EXPOSURE TIME, HOURS PER DAY						
	1/4	1/2	1	2	4	6	8
NO PROTECTION	115	110	105	100	95	92	90
EAR PLUGS WITH AVERAGE SEAL	127	122	117	112	107	104	102
EAR PLUGS AND EARMUFFS	135	130	125	120	115	112	110

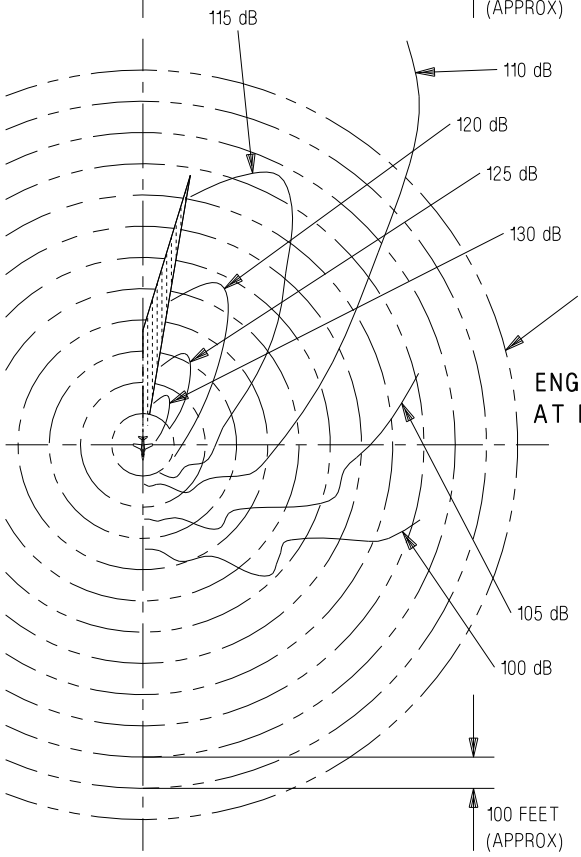


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Figure 3-16. Noise Danger Areas

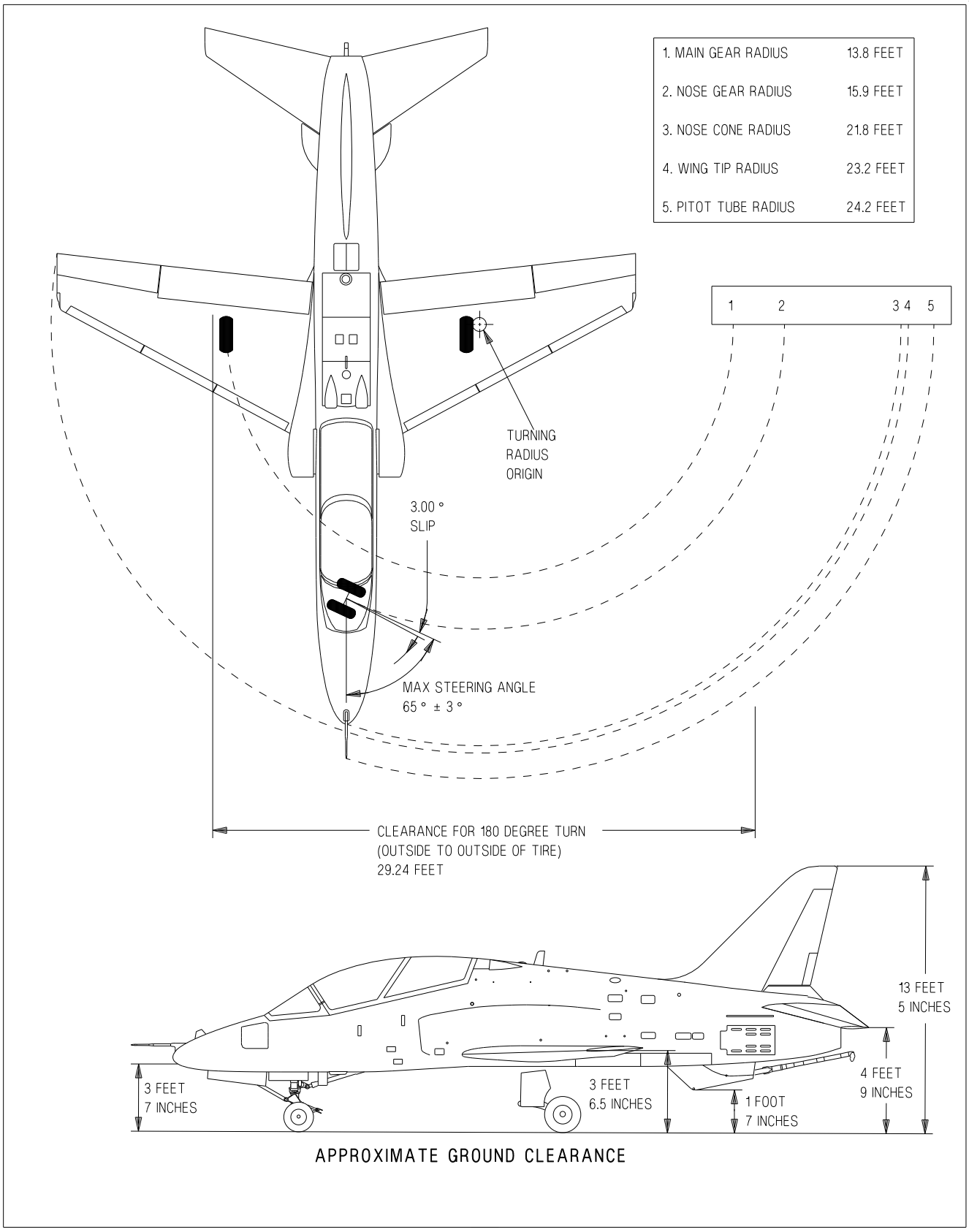

Figure 3-17. Minimum Turning Circle/Ground Clearance

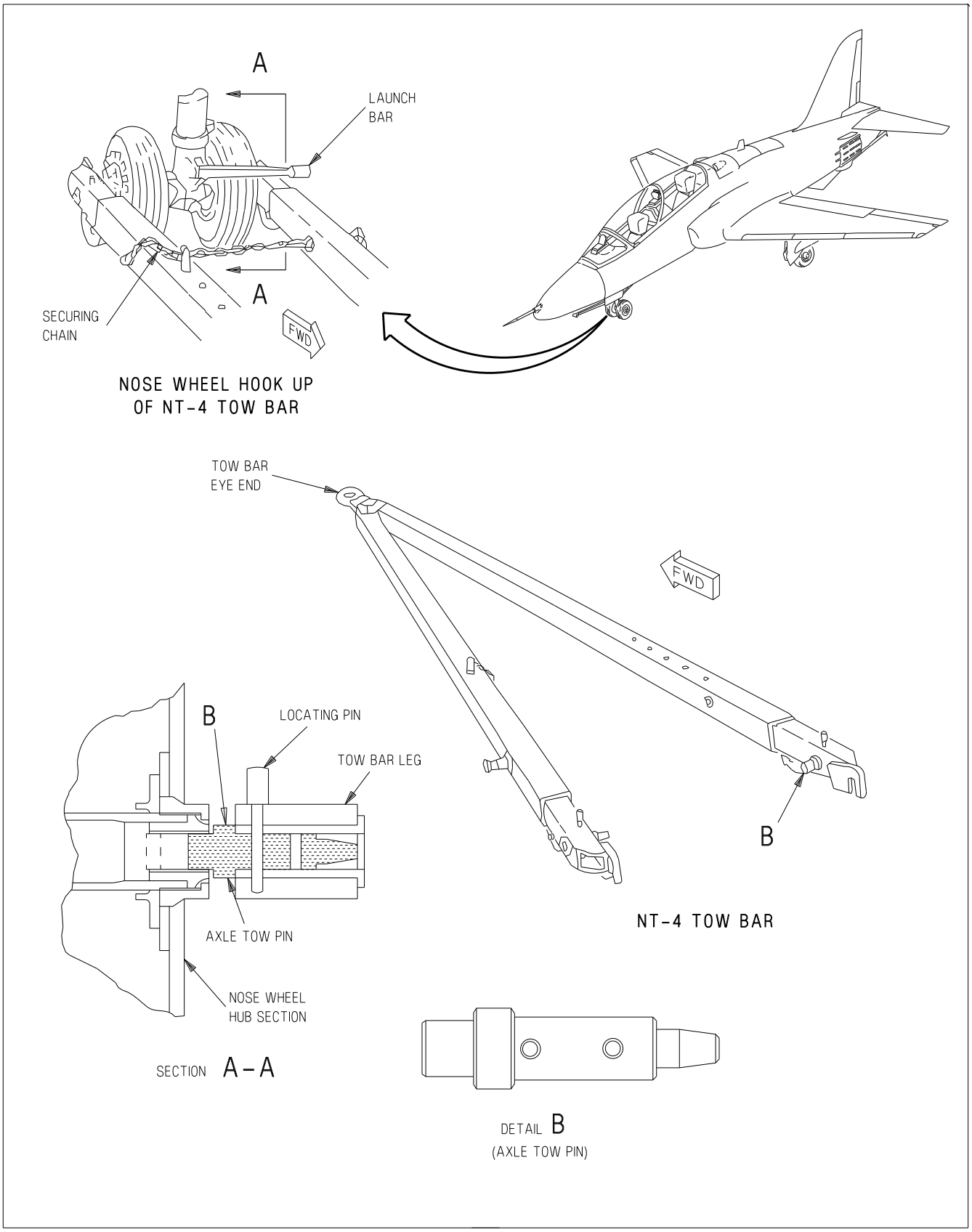

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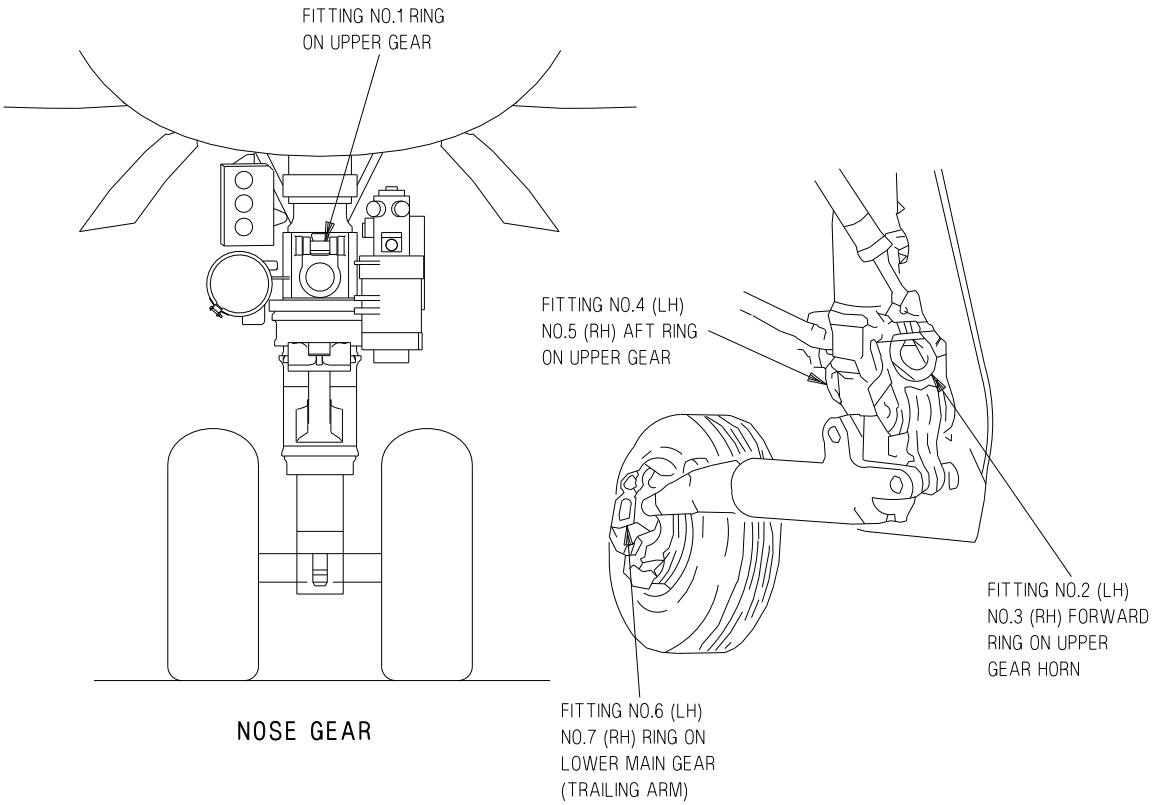
Figure 3-18. Towing



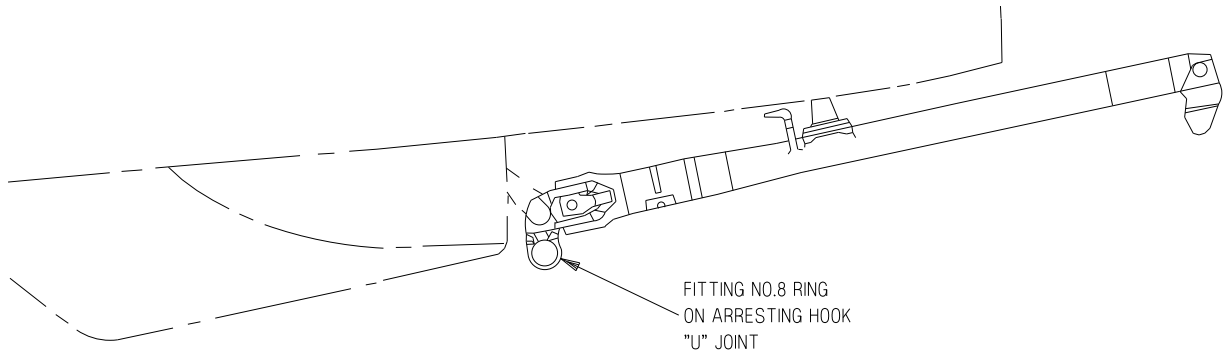


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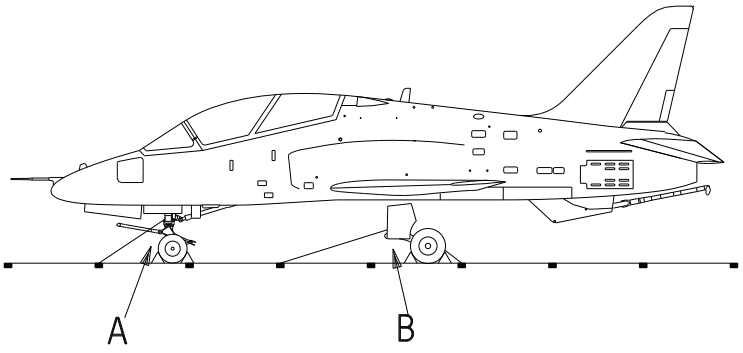
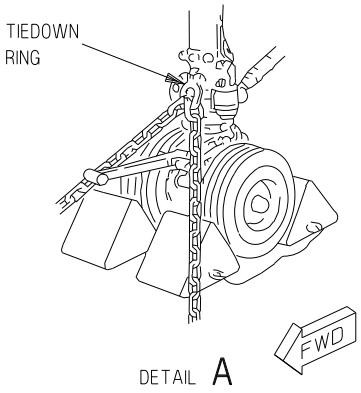
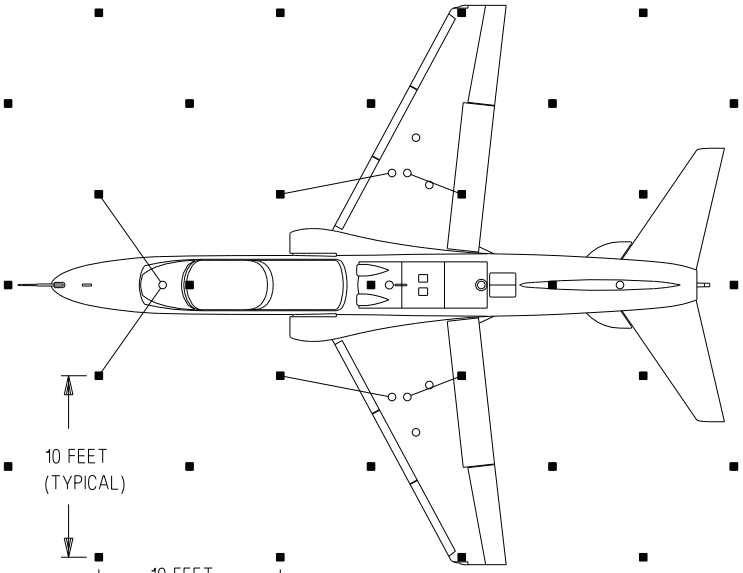
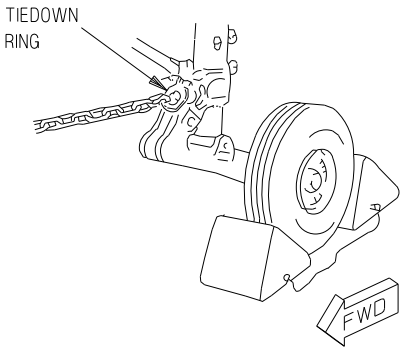
Figure 3-19. Aircraft Tiedown Points





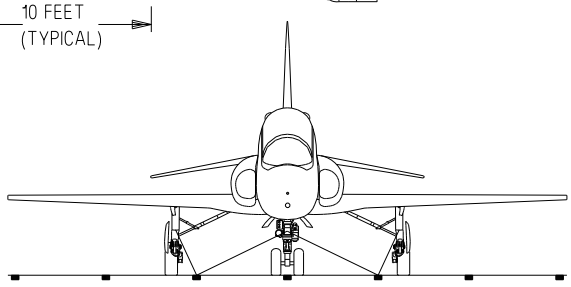
DETAIL A





MLG DOOR REMOVED FOR CLARITY

DETAIL B



LEGEND

- ○ AIRCRAFT FITTING
- ■ DECK FITTING

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Figure 3-20. Normal Weather Tiedown (Shore)

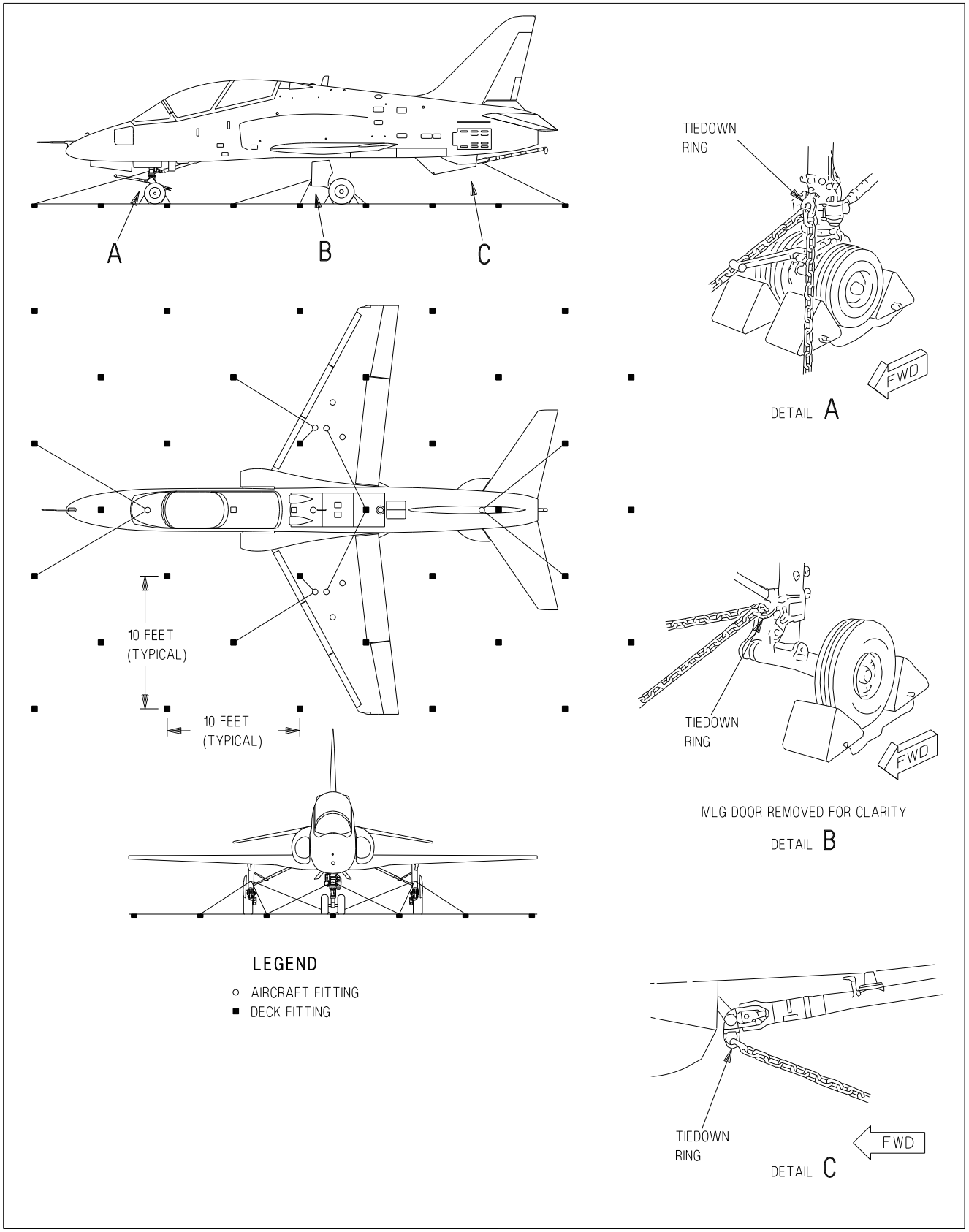

Figure 3-21. Moderate Weather Tiedown (Shore)

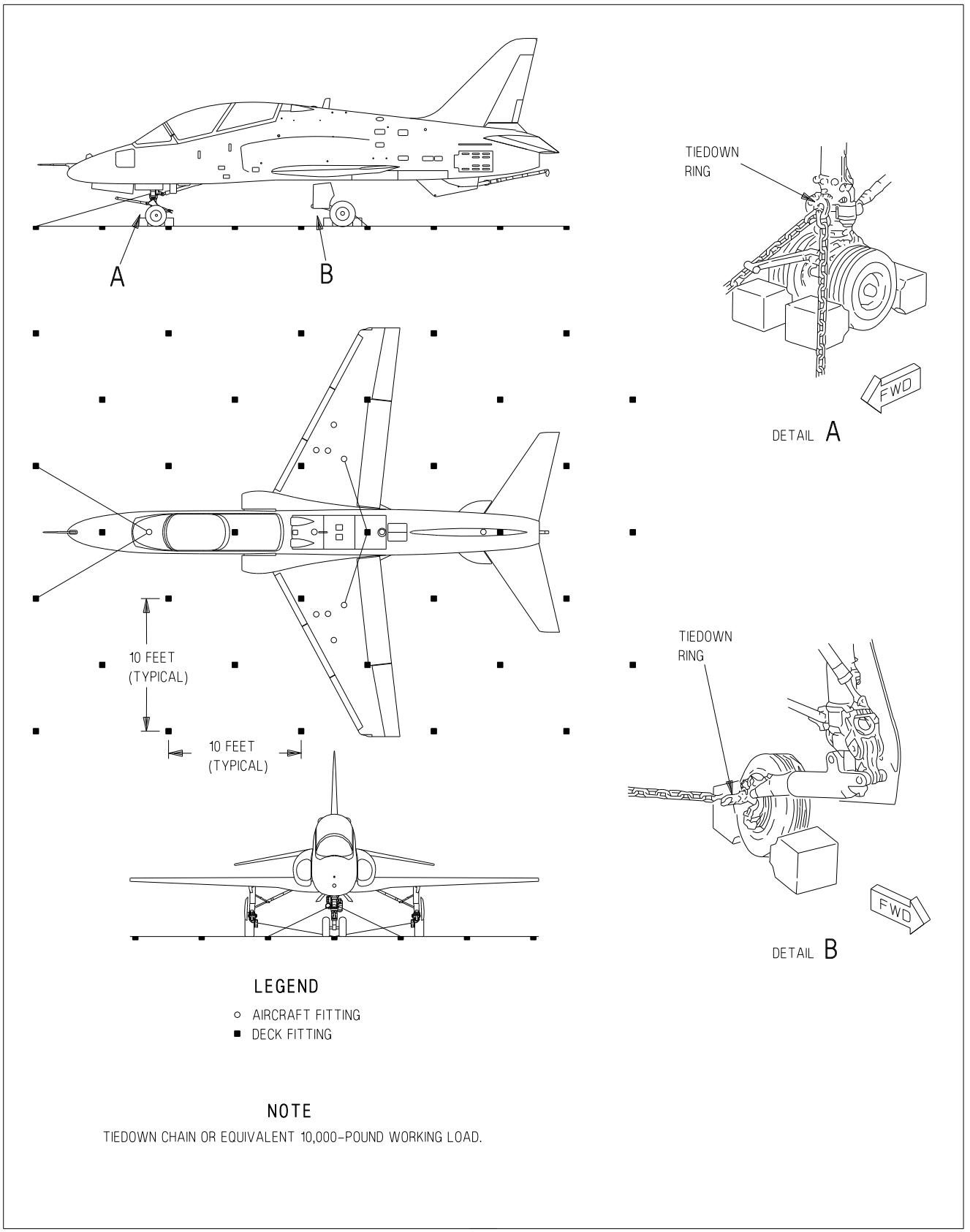

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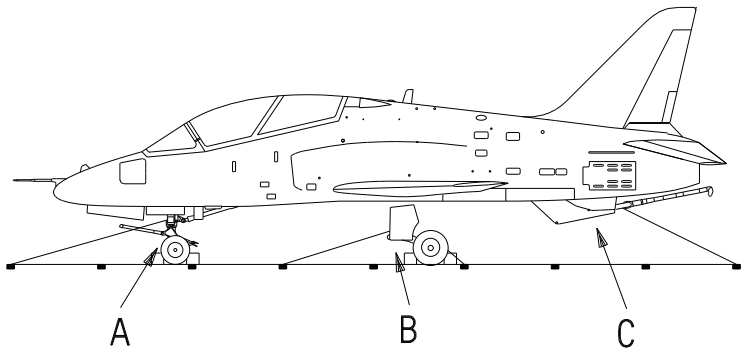
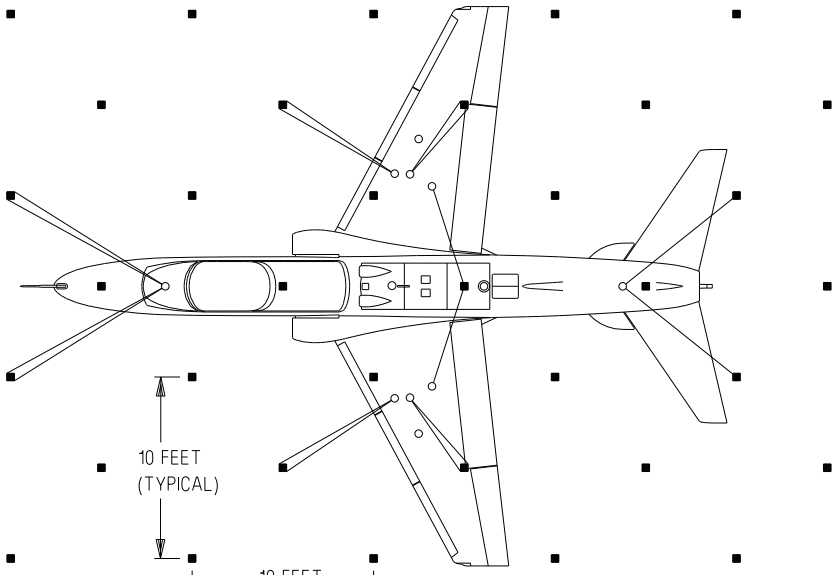
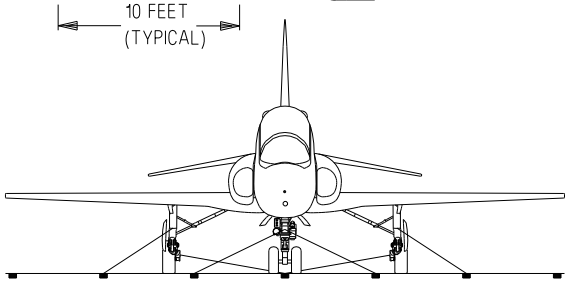
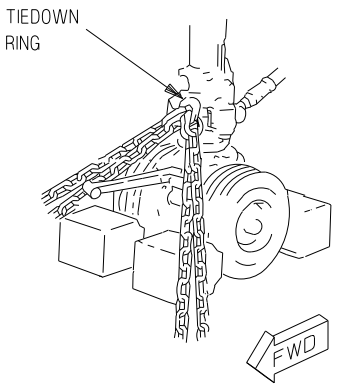
Figure 3-22. Initial Tiedown (Carrier)

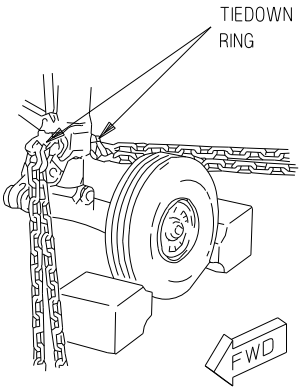








DETAIL A



MLG DOOR REMOVED FOR CLARITY

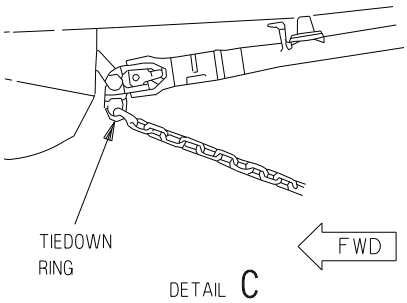
DETAIL B

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 C

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Figure 3-23. Permanent and Moderate/Heavy Weather Tiedown (Carrier)

CHAPTER 4

Operating Limitations

4.1 INTRODUCTION

The following limitations apply to the T-45C.

4.1.1 Solo Flying.

1. 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 LIMITATIONS

F405-RR-401 general operating limitations are shown in Figure 4-1.

4.2.1 Engine Handling Limitations.

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% N_2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout.

4.2.2 Manual Fuel Control Limitations.

1. Ground start is prohibited with manual fuel control.

2. With manual fuel control selected, maximum N_2 RPM limitations are the following:

   a. $N_2 \leq 90$ percent at altitudes greater than 20,000 feet MSL.

   b. $N_2 \leq 95$ percent at altitudes less than or equal to 20,000 feet MSL.

4.2.3 Starting Limitations.

1. Engine start is prohibited with the throttle above the ground idle detent.

2. Minimum N_2 RPM required for engine start is 15 percent.

3. Engine light-off during a normal start must occur within 15 seconds after moving the throttle to idle.

4. For starting, minimum voltage for each battery is 24 volts.

5. No more than three successive engine start attempts may be performed. Following the third start attempt, a 30 minute cool down period must be observed before attempting another engine start.

CONDITION	MAXIMUM N_2 RPM(%)	MAXIMUM EGT(°C)	TIME LIMIT
MILITARY RATED THRUST (MRT)	104	600	30 MINUTES/FLIGHT HOUR
TRANSIENT/ACCELERATION (Note 5)	104	645	LESS THAN 20 SECONDS
MAXIMUM CONTINUOUS	100	550	-
IDLE	55 ±2 (Note 1, 4)	450	-
GROUND START	---	550	(Note 2)
AIRSTART	---	600	(Note 3)

NOTES

1. Bleed valve closed. Nominal RPM will vary depending on engine loading, air bleed, ambient conditions, and altitude. Refer to Figure 4-2.
2. Maximum overshoot of 20° C for 10 seconds.
3. Maximum overshoot of 50° C for 10 seconds (NOTE: The EGT/RPM warning light will operate at 650 ±8° C).
4. Maximum shift in engine idle RPM between the Poststart and Engine Shutdown checks, corrected for standard day, is 2 percent. Idle RPM will normally increase approximately 1 percent for every 1,500 foot increase in altitude and 1 percent for every 10° C in ambient temperature. Refer to Figure 4-2.
5. Transient/acceleration limits apply to any acceleration whether from idle to MRT or any increment in between. EGT may rise to 645° C during or immediately following the acceleration, but must decrease to 600° C or less within 20 seconds after the engine reaches its maximum RPM.

Figure 4-1. F405-RR-401 Operating Limitations

4.3 GTS LIMITATIONS

1. GTS start with external power is prohibited.

2. Minimum interval between each GTS start attempt is 3 minutes. After three consecutive start attempts, a minimum interval of 30 minutes is required before any further start attempts.

3. Additional GTS start attempts after an unsuccessful GTS start attempt are prohibited until the GTS exhaust duct, combustor section are inspected and any residual fuel is removed, and the RAT doors are inspected for discoloration and warpage.

NOTE

- GTS starts not reliable at altitudes above 15,000 feet MSL.
- The GTS 3 minute delay between consecutive starts does not apply in emergency situations.

4.4 FUEL LIMITATIONS

1. 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. Once these additives are

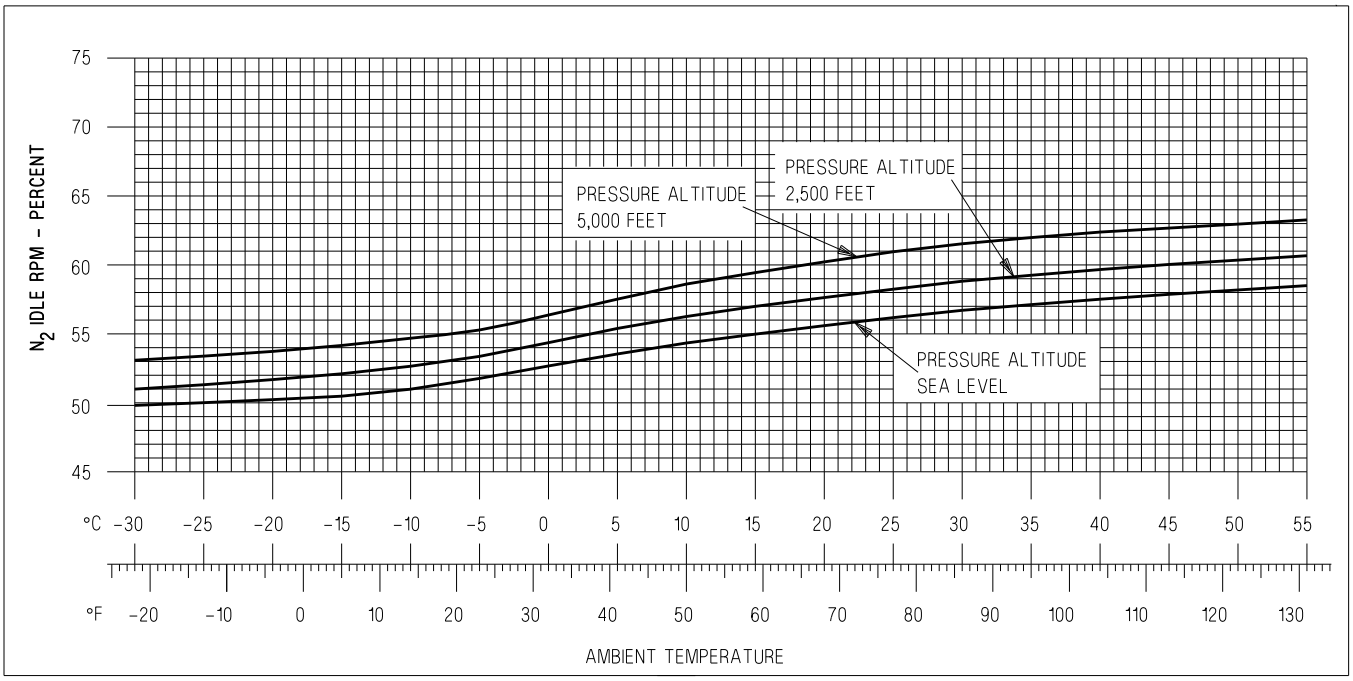

Figure 4-2. Engine Idle RPM

injected into Jet A or Jet A-1 the resultant fuel is essentially JP-8 and can be used without restrictions. Jet B blended with these additives is essentially JP-4 and may be used with the same restrictions as JP-4.

4.5 AIRSPEED LIMITATIONS

Maximum permissible airspeeds in the clean configuration are shown in Figure 4-4. Limitations due to specific aircraft systems are shown in Figure 4-3.

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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

Figure 4-3. System Operation Limitations

4.6 ANGLE-OF-ATTACK LIMITATIONS

1. 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. High gain nose wheel steering shall be used for low speed taxi operations only (less than 10 knots groundspeed).

3. 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.

4. For landings in a configuration other than those described above, sink rate shall not exceed 600 fpm.

4.10 BANNER TOWING

Banner towing is permitted using the TDU-32/B tow banner with the following limits:

1. Banner tow release unit shall have IAAC-926 incorporated. Banner tow operations without IAAC-926 incorporated are not authorized.

2. Banner tow operations:

   a. Maximum altitude 20,000 feet MSL.

   b. Maximum airspeed 220 KIAS.

   c. Maximum bank angle 45 degrees.

   d. Maximum AOA 18 units.

   e. CONTR AUG switch in ALL.

3. Banner tow release:

   a. Minimum banner release altitude 500 feet AGL.

   b. Banner release airspeed 140 to 200 KIAS.

   c. For banner release between 140 to 150 KIAS utilize 1/2 flaps.

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:

(1) 21 percent MAC for greater than 0.80 Mach.

(2) 23 percent MAC for less than or equal to 0.80 Mach.

b. Gear Down:

(1) 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.

2. Aircraft with arresting hook point assembly, part number DA327A5213-501, carrier arrestments are not authorized.

4.16 EXTERNAL STORES LIMITATIONS

1. Only the external stores shown in the External Stores Limitations chart, Figure 4-6, are permitted for carriage. LBA refers to the limits of the basic aircraft.

WARNING

Only WTU-1/B and MK 67 warheads are authorized.

2. Carrier operations with other than clean loading prohibited.

3. Landings with LAU-68 rocket pod (empty or full) or PMBR (with 1 or more bombs) shall not exceed 600 fpm.

4. Carriage of wing-mounted stores with the baggage pod is not authorized.

5. Baggage pod carriage limited to centerline station only.

6. Lateral stick and rudder pedal inputs with carriage of baggage pod is limited to half, except as needed for crosswind landings.

7. Maximum crosswind component with carriage of baggage pod is 10 knots.

8. Maximum amount of load in the baggage pod is 60 pounds of soft luggage (jacket, or bag containing clothing, shave kit, etc.) distributed as follows:

a. 30 pounds secured in the aft compartment and 30 pounds secured in the forward compartment.

b. The contents shall be secured to prevent shifting during maneuvering flight.

c. The center of gravity limits of the loaded pod shall be between 1 and 9 inches aft of the rear suspension lug.

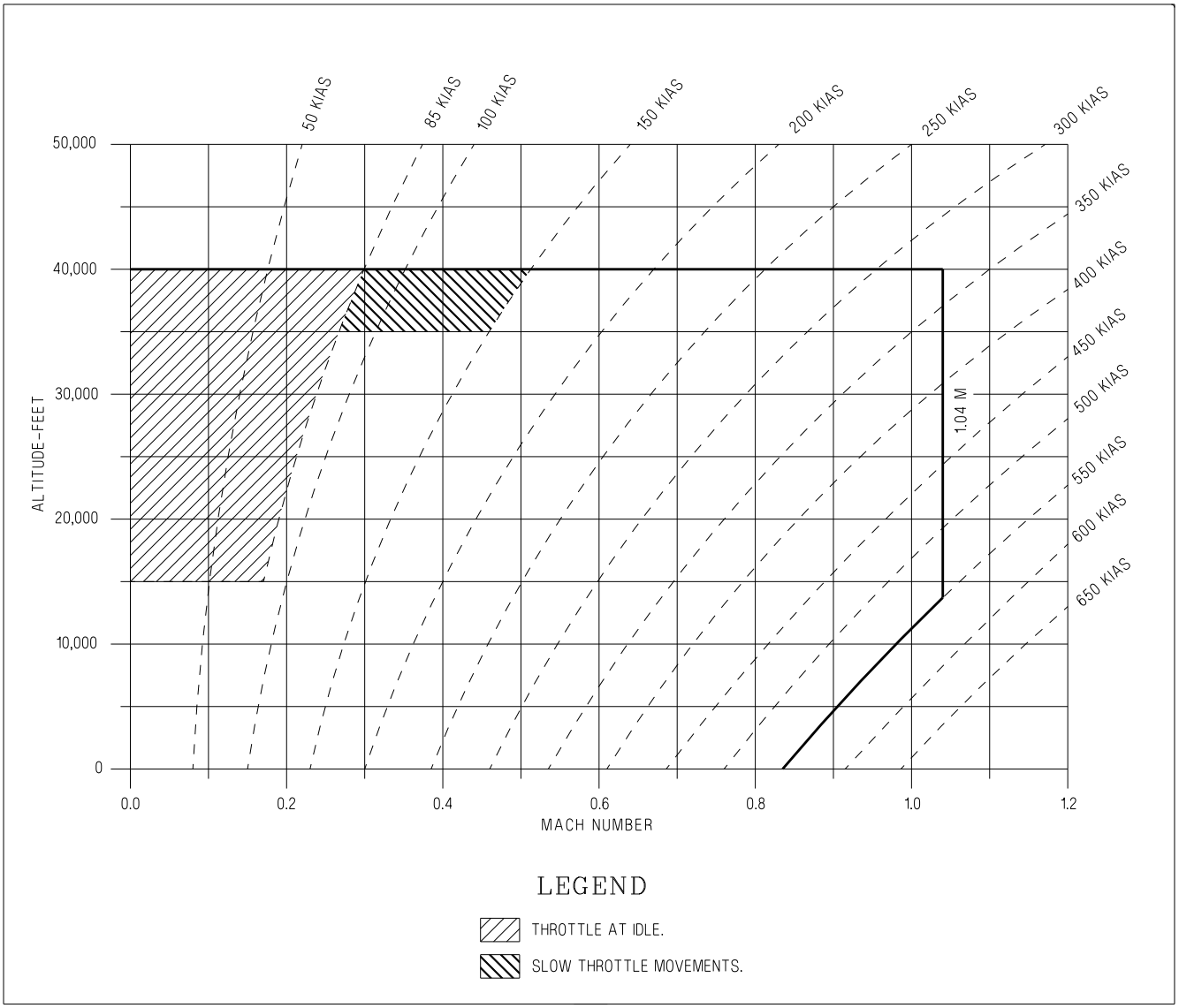
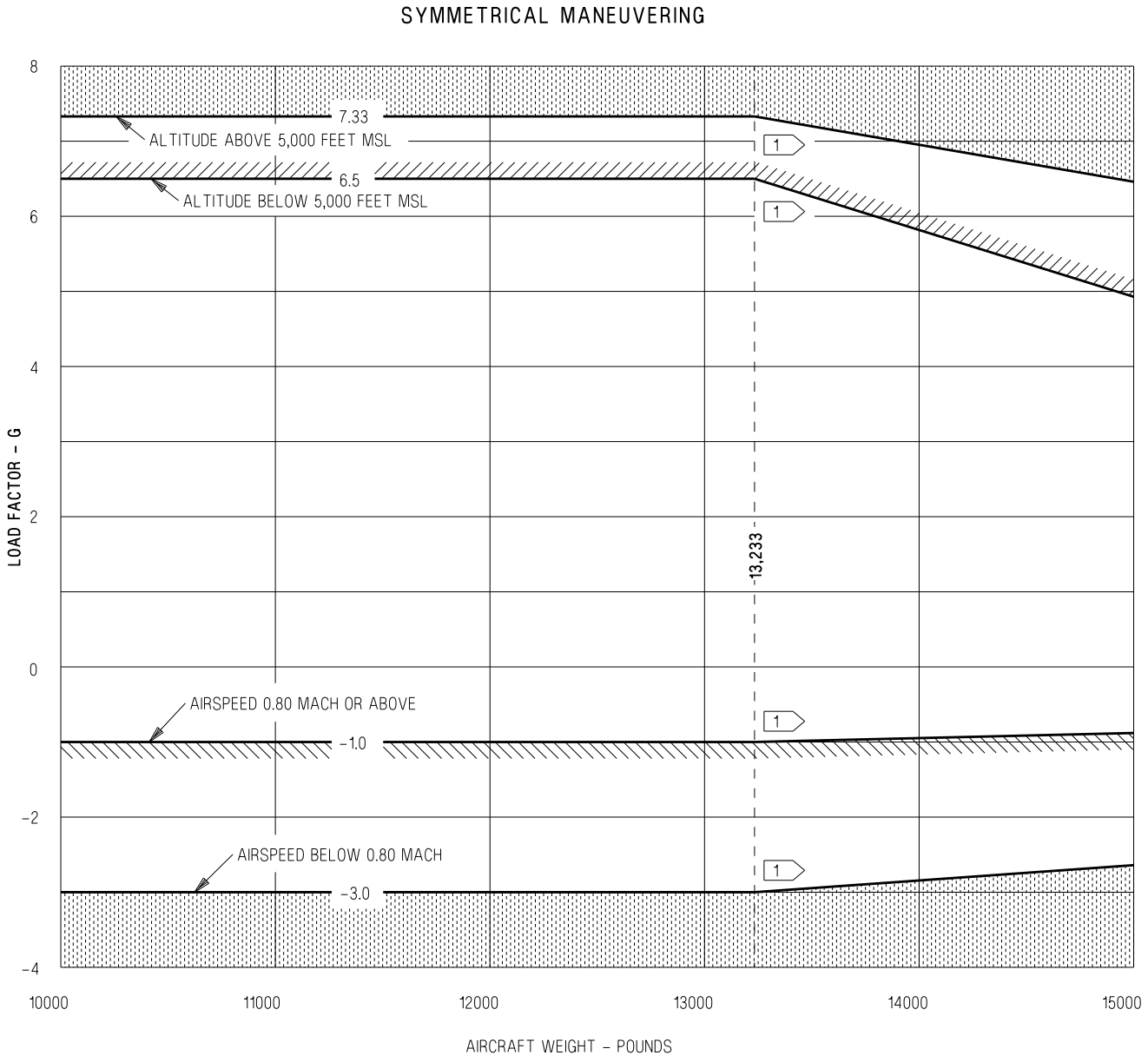


Figure 4-4. T-45C Operating Envelope



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.

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

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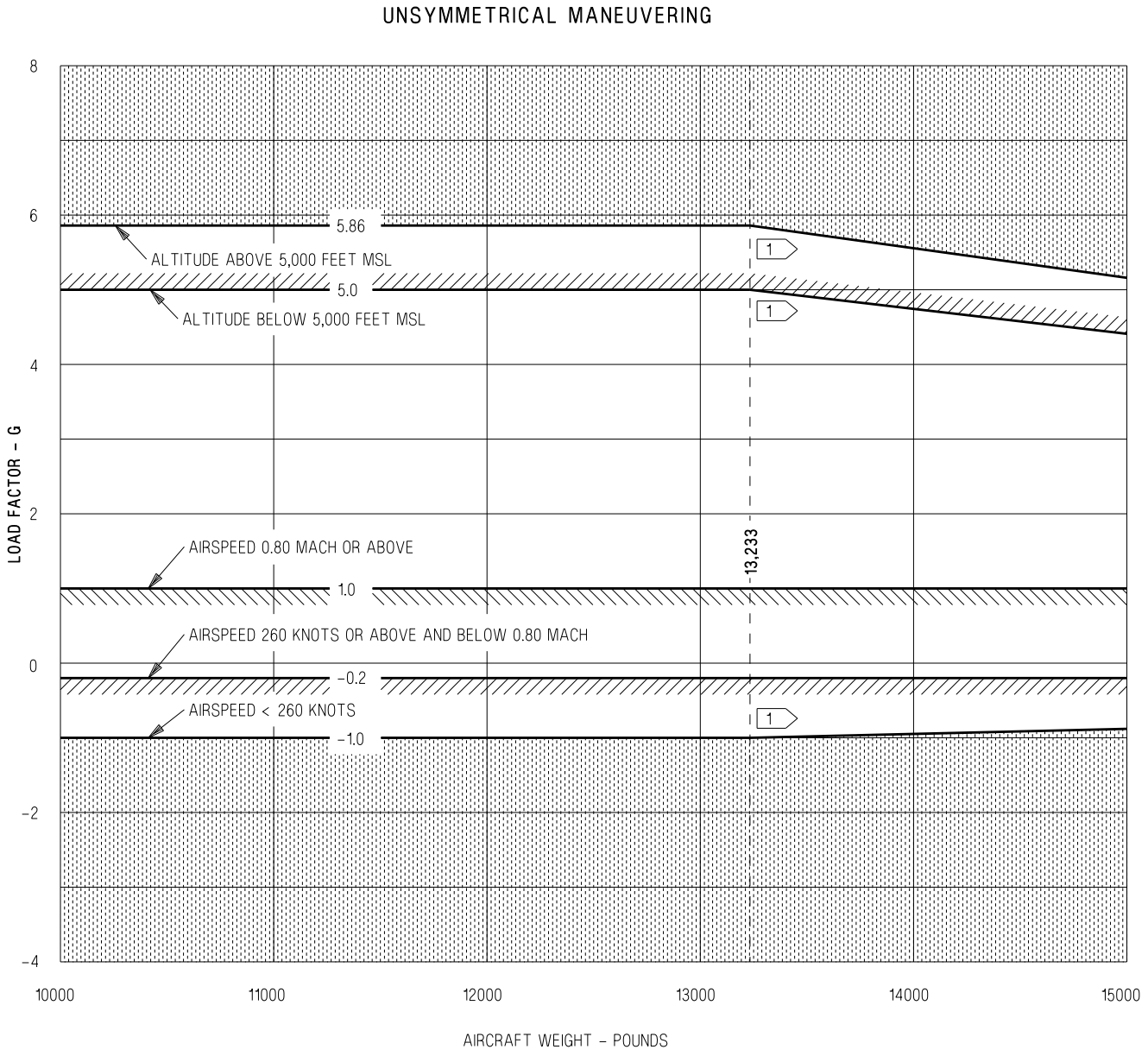
Figure 4-5. T-45C Acceleration Limits (Sheet 1 of 2)



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.

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Figure 4-5. T-45C Acceleration Limits (Sheet 2 of 2)

LBA - LIMIT BASIC AIRCRAFT

STORE	DISTANCE FROM AIRCRAFT CENTERLINE-INCHES			AIRSPEED - MAXIMUM AIRSPEED OR MACH WHICHEVER IS LESS			ACCELERATION - G				MAXIMUM DIVE ANGLE (DEGREES)	ANGLE OF ATTACK LIMITS (UNITS)	CG LIMITS % MAC	CONFIGURATION WEIGHTS (LBS)	APPLICABLE NOTES
	STATION LOADING AND SUSPENSION						CARRIAGE		JETTISON						
	RIGHT	CENTER	LEFT	CARRIAGE (KIAS)	JETTISON (KIAS)	RELEASE (KTAS)	SYM	UNSYM	JETTISON	RELEASE					
Pylon				525/ 0.80	—	—	LBA	LBA	—	—	LBA	LBA	LBA	Wing/77	1, 2, 3
PMBR with 0 to 6 Mk-76 Bombs				525/ 0.80	300	500/ 0.80	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	PMBR/87 MK76/25 each	
LAU-68 with 0 to 7 2.75" FFAR				525/ 0.80	200 TO 350	500/ 0.80 MIN A/S 350 MAX ALT 10,000 FT MSL	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	LAU-68/85 FFAR/21 each	
MIXED LOAD LAU-68 with 0 to 7 2.75" FFAR and PMBR with 0 to 6 Mk-76 Bombs				525/ 0.80	300	500/ 0.80 FFAR MIN A/S 350 MAX ALT 10,000 FT MSL	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	PMBR/87 MK76/25 each LAU-68/85 FFAR/23 each	1, 2, 3

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Figure 4-6. External Stores Limitations (Sheet 1 of 2)

LBA – LIMIT BASIC AIRCRAFT

STORE	DISTANCE FROM AIRCRAFT CENTERLINE–INCHES			AIRSPEED – MAXIMUM AIRSPEED OR MACH WHICHEVER IS LESS			ACCELERATION – G				MAXIMUM DIVE ANGLE (DEGREES)	ANGLE OF ATTACK LIMITS (UNITS)	CG LIMITS % MAC	CONFIGURATION WEIGHTS (LBS)	APPLICABLE NOTES
	STATION LOADING AND SUSPENSION						CARRIAGE		JETTISON						
	RIGHT	CENTER	LEFT	CARRIAGE (KIAS)	JETTISON (KIAS)	RELEASE (KTAS)	SYM	UNSYM	JETTISON	RELEASE					
SINGLE PMBR with 0 to 6 Mk–76 Bombs				525/ 0.80	300	500/ 0.80	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	PMBR/87 MK76/25 each	1, 2, 3
SINGLE LAU–68 with 0 to 7 2.75" FFAR				525/ 0.80	200 TO 350	500/ 0.80 MIN A/S 350 MAX ALT 10,000 FT MSL	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	LAU–68/78 FFAR/21 each	1, 2, 3
Baggage Pod				300/ 0.70	—	—	GR UP FLP UP 0 TO 3.0 GR DN 0 TO 2.0	GR UP FLP UP 1.0 TO 2.0 GR DN 1.0 TO 1.5	—	—		MIN 8 MAX 21.5 (stall tone)	LBA	POD/50 PYLON/58	4, 5

NOTES

1. MIXED WING–MOUNTED STORES OR PYLONS CONFIGURATIONS ARE AUTHORIZED.
2. EITHER LEFT OR RIGHT WING STATION.
3. WING–MOUNTED STORES OR PYLONS MAY BE CARRIED SYMMETRICALLY OR ASYMMETRICALLY. MOST RESTRICTIVE LIMITATIONS APPLY.
4. BAGGAGE POD CARRIAGE LIMITED TO CENTERLINE STATION ONLY.
5. BAGGAGE POD CARRIAGE NOT AUTHORIZED WITH WING MOUNTED STORES.
6. ONLY MK66 MOD 2 AND 4 ROCKETS CONFIGURED WITH MK67 OR WTU–1/B WARHEADS ARE AUTHORIZED. ALL OTHER MOTOR/WARHEAD COMBINATIONS ARE PROHIBITED. REFER TO CHAPTER 22 FOR DETAILS.

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Figure 4-6. External Stores Limitations (Sheet 2 of 2)

PART II

INDOCTRINATION

Chapter 5 - Indoctrination

CHAPTER 5

Indoctrination

5.1 INTRODUCTION

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

In accordance with OPNAVINST 3710.7, 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.

PART III

NORMAL PROCEDURES

Chapter 6 - Flight Preparation

Chapter 7 - Shore-Based Procedures

Chapter 8 - Carrier-Based Procedures

Chapter 9 - Special Procedures

Chapter 10 - Functional Check Flight Procedures

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

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. Recommended preflight path is depicted in Figure 7-1.

7.2.1 Exterior Inspection. The exterior inspection is divided into 13 areas (Figure 7-1). 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.

WARNING

- 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

WARNING

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

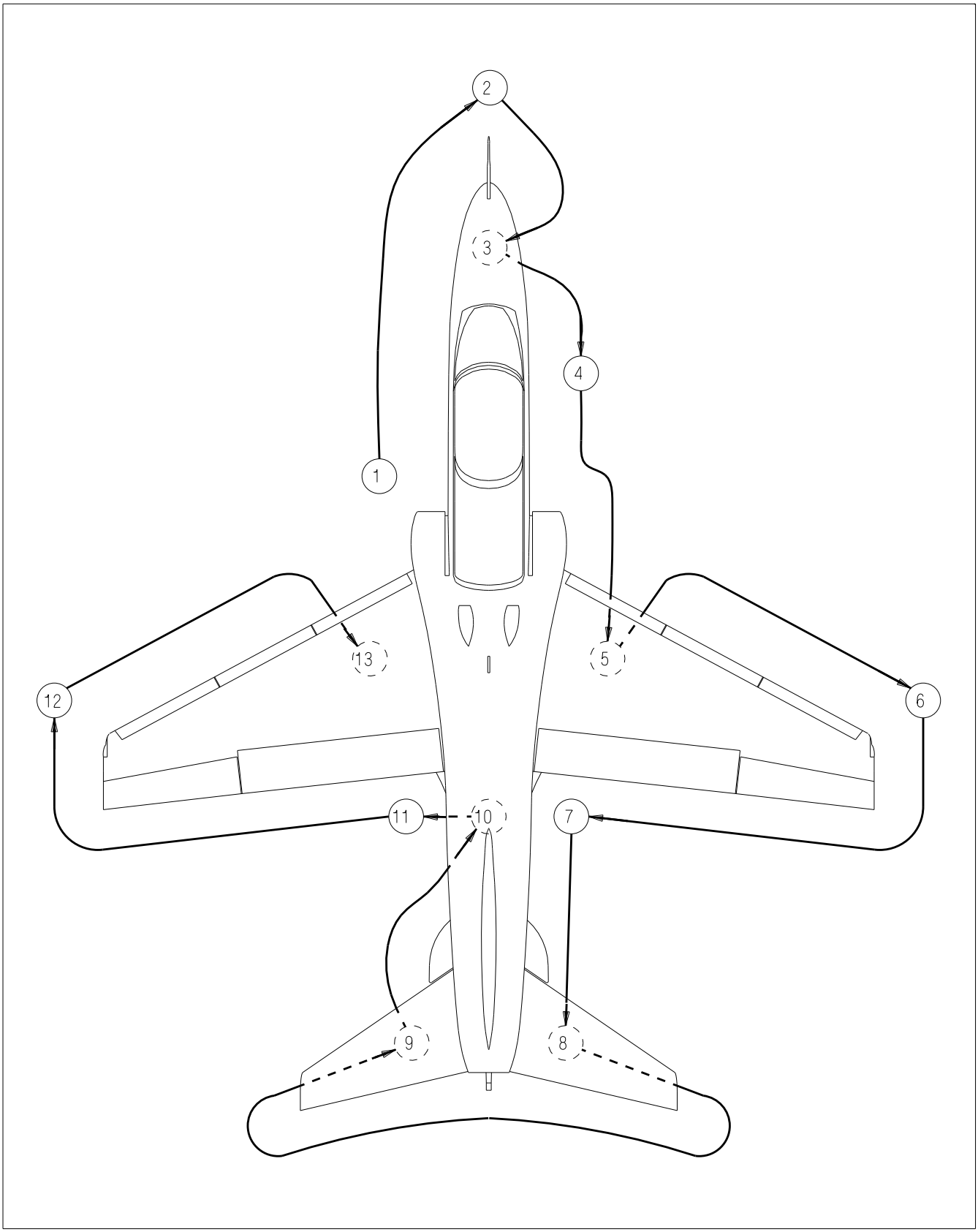

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Figure 7-1. Exterior Inspection

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

WARNING

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

WARNING

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:

WARNING

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.

CAUTION

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
See Figure 7-2.

(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

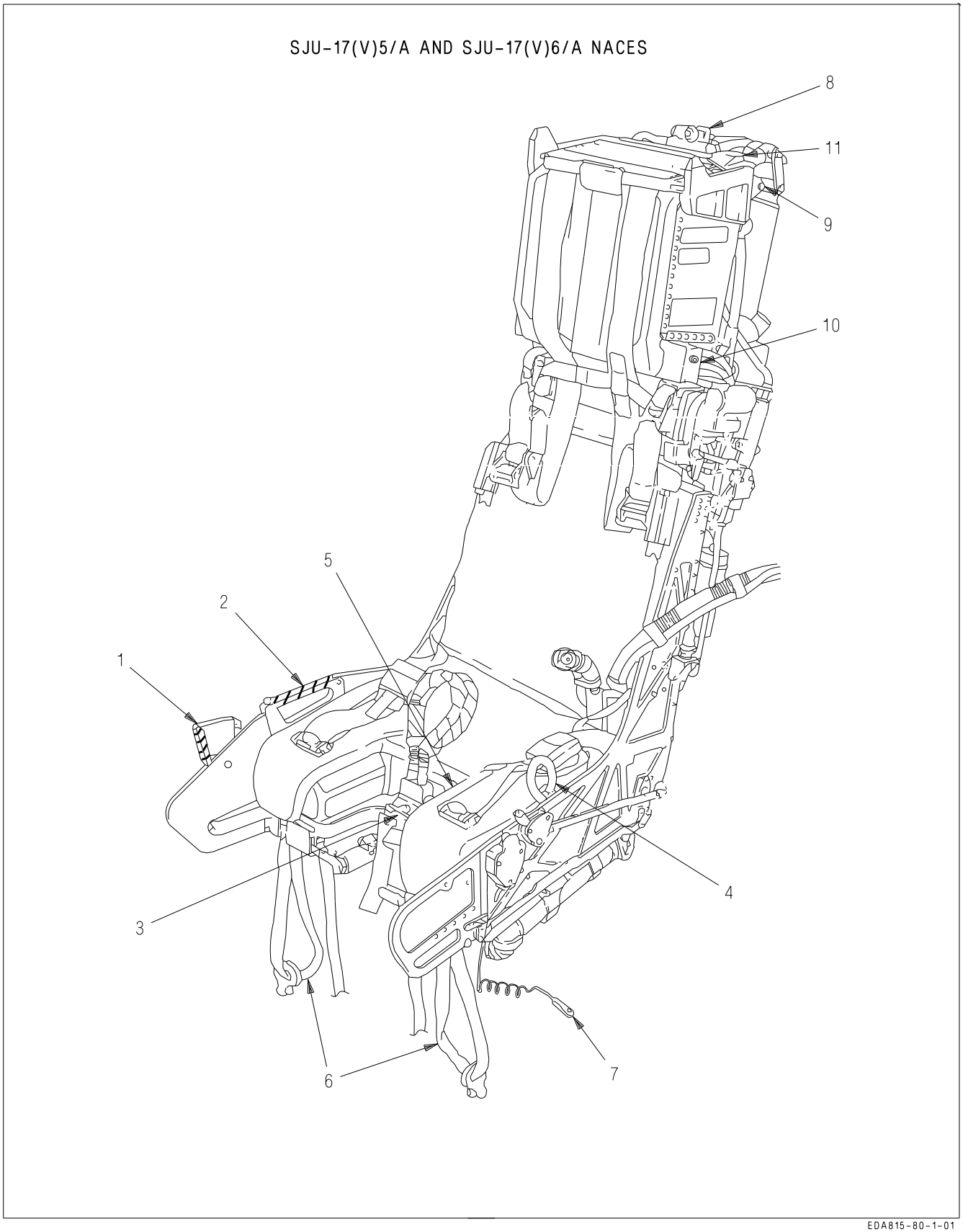

Figure 7-2. Ejection Seat Inspection

(8) Catapult manifold valve - SECURED, HOSE CONNECTED AND RETAINING PIN INSTALLED

(9) Top latch mechanism - SPIGOT INDICATOR IS FLUSH WITH END OF TOP LATCH PLUNGER

WARNING

If 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

CAUTION

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.

WARNING

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 FULL DOWN 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.

WARNING

- 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. Refer to Figure 2-30, Leg Restraint System.

- 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

7.4 INTERIOR CHECK

7.4.1 Forward Cockpit.

1. OBOGS FLOW selector - OFF

2. OBOGS/ANTI-G switch - OFF

3. FUEL SHUTOFF handle - LOCKED (DOWN)

4. IGNITION switch - NORMAL (GUARDED)

5. DISPLAY POWER switch - NORM

6. FUEL CONTRL switch - NORMAL

CAUTION

If MANUAL fuel is selected in either cockpit prior to engine start, the M FUEL advisory light will not be illuminated until the ENGINE switch is placed to START.

7. ENGINE switch - ON

8. RUDDER TRIM knob - NEUTRAL

9. CONTR AUG switch - SBI

10. STBY STAB TRIM switch - GUARDED

11. Throttle friction - OFF

12. Throttle - OFF

13. EXTERIOR LIGHTS master switch - AS REQUIRED

14. FLAPS/SLATS lever - UP

15. ANTI-SKID switch - ON

16. EMER FLAP switch - NORM

17. LAUNCH BAR switch - RETRACT

18. EMER GEAR handle - IN

19. LDG GEAR handle - DOWN

20. MASTER ARM switch - SAFE

21. VCR switch - OFF

22. Flight instruments - SET/CHECK

    a. Standby VSI - ZERO (note any error)

b. Standby attitude indicator - OFF FLAG VISIBLE

c. Standby barometric altimeter - SET BAROMETRIC PRESSURE

d. Standby airspeed indicator - CHECK

e. Standby turn and slip indicator - CENTERED

f. AOA indexer/indicator - CHECK OFF/ FLAG IN VIEW

g. HUD - OFF

h. MFDs - OFF

i. CABIN pressure altimeter - CHECK

23. UHF/VHF No. 1 radio - OFF

24. PITOT HEAT switch - OFF

25. HOOK BYP switch - AS REQUIRED

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

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

40. Exterior lights - AS REQUIRED

41. A-COLL/STROBE light switch - A-COLL

7.4.2 Aft Cockpit. Steps 1 thru 13 must be accomplished prior to engine start.

1. MDL cartridge - LOAD
   Should be installed before electrical power is applied to aircraft. Data is used for GPS information to reduce GINA alignment time. Cartridge must remain in aircraft for the entire flight if MDL waypoints are to be used.

2. VCR switch - OFF

3. VCR - LOAD

4. VCR module - FULLY SEATED, LOCKING BAR SECURE, AND WHITE TAPE NOT VISIBLE

5. Command ejection selector - AS REQUIRED

6. SEAT LIGHT switch - NORMAL

7. OBOGS FLOW selector - OFF

8. FUEL CONTR switch - NORMAL

CAUTION

If MANUAL fuel is selected in either cockpit prior to engine start, the M FUEL advisory light will not be illuminated until after the throttle is placed to IDLE and fuel flow is indicated.

9. ENGINE switch - ON

10. RUDDER TRIM knob - NEUTRAL

11. STBY STAB TRIM switch - GUARDED

12. Throttle - OFF

13. FLAPS/SLATS lever - UP

14. ANTI-SKID switch - ON

15. EMER FLAP switch - NORM

16. EMER GEAR handle - STOWED

17. LDG GEAR handle - DN

18. MASTER ARM OVERRIDE switch - **(T-45A)** NORMAL/**(T-45C)** FORWARD

19. RTCL light switch - OFF

20. Flight instruments - SET/CHECK

    a. Standby VSI - ZERO (note any error)

    b. Standby attitude indicator - OFF FLAG VISIBLE

    c. Standby barometric altimeter - SET BAROMETRIC PRESSURE

    d. Standby airspeed indicator - CHECK

    e. Standby turn and slip indicator - CENTERED

    f. AOA indexer/indicator - CHECK OFF/ FLAG IN VIEW

    g. MFDs - OFF

    h. CABIN pressure altimeter - CHECK

21. UHF/VHF No. 1 radio - OFF

22. Clock - SET

23. HOOK handle - UP

24. COMM control panel - AS DESIRED

25. VOR/ILS - OFF

26. TACAN - OFF

27. UHF/VHF No. 2 radio - OFF

28. AC RESET switch - CENTERED

29. GEN switch - ON

30. Interior lights - AS DESIRED

31. WARN/CAUT lights switch - AS DESIRED

7.5 PRESTART CHECKS

1. Battery switches

    a. BATT 1 and BATT 2 - ON

WARNING

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

    c. BATT 1 and BATT 2 - CHECK ON

2. Seat - ADJUST

3. ICS - CHECK

4. Fuel quantity - CHECK

5. MASTER ALERT light - OUT

6. Advisory panel lights - ENSURE ANTI-SKID ON

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

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

16. Canopy - AS DESIRED

WARNING

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

7.6 STARTING ENGINE

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.

CAUTION

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.

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.

WARNING

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

CAUTION

- 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

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.

3. FUEL CONTR switch - NORMAL
   M FUEL advisory light goes out and ensure previous RPM is achieved.

4. HYD 2 RESET button - PRESS
   Check that HYD 2 caution light goes 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 PER FIGURE 4-2.

NOTE

Bleed valve closure can be confirmed by noting RPM increases approximately 3 percent and EGT decreases by 50° C from previous indications.

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 decrementing (if alignment completes QUAL will be removed and velocity vector displayed)

If alignment QUAL is not decrementing -

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

    d. Waypoint zero - ENTER

    e. After 50 seconds verify QUAL begins to decrement

If alignment QUAL is decrementing and GPS tracking four satellites -

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.

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

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

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.

20. Waypoints - PROGRAM

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.

23. Oxygen mask - ON/CONFIRM FLOW

24. ANTI-G test button - PRESS

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

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

WARNING

Ensure ground personnel are clear of aircraft before actuating flight controls, flaps/slats, speed brakes, arresting hook, and gear doors.

7.8 TAXI

WARNING

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

CAUTION

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

2. ANTI-SKID switch - ON

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 7-3 for typical field takeoff.

CAUTION

With carrier pressurized tires, static MRT checks may cause the tires to skid, possibly resulting in breach of the tire carcasses.

NOTE

Static runups with carrier pressurized tires should be accomplished at or below 90% N_2, with MRT limiters being checked after brake release.

OAT° F	N_2 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.

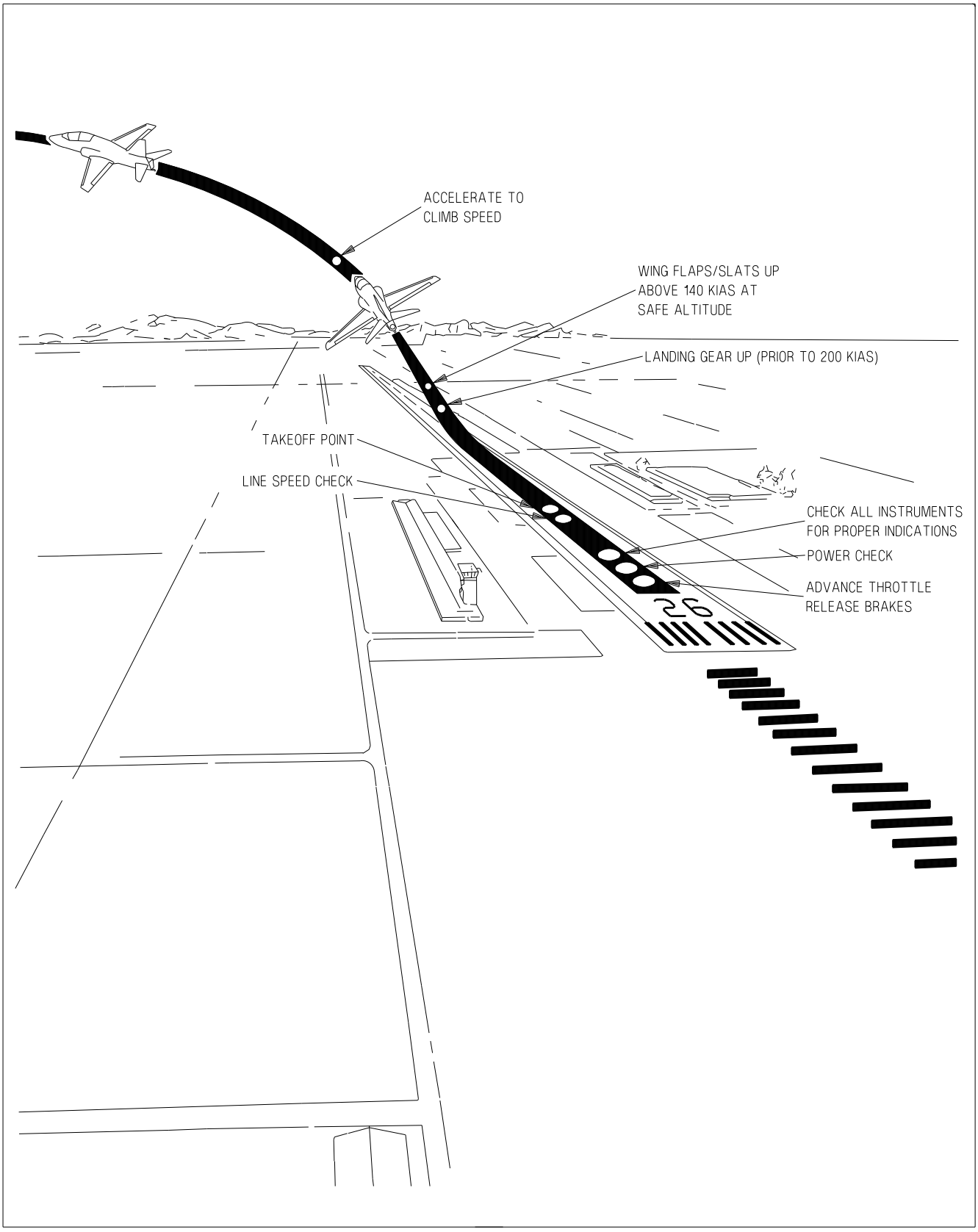

Figure 7-3. Field Takeoff (Typical)

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)

CAUTION

- 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.

1. Canopy defog and cockpit temperature - AS REQUIRED BEFORE THROTTLE REDUCTION
2. MASTER ARM switch - SAFE
3. CONTR AUG switch - ALL
4. Weather/field conditions - CHECKED
5. NAVAIDS - TUNED/IDENTIFIED
6. **(T-45A)** SAHRS - CHECK/ALIGN
7. Standby attitude indicator - ERECT
8. Standby barometric altimeter - SET BAROMETRIC PRESSURE
9. **(T-45A)** Radar altimeter - SET
10. LAW - SET
11. MFDs/HUD - SELECT NAV MODE AND COMPARE DISPLAYS (ADI, HSI, and HUD) WITH STANDBY INSTRUMENTS
12. Fuel - CHECK

CAUTION

Sustained engine operation at less than 70% N_2 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

5. Speed brakes - AS REQUIRED

6. Anti-skid - AS REQUIRED

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 200 KIAS, 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.

CAUTION

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. When the ANTI-SKID switch is set to OFF the approach idle stop will not retract until 2 seconds after weight-on- wheels.

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 7-4 for a typical field landing.

CAUTION

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).

CAUTION

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 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
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.

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)
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 ±2% OF IDLE RPM PER FIGURE 4-2.

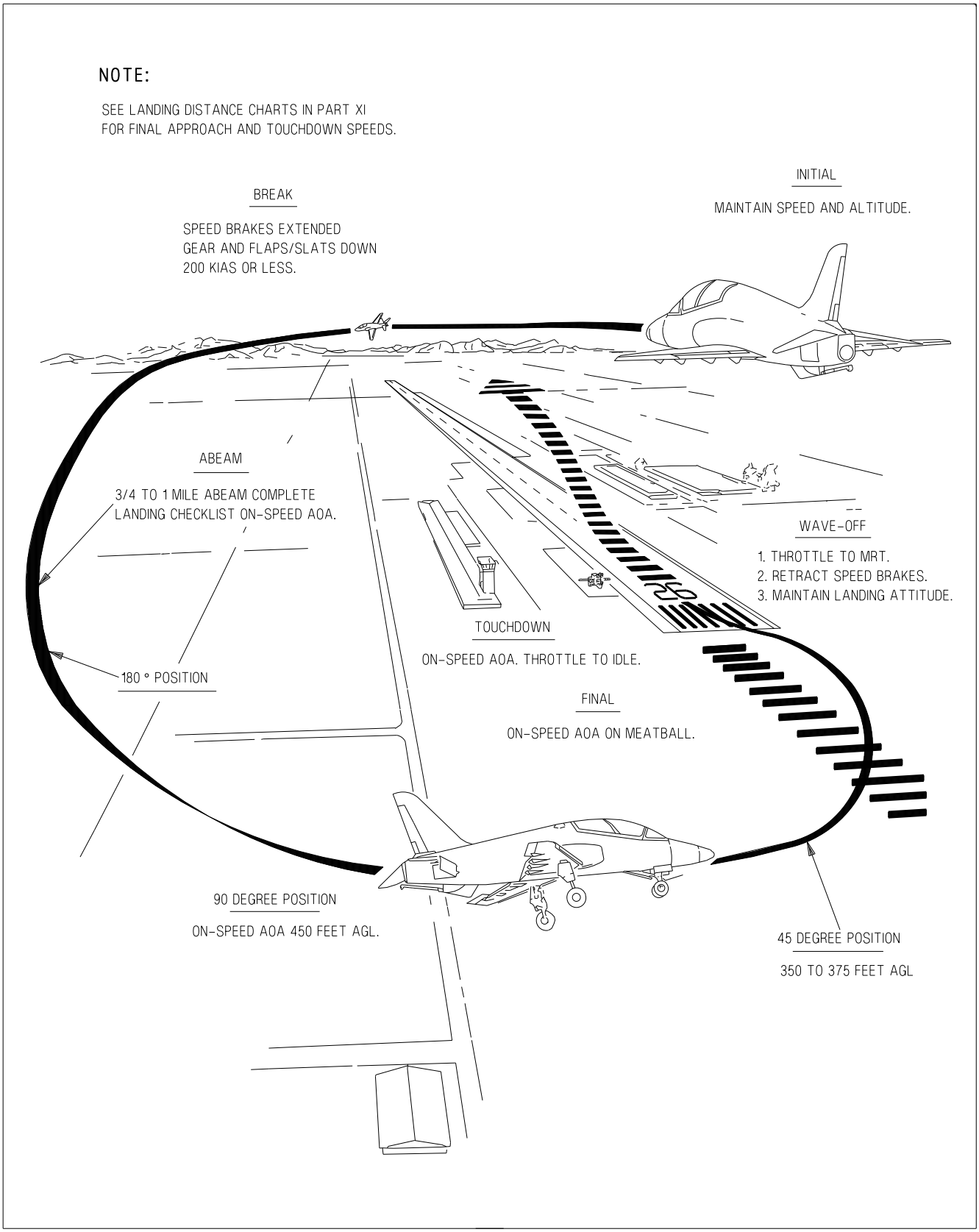

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Figure 7-4. Field Landing Pattern (Typical)

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

WARNING

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

CAUTION

The engine should not be shut down from a high power setting except in an emergency condition.

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)
6. Fuel shutoff handle - PULL
7. MDL cartridge - REMOVE
8. VCR - REMOVE, IF REQUIRED

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. Refer to Shipboard Alignment in Chapter 21.

WARNING

Anti-skid shall be off for all carrier operations.

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.

WARNING

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.

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.

CAUTION

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
2. ANTI-SKID switch - OFF
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

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.

CAUTION

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. See Figure 8-1.

CAUTION

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

2. ANTI-SKID switch - OFF

3. Flaps/Slats - FULL

4. Trim:

   a. Rudder and aileron - ZERO

   b. Stabilator - 3.5 DEGREES NOSE-UP

5. Canopy - CLOSED, LOCKED and LIGHT OUT

6. Harness - CONNECTED

7. Ejection Seat - ARMED

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.

WARNING

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.

WARNING

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

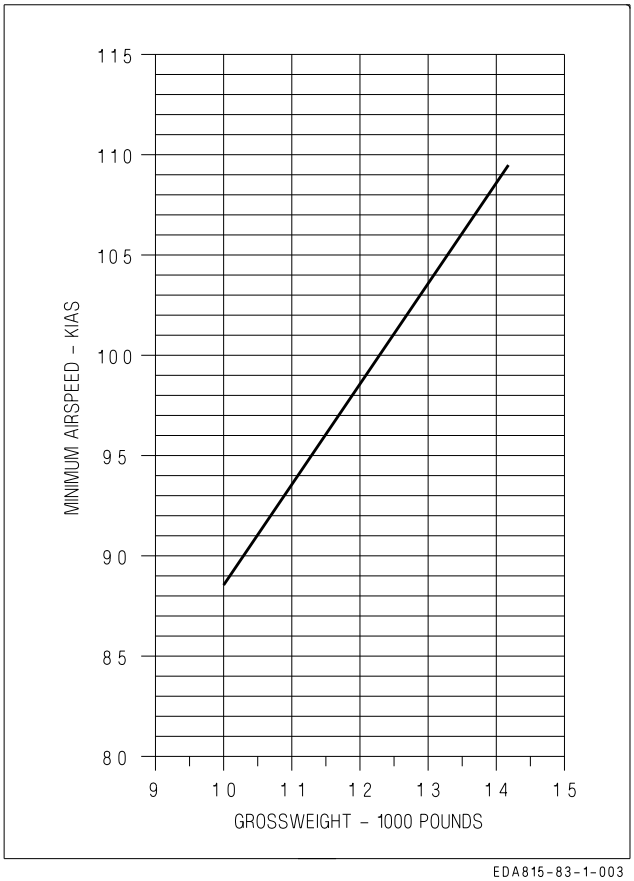

Figure 8-1. Catapult Launch Minimum Endspeed

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, see Figure 8-1. The minimum airspeed was determined during shipboard carrier suitability trials and is applicable for specific gross weights and ambient temperature conditions.

NOTE

- Figure 8-1 denotes the minimum catapult launch airspeed at 59 °F U.S. Standard Day. Most catapult launches are programmed to give 10 to 15 KIAS above the airspeeds depicted on the figure. Trim should be set at 3.5 degrees nose up.
- 15 KIAS above this airspeed results in no settling of the aircraft after launch.
- To correct for ambient temperature, increase the minimum airspeed by the following amount:

70 °F	2 KIAS
80 °F	3 KIAS
90 °F	4 KIAS

- Refer to A1-T45AB-NFM-300, Figures 26-11 through 26-13, for aircraft stall speeds.
- The speeds depicted in Figure 8-1 are applicable to any catapult.

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 (Figure 8-2) 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.

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.

WARNING

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.

CAUTION

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

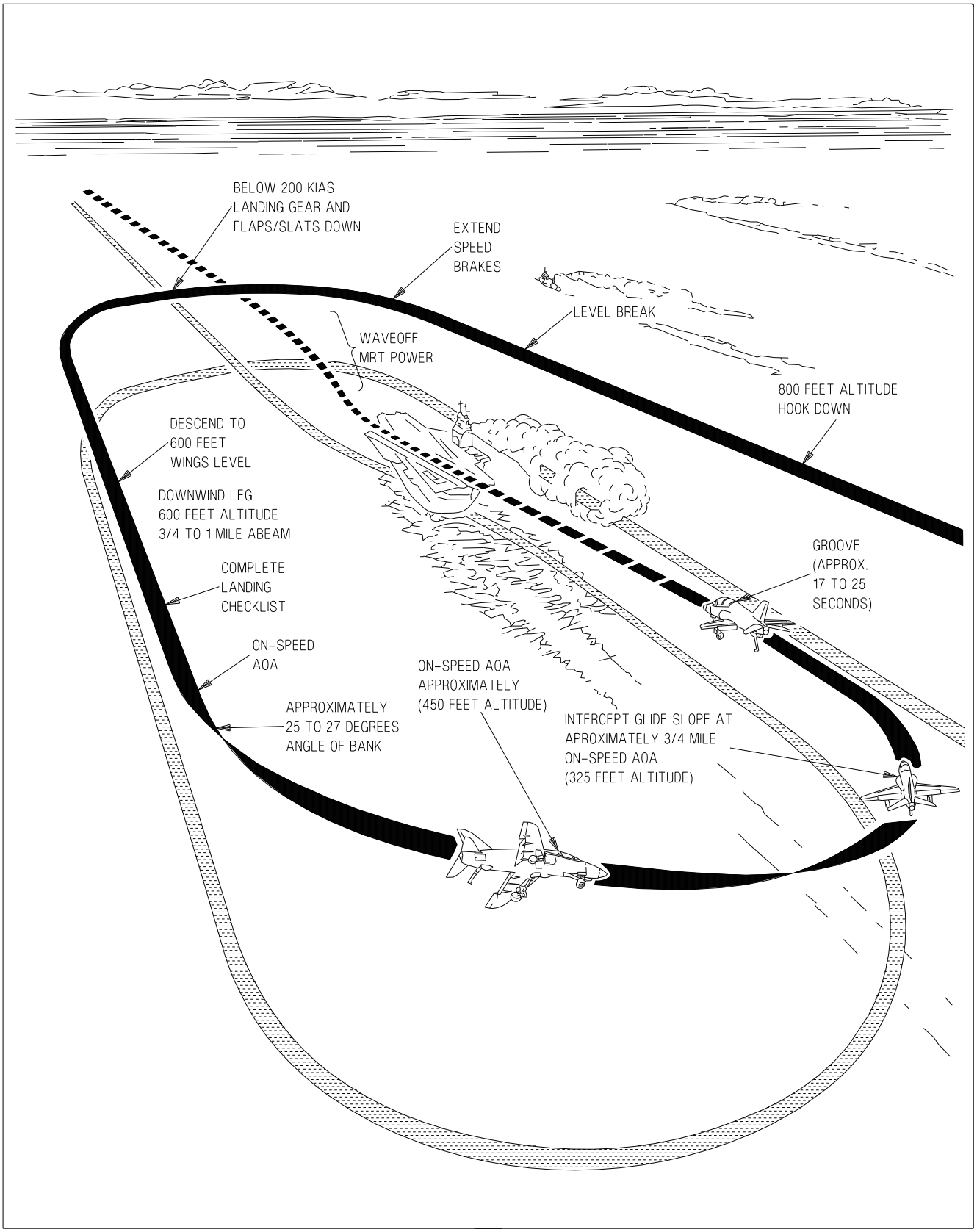

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Figure 8-2. Carrier Landing Pattern (Typical)

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. See Figure 8-3 for a typical CCA.

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

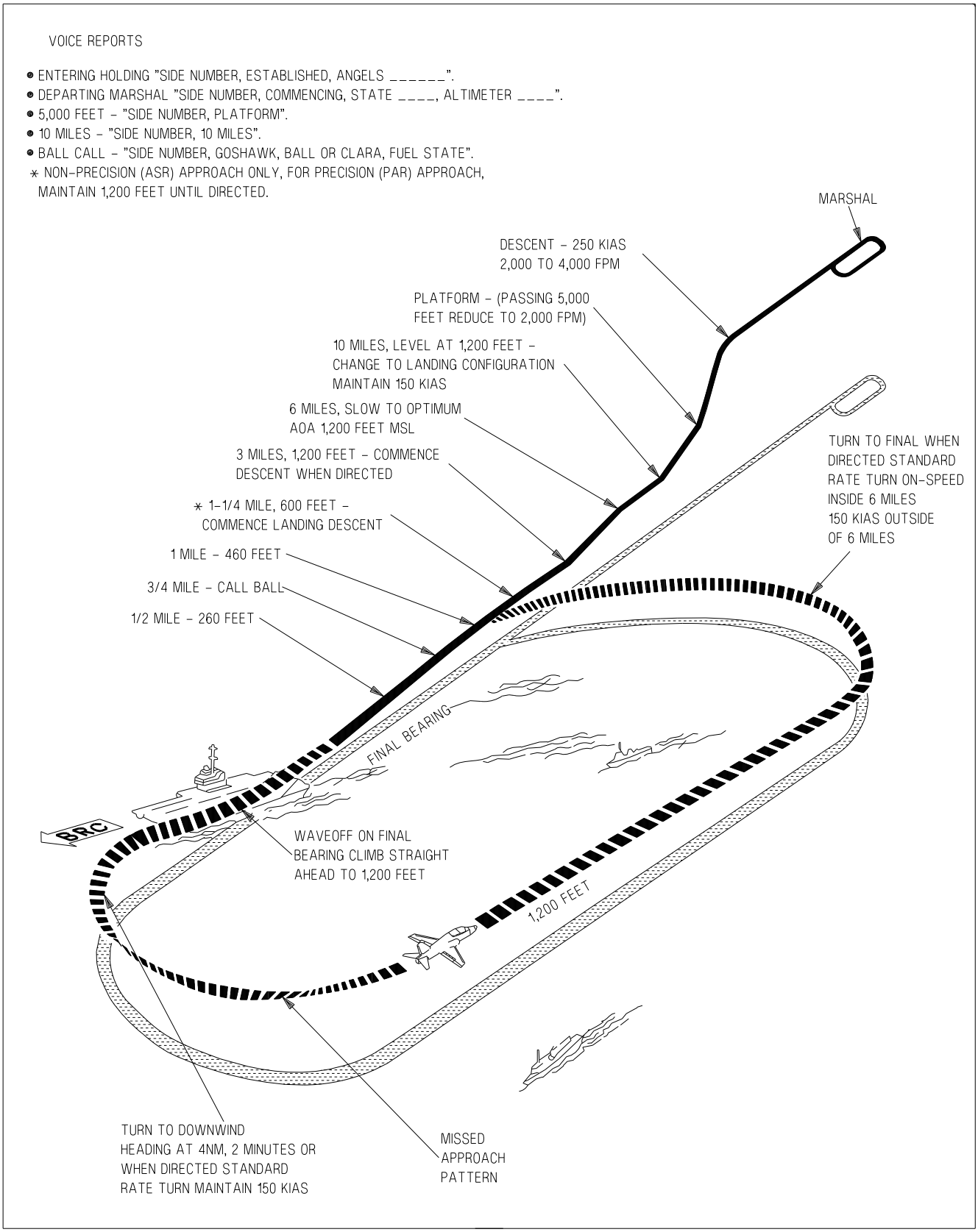

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Figure 8-3. Carrier Controlled Approach (CCA) (Typical)

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 9-1 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. See Figure 9-2.

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.

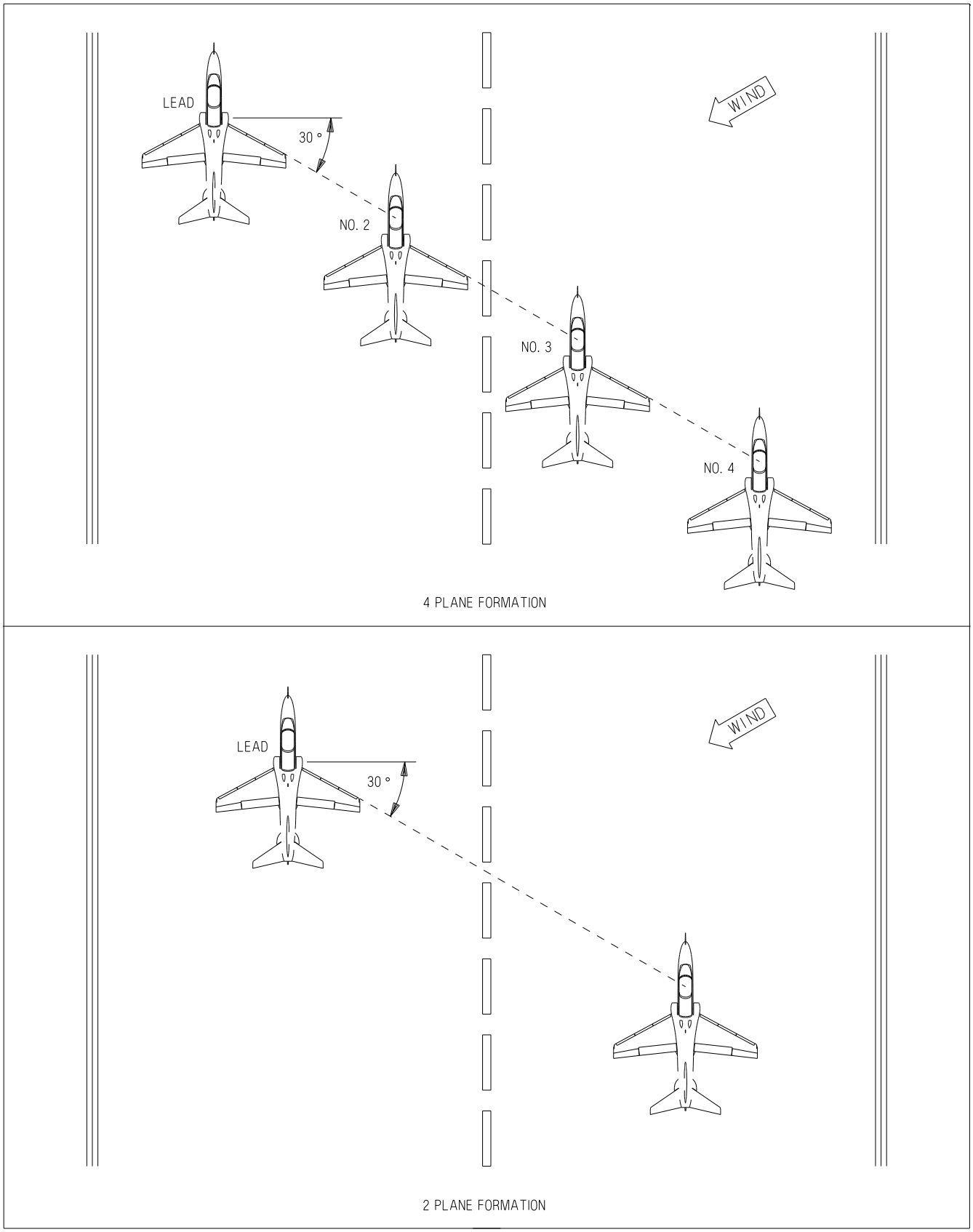

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Figure 9-1. Formation Takeoff Runway Alignments

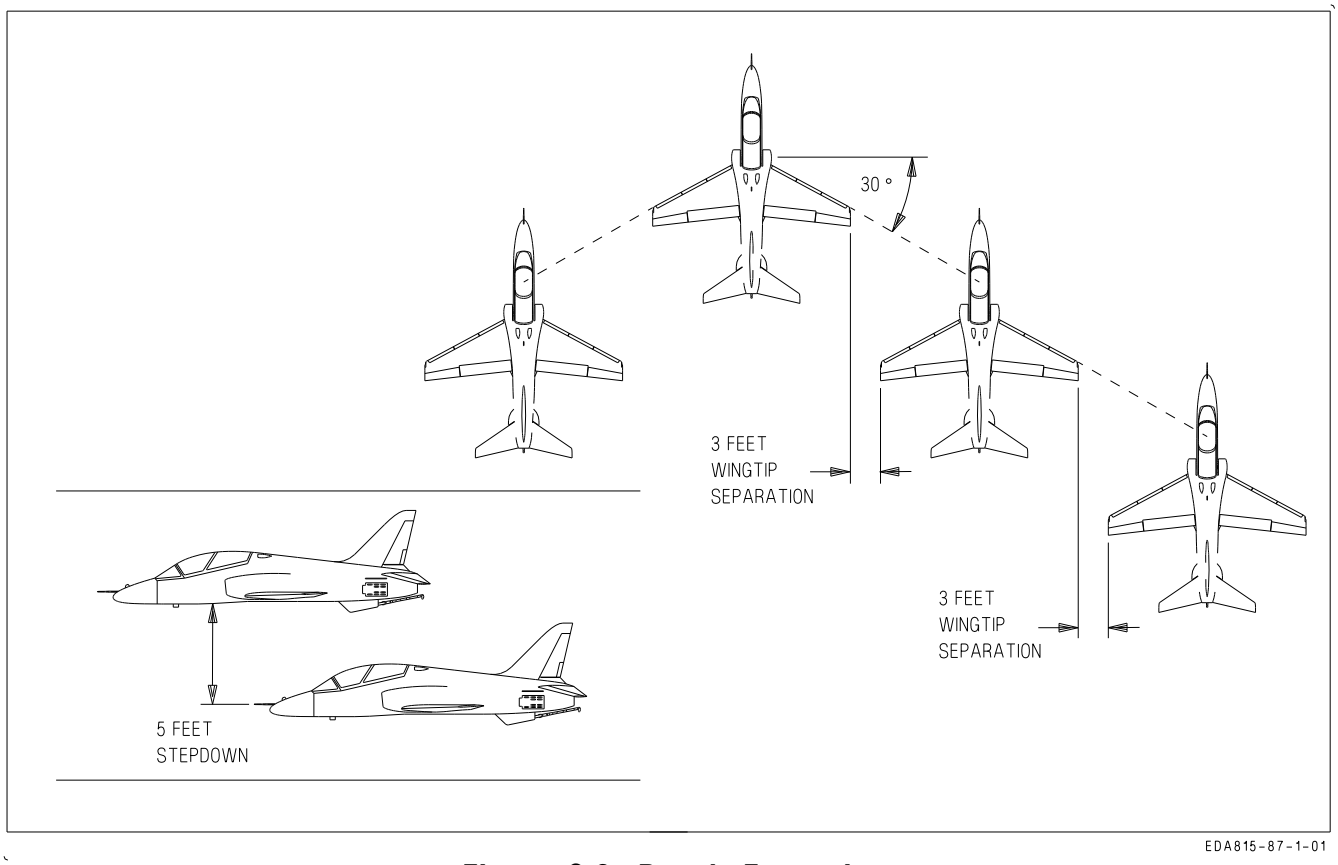

Figure 9-2. Parade Formation

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 degees) 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. See Figure 9-3.

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

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.

WARNING

- 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. Use normal takeoff performance data contained in Chapter 28.

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.

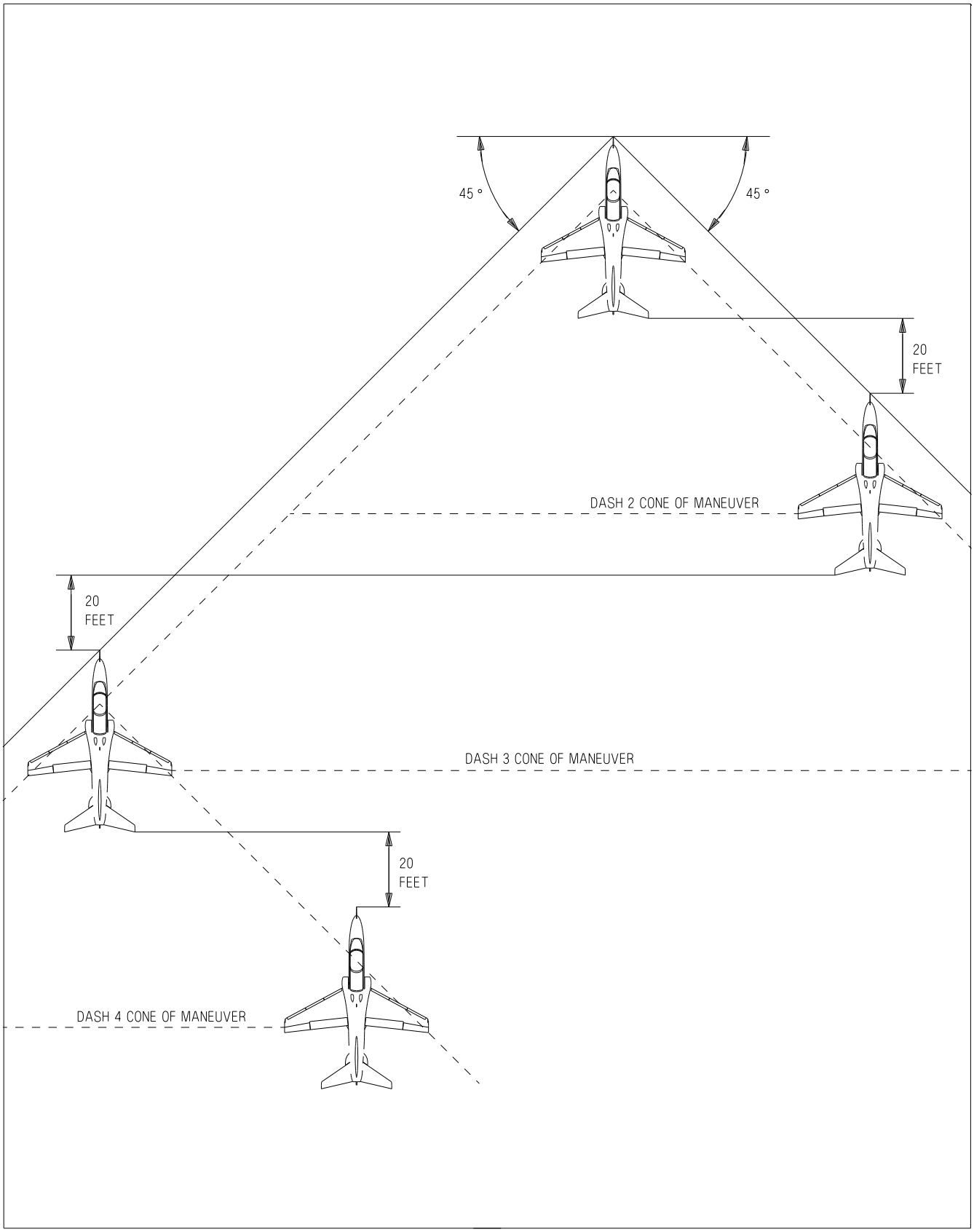

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Figure 9-3. Cruise Formation

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.

WARNING

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.

CAUTION

- 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.

CHAPTER 10

Functional Check Flight Procedures

10.1 GENERAL

Crew members performing functional check flight shall be qualified in accordance with OPNAVINST 3710.7 series and this manual. Crew members shall be provided a thorough briefing and a copy of the Functional Check Flight Checklist (A1-T45AC-NFM-700) by maintenance control personnel. The briefing should describe the requirements for the particular flight.

To complete the required checks in the most efficient and logical order, a flight profile has been established for each check flight condition and identified by the letter corresponding to the purpose for which the check flight is being flown. The applicable letter identifying the profile prefixes each check in the Functional Check flight Checklist, A1-T45AC-NFM-700. The post maintenance check flight procedures are specific, supplementary checks to be performed in conjunction with NATOPS normal procedures (Part III, Chapter 7). Check flight personnel shall familiarize themselves with these requirements before each flight. Thorough, professional check flights are a vital part of the maintenance effort. A daily inspection is required before each check flight.

Battery start procedures will be utilized for all functional check flights.

Flight checks shall be conducted in accordance with the criteria established by OPNAVINST 3710.7 series. OPNAVINST 4790.2 series directs when functional check flights shall be performed.

10.2 CONDITIONS REQUIRING CHECK FLIGHT

Perform applicable flight profile and associated checks in accordance with the following check flight conditions (requirements for which are outlined in OPNAVINST 4790.2):

A. At the completion of aircraft rework and all aircraft acceptances or as required. Constitutes a complete Functional Check Flight. Minimum checks required are prefixed by letter A.

B. After the installation of an engine or engine fuel control, or any component which cannot be checked in ground operation. Minimum checks required are prefixed by letter B.

C. When fixed or movable flight surfaces or flight control system components have been installed, reinstalled, adjusted or rerigged and improper adjustment or replacement of such components could cause an unsafe operating condition. Minimum checks required are prefixed by letter C.

Individual organizations may increase the number of checks required at their own discretion. See Figure 10-1 for the Functional Check Flight Profile.

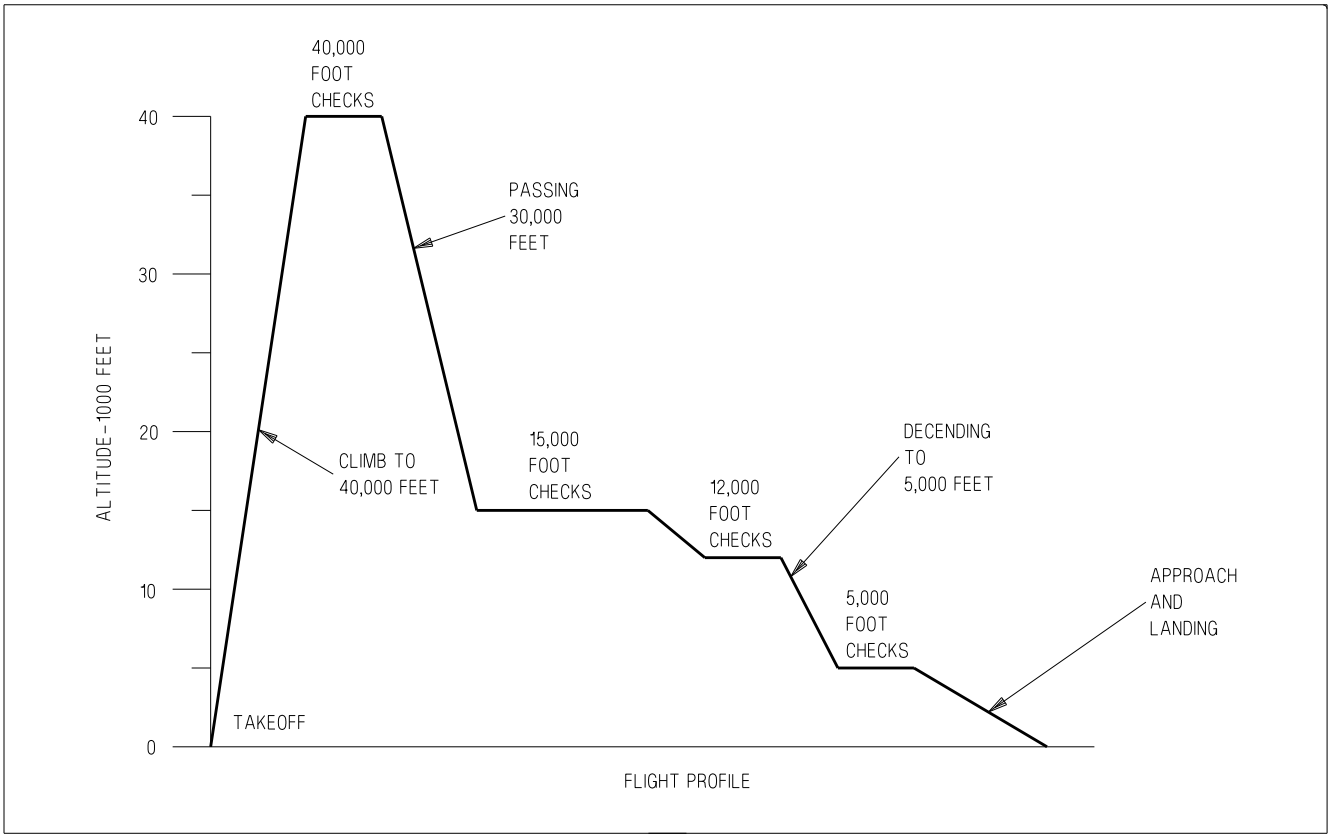


Figure 10-1. Functional Check Flight Profile

10.3 PREFLIGHT

1. (AB) Determine minimum RPM and EGT.

2. (ABC) Preflight and Interior Inspection - PERFORM
   Perform the preflight inspection in accordance with paragraph 7.2. Particular attention shall be made to check for improperly installed panels in those areas where maintenance has been performed. Perform the interior check in accordance with paragraph 7.4.

10.4 PRESTART

Perform prestart checks in accordance with paragraph 7.5, and the following, as required:

1. (A) Pitot heat - CHECK
   Ensure that the PITOT HEAT switch is at OFF and have ground crew check pitot head. Alert ground crew before placing PITOT HEAT switch to ON. Have ground crew confirm that pitot head is getting warm and return PITOT HEAT switch to OFF.

2. (AB) Ignition relay - CHECK
   Pull the FUEL SHUTOFF handle up (OFF position). Ensure the throttle and ENGINE switches OFF, IGNITION switch NORMAL, battery switches ON, and momentarily press and hold the GTS start button. Confirm igniter noise, release the GTS start button and verify ignition ceases.

NOTE

Irregular igniter snapping sound indicates both igniters are operating. A steady igniter snapping sound indicates only one igniter is operating.

3. (A) Throttle quadrant proximity switches - FUNCTIONAL CHECK

a. Ensure the canopy open and wheel chocks are in place. Confirm the CANOPY caution light is illuminated and no caution tone audible. Advance throttle to MRT and verify the MASTER ALERT light illuminates and caution tone is heard. Retard the throttle and check the MASTER ALERT and tone indications cease. The CANOPY light remains illuminated.

b. Canopy - CLOSE

c. Ensure all seat fittings connected, seat unarmed, and parking brake handle pulled. Advance throttle to MRT. Verify the SEAT and PK BRK caution lights illuminate, and caution tone is heard. Retard the throttle and check all warning/caution indications cease.

d. Advance throttle to MRT. Verify all warning/caution indications commence again. Place the ejection SAFE/ARM handle to ARM, release the parking brake verifying affected warning/caution indications cease.

e. Push the FUEL SHUTOFF handle down to the normal position.

4. (A) GTS - START, AFTER GTS START CYCLE IS INITIATED PLACE IGNITION SWITCH TO ISOLATE

10.5 ENGINE START

1. (A) Clear Engine procedure - PERFORM

2. (ABC) Engine start - PERFORM
   Perform engine start in accordance with paragraph 7.6. Check the following:

   a. GTS advisory light illuminates within 20 seconds after pressing GTS start button.

   b. READY advisory light illuminates within 15 seconds after momentarily placing the ENGINE switch to START.

   c. Engine light-off should occur within a maximum of 15 seconds after selecting idle.

   d. GTS and READY advisory lights go out at 45 ±2 percent RPM. (Normally occurs within 28 seconds after advancing the throttle to idle.)

   e. EGT - 550 °C MAXIMUM.

   f. RPM - NOTE; CHECK

   g. Idle EGT - MAX 450 °C

10.6 POSTSTART/PRETAXI

Perform poststart and pretaxi checks in accordance with paragraphs 7.7. Check the following :

1. (AB) Bleed valve closure - CHECK
   Advance the throttle slowly to 70 percent N_2 RPM. (Valve closure should occur at 61 ±4 percent N_2 RPM.)

   a. Place FUEL CONTR switch to MANUAL. A decrease of up to 6 percent N_2 RPM may be seen. Check M FUEL advisory light illuminates and that engine operation continues normally. Return FUEL CONTR switch to NORMAL and check the M FUEL light is extinguished. RPM returns to 70 percent.

   b. Retard the throttle to idle and confirm bleed valve closure. (EGT decreased approximately 50 °C and the RPM increased approximately 3 percent.)

   c. Verify idle RPM within limits.

   d. If the aft cockpit is manned, advance and rapidly retard the throttle to idle, verifying correct throttle connection. Note idle RPM.

2. (A) HYD 2 system - CHECK

   a. Advance throttle to 60 percent RPM minimum

   b. With HYD 2 caution light on and HYD 2 pressure near zero, momentarily press the HYD 2 RESET button. Check that the caution light goes out as hydraulic pressure increases thru 2,000 psi and HYD 2 pressure increases to 3,000 psi.

c. Reduce the throttle to ground idle and move the control stick vigorously to deploy the RAT. As HYD 2 pressure decreases note that the HYD 2 caution light comes on at 1,660 psi and the RAT caution light comes on at 1,500 psi. Have ground crew check RAT is extended.

NOTE

The HYD 2 caution light may go out as the stick inputs are reduced.

d. Advance the throttle to 60 percent RPM minimum and momentarily press the HYD 2 RESET button to stow the RAT. Check the caution indications are out and have the ground crew check the RAT is stowed. Verify HYD 2 pressure normal.

e. Retard the throttle to idle.

3. (AC) Trim - CHECK

a. Trim the stabilator full down and full up. Check that full travel range is at least -3° to +8° and travel time is less than 4.5 seconds.

b. While trimming normally, raise the STBY STAB TRIM cover and check that normal trim stops. Confirm in both directions. Trim the stabilator full up and full down with the STBY STAB TRIM switch and check that travel time is less than 4.5 seconds.

c. Trim the ailerons full left and full right. Check that full range travel time is 7 ±1 seconds.

d. Trim the rudder full left and full right. Check that full range travel time is 18 ±3 seconds.

4. (A) BIT display - CHECK AND RECORD STATUS

5. (A) DSPY BIT - PERFORM

a. Ensure HUD and MFD power knobs are set to ON.

b. Adjust the brightness of the HUD and MFDs.

c. Select MENU, BIT, and then the DSPY option

(1) The DEU will be commanded into BIT and the HUD and MFDs will be blanked.

d. DEU will complete BIT and the HUD and MFDs display their respective test patterns.

e. Adjust the MFD display

(1) Rotate the CONT knob to the minimum setting.

(2) Increase the BRT knob until the display background begins to turn green.

(3) Decrease the display brightness until the green is removed from the display background.

(4) Increase the contrast until 16 distinct shades of gray are visible on the gray scale.

f. Check HUD test pattern

(1) Ensure the test pattern is steady, in focus, and centered horizontally on the HUD.

(2) Verify the display matches the test pattern described in Chapter 2.

(3) Ensure the scratch pad displays T-45A, the text characters are displayed and they are symmetrical and in focus.

g. Check each MFD test pattern

(1) Ensure the test pattern is steady, in focus, and centered in the display

(2) Ensure the test pattern matches the test pattern in Chapter 2.

(3) Verify the gray scale and ensure the 16 blocks present a progressively lighter green than the previous block as you check left to right.

(4) Ensure the test page destination displayed matched the display location.

(5) Ensure the text characters are displayed, are symmetrical, and in focus

h. Press and release each push button on the DEP. Ensure the HUD scratch pad displays the correct DEP operation.

DEP BUTTONS	DISPLAY
1 thru 0	1 thru 0
DCL	DCL
ENT	ENT
LAW	T-45A
CRS	T-45A
HDG	T-45A
BNGO	T-45A
SET DEP +	SETDEP +
SET DEP -	SETDEP -

NOTE

Do not press the MODE or CLR buttons during the test. Selecting MODE will initiate boresight entry and selecting CLR will end the test.

i. Select each option button around each MFD. Ensure the button test symbol is displayed next to the option button selected.

j. Select the STOP option displayed on the MFD from which DSPY IBIT was initiated from or press the CLR button on the DEP.

k. Ensure HUD and each MFD display GO.

6. (A) DATA options - CHECK

a. DATA option - SELECT

b. WYPT data entry - CHECK
Ensure all data can be entered. Verify proper display operation.

c. ACFT data - SELECT OPTION, VERIFY DATA CORRECT

d. GPS waypoint transfer - CHECK

(1) GPS option - SELECT

(2) GPS waypoints - VERIFY AVAILABLE

(3) GPS waypoint transfer - CHECK
Ensure data transfers and display operates properly.

7. (A) Master mode displays - CHECK

a. STRS display - SELECT

b. NAV option - VERIFY SELECTED (BOXED)

c. A/G option symbology and reticle - SELECT AND CHECK
Cycle through submodes (MAN and CCIP) and weapon selection to ensure proper symbology on HUD and MFD STRS (stores) display. Verify reticle operation in DSL submode.

d. A/A option symbology and reticle - SELECT AND CHECK
Cycle through submodes, lead angle computing (LAC) and real time gun sight (RTGS) and verify proper symbology on HUD and MFD STRS display. Verify reticle size is consistent with wingspan value. Verify wingspan can be changed using DEP.

8. (A) Declutter options - CHECK

a. DCL 1 button - PRESS
Ensure proper declutter levels on HUD.

b. DCL 2 button - PRESS
Ensure proper declutter levels on HUD.

9. (A) HUD/MFD barometric altitude - CHECK

   a. MENU/BIT/MANT options - SELECT

   b. BARO ALT DELTA - RECORD

   c. BARO DLTA - SET TO ZERO

   d. BARO PRESSURE - VERIFY SAME AS STANDBY ALTIMETER SETTING

   e. MFD baro altitude - VERIFY WITHIN ±75 FEET OF FIELD ELEVATION

   f. Subtract the MFD baro altitude from the field elevation and enter the difference as the BARO DLTA.

   g. Verify the MFD and HUD baro altitude is within ±10 feet of field elevation.

10. Standby altimeter - CHECK
    Ensure the barometric altitude displayed on the standby barometric altimeter is within ±75 feet of the field elevation.

11. (A) BINGO advisory - CHECK

    a. ADI/BNGO options - SELECT

    b. Set BINGO setting above fuel quantity reading - VERIFY BINGO ADVISORY DISPLAYED ON MFDs AND CAUTION ON HUD

    c. Set BINGO setting below fuel quantity reading - VERIFY BINGO ADVISORY REMOVED FROM MFDs AND CAUTION FROM HUD

12. (A) VOR/ILS BIT - PERFORM
    A warmup period of 5 seconds is required before system operation.

    a. Select the VOR/ILS option on the HSI display.

    b. Set a course of 000° on the HSI display (CRS option).

    c. On the NAV panel, set and hold the power/frequency selector in the TEST position (outer knob).

    d. If the VOR system is receiving a valid VOR signal, verify the following occurs:

       (1) The VOR bearing pointer indicates 315 ±2.5°.

       (2) The course deviation line moves to the left two dots maximum.

       (3) The marker beacon lights illuminate.

    e. If the VOR system is not receiving a valid VOR signal verify the following occurs:

       (1) The marker beacon lights illuminate.

13. (A) TACAN BIT - PERFORM
    A warmup period of 5 seconds is required before system operation.

    a. Select (box) the CDI and TCN options on the HSI display.

    b. Set a course of 180° on the HSI display (CRS option).

    c. Press and hold (minimum of 5 seconds) the TEST push-button on the TACAN control panel.

    d. Verify following occurs:

       (1) The TACAN bearing pointer indicates 180 ±2.5°.

       (2) Range reads 0 ±1 nm.

       (3) The course deviation scale centers.

    e. IFF BIT - PERFORM
    Set the MASTER control switch to NORM and check the GO TEST light comes on for each of the following:

       (1) M-1 switch select TEST

       (2) M-2 switch select TEST

(3) M-3/A switch select TEST

(4) M-C switch select TEST

14. (A) Communications equipment - BIT CHECK

a. UHF/VHF Control panel No. 1 BIT - PERFORM

Set the frequency selector to MAN, and the mode control selector to TEST, then verify 888.888 is displayed on the frequency/channel display.

b. UHF/VHF Control panel No. 2 BIT - PERFORM

Set the frequency selector to MAN, and the mode control selector to TEST, then verify 888.888 is displayed on the frequency/channel display.

15. (AC) CONTR AUG IBIT - PERFORM

NOTE

Ensure GINA is valid. GINA validity is provided at coarse align complete (heading and attitude available).

a. Momentarily press paddle switch and check that the C AUG caution light illuminates.

b. Set CONTR AUG switch momentarily to RESET and verify C AUG caution light extinguishes.

c. Set CONTR AUG switch from SBI to ALL and verify C AUG caution light illuminates for a maximum of 120 seconds and then extinguishes.

16. (A) Steam ingestion valve - CHECK

17. (AC) OBOGS BIT - PERFORM

a. Press and hold the OBOGS pneumatic BIT button and verify the OXYGEN warning light comes on.

b. Release the OBOGS pneumatic BIT button and verify the OXYGEN warning light goes out within 1 minute.

18. (AC) Flight controls - CHECK

a. All flight controls - FREE, FULL TRAVEL AND PROPER MOVEMENT

b. With aileron and stabilator trim settings at zero, move the control stick and allow it to return slowly to the neutral position. The control stick should return to neutral (within 3/16 inch) from displacements forward, aft, left and right.

19. (AC) Speed brake RETRACT override - CHECK

a. Have the ground crew check that the speed brakes are functional. Check the SP BRK and SP BRK FULL advisory lights illuminate when the speed brakes are extended.

b. If the aft cockpit is manned, extend the speed brakes from the forward cockpit in the normal manner. As the speed brakes extend, the aft cockpit selects the RETRACT position. The speed brakes should retract.

c. Check the SP BRK and SP BRK FULL advisory lights are off when the speed brakes are retracted.

20. (AC) Flaps/Slats - CHECK

a. Place FLAPS/SLATS lever to DN. Flaps should move to the full down position within 10 seconds. FLAPS FULL position light illuminates. If aft cockpit is manned, verify FLAPS/SLATS lever moves with front cockpit lever.

b. Place FLAPS/SLATS lever from DN to UP. Flaps should move to up position within 20 seconds and the FLAPS position lights should extinguish. If aft cockpit is manned, verify FLAPS/SLATS lever moves with front cockpit lever.

c. Place FLAPS/SLATS lever to 1/2. Flaps should move to the half position. FLAPS HALF position light should come on.

21. (A) Launch bar - CHECK

a. Ensure nose wheel steering engaged. Place the LAUNCH BAR switch to EXTEND. Check the green L BAR light illuminates and have ground crew verify launch bar is extended. Check NWS has disengaged by slowly pushing the rudder pedals in either direction to check for no nose wheel movement, then engage NWS (press and hold) and verify operation.

b. Steam ingestion valve - CHECK

c. Return LAUNCH BAR switch to RETRACT and check the L BAR light is extinguished. Have ground crew verify launch bar is in the retracted position.

22. (A) Arresting hook - CHECK

a. Lower the arresting hook and have the ground crew verify hook is extended. Check the HOOK warning light comes on and remains on.

b. Raise the arresting hook and verify the HOOK warning light goes out within 6 seconds. Have the ground crew visually check the hook is in the retracted position.

23. (AB) Cockpit air-conditioning - CHECK

a. Ensure the canopy is down and locked. Set RPM at 65 percent. Place the AIR FLOW knob to NORMAL and the CABIN TEMP control knob to MANUAL. Rotate the CABIN TEMP control knob to COOL and WARM. Check that the cockpit temperature changes accordingly. Return the CABIN TEMP control knob to AUTO.

b. Place the AIR FLOW knob to DEFOG. Check for defog airflow and maximum cockpit airflow. Place the knob to MAX DEFOG and check for less cockpit airflow and a higher defog airflow. Return RPM to idle and the AIR FLOW knob to NORMAL.

10.7 TAXI

NOTE

Initiating the CONTR AUG BIT cycles the rudder and rudder tab. Ensure the CONTR AUG BIT is completed prior to taxi or takeoff.

Perform taxi in accordance with paragraph 7.8. Check the following:

1. (A) Wheel brakes - TEST
   When leaving the chocks, check the brakes with the anti-skid OFF and note the SKID advisory light is out. During taxi check the brakes with the ANTI-SKID switch ON. The SKID advisory light should be illuminated.

2. (A) Nosewheel steering - CHECK

a. Aircraft tracking with nose wheel steering disengaged.
   Check for any adverse drifting or pulling to one side or the other.

b. Aircraft tracking with rudder pedals centered and nose wheel steering engaged.
   Check for adverse drift or pulling to one side.

c. Check for response.
   Ensure equal rates of response.

d. Press and hold NWS button to engage high gain.
   Check tracking continues without adverse drift or pulling to one side and the NWS HI advisory light comes on.

e. With the NWS button pressed, check for increased response.
   Ensure equal response both directions

f. Release the NWS button and verify the NWS HI advisory light goes out and response is reduced to low gain.

3. (A) HUD/MFDs - CHECK and velocity vector/waterline symbols

a. During taxi check that the horizon line

are properly positioned.The velocity vectors are displayed on the horizon line with weight-on-wheels and the HUD horizon line is extended.

10.8 TAKEOFF

Perform the takeoff checklist and takeoff checks in accordance with paragraphs 7.9 and 7.10. Check the following:

1. (A) TACAN - FUNCTIONAL CHECK

   a. CDI option - SELECT

   b. Course deviation line should center within ±4 degrees of known course to station.

   c. Range accuracy ±1/2 nm.

2. (A) VOR - FUNCTIONAL CHECK

   a. Course deviation line should center within ±4 degrees of known course to station.

3. (A) HSI/ADI/HUD displays and standby compass - CHECK
   After runway lineup, compare HSI/ADI/HUD display headings and standby compass heading with known runway heading. The HSI/ADI/HUD display headings should be within ±3 degrees of the runway heading and agree within ±1 degree. The standby compass heading should be within limits of the compass correction card of the known runway magnetic heading.

4. (AB) Engine run up - RECORD

   a. Rapidly move the throttle from idle to MRT, check the following:

      Engine accel - Record time to achieve 96 percent N_2 RPM (RPM should be obtained within 7 seconds.)
      RPM - 104 PERCENT MAXIMUM,
      EGT - 600 °C MAXIMUM

      If required, a check of engine serviceability may be made before takeoff by comparing the stabilized indicated N_2 RPM and EGT at MRT conditions with the minimum acceptable values. For the purpose of this check, the stabilization period is between 20 seconds and 1 minute from setting the throttle to MRT.

      The standard day N_1 and N_2 RPM obtained at MRT conditions are established during engine acceptance; these RPM, called placard RPM, are unique for each engine and are given in the engine log book and placarded in the cockpit.

      Figure 10-2 is used to determine the minimum acceptable takeoff N_2 RPM and EGT values relative to a placard N_1 RPM and range of OAT.

      (1) Refer to Figure 10-2 and compute the minimum acceptable EGT and N_2 RPM.

      (2) Record actual EGT and N_2 RPM; values should meet or exceed the minimum values computed in substep (1).

5. (A) Landing gear - RETRACT

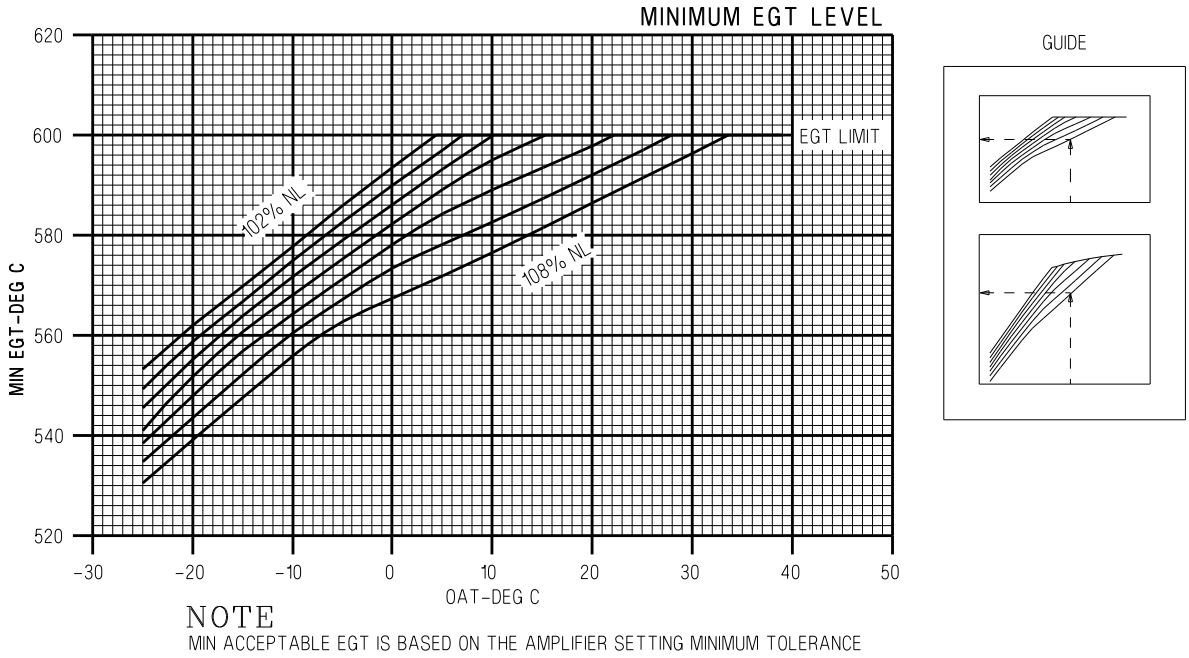
   a. Raise the gear when safely airborne.
      The landing gear should retract within 10 seconds. Check the gear DOOR light is extinguished.

   b. Check that the AOA indexer lights go out as the landing gear is retracted.

10.9 CLIMBING TO 40,000 FEET

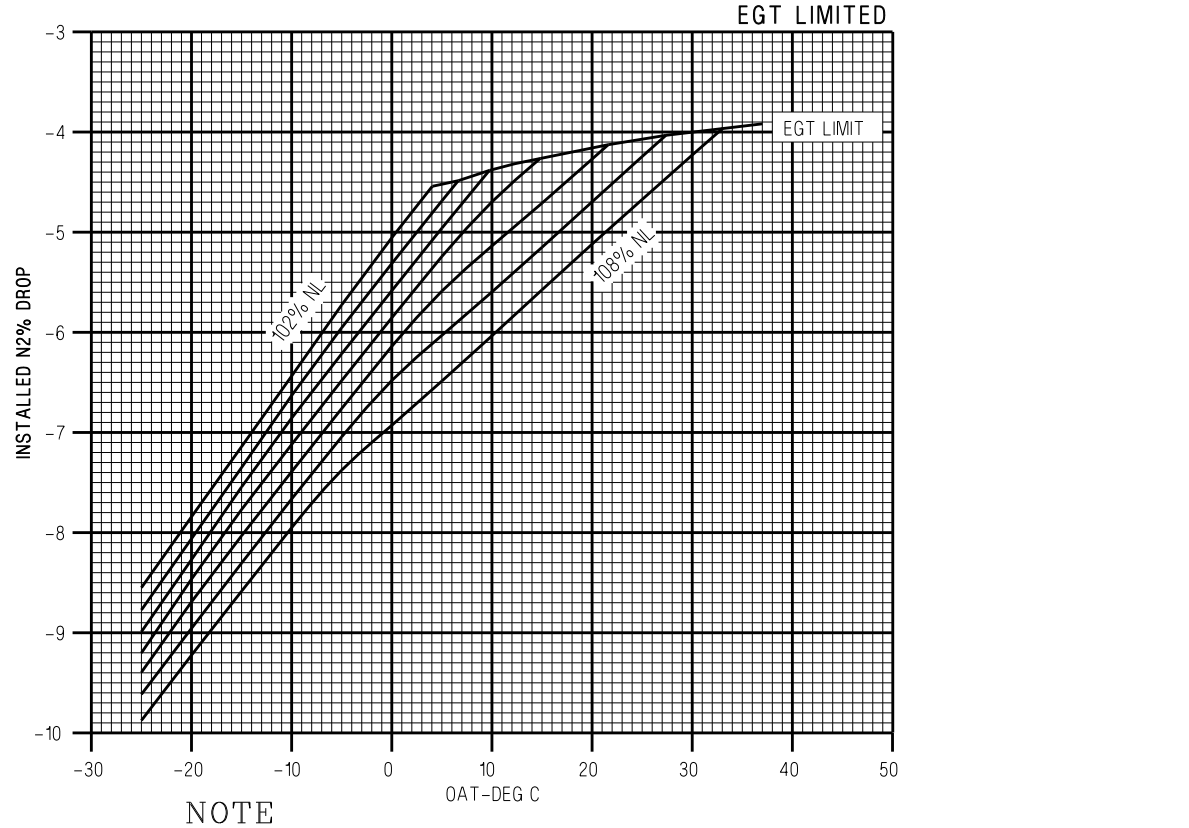
Using MRT, climb at 280 KIAS/0.7 Mach to 35,000 feet and 0.74 Mach to FL400.

1. (A) Communications - CHECK
   Functionally check the UHF/VHF radios using preset, manual and guard frequencies.



NOTE

MIN ACCEPTABLE EGT IS BASED ON THE AMPLIFIER SETTING MINIMUM TOLERANCE



NOTE

MIN ACCEPTABLE N2 RPM = PLACARD N2-N2 RPM DROP WHICH VARIES WITH OAT

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Figure 10-2. Maximum Power Check F405-RR-401 Engine

2. (A) IFF - CHECK

   a. Coordinate with ATC to functionally check the IFF, including Mode C and Emergency.

3. (A) GINA - CHECK

   a. HSI/ADI/HUD display headings should be within ±3 degrees of the standby compass heading after correction for deviation.

   b. HSI/ADI/HUD display headings should agree within ±1 degree.

   c. HSI, ADI, and, HUD - COMPARE
      Cross check displays and ensure smooth operation.

4. (AB) Cockpit pressure - CHECK

   a. At 10,000 feet, the cabin pressure should indicate 7,800 ±500 feet.

   b. Place the AIR FLOW knob to OFF to depressurize the cockpit. The CABIN pressure altimeter should indicate aircraft altitude.

   c. Place the AIR FLOW knob back to NORMAL. The cockpit should repressurize and CABIN altimeter should again read 7,800 ±500 feet.

5. (AB) Cockpit pressure - MONITOR

Aircraft altitude	Cockpit altitude
15,000 feet	10,500 ±500 feet
20,000 feet	12,800 ±500 feet

10.10 40,000 FOOT CHECKS

1. (AB) Cockpit pressure - CHECK

   a. The cabin pressure altimeter should indicate 20,000 ±1,000 feet.

2. (AB) Engine parameters - CHECK

   a. At MRT and no less than 160 KIAS, record the max RPM, EGT, and fuel flow.

   b. Slowly and smoothly retard the throttle to idle. After no more than 30 seconds and at no less than 160 KIAS, record the idle RPM, EGT, and fuel flow.

3. (AB) Engine acceleration - CHECK

   a. With airspeed above 160 KIAS, jam-accelerate the throttle to MRT.

   b. Ensure smooth, surge free acceleration.

4. (AB) Engine jam-deceleration - CHECK

   a. With airspeed above 160 KIAS, jam-decelerate MRT to idle.

   b. Ensure surge and stall free operation.

10.11 PASSING 30,000 FEET

1. (AB) Cockpit pressure - RECORD AT IDLE RPM

   a. The cabin pressure altimeter should indicate 16,800 ±500 feet.

2. (AC) High Mach dive to 0.9 Mach - CHECK
   With the throttle at MRT, 0.75 Mach, trim the aircraft and establish a wings level 30 degree dive.

   a. Record Mach at buffet onset, pitching tendencies, heavy wing tendency, and yaw oscillation.

   b. At not greater than 0.85 Mach, initiate a 5 to 6g pullout and note handling as before.

   c. Check g-suit operation.
      While performing step b. above, check that the anti-g suit inflates at about 2.25g's indicated. Relax the back pressure on the stick and check for rapid deflation of the anti g suit.

10.12 15,000 FOOT CHECKS

1. (AC) Speed brakes - CHECK
   With the airspeed at 329 ±10 KIAS, extend the speed brakes and ensure the following:

a. Normal handling characteristics during extension.

b. Ensure speed brakes fully extend at 329 ±10 KIAS.

c. Slip ball excursions less than 1/2 slip ball.

d. Normal handling characteristics during retraction.

e. SP BRK and SP BRK FULL advisory lights - ON

CAUTION

Minimum interval between each GTS start attempt is 3 minutes. After three consecutive GTS start attempts, a minimum interval of 30 minutes is required before any further start attempts. Additional start attempts after an unsuccessful start are prohibited until the GTS exhaust duct and combustor section are inspected and any residual fuel is removed and the RAT doors are inspected for discoloration and warpage.

2. (AB) GTS operation - CHECK

a. At 15,000 feet, 165 to 250 KIAS and throttle at idle, press and hold the GTS start button for 2 seconds.

NOTE

Power will automatically be removed from the MFDs, HUD, DEU, SADS, and VCR/CEU when the GTS start is initiated. They should return to their previous state when the generator is reset.

b. Check the GENERATOR warning light and the AC INV (aircraft 165080 THRU 165092) caution light illuminate.

c. Note the time from pressing the GTS start button to GTS advisory light illumination.

NOTE

If GTS start attempts are longer than 28 seconds, subsequent in-flight start attempts may exceed the GTS auto shutdown limit.

d. Reset the generator and verify the warning/caution lights are extinguished and the HUD and MFD displays are restored.

CAUTION

To prevent damage to the motor, do not reset generator during GTS start.

NOTE

- The HUD and COMM 2 may require power cycles after the generator is reset.
- The GINA may require an In-Flight Alignment following a GTS start.

e. Shut down the GTS by placing the ENGINE switch to OFF for a minimum of 5 seconds.
Ensure GTS advisory light extinguished.

f. Return ENGINE switch to ON within 30 seconds of selecting OFF.

3. (AC) Trim at maximum level Mach - CHECK

a. Paddle off CONTR AUG and reset to ALL. Trim the aircraft for straight and level flight at 15,000 feet and 0.7 Mach. Record aileron and rudder trim indicator positions. See Figure 10-3.

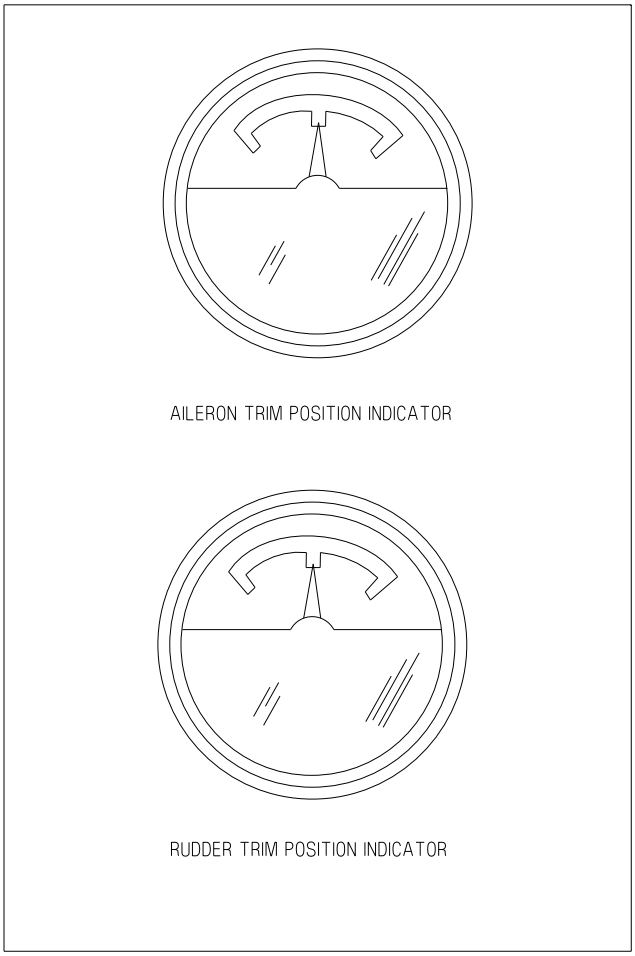


Figure 10-3. Trim Position Indicators

b. Accelerate to maximum level Mach without directionally trimming the aircraft. Record the slip ball excursion (maximum 1/2 slip ball) and maximum level Mach number. See Figure 10-4.

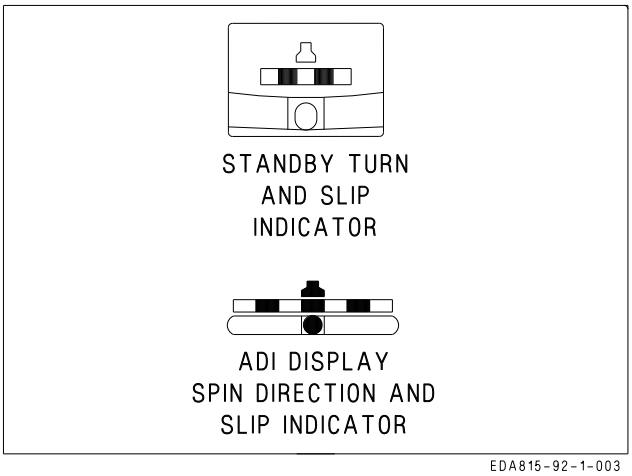


Figure 10-4. Slip Ball Indication -Accelerating

c. Reduce airspeed to 0.6 Mach and record the slip ball excursion (maximum 1/2 slip ball). See Figure 10-5.

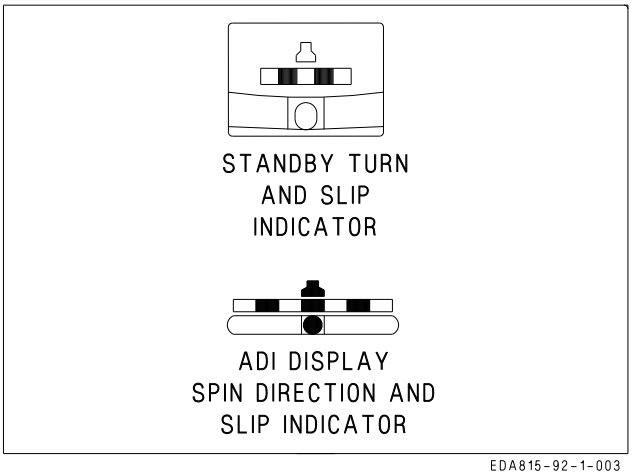


Figure 10-5. Slip Ball Indication -Decelerating

4. (A) Waypoint steering - CHECK

a. Heading marker - CHECK

On HSI select HDG option. Select increment option then decrement option and verify correct movement of command heading marker on HSI, ADI, and HUD.

b. Course setting - CHECK

(1) Select CRS option. Actuate course increment/decrement options and verify correct movement of the course line.

(2) Repeat by entering course thru DEP. Ensure course is updated when ENT is pressed and scratchpads are removed.

c. Perform a course intercept using WYPT steering. All display movement shall be smooth and steady.

d. Verify WYPT AUTO sequential steering. Steering shall automatically switch to the next waypoint in the sequential steering string. Display movement shall be smooth and steady.

e. Perform a course line intercept using TCN and VOR steering. All display movement shall be smooth and steady. Check the planimetric course line in at least one intercept.

f. When established on a TACAN radial check bearing and range accuracy are within reasonable estimates.

g. HSI range scales - CHECK

10.13 12,000 FOOT CHECKS

1. (AC) Clean stall characteristics - CHECK
Record fuel weight. With landing gear and flaps/slats up, throttle at 75 percent RPM, maintain wings level and decelerate at approximately 1 knot/second.

a. Record AOA and airspeed at buffet onset.

b. Check the rudder pedal shaker is activated when the AOA exceeds 21.5 units.

c. Record AOA and airspeed at the stall.

d. Record any abnormal tendencies (such as excessive wing drop or adverse yawing)

2. (AB) Ram air turbine - FUNCTIONAL CHECK

a. Maintain airspeed between 150 to 180 KIAS. Retard the throttle to idle and vigorously move the control stick. Until HYD 2 pressure drops below 1,500 psi. Verify as the pressure decreases below approximately 1,660 psi the HYD 2 caution light illuminates and below approximately 1,500 psi the RAT extends. RAT extension is verified by illumination of the RAT caution light.

b. Minimize control stick inputs and verify that HYD 2 pressure increases to approximately 3,000 psi. Cycle the stick until HYD 2 pressure decreases to approximately 2,700 psi. Minimize control stick inputs and verify HYD 2 pressure continues to slowly decrease. Increase control stick inputs and verify HYD 2 pressure decreases to approximately 2,500 psi and then begins to increase.

NOTE

HYD 2 pressure and rate of pressure decrease/increase are dependent upon control stick input and internal system leakage's.

c. Advance the throttle to maintain 80 percent RPM then lower the landing gear and fully extend the flaps/slats. Reduce airspeed slowly to 105 KIAS. Check that the HYD 2 pressure continues to cycle (decrease to approximately 2,500 psi then increase to 3,000 psi) in response to small stick inputs.

d. Ensure the HYD 2 caution light is extinguished and reset the RAT by pressing the HYD 2 RESET button.

e. Increase airspeed as required.

3. (AC) Landing configuration stall characteristics - CHECK
Record the fuel weight. With landing

gear and flaps/slats down, throttle set at 85 percent RPM, decelerate at approximately 1 KIAS/second.

a. Record the AOA and airspeed at buffet onset.

b. Check that the rudder pedal shaker and tone is activated when the AOA exceeds 21.5 units.

c. Record AOA and airspeed at the stall.

d. Record any abnormal tendencies (such as excessive wing drop or adverse yawing).

e. Transition to the clean configuration.

4. (ABC) Inverted flight (maximum of 30 seconds) - CHECK

In the clean configuration, with the throttle at MRT, roll the aircraft inverted and establish level flight (less than zero g). Check the following:

a. FOD in the cockpit.

b. ADI for proper response.

c. OIL PRESS warning light and FUEL caution light illuminate within 10 ±2 seconds.

Upon illumination of the OIL PRESS light, roll upright and check all caution and warning lights are extinguished.

10.14 DESCENDING TO 5,000 FEET

1. (A) Radar altimeter - CHECK

a. Above 5,000 feet check the radar altimeter symbology is absent from the HUD and MFD displays.

2. (A) HUD weapons symbology - CHECK

a. Set MASTER ARM switch to ARM and verify the MSTR ARM light illuminates (aft cockpit) and the STRS display indicates ARM.

b. Select the A/G master mode and ensure the proper symbology is displayed in the MAN and CCIP submodes during simulated weapons deliveries. Check for proper operation of the HUD breakaway cross. (In CCIP insert an artificially high target altitude, THGT).

c. Select BOMBS R/STA and press the weapons release button. Verify the bomb tone is heard and the weapons counter on the STRS display decrements correctly. Repeat for the L/STA.

d. Select GUN and press the trigger. Verify the gun tone is heard.

e. Select the A/A master mode and ensure the proper symbology is displayed in the LAC and RTGS submodes.

10.15 5,000 FOOT CHECKS

1. (AC) Wheels warning system - CHECK

a. With the LDG GEAR handle set to UP, throttle set to below 95 percent N_2 RPM position, and airspeed below 200 KIAS set the FLAPS/SLATS lever to 1/2 and note the WHEELS warning light comes on and the warning tone is audible.

b. Set the FLAPS/SLATS lever to the UP position and check the warning indications cease.

c. Slow below 170 KIAS and verify that the WHEELS warning light comes on and the warning tone is audible.

d. Advance the throttle above the 95 percent N_2 RPM position and verify the warning indications cease.

2. (AC) Landing gear timing check - PERFORM

a. While maintaining an airspeed at 150 KIAS, place the LDG GEAR handle DN and verify the time for the gear to fully extend (maximum of 15 seconds). Ensure AOA indexers are illuminated.

3. (AC) Angle-of-attack system - CHECK

   a. Emergency flap extension - PERFORM

      (1) RPM - 90% MAXIMUM

      (2) EMERG FLAP switch - DOWN

Do not exceed 30 seconds with the EMER FLAP switch in the DN position.

      (3) Verify flaps - FULL

      (4) FLAPS/SLATS lever - DN

NOTE

HYD 1 pressure will decrease following EMERG FLAP extension until the FLAPS/SLATS lever is selected to the DN position.

      (5) EMERG FLAP switch - NORM

      (6) Reset engine power as required

   b. Establish the landing configuration at 5,000 feet with airspeed slightly above recommended approach speed for the gross weight. Note the lower chevron on AOA indexer is illuminated.

   c. Decrease airspeed as necessary and verify the airspeed indications correspond to the following changes in the AOA indexer presentation:

      (1) Lower chevron only to lower chevron and donut.

      (2) Lower chevron and donut to donut only.

      (3) Donut only to upper chevron and donut.

      (4) Upper chevron and donut to upper chevron only.

   d. Check that the AOA bracket symbology on the HUD follows the indexer and the same criteria of speed vs AOA applies from the low to high bracket end.

4. (A) Standby airspeed indicators - CHECK

   a. At 110 to 130 KIAS compare the forward and aft cockpit standby airspeed indicators and record the airspeed from each. They should agree within 2 knots of each other.

   b. Check that the standby airspeed indication agrees with airspeed display on the HUD and ADI displays. During airspeed changes pointer movement is smooth.

5. (AC) Aircraft - CLEANUP

   a. Place the LDG GEAR handle UP and record the time for the gear to fully retract (maximum of 10 seconds). Ensure the AOA indexers are extinguished.

   b. Raise flaps to 1/2.

6. (C) FLAPS/SLATS lever - UP

7. (A) Emergency landing gear extension - CHECK

   a. With the landing gear up, flaps/slats set at 1/2, and the airspeed at 150 to 180 KIAS, rotate the EMER GEAR handle clockwise and pull the handle. The landing gear doors should open and the gear should extend by gravity. Check the DOOR light, green NOSE, LEFT and RIGHT lights, and the LDG GEAR handle light illuminate.

   b. Place the LDG GEAR handle to the DN position and check the LDG GEAR handle light extinguishes. Return the EMER GEAR handle to its stowed position. Verify DOOR light extinguishes. Raise the LDG GEAR handle and check all lights extinguish.

   c. Set FLAPS/SLATS lever to UP.

8. (A) Arresting hook - CHECK

   a. Set the HOOK handle down and verify the HOOK warning light illuminates and extinguishes.

   b. Raise the HOOK handle and verify the HOOK warning light illuminates and extinguishes within 6 seconds.

9. (A) Radar altimeter - CHECK

   a. Over terrain of known elevation, descend below 5,000 feet AGL and compare the radar altimeter with the barometric altimeter according to the following:

Altitude Above MSL (less terrain elevation)	Radar Altimeter
1,000 feet	1,000 ±150 feet
3,000 feet	3,000 ±450 feet
5,000 feet	5,000 ±750 feet

   b. Perform a 40 degree bank to the right and left. Climb and dive the aircraft at 40 degree angle. The radar altitude read-out should operate smoothly and continuously over the entire range.

   c. Check the LAW advisory is displayed on the MFDs accompanied by the HUD warning indicator and the LAW tone when the aircraft altitude is below the LAW setting. The LAW advisory should be removed when the aircraft is above the LAW setting.

10.16 APPROACH

1. (A) ILS approach - PERFORM
   Check the following:

   a. ILS, LOCALIZER, and GLIDESLOPE advisories are not displayed on the MFDs.

   b. Localizer and glideslope indications

   c. Audio

   d. Marker beacon lights

   e. Course set operation

10.17 LANDING

1. (A) Anti-skid - CHECK
   After touchdown and with the anti-skid switch ON, apply maximum braking. Ensure anti-skid action is smooth and exhibits no excessive left or right pulling tendencies.

2. (ABC) Before engine shutdown check idle RPM within limits

3. (ABC) Engine shutdown
   Perform engine shutdown in accordance with paragraph 7.17.

PART IV

FLIGHT CHARACTERISTICS

Chapter 11 - Flight Characteristics

CHAPTER 11

Flight Characteristics

11.1 INTRODUCTION

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

11.2 FLIGHT CONTROLS

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

11.2.1 Ailerons.

11.2.1.1 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.

11.2.1.2 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.

11.2.2 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.

11.2.3 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.

11.2.4 Control Augmentation Off or Failed. With control augmentation paddled off or failed, rudder trim, SBI, dutch roll damping and turn coordination (ARI) functions are lost. If the problem is in the dutch roll damping or ARI functions, the rudder trim and SBI functions may be restored by momentarily selecting RESET, then remaining in the SBI position. With no dutch roll damping or ARI, the aircraft is a less stable in roll and yaw in the landing configuration, but easily controllable. Adverse yaw will be noticeable with large aileron inputs and small dutch roll oscillations may be evident.

11.2.4.1 Control Augmentation In SBI. With control augmentation in SBI, dutch roll damping and ARI functions are lost. The speed brake interconnect remains active to damp g excursions with speed brake extension and retraction. In the landing configuration, aircraft handling characteristics are similar to those with control augmentation off or failed except that rudder trim remains active.

NOTE

C AUG should not be intentionally set to SBI except during the permitted intentional departures and when necessitated by a failure or an emergency situation. The SBI setting results in undesirable low speed flying qualities and exacerbates wing roll-off and sideslip during stalls.

11.2.5 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.

11.2.6 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.

11.2.6.1 Trim Changes Due To Speed Brakes. The trim change due to speed brake extension/retraction is noticeable, especially in formation flight. However, it is more pronounced with SBI inoperative. 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. With C AUG failed/ SBI inoperative, the trim changes are in the same direction as above, but the magnitude is higher (as much as 1 to 2g's), especially from 220 to 300 KIAS. Parade formation speed brake extension/retraction should be avoided in this region with SBI inoperative.

NOTE

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

11.2.6.2 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.

11.2.7 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.

11.2.8 Emergency Flaps. Emergency flap extension, or a failure of the slats to extend during normal operation, produces a slight increase in aft stick force (2-3 lbs.) and the nose of the aircraft noticeably pitches down (approx. 9°). Coincident with the previously described

trim changes, altitude can be expected to ″balloon″ up to 200 feet. An inordinately large forward stick displacement is required to completely counter this ″ballooning″ effect and is therefore not recommended. Following complete flap extension, the trimmed nose position for straight and level flight is noticeably low at 3-5° nose down. Recommended on-speed AOA for approach to landing in this configuration is 17 units, and approach speed is the same as for the PA configuration.

11.3 GENERAL FLIGHT CHARACTERISTICS

11.3.1 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.

11.3.2 Maneuvering Flight.

11.3.2.1 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.

11.3.2.2 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 0.9 Mach. During loaded rolls, the aircraft exhibits a tendency to unload, losing up to 2g's at higher entry load factors. During loaded rolls at high subsonic Mach numbers (greater than 0.8 Mach), 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.

11.3.2.3 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:

A region of reduced longitudinal stability exists within the trim AOA band at approximately 0.87 true Mach 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 4.0g's 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 4.0g's. A rapid g jump of over 2g's 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 4g's 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.

NOTE

Occasionally during high speed dives a rudder buzz has been noted while passing through the 0.9 Mach region due to shock formation. This buzz can cause rudder deflection of as much as ±5 degrees and may feel similar to the rudder pedal shaker to the pilot. Deselect speed brake (if extended) and slow below transonic speeds to alleviate the rudder buzz. Flying in rudder buzz is not recommended.

11.4 TAKEOFF AND LANDING CHARACTERISTICS

11.4.1 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.

11.4.2 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.

11.4.2.1 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.

11.4.2.2 Landing With Blown Main Tire(s). Upon touchdown with a single blown main tire, the aircraft begins an immediate and rapid yaw or swerve into the side of the blown tire. Additionally, the aircraft establishes an AOB of approximately 3 degrees opposite the direction of yaw (e.g., right yaw, left AOB). During the initial swerve and subsequent pilot inputs to correct it, cockpit lateral accelerations (side to side) can reach up to 0.5 g, which can be very uncomfortable. Landing area lateral deviations vary depending upon how rapidly correct control inputs (rudder inputs opposite to the swerve) are applied. Because of these characteristics, a short field, fly-in arrestment should be used to recover the aircraft.

For a short field arrestment, request LSO assistance and expect a ″talk down″ to a fly-in arrestment. The LSO may elect to use a shallower glideslope than usual; visual glideslope information provided by the fresnel lens may conflict with LSO calls. Under these circumstances, disregard visual glideslope information and respond solely to LSO calls. A normal, on-speed approach should be flown using half or full flaps. Reconfigure the flaps only after visual inspection confirms no flap damage from the blown tire. During the approach to land the pilot should be prepared for the distinct possibility of a bolter and be ready to perform an immediate go around. Normal touch-and-go or bolter technique should be used with an additional and simultaneous rudder application (requiring up to 180 pounds of force) to counter the effects of the blown tire. Prompt but smooth aft stick application, up to full aft stick, reduce time on deck. Once airborne, center the rudder pedals (to prevent a rudder-induced roll) and maintain a fly-away attitude. Power should be reduced only when arrestment is assured, either by an LSO call or when deceleration is felt by the pilot.

For a shipboard arrested landing, the LSO may elect to adjust the touchdown point by targeting the 2-wire. The pilot should be prepared for the possibility of a hookskip bolter. If this occurs, aggressive and rapid rudder pedal deflection after touchdown (requiring up to 180 pounds of force within 0.25 seconds) is required to counter the swerve of a single blown tire to stay within the lateral confines of the landing area. Once airborne, center the rudder pedals and establish a fly-away attitude.

If arresting gear is not available, perform a flared landing with half flaps (if able) using the longest and widest runway available consistent with wind direction and speed. Simulations have shown that landing with a crosswind component of greater than 5 knots on the side corresponding to the blown tire was extremely hazardous due to loss of directional control below approximately 60 KIAS. Crosswinds of up to 15 knots on the side corresponding to the good tire were controllable to a full stop. During ground roll with a crosswind, lateral stick should not be applied into the wind. If landing distance permits, landing with a quartering tailwind from the side of the good tire is preferable to landing with a quartering headwind from the side of the blown tire. Prior to attempting a tailwind landing, the landing distance chart (Section XI) should be used to verify that adequate runway exists. Offset to land on the side of the runway corresponding to the good tire. Upon touchdown, simultaneously retard power to idle and counter the swerve with rudder. Nosewheel steering (NWS) effectiveness can be increased by applying forward stick, up to full forward. Nosewheel steering should be effective for skid angles below 12 degrees. Do not use high gain NWS until the aircraft has slowed to below 10 knots. As the aircraft slows through 100 KIAS, differential braking may be required to maintain directional control. Since anti-skid is off, aggressive braking results in blowing the remaining good tire. Additionally, smooth brake application is required to avoid pilot induced directional oscillations. It is important to keep the skid angle small during rollout, since analysis indicates skid angles greater than approximately 18 degrees may not allow recovery. If rudder inputs at touchdown are not sufficient to prevent a high speed departure from the prepared runway surface, ejection may be the only remaining option and the decision to eject should not be delayed.

WARNING

- Rudder inputs to counter swerve should be applied without brake application. Since the anti-skid system is off, any brake application at high speed increases the likelihood of a blown main tire.
- Consider pilot proficiency and ability to control the swerve before attempting the rollout. If it is determined that the pilot is unable to control the aircraft on rollout, consideration should be given to a gear-up landing or controlled ejection.

If control is retained after the aircraft slows, the engine should be shut down once stopped on the runway or prior to departing the prepared surface. After the aircraft comes to a stop, perform an emergency ground egress.

Landing with two blown main tires shall be done with a fly-in arrestment. Simulations show that the aircraft is directionally stable on the ground at airspeeds above 100 KIAS and that the engine is able to provide sufficient thrust to overcome the drag of the blown tire, allowing a safe go around when the aircraft bolters. If the aircraft does bolter, prompt but smooth aft stick (up to full aft stick) should be used to reduce time on deck. While the aircraft is on deck, the pilot senses that the aircraft is skidding and small uncommanded heading changes may occur, but are easily controllable with appropriate rudder pedal inputs. Multiple attempts should be made to engage the arresting wire until success is achieved. Attempting a landing rollout with both main tires blown is extremely hazardous. The positive directional stability mentioned previously is solely because of the rudder, and, as the aircraft slows below 100 KIAS rudder effectiveness decreases significantly. If a landing rollout

is attempted, a total loss of rudder effectiveness occurs at approximately 70 KIAS, at which point the aircraft becomes directionally unstable. This instability invariably leads to a complete loss of control. Skid angle should be kept as small as possible during rollout since the aircraft cannot be recovered from large skid angles. Some lateral stick applied in the desired direction of travel may improve directional control at higher speeds. During simulation testing, a series of three progressively larger (divergent) directional oscillations began 0.5 second after touchdown at 110 KIAS, but were controllable with aggressive rudder pedal inputs. The final oscillation before complete loss of control usually occurred approximately 2.5 seconds after touchdown at 80 KIAS. Following loss of control, the aircraft would begin skidding sideways and backwards with an unpredictable trajectory. Lateral accelerations (side-to-side) during these oscillations reached up to 0.3 g's and could be very uncomfortable for the pilot. The aircraft most likely remains upright if it stays on the prepared surface. However, it is also likely that it may not stay on the prepared runway surface, and the outcome in this situation cannot be predicted with certainty. If the pilot determines that the aircraft may flip over or impact an obstruction and decides to eject, an early decision is required. The decision to eject is even more critical when there are two crewmembers aboard because of the time delays associated with ejection seat sequencing. The pilot's view of potential obstructions is hampered with skid angles greater than approximately 120 degrees.

When no arresting gear is available (shore or ship), a gear-up landing or controlled ejection provide alternatives to attempting a landing rollout with dual blown main tires. Consideration must be given to hazards associated with these alternatives.

WARNING

Simulations with two blown main tires show that the aircraft becomes uncontrollable below approximately 80 KIAS.

11.5 FLIGHT CHARACTERISTICS WITH EXTERNAL STORES

11.5.1 Symmetric Loadings. PMBR/Mk 76, LAU-68, and pylons are the only wing store loadings which have been flight tested. The baggage pod has been tested within a limited flight envelope. With symmetric loadings, the flying qualities of the aircraft are relatively unchanged from a clean aircraft configuration. The aircraft is slightly more stable in pitch and roll and easier to trim hands off. Roll rate is generally slightly reduced from clean loading. As a result, symmetric wing loadings are slightly more departure resistant than the clean aircraft. A PMBR on one wing and a LAU-68 on the other wing can be considered a symmetric loading with regards to flying qualities.

11.5.2 Asymmetric Loadings. The flight characteristics with asymmetric stores are also relatively unchanged from the clean aircraft at low AOA. The largest tested store asymmetry is approximately 2,500 foot-pounds (full LAU-68 or PMBR with Mk 76s). However, when successive turns are made in one direction, some additional asymmetry due to fuel migration is possible. Even with the worst case asymmetry, the aircraft can be trimmed at all airspeeds. Up to full rudder trim may be required for balanced flight at release airspeeds. Very little aileron is required to trim out the heavy wing. A little lateral stick away from the heavy wing is required as g is increased during dive recovery to prevent a roll into the heavy wing. As airspeed increases, the drag from the store is effective in increasing yaw, therefore, the slip ball should be trimmed at the release airspeed prior to dive releases. At lower speeds on the downwind leg of the weapons pattern, yaw is not significant and can be countered with rudder. The asymmetrical loaded aircraft is less departure resistant than

the clean aircraft. In the landing configuration, up to 3 degrees of additional aileron trim is required.

11.6 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.

11.6.1 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.

11.6.1.1 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. Rudder pedal shaker and tone come on at 21.5 units, which is about 4.5 units (10 knots) prior to stall in this configuration. Just prior (1 unit AOA or less) to stall, a slight wing rock and buffet occurs. If the aft stick is eased at this point the aircraft recovers prior to stall. If the aft stick force is increased, an uncommanded wing drop of 25 to 30 degrees occurs, accompanied by a mild pitch break which defines the stall at about 26 units AOA. Due to the longitudinal stick gearing at near full aft stick travel, a small amount of aft stick commands a large stabilator deflection, so the rate of stall onset occurs more rapidly.

11.6.1.2 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. Stall warning rudder pedal shaker comes on at 21.5 units, which is about 8.5 units (10 knots) prior to stall in PA configuration. The indicated airspeed from 28 units AOA to stall may decrease only one knot. Release of aft stick pressure at this point produces an immediate reduction in AOA and stall recovery. If aft stick is maintained, the nose pitches down about 6 degrees. With gear down/ flaps half/slats down (TO), the stall occurs about 5 to 6 knots faster than in PA configuration, about 29 to 30 units AOA and stall characteristics are very similar. 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.

11.6.1.3 Emergency Flap Configuration. Stall characteristics with emergency flaps extended are significantly different than in PA configuration or normal CR configuration. The aircraft exhibits no natural stall warning during the approach to stall. Slight changes in stall entry technique may affect actual amount of roll off seen at stall.

With flaps deployed by the emergency method, gear down and yaw damper in ALL, the stall warning rudder pedal shaker comes on at 21.5 units AOA, closely followed by the stall at 23-25 units AOA. (Stall airspeed is 7-9 KIAS greater than PA configuration at the same gross weight.) The stall is very disorientating and is characterized by a slight pitch-up of 4-5° followed by an abrupt roll off of 60-80° AOB. Following roll off, the aircraft is left in a 30° nose down pitch attitude. If recovery is initiated immediately upon roll off, altitude loss can be minimized to 700-1000 feet.

With flaps deployed by the emergency method, gear up and yaw damper in ALL, stall occurs at 23-25 units AOA, closely following activation of rudder pedal shaker at 21.5 units. This stall is characterized by a slight pitch-up of about 3°, followed by an abrupt roll off of nominally 110-120°. Airspeeds during stall recovery (using a 2 g recovery) may reach 190 KIAS with altitude loss of approximately 2500 feet. Holding full aft stick at stall may result in roll oscillations, continued rapid roll off of as much as 360° and final pitch attitude approximately 80° nose down.

C AUG setting in SBI significantly increases the wing roll off and sideslip during the stall. With the gear extended, sideslip limitations may be exceeded during the stall.

11.6.1.4 External Stores. With wing stores or baggage pod loaded, stall characteristics are very similar to the clean aircraft, however, stall occurs at about 1 unit lower AOA. With wing store asymmetry, the aircraft rolls into the heavy wing and may require up to one-third lateral stick to maintain wings level on approach to stall. However, the stall characteristics are otherwise similar to symmetric or clean loading.

11.6.1.5 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.

11.6.1.6 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.

11.6.2 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 or 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 as described in paragraph 11.6.5.1. Rolls below 8 units AOA are generally free from the oscillations experienced at high AOA; however, the aircraft may experience a forward stick departure characterized by a rapid buildup in sideslip, as described in paragraph 11.6.5.2.

11.6.3 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. Maneuver dynamics associated with aggravated control inputs at AOA below 8 units are degraded from those at AOA above 8 units. During flight test, full input 180 degree coordinated rolls at less than 8 units AOA did not result in departure, however, the rudder did tend to lock out during some maneuvers. This rudder lock out tendency is a strong indication of impending departure. Full coordinated input rolls held through more than 180 degrees of bank angle change at less than 8 units AOA may result in a violent pitchdown departure as described in paragraph 11.6.5.1. Neither symmetric nor asymmetric store loadings have a significant effect on coordinated maneuver characteristics.

11.6.4 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. The result is that rudder effectiveness appears to decrease with increasing airspeed. Above about 0.6 Mach, very little actual rudder deflection (4 to 5 degrees) is available to generate rolls. Aircraft roll damping is reduced when maneuvering near 0.8 Mach. Rolls are quicker in this region as a result of the reduced roll damping and not because of increased rudder effectiveness or increased available rudder. For a given Mach number, the roll rate is generally highest at buffet onset and again at full aft stick. Full aft stick rudder rolls may result in roll oscillations similar to those generated during lateral stick rolls at high AOA. Rudder rolls at less than 8 units AOA may result in a forward stick departure characterized by increasing sideslip and described in paragraph 11.6.5.2.

11.6.5 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 blow out may occur, causing the rudder to be deflected fully in the direction of the turn needle.

11.6.5.1 Pitchdown Departure. This type of departure, a negative AOA post-stall gyration (PSG) is violent and disorienting and can be encountered when the aircraft has a relatively large roll rate in one direction and a yaw rate in the opposite direction. The departure may occur with rolling cross controls and during recovery from vertical maneuvers within about 10 degrees of the vertical and less than 100 KIAS. Cross

controls at higher Mach sometimes depart; however, as speed increases above 0.5 Mach, there is generally not enough rudder deflection available even with full pedal input to generate the yaw rate needed to depart. A full coordinated input roll at less than 8 units AOA and more than 180 degrees of bank angle change may cause the rudder to blow out with pedal forces so high that the pilot may believe that the rudder is centered. In this case, the rudder opposes lateral stick, leading to departure.

The violent nosedown departure occurs extremely rapidly, with no significant warning to the pilot. It is very uncomfortable and is disorienting. The characteristic unload or pitchdown occurs due to inertial coupling. Additionally, the departure will probably result in a locked engine surge (similar to compressor stall), even if the maneuver was entered with idle power. The first indicator of impending departure is the rudder pedal blowing out to full deflection with no pilot input, indicating rudder blowout has occurred due to sideslip buildup. Some departures follow so quickly that the rudder blowout may not provide a truly usable warning of departure.

Pilot response must be to immediately neutralize lateral and longitudinal stick and aggressively center the rudder pedals. If the response is fast enough, an extended negative AOA PSG may be avoided. Although the pilot may feel that the rudder is neutralized based on the pedal input, the rudder may actually remain at full deflection. As sideslip changes direction, the rudder may blow out in the opposite direction. During the departure, the AOA indicator will be pegged at 0 units. As the aircraft recovers, large oscillations in AOA and sideslip typically occur, which slowly dissipate and eventually stop. Ten to fifteen seconds of out-of-control motion are possible and the pilot may experience 1.5g's laterally in both directions. The departure may be identified as the incipient stages of an inverted spin requiring the pilot to alternate between rudder pedals with several hundred pounds of pedal force in an effort to maintain neutral rudder position. This is in response to large oscillations in sideslip which move the reversible rudder. Aggressively centering the rudder minimizes the possibility of entry into an inverted spin. The aircraft eventually transitions to a nose low attitude and airspeed increases. At this point, the aircraft has recovered and can be flown normally. Failure to center the rudder pedals will likely result in the rudder being blown out in the prospin direction. If the initial yaw rate sustains itself longer than normal and the pilot fails to center the rudder pedals, inverted spin entry is likely.

11.6.5.2 Forward Stick Departures. When maneuvering at or near full forward stick, the aircraft may encounter a departure in which sideslip increases rapidly, often followed by an inverted post-stall gyration similar to the pitchdown departure. In flight test, these departures were encountered by applying full forward stick, then adding lateral stick and/or rudder at 0.4 to 0.5 Mach. When full forward stick is applied and held, maintaining an AOA below zero units, adding even a small amount of lateral stick may generate a departure. Lateral stick inputs are very effective at both high positive and high negative AOA.

The pilot feels lateral g increase as sideslip builds, with a peak lateral g as high as 1.2g's. In addition, just prior to the departure, the rudder locks out in the direction of the sideslip, giving warning of the impending departure. Typically, angle of attack is pegged at zero units and does not vary significantly. Controls should be neutralized and recovery will typically follow within a few seconds. Although extended inverted post-stall gyrations are uncommon in this type of departure, the aircraft may transition to a more violent pitchdown departure and subsequent inverted spin if the aircraft is not recovered upon rudder lock out. Extremely high rudder pedal forces may be required to center the rudder. The engine does not typically surge during a forward stick departure, especially if the maneuver is entered at idle power.

11.6.5.3 Coupled Roll Departure. It has been predicted analytically that lateral stick or coordinated lateral stick and rudder pedal with full forward stick held through more than 180 degrees of bank angle change could result in a coupled roll with roll rates in excess of 500 degrees/second. Due to the severe nature of this

predicted departure mode, it has not been flight tested and, therefore, its existence has not been verified. Roll rates this high would be damaging to the wing structure of the aircraft.

11.6.6 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.

During flight test, there were no engine surges during recoveries from 70 degrees pitch attitude or less. Between 70 and 80 degrees pitch attitude, the aircraft recovers with neutral controls; however, the engine is more likely to surge, especially if the power setting is above idle.

11.6.6.1 Vertical Maneuvering Between 80 and 100 Degrees Pitch Attitude. Vertical maneuvers within 10 degrees of the vertical both upright and inverted at airspeeds of 100 KIAS or less are characterized by the aircraft slowing to zero airspeed, or near zero airspeed, in the vertical. Abrupt control inputs in the vertical at airspeeds below 100 KIAS result in an initial aircraft response which decays to little or no motion as the airspeed approaches zero. After the nose rapidly falls through the horizon, the aircraft usually recovers with no adverse roll or yaw oscillations. The oscillations are somewhat larger than those experienced during the low airspeed vertical maneuvers at 70 degrees pitch attitude or less. The throttle should be retarded to idle, speed brakes retracted, lateral and longitudinal stick should be held neutral, and rudder pedals aggressively centered. Retracting speed brakes can help minimize any post-stall gyrations during recovery. During flight testing, some attempts were made, including use of full aft longitudinal stick, to reduce the pitch rate and thereby minimize adverse aircraft motion during the recovery. Neither the control inputs in the vertical nor control inputs as the nose fell below the horizon had a significant impact on the recovery portion of the maneuver. Approximately 10 percent of the flight test vertical maneuvers at pitch attitudes within 10 degrees of the vertical and airspeeds of 100 KIAS or less resulted in either a pitchdown departure (negative AOA PSG) or an incipient inverted spin. In addition to adverse aircraft dynamics, approximately half of the flight test maneuvers within 10 degrees of the vertical resulted in either a self-recovering surge, a locked engine surge, or an engine flameout. The negative AOA post-stall gyrations are very uncomfortable and disorienting.

During the post-stall gyrations, the pilot will probably encounter extremely high sideslip angles. These high sideslip angles will likely force the unpowered rudder fully deflected. The pilot may need to apply considerable force on the rudder pedals to center the rudder.

Allow airspeed to increase above 180 KIAS before making control inputs following post-stall gyrations. A PSG may occur even if neutral controls have been held throughout the maneuver. Lateral stick inputs prior to recovery could prolong the PSG or result in inverted spin entry. The worst case encountered in flight test was a two turn incipient inverted spin with subsequent recovery.

11.6.7 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.

An engine anomaly will likely occur during PSGs 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. Although less likely in an upright spin, an engine anomaly may occur if the upright spin was entered above 25,000 feet or at a power setting above idle.

Asymmetric wing fuel and/or stores result in smoother upright spin modes and delay recovery from all inverted spin modes. With 100 pounds of wing fuel asymmetry (550 foot-pounds), recoveries from inverted spins required four to five turns during flight testing. Asymmetric fuel or stores result in smoother, less oscillatory inverted spin modes and require additional turns to recover. Recovery with 1,500 foot-pounds wing asymmetry was predicted by simulation to average between 3 to 10 turns. Flight test for spins with asymmetric stores was cut short due to predicted extended recovery times.

11.6.7.1 Upright Spins. Two upright spin modes exist. The first mode is at 30 degrees true AOA (AOA indicator above 28 units). This low AOA (spiral) mode has mild oscillations in roll. As the oscillations build, the aircraft may transition to an inverted spin mode or to the 45 degree AOA upright spin mode. The 30 degree mode is characterized as a jerky, diving spiral since the average nose position becomes lower with each turn and airspeed will increase with every turn. It could also be described as a jerky nose low rudder roll. Airspeed increases at about 10 knots per turn to stabilize at about 180 KIAS. The 30 degree mode has altitude loss which averages 1,250 feet/turn, average roll rate near 60 degrees/second and yaw rate near 40 degrees/second. Spin rate is about 6 seconds per turn.

The second mode is at a true AOA of 45 degrees. The AOA indicator will be pegged at 30 units. This high AOA mode averages 4 seconds per turn and altitude loss is 1,000 feet/turn. This mode will begin to oscillate in roll as AOA approaches 45 degrees and the roll oscillations grow divergently. The early oscillations will probably cause the engine to surge. As oscillations build, the aircraft will gyrate out of the upright spin mode and either recover or couple down into either a pitchdown departure or an inverted spin.

The 30 degree spin mode can be recognized by AOA above 28 units pegged, nose low and airspeed 150 KIAS or higher and increasing by about 10 knots per turn. The 45 degree spin mode did not get beyond an incipient spin phase (one or two turns) before being recovered for engine surge or coupling down into an inverted departure or spin. The 45 degree spin mode was distinguishable from the 30 degree mode by airspeed fairly steady at about 100 to 110 KIAS.

Recovery from either upright mode is accomplished by first neutralizing lateral and longitudinal stick and rudder, retracting the speed brakes (if extended), and retarding the throttle to idle until the spin mode has been determined. The aircraft will likely recover from either

upright spin with neutral controls. If in the 45 degree (high AOA) mode, with neutral controls, apply rudder against the spin (opposite the turn needle) and lateral stick in the direction of the turn needle. If in the 30 degree spin mode, maintain neutral controls until recovery is indicated. Failing to retract the speed brakes extend recovery time. Normal recoveries occur within one turn. Recovery can be recognized by AOA fluctuating or decreasing as opposed to remaining at 30 units, yaw and roll rates damping out and airspeed increasing.

11.6.7.2 Inverted Spins. There are three inverted spin modes: the -40 degree mode, the -60 degree mode, and the -25 degree spin mode. The -40 degree and -60 degree spin modes are similar in characteristics. The -25 degree mode is a separate developed spin mode with different characteristics from the other two. Airspeed provides the pilot's best indication of spin mode. The -60 degree mode is characterized by airspeed oscillating between 50 to 120 KIAS, while the -40 degree mode results in airspeed oscillating within a range of 100 to 160 KIAS. Differentiation between the -60 degree and -40 degree mode is not required for successful recovery. The third spin mode, the -25 degree AOA spin mode, can only be achieved with antispin controls held above 160 KIAS. Normal airspeed range for the -25 degree mode is 140 to 200 KIAS.

All spin modes maintain a load factor of -1 to -1.4g's with the AOA indicator pegged at zero units. Inadvertent entry to any mode is possible during recovery from an upright spin, high pitch attitude vertical maneuvering, maneuvering near full forward stick, a sustained cross controlled roll or a sustained high AOA roll. Inverted spins have relatively high lateral accelerations (0.5 to 1.5g's) which may add to pilot disorientation.

The higher negative AOA modes occur in the true AOA range of -40 to -60 degrees. The high AOA modes are mildly oscillatory in pitch and roll and have rotation rates of about 80 to 100 degrees per second or 3 to 4 seconds per turn. Altitude loss is about 1,000 feet per turn. The aircraft nose attitude varies from about 20 to 70 degrees below the horizon and airspeed is generally below 160 KIAS.

The lower negative AOA spin mode (-25 degree mode) is similar to an inverted diving spiral, even though the aircraft is stalled. Deliberated entry into the -25 degree mode was only accomplished from precise control inputs during a cross control departure and inadvertently during the recovery from the higher AOA inverted spin modes. The nose attitude is about 60 degrees below the horizon with about -15 to -25 degrees true AOA. Airspeed for stabilized inverted spiral modes can vary from 140 to 200 KIAS. The lower AOA mode also has a rotation rate of 80-100° per second or 3-4 seconds per turn, but altitude loss is increased to approximately 1700 feet per turn.

The biggest cue to distinguish between modes is airspeed. If airspeed is 160 KIAS or less (usually oscillating), the aircraft is in the -60 or -40 degree spin mode; if airspeed is 160 KIAS or higher, the aircraft is in the -25 degree spin mode. The turn needle indicates spin direction and the AOA indicator pegged at zero verifies the aircraft is inverted. All spin modes appear quite similar except for airspeed.

Recovery from either of the higher negative AOA inverted spin modes (airspeed below 160 KIAS) can be accomplished by applying full rudder pedal and full lateral stick opposite the turn needle (opposite spin direction). Longitudinal stick should be neutral. Holding in rudder opposite to the turn needle is often difficult due to high sideslip effects on the rudder. Once antispin controls have been applied, airspeed should be monitored carefully. Lateral stick deflection which is anti-spin for the -40 and -60 degree spin modes is prospin for the -25 degree mode. Lateral stick must be neutralized when airspeed increases past 160 KIAS or when the aircraft recovers, whichever occurs first.

NOTE

Failure to neutralize lateral stick with airspeed increasing past 160 KIAS may result in entry into the -25 degree AOA mode and delay recovery.

In flight test, when lateral stick was neutralized during the -25 degree AOA spin, the aircraft either recovered immediately or entered a PSG

and then recovered. Once lateral stick has been neutralized, the AOA indicator should be monitored for indications of recovery for rudder pedal release. AOA increasing above 5 units, and yaw and rolling motions damping out, are positive recovery indications. It is critical that antispin pedal force be maintained until recovery.

WARNING

Releasing pedal force prior to recovery may allow rudder blowout in the prospin direction and significantly delay recovery to below 10,000 feet.

Occasionally the aircraft transitions into a PSG when controls are neutralized, instead of immediately recovering, but subsequently recovers. If rudder is allowed to blow out during the PSG, the aircraft may return to the spin.

In the event the aircraft does not recover and airspeed drops below 160 KIAS for any length of time, the pilot should reapply antispin controls, altitude permitting.

11.7 FLYING CHARACTERISTICS OF THE EMERGENCY HYDRAULIC SYSTEM.

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 has demonstrated, in flight test, a capability to provide sufficient hydraulic power for controllable flight during a total hydraulic pressure loss from the EDP. This capability has been demonstrated in the cruise and emergency approach (emergency gear and emergency flaps) configurations from 20,000 to 10,000 feet MSL between 180 to 120 KIAS. Sufficient RAT hydraulic power was available to successfully fly simulated (10,000 feet) turbulent landings in the emergency approach configuration without exceeding RAT output capability. In general, sustained (15 seconds or more), high frequency (approximately one or more cycles per second), large amplitude (1/3 longitudinal stick combined with a small amount of lateral stick, or more) inputs were required to drive RAT output pressure below 2,500 psi. Although the engine was operating normally during flight testing, the hydraulic system was modified to provide RAT only (i.e., no engine-assist) hydraulic pressure which simulated an engine accessory gearbox or dual EDP failure. In an engine flameout or failure emergency, engine RPM above approximately 8 percent N_2 would result in some engine-assisted hydraulic pressure above that supplied by the RAT. At no time were aircraft handling qualities or flight control system performance degraded.

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

11.8 ENGINE STALL AND FLAMEOUT

11.8.1 Engine Stall. Engine compressor stall is the aerodynamic breakdown of airflow through the compressor section. Factors that can increase the likelihood of compressor stall include: foreign object damage, high aircraft AOA at low airspeed, severe maneuvering, rapid engine acceleration from low power settings, high power settings, unusual flight attitude, flight through jetwash, hot gas ingestion (steam or rocket plume), incorrect engine rigging, and ice formation on inlet ducts.

CAUTION

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.

11.8.2 Compressor Stall Characteristics. Engine compressor stall characteristics will vary depending on power setting, engine acceleration, and maneuver severity. Self-recovering pop stalls are sometimes indicated by a single or a series of audible bangs or pops with correct engine operation being immediately restored with no pilot action. Although the first indication of a compressor stall may be an audible pop or bang followed by a buzzing sound and vibration, external noise due to extreme aircraft maneuvering may mask any audible cues.

Locked-in stalls at low power settings are characterized by a slow EGT rise (as low as 10 °C/second) and a gradual decay in engine RPM, with no audible cue to the pilot. A locked-in stall at idle may not be apparent until the throttle is advanced. EGT rise during a low power stall will accelerate 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. The rate of EGT rise during a locked-in stall at high power settings may reach 100 °C per second. A high power locked-in stall can usually be cleared by positioning the throttle to IDLE. If the stall remains locked-in after the throttle is positioned to IDLE, the indications are a continued gradual decrease in engine RPM with EGT greater than 450 °C. The engine must be shut down to clear a stall that remains locked-in at idle. See Part V, Chapter 15 for engine airstart procedures.

CAUTION

- In the event of an engine surge, immediate action should be taken to simultaneously retard the throttle to IDLE and neutralize the controls to reduce the possibility of engine over temperature.
- Advancing the throttle while the engine is in a surged condition causes the engine to rapidly exceed over temperature conditions.

11.8.3 Engine Flameout. An engine flameout is likely during inverted spins and possible during aircraft recovery following maneuvers within 20 degrees of vertical at airspeeds less than 100 KIAS. A flameout may be preceded by an engine surge. A flameout may be confirmed on the engine indicators as an uncommanded decrease in both RPM and EGT. A reduction in thrust is also evident. See Section V, Chapter 15 for engine airstart procedures.

11.9 ENGINE AIRSTART OPERATIONS

In the event of a flameout or engine shutdown subsequent to a locked-in compressor stall, the engine may be restarted using the immediate, assisted, or windmill procedures. In all cases, the throttle must be set to OFF before an airstart is initiated. As the engine runs down following a flameout or surge, the HYD 2 pump is automatically off-loaded as engine RPM decreases through 42 percent N_2. When the GTS start button is pressed, the engine ignitor plugs are energized, the DC generator is off-loaded, and the fuel boost pump(s) is/are powered from the Essential Services Bus. The engine ignitor plugs energize and fire for 30 seconds after the GTS start button is released. During an immediate or windmill airstart, the GTS may start but it is not used. In the case of an assisted airstart, the GTS is started and the air provided by it is used to assist in starting the engine.

CAUTION

- By design, the throttle cannot be retarded from midthrust setting positions to APPROACH IDLE or IDLE with the finger lifts raised. To bypass the APPROACH IDLE stop or shut down the engine, the finger lifts should not be raised until the throttle is positioned against the APPROACH IDLE stop or IDLE stop.

CAUTION

- When positioning the throttle from OFF to IDLE during a start, the finger lifts should not be raised. Raising the finger lifts while positioning the throttle from OFF to IDLE may result in the throttle being positioned above IDLE during the start.
- Engine starts with the throttle above the ground idle position may cause engine surge/overtemperature.

NOTE

- The HUD, DEP, ADC, and VCR/CEU normally drop off line after pressing the GTS start button. There may be sufficient voltage on the 28 VDC generator bus to allow displays operation to continue with generator off line. The HUD is restored within 60 seconds after generator is reset. If HUD operation is not restored, turn its power off and on with its power rotary switch. If recycling HUD power does not restore the HUD, then reset the DEP with its HUD POWER knob.
- If the GTS is running at idle (GTS advisory light on) after a successful immediate or windmill airstart, it may be shut down by placing the ENGINE switch to the OFF position for a minimum of 5 seconds and then resetting the switch to ON.
- Airstart characteristics are better at lower altitudes and higher airspeeds.
- All MFDs, HUD, DP, ADC , and VCR/CEU normally drop off line after depressing the GTS start button. There may be sufficient voltage on the 28 VDC generator bus to allow displays operation to continue with generator off line. If displays drop off line, the MFDs and HUD are restored within 60 seconds after generator is reset. If HUD operation is not restored, turn its power off and on with its power rotary switch. If recycling HUD power does not restore the HUD, or if generator reset does not restore MFD operation, then reset the DP with its DISPLAY POWER switch.

Light-off usually occurs within 5 seconds of positioning the throttle to IDLE. EGT and RPM should be monitored throughout the start. If light-off is not obtained within 30 seconds after selecting IDLE the throttle must be returned to OFF. If practicable, waiting 30 seconds allows fuel to drain from the engine before initiating another airstart. The fuel boost pump(s) is/are restored to the generator bus approximately 30 seconds after 45 percent RPM has been achieved. Once stabilized idle is achieved, the throttle should be advanced slowly to MRT to check RPM and EGT for normal engine indications. The DC generator and HYD 2 can then be reset. Airstart procedures with the FUEL CONTR switch in MANUAL are similar to those used with the switch in NORMAL; however, due to the loss of the SIFCU, the engine may stabilize at a sub-idle RPM. With MANUAL FUEL selected, RPM may stagnate around 40 percent. If this condition occurs, fuel flow should be increased by slowly advancing the throttle to achieve stabilized sub-idle RPM. EGT should be closely monitored. Sub-idle RPM combined with a high EGT are indications of a hung start or surge, not a stabilized sub-idle condition.

11.9.1 Immediate Airstart. Normally, the fastest airstart is accomplished using the immediate

airstart procedure. An immediate airstart may be attempted at any altitude/airspeed.

NOTE

An immediate airstart attempt is defined as one being conducted within 10 seconds after engine flameout or shutdown.

With the throttle at OFF an immediate airstart is performed by pressing the GTS start button and simultaneously advancing the throttle to IDLE. EGT and RPM should be monitored throughout the airstart. After a successful immediate airstart, the GTS may be shut down by placing the ENGINE switch to the OFF position for a minimum of 5 seconds and then resetting the switch to ON.

11.9.2 Assisted Airstart. The aircraft should be below 15,000 feet, between 165 and 250 KIAS, with the ENGINE switch at ON, and the IGNITION switch at NORMAL. If an Immediate or a Windmill airstart has been attempted, determine if the GTS was started as indicated by the GTS advisory light being illuminated. If the GTS advisory is not illuminated, press the GTS start button to start the GTS. Maximum time between pressing the GTS start button until the GTS advisory light illuminates varies from 20 seconds at sea level to 28 seconds at 20,000 feet. When the GTS light illuminates and with the RPM less than 20 percent, momentarily placing the ENGINE switch to START causes the GTS to run up to full speed to accelerate the engine. The READY light illuminates and the throttle should be advanced to IDLE.

NOTE

The starter is inhibited from cranking the engine if the engine RPM is above 20 percent when the ENGINE switch is momentarily placed to START.

EGT and RPM should be monitored throughout the airstart. When the engine has accelerated to 45 percent RPM, the GTS system automatically shuts down. After a 30 second delay, the fuel boost pump(s) is/are restored to the generator bus. The throttle must be returned to OFF if the airstart is not achieved within 45 seconds after setting the ENGINE switch to START.

11.9.3 Windmill Airstart. A windmill airstart is carried out below 25,000 feet MSL between 250 and 350 KIAS with the throttle at OFF, the ENGINE switch set to ON, the IGNITION switch set to NORMAL, and RPM greater than 13 percent. Windmill airstarts initiated near 25,000 feet/250 KIAS will be slow with higher EGT. Characteristics of starts initiated at lower speeds and higher altitudes can be improved by pushing over to increase airspeed. The GTS start button must be pressed to energize the engine ignitor plugs while simultaneously moving the throttle to the IDLE position. EGT and RPM should be monitored to ensure a successful airstart.

NOTE

- GTS starts are not reliable at altitudes above 15,000 feet MSL.
- Windmill airstarts initiated near 25,000 feet MSL/250 KIAS will be slow with higher EGT. Characteristics of starts initiated at lower speeds and higher altitudes can be improved by pushing over to increase airspeed and decrease altitude.

After a successful windmill airstart, the GTS may be shut down by placing the ENGINE switch to the OFF position for a minimum of five seconds and then resetting the switch to ON.

11.10 ECA INDUCED THRUST TRANSIENTS DURING CLIMB

ECA induced transients during climbs at MRT power have been observed. They typically occur at high altitudes (above 20,000 feet MSL) as the N_1limit and EGT limit become coincident. The transients will subside with increasing altitude as the limiting function is completely transferred to the N_1 limit. The pilot should be aware that this phenomenon exists, but should not assume

that any uncommanded thrust transient is due to the limiting transfer. The transfer of the limiting function should not be confused with the ECA lane transfer.

PART V

EMERGENCY PROCEDURES

Chapter 12 - General Emergencies

Chapter 13 - Ground Emergencies

Chapter 14 - Takeoff Emergencies

Chapter 15 - In-Flight Emergencies

Chapter 16 - Landing Emergencies

Chapter 17 - Ejection

Chapter 18 - Immediate Action Items

Chapter 18A - Warning and Caution Advisories

CHAPTER 12

General Emergencies

12.1 GENERAL EMERGENCY PROCEDURES

This part contains procedures to correct an abnormal or emergency condition. Modify these procedures as required in case of multiple failures, adverse weather, or other peculiar factors. These procedures by no means represent a complete list of conditions a pilot or aircrew can experience during operation. Use common sense and sound judgment to determine the correct course of action. Apply the following rules to all emergencies:

1. Maintain aircraft control

2. Analyze the situation and take proper action

3. Land as soon as practical/possible

NOTE

- Land as soon as possible. Land at the first site at which a safe landing can be made.

- Land as soon as practical. Emergency is not of an immediate nature. Aircraft may be flown to a suitable field where repairs/emergency equipment are available. The landing site and duration of flight is at the discretion of the pilot.

Do only those steps required to manage the problem. When operating a control, be prepared to immediately return the control to its former setting if an undesirable response occurs. As soon as possible, notify the tower, ship, air traffic control (ATC), etc., as applicable, of your emergency, position, and intended action. Broadcast all emergency indications such as airspeed, altitude, heading, and power setting as time permits.

12.1.1 Immediate Action Items. Procedural steps preceded by an asterisk (*) are considered immediate action items. Pilots should be able to accomplish these steps without reference to the checklist.

12.1.2 Warning/Caution/Advisory Lights. The warning, caution, and advisory lights are listed in Figures 12-1, 12-2, and 12-3 together with the cause and corrective action. They are listed under three major headings:

1. Warning Lights/Displays

2. Caution Lights/Displays

3. Advisory Lights/Displays

Each light is listed alphabetically under its major heading: however, if preceded by L or R that letter is not used to place the light alphabetically. Emergency procedures associated with a warning or caution display are shown in this figure and are not repeated elsewhere in this manual.

* Immediate action item
★ Discussion in section V

Warning Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
CABIN ALT	Cabin pressurization failure or air conditioning malfunction. May be due to high AOA or low airspeed.	1. OBOGS - ON AND MASK TIGHT 2. Reduce AOA (if required) 3. AIR FLOW knob - OFF THEN ON **If warning light remains on -** 4. Altitude - DESCEND BELOW 25,000 FEET MSL 5. Land as soon as practical
EGT/RPM	EGT or N_1 RPM too high. **NOTE** EGT/RPM warning light illuminates at 650 ±8 °C or 112.4 ±1 percent N_1.	**GROUND** 1. Throttle - IDLE 2. EGT/RPM - MONITOR **If light remains on -** 3. Throttle - OFF **If EGT and RPM indications normal -** 3. Shut engine down as soon as practical **IN-FLIGHT** *1. Throttle - IDLE (altitude permitting) *2. Controls - NEUTRALIZE *3. EGT/RPM - MONITOR **If EGT is greater than 450 °C for more than 6 seconds after throttle IDLE -** *4. Emergency oxygen actuator - PULL *5. Throttle - OFF *6. Execute appropriate Airstart Procedures **If EGT and RPM indications normal -** 4. Throttle - MINIMUM REQUIRED FOR SAFE FLIGHT 5. Land as soon as practical
FIRE	Engine bay fire detected The first indication of fire is normally illumination of the FIRE warning light accompanied by audible warning tone. Engine fire may be accompanied by one or more of the following: rising EGT, excessive fuel flow, erratic or rough engine operation, or visible flames or smoke trail. Check for secondary indications, EGT/RPM and/or OIL PRESS warning light, HYD 1, HYD 2, TP HOT caution lights, abnormal fuel flow, and visible signs of smoke. **WARNING** Sustained high-frequency, high amplitude control inputs during flight with RAT-only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.	**GROUND** *1. Throttle - OFF *2. FUEL SHUTOFF handle - PULL *3. BATT switches - OFF *4. Egress **TAKEOFF** **If decision is made to stop -** *1. Abort **If fire is confirmed and unable to abort -** *2. Eject **IN-FLIGHT** *1. Throttle - IDLE (minimum for safe flight) *2. Secondary indications - CHECK **If secondary indications exist -** *3. Emergency oxygen actuator - PULL *4. Throttle - OFF *5. FUEL SHUTOFF handle - PULL **If secondary indications persist -** *6. Eject **If fire extinguished -** *6. Prepare for Controlled Ejection **If unable to eject -** *7. Prepare for Flameout Approach **If no secondaries -** 3. Land as soon as possible

Figure 12-1. Warning Lights (Sheet 1 of 4)

* Immediate action item
★ Discussion in section V

Warning Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
GENERATOR	Generator failure The AC INV (aircraft 165080 THRU 165092), C AUG, or F PRES caution lights may also be illuminated. The emergency flood lights will come on if the MIP or CONSOLE lights switches are not set to OFF. If the generator is off for 30 seconds the fuel boost pumps will shutdown and the F PRES caution light will illuminate. Multiple resets are allowed, however, do not hold switch in RESET position. If the F PRES caution light remains illuminated following a successful generator reset, cycling the GEN switch to OFF and back to RESET will normally correct this condition. If the generator will not reset and voltage indication is normal (27 to 29 volts) and GENERATOR light remains on, the likely cause is failure of the undervoltage sensing unit. On aircraft 165080 THRU 165092, subsequent generator failure is indicated by an AC INV light. Emergency gear extension may be required. Both right MFDs and HUD drop off line. Both left MFDs automatically revert to ADI display. DEU, both left MFDs, SADS, VCR/CEU will remain powered for 2 minutes. ★ Refer to Power Distribution Charts	1. Confirm engine operation 2. GEN switch - RESET 3. Voltmeter - CHECK **If generator resets and voltage is abnormal or generator does not reset -** 4. BATT switches - CHECK ON 5. GEN switch - OFF 6. Unnecessary electrical equipment - SECURE 7. Proceed to VMC 8. Land as soon as practical **If MFDs required -** 9. DISPLAY POWER switch - ORIDE 10. DISPLAY POWER switch - NORM WHEN MFDs NO LONGER NEEDED **If generator resets and voltage is normal -** 4. Continue normal operations
GTS FIRE	GTS bay fire detected	**GROUND** *1. ENGINE switch - OFF *2. Throttle - OFF *3. FUEL SHUTOFF handle - PULL *4. BATT switches - OFF *5. Egress **IN-FLIGHT** *1. ENGINE switch - OFF 2. Check for secondary indications of fire **If fire confirmed or flight controls lost -** 3. Eject **If fire not confirmed and control effectiveness remains -** 3. Land as soon as possible
HOOK	Hook position does not agree with handle position. At airspeeds above 300 KIAS, air loads may raise the hook causing the HOOK warning light to illuminate. Once airspeed is reduced below 300 KIAS the hook will fully extend and the HOOK warning light should extinguish.	**HOOK WILL NOT EXTEND** 1. HOOK handle - CYCLE 2. If possible, obtain a visual check 3. Apply positive g loads, in attempt to lower hook **HOOK WILL NOT RETRACT** 1. HYD 1 pressure - CHECK 2. HOOK handle - CYCLE 3. If possible, obtain visual check **If unable to raise hook -** 4. Plan an arrested landing or remove the CDP

Figure 12-1. Warning Lights (Sheet 2 of 4)

* Immediate action item
★ Discussion in section V

Warning Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
HYD FAIL	Total hydraulic pressure loss. **WARNING** Sustained high-frequency, high amplitude control inputs during flight with RAT-only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.	**If unable to maintain controlled flight -** 1. Eject **If flight control remains adequate -** 1. Airspeed - BELOW 300 KIAS/0.6 MACH 2. Hydraulic pressures - MONITOR 3. Land as soon as possible 4. EMER FLAPS switch - DOWN 5. LDG GEAR handle - DOWN 6. EMER GEAR handle - PULL 7. ANTI-SKID switch - OFF 8. Brakes - DO NOT TEST 9. Make Short Field Arrested Landing, if available **If arresting gear not available -** 10. Make smooth brake application 11. Do not attempt to taxi
L BAR	In-flight Launch bar not locked up ★ Refer to Landing Gear Malfunctions - Landing Guides, in Chapter 16	**IN-FLIGHT** 1. Gear - LEAVE DOWN IF PRACTICAL 2. LAUNCH BAR switch - RETRACT 3. Obtain visual check if possible 4. Land ashore only, ensure arresting wires removed
LAW (MFD display)	Altitude is below LAW setting.	Information
LDG GEAR Handle	• Any landing gear position disagrees with the handle. • All gear doors are not up and locked with the handle up.	1. Check landing gear indicator position lights.
MSTR ARM (Aft Cockpit)	Front cockpit MASTER ARM switch set to ARM	Information

Figure 12-1. Warning Lights (Sheet 3 of 4)

* Immediate action item
★ Discussion in section V

Warning Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
OIL PRESS	Oil pressure low Momentary illumination of the OIL PRESS warning light is acceptable under positive g flight conditions following a period of zero or negative g. **CAUTION** If more than idle RPM is needed during recovery, set RPM immediately to 80 to 85% and avoid further chances. If essential, power changes should be made by smooth, slow throttle movements. **NOTE** Loss of oil pressure eventually results in engine seizure. If more than idle RPM needed, the optimum setting is 80 to 85%. Engine seizure is delayed by: minimizing RPM, minimizing throttle movements, maintaining 1 g flight.	*1. Throttle - MINIMUM FOR SAFE FLIGHT *2. Minimize throttle movements 3. Land as soon as possible (Precautionary Approach recommended)
OXYGEN	Oxygen concentration below acceptable limits, bleed air supply temperature is above 250° F or OBOGS BIT failure. OBOGS failure is indicated by the illumination of the OXYGEN warning light, a noticeable problem breathing or hypoxia. The failure may be a high temperature bleed air leak, a heat exchanger failure, or insufficient oxygen concentration. The OXYGEN warning light will come on if the OBOGS/ANTI-G switch is set to OFF.	*1. Emergency oxygen actuator - PULL **If irritants not detected in breathing oxygen -** 2. OBOGS/ANTI-G switch - OFF THEN ON **If irritants detected in breathing oxygen or OXYGEN warning light remains illuminated -** 3. OBOGS/ANTI-G switch - OFF 4. Altitude - DESCEND TO LESS THAN 10,000 FEET CABIN ALTITUDE OR MINIMUM SAFE ALTITUDE 5. Land as soon as practical
WHEELS	Indicates LDG GEAR handle is not set to DN, throttle below 95 percent N_2 RPM position, and either Altitude below 7,200 feet MSL (less than 9,500 ±300 feet MSL when climbing or 7,700 ±500 feet MSL when descending), and airspeed below 170 KIAS OR FLAPS/SLATS lever not set to UP	Information

Figure 12-1. Warning Lights (Sheet 4)

* Immediate action item
★ Discussion in section V

Caution Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
AC INV	Either or both inverters have failed.	1. AC RESET switch - RESET 1 AND 2 **If light remains on -** 2. Maintain VMC and land as soon as practical
ACCEL	Shot of fuel solenoid or steam ingestion bleed valve is not in the proper position. May occur temporarily when passing in close proximity to another aircraft's exhaust while on deck.	**CATAPULT** 1. Suspend launch **IN-FLIGHT** **Above 10,000 feet MSL -** 1. Avoid throttle advances 2. Descend below 10,000 feet MSL **Below 10,000 feet MSL -** 1. Avoid abrupt throttle advances 2. Land as soon as practical 3. Do not land aboard carrier 4. Anticipate slower engine acceleration on approach
AV HOT	Avionics cooling air hot; ground indication only	1. Canopy - ENSURE CLOSED 2. CABIN TEMP control knob - COOL 3. Throttle - ADVANCE RPM TO 70% **If light still remains on -** 4. Unnecessary communications and navigation equipment - SECURE 5. Abort launch
CANOPY	Canopy unlocked	1. CANOPY control lever - CHECK LOCKED 2. Land as soon as practical **If canopy will not lock -** 3. Airspeed - BELOW 200 KIAS 4. Descend below 25,000 feet MSL 5. AIR FLOW knob - OFF 6. Seat - LOWER 7. Visor - DOWN 8. Stow loose gear in cockpit

Figure 12-2. Caution Lights (Sheet 1 of 4)

* Immediate action item
★ Discussion in section V

Caution Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
C AUG	Control augmentation off, degraded, or in IBIT. If SBI is inoperative, pitch oscillations may be unacceptable in formation flight during speed brake operations. Without yaw dampening and ARI, line up control will be more difficult.	1. Paddle switch - PRESS AND RELEASE 2. Verify SADS not degraded **If SADS degraded -** 3. CONTR AUG cannot be reset **If SADS not degraded -** 3. CONTR AUG switch - RESET AND RELEASE 4. Wait 9 seconds **If C AUG caution light remains on -** 5. Paddle switch - PRESS AND RELEASE Yaw damping, ARI, SBI, and rudder trim are inoperative. **If C AUG caution light goes out -** 5. GINA - VERIFY NOT DEGRADED 6. CONTR AUG switch - ALL **If C AUG caution light comes on -** 7. NWS button - PRESS 8. Paddle switch - PRESS AND RELEASE 9. NWS button - PRESS 10. CONTR AUG switch - RESET AND RELEASE Yaw damping and ARI are inoperative. 11. BIT display - CHECK
DOOR	A landing gear door is open. With MLG doors open, door damage may occur from arresting gear strikes. NWS may be inoperative with DOOR caution light illuminated. Consider an arrested landing with NLG doors open due to loss of NWS and degraded directional control.	**LDG GEAR HANDLE UP** 1. Airspeed - BELOW 200 KIAS 2. Ensure EMER GEAR handle fully stowed 3. Obtain visual inspection, if possible 4. Ensure LDG GEAR handle is UP **If light remains on -** 5. Land as soon as practical **LANDING GEAR DOWN** 1. Land past deck pendants **If NWS inoperative -** 2. Execute go-around 3. Make a Short Field Arrested Landing, if available
ECA 2	ECA dual channel failure In the unlikely event of an ECA failure in a full trim condition, fuel flow will be reduced; the EGT and RPM will decrease, and the thrust available will be governed by the maximum RPM obtained. The thrust may be reduced by as much as one third of the normal full throttle value. Very low idle RPM may occur, and the throttle must be handled carefully to avoid stall or flameout. ECA total failure will, in most instances, result in a no trim condition, increasing the RPM and EGT. The EGT and RPM must be controlled carefully within limits by throttle manipulation.	1. Do not exceed 90 percent above 20,000 feet, or 95 percent below 20,000 feet, do not exceed 600° C EGT 2. Land as soon as practical (Precautionary Approach recommended) **If engine instability exists -** 3. Throttle - BETWEEN IDLE AND MID-RANGE, if practical 4. Fuel Control switch - MANUAL 5. Throttle - AS REQUIRED (Maintain RPM above 70%, if practical) 6. Land as soon practical (Precautionary Approach recommended)

Figure 12-2. Caution Lights (Sheet 2 of 4)

* Immediate action item
★ Discussion in section V

Caution Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
F PRES	Fuel pressurization failure, fuel boost pump failure, or one or both ENGINE switches set to OFF. Avoid negative g and abrupt maneuvers which may result in a loss of fuel to the LP pump. At altitudes above 25,000 fuel boiling or vaporization may occur due to the loss of pressurization. Fuel pressurization failure, fuel boost pump failure, ADR failure, or either ENGINE switch set to OFF.	**If ENGINE switches not set to ON -** 1. ENGINE switches - ON **If ENGINE switches set to ON and caution light on -** 1. Throttle - MINIMUM FOR SAFE FLIGHT 2. Avoid negative g maneuvers 3. Altitude - DESCEND BELOW 25,000 4. Land as soon as practical
FUEL	Collector tank fuel is below 350 pounds	1. Fuel flow - REDUCE (if practical) 2. Avoid negative g maneuvers 3. Land as soon as possible
HYD 1	HYD 1 system pressure low. Reduction of HYD 1 pressure below 1,500 psi will result in the loss of the following equipment: Landing gear normal extension Flaps normal extension Slats Speed brakes Nose wheel steering Launch bar (extend) Normal brakes/anti-skid Arresting hook (retract)	1. Airspeed - BELOW 300 KIAS/0.6 MACH 2. HYD 2 pressure - MONITOR 3. Land as soon as practical **Before landing -** 4. EMER FLAPS switch - DOWN 5. LDG GEAR handle - DOWN 6. EMER GEAR handle - PULL 7. ANTI-SKID switch - OFF 8. Brakes - DO NOT TEST 9. Make Short Field Arrested Landing, if available. **If arresting gear not available -** 10. Make smooth brake application 11. Do not attempt to taxi
HYD 2	HYD 2 system pressure low. Reduction of HYD 2 pressure below 1,500 psi will result in extension of the RAT as indicated by illumination of the RAT caution light and fluctuation of the HYD 2 pressure indicator between 2,500 and 3,000 psi.	1. Airspeed - BELOW 300 KIAS/0.6 MACH 2. HYD 1 pressure - MONITOR 3. RAT extension- CONFIRM **If HYD 2 caution light goes out and HYD 2 pressure above 1,800 psi -** 4. HYD 2 - RESET (only one reset) **If HYD 2 caution light remains on or HYD 2 pressure below 1,800 psi -** 5. HYD 2 - DO NOT RESET 6. Land as soon as practical
LP PUMP	Engine driven low pressure fuel pump failure/outlet pressure low	1. Throttle - AVOID ABRUPT MOVEMENT AND SET MINIMUM FOR FLIGHT 2. Avoid unusual attitudes 3. Land as soon as practical
MASTER ALERT	A warning or caution light has been activated.	1. Check warning and caution lights

Figure 12-2. Caution Lights (Sheet 3 of 4)

* Immediate action item
★ Discussion in section V

Caution Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
NWS	Nosewheel steering failure or paddled off	**IN-FLIGHT -** 1. NOSE WHL STR button - PRESS **If NOSE WHL STR caution light remains on -** 2. Make short field arrested landing, if available **GROUND** 1. NOSE WHL STR button - PRESS **If NOSE WHL STR caution light remains on -** 2. Paddle switch - PRESS 3. Brakes - USE DIFFERENTIAL BRAKING TO CONTROL THE AIRCRAFT
PK BRK	Throttle above intermediate position (approximately 60-70% RPM) and parking brake set.	1. Parking brake - CHECK
RAT	RAT is extended. An uncommanded RAT extension is evidenced by illumination of the RAT caution light, normal HYD 2 pressure, and no HYD 2 caution light. The HYD 2 caution light may come on or flicker with the RAT extended and HYD 2 pump operational. To verify HYD 2 pump integrity, engine speed may need to exceed 80 percent RPM.	**If uncommanded and HYD 2 caution light out -** 1. HYD 2 RESET button - PRESS **If RAT does not reset -** 2. Land as soon as practical
SEAT	One or both ejection seats not armed and throttle above intermediate position (approximately 60 to 70 percent RPM).	1. Check occupied seats armed
SKID	Anti-skid system failure If arresting gear is available and the runway is wet, consideration should be given to executing a go-around and performing an arrested landing.	1. Go around if practical **If go around not practical -** 1. Wheel brakes - ENSURE BOTH CREW MEMBERS RELEASE 2. ANTI-SKID switch - OFF 3. Wheel brakes - AS REQUIRED
SLATS	Slats are not in the selected position, or a split slat condition exists, or exceeding 217 KIAS with flaps/slats selected down. With split slats or slats up, abrupt roll off with no stall warning may occur at clean stall AOA (approximately 25 units).	1. Airspeed - BELOW 200 KIAS 2. AOA - MAINTAIN AT OR BELOW 21.5 UNITS 3. Land as soon as practical **If unable to extend flaps -** 4. Do not land aboard carrier 5. Approach speed - FLY ON-SPEED AOA
TP HOT	Tailpipe bay temperature has exceeded limits	**GROUND** *1. Throttle - OFF *2. FUEL SHUTOFF handle - PULL *3. BATT switches - OFF *4. Egress **IN-FLIGHT** *1. Throttle - IDLE (minimum for safe flight) 2. Monitor for engine fire indications 3. Secondary indications - CHECK 4. Land as soon as possible

Figure 12-2. Caution Lights (Sheet 4 of 4)

* Immediate action item
★ Discussion in section V

Advisory Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
AFT	Designated COMM is controlled by the aft cockpit.	Information
ATTITUDE (MFD display)	Displayed when attitude data is invalid. All ADI attitude display information will be removed. If a restart is attempted, the GINA will attempt an alignment until attitudes are valid. Ground alignment requires 3 minutes. In-flight restarts require the aircraft to be in straight and level non-accelerated flight. Shipboard alignments require up to 18 minutes.	1. Revert to standby instruments 2. GINA BIT status - CHECK **If GINA BIT status GO and attitude data display desired -** 3. ACFT DATA display RST option - SELECT **If ATTITUDE display returns -** 4. Proceed VMC 5. Land as soon as practical
AV BIT	A BIT failure has occurred or been simulated since the last time the BIT display was selected.	1. BIT display - CHECK
BINGO (MFD Display)	Fuel below BINGO setting	Information
CORRIDOR (MFD Display)	GPS corridor violation (estimated error), GPS mode only.	1. Do not use GPS approach mode 2. Verify GPS error 3. Check display against other navigation source
ECA	Single lane failure in the ECA	Information
FULL	Flaps are fully extended	Information
FWD	Designated COMM is controlled by the forward cockpit.	Information
GLIDESLOPE (MFD display)	Glideslope invalid, glideslope steering needle will be blanked.	Information
GTS	GTS is at idle speed and ready for start	Information
HALF	Flaps are in 1/2 position	Information
I	Aircraft is over the inner marker.	Information
ILS (MFD display)	Localizer and glideslope invalid, both steering needles will be blanked.	Information
L BAR	Launch bar is extended on the deck and LAUNCH BAR switch is set to EXTEND.	Information
LEFT	Left MLG is down and locked.	Information
LOCALIZER (MFD Display)	Localizer invalid, localizer and glideslope steering needles will be blanked.	Information
M	Aircraft is over the middle marker.	Information
M FUEL	Manual fuel system is selected	Information

Figure 12-3. Advisory Lights (Sheet 1 of 2)

* Immediate action item
★ Discussion in section V

Advisory Lights/Displays

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
NOSE	NLG is down and locked.	Information
NWS HI	Nosewheel steering is in high gain.	Information
O	Aircraft is over the outer marker.	Information
POSITION (MFD Display)	Displayed when positional data is invalid. Heading and velocity data will not be presented on displays. If a restart is attempted, the GINA will attempt an alignment until attitudes are valid. Ground alignment requires 3 minutes. In-flight restarts require the aircraft to be in straight and level non-accelerated flight. Shipboard alignments require up to 18 minutes.	1. Verify position with another nav source (TACAN, VOR) 2. Revert to standby instruments 3. GINA BIT status - CHECK **If GINA BIT status GO and positional data display desired -** 4. ACFT DATA display RST option - SELECT **If POSITION display returns -** 5. Proceed VMC 6. Land as soon as practical
READY	N_1 ≥100 RPM in correct direction and igniters on	Information
RIGHT	Right MLG is down and locked.	Information
SIM MODE (MFD Display)	Improper discrete being input to the DEU. MFDs and HUD will remain inoperative.	**GROUND** 1. Abort mission **IN-FLIGHT** *1. Revert to standby instruments 2. Proceed to VMC as soon as possible 3. Land as soon as practical
SKID	Anti-skid system is selected	Information
SPD BRK	Speed brakes not fully retracted.	Information
SPD BRK/FULL	Speed brakes fully extended.	Information

Figure 12-3. Advisory Lights (Sheet 2 of 2)

CHAPTER 13

Ground Emergencies

13.1 ABNORMAL START

If the engine fails to light off within 15 seconds from moving the throttle to idle (wet start), or fails to accelerate from 45 percent to idling conditions (hung start), or if the EGT is excessive (hot start), or a tailpipe fire indicated this procedure should be used.

GTS LIGHT IS ON

*1. Throttle - OFF

*2. Execute Clear Engine Procedures

13.2 CLEAR ENGINE PROCEDURE

*1. FUEL SHUTOFF handle - DOWN

*2. ENGINE switch - ON (both cockpits)

*3. GTS - START (if GTS light not on)

*4. IGNITION switch - ISOLATE

When RPM below 20% and GTS advisory light illuminates -

*5. ENGINE switch - START

If GTS is no longer required -

6. ENGINE switch - OFF

13.3 TAILPIPE FIRE AFTER SHUTDOWN

*1. Throttle - OFF

*2. Execute Clear Engine Procedure

13.4 HOT BRAKES

When excessive braking has occurred (such as after an aborted takeoff), or hot brakes are suspected, notify the tower to alert the crash crew and to inform other personnel to stand clear. A dragging brake will also produce excessive heat at the wheel. A badly dragging brake could raise wheel temperatures to a point where the fuse plug will melt and deflate the tire. The time to reach peak temperature may exceed 25 minutes.

NOTE

- Do not set the parking brake.
- If the aircrew elect to exit the aircraft, they should remain clear of the brake danger area by walking directly away from the aircraft in the direction of the nose.

13.5 EMERGENCY EGRESS

WARNING

Do not eject unless the canopy is fully closed.

1. Notify other crew member if possible
2. Ejection seat SAFE/ARMED handle - SAFE
3. Throttle - OFF
4. PARKING BRAKE handle - PULL
5. Canopy - OPEN

If canopy cannot be opened -

6. MDC firing handle - PULL

WARNING

Before pulling the handle, lower the helmet visor, close the eyes and keep the hands and body as far away as possible from the MDC pattern on the canopy.

To evacuate with survival kit -

7. Upper Koch fittings - RELEASE

8. Emergency restraint release - PULL

WARNING

For water egress, pull the emergency oxygen actuator and do not disconnect the oxygen/communication hose. Inflate LPU after exiting the aircraft.

To evacuate without survival kit -

7. Koch fittings - RELEASE UPPER AND LOWER

8. Emergency restraint release - PULL

9. Oxygen/communications hose - DISCONNECT

CHAPTER 14

Takeoff Emergencies

14.1 ABORT

There are many circumstances that may require aborting a takeoff. Some of these circumstances are unacceptable engine acceleration characteristics, less than normal takeoff EGT/RPM, illumination of the FIRE warning light, trim failures, loss of oil pressure, fuel transfer failures, smoke in the cockpit, abnormally slow aircraft acceleration to takeoff speed, blown tire, uncommanded swerving, and loss of canopy. Early detection of an aircraft malfunction during takeoff roll is of primary importance. The decision to abort or continue takeoff must be based on the nature of the malfunction, aircraft speed, runway remaining, braking conditions, and whether or not the aircraft can become airborne prior to leaving the runway.

*1. Throttle - IDLE

*2. Speed brakes - EXTEND

*3. Brakes - AS REQUIRED

*4. Hook - DOWN 1,000 FEET PRIOR TO ARRESTING GEAR, IF REQUIRED

NOTE

If off center just prior to engaging the arresting gear, do not attempt to go for the center of the runway. Continue straight ahead parallel to the runway centerline.

*5. Release brakes prior to crossing the arresting gear

CAUTION

Braking during CDP engagement may raise the hook point sufficiently to miss the arresting gear.

6. Transmit your intentions

14.2 AIRCRAFT SETTLING OFF CATAPULT

*1. Throttle - CHECK FULL FORWARD

*2. Maintain 24 units AOA

If settle not stopped -

*3. Eject

14.3 ENGINE FAILURE DURING CATAPULT LAUNCH

*1. Eject

2. If unable to eject - DITCH STRAIGHT AHEAD

14.4 BLOWN TIRE DURING TAKEOFF

A blown nose wheel tire may cause engine FOD. A blown main gear tire may damage the flaps and/or brake lines. Any blown tire may damage the gear doors or wheel well equipment. If the decision to stop is made, the primary danger is loss of directional control. Do not attempt to taxi.

If decision to abort is made -

*1. Rudder - AS REQUIRED TO COUNTER SWERVE

WARNING

Rudder pedal forces as high as 180 pounds may be required to successfully counter the swerve. Failure to counter the swerve may result in the aircraft departing the prepared runway surface.

*2. ANTI-SKID switch - OFF PRIOR TO BRAKING

WARNING

Without anti-skid protection, judicious brake application is required to avoid blowing the remaining tire. If the other tire blows, simulations show the aircraft becomes uncontrollable below approximately 80 KIAS.

If takeoff is continued -

*1. Rudder - AS REQUIRED TO COUNTER SWERVE

WARNING

Rudder pedal forces as high as 180 pounds may be required to successfully counter the swerve. Failure to counter the swerve may result in the aircraft departing the prepared runway surface.

2. Gear and flaps - DO NOT REPOSITION

CAUTION

Retraction of gear or flaps may cause additional damage to flaps, gear doors, or wheel well area.

3. Engine instruments - MONITOR

4. Execute Landing with Blown Tire procedure, paragraph 16.7

14.5 BLOWN TIRE(S) DURING CATAPULT LAUNCH

A blown nose wheel tire may cause engine FOD. A blown main gear tire may damage the flaps and/or brake lines. Any blown tire may damage the gear doors or wheel well equipment.

1. Gear and flaps - DO NOT REPOSITION

CAUTION

Retraction of gear and flaps may cause additional damage to flaps, gear doors, or wheel well area.

2. Engine instruments - MONITOR

3. Execute a dirty BINGO profile to designated divert airfield

NOTE

- The designated divert airfield shall be equipped with operable arresting gear.
- Following a visual inspection that confirms the flaps have not been damaged, consideration may be given to retracting the flaps during the bingo profile.

If unable to divert -

3. Perform Normal Carrier Approach

In all cases -

4. Comply with Landing with Blown Tire(s) Procedure

14.6 LANDING GEAR UNSAFE/FAIL TO RETRACT

1. Airspeed - BELOW 200 KIAS

2. Ensure EMER GEAR handle fully stowed

If light remains on -

3. LDG GEAR handle - DOWN, DO NOT CYCLE

If all gear indicate down and locked -

4. Land as soon as practical

If any gear indicates unsafe -

5. Execute Landing Gear Unsafe/Fail to Extend procedures.

CHAPTER 15

In-Flight Emergencies

15.1 ENGINE FAILURE

Engine flameout indications generally consist of decreasing RPM and EGT with corresponding reduction in thrust. Often the first indication of flameout is the FUEL PRESS caution light, followed by the GENERATOR and AC INV warning/caution lights. The GENERATOR and AC INVERTER lights come on as the engine has spooled down to approximately 42% and an undervoltage is sensed. On aircraft 165093 AND UP, the AC INV caution light does not illuminate unless an AC INV has failed. Immediate airstart should be attempted as soon as possible following confirmation of engine failure (ideally within 10 seconds) to maximize chances of a successful restart.

Failure of the engine main fuel system is likely to be indicated by incorrect or uncommanded engine response. Relighting in MANUAL fuel system is recommended if such a fuel system failure is suspected.

If below 1,500 feet AGL and airspeed below 180 KIAS -

*1. Eject

If above 1,500 feet AGL or airspeed greater than 180 KIAS -

*1. Emergency Oxygen Actuator - PULL

*2. Perform Immediate Airstart

15.2 AIRSTART PROCEDURES

Normally, the fastest airstart is accomplished using the Immediate Airstart Procedure. This procedure provides an opportunity to re-light the engine outside of the normal windmill airstart envelope because the internal engine components are still relatively hot. This procedure also initiates a GTS start attempt which if successful may expedite the assisted airstart attempt should the immediate airstart prove to be unsuccessful. An immediate airstart may be attempted at any altitude/airspeed.

Windmill airstarts are more favorable if RPM is above 13 percent. Windmilling RPM may fall to zero during a prolonged descent at low airspeed due to engine accessory loads. This is not an indication of mechanical failure unless preceded by other symptoms. In the event of windmilling RPM falling below 13 percent refer to the Assisted Airstart procedure, paragraph 15.2.3.

Maximum range gliding distance will be severely reduced with a seized engine. If RPM remains at zero and the READY advisory light does not come on during GTS assisted start, engine seizure is confirmed.

At high altitude and low airspeed conditions the engine should relight satisfactorily but may stagnate between 30 to 40% RPM; in this event it should be possible to complete a satisfactory relight by increasing airspeed and reducing altitude with the throttle at IDLE.

The airstart procedures utilizing the manual fuel system are similar to those employed when on the engine main fuel system. However, due to the loss of the SIFCU, throttle assistance may be required above approximately 40% RPM to attain a stabilized idle speed. The air bleed valve will remain open for 60 seconds after the GTS start button has been released so the initial acceleration to maximum permitted conditions should be slow to avoid the possibility of surge. Loss of ECA influence will necessitate the monitoring of cockpit indicators to prevent exceeding the limitations. The relight envelope for the manual fuel system is with an airspeed of 250 KIAS or greater and altitude less than 25,000 feet.

When the engine RPM spools down to the point that the generator drops off line, the HUD and both right MFDs will also drop off line. Both left

MFDs will automatically switch to the ADI display and remain on for 2 minutes. If a GTS start is initiated both left MFDs, the DEU, SADS, and VCR/CEU will then drop off line.

15.2.1 Immediate Airstart (Any Airspeed/Any Altitude)

*1. Throttle - OFF

Simultaneously perform steps 2 and 3 -

*2. GTS start button - PRESS AND HOLD (MFDs, DEU, SADS and VCR/CEU drop off line)

WARNING

To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.

*3. Throttle - IDLE (monitor EGT/RPM)

WARNING

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

NOTE

Ignitors will fire for 30 seconds after releasing GTS button.

15.2.2 Windmill Airstart

Below 25,000 feet MSL, minimum 13% N_2 RPM (recommend a minimum of 250 KIAS) -

*1. Throttle - OFF

Simultaneously perform steps 2 and 3 -

*2. GTS start button - PRESS AND HOLD (MFDs, DEU, SADS and VCR/CEU drop off line)

WARNING

To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.

*3. Throttle - IDLE (monitor EGT/RPM)

WARNING

Engine starts with throttle above the ground idle position can lead to engine surge/overtemperature.

NOTE

- Ignitors will fire for 30 seconds after releasing GTS button.
- Engine may stagnate between 30-40% N_2 RPM during unassisted (windmill) airstarts. In this event, it should be possible to complete the start by reducing altitude, thus increasing airspeed, with the throttle at idle.

15.2.3 Assisted Airstart

NOTE

GTS starts are not reliable at altitudes above 15,000 feet MSL.

Below 15,000 feet MSL, 165 to 250 KIAS -

*1. Throttle - OFF

*2. GTS - START (MFDs, DEU, SADS and VCR/CEU drop off line)

WARNING

To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.

When RPM drops below 20% N_2 and GTS advisory light illuminates -

*3. ENGINE switch - START

*4. Throttle - IDLE (monitor EGT/RPM)

WARNING

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

NOTE

Ignitors will fire for 30 seconds after releasing GTS button.

15.2.4 Failure To Relight

If no relight within 30 seconds after moving throttle to idle or EGT exceeds limits -

1. Throttle - OFF (allow 30 seconds to drain if practical)
2. ENGINE switch - ON (both cockpits)
3. IGNITION switch - NORMAL
4. Reattempt airstart

NOTE

If airstart attempted in manual fuel, throttle assistance may be required.

If engine will not start and MFDs needed -

5. GEN switch - RESET
6. DISPLAY POWER switch - ORIDE

DEU, SADS, both left MFDs, and the VCR/CEU will be powered by the 28 VDC Essential Services Bus

15.2.5 Successful Airstart

1. Throttle - MINIMUM FOR SAFE FLIGHT
2. GEN switch - RESET

NOTE

If the F PRES caution light is still illuminated following a successful generator reset, cycling the GEN switch to OFF and back to RESET will normally correct this condition.

3. HYD 2 - RESET
4. ENGINE switch - OFF FOR 5 SECONDS, THEN ON WITHIN 30 SECONDS

NOTE

If generator voltage drops below the minimum required by the VHF/UHF radio no. 2, it may not power up properly after a successful airstart. Proper VHF/UHF radio no. 2 operation may be restored by cycling power off and back to on.

5. Land as soon as practical

15.3 ENGINE STALL/EGT/RPM MALFUNCTIONS

Engine stall may produce an audible bang or series of bangs from the engine accompanied by a sudden increase in EGT and decrease in RPM. EGT/RPM malfunctions could be the result of engine stall, emanating from radical maneuvering, icing, or mechanical failure.

Simultaneously perform steps 1 and 2 -

*1. Throttle - IDLE (minimum for safe flight)

*2. Controls - NEUTRALIZE

*3. EGT/RPM - MONITOR

If EGT is greater than 450° C for more than 6 seconds after throttle IDLE -

*4. Emergency oxygen actuator - PULL

*5. Throttle - OFF

*6. Execute Airstart procedures

CAUTION

If EGT is greater than 745° C, engine damage may occur.

NOTE

If EGT is 620° C or greater for 20 seconds, ECA malfunction may have occurred. Verify ECA 2 caution light illuminated for secondary indication.

If EGT and RPM indications are normal -

4. Throttle - MINIMUM FOR SAFE FLIGHT

5. Land as soon as practical

15.3A INCORRECT OR UNCOMMANDED ENGINE RESPONSE

Failure of the main fuel system is indicated by abnormal engine behavior or loss of engine control. At a fixed throttle position the primary symptoms are likely to be fluctuations in RPM accompanied by fluctuations in thrust or an uncommanded acceleration or deceleration. Main fuel system failure during transient throttle operation could result in lack of acceleration/deceleration or faster than normal acceleration that could possibly result in a surge.

*1. Throttle - BETWEEN IDLE AND MID-RANGE, if applicable

*2. Fuel Control switch - MANUAL

3. EGT/RPM - MONITOR (Do not exceed 90% N_2RPM above 20,000 feet MSL, or 95% at 20,000 feet MSL or below. Do not exceed 600° C EGT.)

4. Throttle - AS REQUIRED (maintain N_2 RPM above 70%, if practicable. Continue to monitor EGT/RPM to avoid exceedances.)

5. Land as soon as practical (Precautionary Approach recommended)

15.4 VIBRATIONS

Aircraft vibrations can result from engine/ECS malfunctions, loose panels or control surfaces outside the aircraft, or from a variety of system failures. If loose external panels or control surfaces are suspected, a cautious inspection by another aircraft is recommended when possible.

1. Throttle - MINIMUM FOR SAFE FLIGHT

2. Engine instruments - MONITOR

If engine indications are normal and vibrations continue -

3. Altitude - DESCEND BELOW 10,000 FEET IF POSSIBLE

4. AIR FLOW knob - OFF
   Selects ram air and shut down the ECS CAU. If the CAU is the cause of the vibrations, the vibration frequency should change as the CAU slows and cease as it stops.

If vibrations continue -

5. Reduce airspeed

6. AIR FLOW knob - NORMAL / AS DESIRED
   NORMAL will close ram air and restore pressurization and air conditioning.

7. If possible request inspection by other aircraft

8. Land as soon as practical

15.5 ELECTRICAL FIRE

*1. GEN switch - OFF

2. Non-essential electrical equipment - OFF

If fire out -

3. Land as soon as practical

If fire persists -

3. Proceed to VMC as soon as possible

4. BATT switches - OFF

5. Emergency oxygen actuator - PULL

6. Land as soon as possible

7. Landing gear - EMERGENCY EXTEND

Directional control characteristics will be degraded due to forward NLG doors being open.

8. Plan a no-flap approach and arrested landing, if available. Recommend a Short Field Arrestment due to loss of NWS.

Careful modulation of the engine is required since the ECA is inoperative. Refer to the ECA Caution Light Procedures.

15.6 SMOKE OR FUMES IN COCKPIT

Consider all unidentified fumes in the cockpit as toxic. Do not confuse condensation from the air conditioning system with smoke. A possible source of visible smoke or fumes in the cockpit is from the engine bleed or residual oil in the air conditioning ducts. This smoke is blue gray in color, has a characteristic oily odor, and may cause the eyes to sting. Another source of smoke or fumes is an electrical malfunction or overheat of equipment located in the cockpit. In the event of an electrical short or overload condition, this equipment may generate acrid smoke (usually white or gray color). See procedure for Electrical Fire.

15.6.1 Elimination Of Smoke Or Fumes From Cockpit

*1. Altitude - DESCEND BELOW 25,000 FEET (if practical)

*2. AIR FLOW knob - OFF

If unable to clear smoke or unable to see -

*3. Airspeed - REDUCE

*4. Warn other cockpit occupant/secure loose items.

*5. Seat - LOWER

*6. Visor - DOWN

*7. MDC firing handle - PULL

NOTE

If canopy is shattered, airflow over the cockpit area has a suction effect and causes a greater cabin pressure altitude to be experienced than the actual aircraft altitude. The effect is related to airspeed and altitude, but may typically give an increase of up to 5,000 feet cockpit altitude.

8. Land as soon as possible

15.7 FOGGING OF WINDSCREEN/FOG IN CREW STATION

In humid climates or descents into cooler air fogging may occur. The following procedure is for eliminating fog once it has occurred.

To stop fog/condensation from vents -

1. AIR FLOW knob - OFF

If immediate clearing not required or pressurization required -

1. AIR FLOW knob - MAX DEFOG

2. CABIN TEMP knob - AUTO AND FULL WARM

NOTE

May take several minutes to clear canopy.

If fogging persists -

3. CABIN TEMP knob - MANUAL MODE, FULL WARM POSITION
   If a failure has occurred in the automatic temperature control system, selecting MANUAL mode bypasses the AUTO mode. Monitor temperature manually.

If fogging clears -

4. CABIN TEMP knob - AUTO/TEMP AS REQUIRED
   AUTO mode is the preferred mode, providing temperature protection and reducing pilot work load. If the cause of fogging was due to a system failure, reselection of MANUAL mode and manual control of temperature may be required. Monitor the windscreen and canopy if signs of overheating immediately reduce the temperature. Monitor the ventilation and defog outlets if detect snow or ice immediately increase the temperature.

CAUTION

Avoid maximum temperature operation for extended periods of time. Automatic temperature control limits are inoperative in MANUAL mode and damage to the aircraft may occur.

NOTE

Selecting COOL or WARM drives temperature control valve until knob is released. Temperature control valve remains in last selected position, CABIN TEMP knob springs back to center position.

If fogging continues to persist -

4. AIR FLOW knob - OFF
   This turns off the ECS and reverts to ram air. Defogging may require several minutes, depending on ambient conditions.

15.8 OBOGS CONTAMINATION

If irritants detected in breathing oxygen from the OBOGS, proceed as follows:

*1. Emergency oxygen actuator - PULL

If irritants not detected in breathing oxygen -

2. OBOGS/ANTI-G switch - OFF THEN ON (on aircraft 163600 THRU 163646 BEFORE T-45A AFC-62 hold in ON position for up to 20 seconds)

If irritants detected in breathing oxygen or OXYGEN warning light remains illuminated -

3. OBOGS/ANTI-G switch - OFF

4. Altitude - DESCEND TO LESS THAN 10,000 FEET CABIN ALTITUDE OR MINIMUM SAFE ALTITUDE

5. Land as soon as practical

15.9 TOTAL ELECTRICAL FAILURE

1. Emergency oxygen actuator - PULL
2. Proceed to VMC as soon as possible
3. Land as soon as practical
4. Attempt to reset generator/check BATT switches - ON
5. Landing gear - EMERGENCY EXTEND
   Retraction is not available.

CAUTION

Directional control characteristics will be degraded due to forward NLG doors being open.

6. Plan a no-flap/slat approach and arrested landing, if available. Recommend a short field arrestment due to loss of NWS.

CAUTION

Careful modulation of engine is required since the ECA is inoperative. Refer to ECA Caution Light Procedures.

15.10 TRIM FAILURE

1. Attempt to trim from both cockpits
2. Airspeed - REDUCE
3. STBY stabilator trim - AS REQUIRED

15.10A TRIM RUNAWAY

1. STBY stabilator trim - ACTIVATE
2. Airspeed - REDUCE

15.11 CABIN TEMPERATURE FAILURE

1. CABIN TEMP control knob - MANUAL, ADJUST TEMP

If temperature cannot be controlled -

2. AIR FLOW knob - OFF

NOTE

If cockpit temperature is extreme and not controllable, consider pulling the MDC handle after reducing altitude and airspeed.

15.12 LOSS OF CANOPY

1. Airspeed - REDUCE
2. Altitude - DESCEND BELOW 10,000 FEET
3. Seat - LOWER
4. Visor - DOWN
5. Controllability check - PERFORM
6. Land as soon as possible

POWER DISTRIBUTION
BATTERY POWER ONLY
INOPERATIVE EQUIPMENT

ENGINE
GTS Drain Valve

FLIGHT CONTROLS
Aileron Trim Control
Aileron Trim Postion Indicator
Rudder Trim Control
Stabilator Position Indicator
Stabilator Trim Standby
Yaw Damper

FLIGHT INSTRUMENTS
ADRS Total Air Temp Heater Power
Angle of Attack Heat
Forward and Aft DEP Panel Lighting
Standby Baro Altimeter Vibrator
MFD, Right (Both Cockpits)
Radar Alt

LIGHTING EQUIPMENT
Anti-Collision Lights
Console Lighting
Flood Lighting
Formation Lights
Landing/Taxi Light
MIP Lighting

NAVIGATION EQUIPMENT
UHF/VHF 2
VOR/ILS Control
VOR/ILS/MB

OTHER
AC Isolation Relay
Bomb Release
Cabin Pressure Control 2 (Air Cond)
Comm Control Power B
DEU Cooling Fan
Master Arm
MDL Power
OBOGS Heater
Overvoltage Unit
Reticle Light
Rocket Release
Undervoltage Sensing
Voltage Regulator

POWER DISTRIBUTION
BATTERY POWER ONLY
OPERATIVE EQUIPMENT

ENGINE
Accel/Bleed Valve Control
Accel/Bleed Valve Indicator
Approach Idle Stop
Engine Bleed Valve
Engine Control & EGT Indicator Power
Eng Vib and Press Monitor
Fuel Flow Indicator
Ignitors
Manual Fuel System Bleed Valve Time Delay
Manual Fuel System Control

FLIGHT CONTROLS
Flaps Control (Emer)
Flaps Control Main
Flaps Position Indicator
SADS [2]
Slats Position Indicator
Speedbrake Control
Speedbrake Position Indication
Stabilator Trim Main

FLIGHT INSTRUMENTS
ADI, Standby
Angle of Attack Indicator
MFD, Left (Both Cockpits) [2]
Rudder Pedal Shaker Motor
Turn/Slip Indicator

LIGHTING EQUIPMENT
Annunciator Lights
Emergency Lighting
Navigation Lights, Tail/Wing

NAVIGATION EQUIPMENT
GINA
IFF Control
IFF Rcvr/Xmtr
TACAN
UHF/VHF 1

OTHER
ADR
ADRS
Anti-Skid Control
Arresting Hook
Cabin Pressure Control 1
Cabin Pressure Warning
Cabin Temperature Control
Caution Warning System
Comm Control Power
DC Power External Supply
DC Power Generator Reset
DC Power Voltmeters
DEU [2]
Forward and Aft DEP [2]
Ejection Enable Switch (IFF)
Emergency Jettison (wings only)

OTHER (cont)
Emergency NLG Door Act
External Power
Fire Detection
Fuel Boost Pump Inverters [1]
Fuel Boost Pumps Control [1]
Fuel System Control
Fuel System Low Level Warning
Fuel System Quantity Indicator
Generator Off-Load
Generator Undervoltage
GTS Fuel/Oil Pump
HYD 1, 2 & Brake Transducer
Hydraulic 2 Bypass
Inverters Protection
Landing Gear Control
Landing Gear Selector Valve
Launch Bar
Master Start 1 & 2
Master Switch Batt 2
Nose Wheel Steering
OBOGS Monitor
OBOGS Shutoff Valve
Pitot Probe Heat
Press To Test
Ram Air Turbine Reset
Seat Position
Throttle Proximity Switches
VCR/CEU [2]
Weight-on-Wheels Control

LOAD SHEDDING
The following items are listed in the order of highest amperage draw. Selected items may be turned off to conserve battery power contingent with flight conditions and approach/recovery requirements.

		Amps			Amps
Pitot Heat	-	20	TACAN	-	1.7
Navigation Lights	-	4	IFF	-	1.6
GINA	-	3.5	Stabilator Trim	-	1.5
UHF/VHF Radio	-	2.2			

LEGEND
[1] Operate for 30 seconds after loss of generator bus.
[2] Operate for 2 minutes after loss of generator bus or continuous with DISPLAY POWER switch set to ORIDE.

15.13 PITOT STATIC MALFUNCTION

1. PITOT HEAT switch - CHECK ON

2. Compare instruments - BOTH COCKPITS

NOTE

If unpressurized, the CABIN altimeter indicates approximate MSL altitude.

3. AOA - SUBSTITUTE FOR AIRSPEED

If the Mach/airspeed indicator fails, the angle-of-attack indicator is sufficient to perform the following; the values are for one-g flight:

FLIGHT CONDITION	ANGLE OF ATTACK - UNITS
TAKEOFF (LIFTOFF)	
1/2 flaps	19.5
Full flaps	20
AFTER CLEAR OF OBSTACLES	
Start flaps up	17
MRT CLIMB	
0 to 10,000 feet	10
10,000 to 20,000 feet	10
20,000 to 30,000 feet	10
30,000 to 40,000 feet	11
MAXIMUM ENDURANCE	
Any altitude	14
MAXIMUM RANGE	12 to 13
PENETRATION	
Speed brakes out, 80% RPM, 4,000 to 6,000 fpm rate of descent	11
LANDING	
Gear extension	13
Flap extension	13
GCA pattern (clean)	13
GCA pattern (landing configuration)	10
GCA pattern (final)	17
Carrier pattern and approach	17
STALL WARNING (rudder pedal shaker)	
All configurations	21.5

4. Radar altimeter - USE BELOW 5,000 FEET AGL

5. Notify ATC and remain VMC, if possible

6. Join with wingman, if possible

15.14 UNCOMMANDED ROLL/YAW

If rolling and yawing is experienced during operation of the wing flaps or while the flaps are extended, an asymmetric wing flaps condition probably exists.

*1. FLAPS/SLATS lever - RETURN TO PREVIOUS SETTING
2. Controllability check - PERFORM AS REQUIRED

3. Land as soon as practical

15.15 CONTROLLABILITY CHECK

Loss of structural integrity may result from midair collisions, exceeding structural limits, bird strikes, canopy loss, or hard landings. The decision to investigate the slow flight characteristics prior to landing rests with the pilot and should be based on the following:

a. Severity of damage/malfunction

b. Fuel remaining

c. Flight conditions (IFR vs VFR)

d. Field landing facilities

e. Other existing emergencies

f. Pilot experience

With those considerations in mind perform the following procedure to determine the aircraft controllability.

1. Climb as required, maintaining flying airspeed and proceed toward point of intended landing

2. When possible, obtain a visual inspection by another aircraft to assist in evaluating the damage

3. Slow the aircraft to 200 KIAS in 10 knot increments.

4. Landing gear - DOWN

5. Slow the aircraft in 5 knot increments; slow to an airspeed at which flight controllability starts to become marginal (no slower than optimum AOA). Increase airspeed 10 knots and use as a minimum airspeed for the duration of the flight.

6. If no damage is evident in the flap and slat area, extend the flaps to 1/2 then FULL and check controllability. If damage to slat area but no damage to the flap area consider a no-flap arrested landing. However, if minimum airspeed is too high for landing, extend flaps with EMER FLAPS switch. Flap extension is at pilot's discretion.

7. Field arrested landing recommended. Shipboard landing not recommended.

15.16 DEPARTURE/SPIN PROCEDURE

Forcefully centering the rudder pedals and neutralizing the control stick usually recovers the aircraft from a departure. Extended speed brakes are destabilizing and may aggravate the departure and delay recovery. If the rudder blows out, an inverted spin is likely. Expect engine anomalies following any departure. Retarding the throttle to idle minimizes engine problems but does not eliminate the potential for a flameout or locked surge.

If the engine flames out and the generator drops off line, the HUD and both right MFDs will immediately drop off line, however, both left MFDs will automatically switch to the ADI display and remain on for 2 minutes. If a GTS start is initiated the SADS, DEU, both left MFDs, and VCR/CEU will immediately drop off line.

WARNING

To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.

The pilot should check the altitude, airspeed, AOA, and turn needle to monitor recovery progress or verify spin entry. AOA pegged at 0 units, airspeed oscillating between 50 to 160 KIAS, and turn needle pegged indicate an inverted spin. Although a stabilized upright spin is unlikely, it would be indicated by AOA above 28 units, airspeed oscillating between 80 to 140 KIAS, and turn needle pegged.

While the spins are disorienting, forces on the pilot are tolerable and anti-spin controls can be maintained. Lateral stick should be neutralized when the aircraft has recovered or when airspeed increases through 160 KIAS, whichever occurs first.

NOTE

Failure to neutralize lateral stick with airspeed increasing past 160 KIAS may result in entry into the -25 degree AOA mode and delay recovery.

Anti-spin rudder pedal should be held until the aircraft is recovered.

WARNING

Releasing pedal force prior to recovery may allow the rudder to blow out in the pro spin direction and delay recovery to below 10,000 feet.

AOA should be referenced for indications of recovery. AOA increasing past 5 units indicates inverted spin recovery and AOA decreasing through 20 units indicates recovery from an upright spin.

Occasionally, the rudder may blow out during recovery and the aircraft may not recover but reenters the spin with airspeed decreasing below 160 KIAS. If this occurs, and altitude permits, reapply the departure/spin recovery procedure beginning with neutral controls.

*1. Controls - NEUTRALIZE (forcibly center rudder pedals)

*2. Speed brakes - RETRACT

*3. Throttle - IDLE

*4. Check altitude, airspeed, AOA, and turn needle

If spin confirmed -

*5. Rudder pedal - FULL OPPOSITE TURN NEEDLE (opposite spin direction)

*6. Lateral stick - INVERTED: FULL OPPOSITE TURN NEEDLE (opposite spin direction)
UPRIGHT: FULL WITH TURN NEEDLE (with spin direction)

*7. Longitudinal stick - NEUTRALIZE

If recovery indicated or airspeed increasing through 160 KIAS -

*8. Lateral stick - NEUTRALIZE

When recovery indicated -

*9. Rudder - SLOWLY RELEASE PEDAL FORCE

If out of control passing through 10,000 feet AGL -

*10. Eject

15.17 RUDDER TRIM HARDOVER

An abrupt, small lateral acceleration may be indicative of an uncommanded full authority step in rudder trim which occurs without a C AUG caution light. This condition may occur immediately following reset of electrical generator (such as following a GTS start). The aircraft should still be easily controllable.

1. Check rudder trim to confirm full trim

2. Trim until uncommanded trim is removed

If trim is not responding or too slow -

3. CONTR AUG switch - RESET AND RELEASE
   Rudder goes to neutral

4. Trim as desired

15.18 MFD MALFUNCTION

CAUTION

Turn off malfunctioning displays as they may overheat and cause a fire if not functioning correctly.

15.19 DEU DEGRADE

If DEGD status is displayed for the DEU, check the displays to determine what data is blanked or corrupt. If only a portion of the DEU is malfunctioning or a discrete input to the DEU is invalid or failed, the data associated with that input will be blanked on the displays.

1. BIT display - NOTE DEGD EQUIPMENT

2. Displays - CHECK FOR BLANK DATA

3. Display power switch - RESET (Hold for 5 seconds minimum)

4. Revert to standby instruments for any failed data

15.20 DEU OVERHEAT

If a DEU overheat is indicated on the BIT display, without the AV HOT caution light, this indicates a failure of the DEU cooling fan and a DEU failure is possible.

1. Proceed to VMC as soon as possible

2. Prepare for possible loss of HUD and MFD displays

3. Land as soon as practical

15.21 DEU FAILURE

A catastrophic failure of the DEU will be indicated by the loss of all MFD and HUD displays.

1. Display power switch - RESET (Hold for 5 seconds minimum)
2. Proceed to VMC as soon as possible
3. Land as soon as practical

15.22 GINA FAILURE

There are four potential failure modes which result in an AV BIT advisory, a GINA DEGD on the BIT display, and the removal of display symbology and/or loss of system functionality. The four failure modes are mis-compare, GPS, INS, or a complete GINA (INS and GPS) failure. The indicators for each failure mode are as follows:

a. A mis-compare failure is caused by a detected mis-compare between the INS and GPS position or velocity(s). The system remains in HYBD mode with both INS and GPS options available on the ADI display; however, all velocity derived information is removed from the displays. Aircraft attitude and position information is available.

WARNING

GINA mis-compare logic remains active only when in HYBD mode and receiving four satellites. When operating in INS, the mis-compare logic is not activated which could eventually cause incorrect aircraft attitude, velocity, and position information to be displayed.

NOTE

- GPS antenna shading during maneuvering flight could cause a dropout of one or more satellites causing temporary inactivation, GINA mis-compare logic, and return of previously blanked display symbology.
- During a GINA mis-compare condition, normal aircraft displays may temporarily return for 1-3 seconds at random intervals as the system attempts to resolve the mis-compare.

b. A GPS failure results in the system automatically reverting to INS with HYBD and GPS options blanked on the ADI. GPS aiding, position, velocities and time are not available. Aircraft attitude and position information are available.

c. A INS failure causes the loss of aircraft attitude, position, velocities, and acceleration, and navigation information and is accompanied by an ATTITUDE/POSITION advisory (loss of GINA attitudes may also cause a C AUG caution light with an associated master caution). Aircraft position information will be available via selection of the GPS option.

d. A complete GINA failure results in the loss of all attitude, position, velocity, acceleration, time and navigation information and is accompanied by an ATTITUDE/POSITION advisory (loss of GINA attitudes may also cause a C AUG caution light with an associated master caution).

GROUND

1. Verify INS legend is displayed (ADI) and four satellites are being tracked (DATA:ACFT)
2. Command a restart (RST on DATA:ACFT)

If condition persists -

3. Do not attempt takeoff

IN-FLIGHT

*1. Revert to standby instruments

2. Proceed to VMC as soon as possible

3. Attempt to determine GINA failure mode

4. If INS is suspected and GPS is functional, command a restart (RST on DATA:ACFT)

If condition persists -

5. Use TACAN, VOR or GCA for navigation as available

6. Land as soon as practical

15.23 SADS DEGRADE/FAILURE

If DEGD status is displayed for the SADS, check the displays to determine what data is blanked or corrupt. If only portion of the SADS is invalid/malfunctioning, the data associated with that input will be blanked on the displays. A complete loss of the SADS will result in the loss of the following:

HUD - Indicated & True Airspeed, Barometric Altitude, Mach Number, A/A & A/G Reticles, and Bomb Impact Line.

MFD - Indicated & True Airspeed, Barometric Altitude, Mach Number, and Wind Direction & Speed.

CHAPTER 16

Landing Emergencies

16.1 FLAPS FAILURE

FLAP indicator and FLAPS/SLATS lever position do not agree when flaps/slats commanded down.

1. Airspeed - BELOW 200 KIAS
2. EMER FLAP switch - DOWN

WARNING

The aircraft exhibits no natural stall warning during the approach to stall. Stall warning rudder pedal shakers come on at 21.5 units AOA, closely followed by the stall at 23-25 units AOA.

If unable to extend flaps -

3. Airspeed - FLY ON-SPEED 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

NOTE

Recommend straight in approach with touchdown not greater than 600 fpm.

If not an arrested landing -

4. Ensure do not exceed maximum tire speed

If an arrested landing -

4. Refer to Emergency Field Arrestment Data

16.2 LANDING GEAR UNSAFE/FAIL TO EXTEND

An unsafe gear indication may result from hydraulic failure, electrical failure, airframe damage, or a faulty gear position indicator. Unsafe cockpit gear indications should not be the only factor in the determination of an unsafe gear condition. Gear position should be determined by other aircraft, if available, or other visual means. Maintain airspeed less than 200 KIAS, monitor HYD 1 pressure.

If any gear indicates not down and locked -

1. Airspeed - BELOW 200 KIAS
2. LIGHT TEST/TONE TEST switch - LIGHT TEST (Check landing gear position indicator lights come on)
3. Obtain visual check if available

NOTE

Orange reflective tape on each MLG side brace is aligned to indicate gear down and locked. Orange reflective flags on starboard side of the NLG drag brace indicate NLG down and locked.

If landing gear position indicator lights inoperative and the gear has been visually checked down and locked -

4. Land

If landing gear position indicator lights check good and no obvious damage -

4. Landing gear - CYCLE

If gear still unsafe -

5. LDG GEAR handle - DN

6. EMER GEAR handle - ROTATE CLOCKWISE AND PULL

CAUTION

Nose wheel steering is inoperative.

7. If necessary, perform positive g, negative g, and yawing maneuvers to obtain a down and locked indication.

If landing gear indicates down and locked -

8. Make a Short Field Arrestment

If landing gear remain unsafe -

9. Refer to Landing Gear Malfunction - Landing Guide, Figure 16-1

16.3 LANDING WITH WHEEL BRAKE FAILURE

1. ANTI-SKID switch - OFF

2. Attempt a Short Field Arrestment, paragraph 16.13.2

16.4 LANDING WITH NOSE WHEEL STEERING FAILURE

WARNING

Inoperative nosewheel steering may be caused by a steering system failure or a weight on wheels switch failure. A system failure airborne should be indicated by a NWS caution light. On deck it may only be indicated by a lack of NWS control without a corresponding caution light. Inoperative NWS caused by a weight on wheels switch failure may be indicated by continuous illumination of the AOA indexers on deck.

1. Make a Short Field Arrestment

16.5 SWERVE ON TOUCHDOWN

Swerve after touchdown could be caused by a blown tire, uncommanded brake pressure, or a NWS hardover. Under most circumstances, it is not considered feasible to go around when below approach power or when below 100 KIAS at full flaps (significantly higher speed applies when landing with a reduced flap setting). The pilot's ability to keep the aircraft on the runway is the critical factor in deciding whether to go around or stay on the runway. Significant rudder pedal forces at nominal approach speeds may be required to successfully counter the swerve. Additionally, normal anti-skid braking may not be available if the swerve is caused by a blown tire.

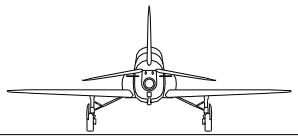
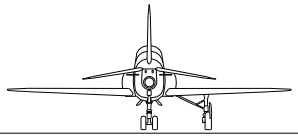
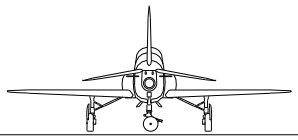
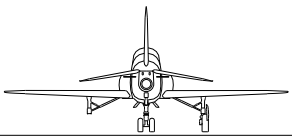
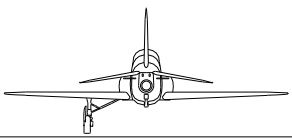
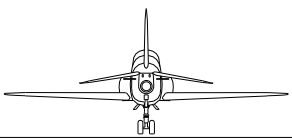
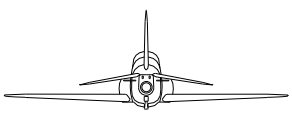
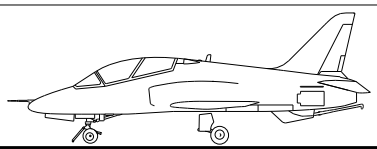
*1. Rudder - AS REQUIRED TO COUNTER SWERVE

WARNING

Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.

*2. Perform go-around, if able

- OBTAIN VISUAL INSPECTION FOR ALL LANDING GEAR EMERGENCIES IF POSSIBLE.
- ANY GEAR NOT LOCKED DOWN SHALL BE TREATED AS THOUGH IT WERE UP.
- FOR ALL EMERGENCIES, REQUEST LSO ASSISTANCE IF AVAILABLE.

LANDING GEAR CONFIGURATION		FIELD				CARRIER
		ARRESTING GEAR		NO ARRESTING GEAR		
		ACTION	NOTES	ACTION	NOTES	ACTION
	NOSE GEAR RETRACTED, STUB OR TRAILING	NO ARRESTED LANDING REMOVE CDP	1,2,4,5,6	LAND	1,2,4,5,6	DIVERT
	ONE MAIN GEAR RETRACTED, TRAILING, OR OVER EXTENDED	MAKE ARRESTED LANDING	1,2,7,12	LAND	1,2,4,6,9, 10,11	DIVERT
	COCKED NOSE GEAR	MAKE ARRESTED LANDING	2,12	LAND	2,5	DIVERT
	ONE OR BOTH MAIN GEAR STUB OR COCKED	NO ARRESTED LANDING REMOVE CDP	1,2,4,6,8, 9,10,11	LAND	1,2,4,6,8, 9,10,11	DIVERT
	NOSE GEAR AND ONE MAIN GEAR RETRACTED OR TRAILING	RETRACT ALL GEAR. IF UNABLE TO RETRACT, EJECT	2,6	RETRACT ALL GEAR. IF UNABLE TO RETRACT, EJECT	2,6	DIVERT
	BOTH MAIN GEAR RETRACTED OR TRAILING	MAKE ARRESTED LANDING	1,2,4,5,6	LAND	1,2,4,5,6	DIVERT
	ALL GEAR UP	NO ARRESTED LANDING REMOVE CDP	1,2,4,6	LAND	1,2,4,6	DIVERT
	LAUNCH BAR DOWN/UNSAFE	NO ARRESTED LANDING REMOVE CDP	1,2,4,5	LAND	1,2,4,5	DIVERT

NOTES

1. EMPTY PMBR/ROCKET POD (OR INERT ROCKETS).
2. BURN DOWN TO MIN FUEL PRIOR TO LANDING.
3. FLARED LANDING TO ROLL IN ARRESTMENT; HOLD NLG OFF RWY UNTIL ARRESTMENT. IF BOLTER OCCURS; GO AROUND.
4. MINIMUM DESCENT RATE LANDING.
5. LOWER NOSE GENTLY BEFORE FALL THROUGH.
6. SECURE ENGINE AT AIRCRAFT CONTACT.
7. HOLD MISSING/DAMAGED GEAR OFF DECK UNTIL ENGAGEMENT.
8. ANTI-SKID OFF.
9. LAND ON SIDE OF RUNWAY TOWARD GOOD GEAR.
10. HOLD WINGS LEVEL AS LONG AS POSSIBLE.
11. USE NOSE WHEEL STEERING AND GOOD BRAKE TO MAINTAIN TRACK.
12. PERFORM FLY-IN ENGAGEMENT.

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Figure 16-1. Landing Gear Malfunction - Landing Guide

3. Refer to procedure for landing with blown tire, or nose wheel steering failure

16.6 WHEEL BRAKE FAILURE

*1. Go around

If go around not feasible -

*1. Wheel brakes - RELEASE (Both cockpits)

CAUTION

Failure to release brake pressure in both cockpits may result in a locked brake condition while switching from anti-skid to normal brakes.

*2. ANTI-SKID switch - OFF

*3. Attempt braking

*4. Hook - DOWN 1,000 FEET PRIOR TO ARRESTING GEAR

5. Throttle - OFF (if departing the runway)

NOTE

If aircraft departing runway, consideration to speed and terrain should be given in deciding to eject or not.

If airborne -

1. ANTI-SKID switch - OFF

2. Attempt a short field arrestment

16.7 LANDING WITH BLOWN TIRE(S)

If it is known prior to landing that a main tire is blown, a short field fly-in arrestment or a shipboard recovery should be used to recover the aircraft. The decision to use either is dictated by the operational and environmental factors surrounding the emergency. All available factors such as: the side on which the tire is blown, obstacles on the carrier deck, field conditions, weather, fuel state, additional malfunctions, and pilot experience should be considered before an option is chosen. An arrested landing is preferable to a non-arrested landing. If both main tires are blown, an arrested landing shall be used to recover the aircraft.

NOTE

Blown tire debris could fod engine, damage flaps/slats, hydraulic lines, and cause hyd 1 failure.

1. ANTI-SKID switch - OFF
2. Hyd 1 pressure - MONITOR
3. Comply with the Short Field Arrestment Procedure

WARNING

Landing with two blown main tires shall be done with a fly-in arrestment. Simulation tests showed directional control was available down to approximately 80 KIAS, after which oscillations became uncontrollable. A bolter should be followed by an immediate go-around. If a fly-in arrestment is not available, pilots shall consider the likelihood of departing the prepared surface during an attempted landing. Environmental conditions such as crosswind, runway condition, slope, terrain and obstructions surrounding the prepared surface and number of crewmembers aboard should be taken into account.

If unable to make an arrested landing (single blown tire) -

3. Perform a flared landing with flaps set to half, if able

WARNING

- Consider pilot proficiency and ability to control the swerve before attempting the rollout. If it is determined that the pilot is unable to control the aircraft on rollout, consideration should be given to a gear-up landing or controlled ejection.
- Landing with a crosswind component of greater than 5 knots on the side corresponding to the blown tire is extremely hazardous due to loss of directional control below approximately 60 KIAS. Offset to land on the good tire side of the longest and widest runway available to allow for the swerve upon touchdown.

CAUTION

Repositioning the flaps is recommended only after a visual inspection confirms that the flaps have not been damaged.

Immediately upon touchdown, simultaneously perform the following -

4. Rudder - AS REQUIRED TO COUNTER SWERVE
5. Throttle - IDLE

WARNING

Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.

NOTE

Cockpit lateral accelerations of up to 0.5 g can be expected upon touchdown and during landing rollout.

6. Below 100 KIAS - SLOWLY APPLY DIFFERENTIAL BRAKES

WARNING

Without anti-skid protection, judicious brake application is required to avoid blowing the remaining tire. If the other

tire blows, simulation shows the aircraft becomes uncontrollable below approximately 80 KIAS.

If runway departure is imminent -

7. Throttle - OFF

WARNING

If the aircraft begins to depart the runway, consideration should be given to speed, obstructions and terrain when deciding to stay with the aircraft or eject.

After the aircraft has come to a complete stop -

8. Perform emergency egress

If unable to make an arrested landing (two blown tires) -

3. Consideration shall be given to either a gear up landing or controlled ejection

WARNING

Simulation shows with two blown main tires the aircraft becomes uncontrollable below approximately 80 KIAS.

If unable to divert to a suitable field, perform a shipboard recovery -

3. Perform a Normal Carrier Approach

NOTE

Consideration should be given to adjustment of the touchdown point by targeting the 2-wire. It is important to take into account which tire is blown and the possible rollout path of the aircraft following a hookskip or bolter.

Immediately upon touchdown simultaneously perform the following -

4. Throttle - MRT

5. Speedbrakes - RETRACT

6. Rudder - AS REQUIRED TO COUNTER SWERVE

WARNING

Rudder pedal forces may be as high as 180 pounds and must be applied within 0.25 sec after touchdown to successfully counter the swerve. Failure to counter the swerve may result in departing the lateral confines of the landing area.

7. Control stick - SMOOTHLY APPLY UP TO FULL BACK STICK

NOTE

Cockpit lateral accelerations of up to 0.5 g can be expected upon touchdown and during landing rollout.

If the aircraft bolters -

8. Rudder pedals - CENTER (NEUTRALIZE) ONCE AIRBORNE AND SET FLY-AWAY PITCH ATTITUDE

16.8 Deleted.

16.9 PRECAUTIONARY APPROACH

The PA may be used whenever circumstances make it desirable such as loss of oil pressure or other engine difficulties which make it undesirable to reduce RPM. A suitable field for a PA is one with a minimum of 8,000 feet of hard surface runway. Select a field with crash equipment and arresting gear, if practicable. See Figure 16-2 for typical Straight-In Precautionary Approach, Figures 16-3 and 16-4 for Overhead Precautionary Approaches, and Figure 16-5 for Abeam Precautionary Approach.

16.10 FLAMEOUT APPROACH

If it is impossible or impractical to eject from the aircraft, a flameout approach may be attempted. Proceed as follows:

1. External stores - JETTISON
2. Throttle - OFF
3. Non-essential electrical equipment - OFF
4. HYD 2 pressure - MONITOR
5. ANTI-SKID switch - CHECK OFF
6. Flaps - EMERGENCY EXTENSION WHEN APPROPRIATE
7. Landing gear - EMERGENCY EXTENSION WHEN APPROPRIATE

CAUTION

Nose wheel steering is inoperative.

8. Field Arrestment if available

16.10A STUCK THROTTLE APPROACH

Simulated stuck throttle approaches have been successfully demonstrated in the clean stores configuration, and with a PMBR and 6 MK-76's loaded on each wing station from 80% to MIL. With the throttle stuck at an RPM setting below 80%, the pilot must quickly assess the aircraft's energy state and attempt to intercept the Overhead Precautionary Approach profile at the nearest suitable field. To assess the aircraft's energy state, maintain straight and level flight at 10,000 feet MSL, if practical. If the aircraft can sustain 300 KIAS or greater, proceed with a Straight-in Stuck Throttle Approach. If the aircraft is not capable of maintaining 300 KIAS, proceed with an Overhead Precautionary Approach as depicted in figure 16-3 or 16-4, or an Abeam Precautionary Approach as depicted in 16-5. If unable to determine sustained level flight airspeed at 10,000 feet MSL, then an RPM setting of at least 88% or 89% (greater than 1700 lbs/hr fuel flow) is recommended to perform a Straight-in Stuck Throttle Approach. During a stuck throttle approach, moderate maneuvering consisting of 2.0 to 4.5 g turns and/or a 1,000 to 4,000 foot climb may be required to slow the aircraft below gear and flap/slat speed. Once established on a 3.0° glide slope during a Straight-in Stuck Throttle Approach, aircraft configuration (flaps, speedbrakes) must be managed while attempting to maintain 150 to 160 KIAS. If the approach speed cannot be maintained at or above 150 KIAS, the engine should not be shutdown until in the flare or upon touchdown (using the FUEL SHUTOFF handle). Recommended engine shutdown is 50 feet AGL for every 10 KIAS above 150 KIAS. Attempt to touchdown on centerline and approximately 500 feet prior to the arresting gear.

CAUTION

Over rotation while attempting to set or maintain landing attitude may cause the aircraft to become airborne and result in subsequent in-flight engagement.

1. THROTTLE - Do not attempt to reset
2. Altitude - Stabilize at 10,000 ft MSL, if practical
3. ANTI-SKID switch - OFF

Stabilized airspeed less than 300 KIAS -

4. Execute Overhead Stuck Throttle Approach

Stabilized airspeed at or above 300 KIAS

4. Execute Straight-in Stuck Throttle Approach

16.10A.1 Overhead Stuck Throttle

1. Airspeed - Decrease below 200 KIAS using speedbrakes, nose attitude, and load factor

2. Landing gear, flaps and speedbrakes - Extend as required to maintain airspeed below 200 KIAS

3. Execute Overhead Precautionary Approach

NOTE

- Flap and speedbrake position should be adjusted to maintain airspeed near the target of 175 KIAS.

- With throttle stuck above 80%, a slightly wider pattern or a longer straight-away on final is required. Additionally, selection of full flaps is required earlier than during a standard Overhead Precautionary Approach to decelerate the aircraft prior to the flare.

4. Attempt Short Field Arrestment

When established in landing flare -

5. FUEL SHUTOFF handle - PULL

CAUTION

Nosewheel steering is inoperative during landing rollout after engine flameout.

NOTE

Upon pulling FUEL SHUTOFF handle, engine RPM should quickly decay to idle as fuel continues to gravity feed to the engine. Engine may continue to operate for approximately 50 seconds after fuel shutoff is pulled, allowing normal flight control during the flare and use of NWS for the initial portion of the ground roll. Use rudder and differential braking for directional control on landing rollout after engine flameout.

16.10A.2 Straight-in Stuck Throttle

1. Airspeed - Decrease below 200 KIAS using speedbrakes, nose attitude, and load factor

2. Landing gear, flaps and speedbrakes - Extend as required to maintain airspeed below 200 KIAS

3. Establish a 3° glide slope through use of a self-contained approach (300 ft/mile from the touchdown point), PAR, and/or the Fresnel lens

NOTE

PAR usage is not recommended during VMC, due to higher aircrew workload.

4. Reconfigure speedbrakes and flaps to reduce airspeed as much as possible (but no lower than on-speed) when established on glide slope

5. Attempt a short field arrestment, if available

If airspeed above 150 KIAS -

6. FUEL SHUTOFF handle - Pull at calculated shutdown altitude

   50 ft AGL at 160 KIAS

   100 ft AGL at 170 KIAS

   150 ft AGL at 180 KIAS

   200 ft AGL at 190 KIAS

If airspeed at or below 150 KIAS -

6. FUEL SHUTOFF handle - Pull on touchdown

CAUTION

Nosewheel steering is inoperative during landing rollout after engine flameout.

NOTE

Upon pulling FUEL SHUTOFF handle, engine RPM should quickly decay to idle as fuel continues to gravity feed to the engine. Engine may continue to operate for approximately 50 seconds after fuel shutoff is pulled, allowing normal flight control during the flare and use of NWS for the initial portion of the ground roll. Use rudder and differential braking for directional control on landing rollout after engine flameout.

16.11 FIELD ARRESTMENT

CAUTION

An engagement in the wrong direction into chain gear severely damages the aircraft.

Determine the condition of the aircraft by all means available (instruments, other aircraft, base radio, LSO, RDO, tower, or other ground personnel). If fuel is streaming, a field arrested landing is not recommended due to the high probability of sparks and heat from the hook igniting the streaming fuel. Determine the best available arresting gear and the type of arrestment. Notify control tower as far in advance as possible and give estimated time to landing in minutes. Unrigged gear requires 10 to 20 minutes to rig. If conditions allow, make practice passes to accurately locate arresting gear. Lock shoulder harness.

Engage arresting gear on the centerline, in a landing attitude, as slow as practical, and with feet off the brakes. After arrestment, common sense and conditions determine whether to keep the engine running or to shut down the engine and evacuate the aircraft.

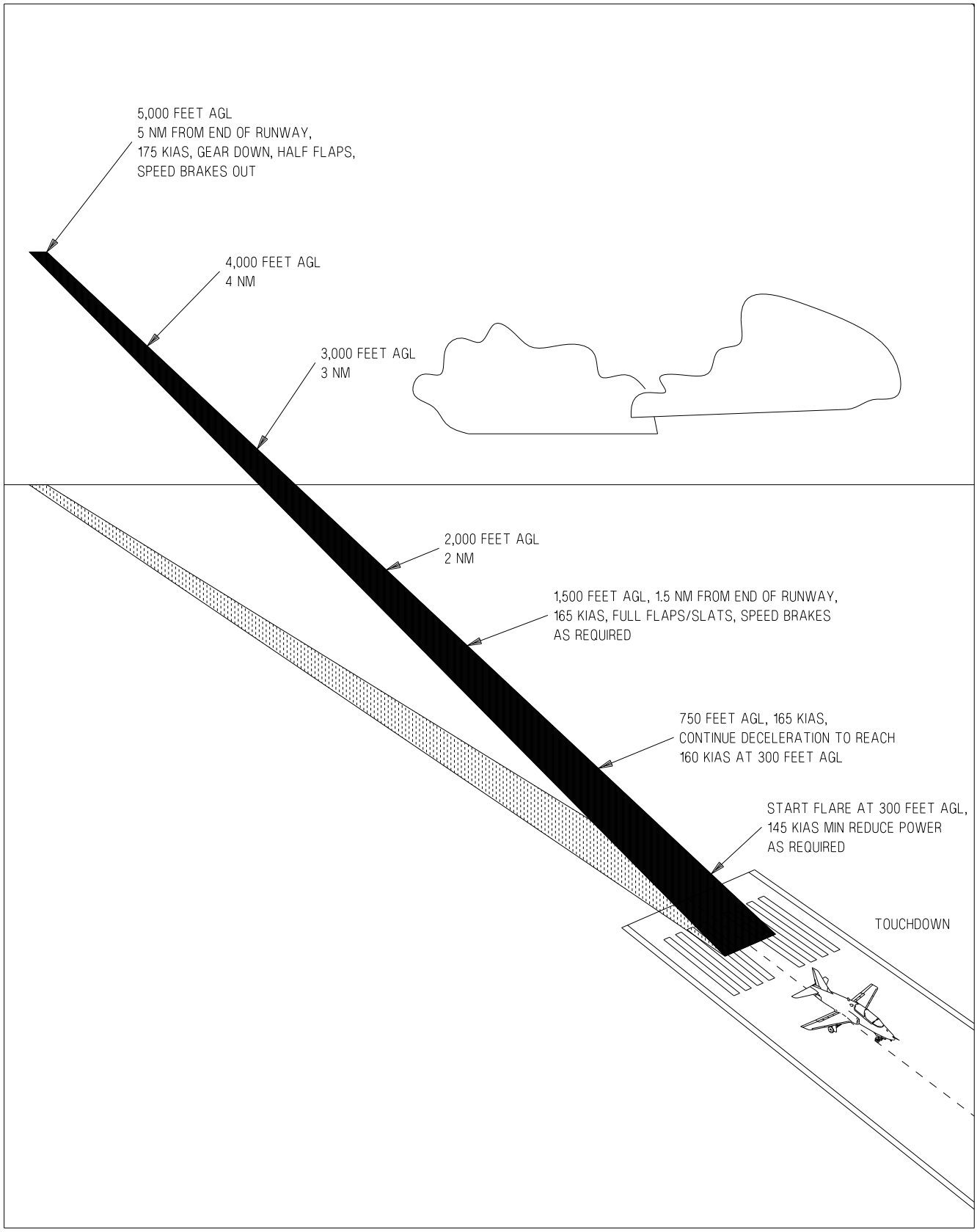
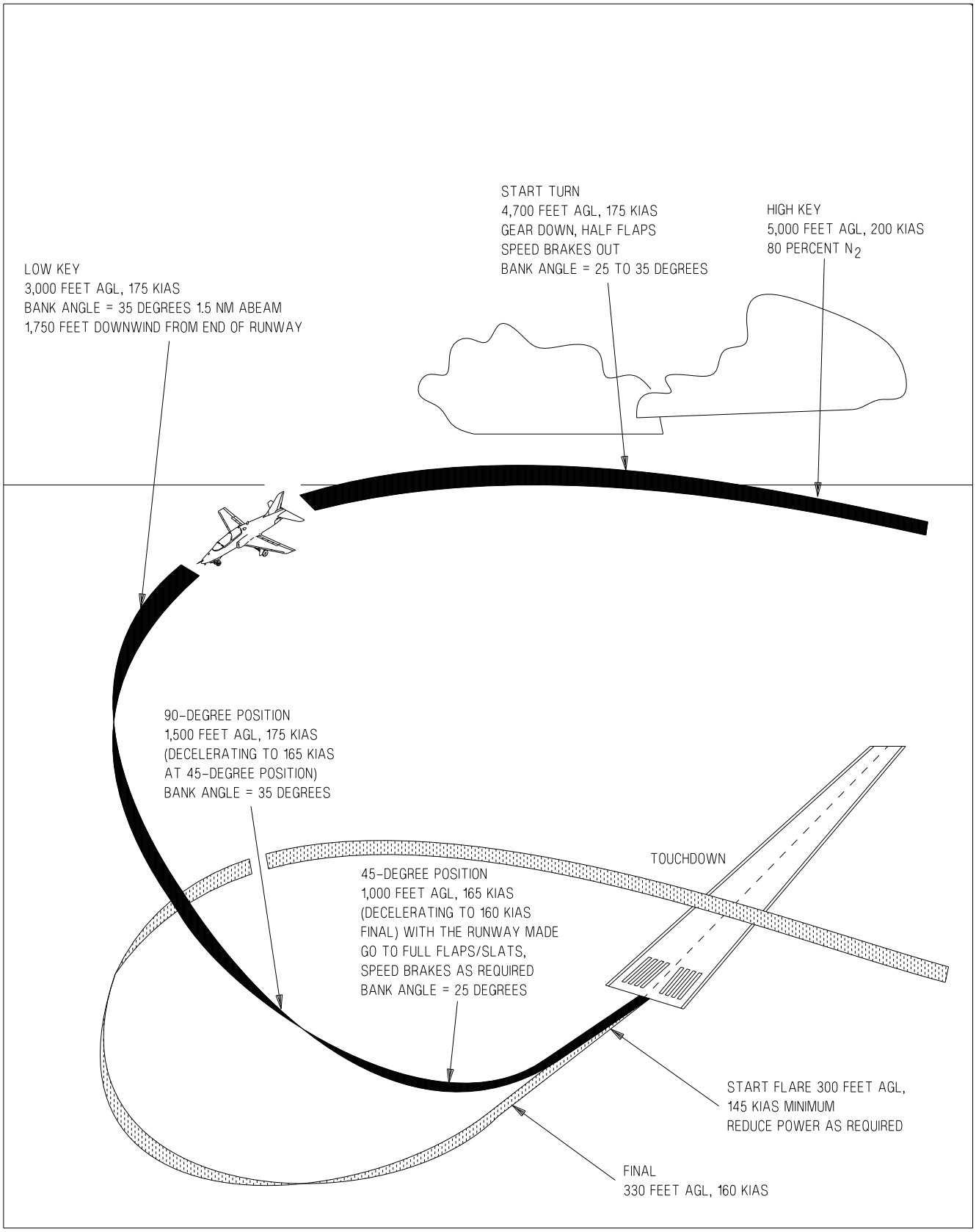


Figure 16-2. Straight-in Precautionary Approach



EDA815-95-1-003

Figure 16-3. Overhead Precautionary Approach (Perpendicular Entry)

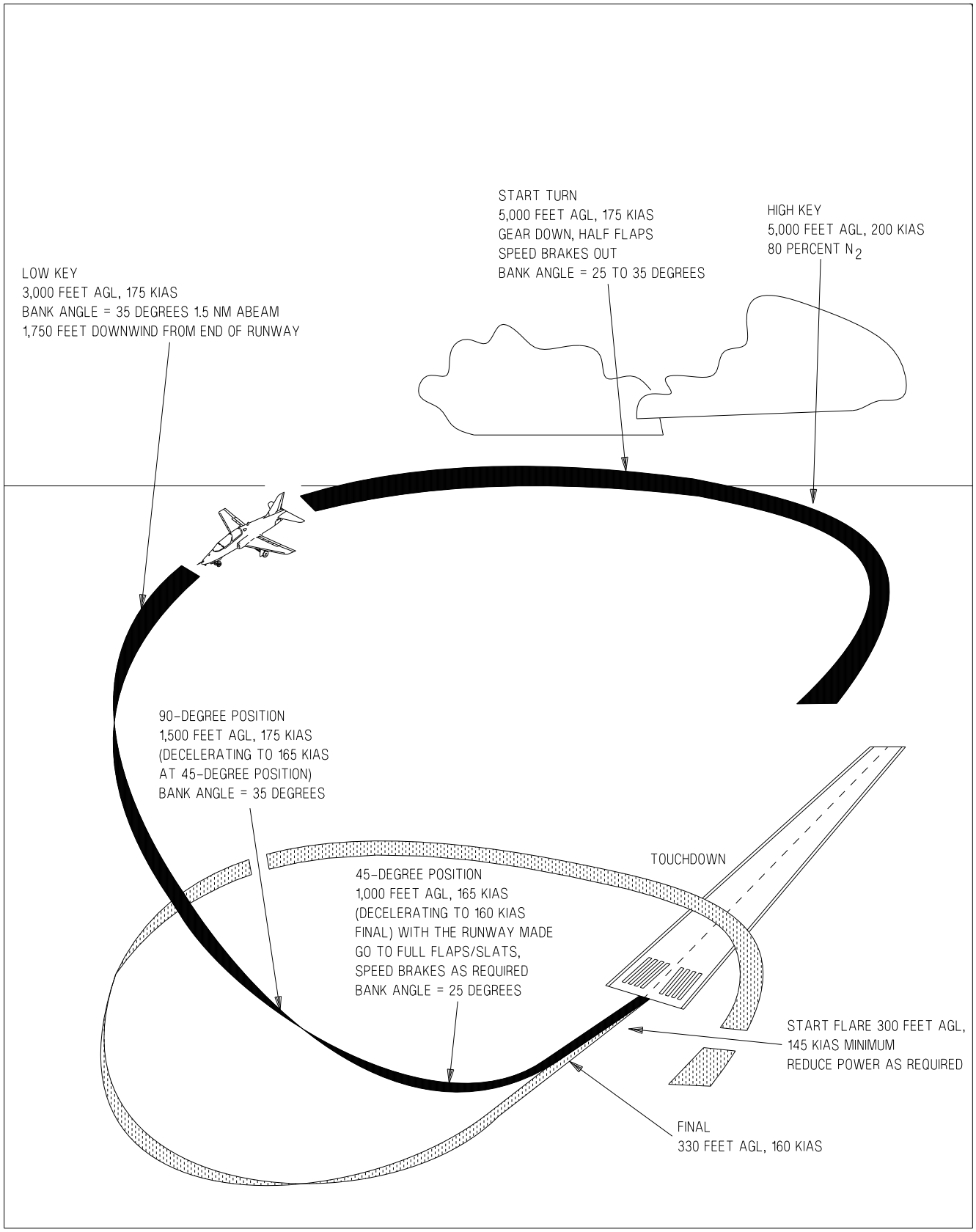


Figure 16-4. Overhead Precautionary Approach (Parallel Entry)

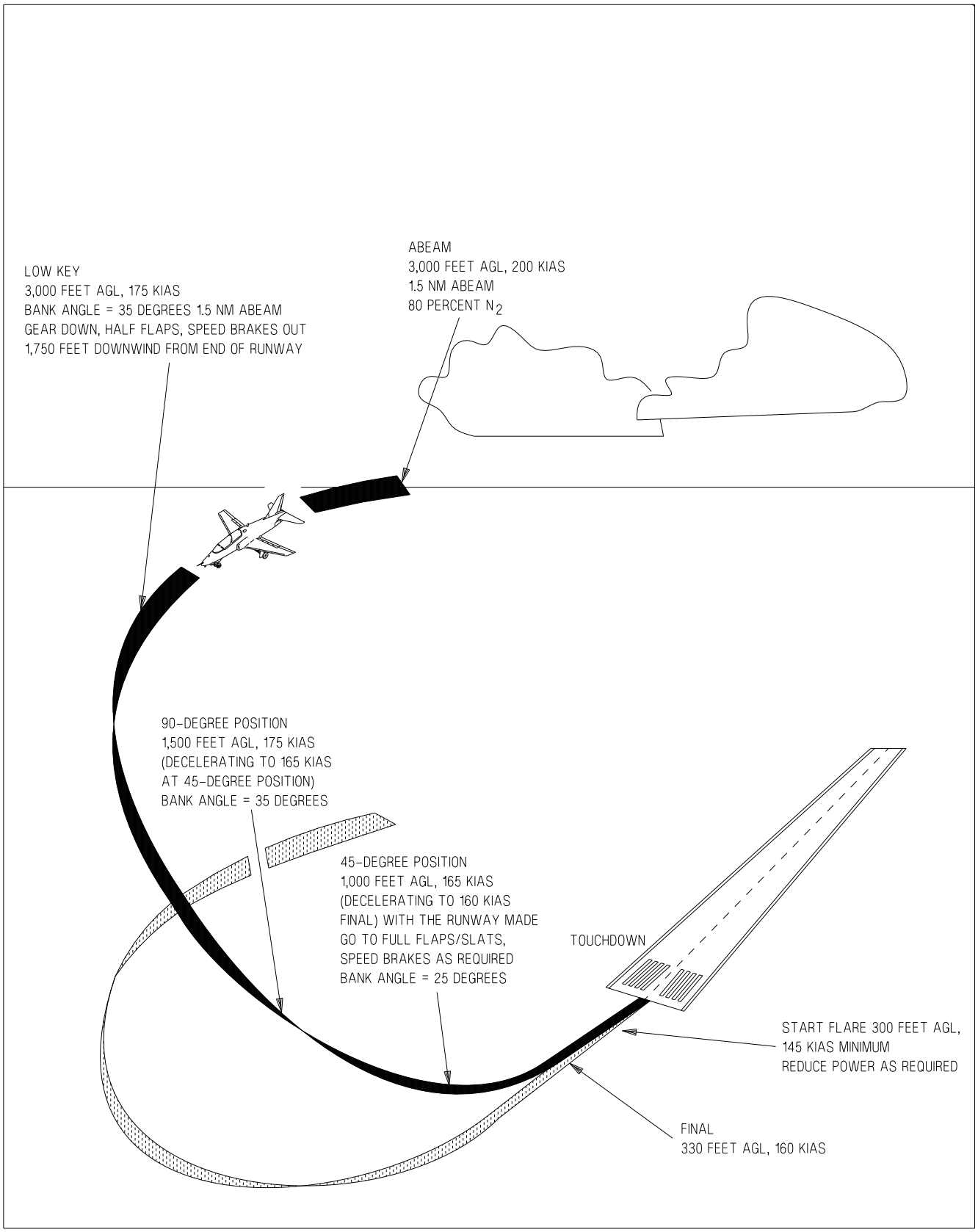


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Figure 16-5. Abeam Precautionary Approach

16.11.1 Field Arresting Gear. Field arresting gear includes anchor chain, water squeeze, and Morest types. All require engagement of the arresting hook with a crossdeck pendant rigged across the runway. Location of the pendant further identifies the gear type as follows:

SHORT FIELD - Located 1,500 to 2,000 feet past approach end of runway. Usually rigged for immediate use.

MIDFIELD - Located near halfway point of runway. Usually requires request to rig for desired direction.

ABORT - Located 1,500 to 2,000 feet short of departure end of runway. Usually rigged for immediate use.

OVERRUN - Located shortly past departure end of runway. Usually rigged for immediate use.

A field may have all, none, or any combination of types. The type, location, and compatibility of the aircraft with the installed gear must be known along with the local policy for rigging the gear.

16.11.2 Short Field Arrestment. If there are anticipated problems with directional control or stopping the aircraft, or a minimum rollout is desired, make a short field arrestment. Request LSO assistance. Lower the hook before starting the approach and get a positive hook down check. The LSO is near the touchdown point with a radio. Determine the arresting gear maximum engagement speed. Approach speed depends upon the emergency. A constant glideslope approach to touchdown is encouraged using the fresnel lens, if available.

If directional control is not in question, touch down on centerline approximately 500 feet prior to the arresting gear. Maintain approach power and landing attitude (approximately 5 degrees nose up) until after arresting gear engagement or wave-off is initiated. Prepare for a go-around in case there is a bolter. The correct pitch attitude can generally be achieved by holding one half aft stick until engagement. Do not apply brakes prior to engaging the arresting wire. If required, secure the engine and evacuate the aircraft.

If directional control is in question (blown tire, locked brake, cocked nosewheel, unsafe gear), touch down on centerline at or just before the arresting wire (within 50 feet). Upon touchdown, simultaneously add power to MRT, retract the speedbrakes, counter swerve with rudder and rotate to a 5 to 10 degree nose-up pitch attitude (10 degrees maximum). This technique maintains the proper pitch attitude for arresting wire engagement and also prepares the aircraft for an immediate fly-away should the hook not engage the arresting wire.

For short field arrestment -

1. Hook - DOWN
2. Fly normal approach

If directional control not in question -

3. Touch down 500 feet prior to arresting gear
4. Maintain approach power setting and landing attitude (approximately 5 degrees nose-up/one-half aft stick)

CAUTION

Failure to maintain a proper landing attitude or applying brake pressure while crossing the arresting gear greatly reduces the chances of a successful arrestment.

When arrestment is assured (either by LSO call or when deceleration is felt by the pilot) -

5. Throttle - IDLE

If the aircraft bolters -

5. Execute go-around immediately

If directional control is in question (blown tire, locked brake, cocked nosewheel, unsafe gear) -

3. Touch down at or just prior to arresting gear (within 50 feet) with LSO assistance

Immediately upon touchdown simultaneously perform the following -

4. Throttle - MRT
5. Speedbrakes - RETRACT
6. Rudder - AS REQUIRED TO COUNTER SWERVE
7. Stick - SMOOTHLY APPLY UP TO FULL AFT STICK

WARNING

- Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.
- Failure to immediately rotate the aircraft following a hook skip/bolter increases time on deck, which may allow excessive yaw rates to develop and result in an unrecoverable condition.

NOTE

Cockpit lateral accelerations of up to 0.5 g can be expected upon touchdown and during landing rollout.

When arrestment is assured (either by LSO call or when deceleration is felt by the pilot) -

8. Throttle - IDLE

If the aircraft bolters -

8. Rudder pedals - CENTER (NEUTRALIZE) ONCE AIRBORNE AND SET FLY-AWAY PITCH ATTITUDE

16.11.3 Long Field Arrestment. Make a long field arrestment when there is a stopping problem such as aborted takeoff, wet or icy runway or loss of brakes and it is not possible to go around for a short field arrestment. If a long field arrestment is selected due to an emergency which results in an approach speed so fast that it exceeds the approach-end arresting gear limits, be prepared for possible tire failure. Lower the hook in time for it to fully extend before engagement (normally 1,000 feet before the arresting gear). Line up on the runway centerline. Tell the tower of your intention to engage the arresting gear so aircraft landing behind you is waved off.

When the flaps are fully extended or extended using the emergency system and aircraft weight is less than 11,900 pounds, the hook point may ride above the runway surface when the aircraft is in a three-point attitude and sufficient lift exists. The aircrew should raise the flaps to 1/2 prior (if practical) to crossing the arresting gear to ensure the hook point is properly positioned for engaging the arresting gear. At any weight, braking during wire engagement may raise the hookpoint sufficiently to miss the arresting gear.

1. Hook - DOWN (1,000 FEET PRIOR TO ARRESTING GEAR)
2. Maintain directional control
3. Raise flaps to 1/2 prior to crossing the arresting gear (if practical)
4. Release brakes prior to crossing the arresting gear

16.12 FIELD ARRESTING GEAR DATA

See Figure 16-6.

EMERGENCY FIELD ARRESTMENT DATA

TYPE OF ARRESTING GEAR	MAXIMUM ENGAGING SPEED (KIAS) (D)			MAXIMUM OFF-CENTER ENGAGEMENT (FEET)
	SHORT-FIELD ARRESTMENT	LONG-FIELD ARRESTMENT	ABORTED TAKEOFF	
	GROSS WEIGHT UP TO 13,360 LB (K,L)	GROSS WEIGHT UP TO 13,360 LB (M)	GROSS WEIGHT 13,460-14,500 LB (C)	
E-28	163 (A)	163 (A)	161 (A)	40
E-28 (G)	158 (A)	158 (A)	156 (A)	40
M-21	150 (A)	150 (A)	149 (A)	10
BAK-9	160	160	160	30
BAK-12 (E)	160	160	160	50
DUAL BAK-12 (F)	122 (B)	122 (B)	132 (A)	30
BAK-13	160	160	160	40

CAUTION

After engagement into E-28 or BAK-13 arresting gear systems, when aircraft speed has been reduced to approximately 20 KIAS, braking should be applied to stop the forward motion of the aircraft. This will prevent an aircraft with idle power from slowly pulling the gear through to a two-block position, and will more quickly allow the runway to be cleared for other aircraft operations. However, in the event of a two-block into any system except E-5, engine thrust should judiciously be applied during walkback. Some walkback is necessary to clear the deck pendant from the arresting hook; however, the application of excessive power in controlling walkback increases the possibility of deck pendant hang-up in the arresting hook point.

NOTES

(A) MAXIMUM ENGAGING SPEED LIMITED BY AIRCRAFT ARRESTING HOOK STRENGTH.

(B) MAXIMUM ENGAGING SPEED LIMITED BY AIRCRAFT LIMIT HORIZONTAL DRAG-LOAD FACTOR (MASS ITEM LIMIT G).

(C) DATA PROVIDED IN ABORTED TAKEOFF COLUMN MAY BE USED FOR EMERGENCY HIGH GROSS WEIGHT ARRESTMENT.

(D) MAXIMUM ENGAGING SPEED LIMITED BY ARRESTING GEAR CAPACITY, EXCEPT WHERE NOTED.

(E) STANDARD BAK-12 LIMITS ARE BASED ON 150 FOOT SPAN, 1 INCH CROSS DECK PENDANT, 40,000 POUND WEIGHT SETTING, AND 950 FOOT RUNOUT. NO INFORMATION AVAILABLE REGARDING APPLICABILITY TO OTHER CONFIGURATIONS.

(F) DUAL BAK-12 LIMITS ARE BASED ON 150 TO 300 FOOT SPAN, 1 1/4 INCH CROSS DECK PENDANT, 50,000 POUND WEIGHT SETTING, AND 1,200 FOOT RUNOUT. NO INFORMATION AVAILABLE REGARDING APPLICABILITY TO OTHER CONFIGURATIONS.

(G) ONLY FOR THE E-28 SYSTEMS AT KEFLAVIK AND BERMUDA WITH 920 FOOT TAPES.

(H) OFF-CENTER ENGAGEMENT INTO AN E-5 SYSTEM MAY NOT EXCEED 25 PERCENT OF THE RUNWAY SPAN.

(J) BEFORE MAKING AN E-5 SYSTEM ARRESTMENT, THE PILOT MUST CHECK WITH THE AIR STATION TO CONFIRM MAXIMUM ENGAGING SPEED BECAUSE OF A POSSIBLE INSTALLATION WITH LESS THAN MINIMUM REQUIRED RATED CHAIN LENGTH. CHAIN LENGTH RATINGS ARE REFERENCED IN FLIGHT INFORMATION PUBLICATION (IFR-SUPPLEMENT).

(K) MAXIMUM OF 3.0 DEGREE GLIDE SLOPE.

(L) CONSULT APPROPRIATE NATOPS SECTION FOR RECOMMENDED APPROACH SPEED.

(M) FLARED OR MINIMUM RATE OF DESCENT LANDING.

(N) THE E-5 SYSTEM DATA PROVIDED FOR LONG-FIELD LANDING MAY BE USED FOR LIGHTWEIGHT ABORTED TAKEOFF.

Figure 16-6. Emergency Field Arrestment Data (Sheet 1 of 2)

EMERGENCY FIELD ARRESTMENT DATA

AIRCRAFT ENGAGING SPEED LIMITS FOR E-5 EMERGENCY ARRESTING GEAR												
ARRESTING GEAR RATING (J)	SHORT FIELD LANDING UP TO 13360 POUNDS (K,L,H)				LONG FIELD LANDING UP TO 13360 POUNDS (M,H)				ABORTED TAKEOFF 13460 TO 14500 POUNDS (C,N,H)			
	STANDARD CHAIN		HEAVY CHAIN		STANDARD CHAIN		HEAVY CHAIN		STANDARD CHAIN		HEAVY CHAIN	
	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3
COL 1	COL 2	COL 3	COL 4	COL 5	COL 6	COL 7	COL 8	COL 9	COL 10	COL 11	COL 12	COL 13
300-349	84(D)	84(D)	78(D)	78(D)	84(D)	84(D)	78(D)	78(D)	80(D)	80(D)	75(D)	75(D)
350-399	93(D)	93(D)	92(D)	92(D)	93(D)	93(D)	92(D)	92(D)	89(D)	89(D)	89(D)	89(D)
400-449	101(D)	101(D)	106(D)	106(D)	101(D)	101(D)	106(D)	106(D)	97(D)	97(D)	102(D)	102(D)
450-499	110(D)	110(D)	120(D)	120(D)	110(D)	110(D)	120(D)	120(D)	106(D)	106(D)	115(D)	115(D)
500-549	117(D)	117(D)	134(D)	134(D)	117(D)	117(D)	134(D)	134(D)	114(D)	114(D)	129(D)	129(D)
550-599	125(D)	125(D)	149(D)	149(D)	125(D)	125(D)	149(D)	149(D)	121(D)	121(D)	143(D)	143(D)
600-649	133(D)	133(D)	150(D)	153(B)	133(D)	133(D)	150(D)	153(B)	129(D)	129(D)	150(D)	158(D)
650-699	140(D)	140(D)	150(D)	153(B)	140(D)	140(D)	150(D)	153(B)	136(D)	136(D)	150(D)	163(A)
700-749	147(D)	147(D)	150(D)	153(B)	147(D)	147(D)	150(D)	153(B)	144(D)	144(D)	150(D)	163(A)
750-799	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	151(D)	150(D)	163(A)
800-849	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	158(D)	150(D)	163(A)
850-899	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)
900-949	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)
950-999	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)
1000-1049	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)
1050-1099	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)
1100	150(D)	154(B)	150(D)	153(B)	150(D)	154(B)	150(D)	153(B)	150(D)	163(A)	150(D)	163(A)

Refer to sheet 1 for cautions and notes.

Figure 16-6. Emergency Field Arrestment Data (Sheet 2 of 2)

16.13 DITCHING

Ditching the aircraft should be the pilot's last choice. Ejection is recommended whenever possible.

WARNING

The aircraft should be ditched only when ejection has failed.

Before Impact -

1. Landing gear - UP
2. Flaps/slats - DOWN
3. External stores - JETTISON
4. Arresting hook - DOWN
5. Shoulder harness - LOCK
6. Make radio distress call
7. IFF - SQUAWK EMERGENCY
8. Visor - DOWN
9. Oxygen mask - TIGHTEN
10. Lower seat, assume position for ditching (feet on rudder pedals, knees flexed)
11. Emergency oxygen actuator - PULL
12. MDC firing handle - PULL
13. Fly parallel to swell pattern
14. Attempt to touch down along wave crest
15. Throttle - OFF PRIOR TO IMPACT
16. Emergency Egress - PERFORM

CHAPTER 17

Ejection

17.1 GENERAL

The ejection seat must be used to escape from the aircraft in flight. If the canopy fails to detonate, the seat will eject through the canopy. Analysis of ejections using NACES show:

1. Optimum airspeed for ejection is 250 KIAS or less.

2. Appreciable forces are exerted on the body when ejection is performed at airspeeds of 250 to 600 KIAS rendering escape more hazardous.

3. Above 600 KIAS, excessive forces are exerted on the body making ejection extremely hazardous.

WARNING

During ejection seat development and testing, the SJU-17(V) 5/A and SJU-17(V) 6/A were qualified for use by aviators with nude weights from 136 lbs. to 213 lbs. Operation of the seat by personnel not within these parameters subjects the occupant to increased risk of injury.

General injury risks:

- Ejection seat stability is directly related to occupant restraint. All occupants should be properly restrained in the seat by their torso harness for optimum performance and minimum injury risk.
- Inertia reel performance may be degraded for occupants outside of the qualified weight range. Lighter occupants may be injured during haulback, and both light and heavy occupants may experience poor ejection positions, resulting in an increased risk of injury during ejection.

Injury risks for aviators with nude weights less than 136 pound:

- The catapult was designed for the ejection seat qualified weight range. Lighter weight occupants are subject to a higher risk of injury on the catapult due to greater accelerations.
- Lighter weight occupants are at a greater risk of injury during ejections above 300 knots due to instability during drogue deployment.
- Lighter weight occupants are at a greater risk of injury during ejections near the upper end of Mode I (approaching 300 knots) due to high parachute opening shock.

Injury risks for aviators with nude weights greater than 213 pounds:

- Larger occupants may not attain sufficient altitude for parachute full inflation in zero-zero cases or at extremely low altitudes and velocities.
- Larger occupants may not attain sufficient altitude to clear the aircraft's tail structure.

When circumstances permit, slow the aircraft prior to ejection to reduce the forces on the body.

WARNING

Never actuate the emergency restraint release before ejection. Actuation of the handle releases the pilot from the seat and moves the SAFE/ARMED handle to the SAFE position, making ejection initiation by the seat occupant impossible. Further, if ejection is then initiated by the other cockpit, both seats will be ejected with probable fatal results.

With wings level and no sink rate, ejection is feasible within the following parameters:

1. Ground level, zero airspeed
2. Ground to 50,000 feet, 550 KIAS maximum

Ejection at low altitude allows only a matter of seconds to prepare for landing. Over water, inflation of the LPU is the most important step to be accomplished. The second most important step is the release of the parachute quick-release fittings after entering the water if the SEAWARS Koch fittings fail to operate. *

The ejection system is designed to go through the canopy whether or not the canopy is prefractured. Ejection with the canopy in any position other than fully closed and locked involves contact of the ejection seat and/or occupant with the canopy frame resulting in seat malfunction and serious occupant injury. If the canopy opens inadvertently in flight and a controlled ejection is required, yaw the aircraft to starboard to cause the canopy to depart the aircraft.

WARNING

- Ejection with canopy in any position other than fully closed and locked is not recommended. Serious bodily injury and seat malfunction may occur.
- Severe head/neck injury may occur if ejection is initiated with aircrew head above ejection seat canopy breakers and ejection occurs in the Backup Mode (through canopy).
- If the seat becomes unlocked from the catapult and slides partially up the rails or completely out of the cockpit, ejection and/or chute deployment is still possible, but the ejection handle must be pulled followed by activation of the manual override handle. Under these circumstances, low altitude ejection capabilities are compromised.

17.2 LOW ALTITUDE EJECTION

Low altitude ejection decision must be based on the minimum airspeed, minimum altitude, dive angle, bank angle, and sink rate limitations. Ejection seat trajectory is improved if the aircraft is zoomed. The additional altitude increases time available for seat separation and parachute deployment. Do not delay ejection if the aircraft is nose down and cannot be leveled.

When ejection is in the immediate vicinity of the carrier, parachute entanglement combined with the wake and associated turbulence can rapidly submerge the pilot. The deployed seat survival kit may contribute to shroud line entanglement. The survivor must be prepared to cut shroud lines that are dragging him down.

The crashed aircraft may release large quantities of jet fuel and fumes which could hamper breathing and create a fire hazard if a smoke or flare marker is present. The emergency oxygen system may be invaluable in this case and discarding the survival kit would terminate its use. However, totally discarding the survival kit may be appropriate after considering weather, sea conditions, and rescue potential.

The variety and complexity of conditions encountered during the "time critical" actions following a low altitude overwater ejection make it impossible to formulate procedures to cover every contingency.

17.3 HIGH ALTITUDE EJECTION

The basic low altitude procedure is applicable to high altitude ejection. The zoom is useful to slow the aircraft to a safer ejection speed or to provide more time and glide distance if immediate ejection is not necessary. If the aircraft is descending out of control, eject by 10,000 feet AGL. Even if under control, do not delay ejection below 2,000 feet AGL. Head the aircraft toward an unpopulated area, if possible.

17.4 EJECTION PROCEDURES

See Figure 17-1, sheets 1 thru 8, for ejection procedures. See Figure 17-2, sheets 1 thru 3, for minimum safe ejection altitude.

WARNING

There is no manual bailout capability with this ejection seat.

NOTE

A pull force of 40 to 60 pounds is required to actuate the ejection handle.

17.4.1 Deleted by Change 4.

17.4.2 Controlled Ejection. If time and conditions permit -

1. Alert other crewmember
2. (Aft cockpit) Command ejection selector - BOTH

WARNING

- In the FWD BOTH/AFT SELF mode, if the AFT crew member initiates ejection, followed be ejection initiation by the FWD seat, the FWD seat canopy will not automatically fracture prior to ejection. In this scenario, the MDC firing handle will function normally and should be used to fracture the FWD canopy prior to FWD seat ejection if time permits.
- Automatic command ejection sequencing is impossible with the selector in the SOLO position. If ejection is simultaneously initiated in this mode, the seats may collide.

3. Level wings and minimize rate of descent
4. IFF - SQUAWK EMERGENCY
5. Follow radio distress procedures
6. Stow loose equipment
7. Shoulder harness lock lever - LOCKED
8. Lap belt and shoulder harness tight, visor down, helmet secured, oxygen mask tight
9. Trade airspeed for altitude (if appropriate)
10. Slow aircraft as much as possible
11. Ejection handle - PULL

17.4.3 Seat Operation. After pulling the ejection handle, the IFF is actuated, the harness retraction unit positions the occupant, and the canopy is detonated.

1. Catapult fires and seat is propelled up guide rails. Occupant's legs are restrained. Emergency oxygen and radio beacon are actuated. The under seat rocket motor fires at the end of catapult stroke.

2. Drogue catapult fires. Drogue is deployed to stabilize and decelerate seat.

NOTE

If emergency oxygen fails to activate upon ejection, pull the oxygen actuator on the left side of the seat survival kit.

17.4.3.1 Low Altitude Sequence (below 18,000 feet)

1. Drogue bridle release mechanisms operate to release drogue from seat.

2. Parachute extractor rocket fires to extract and deploy parachute.

3. Harness release and seat/man separation occur between 0.65 to 3.10 seconds after ejection initiation. Timings are dependent upon altitude and airspeed.

17.4.3.2 High Altitude Sequence (above 18,000 feet)

1. Seat with pilot descends, stabilized by the drogue, to 18,000 feet

2. At 18,000 feet, drogue is released, parachute is extracted and deployed, and seat/man separation occurs. Pilot then descends on parachute.

WARNING

The sequencer mechanism operates as a function of altitude above mean sea level. If ejecting over high altitude terrain, it may be necessary to pull the emergency restraint release to obtain early seat/man separation and adequate altitude for the parachute to open.

17.4.3.3 Manual Seat/Man Separation

If below 14,000 feet and automatic seat/man separation fails to occur:

1. Locate emergency restraint release on right side of seat bucket. Depress handle thumb button and pull handle sharply upwards as far as possible.

2. Emergency restraint release cartridge fires to activate parachute extractor rocket and upper and lower harness locks. Seat/man separation occurs as the parachute is extracted and deployed.

17.5 SAR ON SCENE COMMANDER'S CHECKLIST

In the event an aircraft mishap occurs beyond the control boundaries of an airport, the responsibility for initial coordination of the Search and Rescue effort is left with one of the following:

1. Senior aviator in the flight.

2. Senior student in the flight.

3. Any aviator airborne identifying himself/herself as senior.

The on scene commander shall:

1. Assume responsibility for the remainder of the flight.

2. Make the necessary voice reports.

3. Keep the downed aircraft/pilots in sight.

Flight management by the on scene commander falls into two categories:

1. Remainder of flight remains intact.

2. Flight members not needed for SAR effort are ordered to Return to Base (RTB).

The particulars for either situation listed above should be covered in the flight brief and be fully understood by all members in the flight. The on scene commander should utilize the following checklist commensurate with the situation:

I. Identification

1. Number of survivors.

2. Establish an order of communication.

3. Determine injuries.

4. Check all assets' time on station and equipment on board which may help pinpoint survivor location, etc.

II. Location

1. Request general terrain description.

2. Determine signalling devices.

3. Request beeper for homing.

4. Request survivor(s) give vectors to their position.

5. Pinpoint location of each survivor.

III. Recovery

1. Brief helo and remainder of SAR team.

   a. Number and physical condition of survivor(s).

   b. Distance to survivor(s) from a known geographical check point.

   c. Terrain description.

   d. Survivor(s) pinpoint location.

   e. Altitude of recovery area.

   f. Wind speed and direction.

   g. Describe survivor(s) signal devices.

   h. Describe ingress/egress routes.

   i. Emergency safe landing areas.

2. Direct survivor(s) to:

   a. Prepare and ignite smokes.

   b. Vector helo if necessary.

   c. Retain helmet for recovery.

EJECTION PREPARATION

THESE PROPER BODY POSITIONS MUST
BE TAKEN TO PREVENT INJURY

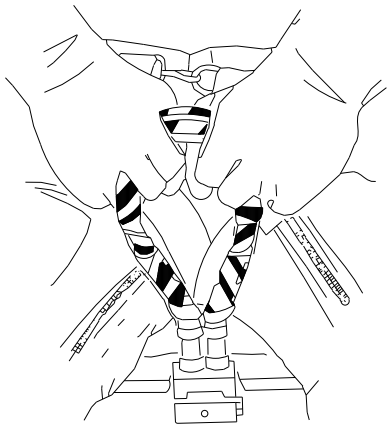
1. PRESS HEAD FIRMLY AGAINST HEADREST.
2. ELEVATE CHIN SLIGHTLY (10 DEGREES).
3. PRESS SHOULDERS AND BACK FIRMLY AGAINST THE SEAT.
4. HOLD ELBOWS AND ARMS FIRMLY TOWARD SIDES.
5. PRESS BUTTOCKS FIRMLY AGAINST THE SEAT BACK.
6. ATTEMPT TO PLACE THIGHS FLAT AGAINST SEAT.
7. PLACE HEELS FIRMLY ON DECK, TOES ON RUDDER PEDALS.

EJECTION INITIATION

THE RECOMMENDED METHOD FOR EJECTION INITIATION IS DEPICTED BELOW.

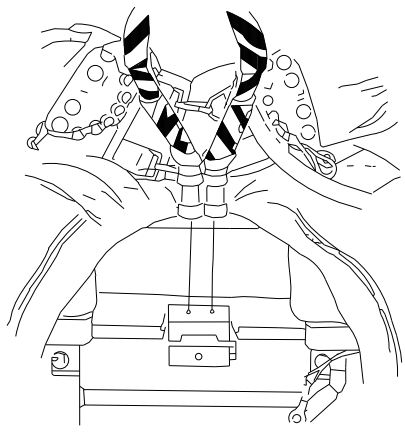
NOTE

DURING ANY COMBINED LOW ALTITUDE/LOW AIRSPEED SITUATION, CONTINUE TO FLY THE AIRCRAFT WITH THE RIGHT HAND, KEEPING WINGS LEVEL AND MAINTAINING ALTITUDE OR THE LOWEST POSSIBLE SINK RATE WHILE INITIATING EJECTION SEQUENCE WITH THE LEFT HAND.



GRIP THE EJECTION HANDLE WITH THE THUMB AND AT LEAST TWO FINGERS OF EACH HAND, PALMS TOWARD BODY AND ELBOWS CLOSE TO BODY.

GRIP HANDLE WITH STRONG HAND PALMS INWARD, GRIP WRIST OF STRONG HAND WITH OTHER HAND, PALMS TOWARD BODY AND ELBOWS CLOSE TO BODY.



PULL HANDLE SHARPLY UP AND TOWARD ABDOMEN, KEEPING ELBOWS IN. INSURE TO PULL HANDLE TO END OF TRAVEL.

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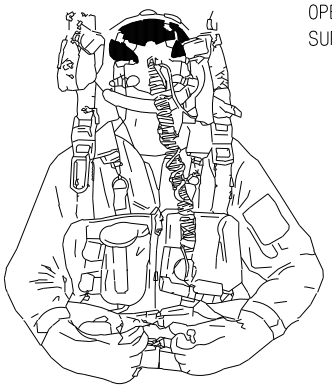
Figure 17-1. Ejection Procedures (Sheet 1 of 8)

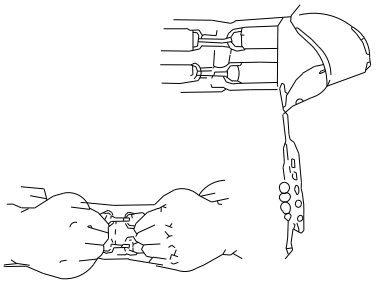
POST EJECTION PROCEDURES (AFTER PARACHUTE DEPLOYMENT)

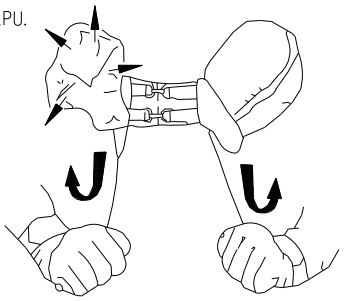
WARNING

ALTHOUGH THE FLU-8 AUTOMATIC INFLATION DEVICE IS DESIGNED TO INFLATE THE LPU UPON WATER CONTACT, MANUAL INFLATION REMAINS THE PRIMARY MODE OF OPERATION. AUTOMATIC ACTUATION IS INTENDED FOR DISABLED OR UNCONSCIOUS SURVIVORS OR IF THERE IS INSUFFICIENT TIME TO MANUALLY ACTIVATE THE LPU.

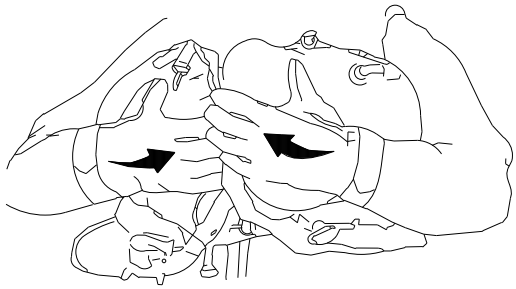
LPU INFLATION







1. LOCATE AND PULL LPU BEADED HANDLES DOWN AND STRAIGHT OUT TO INFLATE. IF BEADED HANDLE INFLATION FAILS, USE ORAL INFLATION TUBE.



NOTE

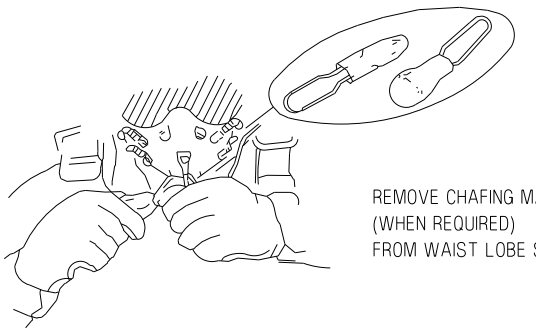
THE PROCEDURES OUTLINED APPLY TO OVER LAND OR OVER WATER EJECTIONS. HOWEVER, INFLATION OF THE LPU MAY BE UNDESIRABLE OVER LAND.

2. IF NECESSARY, SQUEEZE LPU WAIST LOBES TOGETHER TO HELP RELEASE COLLAR LOBE, OR MANUALLY RELEASE VELCRO ON THE COLLAR TO ACHIEVE COMPLETE COLLAR LOBE INFLATION.

WARNING

FAILURE TO SNAP WAIST LOBES BEFORE WATER ENTRY MAY RESULT IN FACE-DOWN FLOTATION.

OPTION PROCEDURE



REMOVE CHAFING MATERIAL (WHEN REQUIRED) FROM WAIST LOBE SNAPS.

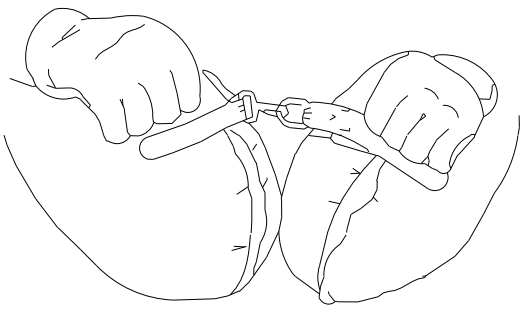


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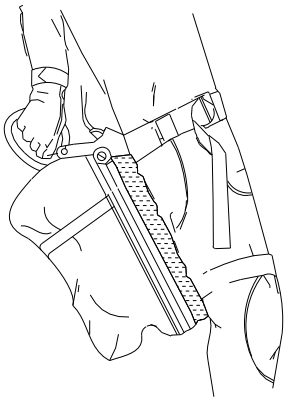
Figure 17-1. Ejection Procedures (Sheet 2 of 8)

SEAT KIT DEPLOYMENT

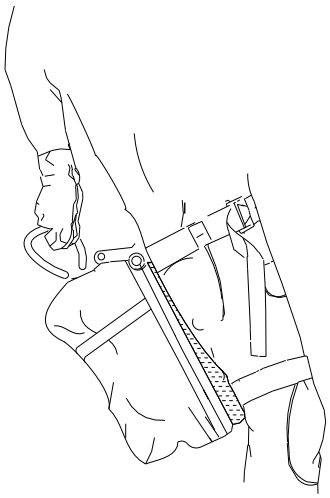
WARNING

DEPLOYING THE SEAT KIT OVER LAND IS NOT RECOMMENDED.

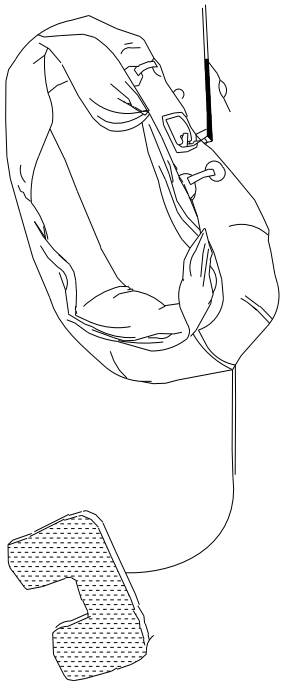
1. AFTER INFLATING THE LPU, PREPARE TO DEPLOY THE SEAT KIT.



2. WITH EITHER HAND, LOCATE THE RAFT RELEASE AT THE REAR OF THE SEAT KIT.



3. PULL OUTWARDS ON THE RAFT RELEASE UNTIL THE SEAT KIT IS DEPLOYED.



4. SEAT KIT DEPLOYED WITH THE LIFE RAFT FULLY INFLATED BELOW THE UPPER HALF OF THE SEAT KIT.

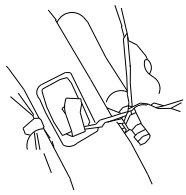


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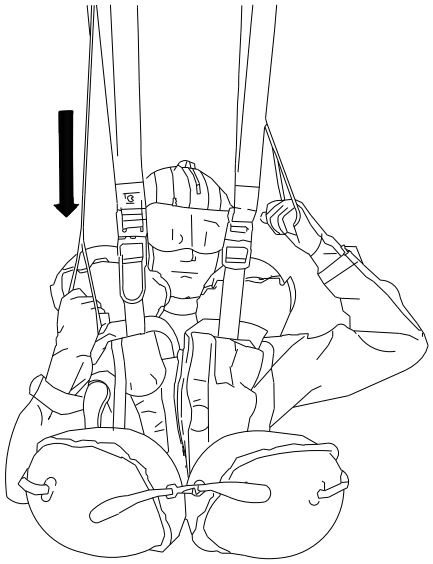
Figure 17-1. Ejection Procedures (Sheet 3 of 8)

PARACHUTE STEERING



PULL DOWN ON THE LEFT OR RIGHT LANYARD TO STEER IN THE DESIRED DIRECTION.

LANDING PREPARATION OVER WATER

TRY TO DETERMINE THE WIND DIRECTION AT THE SURFACE USING WHITE CAPS, SMOKE FROM THE WRECKAGE, OR KNOWN SURFACE WINDS IN THE VICINITY. NOTE THAT THE WINDS AT THE SURFACE MAY BE QUITE DIFFERENT FROM THOSE ENCOUNTERED AT ALTITUDE.

WHEN NEARING THE SURFACE, MANEUVER THE PARACHUTE SO THAT YOU ARE FACING INTO THE WIND. THEN ASSUME THE PROPER BODY POSITION FOR LANDING.

- FEET TOGETHER.
- KNEES SLIGHTLY BENT.
- TOES POINTED SLIGHTLY DOWNWARD.
- EYES ON THE HORIZON.
- FIRMLY GRASP CANOPY RELEASE FITTINGS.
- TUCK ELBOWS IN PRIOR TO WATER ENTRY.

WARNING

- IF A PARACHUTE LANDING IS MADE INTO THE WATER OR A HIGH WIND PREVENTS NORMAL SPILLING OF THE PARACHUTE CANOPY, DISCONNECT BOTH QUICK-RELEASE FITTINGS THAT ATTACH RISERS TO THE TORSO-HARNESS SUIT, THUS JETTISONING THE PARACHUTE CANOPY.
- DO NOT DISCONNECT THE QUICK-RELEASE FITTINGS UNTIL AFTER CONTACT WITH GROUND OR WATER.

LANDING PREPARATION OVER LAND

PERFORM THE SAME PROCEDURES AS FOR OVER WATER, BUT WITH THE FOLLOWING EXCEPTIONS:

1. VISOR - DOWN.
2. GLOVES - ON.
3. DO NOT DEPLOY SEAT KIT.

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Figure 17-1. Ejection Procedures (Sheet 4 of 8)

PARACHUTE LANDING FALL (PLF) PROCEDURES

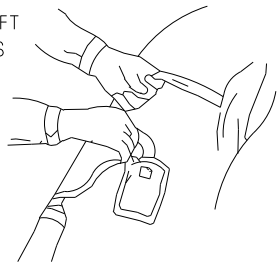
UPON TOES TOUCHING GROUND SURFACE:

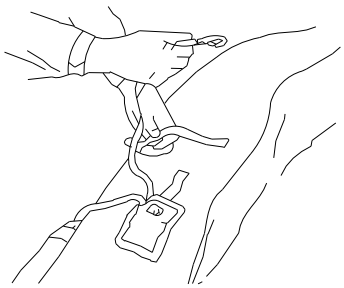
1. ARCH SIDE OF BODY IN DIRECTION OF FALL.
2. CONTACT GROUND AT FIVE POINTS OF BODY CONTACT:
   A. BALLS OF FEET.
   B. CALF.
   C. THIGH.
   D. BUTTOCKS.
   E. UPPER BACK.
3. RELEASE PARACHUTE FITTINGS.

RAFT BOARDING

WHEN CLEAR OF THE PARACHUTE CANOPY, RETRIEVE THE LIFE RAFT BY LOCATING THE DROPLINE AND PULLING THE RAFT TO YOU.

1. LOCATE AND REMOVE THE RAFT RETAINING LANYARD FROM ITS POCKET JUST ABOVE THE CO_2 CYLINDER.

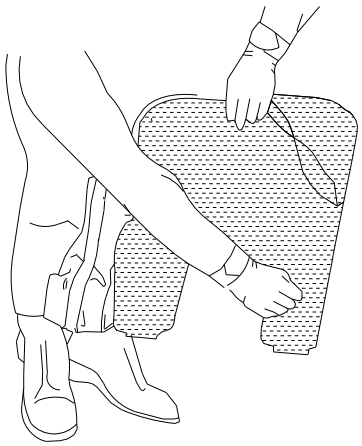




NOTE

ENSURE THAT RAFT RETAINING LANYARD IS SECURELY ATTACHED AND OXYGEN HOSE HAS BEEN DISCONNECTED FROM SEAT KIT (IF NOT PREVIOUSLY ACCOMPLISHED) BEFORE RELEASING UPPER HALF OF SEAT KIT.

2. ATTACH THE SNAPHOOK TO GATED HELO-HOIST LIFT RING.
3. LOCATE THE QUICK-RELEASE FITTING AND RELEASE UPPER HALF OF SEAT KIT.
4. BRING RAFT AROUND FOR ENTRY INTO SMALLER END (STERN).
5. GRASP STERN AND FORCIBLY PUSH UNDER LPU WAIST LOBES.
6. USING BOARDING HANDLES, PULL INTO RAFT AND TURN TOWARD A SEATED POSITION.
7. LOCATE THE SEA ANCHOR AND DEPLOY IT.
8. RETRIEVE LOWER HALF OF SEAT KIT.



NOTE

- THE AN/URT-33A IS NOT SECURED AND ONCE REMOVED FROM THE SEAT KIT, CARE MUST BE TAKEN TO PREVENT ITS LOSS.
- THE AN/URT-33A HAS A RETRIEVAL LANYARD SECURED TO IT WITH RUBBER BANDS. ATTACH THE LANYARD TO A SUITABLE PLACE ON SURVIVAL EQUIPMENT. THEN REMOVE THE AN/URT-33A FROM ITS BRACKET.

9. LOCATE AND RETRIEVE THE AN/URT-33A FROM THE UPPER HALF OF THE SEAT KIT.
10. IMMEDIATELY, SECURE SURVIVAL PACKAGE TO GATED HELO-HOIST LIFT RING.

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Figure 17-1. Ejection Procedures (Sheet 5 of 8)

RESCUE

IF SURVIVOR PICKUP IS TO BE EFFECTED BY RESCUE HELICOPTER, THE FOLLOWING PROCEDURES SHOULD BE FOLLOWED:
(UNASSISTED RESCUE – NO SWIMMER DEPLOYED)

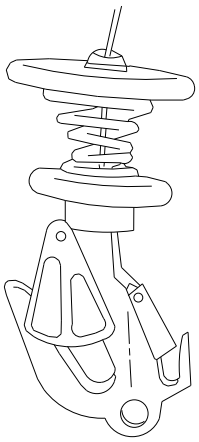
1. STOW OR DISCARD LOOSE GEAR, ROLL OUT OF RAFT ON RIGHT SIDE (SIDE WITH CO_2 CYLINDER).
2. SWIM AWAY FROM RAFT. ENSURE THAT HELMET VISOR HAS BEEN LOWERED.
3. REMOVE RAFT RETENTION LANYARD AFTER RESCUE DEVICE HAS BEEN LOWERED.

WARNING

- TO ALLOW DISCHARGE OF STATIC ELECTRICITY AND PREVENT ELECTRICAL SHOCK, AVOID TOUCHING RESCUE DEVICE UNTIL IT HAS MADE CONTACT WITH WATER/GROUND.
- TO AVOID SEVERE INJURY, KEEP HANDS CLEAR OF HOOK AND RING ASSEMBLIES DURING HOISTING.
- UNDER NO CIRCUMSTANCES SHOULD SURVIVORS ATTEMPT TO ASSIST THEIR ENTRANCE INTO HELICOPTER OR MOVE FROM THE RESCUE DEVICE UNTIL HELICOPTER AIRCREWMAN ASSISTS THEM TO A SEAT IN THE AIRCRAFT.

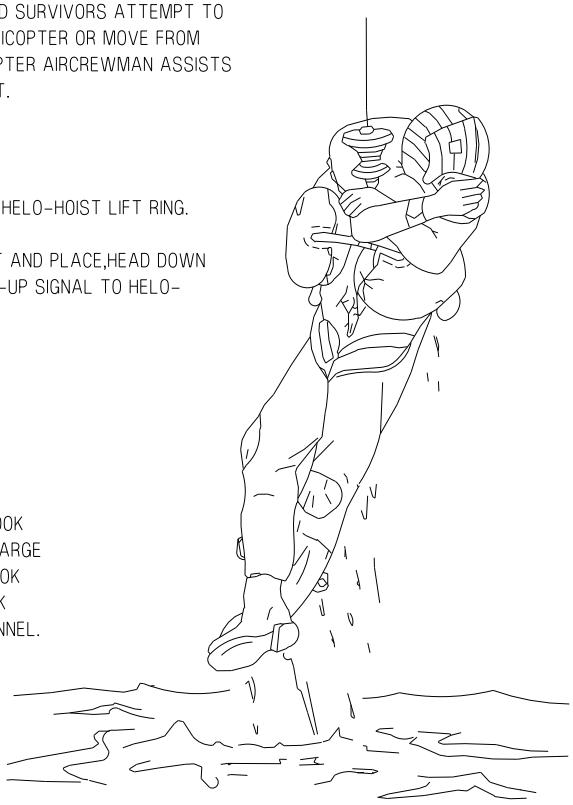
PROCEDURES FOR USE OF THE RESCUE HOOK

1. ATTACH LARGE HOOK TO GATED HELO-HOIST LIFT RING.
2. CROSS ARMS IN FRONT OF CHEST AND PLACE,HEAD DOWN AND TO THE LEFT. GIVE THUMBS-UP SIGNAL TO HELO-HOIST OPERATOR.



NOTE

THE HELO RESCUE HOOK HAS A SMALL AND LARGE HOOK. THE LARGE HOOK IS THE PRIMARY HOOK FOR HOISTING PRESONNEL.



3. POSITION OF AIRCREWMAN DURING HELO-HOIST. UPON CLEARING GROUND/ WATER, CROSS FEET.

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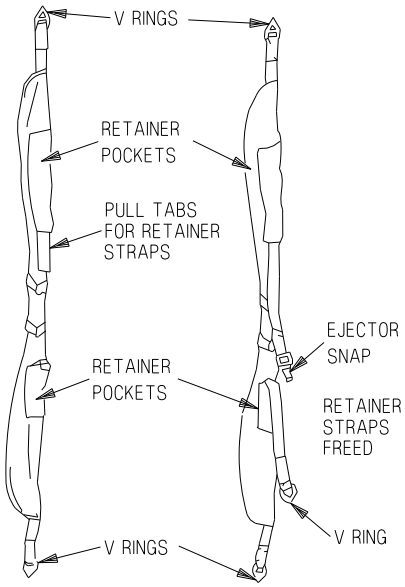
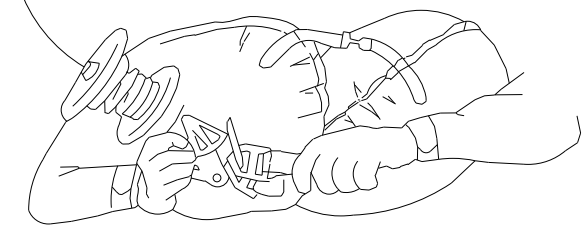
Figure 17-1. Ejection Procedures (Sheet 6 of 8)

PROCEDURES FOR USE OF THE RESCUE STROP (HORSECOLLAR)



1. GRASP FREE END OF RESCUE STROP.
2. SWIM IN A CIRCLE TOWARD RESCUE HOOK COMPLETELY ENCIRCLING BODY WITH RESCUE STROP.



3. ATTACH FREE END OF STROP TO LARGE HOOK.

4. PULL BOTH RETAINER STRAPS FREE AND CONNECT EJECTOR SNAP TO V-RING OF OTHER RETAINER STRAP. PULL TIGHT.
5. ENSURE RESCUE STROP IS ABOVE LPU WAIST LOBES AND HIGH ON BACK. WRAP ARMS AROUND STROP AND PLACE HANDS IN ARMPITS. KEEP HEAD DOWN, AND GIVE THUMBS UP SIGNAL TO HELO-HOIST OPERATOR.

6. POSITION OF AIRCREWMAN DURING HOIST. UPON CLEARING WATER, CROSS FEET.

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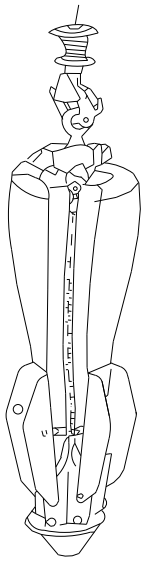
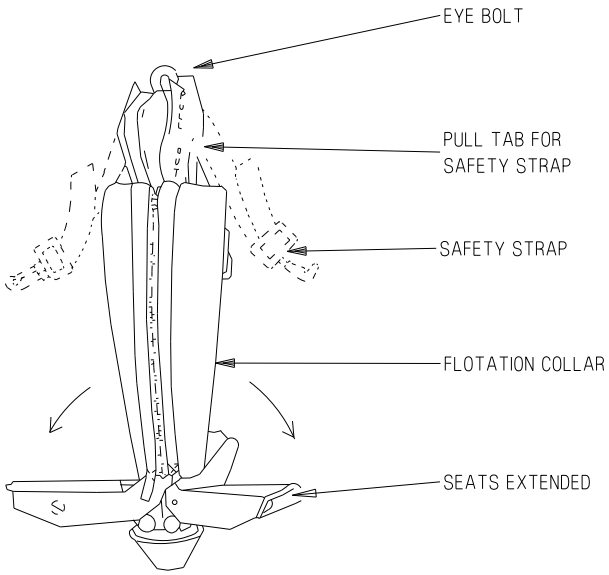
Figure 17-1. Ejection Procedures (Sheet 7 of 8)

PROCEDURES FOR USE OF THE FOREST PENETRATOR



FOREST PENETRATOR WITH FLOTATION COLLAR AND SEATS RETRACTED (SAFETY STRAPS OMITTED TO SHOW CONNECTION OF RESCUE HOOK TO EYE-BOLT).



FOREST PENETRATOR WITH FLOTATION COLLAR AND SEATS EXTENDED.

1. UNSNAP LPU WAIST LOBES.
2. EXTEND ONLY ONE SEAT ON FOREST PENETRATOR.
3. SIT ON SEAT FACING FLOTATION COLLAR. USING ELBOWS, SEPARATE LPU WAIST LOBES AND PULL SHAFT OF PENETRATOR CLOSE TO CHEST.
4. PASS SAFETY STRAP UNDER ARM AROUND BACK, AND UNDER OTHER ARM. CONNECT SAFETY STRAP AND TIGHTEN.
5. TURN HEAD DOWN AND TO THE LEFT. GIVE THUMBS UP SIGNAL TO HELO-HOIST OPERATOR.

6. UPON CLEARING WATER, CROSS FEET.

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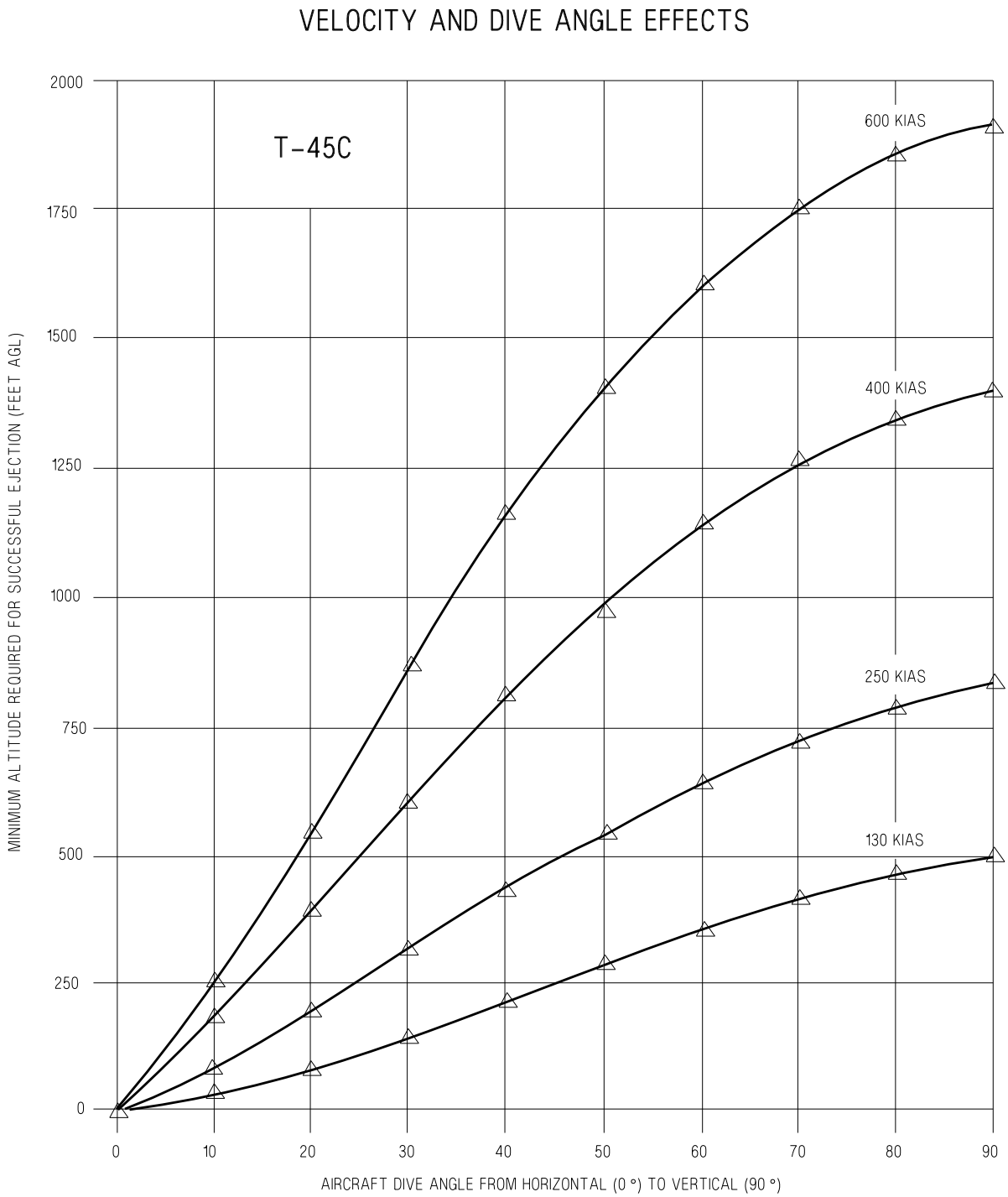
Figure 17-1. Ejection Procedures (Sheet 8 of 8)



NOTES:

- Minimum ejection heights are based on initiation of the escape system, and the time required for a complete dual sequenced ejection is included.
- Pilot reaction time is not included.
- Ejection altitude is below 5000 feet MSL.

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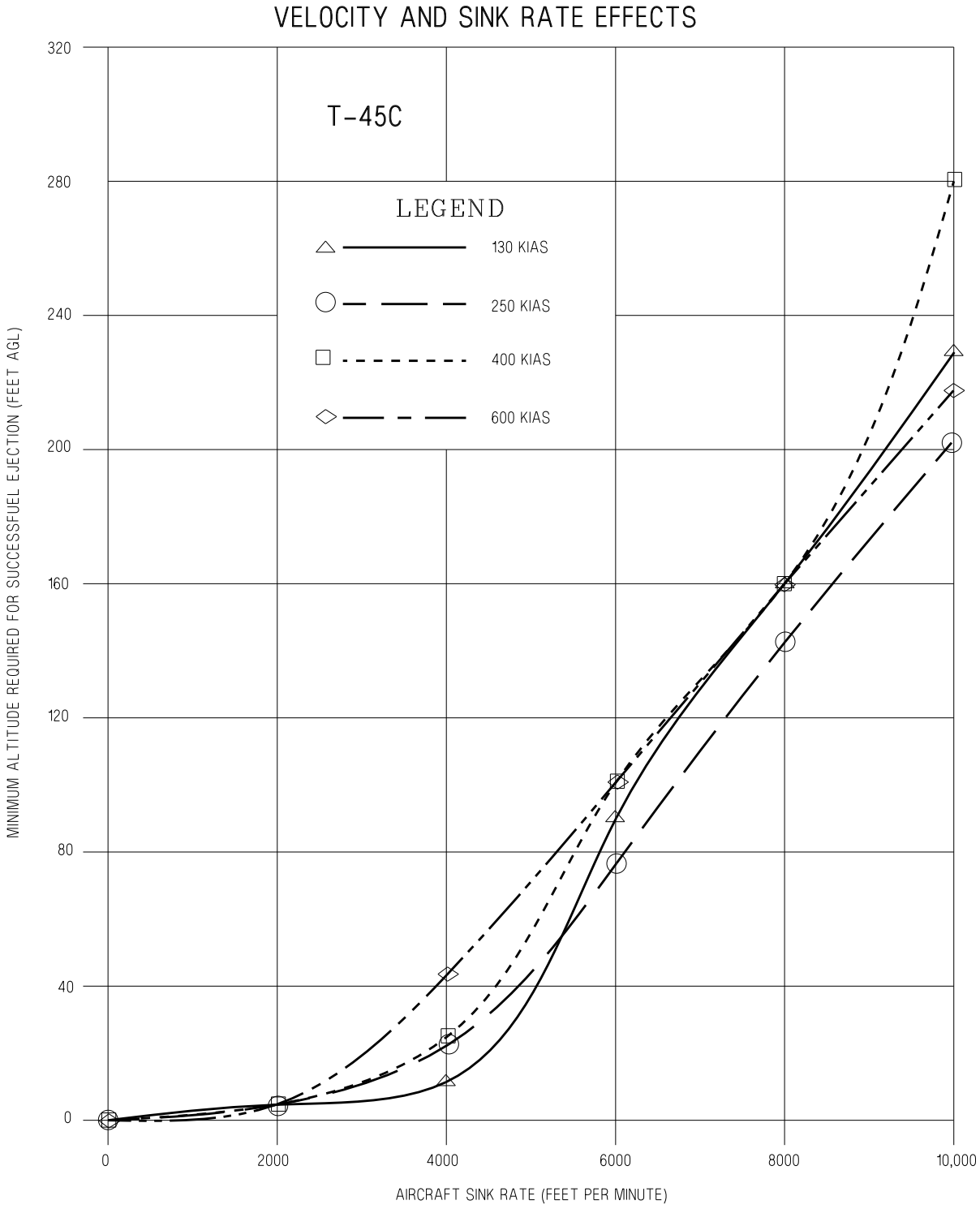
Figure 17-2. Minimum Safe Ejection Altitudes (Sheet 1 of 3)



NOTES:

- Minimum ejection heights are based on initiation of the escape system. and the time required for a complete dual sequenced ejection is included.
- Pilot reaction time is not included.
- Ejection altitude is below 5000 feet MSL.

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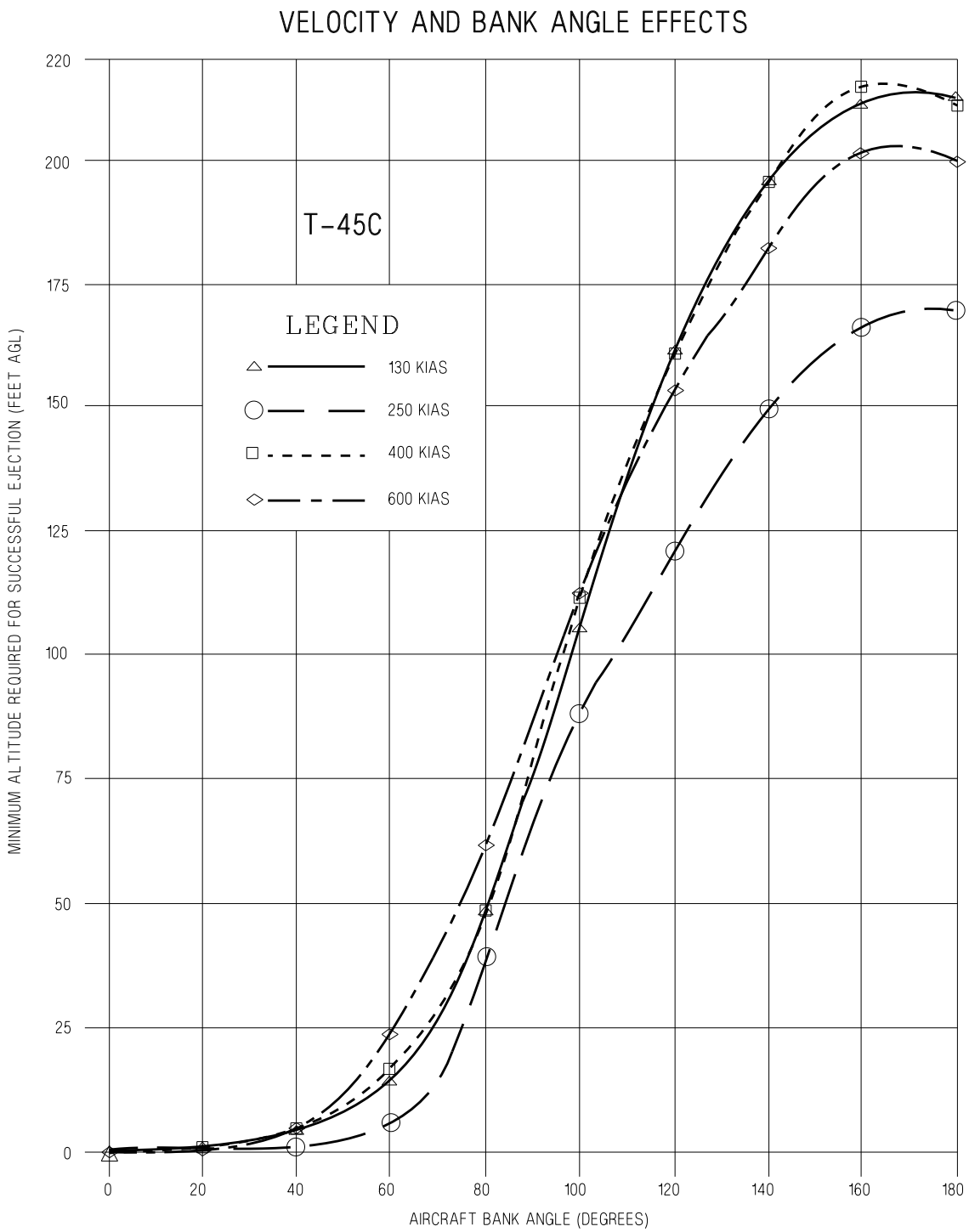
Figure 17-2. Minimum Safe Ejection Altitudes (Sheet 2 of 3)



NOTES:

- Minimum ejection heights are based on initiation of the escape system, and the time required for a complete dual sequenced ejection is included.
- Bank angle data is for coordinated flight. Yaw or slip will increase the height required for recovery.
- Pilot reaction time is not included.
- Ejection altitude is below 5000 feet MSL.

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Figure 17-2. Minimum Safe Ejection Altitudes (Sheet 3 of 3)

CHAPTER 18

Immediate Action Items

This part contains only immediate action items. It is intended for review only and does not contain any steps which are not immediate action nor does it contain notes, cautions, warnings, or explanatory matter associated with particular procedures.

18.1 EGT/RPM WARNING LIGHT

IN-FLIGHT

*1. Throttle - IDLE (minimum for safe flight)

*2. Controls - NEUTRALIZE

*3. EGT/RPM - MONITOR

If EGT is greater than 450 °C for more than 6 seconds or the stall remains locked in-

*4. Emergency oxygen actuator - PULL

*5. Throttle - OFF

*6. Execute appropriate Airstart Procedures

18.2 FIRE WARNING LIGHT

GROUND

*1. Throttle - OFF

*2. FUEL SHUTOFF handle - PULL

*3. BATT switches - OFF

*4. Egress

TAKEOFF

If decision is made to stop -

*1. Abort

If fire is confirmed and unable to abort -

*2. Eject

IN-FLIGHT

*1. Throttle - IDLE (minimum safe for flight)

*2. Secondary indications - CHECK

If secondary indications exists -

*3. Emergency oxygen actuator - PULL

*4. Throttle - OFF

*5. FUEL SHUTOFF handle - PULL

If secondary indications persist -

*6. Eject

If fire extinguished -

*6. Prepare for Controlled Ejection

If unable to eject -

*7. Prepare for Flameout Approach

18.3 GTS FIRE WARNING LIGHT

GROUND

*1. ENGINE switch - OFF

*2. Throttle - OFF

*3. FUEL SHUTOFF handle - PULL

*4. BATT switches - OFF

*5. Egress

IN-FLIGHT

*1. ENGINE switch - OFF

18.4 Deleted by Change 4

18.5 OIL PRESS WARNING LIGHT

*1. Throttle - MINIMUM FOR SAFE FLIGHT

*2. Minimize throttle movements

18.6 OXYGEN WARNING LIGHT

*1. Emergency oxygen actuator - PULL

18.7 CANOPY CAUTION LIGHT

*1. CANOPY control lever - CHECK LOCKED

18.8 TP HOT CAUTION LIGHT

GROUND

*1. Throttle - OFF

*2. FUEL SHUTOFF handle - PULL

*3. BATT switches - OFF

*4. Egress

IN-FLIGHT

*1. Throttle - IDLE (minimum for safe flight)

18.9 SIM MODE ADVISORY PROCEDURES

IN-FLIGHT

*1. Revert to standby instruments

18.10 ABNORMAL START

*1. Throttle - OFF

*2. Execute Clear Engine Procedure

18.11 CLEAR ENGINE PROCEDURE

*1. FUEL SHUTOFF handle - DOWN

*2. ENGINE switch - ON (both cockpits)

*3. GTS - START (if GTS light not on)

*4. IGNITION switch - ISOLATE

When RPM below 20 percent and GTS advisory light illuminates -

*5. ENGINE switch - START

18.12 TAILPIPE FIRE AFTER SHUTDOWN

*1. Throttle - OFF

*2. Execute Clear Engine Procedure

18.13 ABORT

*1. Throttle - IDLE

*2. Speed brakes - EXTEND

*3. Brakes - AS REQUIRED

*4. Hook - DOWN 1,000 FEET PRIOR TO ARRESTING GEAR, IF REQUIRED

*5. Release brakes prior to crossing the arresting gear

18.14 AIRCRAFT SETTLING OFF CATAPULT

*1. Throttle - CHECK FULL FORWARD

*2. Maintain 24 units AOA

If settle not stopped -

*3. Eject

18.15 ENGINE FAILURE DURING CATAPULT LAUNCH

*1. Eject

18.16 BLOWN TIRE DURING TAKEOFF

If decision to abort is made -

*1. Rudder - AS REQUIRED TO COUNTER SWERVE

*2. ANTI-SKID switch - OFF PRIOR TO BRAKING

If takeoff is continued -

*1. Rudder - AS REQUIRED TO COUNTER SWERVE

18.17 ENGINE FAILURE

If below 1,500 feet AGL and airspeed below 180 KIAS -

*1. Eject

If above 1,500 feet AGL or airspeed greater than 180 KIAS -

*1. Emergency Oxygen Actuator - PULL

*2. Perform Immediate Airstart

18.18 AIRSTART PROCEDURES

18.18.1 Immediate Airstart (Any Airspeed/Any Altitude)

*1. Throttle - OFF

Simultaneously perform steps 2 and 3 -

*2. GTS start button - PRESS AND HOLD (MFDs, DEU, SADS, and VCR/CEU drop off line)

*3. Throttle - IDLE (monitor EGT/RPM)

18.18.2 Windmill Airstart

Below 25,000 feet MSL, minimum 13% N_2 RPM (recommend a minimum of 250 KIAS) -

*1. Throttle - OFF

Simultaneously perform steps 2 and 3 -

*2. GTS start button - PRESS AND HOLD (MFDs, DEU, SADS and VCR/CEU drop off line)

*3. Throttle - IDLE (monitor EGT/RPM)

18.18.3 Assisted Airstart

Below 15,000 feet MSL, 165 to 250 KIAS -

*1. Throttle - OFF

*2. GTS - START (MFDs, DEU, SADS and VCR/CEU drop off line)

When RPM drops below 20% N_2 and GTS advisory light ON -

*3. ENGINE switch - START

*4. Throttle - IDLE (monitor EGT/RPM)

18.19 ENGINE STALL/EGT/RPM MALFUNCTIONS

Simultaneously perform steps 1 and 2 -

*1. Throttle - IDLE (minimum for safe flight)

*2. Controls - NEUTRALIZE

*3. EGT/RPM - MONITOR

If EGT is greater than 450° C for more than 6 seconds after throttle IDLE -

*4. Emergency oxygen actuator - PULL

*5. Throttle - OFF

*6. Execute Airstart procedures

18.20 INCORRECT OR UNCOMMANDED ENGINE RESPONSE

*1. Throttle - BETWEEN IDLE AND MID-RANGE, if applicable

*2. FUEL CONTR switch - MANUAL

18.21 ELECTRICAL FIRE

*1. GEN switch - OFF

18.22 SMOKE OR FUMES IN COCKPIT

18.22.1 Elimination Of Smoke Or Fumes From Cockpit

*1. Altitude - DESCEND BELOW 25,000 FEET (if practical)

*2. AIR FLOW knob - OFF

If unable to clear smoke or unable to see -

*3. Airspeed - REDUCE

*4. Warn other cockpit occupant/secure loose items

*5. Seat - LOWER

*6. Visor - DOWN

*7. MDC firing handle - PULL

18.23 OBOGS CONTAMINATION

*1. Emergency oxygen actuator - PULL

18.24 UNCOMMANDED ROLL/YAW

*1. FLAPS/SLATS lever - RETURN TO PREVIOUS SETTING

18.25 DEPARTURE/SPIN PROCEDURE

*1. Controls - NEUTRALIZE (forcibly center rudder pedals)

*2. Speed brakes - RETRACT

*3. Throttle - IDLE

*4. Check altitude, airspeed, AOA, and turn needle

If spin confirmed -

*5. Rudder pedal - FULL OPPOSITE TURN NEEDLE (opposite spin direction)

*6. Lateral stick - INVERTED: FULL OPPOSITE TURN NEEDLE (opposite spin direction)
UPRIGHT: FULL WITH TURN NEEDLE (with spin direction)

*7. Longitudinal stick - NEUTRALIZE

If recovery indicated or airspeed increasing through 160 KIAS -

*8. Lateral stick - NEUTRALIZE

When recovery indicated -

*9. Rudder - SLOWLY RELEASE PEDAL FORCE

If out of control passing through 10,000 feet AGL -

*10. Eject

18.26 GINA FAILURE

*1. Revert to standby instruments

18.26A SWERVE ON TOUCHDOWN

*1. Rudder - AS REQUIRED TO COUNTER SWERVE

WARNING

Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.

*2. Perform go-around, if able

18.27 WHEEL BRAKE FAILURE

*1. Go around

If go around not feasible -

*1. Wheel brakes - RELEASE (Both cockpits)

*2. ANTI-SKID switch - OFF

*3. Attempt braking

*4. Hook - DOWN (1,000 feet prior to arresting gear)

CHAPTER 18A

Warning and Caution Summaries

This part contains only warning and cautions from throughout the manual. It is intended for review only and does not contain any steps which are immediate action nor does it contain explanatory matter associated with particular procedures.

18A.1 SYSTEM DESCRIPTIONS

18A.1.1 ENGINE SYSTEM

18A.1.1.1 Manual Fuel Control System

CAUTION

- Selecting manual fuel at high RPM may result in exceeding RPM or EGT limits.

- Starting the engine on the ground with manual fuel control is not permitted.

18A.1.1.2 Gas Turbine Starter

CAUTION

Minimum interval between each GTS start attempt is 3 minutes. After three consecutive GTS start attempts, a minimum interval of 30 minutes is required before further start attempts. Additional start attempts after an unsuccessful start are prohibited until the GTS exhaust duct, combustor section are inspected and any residual fuel is removed and the RAT doors are inspected for discoloration and warpage.

18A.1.1.3 Engine Starting Operation

WARNING

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

CAUTION

- 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.

- 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 N_1 compressor to rotate backward.

18A.1.2 AVIONICS SYSTEM

18A.1.2.1 Head-Up Display (HUD)

WARNING

The HUD shall not be used as a primary flight instrument.

18A.1.2.2 Airborne Data Recorder (ADR)

WARNING

The ADR is used to assist engine starting by dumping HYD 2 pump pressure to return line and reducing engine loads when N_2 is below 42 percent. An ADR failure may cause it to energize the HYD 2 pump bypass valve and reduce pump output pressure. The HYD 2 caution light illuminates if pressure drops below 1600 psi, and the RAT extends if pressure drops below 1500 PSI.

CAUTION

An ADR failure causes blanking of the following HUD/MFD display parameters:

HSI display	wind speed/direction
DATA display	wind speed/direction
ADI display	TAS, AOA, RALT
HUD nav modes	AOA, RALT
HUD A/A mode	aiming reticle
HUD A/G mode	CCIP marker, bomb fall line, breakaway cross, AOA, RALT
Engine page	N_2 RPM , FF, FQTY, N_1 RPM, TAT C, EPR, T6 C, HPC PRESS, and PLA

18A.1.3 HYDRAULIC SYSTEM

18A.1.3.1 Emergency Hydraulic System Description

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

18A.1.3.2 Emergency Hydraulic System Operation

CAUTION

Placing EMER FLAPS switch to the DOWN position when normal HYD 1 pressure is available will cause the hydraulic fluid to rapidly overheat, possibly causing a HYD 1 seal failure resulting in HYD 1 system failure.

18A.1.4 FLIGHT CONTROLS AND TRIM SYSTEMS

18A.1.4.1 Stabilator Trim

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.

18A.1.5 SPEED BRAKE SYSTEM

CAUTION

With a CONTR AUG caution light illuminated, SBI is not available and the speed brakes should not be used in close formation flight.

18A.1.6 LANDING GEAR SYSTEM

18A.1.6.1 Landing Gear System Emergency Operation

WARNING

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.

CAUTION

- With the main gear doors open, door damage may result from arresting gear strikes.
- In the event of an actual emergency gear extension, the normal landing gear handle should be placed in the DN position before pulling the EMERGEAR handle. When a safe gear indication is achieved the EMER GEAR handle should remain out and the aircraft should be landed as soon as practicable.

18A.1.7 NOSE WHEEL STEERING SYSTEM

CAUTION

- 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.

18A.1.8 WHEEL BRAKES/ANTI-SKID SYSTEM

CAUTION

- Release brakes prior to deselecting anti-skid to avoid locking brakes and blowing tires when normal brakes engage.

18A.1.8.1 Anti-Skid Operation

CAUTION

Failure of weight off wheels circuits will prevent anti-skid activation on touchdown, with no indication to the pilot and subsequent loss of brakes. Placing the ANTI-SKID switch to OFF will engage the normal (No Anti-Skid) brake system and restore braking authority.

18A.1.9 BOARDING SYSTEM

18A.1.9.1 Boarding System Operation

CAUTION

When entering or leaving the cockpit, do not grasp the canopy transparencies or use the forward glareshield as a handhold. In addition to the handholds provided, the canopy rail/windscreen frame may also be used as a handhold. Do not use the bottom lip of the engine left air intake as a step.

18A.1.10 CANOPY SYSTEM

18A.1.10.1 Canopy Operation

WARNING

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.

18A.1.10.2 Mild Detonating Cord

WARNING

- Actuation of the MDC inadvertently or through the ejection process with the helmet visor up could result in severe eye injury.
- Do not use the MDC firing handle or initiator cover as a handhold.

18A.1.11 EJECTION SEAT SYSTEM

18A.1.11.1 Safe/Armed Handle

WARNING

With one seat armed and one seat safe, the armed seat can initiate ejection of both seats.

CAUTION

Ensure the SAFE/ARMED handle is in the SAFE or ARMED position. It is possible for the handle to be positioned between the SAFE and ARMED positions.

18A.1.11.2 Command Ejection Selector

WARNING

In the FWD BOTH/AFT SELF mode, if the AFT crew member initiates ejection, followed be ejection initiation by the FWD seat, the FWD seat canopy will not automatically fracture prior to ejection. In this scenario, the MDC firing handle will function normally and should be used to fracture the FWD canopy prior to FWD seat ejection, if time permits.

18A.1.12 ENVIRONMENTAL CONTROL SYSTEM

18A.1.12.1 Manual Mode

CAUTION

- Extended operation in MANUAL mode with very cool temperature selected may result in freeze-up condition of the water separator coalescer and premature failure of the internal coalescer bypass relief valve.
- Extended operation in the MANUAL mode with WARM selected may cause excessive temperatures resulting in weakening or damage of the windscreen.

18A.1.13 ON-BOARD OXYGEN GENERATING SYSTEM

18A.1.13.1 OBOGS Operation

WARNING

Testing of the OBOGS above 9,000 feet shuts down the OBOGS system.

CAUTION

Should the OBOGS/ANTI-G switch return to the OFF position in-flight, for any unknown reason, do not attempt to reset more than once.

18A.1.14 BIT SYSTEM

18A.1.14.1 CONTR AUG BIT

WARNING

Initiating the CONTR AUG IBIT cycles the rudder and rudder tab. Ensure the YDS IBIT is complete prior to takeoff.

18A.1.15 MISCELLANEOUS EQUIPMENT

18A.1.15.1 External Baggage Container

CAUTION

To prevent damage to latches, the bottom latches should be unlocked first when opening the pod and the top latches should be secured first when closing the pod.

18A.2 SERVICING AND HANDLING

18A.2.1 REFUELING

WARNING

- Perform all fueling operations in a well ventilated area.
- Stop all maintenance on aircraft during fueling operations.
- Ensure adequate grounding of aircraft and fueling equipment.
- Ensure that no electrical or electronic equipment is operating in the area.
- Ensure that adequate fire fighting equipment is in the immediate area of the fueling operation.
- If fuel discharges from the fuel vent in the tail cone, stop fueling immediately.

18A.2.1.1 Pressure Refueling

CAUTION

If the XFR CLOSED light does not illuminate, discontinue refueling procedure; one or both transfer valves may be open, resulting in a fuel spill.

18A.2.1.2 Hot Refueling

CAUTION

- The aircraft shall not be hot refueled by the gravity fueling method.
- Due to the close proximity of the pressure refuel/defuel coupling to the left engine intake, ground crew shall remain clear and aft of engine intake during hot refueling operations.

- If the XFR CLOSED light does not illuminate, discontinue refueling procedure; one or both transfer valves may be energized open resulting in a fuel spill.

18A.2.2 HYDRAULIC SYSTEM SERVICING

18A.2.2.1 Reservoir Nitrogen Servicing

WARNING

Make sure that the nitrogen source pressure is not regulated above 150 psi. Over pressurization could result in hose rupture, personnel injury and equipment damage.

CAUTION

Over inflation damages the reservoir. The inflation pressure must only exceed the reservoir pressure by the minimum required for flow.

18A.3 OPERATING LIMITATIONS

18A.3.1 EXTERNAL STORES LIMITATIONS

WARNING

Only WTU-1/B and MK 67 warheads are authorized.

18A.4 SHORE-BASED PROCEDURES

18A.4.1 PREFLIGHT INSPECTION

18A.4.1.1 Exterior Inspection

WARNING

- 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 results 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.
- 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.

18A.4.2 ENTERING COCKPIT

18A.4.2.1 Cockpits

WARNING

- 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.
- If top latch mechanism does not meet outlined requirements, seat could rise up catapult guide rail during aircraft maneuvers.
- 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.

CAUTION

- 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.

- To prevent SEAWARS/trombone damage, do not adjust seat prior to securing the harness.

18A.4.2.2 In The Cockpit

WARNING

- 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. Refer to Figure 2-20, Leg Restraint System.

- Failure to route the restraint lines properly through the garters could cause serious injury during ejection/ emergency egress.

18A.4.3 INTERIOR CHECK

18A.4.3.1 Aft And Forward Cockpit

CAUTION

If MANUAL fuel is selected in either cockpit prior to engine start, the MANUAL FUEL advisory light will not be illuminated until the ENGINE switch is placed to START.

18A.4.4 PRESTART CHECKS

WARNING

- 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.

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

18A.4.5 STARTING THE ENGINE

WARNING

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

CAUTION

- 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.

- Advancing throttle to IDLE before ROTATION 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.

18A.4.6 POSTSTART

CAUTION

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.

18A.4.6.1 Plane Captain

WARNING

Ensure ground personnel are clear of aircraft before actuating flight controls, flaps/slats, speed brakes, arresting hook, and gear doors.

18A.4.7 TAXI

WARNING

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.

CAUTION

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

18A.4.8 TAKEOFF

CAUTION

- 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.

18A.4.9 DESCENT/PENETRATION

CAUTION

Sustained engine operation at less than 70 percent N_2 above 30,000 feet MSL may result in a sub-idle condition leading to engine flameout. If flameout occurs a normal airstart should be performed.

18A.4.10 LANDING

18A.4.10.1 Normal Field Landing

CAUTION

- Failure to retard the throttle from approach idle to idle after landing could result in hot brakes during subsequent ground operations.
- Improper braking and NWS technique may result in exaggerated PIO.

18A.4.10.2 Flaps/Slats Up Landing

CAUTION

Ensure maximum wheel speed is not exceeded at touchdown.

18A.4.11 AFTER LANDING (CLEAR RUNWAY)

18A.4.11.1 Engine Shutdown

WARNING

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

CAUTION

The engine should not be shut down from a high power setting except in an emergency condition.

18A.5 CARRIER-BASED PROCEDURES

18A.5.1 GENERAL

WARNING

Anti-skid shall be off for all carrier operations.

18A.5.2 HANGAR DECK OPERATION

WARNING

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

18A.5.3 POSTSTART

CAUTION

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

18A.5.4 TAXI

CAUTION

Whenever hot jet exhausts from other aircraft are directed toward the intake a potential for overtemp exists.

18A.5.5 BEFORE CATAPULT HOOK-UP

CAUTION

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.

18A.5.6 CATAPULT LAUNCH

WARNING

- 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.

- 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.

18A.5.7 WAVEOFF TECHNIQUE

WARNING

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.

CAUTION

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.

18A.6 SPECIAL PROCEDURES

18A.6.1 GUN BANNER TOW PROCEDURES

18A.6.1.1 Runway Hookup And Landing With A Banner

WARNING

- Ensure the short field arresting gear has been derigged.
- Banner crosswind limit is 10 knots.

CAUTION

- 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.

18A.7 FUNCTIONAL CHECK FLIGHT PROCEDURES

18A.7.1 15,000 FOOT CHECKS

CAUTION

- Minimum interval between each GTS start attempt is three minutes. After three consecutive GTS start attempts, a minimum interval of 30 minutes is required before any further start attempts. Additional start attempts after an unsuccessful start are prohibited until the GTS exhaust duct, combustor section are inspected and any residual fuel is removed and the RAT doors are inspected for discoloration and warpage.

CAUTION

- To prevent damage to the motor, do not reset generator during GTS start.

18A.7.2 5,000 FOOT CHECKS

CAUTION

Do not exceed 30 seconds with the EMER FLAP switch in the DN position.

18A.8 FLIGHT CHARACTERISTICS

18A.8.1 GENERAL FLIGHT CHARACTERISTICS

18A.8.1.1 High Speed Dive

CAUTION

A region of reduced longitudinal stability exists within the trim AOA band at approximately 0.87 true Mach 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.

18A.8.1A TAKEOFF AND LANDING CHARACTERISTICS

18A.8.1A.1 Landing With Blown Main Tire(s)

WARNING

- Rudder inputs to counter swerve should be applied without brake application. Since the anti-skid system is off, any brake application at high speed increases the likelihood of a blown main tire.

- Consider pilot proficiency and ability to control the swerve before attempting the rollout. If it is determined that the pilot is unable to control the aircraft on rollout, consideration should be given to a gear-up landing or controlled ejection.

- Simulations with two blown main tires show that the aircraft becomes uncontrollable below approximately 80 KIAS.

18A.8.2 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.

18A.8.3 SPINS

18A.8.3.1 Inverted Spins

WARNING

Releasing pedal force prior to recovery may allow rudder blowout in the pro-spin direction and significantly delay recovery to below 10,000 feet.

18A.8.4 FLYING CHARACTERISTICS OF THE EMERGENCY HYDRAULIC SYSTEM

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

18A.8.5 ENGINE STALL AND FLAMEOUT

18A.8.5.1 Engine Stall

CAUTION

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.

18A.8.5.2 Compressor Stall Characteristics

CAUTION

- In the event of an engine surge, immediate action should be taken to simultaneously retard the throttle to IDLE and neutralize the controls to reduce the possibility of engine over temperature.

- Advancing the throttle while the engine is in a surged condition causes the engine to rapidly exceed over temperature conditions.

18A.8.6 ENGINE AIRSTART OPERATIONS

CAUTION

- By design, the throttle cannot be retarded from midthrust setting positions to APPROACH IDLE or IDLE with the finger lifts raised. To bypass the APPROACH IDLE stop or shut down the engine, the finger lifts should not be raised until the throttle is positioned against the APPROACH IDLE stop or IDLE stop.

- When positioning the throttle from OFF to IDLE during a start, the finger lifts should not be raised. Raising the finger lifts while positioning the throttle from OFF to IDLE may result in the throttle being positioned above IDLE during the start.

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

18A.9 GENERAL EMERGENCIES

18A.9.1 WARNING LIGHTS

18A.9.1.1 Fire

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT-only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

18A.9.1.2 Hyd Fail

WARNING

Sustained high-frequency, high amplitude control inputs during flight with RAT-only hydraulic pressure could result in loss of aircraft control. Ejection outside the safe ejection envelope may occur if control is lost during a landing attempt.

18A.10 GROUND EMERGENCIES

18A.10.1 EMERGENCY EGRESS

WARNING

- Do not eject unless the canopy is fully closed.
- Before pulling the handle, lower the helmet visor, close the eyes and keep the hands and body as far away as possible from the MDC pattern on the canopy.
- For water egress, pull the emergency oxygen actuator and do not disconnect the oxygen/communication hose. Inflate LPU after exiting the aircraft.

18A.11 TAKEOFF EMERGENCIES

18A.11.1 ABORT

CAUTION

Braking during CDP engagement may raise the hook point sufficiently to miss the arresting gear.

18A.11.2 BLOWN TIRE DURING TAKEOFF

WARNING

- Rudder pedal forces as high as 180 pounds may be required to successfully counter the swerve. Failure to counter the swerve may result in the aircraft departing the prepared runway surface.
- Without anti-skid protection, judicious brake application is required to avoid blowing the remaining tire. If the other tire blows, simulations show the aircraft becomes uncontrollable below approximately 80 KIAS.
- Rudder pedal forces as high as 180 pounds may be required to successfully counter the swerve. Failure to counter the swerve may result in the aircraft departing the prepared runway surface.

CAUTION

Retraction of gear or flaps may cause additional damage to flaps, gear doors, or wheel well area.

18A.11.3 BLOWN TIRE DURING CATAPULT LAUNCH

CAUTION

Retraction of gear or flaps may cause additional damage to flaps, gear doors, or wheel well area.

18A.12 IN-FLIGHT EMERGENCIES

18A.12.1 AIRSTART PROCEDURES

18A.12.1.1 Immediate Airstart (Any Airspeed/Any Altitude), Windmill Airstart, And Assisted Airstart

WARNING

- To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.
- Engine starts with the throttle above the ground idle position may cause engine surge/over-temperature.

18A.12.2 ENGINE STALL/EGT/RPM MALFUNCTIONS

CAUTION

If EGT is greater than 745 °C, engine damage may occur.

18A.12.3 ELECTRICAL FIRE

CAUTION

- Directional control characteristics are degraded due to forward NLG doors being open.

CAUTION

- Careful modulation of the engine is required since the ECA is inoperative. Refer to the ECA Caution Light Procedures.

18A.12.4 FOGGING OF WINDSCREEN/FOG IN CREW STATION

CAUTION

Avoid maximum temperature operation for extended periods of time. Automatic temperature control limits are inoperative in MANUAL mode and damage to the aircraft may occur.

18A.12.5 TOTAL ELECTRICAL FAILURE

CAUTION

- Directional control characteristics are degraded due to forward NLG doors being open.
- Careful modulation of engine is required since the ECA is inoperative. Refer to ECA Caution Light Procedures.

18A.12.6 DEPARTURE/SPIN PROCEDURE

WARNING

- To prevent loss of situational awareness and aircraft control, ensure the aircraft is recovered/upright and you have switched your instrument scan to the standby instruments before initiating a GTS start.
- Releasing pedal force prior to recovery may allow the rudder to blow out in the prospin direction and delay recovery to below 10,000 feet.

18A.12.7 MFD MALFUNCTION

CAUTION

Turn off malfunctioning displays as they may overheat and cause a fire if not functioning correctly.

18A.13 LANDING EMERGENCIES

18A.13.1 FLAPS FAILURE

WARNING

The aircraft exhibits no natural stall warning during the approach to stall. Stall warning rudder pedal shakers come on at 21.5 units AOA, closely followed by the stall at 23-25 units AOA.

18A.13.2 LANDING GEAR UNSAFE/FAIL TO EXTEND

CAUTION

Nose wheel steering is inoperative.

18A.13.3 LANDING WITH NOSE WHEEL STEERING FAILURE

WARNING

Inoperative nosewheel steering may be caused by a steering system failure or a weight on wheels switch failure. A system failure airborne should be indicated by a NWS caution light. On deck it may only be indicated by a lack of NWS control without a corresponding caution light. Inoperative NWS caused by a weight on wheels switch failure may be indicated by continuous illumination of the AOA indexers on deck.

18A.13.3A SWERVE ON TOUCHDOWN

WARNING

Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.

18A.13.3B LANDING WITH BLOWN TIRE(S)

WARNING

- Landing with two blown main tires shall be done with a fly-in arrestment. Simulation tests showed directional control was available down to approximately 80 KIAS, after which oscillations became uncontrollable. A bolter should be followed by an immediate go-around. If a fly-in arrestment is not available, pilots shall consider the likelihood of departing the prepared surface during an attempted landing. Environmental conditions such as crosswind, runway condition, slope, terrain and obstructions surrounding the prepared surface and number of crewmembers aboard should be taken into account.

- Consider pilot proficiency and ability to control the swerve before attempting the rollout. If it is determined that the pilot is unable to control the aircraft on rollout, consideration should be given to a gear-up landing or controlled ejection.

- Landing with a crosswind component of greater than 5 knots on the side corresponding to the blown tire is extremely hazardous due to loss of directional control below approximately 60 KIAS. Offset to land on the good tire side of the longest and widest runway available to allow for the swerve upon touchdown.

- Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.

- Without anti-skid protection, judicious brake application is required to avoid blowing the remaining tire. If the other tire blows, simulation shows the aircraft becomes uncontrollable below approximately 80 KIAS.

- If the aircraft begins to depart the runway, consideration should be given to speed, obstructions and terrain when deciding to stay with the aircraft or eject.

- Rudder pedal forces may be as high as 180 pounds and must be applied within 0.25 sec after touchdown to successfully counter the swerve. Failure to counter the swerve may result in departing the lateral confines of the landing area.

CAUTION

Repositioning the flaps is recommended only after a visual inspection confirms that the flaps have not been damaged.

18A.13.4 WHEEL BRAKE FAILURE ON LANDING

CAUTION

Failure to release brake pressure in both cockpits may result in a locked brake condition while switching from anti-skid to normal brakes.

18A.13.5 FLAMEOUT APPROACH

CAUTION

Nose wheel steering is inoperative.

18A.13.6 STUCK THROTTLE APPROACH

CAUTION

Over rotation while attempting to set or maintain landing attitude may cause the aircraft to become airborne and result in subsequent in-flight engagement.

18A.13.6.1 Overhead Stuck Throttle and Straight-in Stuck Throttle

CAUTION

Nosewheel steering is inoperative during landing rollout after engine flameout.

18A.13.7 FIELD ARRESTMENT

CAUTION

An engagement in the wrong direction into chain gear severely damages the aircraft.

18A.13.7.1 Short Field Arrestment

WARNING

- Rudder pedal forces may be as high as 180 pounds to successfully counter the swerve. Failure to counter the swerve may result in departing the prepared runway surface.
- Failure to immediately rotate the aircraft following a hook skip/bolter increases time on deck, which may allow excessive yaw rates to develop and result in an unrecoverable condition.

CAUTION

Failure to maintain a proper landing attitude or applying brake pressure while crossing the arresting gear greatly reduces the chances of a successful arrestment.

18A.13.8 FIELD ARRESTING GEAR DATA

CAUTION

After engagement into E-28 or BAK-13 arresting gear systems, when aircraft speed has been reduced to approximately 20 KIAS, braking should be applied to stop the forward motion of the aircraft. This will prevent an aircraft with idle power from slowly pulling the gear through to a two-block position, and will more quickly allow the runway to be cleared for other aircraft operations. However, in the event of a two-block into any system except E-5, engine thrust should judiciously be applied during walkback. Some walkback is necessary to clear the deck pendant from the arresting hook; however, the application of excessive power in controlling walkback increases the possibility of deck pendant hang-up in the arresting hook point.

18A.13.9 DITCHING

WARNING

The aircraft should be ditched only when ejection has failed.

18A.14 EJECTION

18A.14.1 GENERAL

WARNING

- During ejection seat development and testing, the SJU-17(V) 5/A and SJU-17(V) 6/A were qualified for use by aviators with nude weights from 136 lbs. to 213 lbs. Operation of the seat by personnel not within these parameters subjects the occupant to increased risk of injury.
- Never actuate the emergency restraint release before ejection. Actuation of the handle releases the pilot from the seat and moves the SAFE/ARMED handle to the SAFE position, making ejection initiation by the seat occupant impossible. Further, if ejection is then initiated by the other cockpit, both seats will be ejected with probable fatal results.
- Ejection with canopy in any position other than fully closed and locked is not recommended. Serious bodily injury and seat malfunction may occur.
- Severe head/neck injury may occur if ejection is initiated with aircrew head above ejection seat canopy breakers and ejection occurs in the Backup Mode (through canopy).
- If the seat becomes unlocked from the catapult and slides partially up the rails or completely out of the cockpit, ejection and/or chute deployment is still possible, but the ejection handle must be pulled followed by activation of the manual override handle. Under these circumstances low altitude ejection capabilities are compromised.

18A.14.2 EJECTION PROCEDURES

WARNING

There is no manual bailout capability with this ejection seat.

18A.14.2.1 Controlled Ejection

WARNING

- In the FWD BOTH/AFT SELF mode, if the AFT crew member initiates ejection, followed be ejection initiation by the FWD seat, the FWD seat canopy will not automatically fracture prior to ejection. In this scenario, the MDC firing handle will function normally and should be used to fracture the FWD canopy prior to FWD seat ejection if time permits.
- Automatic command ejection sequencing is impossible with the selector in the SOLO position. If ejection is simultaneously initiated in this mode, the seats may collide.

18A.14.2.2 High Altitude Sequence (Above 18,000 Feet)

WARNING

The sequencer mechanism operates as a function of altitude above mean sea level. If ejecting over high altitude terrain, it may be necessary to pull the emergency restraint release to obtain early seat/man separation and adequate altitude for the parachute to open.

18A.15 EXTREME WEATHER OPERATION

18A.15.1 COLD WEATHER OPERATIONS

WARNING

The collection of ice, snow, and frost on the aircraft surfaces constitutes one of the major flight hazards in low temperature operation and can result in loss of lift and adverse stalling characteristics.

18A.15.1.1 Before Entering The Aircraft

CAUTION

- Do not permit the ground crew to scrape or chip ice from aircraft surfaces, as damage to the aircraft skin will result.
- Check that water from ice removal operations does not refreeze, particularly on the control hinges.

18A.15.1.2 Starting And Warmup Ground Check

CAUTION

In icing conditions, engine ground running should be kept to a minimum. Icing may occur when the ambient temperature is +42 °F (+6 °C) or less and relative humidity is 50 percent or more.

18A.15.1.3 Before Takeoff

WARNING

Do not take off with a frosted windshield, or with frost, snow, or ice on the wings or control surfaces.

CAUTION

Pitot heat should not be left ON, as prolonged ground operation without cooling airflow can damage the heating element.

18A.15.1.4 Descent/Landing

WARNING

Ice present on wing surfaces may significantly increase stalling airspeed. Approach airspeed should be held above optimum if ice is detected. Consider an arrested landing if higher than normal approach airspeed is utilized.

18A.15.2 HYDROPLANING

18A.15.2.1 Landing On Wet Runway

CAUTION

- Painted areas on runways, taxiways, and ramps are significantly more slippery than unpainted areas.
- When conditions of snow or ice exist, approach ends of runways are usually more slippery than any other areas due to the melting and refreezing of ice and snow at this location.

18A.16 COMMUNICATIONS - NAVIGATION EQUIPMENT AND PROCEDURES

18A.16.1 NAVIGATION

18A.16.1.1 GINA Failure

WARNING

GINA mis-compare logic remains active only when in HYBD mode and receiving 4 satellites. When operating in INS or GPS modes, the mis-compare logic is not activated which could eventually cause incorrect aircraft attitude, velocity, and position information to be displayed.

18A.16.1.2 Waypoint CDI Steering and Waypoint Offset CDI Steering

WARNING

The course deviation line may suddenly jump from centered to a large deviation as the landing gear extends. The jump is due to the transition from normal mode to the approach mode and the resulting change in course deviation sensitivity, not to a sudden change in aircraft attitude.

18A.17 ARMAMENT SYSTEM

18A.17.1 ARMAMENT SYSTEM CONTROLS AND INDICATORS

18A.17.1.1 Gunsight

CAUTION

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.

18A.17.2 SUSPENSION EQUIPMENT/EXTERNAL STORES

18A.17.2.1 LAU-68 Series Aircraft Rocket Launcher

WARNING

Mixing of rocket motors is prohibited.

18A.17.2.2 T-45 Delivery Data Tables - Bombs and Rockets

WARNING

Releases below the altitudes provided in the delivery data tables for 2.75-inch rockets are prohibited due to rocket motor, warhead and case debris and their ricochet potential.

PART VI

ALL-WEATHER OPERATION

Chapter 19 - Instrument Procedures

Chapter 20 - Extreme Weather Operation

CHAPTER 19

Instrument Procedures

19.1 INSTRUMENT FLIGHT PROCEDURES

This section presents certain characteristics and limitations of the aircraft during instrument flight conditions as a supplement to previous training and experience. Successful completion of a mission under instrument flight conditions requires careful planning, instrument proficiency on the part of the pilot, and adequate instrumentation for climb out, cruise, and approach.

19.2 INSTRUMENT TAKEOFF

19.2.1 Prior to Takeoff.

1. Check all communications and navigation equipment for correct operation.
2. Set navigation equipment to local station.
3. Check cockpit lighting, if necessary, and set as low as possible in order to retain night vision. Adjust the kneeboard lights for use in reading approach plates, charts, knee board cards, etc.
4. Standby airspeed indicator - CHECK
5. Standby VSI - ZERO (Note error if not zero).
6. Standby barometric altimeter - Set to field barometric pressure. Ensure error not more than ±75 feet.
7. Standby attitude indicator - ADJUST
8. HUD, HSI, ADI heading indications - COMPARE WITH STANDBY INSTRUMENTS
9. Clock - SET AND RUNNING
10. Standby compass - SWINGS FREELY, FLUID FULL.
11. HUD, HSI, ADI heading indications - CHECK FOR PROPER OPERATION WHILE TAXIING.
12. Turn needle and slip indicator - Check for proper functioning in a turn.
13. Normal checklists - COMPLETE

19.2.2 Takeoff. When in takeoff position and lined up with the runway:

1. HSI/ADI/HUD and standby compass - ALIGNED WITH RUNWAY
2. ADI display - CHECK FOR CORRECT INDICATIONS
3. IFF - NORMAL
4. PITOT HEAT - CHECK ON
5. Advance throttle to MRT, release brakes, maintain directional control with nose wheel steering.
6. At 5 KIAS below lift-off speed, rotate the nose to 10 to 12 degrees on the ADI.
7. When the vertical speed indicator and altimeter indicate that a positive climb has been established, and at a minimum of 100 feet AGL, raise the gear and maintain a positive rate of climb.
8. When safely airborne and at an airspeed of 140 KIAS, wings level, raise the flaps/slats.
9. As the flaps/slats are retracted, it is necessary to raise the nose an additional 1 or 2 degrees to counteract the sinking effect.

19.3 INSTRUMENT PENETRATION

A penetration is a maneuver that combines a high rate of descent with a constant airspeed and maintains the aircraft within a specified airspace. It is designed to minimize fuel consumption and the effects of turbulence, icing, and

wind, and serves to place the aircraft in position for a landing. Prior to commencing a penetration, refer to the Descent/Penetration Procedures in Chapter 7.

19.3.1 Clean Penetration. The clean penetration is conducted at 250 KIAS, speed brakes extended, 4,000 to 6,000 fpm rate of descent, and power as required.

In the event of low fuel state, a penetration can be accomplished utilizing idle RPM and speed brakes retracted, maintaining 250 KIAS and 1,500 to 2,000 fpm rate of descent. Prior to descent, place AIR FLOW knob to MAX DEFOG (if required) to minimize the possibility of windscreen fogging.

The penetration descent should be broken when required by the approach but normally no later than 5,000 feet AGL. Break the rate of descent by taking out one-half the nose down attitude and adjusting power and speed brakes as needed to maintain the desired airspeed. Be careful not to break the minute to live rule. When 10 percent of the rate of descent above the level-off altitude, begin adjusting the nose attitude to effect a smooth level off. Gear and flaps/slats should be lowered (200 KIAS maximum) prior to the final approach fix in order to reach the fix in the landing configuration at the desired approach speed.

19.3.2 Dirty Penetration. The "dirty" penetration is performed at 150 KIAS, gear down, flaps/slats full, (or as desired if in section), speed brakes extended, and a rate of descent of 3,000 to 5,000 fpm. Break the rate of descent at 5,000 feet AGL, or as required for the approach. Maintain 150 KIAS. Transition to level off at approximately 1,000 feet prior to desired altitude.

19.4 INSTRUMENT APPROACHES

See Figures 19-1 thru 19-4 for typical TACAN, VOR, ILS, and radar approaches.

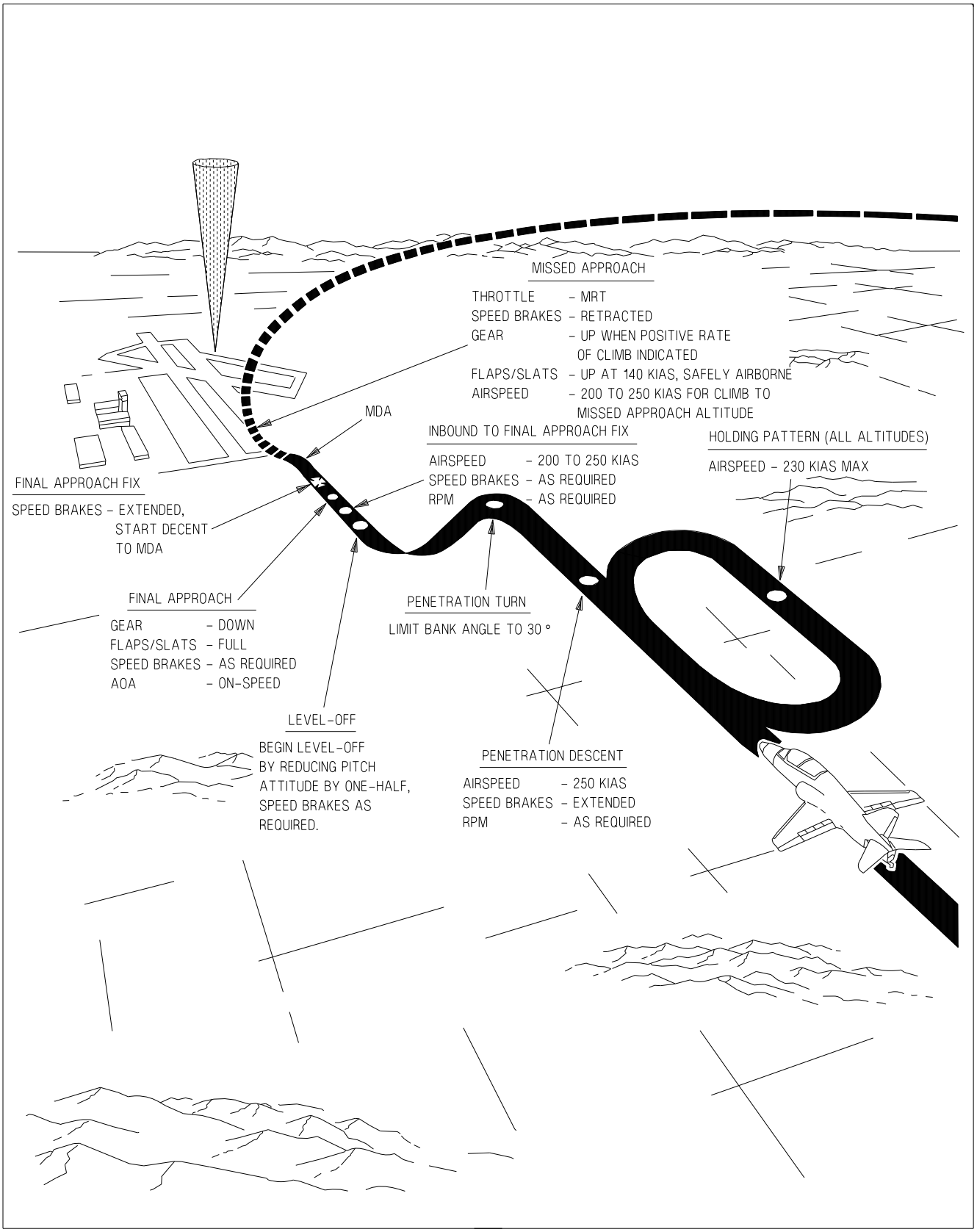

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Figure 19-1. TACAN Holding, Penetration and Approach (Typical)

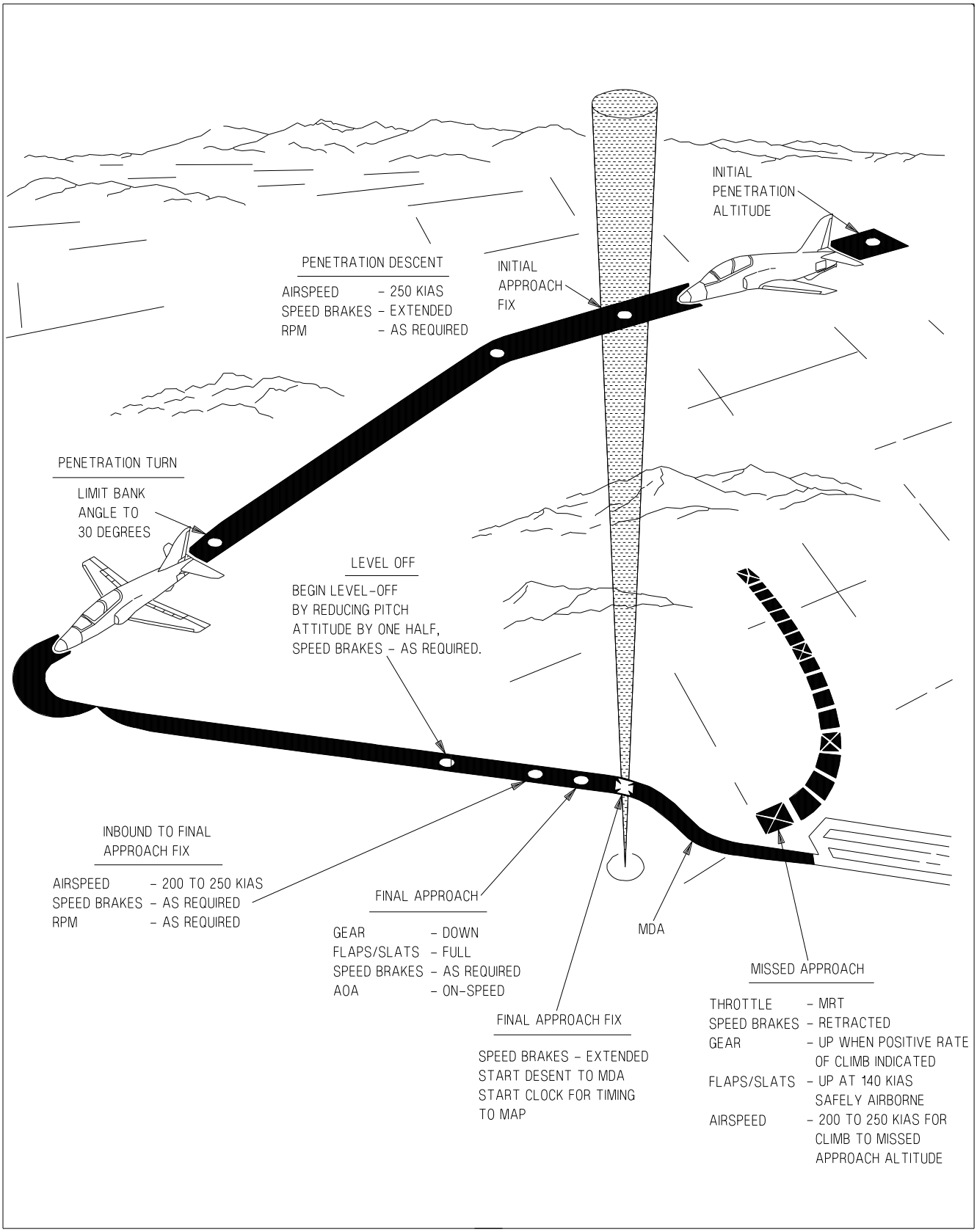

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Figure 19-2. VOR Penetration and Approach (Typical)

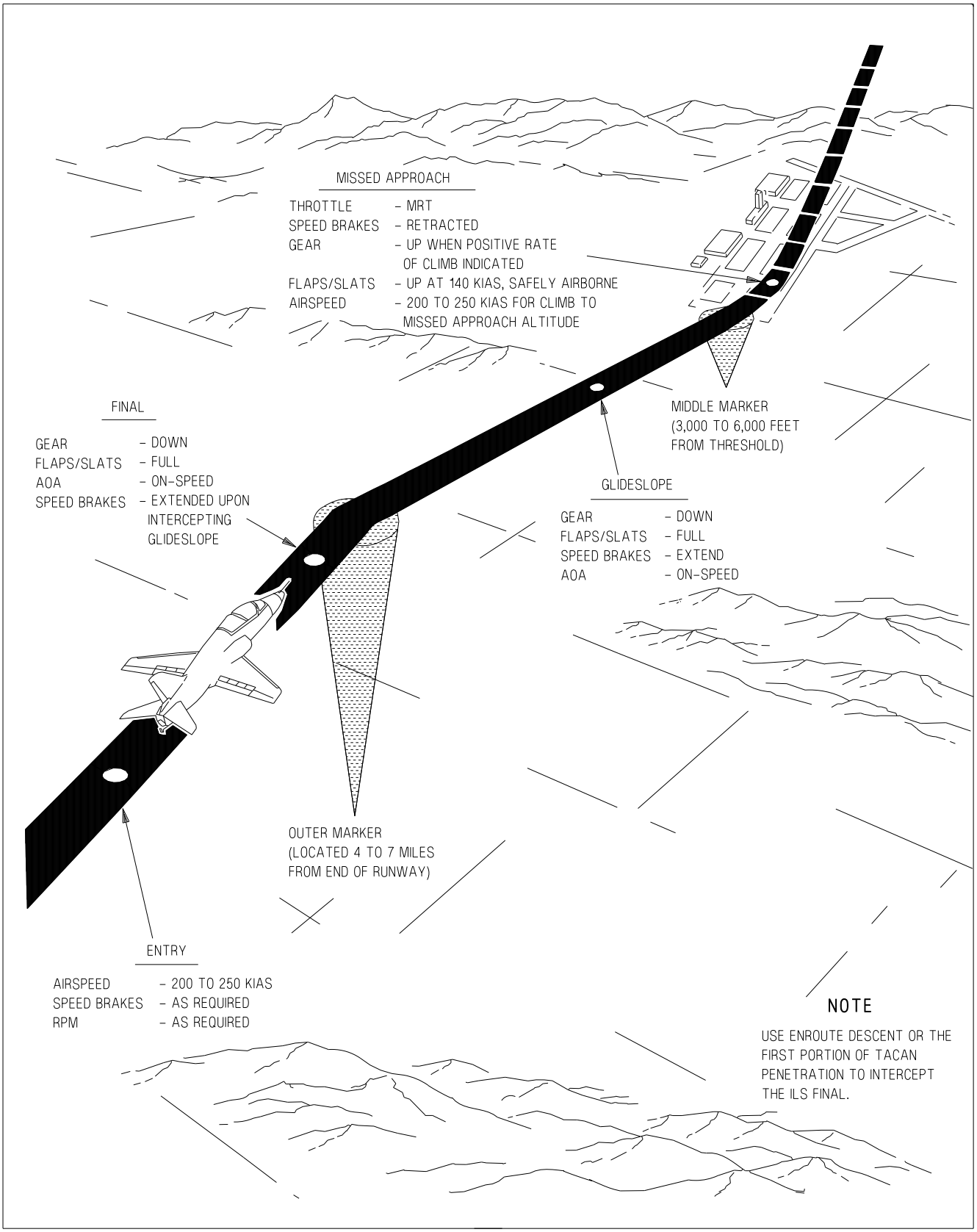

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Figure 19-3. ILS Approach (Typical)

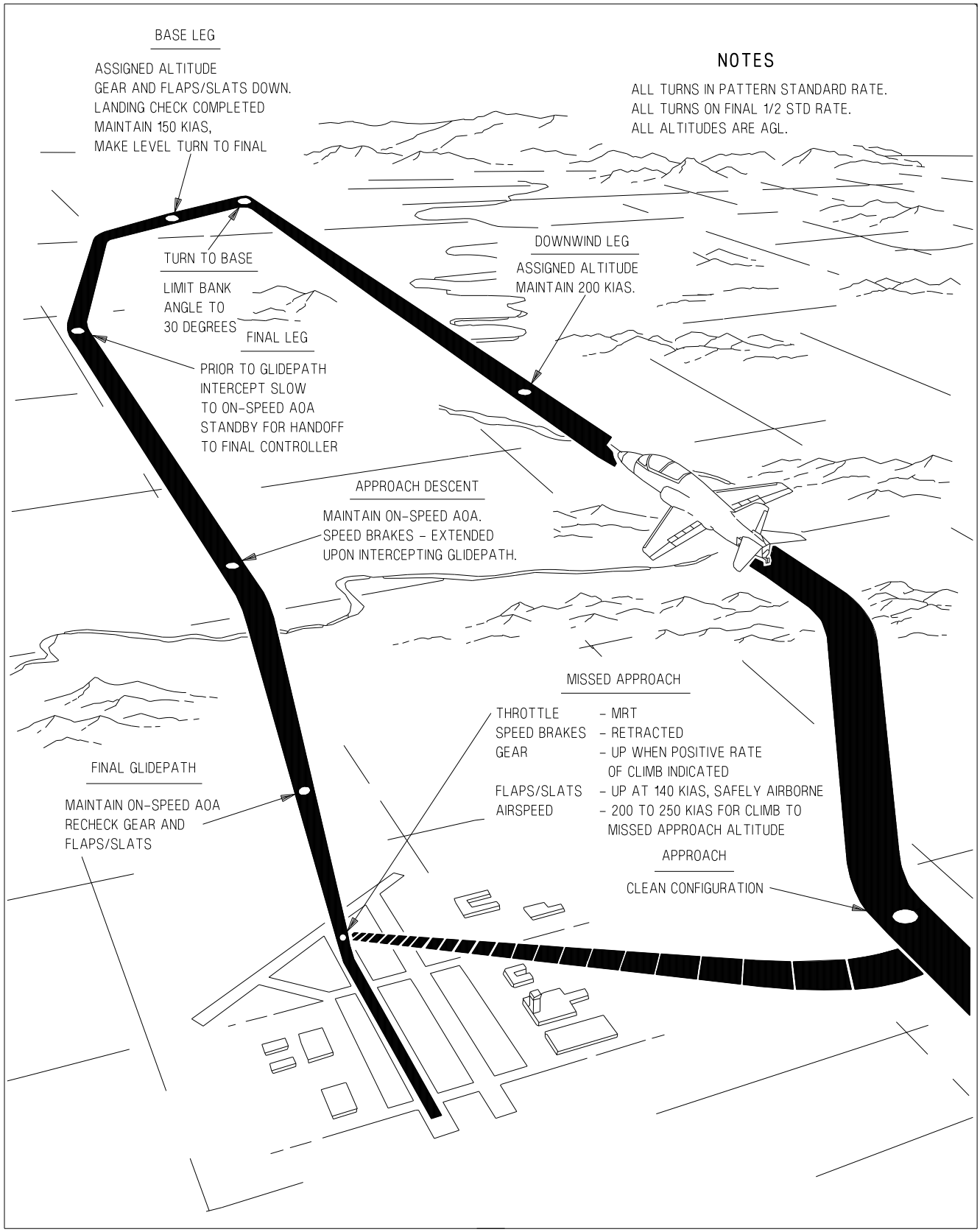

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Figure 19-4. Ground-Controlled Approach (Typical)

CHAPTER 20

Extreme Weather Operation

20.1 ICE, RAIN AND SNOW

Precipitation can create flight hazards when the temperature borders on freezing. A thorough preflight inspection just prior to takeoff is essential. Frost can form on the wing surface in a very short time, making takeoff hazardous. Wet snow, if allowed to accumulate while the aircraft is on the ground, may freeze while the aircraft is gaining altitude and seriously reduce airspeed and range for an indefinite period. Takeoffs should never be attempted when frost, ice, or patches of wet snow adhere to the surfaces.

Aircraft icing creates many hazards to the safe operation of aircraft. Ice on the airframe can alter or destroy the effectiveness of airfoils, load an aircraft beyond its weight carrying ability, reduce the effectiveness of communication antennas, create serious cockpit visibility problems, and introduce large errors in air pressure actuated flight instruments. Structural icing occurs only in clouds or precipitation. Engine icing can occur in clear air as well as in the clouds. Under certain conditions, it can reduce the available power output of the engine, or result in engine failure. (For a complete description of aircraft icing, see Chapter 5 of the NATOPS Instrument Flight Manual.)

If icing occurs, a loss of airspeed can be expected. Decreased engine RPM and increased EGT are indications of engine icing; but if RPM remains constant with rising EGT, it is likely caused by ice on the air intake ducts. If icing is encountered, immediate action must be taken to leave icing conditions by changing altitude and/or course.

The T-45C has no anti-ice capability for either the airframe or canopy. Bleed air is constantly ducted from the compressor section to provide heat for engine anti-icing whenever the engine is running. The aircraft is equipped with a pitot heater which is activated by a cockpit switch, and an AOA probe heater that is energized whenever weight is off wheels.

Snow or fog may occur in the cockpits when humid air is cooled. This usually occurs during takeoffs and landings. Visible moisture in front of the pilot may be so thick as to obscure the entire instrument panel. The AIR FLOW knob should be placed to MAX DEFOG and the CABIN TEMP knob to WARM (to be readjusted later to a more comfortable temperature).

During flight through heavy rain there may be a loss of thrust of up to 15 percent. This will be indicated by a reduction of N_2 and fuel flow. The engine parameters will return to normal and the thrust restored upon leaving the heavy rain condition.

20.2 COLD WEATHER OPERATIONS

Low temperatures will be encountered in all regions at high flight altitudes. However, most cold weather difficulties exist on the deck or airfield. Safety of flight depends on thorough preparation and careful observation of weather by the pilot. Equally important are preflight inspections which lessen the hazards of cold weather when the aircraft is exposed to ice, snow, and frost while on the ground.

WARNING

The collection of ice, snow, and frost on the aircraft surfaces constitutes one of the major flight hazards in low temperature operation and can result in loss of lift and adverse stalling characteristics.

20.2.1 Before Entering The Aircraft. A thorough check of the following items should be made by the pilot before entering the cockpit:

1. Visually check engine intakes for evidence of ice.

2. Check fuel drains, fuel lines, and shutoff valves for frozen condensation.

3. Remove all ice from fuel tank vents, static air sources, and pitot tube.

4. Remove dirt and ice from shock struts. Inspect switches, door hinges, actuating cylinders, and wheels.

5. Check control surfaces and hinges.

6. Check that the entire aircraft is free of ice, snow, and frost. Remove ice carefully by approved methods and remove snow or frost by light brushing.

- Do not permit the ground crew to scrape or chip ice from aircraft surfaces, as damage to the aircraft skin will result.

- Check that water from ice removal operations does not refreeze, particularly on the control hinges.

7. Make sure that wheels are chocked securely to prevent slippage.

20.2.2 Entering The Aircraft. The canopy seal should be inspected to ensure that no ice has accumulated to prevent proper sealing.

20.2.3 Starting and Warmup Ground Check.

In icing conditions, engine ground running should be kept to a minimum. Icing may occur when the ambient temperature is +42 °F (+6 °C) or less and relative humidity is 50 percent or more.

NOTE

- When FOD screens are installed and conditions are favorable for ice formation, continuous monitoring of screens for ice buildup is recommended; if ice forms, reduce engine power to idle until ice clears.

- At temperatures below -15 °F (-26 °C), the flight controls should not be cycled for a minimum of 5 minutes after engine start to allow the hydraulic fluid to warm. The controls should then be cycled in small circular motions to slowly warm the actuators. This minimizes damage to actuator seals thus preventing hydraulic leaks.

- The OBOGS monitor may require 10 minutes of warm up time before a satisfactory OBOGS BIT can be accomplished. Placing the OBOGS/ANTI-G switch to ON turns on the electric heaters in the concentrator and monitor.

1. Check all flight controls, both visually and by feel, for unrestricted movement.

2. Run through a complete cycle with rudder trim, stabilator trim, aileron trim, speed brakes, and flaps/slats, several times, to ensure correct operation.

3. Make sure all instruments have been sufficiently warmed up to ensure normal operation. Check for sluggish instrument indicator movement during taxiing.

4. Cockpit temperature as desired.

5. Use caution while running the engine up on slippery surfaces.

20.2.4 Taxiing.

1. If it is necessary to taxi on ice or snow, allow a greater distance for stopping. Skidding may occur with temporary loss of control when sharp turns are made or when a crosswind exists. Taxiing in deep snow is difficult and may also cause freezing of brakes and gear after takeoff.

2. Avoid taxiing through melted snow or slush to prevent accumulation of ice on the aircraft surfaces.

3. Use caution when taxiing in the vicinity of other aircraft. Increase the space between aircraft to ensure safe stopping distance.

20.2.5 Before Takeoff.

1. Turn cockpit temperature to WARM temporarily to ensure minimum fogging and frosting.

WARNING

Do not take off with a frosted windshield, or with frost, snow, or ice on the wings or control surfaces.

2. Place the PITOT HEAT switch ON just prior to takeoff.

CAUTION

Pitot heat should not be left ON, as prolonged ground operation without cooling airflow can damage the heating element.

3. If surface of runway is too slippery for engine runup, the power check should be made during early part of the takeoff ground roll.

20.2.6 Takeoff.

1. When starting the takeoff run, advance the throttle to MRT and check engine instruments.

2. After takeoff from snow or slush covered runways, the gear and flaps/slats should remain down for 1 minute to clear accumulated snow and slush. This prevents possible freezing in the up position. Expect slower operation of the landing gear in cold weather.

3. Check instruments. At extremely low temperatures, allow instruments sufficient time to warm up to ensure reliable operation.

20.2.7 During Flight. The flight characteristics of the aircraft are not affected by cold weather.

20.2.8 Descent/Landing.

1. Should canopy frosting, fog or snow in the cockpit occur, increase the temperature.

2. A carrier-type approach is recommended for landing on wet and icy runways. This uses the maximum runway available, requires a minimum of braking, and allows landing at the lowest airspeed.

WARNING

Ice present on wing surfaces may significantly increase stalling airspeed. Approach airspeed should be held above optimum if ice is detected. Consider an arrested landing if higher than normal approach airspeed is utilized.

3. When landing on snow, wet, or ice covered runways, be careful to avoid drift which will cause skidding and consequent loss of directional control. Maintain a straight course down the runway applying brakes evenly and lightly. The best approach to a landing on a wet and icy runway is a carrier type approach, with touchdown as close to the approach end of the runway as possible. After touchdown, if crosswinds are not a factor, leave flaps/slats down for increased drag and shortened roll out. If anti-skid

brakes are not available, apply steady pressure to the brakes. Should skidding occur, immediately release the brakes and then reapply steady pressure. See Chapter 7 for thorough discussion of landing procedures.

20.2.9 Shutdown and Postflight.

1. Use normal shutdown procedures.
2. Check that wheels are chocked securely.
3. During servicing, ensure trapped water is removed from fuel low point drains. Every effort should be made during servicing to prevent moisture from entering fuel system.
4. Have covers and plugs installed when aircraft is tied down outside.

20.3 TURBULENCE AND THUNDERSTORMS

Flight through known areas of thunderstorm activity or severe turbulence should not be conducted.

20.3.1 Turbulence. The key to flying in turbulent air is to fly attitude. An airspeed of 250 KIAS should be maintained.

20.3.2 Thunderstorms. If a storm area covers a wide front, it is usually advisable to fly above the weather to avoid heavy icing and hail damage to the aircraft. However, do not attempt to top a storm by sacrificing airspeed. A thunderstorm penetration airspeed of 250 KIAS is recommended. Vertical air currents in well developed thunderstorms sometimes alter the aircraft altitude several thousand feet, and airspeed fluctuates considerably. Rather than attempt to fly at a constant altitude, the pilot should maintain the initial flight attitude commensurate with a safe airspeed, keep a constant throttle setting, and use light stick forces to fly the ADI display indicator. Abrupt pitch corrections should be avoided. Chasing the Mach-airspeed indications should be avoided because the readings are unreliable during pressure changes within the storm cell and airspeed has been known to go to zero during thunderstorm penetration. Flying by pitch attitude reference should keep the airspeed and altitude relatively constant regardless of pitot-static instrument indications.

20.3.3 Approaching the Storm. Preparation before entering the storm may be generalized into four basic steps. The first letter of each step spells HALT: Heat, Airspeed/attitude, Light, and Tight.

1. HEAT
   a. PITOT HEAT switch - CHECK ON
2. AIRSPEED/ATTITUDE
   a. Maintain airspeed of 250 KIAS and set throttle friction.
   b. Establish an instrument scan, and stabilize airspeed and attitude prior to penetrating the storm.
   c. Fly on a heading which provides the quickest passage through the storm and at an altitude affording the least turbulence and icing.
   d. Avoid the upper 2/3 of a mature cell (turbulence and hail) and freezing level ±2,000 feet (lightning).
3. LIGHT
   a. Turn all cockpit lights on BRIGHT including floodlights.
4. TIGHT
   a. Lower the seat to prevent striking the head against the canopy and to reduce the blinding effect of lightning.
   b. Tighten lap belts.
   c. Lock shoulder harness.

20.3.4 In the Storm. Once inside the storm, the problem becomes one of holding attitude and heading. Do not chase the altimeter or the airspeed. The primary instrument is the ADI display. All control movements should be small and the tendency to correct for every motion of the

aircraft should be avoided. Maintain wings level and use as little stabilator control as possible. Maintain the initial heading through the storm, correcting any deviation from the flight plan after emerging from the weather. Devote all attention to flying the aircraft. Expect turbulence, precipitation, and lightning.

20.4 HYDROPLANING

Operations on wet or flooded runways may produce four conditions under which tire traction may be reduced:

- Dynamic hydroplaning
- Viscous hydroplaning
- Combined viscous and dynamic hydroplaning
- Reverted rubber skids

20.4.1 Landing On Wet Runway. If anti-skid braking is not available, landing ground roll distances are significantly increased on a wet or slippery runway. After the nose wheel is lowered, the wheel brakes should be applied carefully to avoid locking the brakes. Hydroplaning and/or tire skidding on a wet or icy runway increases stopping distance and can easily result in loss of directional control. The nose wheel steering may be relatively ineffective. An arrested landing should be considered if the arresting gear is available.

- Painted areas on runways, taxiways, and ramps are significantly more slippery than unpainted areas.
- When conditions of snow or ice exist, approach ends of runways are usually more slippery than any other areas due to the melting and refreezing of ice and snow at this location.

20.5 HOT WEATHER AND DESERT OPERATIONS

Operation of the aircraft in hot weather and in the desert requires that precautions be taken to protect the aircraft from damage caused by high temperatures, dust, and sand. Care should be taken to prevent the entrance of sand into aircraft parts and systems such as the engine, fuel system, pitot static system, etc. All filters should be checked more frequently than under normal conditions. Plastic and rubber segments of the aircraft should be protected both from high temperatures and blowing sand. Canopy covers should be left off to prevent sand from accumulating between the cover and the canopy and acting as an abrasive on the canopy. Desert and hot weather operation require that in addition to normal procedures, the following precautions be observed.

20.5.1 Before Starting Engine.

1. Make a visual inspection of aircraft exterior, checking for system leakages, sand or dust accumulation, tire over inflation or blistering, corrosion, and loose inspection plates.
2. Ensure that all lockpins, protective covers, and plugs (including pitot tube cover) are removed. Make sure air conditioning system is turned on.

20.5.2 After Starting Engine.

1. Make engine ground runup as short as possible.
2. Acceleration to idle RPM may take longer than on normal or cold day.

20.5.3 Taxiing and Takeoff.

1. While taxiing, open the canopy if necessary.
2. Avoid excessive use of brakes.
3. Due to lower air density in hot weather, be prepared for slower acceleration, longer takeoff distance, and reduced thrust at all throttle settings.

20.5.4 Approach and Landing.

1. When descending into warm humid conditions, abrupt canopy fogging may occur. To prevent this condition, place the cockpit air conditioning knob to MAX DEFOG before descent.

2. Turn nonessential electrical equipment off before entering the landing pattern.

3. Utilize all available runway for stopping the aircraft without overheating the wheel brakes.

20.5.5 After Landing.

1. Immediately turn avionics equipment off.

2. If sand or dust is not blowing, leave canopy open to permit air circulation within the cockpit.

3. Ensure protective covers are installed on pitot tube, intake and exhaust ducts.

PART VII

COMMUNICATIONS - NAVIGATION EQUIPMENT AND PROCEDURES

Chapter 21 - Communications - Navigation Equipment and Procedures

CHAPTER 21

Communications - Navigation Equipment and Procedures

21.1 COMMUNICATIONS

The communication system consists of the following equipment.

COMMUNICATION EQUIPMENT

TYPE	DESIGNATION	FUNCTION
Intercom System	ICS	Processes all audio signals heard by crew members and provides interphone between crew members and ground crew when on the ground.
UHF/VHF Radio	AN/ARC-182(V)	Provides air-to-air and air-to-ground communications.
Identification System (IFF)	AN/APX-100(V)	Provides automatic coded IFF replies to interrogating radar stations and transmits coded altitude to civil and military Air Traffic Control interrogators.

21.1.1 Comm Control Transfer System. The COMM control transfer system (Figure 21-3) allows transfer of cockpit operating control of either or both UHF/VHF radios. The system consists of COMM 1, and COMM 2 push-button switches/lights located on the center pedestal in both cockpits. Depression of the COMM 1 or COMM 2 transfer switch selects whether the forward or aft cockpit has control of the COMM 1 or COMM 2 radios.

21.1.2 Intercommunications System. Intercommunications between cockpits and to the ground crew is provided by the intercom system (ICS). The system also provides amplification and selection of both internally and externally produced audio signals. Individual volume controls adjust the intercom and receiver volume to the pilot's headset. Ground crew intercom is provided through a ground crew receptacle located on the nose gear strut.

21.1.3 UHF/VHF Communication System. The AN/ARC-182(V) UHF/VHF communication system provides air-to-air and air-to-ground communications. The system consists of two receiver-transmitters (COMM 1 and COMM 2) with their associated controls. COMM 1 receives and transmits on the upper antenna, COMM 2 on the lower antenna. See Figure 21-2 for antenna locations. The system provides transmission and reception of amplitude and frequency modulated signals (AM or FM) on 11,960 channels, spaced 25 KHz apart, or on within the frequency range of 30.0 to 399.975 MHz. The COMM 1 and 2 radios operate in the frequency bands illustrated in Figure 21-1. In addition to a manual frequency input, the aircrew has access to 30 preset channels.

The guard receiver in each radio monitors the guard channel for the frequency band in which the radio is operating.

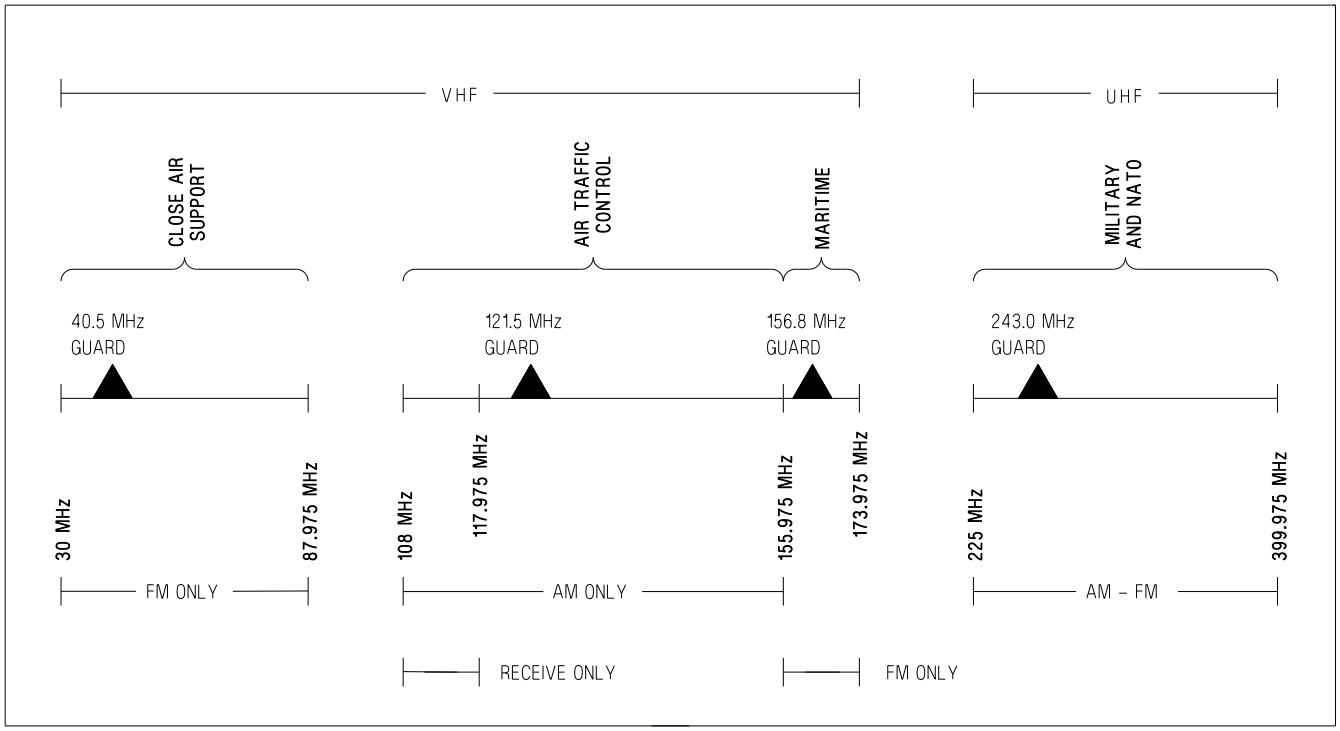


Figure 21-1. Frequency Bands

21.1.4 Communications Controls and Indicators. Communication controls and indicators consist of the UHF/VHF control panels, COMM control panel, COMM transfer switches, and the throttle microphone switch (Figure 21-3).

21.1.4.1 UHF/VHF Control Panel. The COMM 1 and COMM 2 radios are operated by controls on the UHF/VHF control panels located on center pedestal and on the right console in both cockpits.

21.1.4.1.1 UHF/VHF Control Knob. Rotating knob adjusts level of UHF/VHF audio signals delivered to pilot's headset.

21.1.4.1.2 Squelch Switch

SQL	Eliminates main receiver background noise when no signal is being received.
OFF	Disables main receiver automatic squelch. Increases receiver sensitivity and background noise which permits receipt of weaker signals.

21.1.4.1.3 Frequency/Channel Display. Displays digital readouts of the selected frequency/channel as selected by the cockpit having control of the appropriate transfer switch and BIT results.

21.1.4.1.4 UHF AM/FM Mode Switch. Selects either AM or FM mode when receiver/transmitter (R/T) is tuned to frequencies in the 225.000 to 399.975 MHz band. This switch is normally left in the AM position. In all other bands, AM or FM mode selection is automatic.

21.1.4.1.5 Brightness Control Knob. Rotate to adjust light intensity of frequency/channel display.

21.1.4.1.6 Mode Control Selector

OFF	Power is removed from the set.
T/R	Set is energized to receive or transmit on selected channel or frequency.
T/R & G	Same as for T/R position except guard receiver is energized to receive on guard channel of selected band.
DF	Not functional.
TEST	Initiates BIT for R/T. Test results are displayed on the frequency/channel display.

21.1.4.1.7 Frequency Select Switches (Four). With frequency selector at MAN or READ position, move switch forward or up to increase frequency, aft or down to decrease frequency. Switch farthest to the left is associated with hundreds and tens megahertz readouts. Second and third switches are associated with units and tenths, and the fourth switch is associated with hundreds and thousands readouts.

21.1.4.1.8 Frequency Selector (Outer Knob). With outer knob at PRESET, rotate to select any one of 30 preset channels.

243	RT is automatically tuned to 243.000 MHz (UHF Guard frequency) and overrides mode control selector function, dependent on which cockpit currently has comm control selected. All control functions, except volume and brightness, are disabled.
MAN	Permits manual selection of an operating frequency using frequency select switches. R/T is disabled during frequency change.
G	R/T is tuned to the guard frequency in the band in which the set was last tuned. Frequency/ channel display indicates guard frequency.
PRESET	Enables selection of any one of 30 preset channels with the channel selector (inner knob). Selected channel is displayed by the two center digit readouts of the frequency/channel display
READ	Enables selection of any one of 30 preset frequencies with the channel selector (inner knob). Displays frequency (rather than channel number) of the preset channel on frequency/channel display.
LOAD	Automatically loads the displayed selected frequency into the selected preset channel.

21.1.4.1.9 Channel Selector (Inner Knob). The knob is enabled when the frequency selector knob (outer knob) is set to PRESET or READ. Rotating the knob clockwise scrolls through the preset channels/frequencies in ascending order. Rotating the knob counterclockwise scrolls through the preset channels/frequencies in descending order.

21.1.4.2 COMM Transfer Switches. These switches are located on the center pedestal in both cockpits.

COMM 1 Transfer Switch	Press to select between FWD or AFT cockpit. Illuminated - Indicates cockpit exercising control of COMM 1 radio.
COMM 2 Transfer Switch	Press to select between FWD or AFT cockpit. Illuminated - Indicates cockpit exercising control of COMM 2 radio.

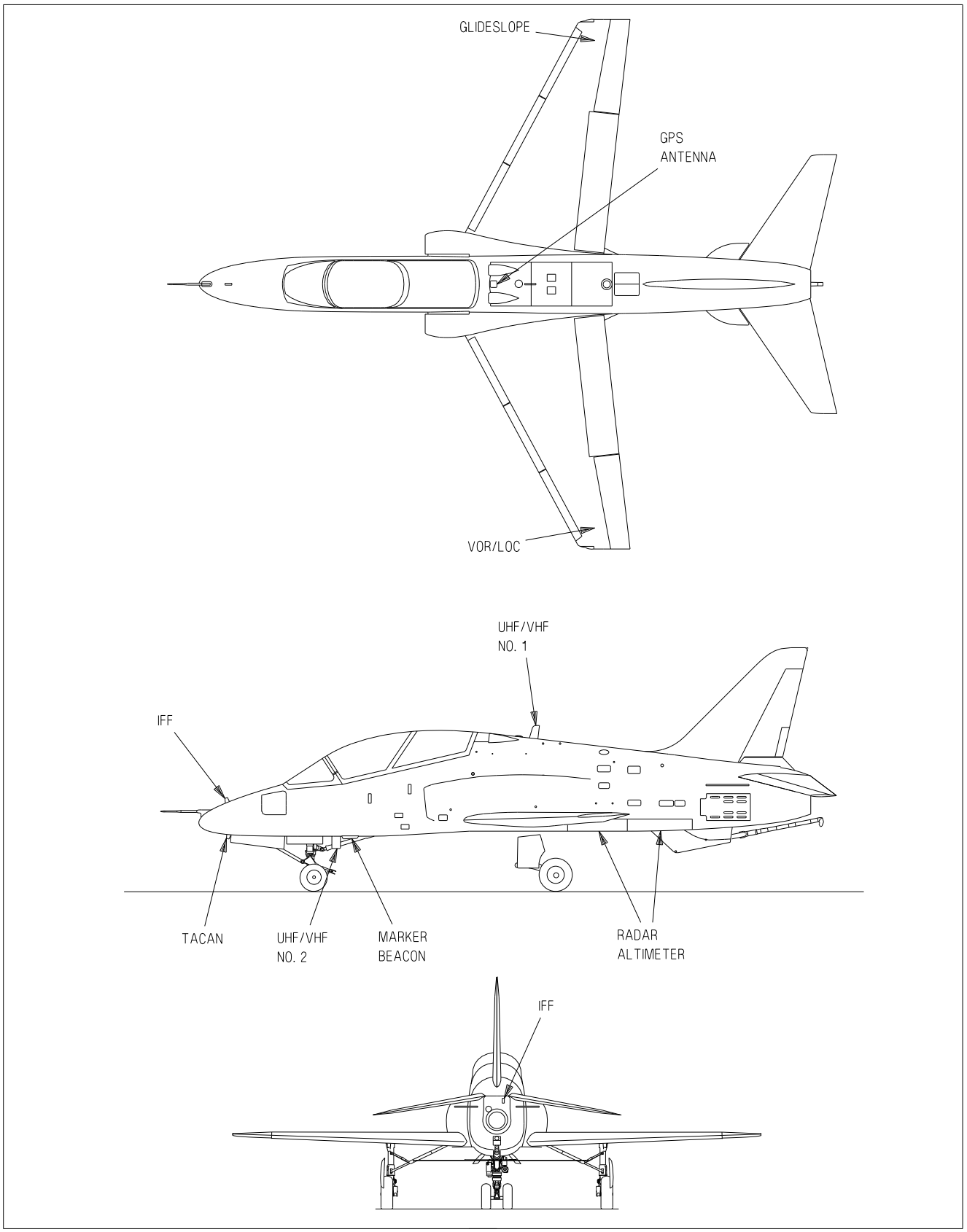
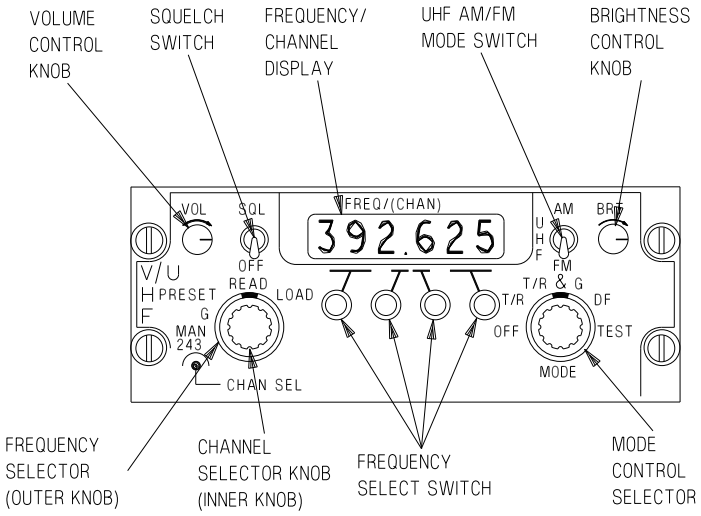
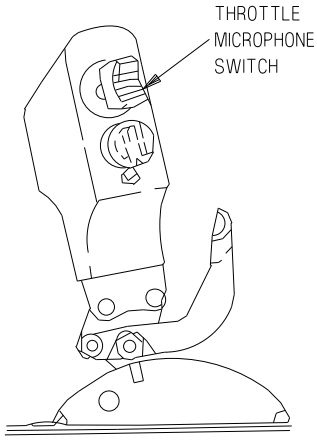
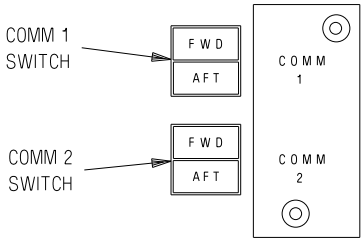


Figure 21-2. Antenna Locations

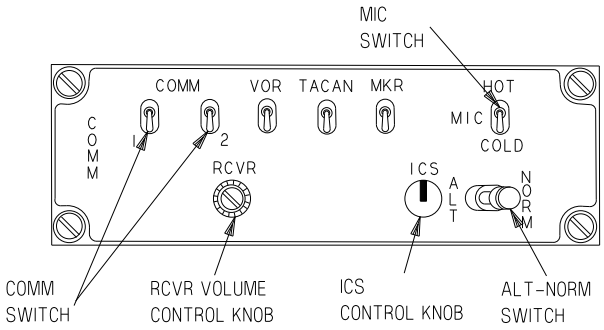


UHF/VHF CONTROL PANEL (2)





COMM CONTROL TRANSFER PANEL



COMMUNICATION CONTROL PANEL

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Figure 21-3. Communication Controls/Indicators

21.1.4.2 COMM Control Panel. The COMM control panel is located on the right pedestal in both cockpits. Audio signals from communication radios, VOR, TACAN, marker beacon (MKR), and microphone selections are controlled at this panel as are selections of receiver (RCVR) volume, ICS volume, and audio amplification.

21.1.4.2.1 MIC Switch

HOT	Permits intercom between cockpits, cockpits/ground crew without microphone switch on throttle being depressed.
COLD	With microphone switch on throttle depressed, permits intercom between cockpits, and cockpits/ground crew.

21.1.4.2.2 ALT-NORM Switch

ALT	Selects alternate audio amplifier when normal amplification circuitry fails.
NORM	Normal audio amplifier operation.

21.1.4.2.3 ICS Volume Control Knob.

Rotating knob adjusts intercom reception volume independent of other cockpit volume setting.

21.1.4.2.4 RCVR Volume Control Knob.

Rotating knob adjusts volume of all receiver audio signals delivered to pilot's headset. With exception of MKR signals, volume of receiver audio signals from COMM, VOR, TACAN are also adjustable by use of individual system control units.

21.1.4.2.5 COMM Switch

1	Up position allows reception of comm radio 1 signals in pilot's headset, (radio 1 transmission is not affected).
2	Up position allows reception of comm radio 2 signals in pilot's headset, (radio 2 transmission is not affected).

21.1.4.3 Throttle Microphone Switch

Up (XMIT-1)	Allows transmission on frequency/channel selected on comm radio 1.
Down (XMIT-2)	Allows transmission on frequency/channel selected on comm radio 2.
Depress (ICS)	Allows intercommunication between cockpits and/or between cockpits and ground crew when MIC switch is in COLD position.

21.1.4.4 Loading Preset Channels. To load preset channels, proceed as follows:

1. Set mode control selector to T/R.
2. Set frequency selector to PRESET and rotate channel selector to obtain desired channel readout on the frequency/channel display.
3. Set frequency selector to READ.
4. Actuate frequency select switches to obtain designated frequency readout on the frequency/channel display.
5. Set frequency selector to LOAD.
6. Set frequency selector to READ.
   Selected frequency should be shown on the frequency/channel display.
7. Set mode control selector to OFF then back to T/R.
   Selected frequency should be shown again on the frequency/channel display
8. Set mode control selector to OFF.

21.1.4.5 UHF/VHV BIT. A BIT of the UHF/VHF receiver/transmitter is performed as follows:

1. Set frequency selector to MAN.

2. Set mode control selector to TEST
   Operational readiness of the system is indicated by the digital readout of 888.888 on the frequency/channel display. If the digital readout is different than 888.888, system malfunction is confirmed.

21.2 IDENTIFICATION SYSTEM (IFF)

The AN/APX-100(V) IFF (identification friend or foe) transponder set provides automatic identification of the aircraft in which it is installed when challenged by a surface or airborne interrogator set and provides momentary identification of position (I/P) upon request. The system operates in modes 1, 2, and 3/A which are selective identification feature (SIF) modes and in mode C, the altitude reporting mode. Mode 4 is not functional.

21.2.1 System Operation. An airborne transponder receives a series of multiple-pulse interrogation signals from a ground based, shipboard, or airborne interrogator. Each interrogation is decoded and, if validity criteria are met, a reply pulse signal is transmitted. The interrogator decodes the replies to provide identification, altitude, and position information. Each interrogation is identified by pulse spacing as belonging to one of several modes. The reply to each mode contains information from a separate coding input to the transponder. In this way the interrogator operator (usually a ground based traffic controller) can extract various items of information by using different interrogation modes.

The two modes common to IFF are Modes 3/A and C. Mode 3/A replies contain a four-digit numerical code entered manually at the system control panel, as assigned by the air traffic controller. A total of 4,096 code combinations can be entered. Mode C replies contain encoded altitude information from the DEU. The altitude reporting capability covers the range from sea level to 50,000 feet MSL in 100-foot increments.

Modes 1, 2, and 4 are exclusive military modes used in IFF. The reply codes for Modes 1 and 2 are entered manually, at the system control panel in the case of Mode 1 and at the front of the transponder in the case of Mode 2. The Mode 1 reply is a two-digit code with 32 combinations, while Mode 2 uses a four-digit code with 4096 combinations. Mode 4 operation requires the addition of a special computer to the system.

Two special functions which apply only to Modes 1, 2, and 3/A are Special Position Identification (or Ident) and the Emergency Function.

The identification function is activated either by setting the I/P switch to IDENT, or MIC position and keying the microphone button. When activated, the system adds one or more pulses to the reply pulse signal, causing the aircraft's signature on the controller's radar display to assume a distinctive appearance as compared to other aircraft using the same code. The function remains in effect for approximately 20 seconds after release of the I/P switch or microphone button.

The AN/APX-100 (V) is a diverse transponder capable of transmitting selectively through the forward or aft IFF antenna. Duplicate receiver circuits monitor both antenna inputs continuously. If an interrogation is received at both antennas simultaneously, the subsequent reply signal is routed to the antenna which provided the higher amplitude interrogation. If only one antenna receives an interrogation, that antenna transmits the reply. System operation may be confined to one antenna by setting the antenna switch to TOP or BOT position, however, the preferred position is DIV.

The system contains BIT circuits which provide simulated interrogations for the SIF modes. The modes are tested individually by placing the spring-loaded M-3/A or M-C switches to the forward TEST position while the master control selector is in the NORM position. If valid replies are transmitted, the control panel

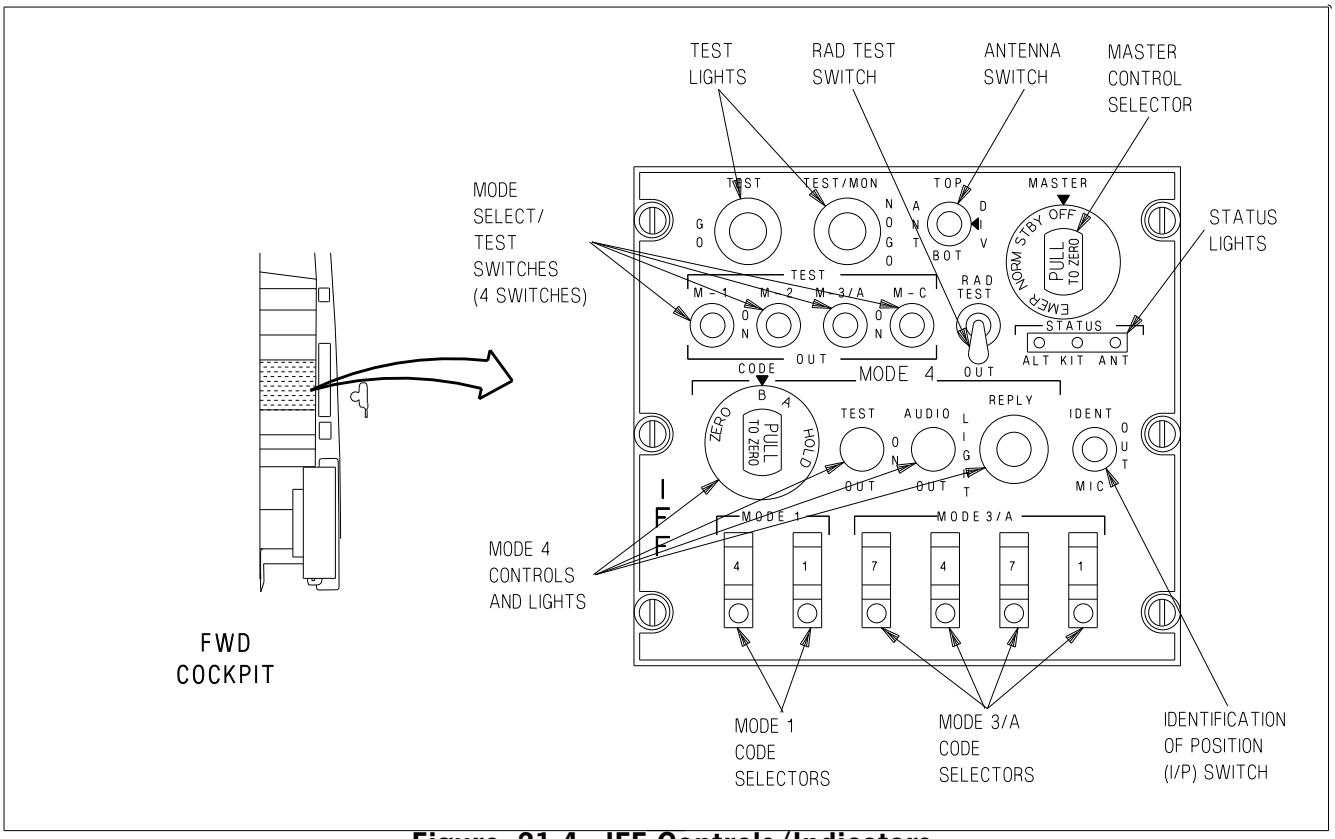

Figure 21-4. IFF Controls/Indicators EDA815-107-1-01

Test GO light illuminates. The same light is used to monitor replies to external interrogations when the spring-loaded RAD test switch is in the forward position.

To enable the system to operate normally in one of the SIF modes, the applicable switch (M-1, M-2, M-3/A, or M-C) is placed in the ON position, while the master control selector is in NORM. Any or all of the modes may be enabled at one time. Placing the master selector in STBY prevents the system from transmitting replies. The EMER position of the master selector overrides the M-1, M-2, M-3/A, and M-C switches to enable all the SIF modes and to provide emergency reply formats in Modes 1, 2, and 3/A. In Mode 3/A the code in use is replaced by 7700. Care should be taken to avoid entering any code starting with "77" on the MODE 3/A code selectors with the M-3/A switch set to ON, since such a reply will be decoded as an emergency signal.

21.2.2 IFF Controls and Indicators. IFF transponder set (Figure 21-4) is installed and can be operated from the forward cockpit only. The DEU provides encoded altitude information to the IFF system for mode C operation. The IFF will automatically change to emergency mode upon seat ejection.

21.2.2.1 Mode Select/Test Switches (Four).

TEST (Spring-loaded to ON)	BIT function in receiver transmitter self-interrogates Modes 1, 2, 3/A, or C.
ON	Permits receiver-transmitter reply to Modes 1, 2, 3/A, or C interrogations.
OUT	Disables the receiver-transmitter for the mode selected.

21.2.2.2 Test Lights (Two). With RAD TEST switch at RAD TEST or mode select/test switch(es) at TEST.

GO light (Green) illuminates	System BIT successful.
NO GO light (Red) illuminates	System BIT fails.

21.2.2.3 Antenna Switch

TOP	Selects forward antenna.
DIV	Diverse setting; antenna is automatically selected.
BOT	Selects aft antenna.

21.2.2.4 RAD TEST Switch. RAD TEST permits reply to test mode interrogations from test equipment, spring loaded to OUT.

21.2.2.5 Master Control Selector

OFF	Disconnects power to system.
STBY	Places receiver-transmitter in warmup (standby condition). Allow a minimum of 2 minutes warmup when system is first turned on.
NORM	Applies power to receiver-transmitter at normal receiver sensitivity for full range operation.
EMER	Transmits emergency reply signals to modes 1, 2, or 3/A interrogations regardless of Mode Select settings. Code 7700 mode 3/A is transmitted regardless of the code set in the mode 3/A code selectors.

21.2.2.6 Status Lights

ALT light	Not functional.
KIT light	Not functional.
ANT light	Illuminates during self-test to indicate high degradation in antenna system.

21.2.2.7 Identification of Position (I/P)

IDENT	Initiates identification reply for approximately 20 seconds.
OUT (Spring-loaded from IDENT)	Prevents triggering of reply.
MIC	Permits replies to be transmitted by pressing microphone button.

21.2.2.8 MODE 3/A Code Selectors (Four). Selects and displays Mode 3/A four-digit reply code number. For Air Traffic Control.

21.2.2.9 MODE 1 Code Selectors (two). Selects and displays Mode 1 two-digit reply code number. For Security Identification (not normally used).

21.2.2.10 MODE 4 Controls and Lights. Not functional.

21.3 NAVIGATION

The navigation system consists of the following equipment:

NAVIGATION EQUIPMENT

TYPE	DESIGNATION	FUNCTION
TACAN	AN/ARN-136B(V)	Provides distance and bearing information to ground TACAN stations and range information to cooperating aircraft.
VOR/ILS	AN/ARN-144(V)	Provides bearing information to ground VOR stations, and ILS localizer and glideslope information.
GINA	LN-100G	Provides data (attitude, velocity, position, acceleration and time) to other systems to support navigation, time distribution, weapons delivery, and flight controls functions.

21.3.1 Navigation Controls and Indicators.

Navigation controls and indicators consist of the COMM Control Panel, VOR/ILS Control Panel, TACAN Control Panel, Marker Beacon Lights, DEP, HUD, and any of the four MFDs, see Figure 21-5. The controls and indicators are integrated in the navigation system. HSI, ADI, and HUD symbology and functions are described in Chapter 2.

21.3.1.1 COMM Control Panel

21.3.1.1.1 VOR Switch. Up - VOR audio signals are delivered to pilot's headset.

21.3.1.1.2 TACAN Switch. Up - TACAN audio signals are delivered to pilot's headset.

21.3.1.1.3 MKR Switch. Up - Marker beacon audio signals are delivered to pilot's headset.

21.3.1.2 TACAN Control Panel

21.3.1.2.1 Test Button. Push - Initiates system BIT.

21.3.1.2.2 Channel Display Window. Displays selected TACAN channel.

21.3.1.2.3 Option Select Switch

Y	Selects Y channel for TACAN operation. There are 126 preset operating channels.
X	Selects X channel for TACAN operation. There are 126 preset operating channels.
XA/A	Selects TACAN air-to-air mode. Distance information to suitable equipped aircraft is displayed on the HSI.

21.3.1.2.4 Volume Control Knob. Rotating knob adjusts volume of TACAN station identification signals.

21.3.1.2.5 Channel Selector. Rotating selector selects desired channel to display on the channel window. The inner knob selects the units window, the outer knob selects the tens and hundreds windows.

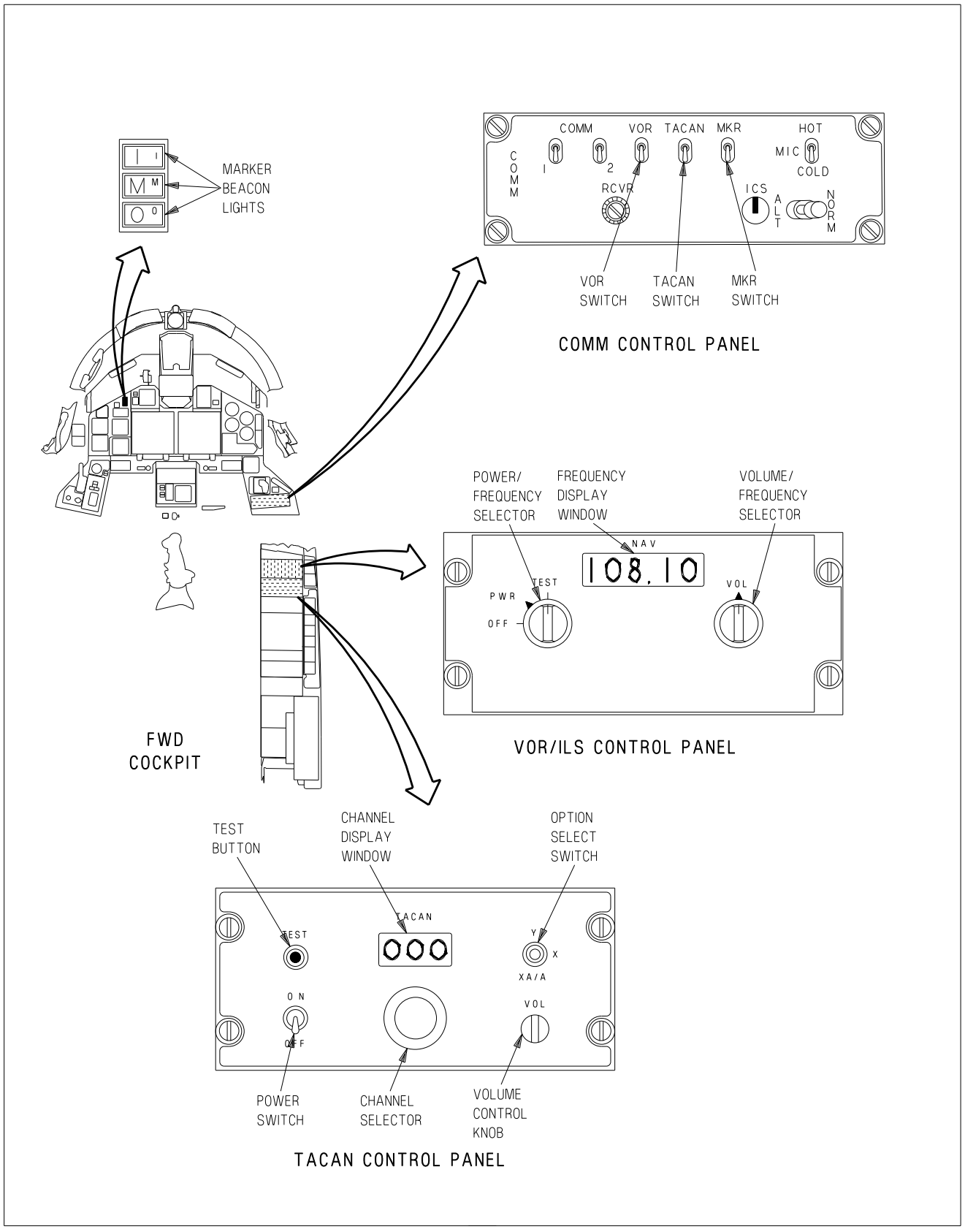

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Figure 21-5. Navigation Controls/Indicators (Sheet 1 of 2)

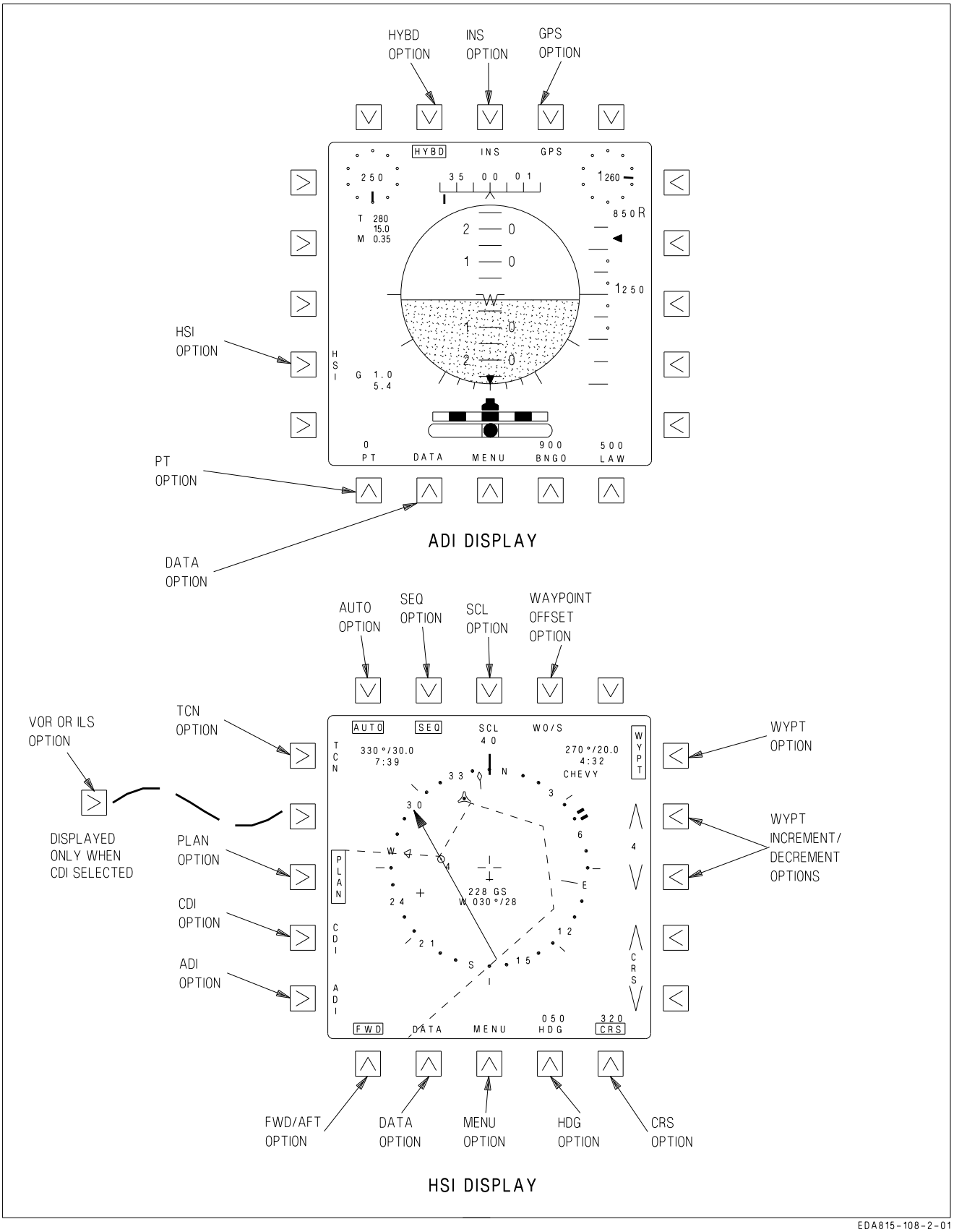


Figure 21-5. Navigation Controls/Indicators (Sheet 2 of 2)

21.3.1.2.6 Power Switch

ON	Connects power to system.
OFF	Disconnects power to system.

21.3.1.3 VOR/ILS Control Panel

21.3.1.3.1 Power/Frequency Selector (Outer Knob)

OFF	Disconnects power to system.
PWR	Connects power to system.
TEST	Initiates system BIT.

21.3.1.3.2 Power/Frequency Selector (Inner Knob). Rotate to change frequency of operation in 1-MHz increment.

21.3.1.3.3 Frequency Display Window. Displays frequency in use.

21.3.1.3.4 Volume/Frequency Selector (Outer Knob). Rotate - Adjusts volume of audio signals.

21.3.1.3.5 Volume/Frequency Selector (Inner Knob). Rotate to change frequency of operation in 50-kHz increment.

21.3.1.4 Marker Beacon Lights

O (Blue) Illuminated	Aircraft is passing over the outer marker beacon.
M (Amber) Illuminated	Aircraft is passing over the middle marker beacon.
I (White) Illuminated	Aircraft is passing over the inner marker beacon.

21.3.1.5 ADI Display. The ADI display allows selection of the HSI display, the DATA displays, the MENU display, and position keeping source, see Figure 21-5. Refer to Chapter 2 for a description of the BNGO option (bingo fuel) and LAW option (low altitude warning). When a navigational source is unavailable, the option to select that source will not be displayed.

21.3.1.5.1 HSI Option. When this option is selected the HSI format is displayed.

21.3.1.5.2 HYBD (Hybrid) Option. This option appears when the INS and GPS options are displayed. When this option is selected (boxed), the GINA uses the best estimate of position based on a combination of GPS and INS data. During ground initialization, this is the default mode. See GINA Operating Modes, paragraph 21.3.2.2.

21.3.1.5.3 INS Option. This option is displayed when INS alignment is complete. When this option is selected (boxed), the INS portion of the GINA operates in a stand alone mode (INS sole source of navigation data), unaided by the GPS. See GINA Operating Modes, paragraph 21.3.2.2.

21.3.1.5.4 GPS Option. This option is displayed when GPS navigation data is valid (satellites are acquired, and the GPS receiver is providing a valid solution). When this option is selected (boxed), GPS data is provided as the sole source of positional data. See GINA Operating Modes, paragraph 21.3.2.2.

21.3.1.5.5 DATA Option. When this option is initially selected the WYPT DATA format is displayed. This format allows selection of the ACFT DATA sublevel display and the GPS DATA sublevel display. All subsequent selections of this option will reselect the DATA format previously selected in that crew station.

21.3.1.6 HSI Display. The HSI display allows selection of the MENU display, ADI format, steering modes (waypoint, waypoint offset, TACAN, or VOR/ILS), HSI steering submode (PLAN or CDI), scale of the HSI display, waypoint selection, HSI take control options, the DATA sublevel display, HDG (heading) setting option, and CRS (course) setting/enabling option.

21.3.1.6.1 ADI Option. When this option is selected the ADI format is displayed.

21.3.1.6.2 CDI (Course Deviation Indication) Option. When the CDI option is selected, it is boxed and the PLAN option/submode is unboxed/deselected. Selecting the CDI option commands the HSI display into the CDI submode. When the CDI submode is selected and the CRS option selected the CDI course line and course deviation dots are displayed. The center section of the course line will not be displayed if the steering mode (TACAN, waypoint, waypoint offset, VOR, ILS) is not selected or the selected steering mode information is invalid.

21.3.1.6.3 PLAN (Planimetric) Option. When this option is selected, it is boxed and the CDI option/submode is unboxed/deselected. Selecting the PLAN option commands the HSI display into the PLAN submode. The planimetric course line will be displayed when the PLAN option, CRS option, steering mode (TACAN, waypoint, or waypoint offset) are selected and the selected steering mode information is valid.

21.3.1.6.4 VOR/ILS Option. The option is displayed only when the CDI mode is selected, however only one option (steering mode) is displayed at a time. The VOR option appears when power is applied to the VOR/ILS system, a VOR frequency is tuned, and the CDI mode is selected. The ILS option appears when power is applied to the VOR/ILS system, an ILS frequency is tuned, and the CDI mode is selected. VOR/ILS steering is selected/deselected (boxed/unboxed) by alternate actuations of the appropriate option. Selection of VOR steering automatically deselects the previous steering mode (WYPT, WO/S, or TCN). The digital VOR bearing is displayed when a valid signal is received and the CDI mode is selected. ILS steering can be selected either singly or in conjunction with WYPT, WO/S, or TCN steering. When selected singly the CDI course line will display the ILS course. When selected in conjunction with the WYPT, WO/S, or TCN the CDI course line or planimetric course line will display the WYPT, WO/S, or TCN course. The ILS steering information will be presented on the ADI and HUD localizer and glideslope steering needles.

21.3.1.6.5 TCN (TACAN) Option. This option is used to select/deselect (box/unbox) TACAN steering mode. When the TCN option is selected and a TACAN station is tuned, the TACAN bearing pointer and tail are displayed. Selection of TCN steering automatically deselects the previous steering mode (WYPT, WO/S, or VOR). TCN may be selected in either the PLAN or CDI submode.

21.3.1.6.6 WYPT (Waypoint) Option. This option mode is used to select/deselect (box/unbox) waypoint steering mode. When the WYPT option is selected the WYPT bearing pointer and tail are displayed. Selection of WYPT steering automatically deselects the previous steering mode (WO/S, TCN, or VOR). WYPT may be selected in either the PLAN or CDI submode.

21.3.1.6.7 WO/S (Waypoint Offset) Option. This option is used to select/deselect (box/unbox) waypoint offset steering mode. When the WO/S option is selected the waypoint offset bearing pointer and tail are displayed. Selection of the WO/S option automatically deselects the previous steering mode (WYPT, TCN, or VOR). The WO/S option is available only when an offset has been entered for the waypoint and may be selected in either the PLAN or CDI submode.

NOTE

Selecting the waypoint increment or decrement option automatically deselects waypoint offset steering and returns to waypoint steering.

21.3.1.6.8 SEQ (Sequential) Option. This option is used to select/deselect (box/unbox) sequential steering. When the SEQ option is selected the sequential steering lines are displayed between each entered waypoint. Two waypoints must be entered before the lines will be displayed. If SEQ is selected during waypoint entry the steering lines will appear when the second waypoint is entered and as each subsequent waypoint is entered.

21.3.1.6.9 AUTO (Automatic Sequential) Option. This option is used to select/deselect (box/unbox) automatic sequential steering. When the AUTO option is selected the AUTO and WYPT options are boxed and any other steering option (TCN, VOR/ILS, or WO/S) is automatically deselected. Selecting the boxed AUTO option will deselect automatic sequential steering. Selecting the boxed WYPT option or another steering option (TCN, VOR/ILS, or WO/S) will automatically deselect AUTO sequential steering and waypoint steering.

21.3.1.6.10 SCL (Scale) Option. This option is used to select range scales of 10, 20, 40, 80, or 160 nm. The number below SCL legend indicates the distance from the aircraft symbol to the inner edge of the compass rose. Successive actuations of the option decrement the scale one at a time then wrap around from 10 to 160.

21.3.1.6.11 Waypoint Increment/Decrement Options. The waypoint increment/decrement (∧/∨) options are used to increase/decrease the steer to waypoint. The steer to waypoint number is displayed between the options. Either option may be held to scroll to the desired waypoint.

NOTE

Selecting the waypoint increment or decrement option automatically deselects waypoint offset steering and returns to waypoint steering.

21.3.1.6.12 DATA Option. When this option is selected the WYPT DATA format is displayed. This format allows selection of the ACFT DATA sublevel display and the GPS DATA sublevel display.

21.3.1.6.13 FWD/AFT Option. This option provides selection and indication of which cockpit controls the HSI display. The option initializes with the FWD cockpit selected (boxed). Each selection of the option toggles control to the opposite cockpit. The controlling cockpit identifier is displayed boxed in option legend. In addition, the selected cockpit controls: VOR/ILS and TACAN channel selection, command heading selection, command course selection, tactical waypoint selection, steering reference selection, sequence lines selection, and scale selection.

NOTE

Navigational specific functions on the HSI may only be exercised by the crewmember that has navigational control. Both crewmembers may change functions via the DEP regardless of the navigational control.

21.3.1.6.14 HDG Option. When this option is selected (boxed) the command heading may be set. Refer to HSI Command Heading Setting, paragraph 21.3.3.2.

21.3.1.6.15 CRS Option. When this option is selected (boxed) the desired course may be entered. Refer to HSI Display Course Setting, paragraph 21.3.3.1.1. In addition, when selected the HSI course lines and HUD steering arrow and deviation scale are enabled.

21.3.2 Global Positioning System/Inertial Navigation Assembly (GINA). The LN-100G is a self contained, all attitude, world wide, strap-down inertial system with an embedded GPS receiver. The GINA provides acceleration, position, heading, digital and analog attitude (roll, pitch, and heading), attitude rates, and time to the DEU over the mux bus.

WARNING

- GPS may not be used as a primary navigation source to file or fly in national airspace. No USN GPS equipped aircraft meet the FAA standards to fly enroute, terminal or non-precision approaches under VMC or IMC conditions.
- GPS authorized:
  1. For tactical use only
  2. As an aid to visual navigation
  3. For supplemental navigation

The inertial system uses three ring laser gyros, one mounted in each aircraft reference axis that

detects rotation in their respective axis for output to the system processor. There are also three accelerometers, one mounted in each aircraft reference axis that detect acceleration in their respective axis for output to the system processor.

The embedded GPS receiver receives, tracks, and processes GPS signals from the GPS antenna, and provides pseudo range, delta range, and time data to the system processor.

The embedded GPS and inertial system navigation data is then sent to the DEU over the mux bus.

21.3.2.1 GINA BIT. At aircraft power up, the following operations automatically occur: the GINA is powered up, power up BIT is initiated, and the alignment process begins.

Pilot initiated BIT is also available using the BIT format, however, this capability is only provided with weight-on-wheels and the parking brake set. A continuous BIT which occurs in the background is performed after power up BIT. Power up BIT is the most extensive BIT and continuous BIT is the least extensive. Upon completion of BIT following initial aircraft power up, the DEU commands the GINA to the hybrid mode. Following any commanded BIT, the GINA will return to the last commanded mode, refer to the BIT System description, Chapter 2. GINA power may be cycled using the GINA PWR option on the BIT display.

NOTE

Do not attempt to interrupt a GINA IBIT by selecting STOP on the BIT page. Attempting to interrupt the GINA IBIT by selecting STOP may require recycling of the GINA power and realignment.

21.3.2.1.1 GINA Failure. There are four potential failure modes which result in an AV BIT advisory, a GINA DEGD on the BIT display, and the removal of display symbology and/or loss of system functionality. The four failure modes are mis-compare, GPS, INS, and a complete GINA (INS and GPS) failure. The mis-compare failure causes the removal of all velocity derived information from the displays. A failed GPS component causes the GINA to default to INS mode and results in the loss of GPS aiding, position, velocities, and time. A failed INS component results in the loss of aircraft attitude, velocities, and acceleration information and is accompanied by an ATTITUDE/POSITION advisory. A completely failed GINA (both components) results in the loss of all attitude, position, velocity, acceleration, time and navigation information and an ATTITUDE/POSITION advisory. (Loss of GINA attitudes may also result in illumination of the C AUG/master caution lights.)

a. Mis-compare Failure. Mis-compare logic has been incorporated to provide aircrew with an advisory cue when the INS and GPS outputs do not agree within a certain threshold. Although both the INS and GPS components may still be operating, this serves as a warning to the pilot that the GINA may be slowly degrading which could eventually cause incorrect aircraft attitude, velocity, and position information to be displayed. The system remains in HYBD mode with both INS and GPS options still available on the ADI display. The mis-compare logic uses both velocity and position outputs for comparison and is activated upon alignment of the INS and receipt of a valid GPS signal. The threshold for flagging a mis-compare is a dynamic statistical value that can be affected by several variables; however, nominal values are 6.5 ft/sec and 2000 ft for a time period of approximately 25 seconds. The velocity information returns to the display formats and the GINA DEGD on the BIT page is removed as soon as the INS and GPS velocity and position outputs differ by less than the threshold. A GINA mis-compare failure (position or velocity) affects the aircraft displays as follows:

HUD	Removed: velocity vectors, digital vertical velocity, ground speed, time-to-go
	Changed: barometric altitude reverts to un-filtered
	Displayed: waterline symbol
ADI	Removed: vertical velocity caret, digital vertical velocity
	Changed: barometric altitude reverts to un-filtered
	Displayed: AVBIT advisory
HSI	Removed: ground speed, wind speed, wind direction, time-to-go, ground track marker
	Displayed: AVBIT advisory
BIT	Displayed: GINA DEGD, AVBIT advisory

WARNING

GINA mis-compare logic remains active only when in HYBD mode and receiving 4 satellites. When operating in INS, the mis-compare logic is not activated.

NOTE

- GPS antenna shading during maneuvering flight can cause a dropout of one or more satellites causing temporary inactivation, GINA mis-compare logic, and return of previously blanked display symbology.
- During a GINA mis-compare condition, normal aircraft displays may temporarily return for 1-3 seconds at random intervals as the system attempts to resolve the mis-compare.

b. GPS Failure. A GINA GPS receiver component failure affects aircraft displays as follows:

HUD	Changed: GPS time replaced by DP elapsed time since turn-on
ADI	Removed: HYBD and GPS options
	Changed: INS option boxed
	Displayed: AVBIT advisory
ACFT-:DATA	Removed: may not be tracking satellites
	Displayed: AVBIT advisory
ACFT:GPS	Removed: EHPE, EVPE, and GPS time
	Displayed: AVBIT advisory
BIT	Displayed: GINA DEGD, AVBIT advisory

c. INS Failure. The difference between INS failure and a complete GINA failure is that the GPS option remains displayed allowing the crew to request display of GPS positional/time information. An INS component failure affects aircraft displays as follows:

HUD	Removed: velocity vectors, digital vertical velocity, ground speed, time-to-go, pitch ladder, heading scale and caret, bank scale and pointer, G, A/A and A/G reticles, and bomb impact line
	Changed: barometric altitude reverts to un-filtered
	Displayed: waterline symbol

ADI	Removed: vertical velocity caret, digital vertical velocity, ADI ball shading, roll pointer, pitch ladder, HYBD/INS options, heading scale and caret, G's, bank pointer, spin direction indicator, and slip indicator Changed: barometric altitude reverts to un-filtered Displayed: ATTITUDE/ POSITION and AVBIT advisories
HSI	Removed: ground speed, wind speed, wind direction, time-to-go, ground track marker, compass rose, waypoint/waypoint offset symbols and bearing pointer, heading bug, TACAN symbol, VOR bearing, course line, and ground track pointer Displayed: ATTITUDE/ POSITION and AVBIT advisories
BIT	Displayed: GINA DEGD, ATTITUDE/POSITION, and AVBIT advisories

d. Complete GINA Failure. A complete GINA failure (INS and GPS) affects aircraft displays as follows:

HUD	Removed: velocity vectors, digital vertical velocity, ground speed, time-to-go, pitch ladder, heading scale and caret, bank scale and pointer, G, A/A and A/G reticles, and bomb impact line Replaced: GPS time with DP elapsed time since turn-on Changed: barometric altitude reverts to un-filtered Displayed: waterline symbol ADI
	Removed: vertical velocity caret, digital vertical velocity, ADI ball shading, roll pointer, pitch ladder, HYBD/INS/GPS options, heading scale and caret, G's, bank pointer, spin direction indicator, and slip indicator Changed: barometric altitude reverts to un-filtered Displayed: ATTITUDE/ POSITION and AVBIT advisories
HSI	Removed: ground speed, wind speed, wind direction, time-to-go, ground track marker, compass rose, waypoint/waypoint offset symbols and bearing pointer, TACAN symbol, VOR bearing, course line, and ground track pointer Displayed: ATTITUDE/ POSITION and AVBIT advisories
DATA:ACFT	Removed: number of satellites may not be displayed, and AVBIT advisory
DATA:GPS	Removed: EHPE, EVPE, and GPS time Displayed: ATTITUDE/ POSITION and AVBIT advisories
BIT	Displayed: GINA DEGD, ATTITUDE/POSITION, and AVBIT advisories

21.3.2.2 GINA Operating Modes. There are four operational modes, HYBD, INS, GPS, or DGRO (directional gyro). Upon initial power up (weight-on-wheels) the GINA will be commanded by the DEU into the HYBD mode. During flight (weight-off-wheels), if power to the GINA is interrupted, once it is restored the DEU will command the GINA to the mode selected at the time of the interruption. The HYBD, INS,

and GPS options are displayed on the ADI display only when the mode is available.

21.3.2.2.1 HYBD Mode. The HYBD mode is the most accurate of the four GINA operating modes. This mode is selected automatically during aircraft power up (weight-on- wheels) or when the HYBD option on the ADI is selected. In this mode the GPS provides continuous positional updates/corrections to the INS. If the GPS cannot acquire the required satellites the GINA will automatically select the INS mode. The GINA will return to the HYBD mode when the GPS reacquires the satellites. If the INS does not complete its alignment or is invalid the GINA automatically defaults to the DGRO mode. The GINA will continue to monitor the INS, if its validity returns and the GPS is available then it will automatically restore the HYBD mode. The HYBD mode option is boxed when it is selected.

21.3.2.2.2 GPS Mode. In this mode aircraft positional data is provided solely by the embedded GPS receiver. GPS can be manually selected by actuating the GPS option on the ADI display. Selecting the GPS mode does not affect the INS mode.

NOTE

In GPS mode the velocity vector and aircraft attitude are driven by INS velocities.

21.3.2.2.3 INS Mode. In this mode aircraft navigation data is provided solely by the inertial navigation assembly. This mode is automatically selected if operating in HYBD or GPS and a GPS failure occurs. INS can also be manually selected by pressing the INS option on the ADI display.

21.3.2.2.4 DGRO Mode. DGRO is an attitude heading back up mode. This mode is automatically selected when there is insufficient initialization data and the parking brake is not set during ground alignment. DGRO can be manually selected by actuating the DGRO option on the ACFT DATA sublevel display.

21.3.2.3 ACFT Display. The ACFT (aircraft) display is selected by actuating the DATA option then the ACFT option. See Figure 21-6. This display presents barometric pressure setting, aircraft present position (latitude and longitude), magnetic variation, UTC time and date, heading, groundspeed, winds (true direction and speed), alignment information (time and quality), and the number of satellites being tracked by the GPS as follows:

BARO PRESS	Displays the barometric pressure setting being used by the DEU. Signal is from the standby altimeter in the front cockpit.
LAT	Aircraft present latitude stored in the INS portion of the GINA. If GPS mode is selected as the navigation mode, latitude is provided by the GPS.
LONG	Aircraft present longitude stored in the INS portion of the GINA. If GPS mode is selected as the navigation mode, longitude is provided by the GPS.
MVAR	Magnetic variation determined by GINA for aircraft present position.
TIME	Displayed when GINA does not have a valid UTC time. Will display entered value when manually entered through the DEP.
DATE	Displayed when GINA does not have a valid date. Will display entered value when manually entered through the DEP.
HDG	Aircraft heading.
GND SPD	Aircraft ground speed.
WIND	Wind direction and speed, the data is provided by the GINA and the calculations are made by the DEU. Data displayed with weight-off-wheels.

ALGN	Minutes and seconds GINA has been in alignment mode. Is removed when the alignment is completed and weight-off-wheels.
QUAL	Displays the alignment quality in kilometers per hour. The display is removed when alignment is complete and weight-off-wheels.
GPS SAT	Displays the number of satellites the GPS is tracking. Number range is 0 to 4.

Options are provided for selecting: other displays, shipboard alignment, DGRO mode or reinitializing the GINA.

21.3.2.3.1 HSI Option. When this option is selected, the HSI display is displayed.

21.3.2.3.2 ADI Option. When this option is selected the ADI display is displayed.

21.3.2.3.3 WYPT Option. When this option is selected the WYPT DATA sublevel display is displayed.

21.3.2.3.4 MENU Option. When this option is selected the main menu display is displayed.

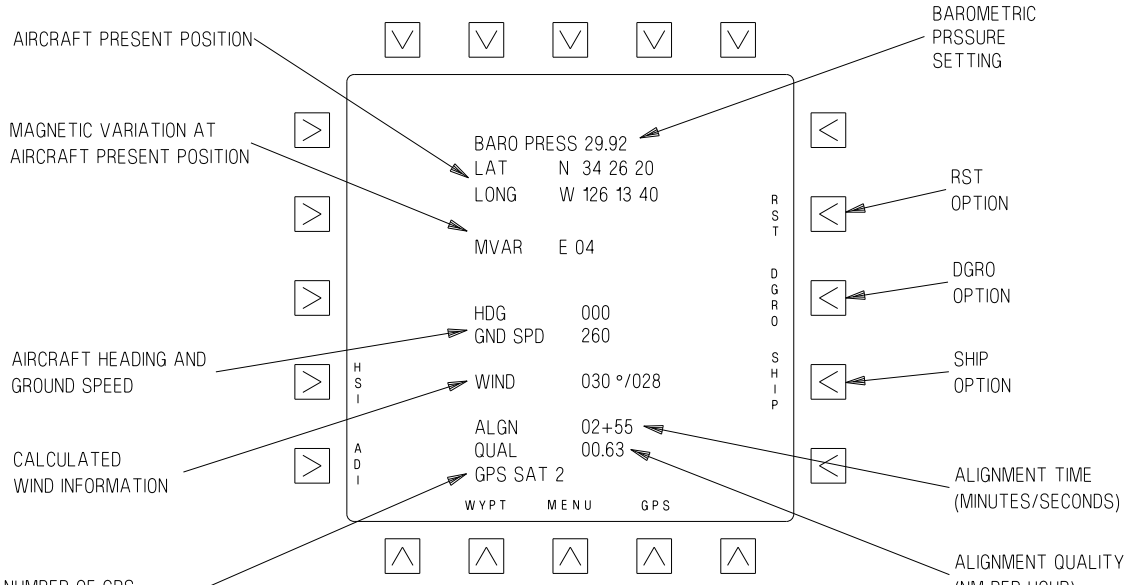
21.3.2.3.5 GPS Option. When this option is selected the GPS DATA sublevel display is displayed.

21.3.2.3.6 SHIP Option. Selecting (boxing) this option signals the GINA that the alignment will be a shipboard alignment. The SHIP option is displayed only with weight-on-wheels and an incomplete alignment or when the DGRO option is selected with weight-on-wheels and true heading invalid. The option is available to allow alignment when aboard the carrier. The option must be selected prior to restarting the GINA.

21.3.2.3.7 DGRO Option. When this option is selected (boxed) the GINA is commanded into the DGRO (directional gyro) mode. The option is also boxed when the GINA has insufficient data to operate/align in the HYBD or INS modes. The option is unboxed when the GINA returns to one of the other operational modes (manually or automatically). When selected the EHDG option is presented prior to the GINA resolving heading.

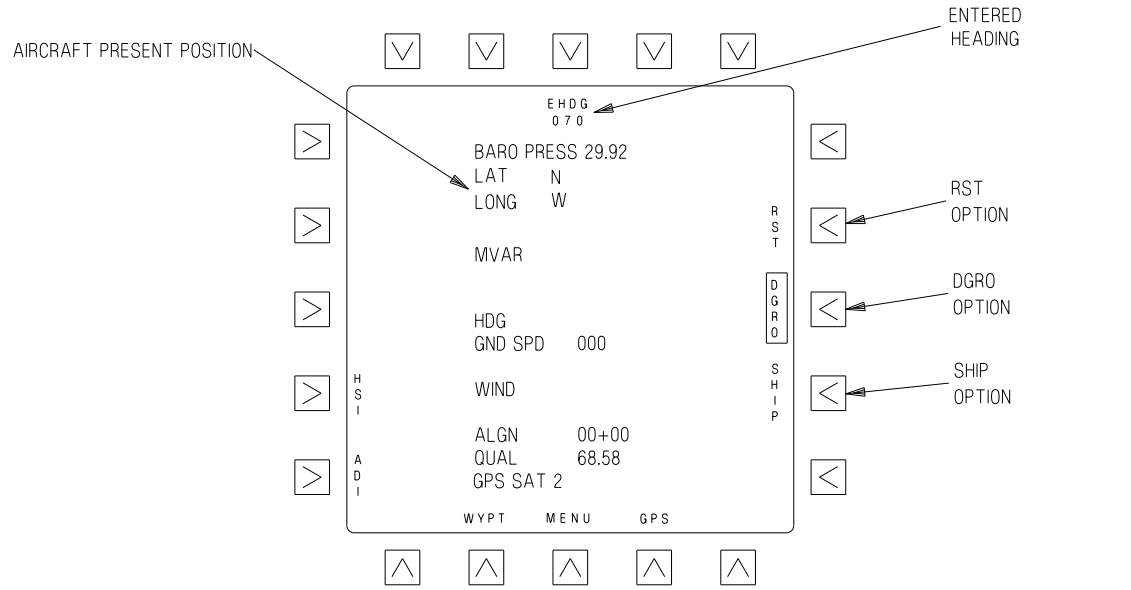
21.3.2.3.8 RST Option. Selecting the RST (restart) option boxes the option and reinitializes the GINA from any state. When selected, the DEU commands the GINA into the DGRO mode and after the mode change reinitializes the GINA. When the reinitialization is complete the GINA returns to the appropriate operational mode.

The RST option provides a means by which the GINA can be reinitialized without removing GINA power. When RST is selected, intialization data is sent to the GINA and a hybrid alignment is commanded by the DEU.



ACFT DATA SUBLEVEL

- GINA ALIGNMENT DATA



ACFT DATA SUBLEVEL

- DGRO ALIGNMENT MODE

EDA815-109-1-01

Figure 21-6. Aircraft Data Sublevel (Sheet 1of 2)

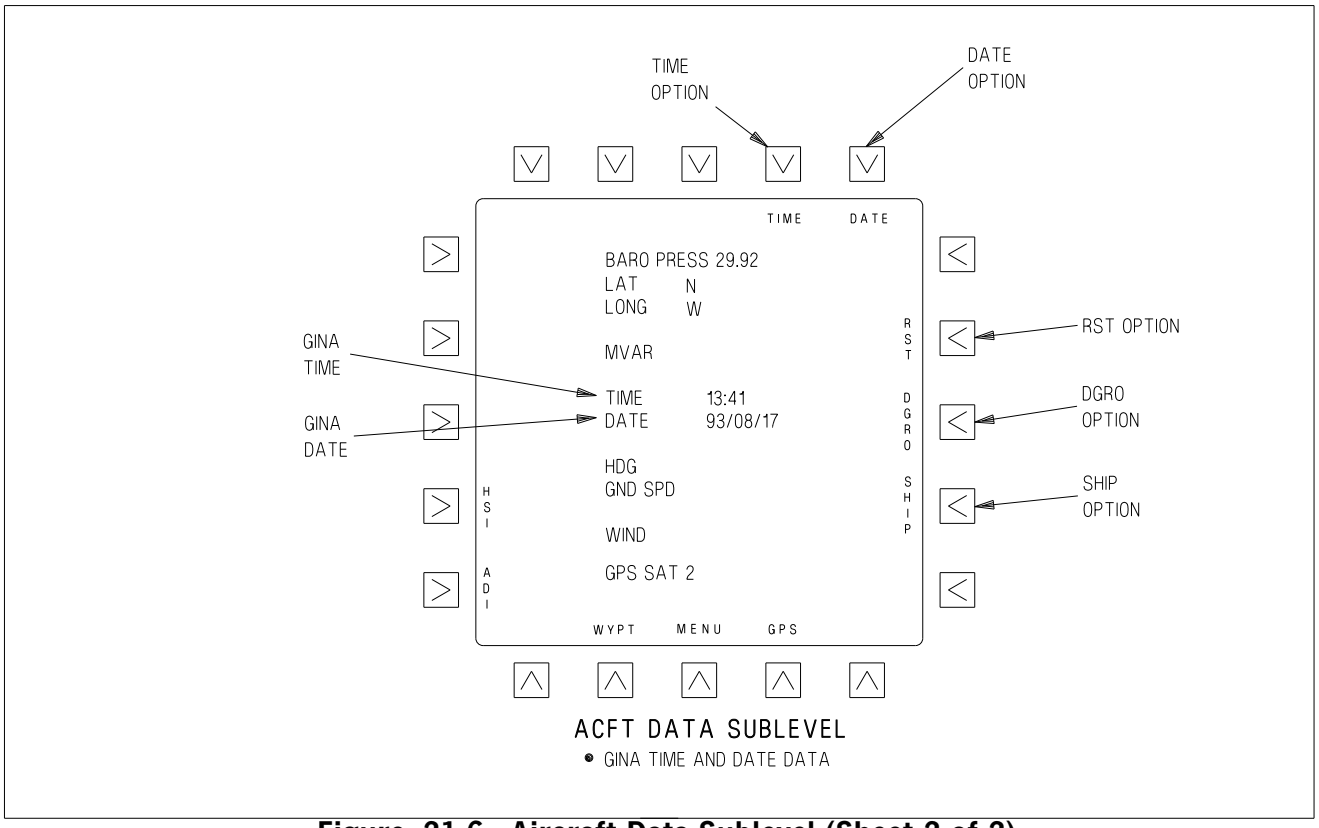


Figure 21-6. Aircraft Data Sublevel (Sheet 2 of 2) EDA815-109-2-01

21.3.2.3.9 DATE Option. The DATE option is displayed when the GINA has an invalid date. When selected, the option is boxed and the DEP and scratchpads are enabled to enter the date. The scratchpads will initially display the date identifier followed by: yymmdd. The date should be entered using the DEP data entry buttons, two digits for the year (yy), two digits for the month (mm), and two digits for the day (dd). When the date has been entered, pressing the DEP ENT button will store the date in the DEU and unbox the option.

21.3.2.3.10 TIME Option. The TIME option is displayed when the GINA has an invalid UTC time. When selected, the option is boxed and the DEP and scratchpads are enabled to enter the UTC time. The scratchpads will initially display the time identifier followed by: hhmm. The time (zulu) should be entered using the DEP data entry buttons, two digits for the hour (hh), and two digits for the minutes (mm). When the time has been entered, pressing the DEP ENT button will store the time in the DEU and unbox the option.

21.3.2.3.11 EHDG Option. The EHDG (entered heading) option is displayed when the DGRO option is selected (boxed) and the GINA has not resolved heading. When EHDG option is displayed the current entered heading is displayed below the option. At power up the heading defaults to 000. Selecting the EHDG option boxes the option and enables the DEP and scratchpads for entry of the EHDG. The current aircraft heading should be entered using the DEP data entry buttons, preceding zeros are not required. When the heading has been entered, pressing the DEP ENT button will store the heading in the DEU and unbox the option.

21.3.2.4 GINA Alignment. The GINA will automatically attempt to align with the application of generator power. Initially the GINA will attempt to align using the GPS for position. If GPS is not available and the GINA had a valid present position when it was powered down (via BIT display) prior to aircraft shutdown, the GINA will use the internally stored position as the alignment reference. If neither of the previously stated options are available prior to engine

start, the alignment will be suspended until the DEU sends the waypoint zero location to the GINA. Waypoint zero is the position of the aircraft that was stored at the time the generator drops below the DEU shutdown voltage. Waypoint zero is sent to the GINA during alignment when: the RST option is selected, the GINA power is cycled off and back on, or waypoint zero is changed. During alignment the GPS is also initialized. To manually initiate GINA alignment there must be weight-on-wheels, the parking brake must be set, and power applied to the aircraft. If the alignment is initiated without the parking brake set the GINA will automatically default to the DGRO mode. During GINA alignment, the inertial system performs a gyrocompass alignment until the GPS data is valid. GINA alignment can be monitored via the ACFT DATA sublevel display. The following cues indicate when GINA alignment is complete:

1. INS appears on the ADI display.

2. The velocity vector replaces the waterline symbol on the HUD.

In the DGRO mode the INS alignment is complete when heading is valid. If GPS is unavailable, homeplate location and aircraft heading (DGRO mode only) must be manually entered.

21.3.2.4.1 Ground Alignment.

1. PARKING BRAKE - SET

2. Alignment progress - CHECK, GROUND ALIGNMENT

   a. MENU/DATA/ACFT options - SELECT

   b. Verify GPS is tracking four satellites and alignment QUAL is decrementing. If alignment completes the INS option is displayed on the ADI and the velocity vector displayed.

If alignment QUAL is not decrementing within 90 seconds after power is applied to the GINA -

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

   d. Waypoint zero - ENTER

   e. After 50 seconds verify QUAL begins to decrement

21.3.2.4.2 Shipboard Alignment. A shipboard alignment is performed when the aircraft is aboard a ship and the GINA is not aligned. To perform a shipboard alignment the aircraft must be weight-on-wheels and the GPS is tracking four satellites. The alignment is initiated by selecting (boxing) the SHIP option on the ACFT DATA sublevel display, and then selecting the RST option.

There are two options available for initiating the GINA before launch aboard ship. The length of time before launch typically is the deciding factor between choosing a full alignment or DGRO alignment. If the aircraft will launch in less than 8 minutes, a Shipboard DGRO Mode Alignment should be performed. If more than 8 minutes are available before launch, a Shipboard Alignment should be performed.

1. MENU/DATA/ACFT/SHIP options - SELECT

2. Obtain aircraft's present position from ships navigation system and enter the present position as waypoint zero.

3. RST option - SELECT
   Attitudes available in approximately 20 seconds. Position and heading available in approximately 8 minutes.

When heading available -

4. CONTR AUG IBIT - PERFORM

5. Alignment complete when velocity vector displayed
   Full alignment (velocity vector displayed) takes approximately 18 minutes to complete. If aircraft must launch before full alignment is complete, but the position and heading are available at launch, the alignment will automatically complete within 3 to 5 minutes.

21.3.2.4.3 Shipboard DGRO Alignment. A shipboard DGRO alignment should be selected when the aircraft will launch in less than 8 minutes, exceeding the time required for a full shipboard alignment. The DGRO mode will provide attitude and heading for takeoff. Following takeoff an In-Flight Alignment should be performed. To initiate a ship board alignment select (box) the DGRO option and verify the EHDG option displayed. Select (box) the EHDG option and enter the aircrafts magnetic heading via the DEP data entry buttons. After pressing the DEP ENT button verify the entered magnetic heading appears under the EHDG option and the EHDG option is unboxed. The DGRO mode alignment should be completed within 1 minute. This can be verified by the HUD and MFDs display of the following information: the pitch ladder, waterline symbol, and aircraft heading.

1. MENU/DATA/ACFT/SHIP option - SELECT
2. DGRO option - SELECT
   Attitudes available in approximately 20 seconds. Aboard ship accomplishes restart.
3. EHDG option - SELECT
4. Aircraft magnetic heading - ENTER THRU DEP
   Heading available upon data entry, appears on ADI and HUD.
5. CONTR AUG IBIT - PERFORM

After launch -

6. In-Flight Alignment - PERFORM

21.3.2.4.4 In-Flight Alignment. An inherent capability of HYBD mode is an in-flight alignment (IFA). Should power be interrupted or discontinued to the GINA and an IFA be necessary to initiate an inflight alignment the aircraft should be in straight, level and unaccelerated flight. The GINA power option on the BIT display should be cycled off (unboxed) then on (boxed). Initialization is automatic. If an in-flight alignment is required for other than a loss of GINA power (incorrect or missing data), the alignment may be initiated by selecting the RST option. The RST option should only be selected while in straight, level and unaccelerated flight. Straight and level flight should be maintained until attitudes are valid and the pitch ladder is displayed on the HUD. Airspeed should remain below 250 knots until GPS data is valid. If GPS data is not valid within 9 minutes, reduce airspeed, cycle power on the GINA, and start again. After attitudes are valid, 90 degree heading changes 1 minute apart will reduce alignment time. Alignments normally take 5 to 15 minutes. HYBD mode will be displayed and automatically selected at completion of the alignment.

1. Establish straight, level, and unaccelerated flight
2. MENU/DATA/ACFT/RST options - SELECT
3. Straight, level, and unaccelerated flight - MAINTAIN UNTIL ATTITUDES ARE AVAILABLE

When attitudes are displayed -

4. Begin shallow turns to improve alignment time and quality
5. Alignment complete when velocity vector displayed on HUD and the INS/HYBD option is displayed on the ADI

21.3.3 Navigation Programming. Navigation programming consists of command heading setting, course setting (steering functions), manual waypoint entry, GPS waypoint entry, waypoint offset entry, and various GPS functions.

21.3.3.1 Course Setting. The course setting function is used in conjunction with the CDI and PLAN steering modes. In the CDI and PLAN modes the course setting function is used to adjust the course line. The course may be entered either from the HSI display or through the DEP. Destination waypoint magnetic variation is used to compute the waypoint/offset course line orientation.

21.3.3.1.1 HSI Display Course Setting. To enter a course using the HSI display, select the CRS option. This will box the CRS option, display the CRS increment/decrement arrows, and display the course line, see Figure 21-7. The desired course can now be entered by actuating the increment/decrement arrows. Selection of the course is indicated by the rotation of the course line about steer to point/aircraft symbol and the digital display of the course above the CRS option.

21.3.3.1.2 DEP Course Setting. To enter a course using the DEP, press the CRS button on the DEP. The scratchpads and the course line will be displayed. The current course heading and identifier (CS) will be displayed in each scratchpad. The course heading can now be entered using the DEP data entry buttons, preceding zero(s) are not required. The scratchpads will display the newly entered course and the identifier. Pressing the DEP ENT button will store the course heading in the DEU, display the new course heading above the CRS option on the HSI.

21.3.3.2 Command Heading Setting. The command heading is available for navigation reference purposes. The command heading may be entered either from the HSI display or through the DEP.

21.3.3.2.1 HSI Command Heading Setting. To enter a command heading using the HSI display, select the HDG option. This will box the HDG option and display the HDG increment/decrement options, see Figure 21-7. The desired heading can now be entered by actuating the increment/decrement options. Selection of the commanded heading is indicated by the position of the command heading marker on the HSI, ADI, and HUD, and the digital display of the selected command heading above the HDG option.

21.3.3.2.2 DEP Command Heading Setting. To enter a command heading using the DEP, press the HDG button on the DEP. The scratchpads with the current command heading and identifier (CH) will be displayed. The command heading can now be entered using the DEP data entry buttons, preceding zero(s) are not required. The scratchpads will display the newly entered heading and identifier. Pressing the DEP ENT button will store the heading in the DEU, display the new command heading above the HDG option on the HSI. If CRS was selected

on the HSI, it will remain selected when DEP ENT is selected.

21.3.3.3 Waypoint Programming. A waypoint is a geographical point whose latitude, longitude, elevation, and magnetic variation is entered in the DEU. Waypoints may be manually entered via the DEP or they can be transferred from the MDL to the DEU. Waypoints are used as a means of steering and navigation. A maximum of 11 waypoints can be entered, 10 are tactical (1 thru 10), and waypoint 0 reserved for home plate (home plate symbol on the HSI display).

21.3.3.3.1 Manual Waypoint Programming. Manual entry of waypoints must be done using the WYPT DATA sublevel display, see Figure 21-7. The display is selected by pressing the DATA option on the MENU display, ADI display, etc. This display presents the following for the selected waypoint: waypoint number, latitude, longitude, elevation, and magnetic variation.

To select the desired waypoint, press the waypoint increment (∧) or decrement (∨) option until the desired waypoint number is displayed between the increment and decrement options and above the displayed waypoint data. To enter latitude, longitude, elevation, and magnetic variation, select the appropriate option: LAT (latitude), LONG (longitude), ELEV (elevation), or MVAR (magnetic variation). When an option is selected, it is boxed and the DEP is initialized for data entry using the data entry buttons. When data is being entered, the information appears in the scratchpads. Latitude or longitude direction (N, S, E, or W) must be entered first, followed by the degrees, minutes, and seconds. Positive or negative (+ or -) must be entered prior to entering elevation. MVAR direction (E or W) must be entered first followed by the degrees. The scratchpads will have decimal points displayed in the appropriate positions prior to entry. When the ENT button is selected, if the data is valid the waypoint is stored in the DEU, the scratchpads disappears, and the data is updated on the WYPT DATA sublevel display.

21.3.3.3.2 GPS Waypoint Programming. Entry of waypoints using a library of GPS waypoints is accomplished by transferring waypoints from the MDL to the DEU using the GPS DATA sublevel format, see Figure 21-7. The display is selected by pressing the DATA option and then the GPS option.

The waypoint to be overwritten is selected using the waypoint increment/decrement options. Select the increment (∧) or decrement (∨) option to increment/decrement to the desired waypoint. The selected waypoint number is indicated between the waypoint increment/decrement options and in the lower right corner (selected waypoint data). This waypoint will be replaced with the GPS waypoint.

Now a GPS waypoint must be selected. There are up to 200 International Civil Aviation Organization (ICAO) waypoints stored in the MDL, however, only 15 can appear on the display at a time (displayed in 3 columns of 5 waypoints). Upon power up the data for the first 15 waypoints stored in the MDL are transferred to the DEU. If the desired waypoint is not currently displayed, use the GPS waypoint page increment (∧) or decrement (∨) options to access the desired page. When the desired page is selected, use the GPS waypoint select options, down (∨) or right (>), to move the box to the desired waypoint. The selected GPS waypoint data appears in the lower left corner of the display. To replace the selected waypoint with the selected GPS waypoint scroll to desired waypoint using increment (∧) or decrement (∨) options on the right side of the screen (on initial power up it is waypoint 0), then select the XFER option. To verify successful transfer of the GPS waypoint, compare GPS waypoint data to selected waypoint data, they should read the same and the proper ICAO identifier should be displayed beside the waypoint number. The ICAO identifier will be displayed below the waypoint data block on the HSI when a GPS waypoint is selected.

21.3.3.3.3 Sequential Waypoint Programming. Sequential waypoint programming is used for AUTO sequential waypoint steering or to define an area. A maximum of 10

waypoints can be programmed for sequential steering, the order of the steering is identified in the waypoint sequential string. Waypoints should be programmed prior to programming the string.

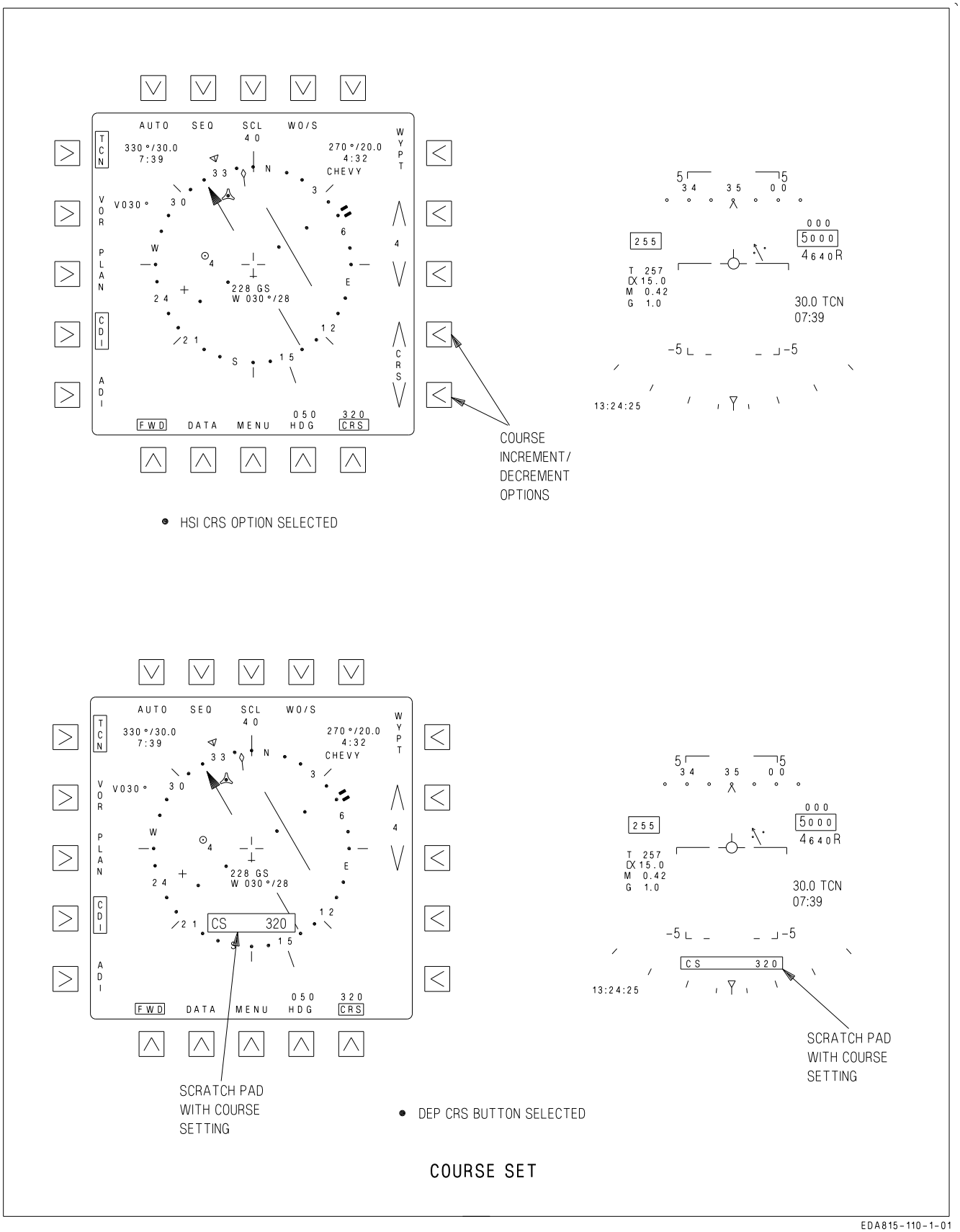


Figure 21-7. Navigation Programming (Sheet 1 of 4)

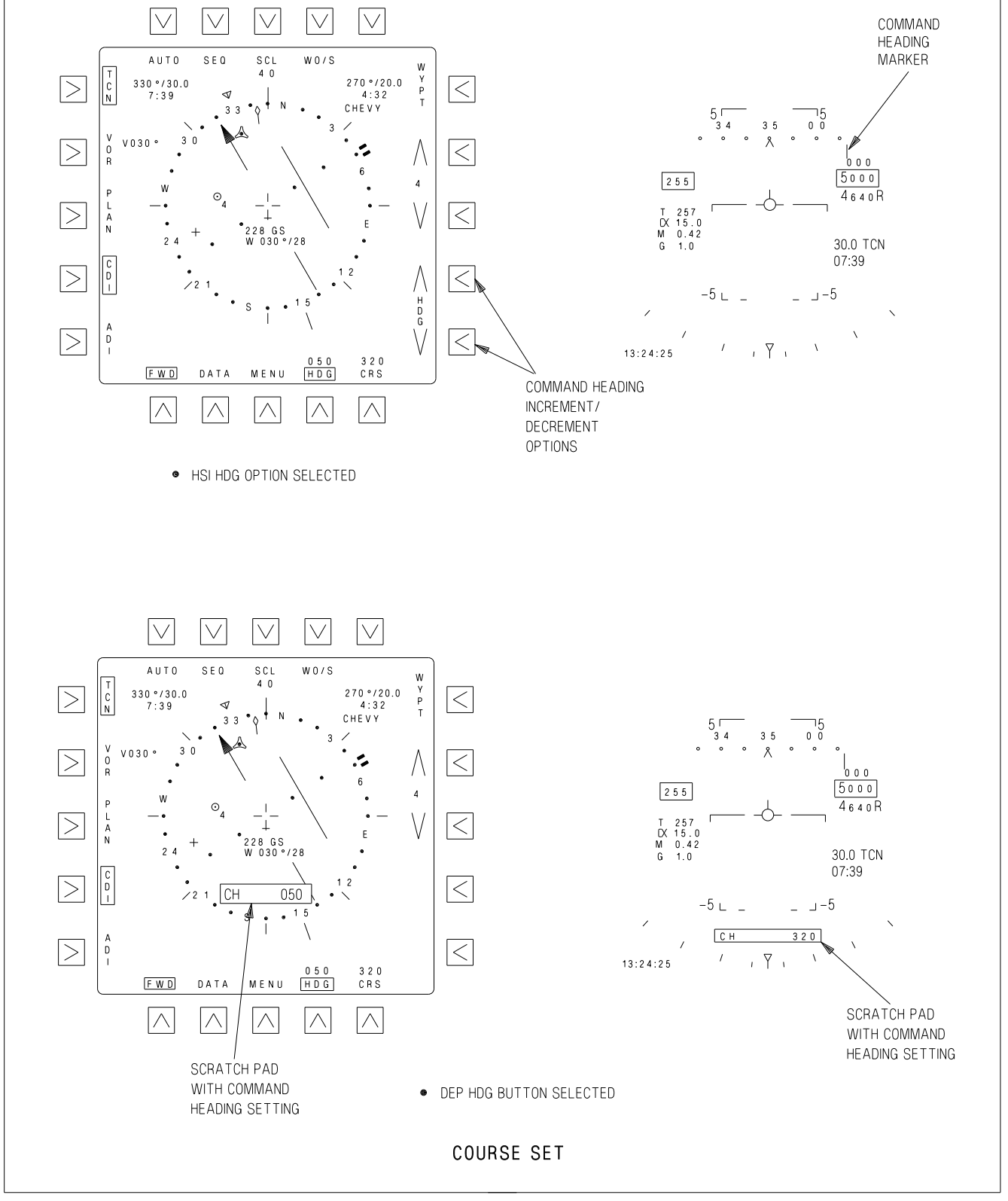


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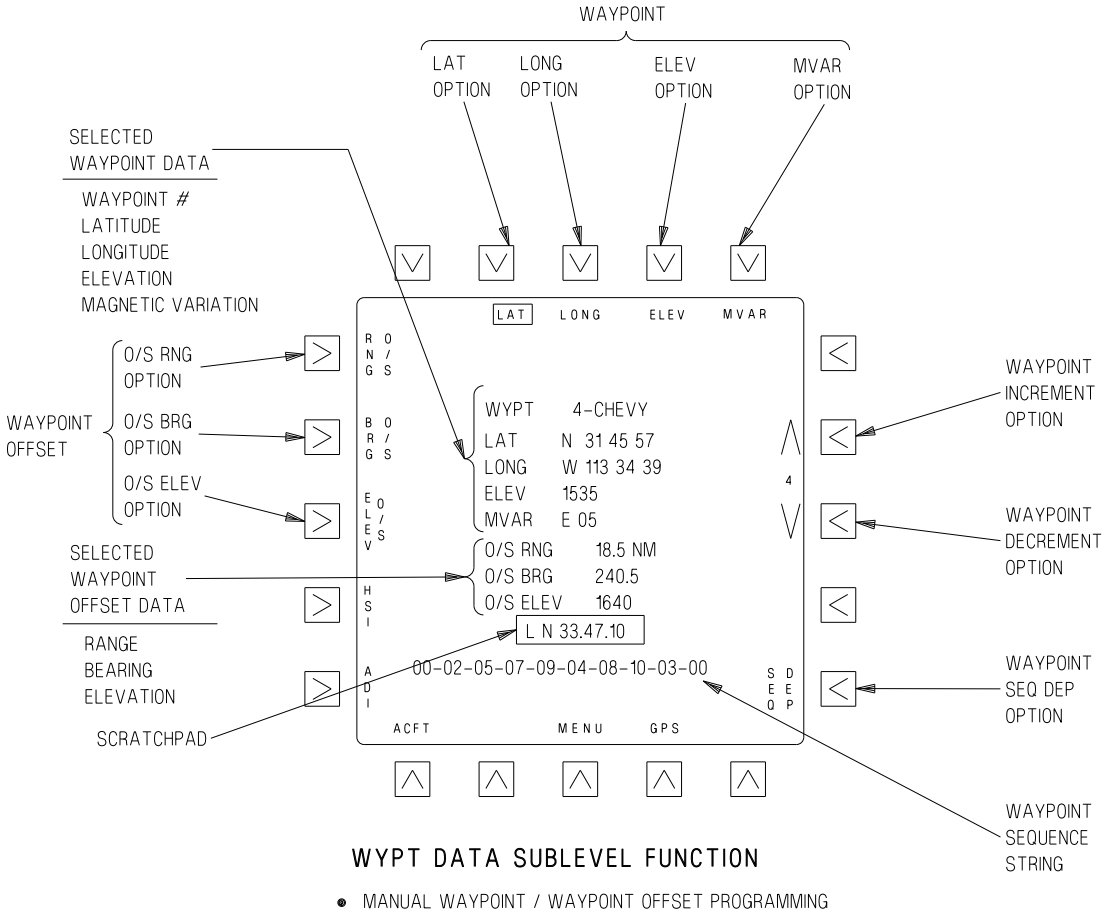
Figure 21-7. Navigation Programming (Sheet 2 of 4)



WYPT DATA SUBLEVEL FUNCTION

- MANUAL WAYPOINT / WAYPOINT OFFSET PROGRAMMING

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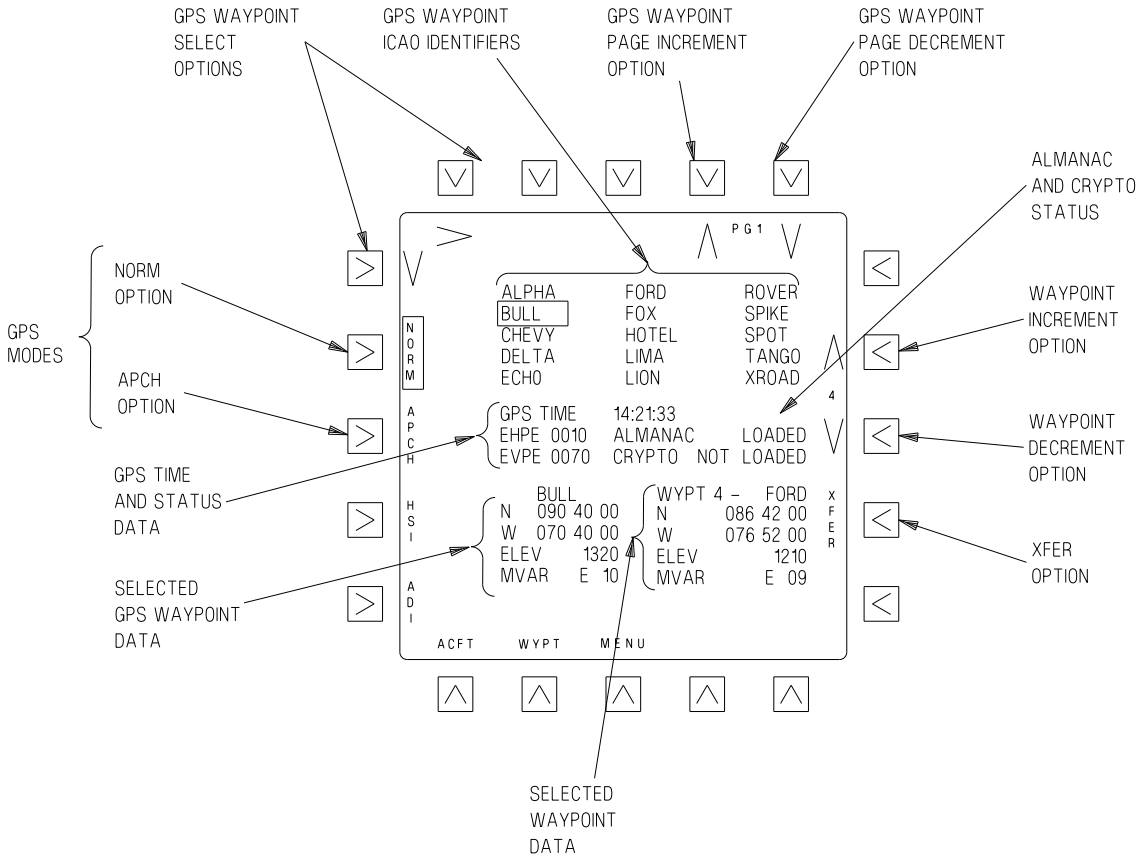
Figure 21-7. Navigation Programming (Sheet 3 of 4)



GPS DATA SUBLEVEL FUNCTIONS

- GPS WAYPOINT PROGRAMMING
- GPS CORRIDOR SELECTION
- GPS STATUS DATA

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Figure 21-7. Navigation Programming (Sheet 4 of 4)

To program the waypoint sequential string, select the WYPT DATA sublevel display. The previous waypoint sequential string will be displayed on the MFD. If the previous string is incorrect, select the SEQ DEP option, this will blank the string and enable the DEP for entry of the waypoint sequential string. The waypoints are entered by pressing the appropriate numbered data entry button on the DEP for the associated waypoint and then pressing the DEP ENT button. The waypoint number is now inserted into the string and appears on the WYPT DATA display. Repeat this action until the string is complete. There is no limit to how many times a waypoint may be entered into the string. When the tenth waypoint is entered, the string is automatically considered complete, the string is saved and the SEQ DEP option is unboxed. If the string is less than 10 waypoints, pressing the boxed SEQ DEP option will save the string and unbox the SEQ DEP option. During entry of the waypoint number on the DEP, if the waypoint number on the scratchpads is incorrect, pressing the DEP CLR button will clear the scratchpad and permit entry of the correct number. Once the DEP ENT has been pressed, if an incorrect waypoint number has been entered, the completed string must be deleted by deselecting and reselecting the SEQ DEP option on the WYPT DATA display and re-entering the waypoint string. Selecting the SEQ option on the HSI display will enable the dashed sequential steering lines. A minimum of two waypoints must be entered into a waypoint string before the SEQ option is displayed. The sequential steering lines will be displayed as each waypoint is added to the string. Selecting the larger scale on the HSI display, permits the aircrew to verify the proper selection of the waypoint sequential string as the string is entered.

NOTE

If first waypoint is also used as the last waypoint of the string, ensure the first waypoint in the string is selected, otherwise AUTO sequence will automatically disconnect when the waypoint is first overflown.

21.3.3.4 Waypoint Offset Programming. A waypoint offset is a point defined by bearing and range from an entered waypoint and an elevation. An offset may be entered for each entered waypoint.

Manual entry of waypoint offsets must be done using the WYPT DATA sublevel display, see Figure 21-7. The display is selected by pressing the DATA option on the MENU display, ADI display, etc. This display presents the following for the selected waypoint: waypoint number, waypoint data, and waypoint offset range, bearing, and elevation.

To select the desired waypoint, press the waypoint increment (∧) or decrement (∨) option until the desired waypoint number is displayed between the increment and decrement options and above the displayed waypoint data. To enter waypoint offset's range, bearing, and elevation select the appropriate option, O/S BRG (bearing), O/S RNG (range), and O/S ELEV (elevation). When the option is selected, it is boxed and the DEP is initialized for data entry (data entry buttons), and the scratchpads are displayed. Offset range must be between 0 to 99.9 nm, offset bearing must be between 0 (or 360) to 359.9 degrees, and offset elevation must be between -999 to 9,999 feet MSL. The waypoint offset will initially default to the waypoints elevation. Once the data has been entered and the DEP ENT button is pressed, the scratchpad disappears, the waypoint offset information is stored in the DEU, the WYPT DATA display is updated, and the scratchpads are removed. See Chapter 2, Data Entry Panel (DEP), for a description of the DEP. If the waypoint position is changed after the offset is entered, the offset data will automatically be reset to zero.

21.3.3.5 GPS Corridor. This function allows the aircrew to monitor GPS accuracy. There are two modes NORM (normal) and APCH (approach), and they appear on the GPS DATA sublevel display, see Figure 21-7. The GPS DATA sublevel is commanded by selecting the DATA option, then selecting the GPS option. These modes are automatically selected based upon the landing gear position. APCH (approach) mode is selected with the landing gear down and the NORM mode is selected with the landing gear up. The automatic modes may be overridden by selecting (boxing) the desired option. These modes are only active when the GPS option on the ADI display has been selected (boxed) as the sole navigation source, the condition is detected for 5 seconds, at an airspeed of less than 300 knots. These selections do not affect the scaling of the CDI.

The NORM mode is used for standard flight operations and triggers a CORRIDOR advisory when an error of 333 meters is detected for 5 seconds. The APCH mode is used for precision maneuvers such as an instrument approach. This mode triggers a CORRIDOR advisory when an error of 33 meters occurs.

NOTE

If the crypto keys have not been loaded into the GINA, the GPS will be unable to achieve the APCH mode accuracy. To remove the CORRIDOR advisory, manually select the NORM mode option after the landing gear has been extended.

21.3.3.6 GPS Status Data. GPS status data appears on the GPS DATA sublevel display, see Figure 21-7. The GPS DATA sublevel display is accessed by selecting the DATA option, then selecting the GPS option. This display indicates GPS time, EHPE (estimated horizontal position error), EVPE (estimated vertical position error), almanac status, and crypto status. The crypto keys are not used, as a result the crypto status will always appear NOT LOADED.

The estimated horizontal position error (EHPE) and estimated vertical position error (EVPE) errors are displayed in meters and used for the CORRIDOR advisory. The almanac status will appear as LOADED or NOT LOADED, which indicates if valid almanac file is loaded in the GINA. The almanac file is used to show which GPS satellites are in position for communication based on current aircraft position and time, and is transferred to the GINA from the MDL when the GINA is initialized.

21.3.4 Waypoint Steering. There are three types of waypoint steering available: PLAN, CDI, and AUTO. The HSI initializes with the PLAN mode selected and no steering selected. Waypoint range, bearing, time to go (to the selected waypoint) is displayed in the upper right corner of the HSI, see Chapter 2. Range, sequence number (W##), and time to go for the selected waypoint are displayed on the lower right side of the HUD when the WYPT option is selected. If ILS steering is selected in conjunction with waypoint steering the HUD will continue to display waypoint range and time to go, but WILS will replace the waypoint sequence number indicating both waypoint and ILS steering are selected.

21.3.4.1 Waypoint PLAN Steering. PLAN mode waypoint steering allows the aircrew to fly a selected course to the waypoint by maneuvering the aircraft (aircraft symbol) to intersect the course line, then maintaining the aircraft on the selected course.

PLAN mode waypoint steering is selected by selecting (boxing) the PLAN option, then selecting (boxing) the WYPT option. When this is done the waypoint bearing pointer and tail appear on the HSI, displaying bearing to the currently selected waypoint and the command steering marker on the ADI and HUD displays great circle route steering to the selected waypoint. The ground track marker can be placed over the waypoint bearing pointer, providing wind corrected steering to the waypoint. A course can now be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected (boxed) a course line appears over the waypoint symbol and the desired course can now be set, see Figure 21-8. In addition, when the CRS option is selected the

HUD course steering arrow and deviation scale are enabled and the command steering marker is removed from the ADI and HUD, see Chapter 2. The HUD course line and deviation scale are displayed and their sensitivity is based upon landing gear position. With the landing gear down they are displayed when course deviation is 0.03 nm or greater and full deflection (two dots) represents 0.3 nm deviation. With the landing gear up they are displayed when course deviation is 0.4 nm or greater and full deflection (two dots) represents 4 nm deviation.

21.3.4.2 Waypoint CDI Steering. CDI mode waypoint steering allows the aircrew to observe the amount of deviation from the selected course. The aircrew should position the aircraft (aircraft symbol) so the deviation line is centered over the aircraft symbol.

CDI mode waypoint steering is selected by selecting (boxing) the CDI option, then selecting (boxing) the WYPT option. When this is done the waypoint bearing pointer and tail appear referenced to the currently selected waypoint symbol, and a set of four course deviation dots (deflection scale) also appear. The command steering marker on the ADI and HUD displays great circle route steering to the selected waypoint. A course can be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1.

When the CRS option is selected (boxed) the segmented CDI course line will appear centered over the aircraft symbol with the center portion (course deviation line) parallel and offset from the head and tail of the course line based upon the digital course displayed above the CRS option. In addition, when the CRS option is selected the HUD course steering arrow and deviation scale are enabled and the command steering marker is removed from the ADI and HUD, see chapter 2. The desired course can now be set. Full scale deflection (two dots) of the HUD course steering arrow and HSI CDI course line center segment is based upon the position of the landing gear. With the landing gear up it represents 4 nm deviation. With landing gear down it represents 0.3 nm course deviation. The HUD course steering arrow and deviation scale will be displayed when the aircraft course deviation is 0.03 nm or greater with the landing gear down, or 0.4 nm or greater with the landing gear up. The aircraft should be flown so the course deviation line is centered in the course line (no deviation), see Figure 21-8.

WARNING

The course deviation line may suddenly jump from centered to a large deviation as the landing gear extends. The jump is due to the transition from normal mode to the approach mode and the resulting change in course deviation sensitivity, not to a sudden change in aircraft attitude.

NOTE

Manual selection of APCH or NORM mode does not affect the operation of the course deviation scale.

21.3.4.3 Waypoint AUTO (Automatic Sequential) Steering. Before AUTO sequential steering can be selected a waypoint sequence string must be programmed. AUTO sequential steering is selected by pressing (boxing) the AUTO option on the HSI display. When the AUTO option is selected any previously selected steering mode (TCN, VOR/ILS, or WO/S) is deselected. Steering cues are based upon the PLAN or CDI mode selection. Selection of the SEQ option will display the dashed sequential steering lines on the HSI display.

With AUTO sequential steering selected, steering is provided to the first waypoint in the waypoint sequence string. When the range to the waypoint is less than 5 nm and the difference between the waypoint bearing and aircraft ground track transitions from less than to greater than 90 degrees, the next waypoint in the sequence string is automatically selected and the course setting is updated to the current leg bearing. The waypoint increment/decrement options permit selection of waypoints contained within the sequential string, providing manual selection for steering to the desired waypoint in

the sequence string. Selection of the last waypoint in the string then wraps around to the first waypoint and vice versa.

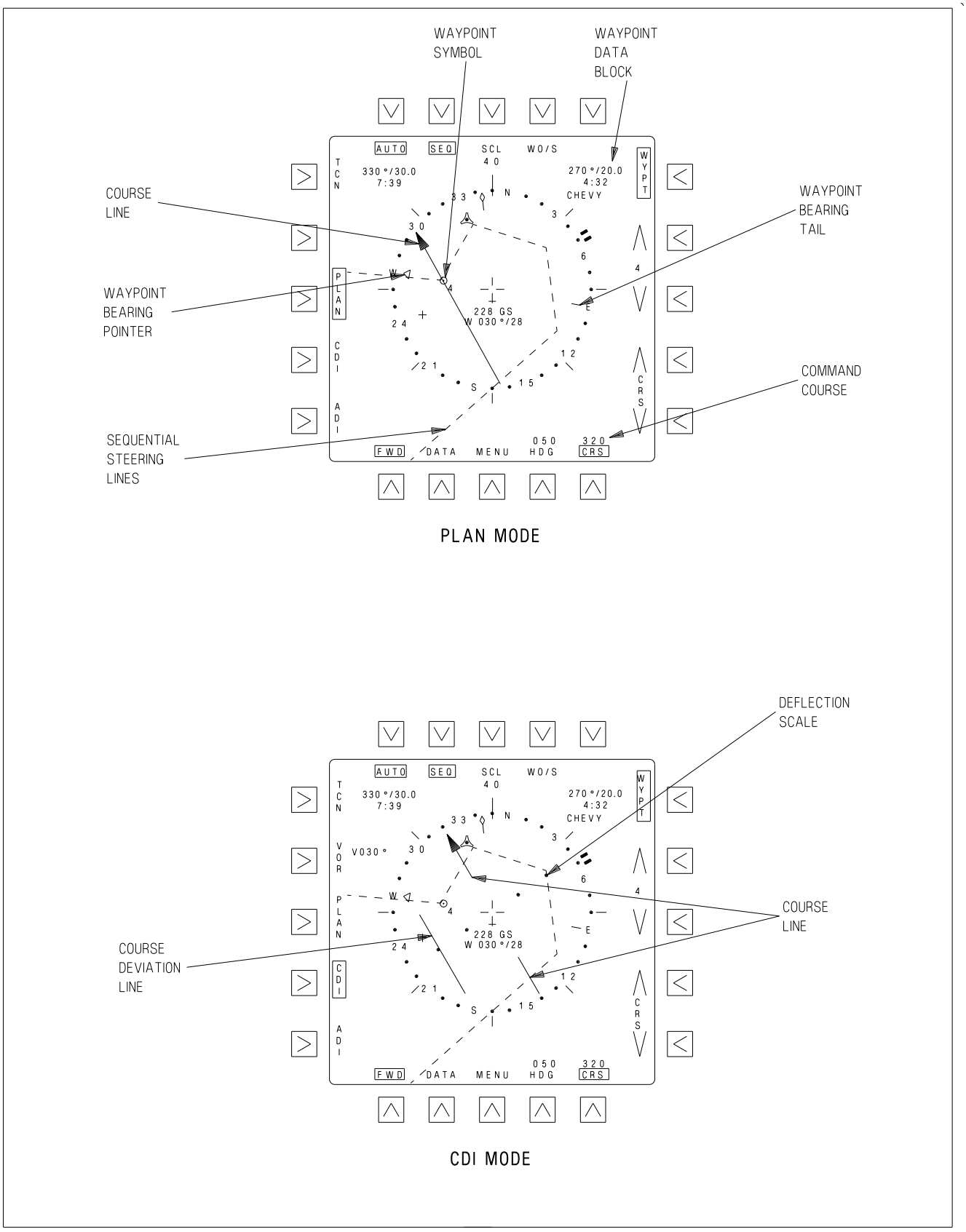

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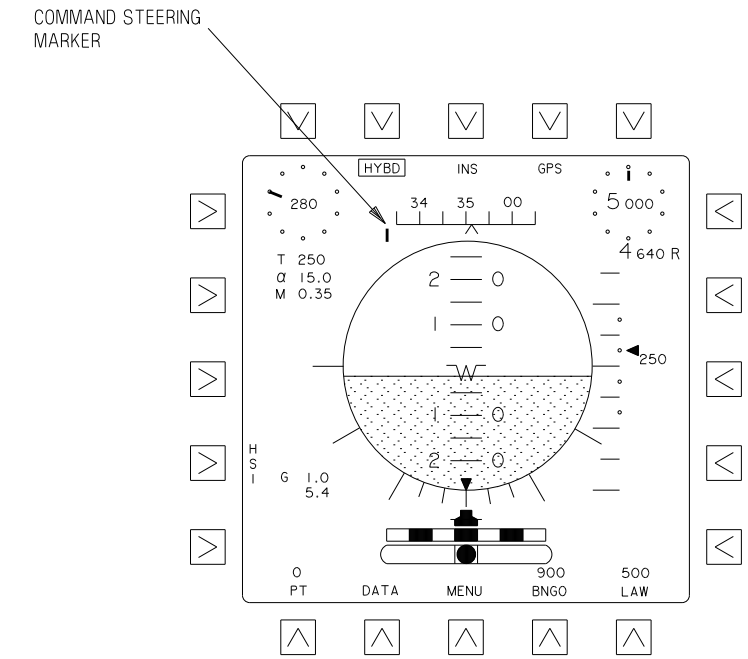
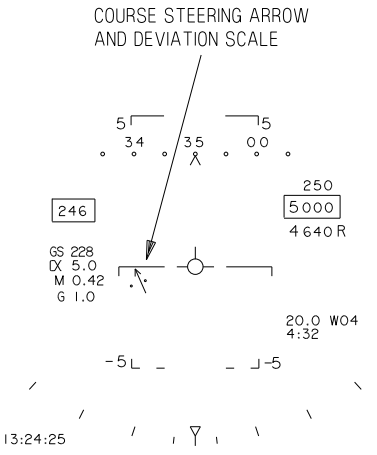
Figure 21-8. Waypoint Steering (Sheet 1 of 2)

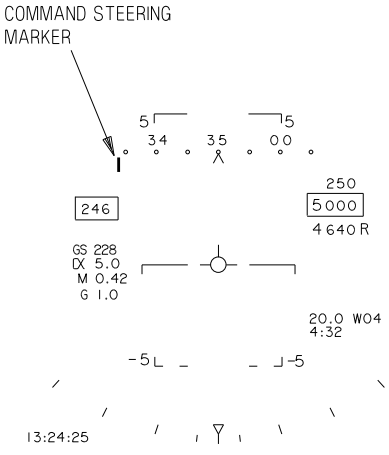


ADI DISPLAY



HUD

CRS OPTION SELECTED
(BOXED) ON HSI



HUD

CRS OPTION NOT SELECTED
(UNBOXED) ON HSI

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Figure 21-8. Waypoint Steering (Sheet 2 of 2)

AUTO sequential steering is deselected when any of the following occur: pressing the boxed AUTO option, pressing the boxed WYPT option, selection of another steering mode option (TCN, VOR/ILS, or WO/S), or when the last waypoint in the sequence is within 5 nm and the difference between the waypoint bearing and aircraft ground track transitions from less than to greater than 90 degrees. Unless the WYPT option is pressed or another steering mode is selected, when AUTO sequential steering is automatically deselected the WYPT steering will remain selected and the last sequential waypoint provides the steering reference.

21.3.5 Waypoint Offset Steering. There are two types of waypoint steering available: PLAN and CDI. The HSI initializes with the PLAN mode selected and no steering selected. Upon selection of the WO/S option on the HSI the selected waypoint's offset range, bearing, and time to go (to the selected waypoint's offset) is displayed in the upper right corner, refer to the HSI description in Chapter 2. Range, sequence number (O##), and time to go for the selected waypoint offset are displayed on the lower right side of the HUD when the WO/S option is selected (boxed). If ILS steering is selected in conjunction with waypoint offset steering the HUD will continue to display waypoint offset range and time to go, but OILS will replace the waypoint offset sequence number indicating both waypoint offset and ILS steering are selected.

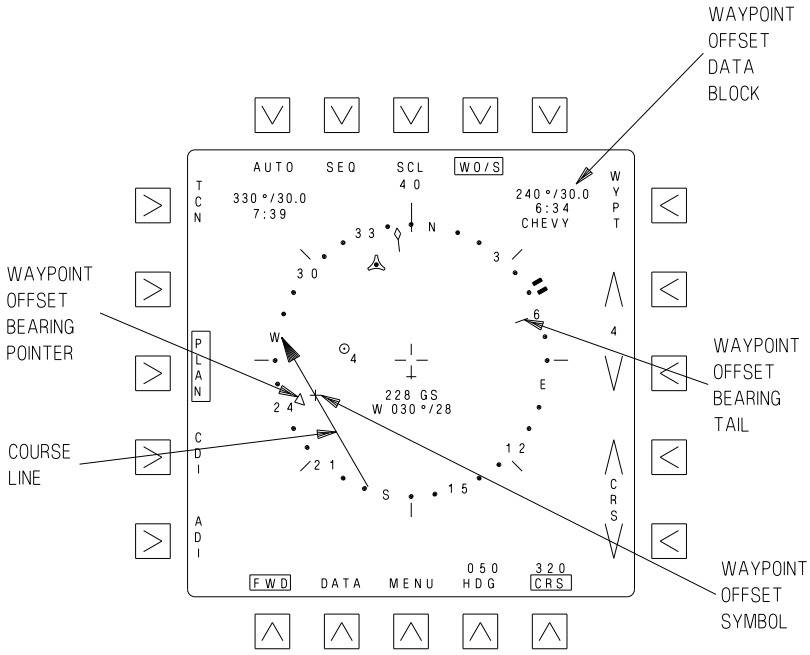
21.3.5.1 Waypoint Offset PLAN Steering. Waypoint offset PLAN mode steering allows the aircrew to fly a selected course to the waypoint offset. This is done by maneuvering the aircraft (aircraft symbol) to intersect the course line, then maintaining the aircraft on the selected course.

Waypoint offset PLAN mode steering is selected by pressing (boxing) the PLAN option, then pressing (boxing) the WO/S option. When this is done the waypoint offset bearing pointer and tail appear on the HSI, referenced to the currently selected waypoint's offset and the command steering marker on the ADI and HUD displays great circle route steering to the selected waypoint offset. A course can now be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected (boxed)a course line appears over the waypoint offset symbol and the desired course can now be set, see Figure 21-9. In addition, when the CRS option is selected the HUD course steering arrow and deviation scale are enabled and the command steering marker is removed from the ADI and HUD, see chapter 2. The HUD course line and deviation scale are displayed and their sensitivity is based upon landing gear position. With the landing gear down they are displayed and their sensitivity is based upon landing gear position. With the landing gear down they are displayed when course deviation is 0.03 nm or greater and full deflection (two dots) represents 0.3 nm deviation. With the landing gear up they are displayed when course deviation is 0.4 nm or greater and full deflection (two dots) represents 4 nm deviation.

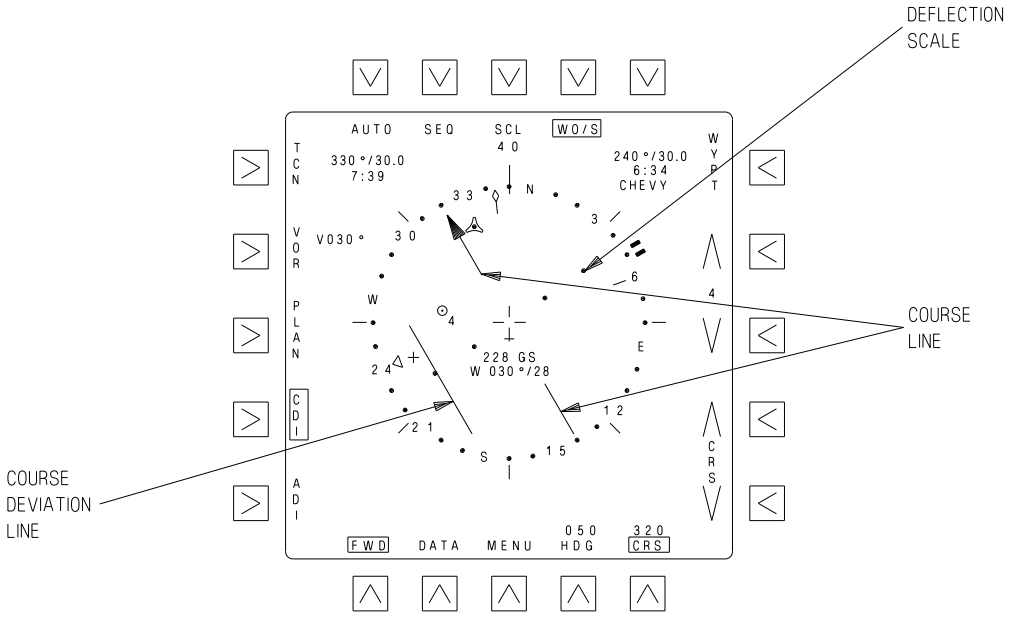
21.3.5.2 Waypoint Offset CDI Steering. Waypoint offset CDI mode steering allows the aircrew to observe the amount of deviation from the selected course. The aircrew should position the aircraft (aircraft symbol) so the deviation line is centered over the aircraft sysmbol.

Waypoint offset CDI mode steering is selected by pressing (boxing) the WO/S option. When this is done the waypoint offset bearing pointer and tail appear referenced to the currently selected waypoint's offset symbol and a set of four course deviation dots (deflection scale) also appear. The command steering marker on the ADI and HUD displays great circle route steering to the selected waypoint offset.

A course can be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected (boxed) the segmented CDI course line will appear centered over the aircraft symbol with the center portion (course deviation line) parallel and offset from the head and tail of the course line based upon the digital course displayed above the CRS option. In addition, when the CRS option is selected the HUD course steering arrow and deviation scale are enabled and the command steering marker is



PLAN MODE



CDI MODE

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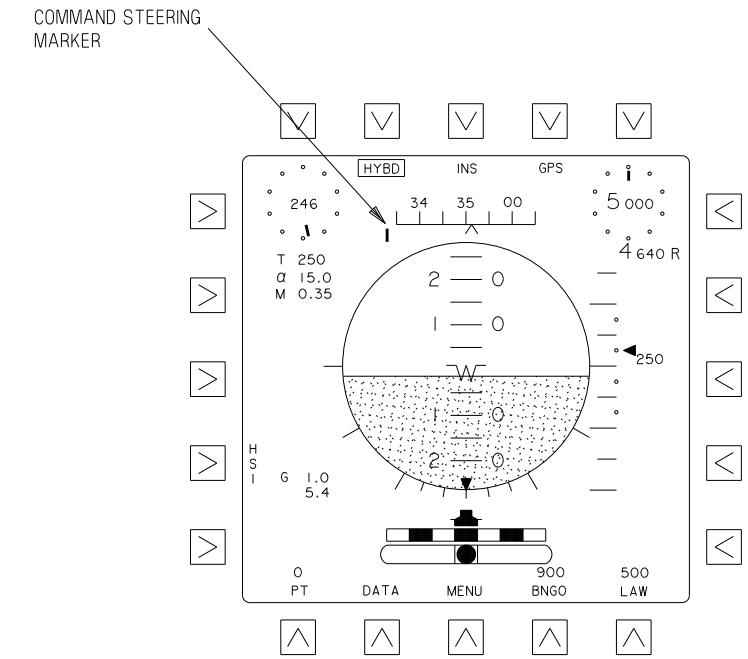
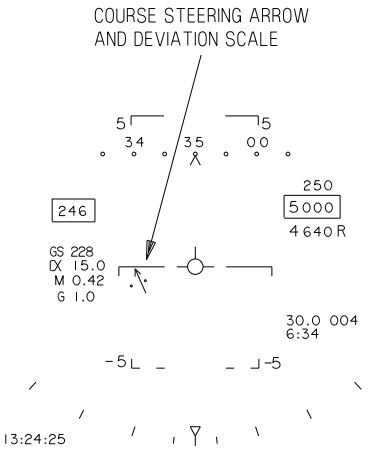
Figure 21-9. Waypoint Offset Steering (Sheet 1 of 2)

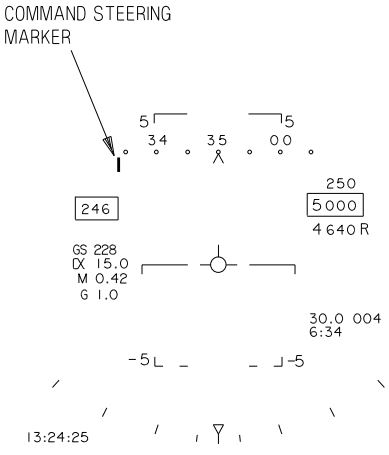


ADI DISPLAY



HUD

CRS OPTION SELECTED (BOXED) ON HSI



HUD

CRS OPTION NOT SELECTED (UNBOXED) ON HSI

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Figure 21-9. Waypoint Offset Steering (Sheet 2 of 2)

removed from the ADI and HUD, see Chapter 2. The desired course can now be set. Full scale deflection (two dots) of the HUD course steering arrow and HSI CDI course line center segment is based upon the position of the landing gear. With the landing gear up it represents 4 nm deviation. With landing gear down it represents 0.3 nm course deviation. The HUD course steering arrow and deviation scale will be displayed when the aircraft ground track deviation from the course line is 0.4 nm or greater with the landing gear up, or 0.03 nm or greater with the landing gear down. The aircraft should be flown so the course deviation line is centered in the course line (no deviation), see Figure 21-9.

WARNING

The course deviation line may suddenly jump from centered to a large deviation as the landing gear extends. The jump is due to the transition from normal mode to the approach mode and the resulting change in course deviation sensitivity, not to a sudden change in aircraft attitude.

NOTE

Manual selection of APCH or NORM mode does not affect the operation of the course deviation scale.

21.3.6 TACAN (Tactical Air Navigation) System. The AN/ARN-136B(V) TACAN system provides precise magnetic bearing and/or slant range distance to a TACAN ground station or range to a suitably equipped aircraft. The system consists of a receiver/transmitter and azimuth computer located in the forward equipment bay, an antenna (Figure 21-2), and TACAN control panels in both cockpits (Figure 21-5).

21.3.6.1 TACAN Operation. The TACAN system operates in the L-Band frequency range, limiting the operating range to line of sight which depends upon aircraft altitude. The aircraft receives a three letter audio station signal to identify the beacon being received. The system operates on one of 252 channels. Each channel corresponds to two frequencies, one for air-to-ground interrogation and the other for ground-to-air responses. The range of interrogation frequencies is 1025 to 1150 MHz (126 channels at 1 MHz intervals), and the reply frequency is 63 MHz above or below the interrogation frequency in the frequency range of 962 to 1213 MHz. In air-to-ground mode, the system provides an indication of magnetic bearing and slant range to a selected surface beacon. When operating in conjunction with aircraft having air-to-air (A/A) capability, the A/A mode provides line of sight distance between two aircraft operating their TACAN sets 63 channels apart. Up to five aircraft can determine line of sight distance from a sixth aircraft in the A/A mode.

21.3.6.2 TACAN BIT. A warmup period of 5 seconds is required before system operation. A built-in-test of the TACAN system is performed as follows:

1. Select (box) the CDI and TCN options on the HSI display.
2. Set a course of 180 degrees on the HSI display (CRS option).
3. Press and hold (minimum of 5 seconds) the TEST push-button on the TACAN control panel.

The following occurs:

4. The TACAN bearing pointer will indicate 180 ±2.5 degrees
5. Range will read 0 ±1 nm.
6. The course deviation scale will be centered.

21.3.6.3 TACAN Steering. TACAN steering requires that a valid TACAN station be selected. TACAN range, bearing, time to go, and station appear in the upper left corner, refer to the HSI description in Chapter 2. Range, steering mode (TCN), and time to go for the selected TACAN is displayed on the lower right side of the HUD. If ILS is selected in conjunction with TACAN steering the HUD will continue to display

TACAN range and time to go, but TILS will replace TCN indicating both TACAN and ILS steering are selected. There are two types of TACAN steering available, PLAN and CDI. The HSI initializes with PLAN mode selected and no steering selected.

21.3.6.3.1 TACAN PLAN Steering. PLAN mode TACAN steering allows the aircrew to fly a selected course to the TACAN station. This is done by maneuvering the aircraft (aircraft symbol) to intersect the course line, then maintaining the aircraft on the selected course.

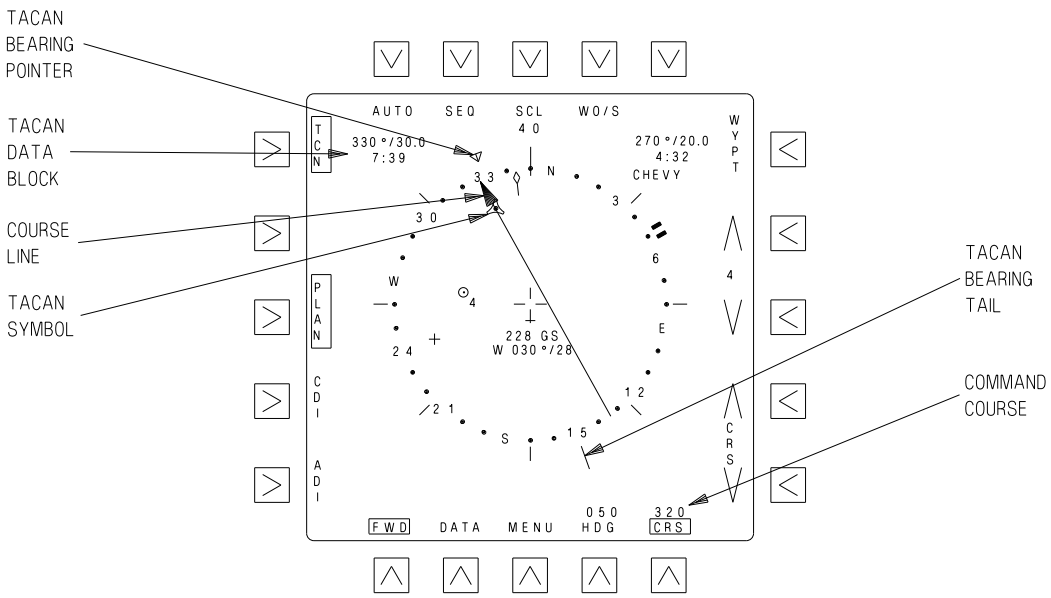
PLAN mode TACAN steering is selected by actuating (boxing) the PLAN option, then selecting (boxing) the TCN option. When this is done the TACAN bearing pointer and tail appear on the HSI, referenced to the currently selected TACAN station and the command steering marker on the ADI and HUD displays great circle route steering to the selected TACAN station. A course can now be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected (boxed) a course line appears over the TACAN symbol and the desired course can now be set, see Figure 21-10. In addition, when the CRS option is selected the HUD course steering arrow and deviation scale are enabled and the command steering marker is removed from the ADI and HUD, see Chapter 2. The HUD course line and deviation scale are displayed with a course deviation greater than 1 degree. Course deviation is 5 degrees for one dot deviation and full deflection (two dots) represents 10 degrees deviation.

21.3.6.3.2 TACAN CDI Steering. CDI mode TACAN steering allows the aircrew to observe the amount of deviation from the selected course. The aircrew should position the aircraft (aircraft symbol) so the deviation line is centered over the aircraft symbol.

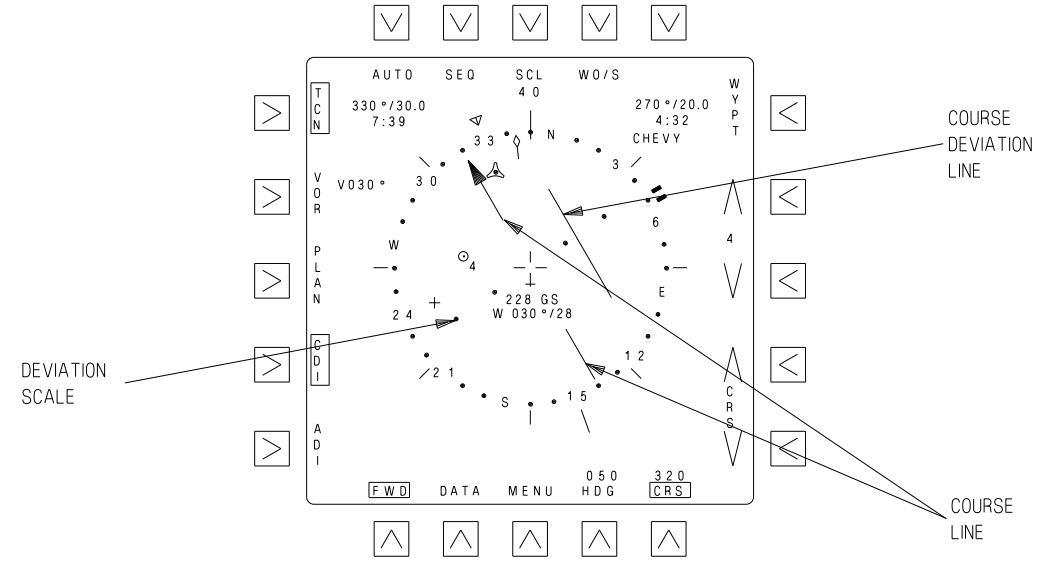
CDI mode TACAN steering is selected by actuating (boxing) the CDI option, then selecting (boxing) the TCN option. When this is done the TACAN bearing pointer and tail appear referenced to the currently selected TACAN station and a set of four course deviation dots (deflection scale) also appear. The command steering marker on the ADI and HUD displays great circle route steering to the selected TACAN station. A course can be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected (boxed) the segmented CDI course line will appear centered over the aircraft symbol with the center portion (course deviation line) parallel and offset from the head and tail of the course line based upon the digital course displayed above the CRS option. In addition, when the CRS option is selected (boxed) the HUD course steering arrow and deviation scale are enabled and the command steering marker is removed from the ADI and HUD, see Chapter 2. The desired course can now be set. Deflection of the HUD course steering arrow and HSI CDI course line center segment is based upon the amount of course deviation. One dot represents 5 degrees deviation and two dots (full deflection) represents 10 degrees deviation. The aircraft should be flown so the course deviation line is centered in the course line (no deviation), see Figure 21-10.

NOTE

- Manual selection of APCH or NORM mode does not affect the operation of the course deviation scale.
- Loss of TACAN range while in CDI steering mode results in the removal of the following data from the HSI TACAN data block: TACAN station symbol, digital range and time-to-go. The HSI course line and TACAN digital bearing display continue to update, but the course deviation line remains frozen at the last DME update. The HUD TACAN digital time-to-go, distance to selected steerpoint, course steering arrow, and deviation scale are also removed.



PLAN MODE



CDI MODE

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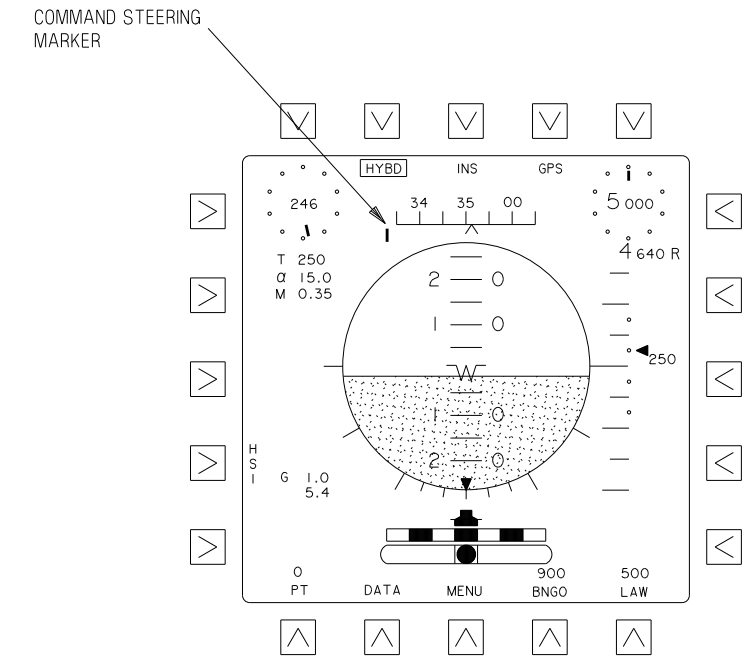
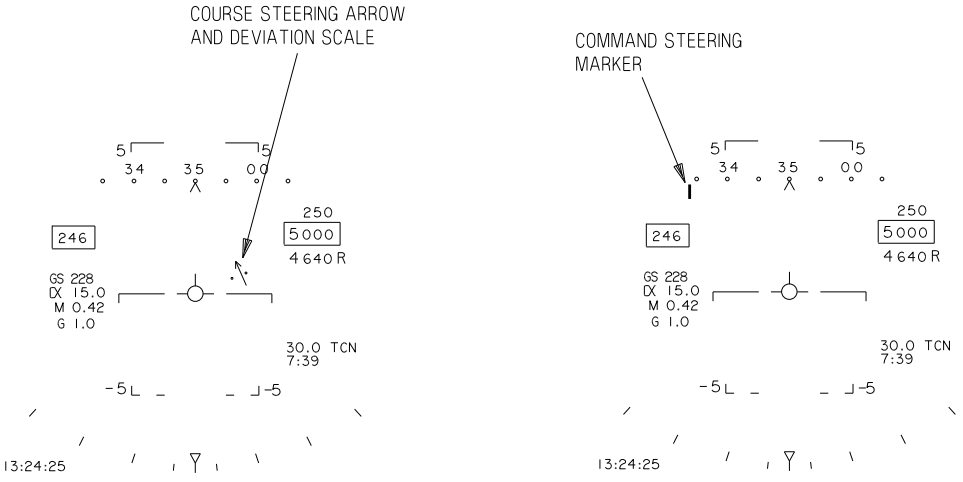
Figure 21-10. TACAN Steering (Sheet 1 of 2)



ADI DISPLAY



HUD

CRS OPTION SELECTED (BOXED) ON HSI

HUD

CRS OPTION NOT SELECTED (UNBOXED) ON HSI

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Figure 21-10. TACAN Steering (Sheet 2 of 2)

21.3.7 VOR/ILS System. The AN/ARN-144(V) VOR/ILS system provides VOR navigation information to the HSI, ADI and HUD displays. When ILS is selected and an ILS frequency is tuned, the localizer and glideslope steering needles display localizer course and glideslope deviation on the ADI and HUD. Marker beacon passage is indicated by flashing of the marker beacon lights and an audio tone.

The system consists of a receiver located in the forward equipment bay, antennas (Figure 21-2), VOR/ILS control panels and marker beacon lights in both cockpits (Figure 21-5).

The system frequency range for VOR navigation information (displayed on the HSI) is the even decimal frequencies from 108.00 to 111.85 MHz and all frequencies from 112.00 to 117.95 MHz. The ILS operates on odd decimal frequencies from 108.10 to 111.95 MHz for ILS localizer and glideslope information. Tuning to a localizer frequency automatically selects a paired glideslope frequency.

21.3.7.1 VOR Operation. With the power/frequency selector on the VOR/ILS control panel set to PWR and a valid VOR frequency is tuned, the transmitting ground station signals are routed through the VOR/LOC antenna to the receiver. The VOR signal includes a reference phase and a variable phase with the phase difference being directly related to the bearing of the ground station from or to the aircraft. The receiver processes these signals and the heading input signal from the GINA to provide outputs for positioning the VOR bearing pointer on the HSI display and the command steering marker on the HUD and ADI. The station identity signal is also processed by the receiver to provide audio signal to the pilot headset when the VOR switch on the COMM control panel is set to VOR position, see Figure 21-11.

21.3.7.2 ILS Operation. With the power/frequency selector on the VOR/ILS control panel set to PWR and a valid ILS frequency is tuned, signals from the localizer and glideslope transmitters are routed through the VOR/LOC and glideslope antennas to the receiver. The receiver detects, filters and compares the 90 Hz and 150 Hz signals to provide outputs, proportional to localizer and glideslope deviations, displayed on the HSI, ADI, and HUD displays. See Figure 21-12.

21.3.7.3 VOR/ILS BIT. A warmup period of 5 seconds is required before system operation. A built-in-test of the VOR/ILS system is performed as follows:

1. Select the VOR/ILS option on the HSI display.
2. Set a course of 000 degrees on the HSI display (CRS option).
3. Set and hold the Power/Frequency selector in the TEST position.

If the VOR system is receiving a valid VOR signal the following occurs:

1. The VOR bearing pointer will indicate 315 ± 3.0 degrees.
2. The course deviation line will move to the left ±2 dots maximum.
3. The marker beacon lights will illuminate.

If the VOR system is not receiving a valid VOR signal the following occurs:

1. The marker beacon lights will illuminate.

21.3.7.4 VOR Steering. VOR steering is only available in the CDI mode. CDI mode VOR steering allows the aircrew to observe the amount of deviation from the selected course. The aircrew should position the aircraft (aircraft symbol) so the deviation line is centered over the aircraft symbol. VOR bearing appears when a valid station is tuned.

CDI mode VOR steering is selected by actuating (boxing) the CDI option, then selecting (boxing) the VOR option. When this is done the VOR bearing pointer and tail are displayed referenced to the currently selected VOR station and a set of four course deviation dots (deflection scale) also appear. The command steering marker on the ADI and HUD displays bearing to the

selected station. VOR is displayed on the lower right side of the HUD indicating the selected steering mode. A course can now be set using the CRS option, refer to Course Setting, paragraph 21.3.3.1. When the CRS option is selected a course line will appear centered over the aircraft symbol with the center portion (course deviation line) parallel and offset from the head and tail of the course line based upon the digital course displayed above the CRS option. The desired course can now be set. Full scale deflection (two dots) of the CDI course line center represents 10 degree deviation. The aircraft should be flown so the course deviation line is centered in the course line (no deviation), see Figure 21-10.

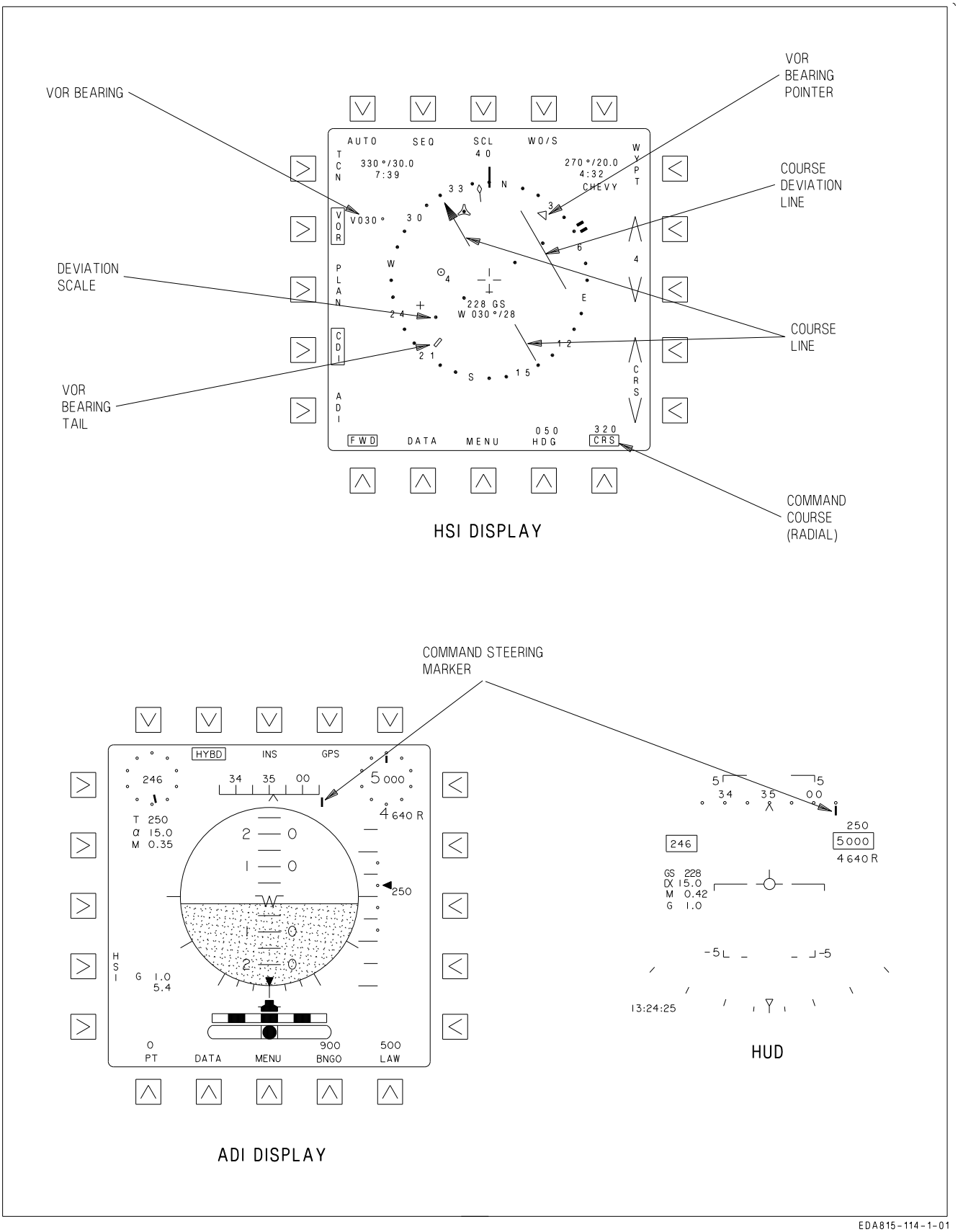

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Figure 21-11. VOR Steering

21.3.7.4.1 ILS Steering. ILS steering provides the aircrew with the precision steering symbology required for an instrument approach. ILS steering requires that a valid ILS station be selected. When selected (boxed) ILS is displayed on the lower right side of the HUD. If TACAN, waypoint, or waypoint offset steering is selected in conjunction with the ILS the steering identifier will be changed to indicate both steering modes are selected (TILS, WILS, or OILS). ILS can only be selected in the CDI mode, however, once selected it will remain selected and the localizer and glideslope needles displayed (ADI and HUD) in either the CDI or PLAN mode until the frequency is changed or it is deselected.

21.3.7.4.2 ILS CDI Steering. CDI mode ILS steering is selected by actuating (boxing) the CDI option, then selecting (boxing) the ILS option on the HSI display.

When ILS steering is selected, a set of four course deviation dots (deflection scale) and course line appear on the HSI display and the localizer and glideslope needle are displayed on the ADI and HUD. The course line is centered over the aircraft symbol and is segmented with the center portion (course deviation line) parallel and offset from the head and tail of the course line. The CRS setting does not affect the deviation indication, however, it may be adjusted at this time to align the CDI course line with the actual ILS course heading, providing a correctly oriented view of the course deviation. In the ILS steering mode the command steering marker will be referenced to the command heading setting.

On the HSI display, the ILS deviation scale is relative. The relative representation must be interpreted by the aircrew based on the width of the localizer course. For example, if the localizer course is 5 degrees wide the full scale deflection is 2.5 degrees and each dot is 1.25 degrees see Figure 21-12.

NOTE

In ILS steering the course selection has no affect on the displayed deviation indication.

On the ADI display and HUD, the localizer steering needle deflects up to 2.5 degrees either side (azimuth) of the waterline symbol (ADI) or velocity vector (HUD). The glideslope steering needle deflects up to 1 degree either side (elevation) of the waterline symbol or velocity vector (top and bottom of the localizer needle), see Figure 21-12. The localizer or glideslope needles flash when they become limited. When glideslope or localizer inputs become invalid the respective needle will be blanked and a GLIDESLOPE or LOCALIZER advisory will flash. An invalid localizer input shall also blank the glideslope needle. If both inputs are invalid, an ILS advisory will flash. While in CDI mode, another steering mode (TCN, WYPT, WO/S) may be selected without deselecting ILS. If another steering mode is selected the CDI course line will display course deviation to the other navigation source and the localizer and glideslope needles shall display ILS steering. The command steering marker shall either switch to indicate great circle steering to the selected steering reference or if CRS is boxed be removed, refer to chapter 2.

21.3.7.4.3 ILS Steering With PLAN Mode Selected. ILS steering may be displayed on the ADI and HUD when PLAN mode is selected. The ILS steering mode must first be selected from the CDI mode display, see paragraph 2.3.7.5.2. Once ILS has been selected on the CDI display the HSI may be switched to the PLAN mode without deselecting ILS. ILS steering will continue to be provided on the HUD and ADI, however, a course line for ILS will not be displayed on the HSI. ILS will be deselected when the channel is changed.

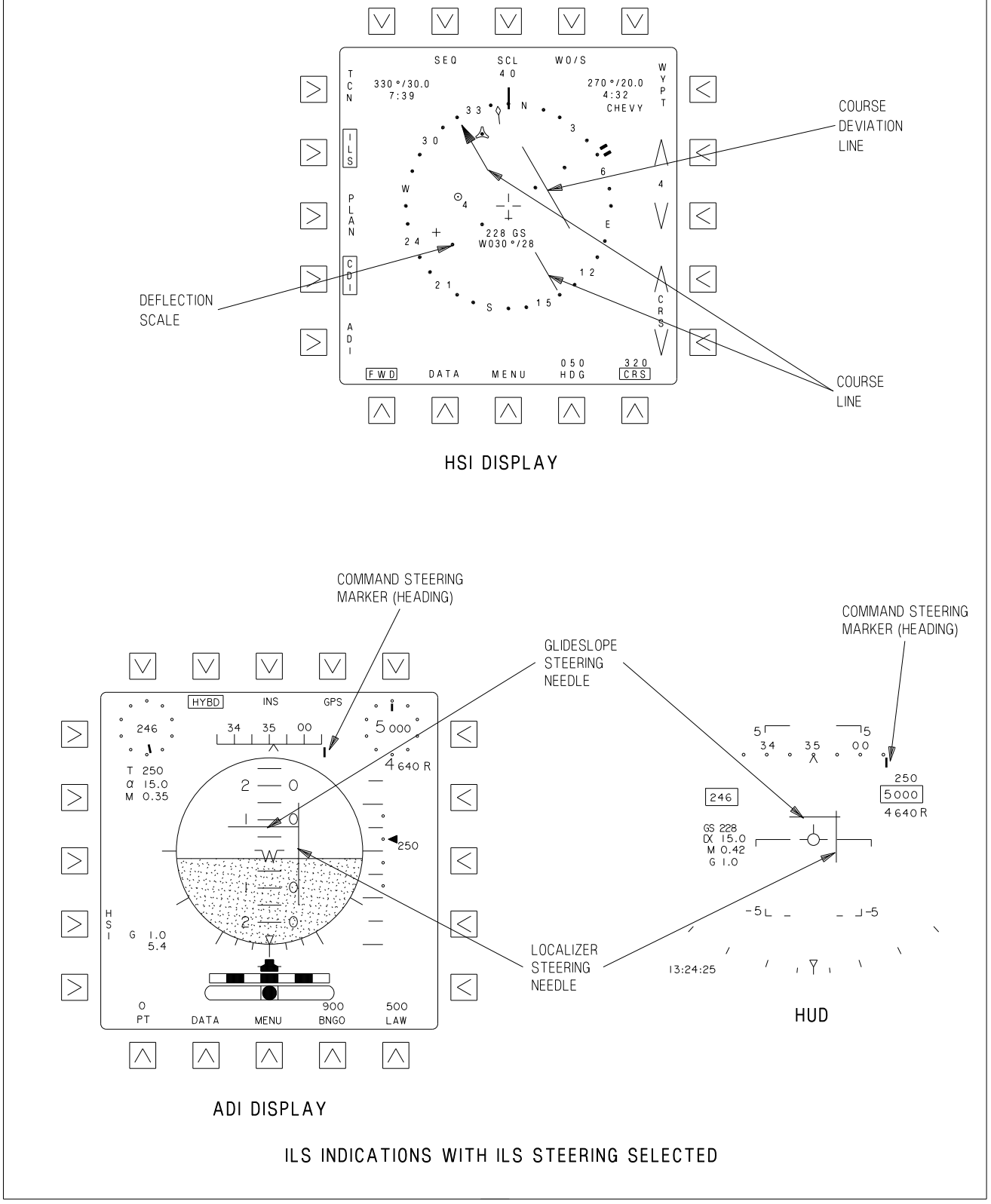

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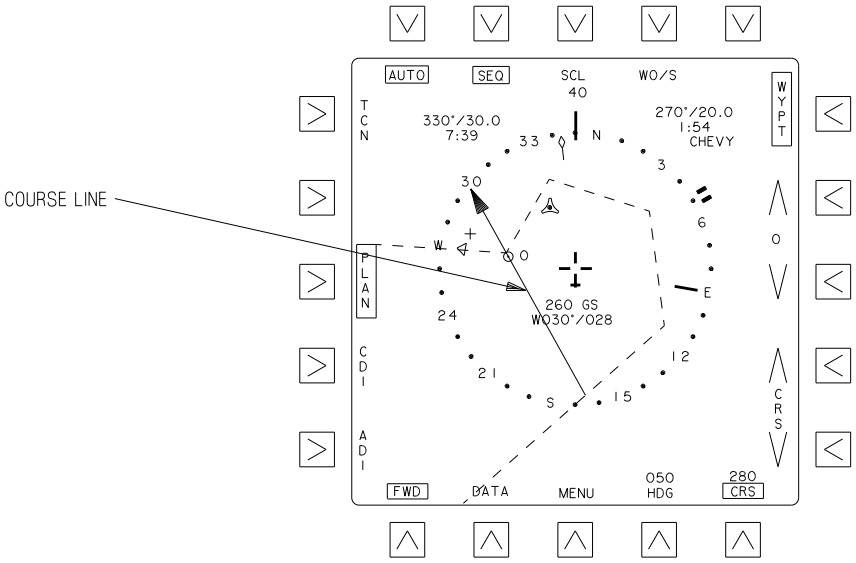
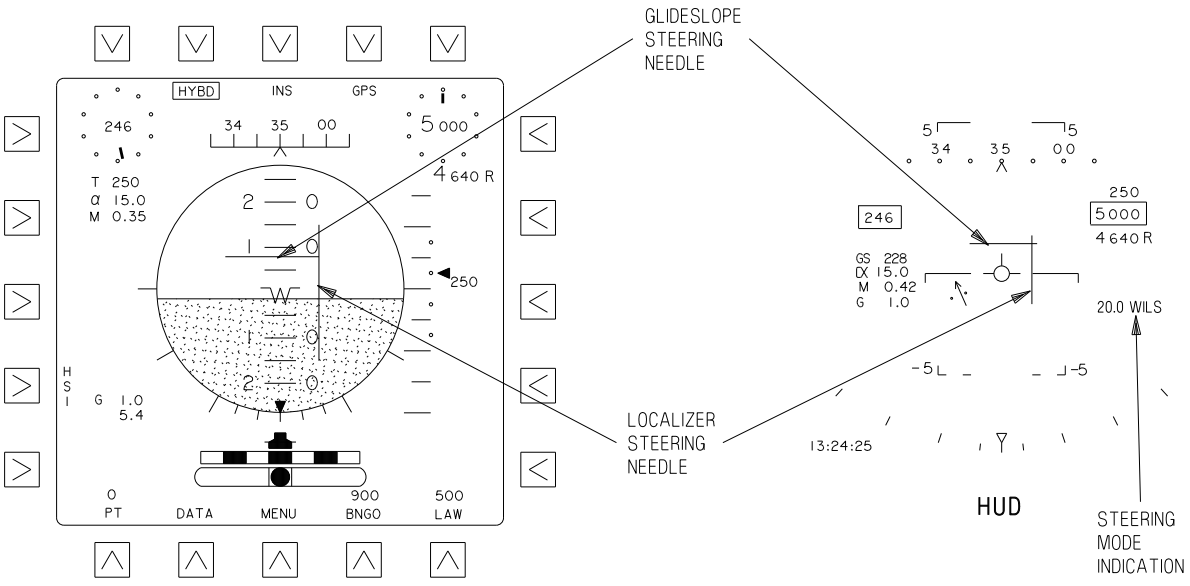
Figure 21-12. ILS Steering (Sheet 1 of 2)



PLAN MODE



ADI DISPLAY

ILS INDICATIONS WITH A DIFFERENT STEERING MODE SELECTED (TYPICAL)

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Figure 21-12. ILS Steering (Sheet 2 of 2)

21.4 VISUAL SIGNALS

The standard hand signals used for all naval aircraft operations are contained in NWP 50-2 series and apply to the T-45C aircraft operation. See figure 21-13, sheets 1 thru 9.

21.5 DECK/GROUND HANDLING SIGNALS

See Figure 21-14, sheets 1 thru 3.

VISUAL COMMUNICATIONS

GENERAL SIGNALS

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
THUMBS UP OR NOD OF HEAD	FLASHLIGHT MOVED VERTICALLY UP AND DOWN REPEATEDLY	AFFIRMATIVE (“YES” OR “I UNDERSTAND”)	
THUMBS DOWN OR TURN OF HEAD FROM SIDE TO SIDE	FLASHLIGHT MOVED HORIZONTALLY BACK AND FORTH REPEATEDLY	NEGATIVE (“NO” OR “I DO NOT UNDERSTAND”)	
HAND CUPPED BEHIND EAR AS IF LISTENING		QUESTION USED IN CONJUNCTION WITH ANOTHER SIGNAL. THIS GESTURE INDICATES THAT THE SIGNAL IS INTERROGATORY	AS APPROPRIATE
HAND HELD UP WITH PALM OUTWARD		WAIT	
EMPLOY FINGERS HELD VERTICALLY TO INDICATE DESIRED NUMERALS 1 THRU 5. WITH FINGERS HORIZONTAL. INDICATE NUMBER WHICH ADDED TO 5 GIVES DESIRED NUMBER FROM 6 TO 9. A CLENCHED FIST INDICATES 0. (HOLD HAND NEAR CANOPY WHEN SIGNALING).		NUMERALS AS INDICATED	A NOD OF THE HEAD (“I UNDERSTAND”) TO VERIFY NUMERALS. IF ORIGINATOR NODS, INTERPRETATION IS CORRECT. IF ORIGINATOR REPEATS NUMERALS, ADDRESSEE SHOULD CONTINUE TO VERIFY THEM UNTIL THEY ARE UNDERSTOOD
RAISED FIST WITH THUMB EXTENDED IN DRINKING POSITION.		HOW MUCH FUEL DO YOU HAVE?	INDICATE REMAINING FUEL IN HUNDREDS OF POUNDS BY FINGER NUMBERS

Figure 21-13. Visual Communications (Sheet 1 of 9)

MALFUNCTIONING EQUIPMENT (HEFOE CODE)

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
ARM ACROSS FOREHEAD (WEEPING SIGNAL) AND THEN INDICATING BY FINGER NUMBERS 1 TO 5 THE AFFECTED SYSTEM.	FLASHLIGHT HELD CLOSE TO TOP OF CANOPY, POINTED TOWARD WINGMAN. FOLLOWED BY 1 TO 5 DASHES TO INDICATE SYSTEM AFFECTED.	NUMBER OF FINGERS OR DASHES MEANS: 1. HYDRAULIC SYSTEM 2. ELECTRICAL SYSTEM 3. FUEL SYSTEM 4. OXYGEN SYSTEM 5. ENGINE	DAY: NOD OR THUMBS UP (“I UNDERSTAND”) NIGHT: VERTICAL MOVEMENT OF FLASHLIGHT PASS LEAD TO DISABLED PLANE OR ASSUME LEAD, IF INDICATED.

Figure 21-13. Visual Communications (Sheet 2 of 9)

VISUAL COMMUNICATIONS

FORMATION

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
OPEN HAND HELD VERTICALLY AND MOVED FORWARD OR BACKWARD, PALM IN DIRECTION OF MOVEMENT		ADJUST WING POSITION FORWARD OR AFT.	WINGMAN MOVES IN DIRECTION INDICATED.
OPEN HAND HELD HORIZONTALLY AND MOVED SLOWLY UP OR DOWN, PALM IN DIRECTION OF MOVEMENT.		ADJUST WING POSITION UP OR DOWN.	WINGMAN MOVES UP OR DOWN AS INDICATED.
OPEN HAND USED AS IF BECKONING INBOARD OR PUSHING OUTBOARD.		ADJUST WING POSITION LATERALLY TOWARDS OR AWAY FROM LEADER.	WINGMAN MOVES IN DIRECTION INDICATED.
HAND OPENED FLAT AND PALM DOWN, SIMULATING DIVE OR CLIMB.		I AM GOING TO DIVE OR CLIMB.	PREPARE TO EXECUTE.
HAND MOVED HORIZONTALLY ABOVE GLARE SHIELD, PALM DOWN.		LEVELING OFF.	PREPARE TO EXECUTE.
TWO FINGERS POINTED TOWARD EYES (MEANING IFF/SIF SIGNALS FOLLOWED BY: 1. CUT 2. THREE DIGIT NUMERALS		1. TURN IFF/SIF TO “STANDBY”. 2. SET MODE AND CODE INDICATED: FIRST NUMERAL-MODE. SECOND AND THIRD NUMERALS-CODE.	REPEAT, THEN EXECUTE.
HEAD MOVED BACKWARD.		SLOW DOWN.	EXECUTE.
HEAD MOVED FORWARD.		SPEED UP.	EXECUTE.
HEAD NODDED RIGHT OR LEFT.		I AM TURNING RIGHT OR LEFT.	PREPARE TO EXECUTE.

Figure 21-13. Visual Communications (Sheet 3 of 9)

VISUAL COMMUNICATIONS

FORMATION (CONT)

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
THUMB WAVED BACKWARD OVER SHOULDER.		TAKE CRUISE FORMATION OR OPEN UP.	EXECUTE.
1. HOLDS UP RIGHT (OR LEFT) FOREARM VERTICALLY, WITH CLENCHED FIST OR SINGLE WING-DIP. 2. SAME AS ABOVE EXCEPT WITH PUMPING MOTION OR DOUBLE WING-DIP.		1. WINGMAN CROSS UNDER TO RIGHT (OR LEFT) ECHELON OR IN DIRECTION OF WING DIPS. 2. SECTION CROSS UNDER TO RIGHT (OR LEFT) ECHELON OR IN DIRECTION OF WING DIPS.	1. EXECUTE. 2. EXECUTE.
TRIPLE WING-DIP.		DIVISION CROSS UNDER. FORM A VEE OR BALANCED FORMATION.	EXECUTE.
PORPOISING AIRCRAFT.		CLOSE UP OR JOIN UP; JOIN UP ON ME.	EXECUTE.
ROCKING OF WINGS BY LEADER.		PREPARE TO ATTACK.	EXECUTE PREPARATION TO ATTACK.
OPEN AND CLOSE FOUR FINGERS AND THUMB.	THREE DASHES WITH EXTERNAL LIGHTS.	EXTEND OR RETRACT SPEED BRAKE AS APPROPRIATE.	REPEAT SIGNAL. EXECUTE UPON HEAD-NOD FROM LEADER OR WHEN LEADER'S SPEED BRAKE EXTENDS/RETRACTS.
ROTARY MOVEMENTS OF CLENCHED FIST IN COCKPIT AS IF CRANKING WHEELS. FOLLOWED BY HEAD NOD.	TWO DASHES WITH EXTERNAL LIGHTS.	LOWER OR RAISE LANDING GEAR AND FLAPS AS APPROPRIATE.	REPEAT SIGNAL. EXECUTE UPON HEAD-NOD FROM LEADER OR WHEN LANDING GEAR CONFIGURATION OF LEADER CHANGES.

Figure 21-13. Visual Communications (Sheet 4 of 9)

VISUAL COMMUNICATIONS

FORMATION (CONT)

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
LEADER LOWERS HOOK.		LOWER ARRESTING HOOK.	WINGMAN LOWERS ARRESTING HOOK. LEADER INDICATES WINGMAN'S HOOK IS DOWN WITH. THUMBS-UP SIGNAL.
OPEN HAND HELD UP. FINGERS TOGETHER MOVED IN FORE-AND-AFT CHOPPING MOTION (BY LEADER)		COURSE TO BE STEERED IS PRESENT COMPASS HEADING.	NOD OF HEAD ("I UNDERSTAND").
POINTING INDEX FINGER TOWARD RUNWAY/SHIP IN STABBING MOTION, REPEATEDLY. FOLLOWED BY LEAD CHANGE SIGNAL	ONE DASH WITH EXTERNAL LIGHTS	LANDING RUNWAY OR BALL AND SHIP IN SIGHT.	ASHORE: TAKE POSITION FOR LANDING. CARRIER: BREAK OFF AND LAND.

Figure 21-13. Visual Communications (Sheet 5 of 9)

VISUAL COMMUNICATIONS

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
1. SECTION TAKEOFF - LEADER GIVES THUMBS UP. 2. WINGMAN GIVES THUMBS UP. 3. LEADER RAISES ARM VERTICALLY. 4. LEADER LOWERS ARM.		1. I HAVE COMPLETED MY TAKE OFF CHECK-LIST AND AM READY FOR TAKEOFF. 2. I HAVE COMPLETED MY TAKEOFF CHECK-LIST AND AM READY FOR TAKEOFF. 3. PREPARE TO EXECUTE SECTION TAKE-OFF. 4. I AM COMMENCING TAKEOFF.	1. STANDS BY FOR REPLY FROM WINGMAN. HOLDING THUMBS UP UNTIL ANSWERED. 2. WINGMAN STANDS BY FOR IMMEDIATE TAKEOFF. 3. PREPARE TO EXECUTE SECTION TAKE-OFF. 4. EXECUTE SECTION TAKEOFF.
1. LEADER PATS SELF ON THE HEAD, POINTS TO WINGMAN.	1. LEAD AIRCRAFT TURNS ANTI-COLLISION/ STROBE LIGHT ON. 2. IF EXTERNAL LIGHTS ARE INOPERATIVE. LEADER SHINES FLASHLIGHT ON HELMET THEN SHINES LIGHT ON WINGMAN.	LEADER SHIFTING LEAD TO WINGMAN.	1. (DAY) WINGMAN PATS HEAD AND ASSUMES LEAD. 2. (NIGHT) WINGMAN TURNS ANTI-COLLISION/STROBE LIGHTS OFF AND ASSUMES LEAD. IF EXTERNAL LIGHTS ARE INOP- 3. (NIGHT) WINGMAN SHINES FLASHLIGHT AT LEADER. THEN ON HIS HELMET AND ASSUMES LEAD.
LEADER PATS SELF ON HEAD AND HOLDS UP TWO OR MORE FINGERS.		LEADER SHIFTING LEAD TO DIVISION DESIGNATED BY NUMERALS.	WINGMAN RELAYS SIGNAL; DIVISION LEADER DESIGNATED ASSUMES LEAD.

Figure 21-13. Visual Communications (Sheet 6 of 9)

VISUAL COMMUNICATIONS

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING (CONT)

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
PILOT BLOWS KISS TO LEADER.		I AM LEAVING FORMATION.	LEADER NODS ("I UNDERSTAND") OR WAVES GOOD-BYE
LEADER BLOWS KISS AND POINTS TO AIRCRAFT.		AIRCRAFT POINTED OUT, LEAVE FORMATION.	WINGMAN INDICATED BLOWS KISS AND EXECUTES.
LEADER POINTS TO WINGMAN, THEN POINTS TO EYE, THEN TO VESSEL OR OBJECT.		DIRECTS PLANE TO INVESTIGATE OBJECT OR VESSEL.	WINGMAN INDICATED BLOWS KISS AND EXECUTES BREAK AWAY FROM LEADER.
DIVISION LEADER HOLDS UP AND ROTATES TWO FINGERS IN HORIZONTAL CIRCLE, PREPARATORY TO BREAKING OFF.		SECTION BREAKOFF.	WINGMAN RELAYS SIGNAL TO SECTION LEADER. SECTION LEADER NODS ("UNDERSTAND") OR WAVES GOODBYE AND EXECUTES.
LEADER DESCRIBES HORIZONTAL CIRCLE WITH FOREFINGER.		BREAKUP (AND RENDEZVOUS).	WINGMAN TAKES LEAD, PASSES SIGNAL AFTER LEADER BREAKS, AND THEN FOLLOWS.
LANDING MOTION WITH OPEN HAND:		REFERS TO LANDING OF AIRCRAFT, GENERALLY USED IN CONJUNCTION WITH ANOTHER SIGNAL.	
1. FOLLOWED BY PATTING HEAD.		1. I AM LANDING	1. NODS. ("I UNDERSTAND") OR WAVES GOODBYE.
2. FOLLOWED BY POINTING TO ANOTHER AIRCRAFT.		2. DIRECTS INDICATED AIRCRAFT TO LAND.	2. AIRCRAFT INDICATED REPEATS SIGNAL, BLOWS A KISS AND EXECUTES.

Figure 21-13. Visual Communications (Sheet 7 of 9)

VISUAL COMMUNICATIONS

ARMING SIGNALS

DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
1. ARMING SUPERVISOR: HANDS OVER HEAD.	WANDS HELD OVERHEAD.	PILOT: CHECKS ALL ARMAMENT SWITCHES OFF AND SAFE.	PILOT: EXECUTE. BOTH HANDS IN VIEW OF ARMING SUPERVISOR AFTER CHECKING SWITCH POSITION (HANDS REMAIN IN VIEW DURING CHECK AND HOOKUP).
2. ARMING SUPERVISOR POINTS AT CREW MEMBER (USED IF APPLICABLE)	POINT ONE WAND TOWARDS CREW MEMBER.	CREW: PERFORM STRAY VOLTAGE CHECK.	ARMING CREW: EXECUTE. GIVE ARMING SUPERVISOR THUMBS UP IF NO STRAY VOLTAGE EXISTS.
3. ARMING SUPERVISOR: RAISES FIST. THUMB EXTENDED UPWARD, TO MEET PALM OF OTHER HAND.	POINT ONE WAND VERTICALLY TO MEET OTHER WAND HELD HORIZONTALLY.	ARMING CREW: ARM WEAPONS (AS APPLICABLE).	ARMING CREW: EXECUTE. GIVE ARMING SUPERVISOR THUMBS UP WHEN ARMING COMPLETED AND CLEAR IMMEDIATE AREA.
4. ARMING SUPERVISOR GIVES PILOT:			
A. THUMBS UP	A. BOTH WANDS FLICKED VERTICALLY ABOVE HEAD.	A. AIRCRAFT IS ARMED AND ALL PERSONNEL AND EQUIPMENT CLEAR OF AREA.	A. HOLD UNTIL ARMING CREW CLEAR OF ARMING.
B. THUMBS DOWN	B. ONE WAND HELD VERTICALLY, POINT DOWN, MOVING IN AN UP AND DOWN MOTION.	B. AIRCRAFT IS DOWN	B. RETURN TO LINE

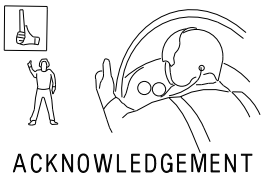
Figure 21-13. Visual Communications (Sheet 8 of 9)

VISUAL COMMUNICATIONS

DEARMING SIGNALS

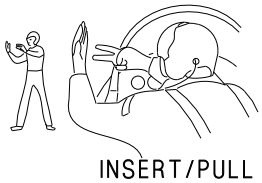
DAY SIGNAL	NIGHT SIGNAL	MEANING	RESPONSE
1. DEARMING SUPERVISOR: HANDS OVER HEAD.	WANDS HELD OVER HEAD	PILOT: CHECK ALL ARMAMENT SWITCHES OFF OR SAFE.	PILOT: EXECUTE. RAISE BOTH HANDS TO VIEW OF DEARMING SUPERVISOR AFTER CHECKING SWITCH POSITIONS. (HANDS REMAIN IN VIEW DURING DEARMING.)
2. DEARMING SUPERVISOR POINTS AT CREW MEMBER.	POINTS ONE WAND TOWARDS CREW MEMBER.	CREW: SAFE WEAPONS (AS APPLICABLE).	CREW: EXECUTE.
3. DEARMING SUPERVISOR GIVES PILOT: THUMBS UP	BOTH WANDS FLICKED VERTICALLY ABOVE HEAD	PILOT: AIRCRAFT IS DEARMED AND CREW AND EQUIPMENT CLEAR OF AIRCRAFT.	PILOT: HOLD UNTIL ARMING CREW CLEAR OF ARMING AREA - THEN RETURN TO LINE.

Figure 21-13. Visual Communications (Sheet 9 of 9)



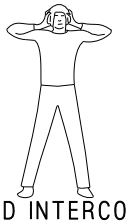
ACKNOWLEDGEMENT

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.



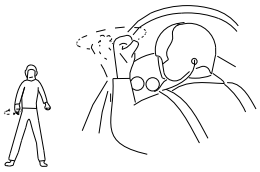
INSERT/PULL ELECTRICAL POWER

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

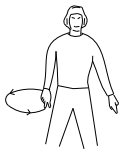
PILOT MOVES CLENCHED FIST IN CIRCULAR MOTION IN VIEW OF SIGNALMAN.

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

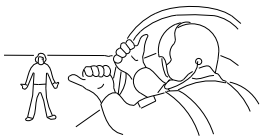
ENGINE RUN-UP

PILOT MOVES INDEX FINGER IN CIRCULAR MOTION INDICATING HE IS READY TO RUN UP ENGINE, SIGNALMAN RESPONDS WITH SIMILAR SIGNAL WHEN ALL CLEAR.



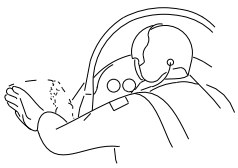
START GTS

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.

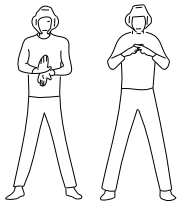


AM I CLEAR UNDERNEATH

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.

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Figure 21-14. Deck/Ground Handling Signals (Sheet 1 of 3)

COME AHEAD

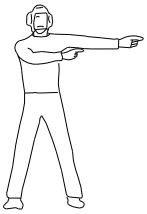
HANDS AT EYE LEVEL, EXECUTE MOTION: RATE OF MOTIONS INDICATES DESIRED SPEED OF AIRCRAFT. FOR NIGHT OPERATION, WAVE WANDS SIDE TO SIDE.

RIGHT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.

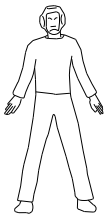
LEFT TURN

PULL DESIRED WING AROUND WITH REGULAR "COME AHEAD". POINT AT OPPOSITE BRAKE.



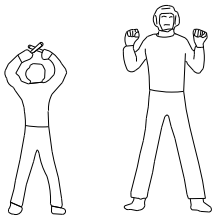
TURNOVER OF COMMAND

BOTH HANDS POINTED AT NEXT SUCCEEDING TAXI SIGNALMAN.



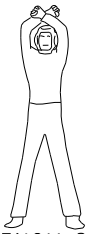
SLOW DOWN

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

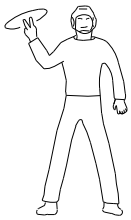
MAKE RAPID FANNING MOTION WITH ONE HAND IN FRONT OF THE FACE. POINT TO WHEEL WITH OTHER HAND.

ENGINE FIRE

DESCRIBE A LARGE FIGURE EIGHT WITH ONE HAND AND POINT TO THE FIRE AREA WITH THE OTHER HAND.

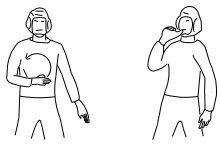
CUT ENGINE

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.

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Figure 21-14. Deck/Ground Handling Signals (Sheet 2 of 3)

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

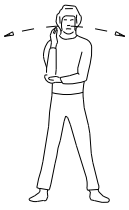
STICK AFT LEADING EDGE DOWN

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.

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Figure 21-14. Deck/Ground Handling Signals (Sheet 3 of 3)

PART VIII

WEAPONS SYSTEM

Chapter 22 - Armament System

CHAPTER 22

Armament System

22.1 ARMAMENT SYSTEM GENERAL

The armament system consists of equipment and components which provide for carriage, jettison, sighting, gun firing simulation, and controlled release of external stores.

Simulated and actual delivery of A/G ordnance is optimized by selecting the A/G master mode, see A/G Master Mode. Simulated firing of the A/A gun is optimized by selecting the A/A master mode, see A/A Master Mode.

The aircraft is capable of carrying a variety of ordnance. Each wing pylon is capable of carrying a LAU-68 rocket launcher with provisions for seven 2.75 inch folding fin aircraft rockets (FFAR), or a practice multiple bomb rack (PMBR) with provisions to carry six Mk 76 or BDU-33D/B (25 lb) practice bombs. The centerline pylon can be used only to carry a baggage container.

NOTE

Both wing pylons incorporate an ejector release unit (ERU) for emergency jettison. The ERU shall always be considered armed.

22.2 ARMAMENT SYSTEM CONTROLS AND INDICATORS

Forward cockpit armament controls consists of the emergency jettison button, HUD, two MFDs, DEP, master arm switch, and the control stick weapons release button and gun trigger. Aft cockpit armament controls consist of the emergency jettison button, master arm override switch/master arm light, two MFDs, DEP, reticle light switch, gunsight (mils depression knob and readout), and control stick weapons release button and gun trigger. See Figure 22-1. Also, see the foldout section (F0-3 Forward Cockpit and FO-5 Aft Cockpit) for arrangement of these controls.

The following paragraphs describe hardware (buttons and switches) that are master mode independent. Symbology displayed on the HUD and MFDs is tailored to the selected master mode and selected weapon/mode. Refer to paragraph 22.3.1 A/G Stores Display Symbology, paragraph 22.3.3 A/G HUD Symbology, paragraph 22.4.1 A/A Stores Display Symbology, and paragraph 22.4.3 A/A HUD Symbology.

22.2.1 Emergency Jettison Button (FWD And Aft Cockpits). The emergency jettison button is powered by the 28 VDC Essential Bus and is placarded PUSH TO JETT.

NOTE

External stores located on centerline pylon will not jettison.

Pressing the EMER JETT button in either cockpit releases external stores from both wing stations simultaneously, regardless of the selected weapon on the stores display, master armament or master armament override switches. Emergency jettison release requires aircraft weight-off-wheels and either normal or battery power on the aircraft.

22.2.2 Master Armament Switch (FWD Cockpit). The master armament switch is a two position, pull to unlock, toggle switch placarded MASTER ARM and SAFE. All armament circuits are controlled by the master armament switch, with the exception of emergency jettisoning of external stores. With the master armament switch in the MASTER ARM position, armament circuits are energized, and the master armament red indicator light, placarded MSTR ARM is illuminated (aft cockpit).

SAFE	Deenergizes armament circuits.
MASTER ARM	Energizes armament circuits and illuminates MSTR ARM indicator light in the aft cockpit.

22.2.3 Master Armament Override Switch (Aft Cockpit). The master armament override switch is a two position toggle switch. This switch is placarded MASTER ARM with SAFE and FORWARD positions, and the master armament indicator light is placarded MSTR ARM. The master armament override switch is a safety feature that allows the armament system to be disabled when SAFE is selected. The switch has a solenoid that holds the toggle in the SAFE position until electrical power is removed from the solenoid. When power is removed the switch returns to the FORWARD position. Power to the solenoid can also be removed by setting the master armament switch to MASTER ARM, or when the weight-on-wheels switch is activated. The master armament override switch can also be manually switched back to the FORWARD position.

FORWARD	Forward cockpit controls armament system.
SAFE	Disables armament control system.

22.2.4 MSTR ARM Light (Aft Cockpit). Indicates master armament switch in the forward cockpit is in the MASTER ARM position.

22.2.5 Weapons Release Button (FWD And Aft Cockpits). The weapons release button, often referred to as the bomb ''pickle'' button, is located on the upper left side of the control stick grip in both cockpits. This button is used to release ordnance from the wing stations. The button functions only when the 28 VDC Generator Bus is powered and can be disabled from the aft cockpit with the master armament override switch.

With the master arm switch in the MASTER ARM position and a wing station selected on the stores display, pressing the button releases the bomb(s) or fires the rocket(s).

22.2.6 Gun Trigger (FWD And Aft Cockpits). The gun trigger is located on the front of the control stick grip in both cockpits, and is used to fire the simulated gun. The trigger functions only when the 28 VDC Generator Bus is powered and can be disabled from the aft cockpit with the master armament override switch.

With the master arm switch in the MASTER ARM position and the gun selected on the stores display, squeezing the trigger simulates gun firing.

22.2.7 Gunsight Description (Aft Cockpit). A lighted gunsight (Figure 22-1) is located directly above the instrument panel in the aft cockpit. The unit provides capability of air-to-ground target viewing and aiming with a conventional fixed pipper. Gunsight controls include a RTCL (reticle) light switch, mils depression set knob, and mils depression readout window.

Light is beamed through a reticle downward to a collimating mirror and is superimposed over the outside view by a transparent partially reflecting combiner glass. The proper ballistic drop of the projectile is set into the gunsight as MIL depression. The center of the reticle image (pipper) should coincide with the target at the predetermined altitude and airspeed. If the target is moving or wind is present, pipper offset must be established by using the graduations (25 mil increments) on the reticle.

CAUTION

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.

22.2.7.1 RTCL Light Switch

BRIGHT	Turns gunsight reticle on and selects high intensity.

OFF	Turns gunsight reticle off.
DIM	Turns gunsight reticle on and selects low intensity.

22.2.7.2 MILS Depression Set Knob. Rotating selects mils depression setting (0 to 270 mils) displayed on readout window.

22.2.7.3 MILS Depression Readout. Displays mils depression setting selected by mils depression set knob.

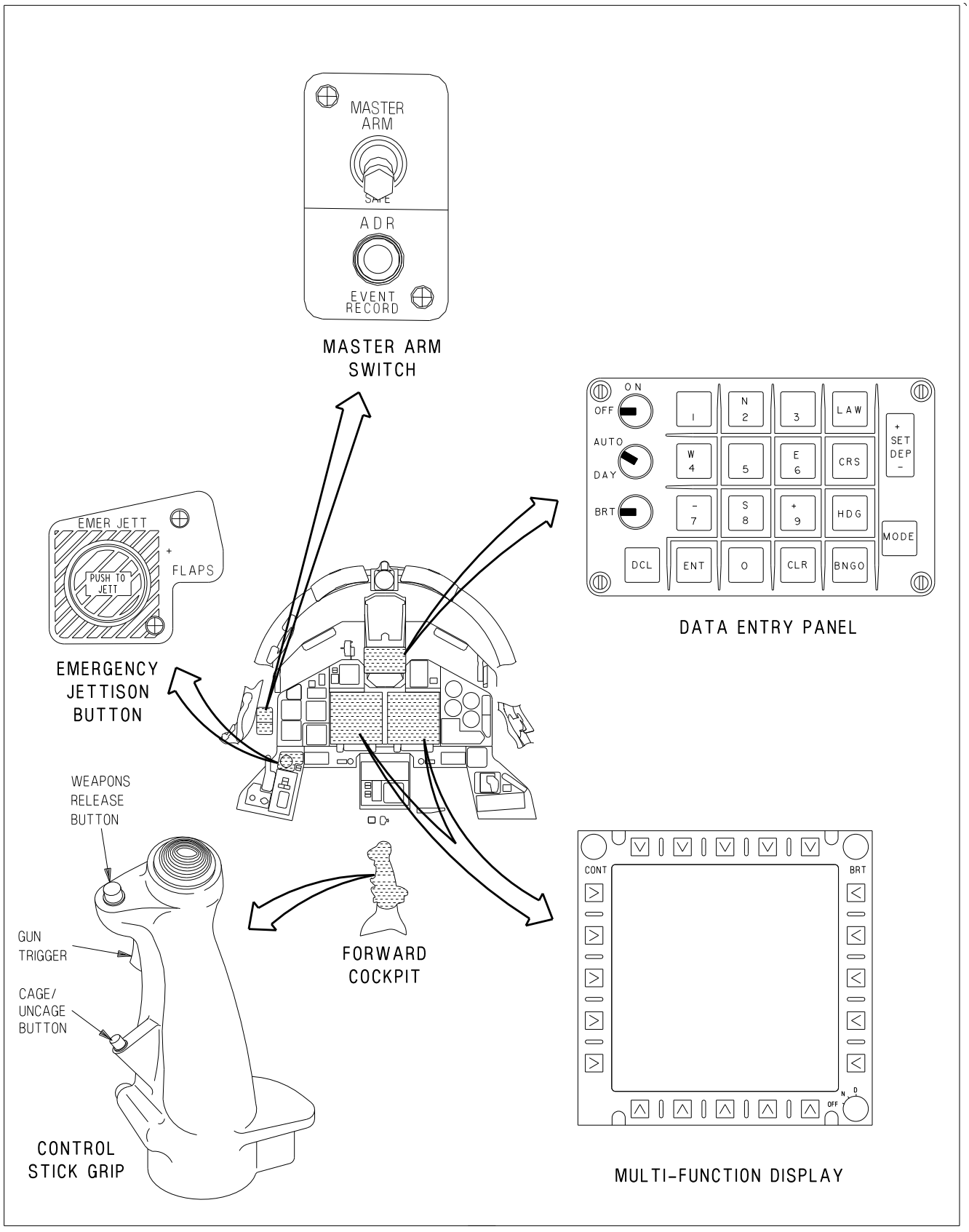

Figure 22-1. Armament Control and Indicators (Sheet 1 of 2)

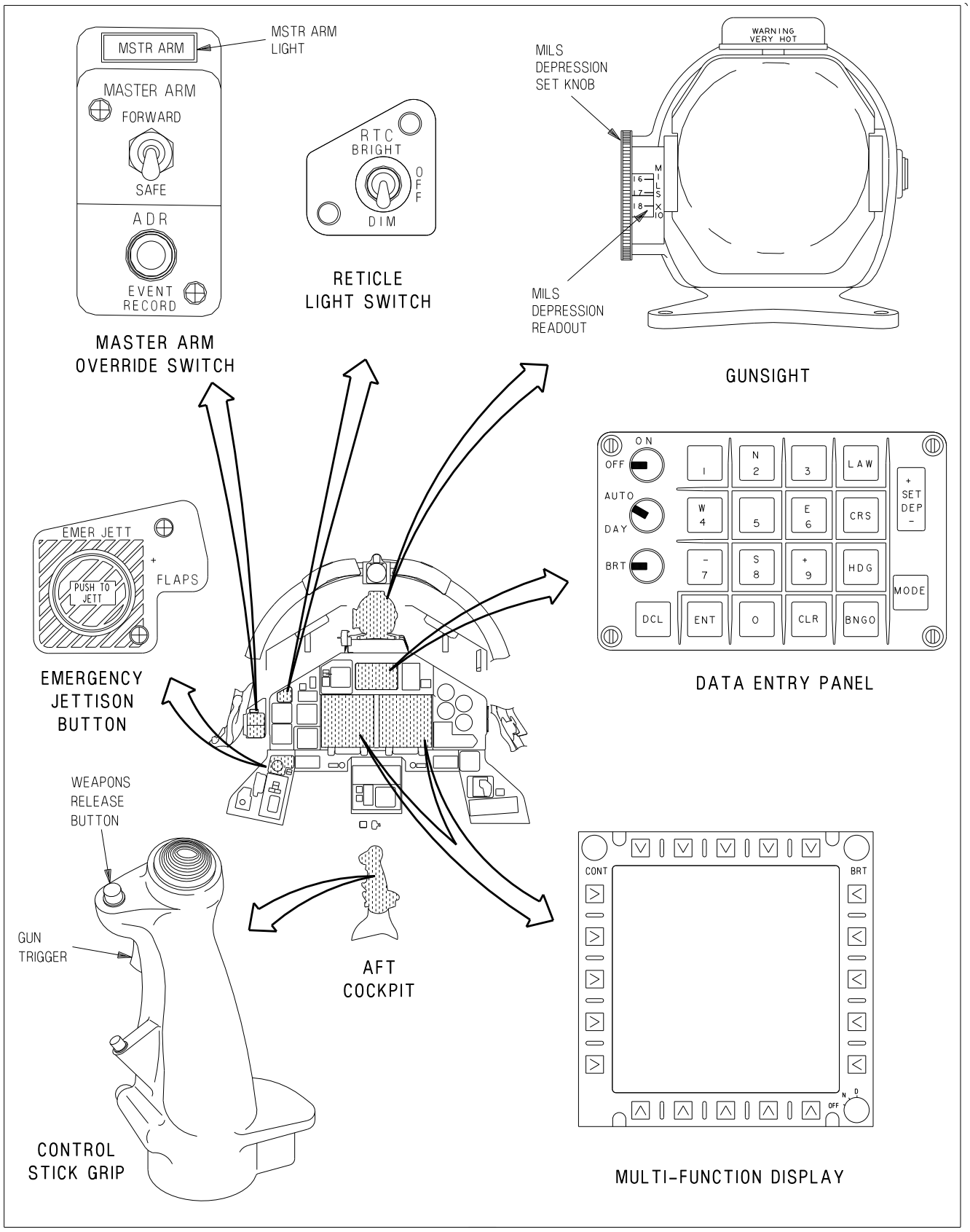

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Figure 22-1. Armament Control and Indicators (Sheet 2 of 2)

22.3 A/G MASTER MODE.

The A/G master mode is selected from either cockpit by actuating (boxing) the A/G option on the stores display or actuating the MODE button on the DEP to cycle to the A/G master mode. The A/G master mode has two submodes: manual (MAN) and continuously computed impact point (CCIP). Selection of MAN or CCIP submodes is accomplished via the A/G stores display. The ballistics and display in the CCIP submode is dependent upon the type of weapon (BOMBS, ROCKETS, A/G GUN) selected.

At power up selecting the A/G master mode will initializes with the gun selected in the MAN mode. Upon subsequent selections of the A/G stores display the previously selected mode (MAN or CCIP) is selected.

22.3.1 A/G Stores Display Symbology. The A/G stores display is selected by actuating the STRS option on the MENU format (A/G master mode already selected). See Figure 22-2.

22.3.1.1 Master Arm Status. Indicates master arm status: SAFE or ARM. Master arm status is selected via the master arm panel.

22.3.1.2 Selected Weapon Indication. Indicates the selected A/G weapon: RKTS (rockets), BOMB, or GUN. This indication only appears when a weapon/weapon station has been selected (boxed) via the weapon and station select options.

22.3.1.3 Weapon Quantity Indication. Indicates the selected weapon quantity for bombs and rockets. The system initializes to a quantity of six for bombs and seven for rockets. There is no quantity indication for the simulated gun. This indication only appears when a weapon/weapon station has been selected (boxed) via the weapon and station select options.

22.3.1.4 Mil Depression Indication (MAN). Indicates the mil depression setting of the depressed sight line (DSL) reticle on the HUD. This setting is adjusted using the SET DEP rocker switch on the DEP. The system initializes at 140 mils and can be adjusted from 0 to 270 mils.

22.3.1.5 Target Height Indication (CCIP). Indicates the height of the current steer waypoint (default) or the entered target height using the THGT option.

22.3.1.6 Rocket Firing Mode. Indicates the selected rocket firing mode of SINGLE or RPPL (ripple).

22.3.2 A/G Stores Display Options. A/G submode selection, weapon selection, station selection, weapon quantity selection, and mode/weapon unique selections are available using these options. See Figure 22-2.

22.3.2.1 Weapon and Station Select Options. These options are available along the top of the A/G stores display. The RKT and BOMB options on either side of the GUN option (left/right) are used to select rockets or bombs for the left or right wing stations. To select a weapon and weapon station, press the desired option button. When the desired weapon/wing station is selected, the option is boxed, the previously selected option is deselected (unboxed), and the selected weapon and quantity indication appears on the wingform. The selected weapon and quantity indications are removed when another weapon/weapon station is selected. When RKT is selected, the RPPL option and rocket firing mode also appears on the stores display. The GUN option indicates the centerline station.

22.3.2.2 Bombs/Rocket Quantity Select Options. When a bomb or rocket is selected, these options are used to adjust (increment/decrement) the number of bombs/rockets on the stores display.

Since there is no interface between the weapon station and the aircraft (stores display), it is important that the selected bomb/rocket quantity on the stores display match the actual bomb/rocket load on the aircraft. If they don't match, the stores display will not correctly reflect the actual weapon loadout.

22.3.2.3 MAN Option. Selecting this option commands the manual submode, boxes the MAN

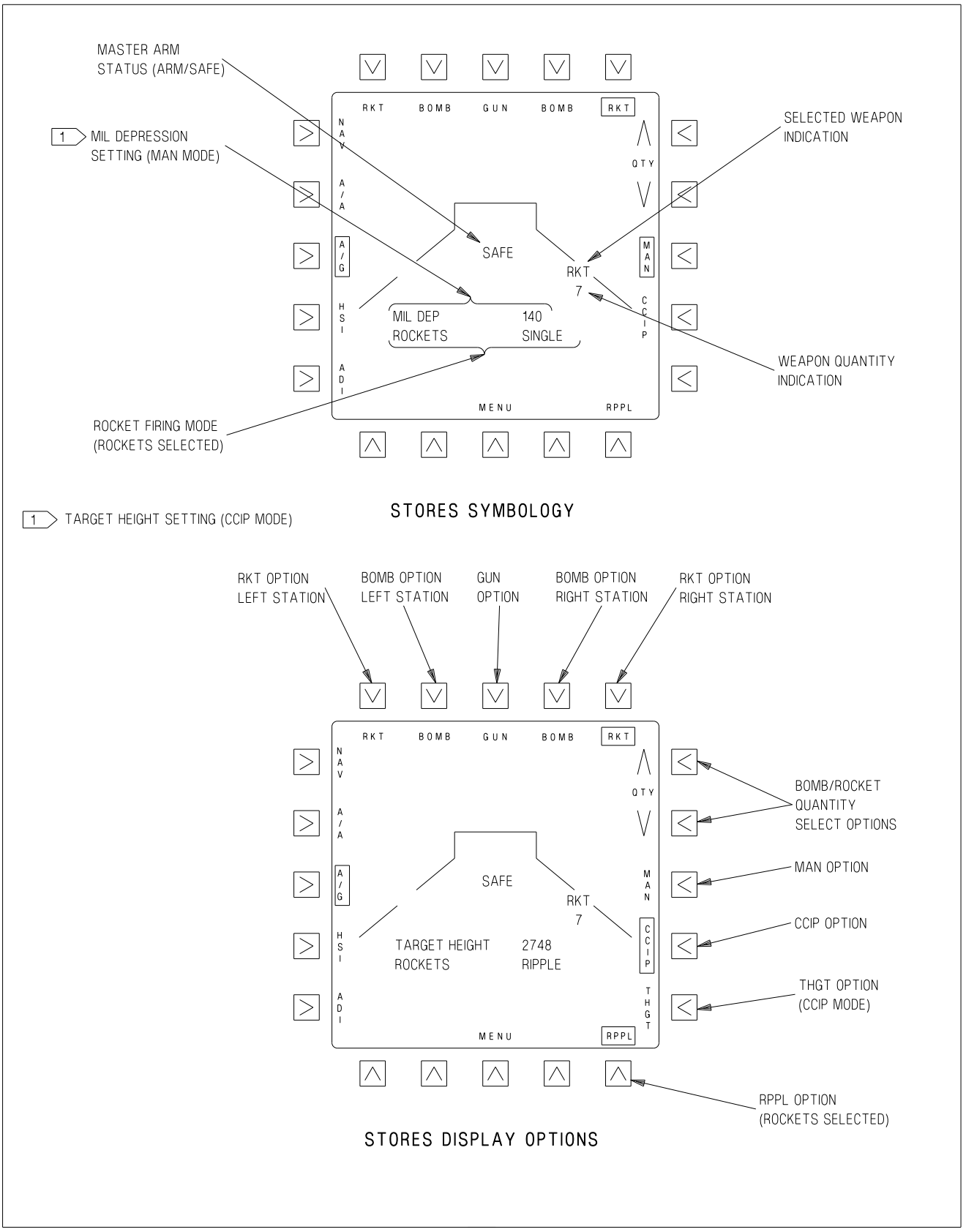

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Figure 22-2. A/G Stores Displays

option, deselects (unboxes) the CCIP mode (option), and displays the mil depression setting.

22.3.2.4 CCIP Option. Selecting this option commands the CCIP submode, boxes the CCIP option, deselects (unboxes) the MAN mode (option), and displays the THGT option.

The CCIP mode indicates the computed weapons impact point for instantaneous weapon release. In CCIP mode, the target height is initially set equal to the selected tactical waypoints entered elevation. The RALT value is used in calculating the CCIP. If RALT is invalid, height above target is calculated by the difference between BARO ALT and entered target height on the A/G STRS display.

22.3.2.5 THGT (Target Height) Option (CCIP). In the CCIP mode the target height solution is used in calculating the CCIP point when radar altitude is invalid. In the CCIP mode the current steer to waypoint is used as target height. This option allows the aircrew to change the target height setting. Actuating the THGT option boxes the option, brings up the scratchpad on the HUD and stores display, and initializes the DEP for data entry in feet. When the data has been entered, the THGT option is unboxed, the scratchpad is removed, and the new target height is displayed. When another waypoint or waypoint offset is selected that waypoint elevation is then stored as the target height.

22.3.2.6 RPPL (Ripple) Option (Rockets). Successive actuations of the RPPL option select/deselect (box/unbox) the RPPL mode (option). When RPPL is selected and the pickle button is actuated, all rockets of the selected station will be fired and the rocket quantity indication decrements to zero. When RPPL is deselected and the pickle button is pressed, single rocket is activated and the rocket quantity indication decrements by one.

Since there is no interface between the weapon station and the aircraft (stores display), it is important that the RIPPLE/SINGLE setting on the rocket launcher match the RPPL selected/deselected setting on the stores display. If these settings do not match, the aircrew may inadvertently single or ripple fire based on the incorrect stores display indication.

22.3.3 A/G HUD Symbology. Selection of the A/G master mode can be identified on the HUD by the appearance of the mode indication and weapon type cue. The symbology displayed on the HUD also varies depending on the mode and weapon. The symbology described here is unique to the A/G master mode. See Figure 22-3.

22.3.3.1 Mode Indication. Indicates the selected mode, CCIP or MAN.

22.3.3.2 Weapon Type/Master Arm Indication. The selectable types of A/G weapons are: GUN, RKTS, and BOMB. Master arm SAFE status is indicated with an X through the weapon legend. ARMed status is indicated by the absence of the X.

22.3.3.3 Displayed Impact Line (DIL) (Bombs). The DIL appears only in the CCIP mode with bombs as the selected weapon. The DIL provides an azimuth steering reference.

22.3.3.4 CCIP Cue. This cue indicates the computed weapons impact point for instantaneous weapon release.

22.3.3.5 Mil Depression Setting (MAN). Indicates the mil depression setting of the DSL reticle on the HUD. This setting is adjusted using the SET DEP rocker switch on the DEP. The system initializes at 140 mils and can be adjusted from 0 to 270 mils.

22.3.3.6 Depressed Sight Line Aiming Reticle (MAN). This cue is a non-computing reticle which overlays the point the weapon would impact given the weapon type, airspeed, AOA, and aircraft direction of flight. The reticle can be positioned up/down on the HUD using the SET DEP rocker switch.

22.3.3.7 Weapon Release Cue. This cue appears as a small X to the right of the selected weapon. It is displayed for 2 seconds when the pickle button or gun trigger is actuated.

22.3.3.8 Break X. A large X appears in the center of the HUD when an immediate 4g pullup is required to achieve a ground clearance of 1,000 feet. The break X will not appear at dive angles less than 15 degrees.

22.3.3.9 Break X Invalid Cue. This cue appears as a B with a slash (/) through it. The break X invalid cue indicates that inputs to the break X are invalid.

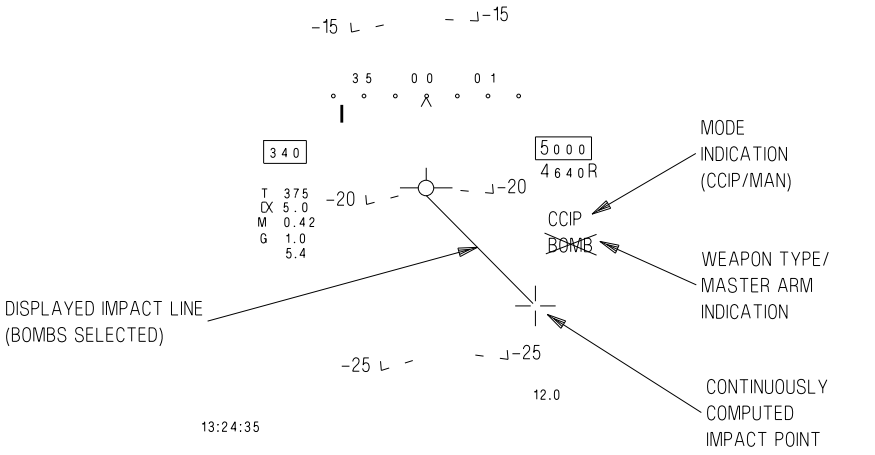
22.3.4 Manual (MAN) Mode. In addition to the normal gear up NAV symbology on the HUD,

the MAN mode provides: MAN mode indication, selected weapon indication, MASTER ARM status, and the DSL aiming reticle. The mil depression indication appears on both the HUD and stores display. The MAN mode provides a fixed impact point based on the parameters of a preplanned weapon delivery. When the DSL aiming reticle is about to overlay the target, the pickle button/trigger should be actuated to initiate weapon release/firing.

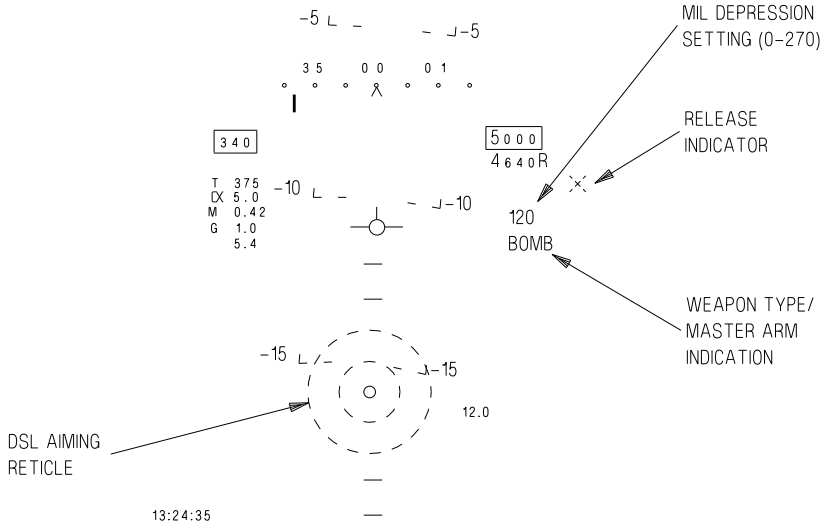
22.3.5 CCIP Mode - Bombs. In addition to the normal gear up NAV symbology on the HUD, the CCIP mode provides: CCIP mode indicator, selected weapon (BOMB), master arm status, CCIP cue, and displayed impact line. The displayed impact line provides azimuth steering reference to aid in aligning the CCIP cue over the target. When the CCIP cue superimposes the target, bombs should be released by pressing the pickle button.

22.3.6 CCIP Mode - Rockets/Guns. In addition to the normal gear up NAV symbology on the HUD, the CCIP mode provides: CCIP mode indicator, selected weapon (RKTS/GUN), master arm status, and CCIP cue.

The CCIP cue represents the impact point of the rocket or gun shell if the weapon is fired immediately. The solution is computed for maximum slant range of 8,000 feet for guns and 12,000 feet for rockets. The aircraft should be maneuvered to track the target with the CCIP cue. When the CCIP cue superimposes the target, gun/rocket should be fired by pressing the trigger/pickle button. The CCIP cue flashes three times per second when beyond the proper slant range.



CCIP MODE



MAN MODE

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Figure 22-3. A/G HUD Symbology

22.4 A/A MASTER MODE.

The A/A master mode is selected by actuating (boxing) the A/A option on the stores display or by actuating the MODE button on the DEP to cycle to the A/A master mode. The A/A master mode has two submodes: lead angle computing (LAC) and real time gun sight (RTGS). Selection of LAC or RTGS submodes is accomplished via the A/A stores display.

At power up selecting the A/A master mode will initialize with gun selected in the LAC mode. Upon subsequent selections of the A/A stores display, the previously selected mode (LAC or RTGS) is selected.

22.4.1 A/A Stores Display Symbology. The A/A stores display is selected by actuating the STRS option on the MENU display (A/A master mode already selected). See Figure 22-4.

22.4.1.1 Master Arm Status. Indicates master arm status; SAFE or ARM. Master arm status is selected via the master arm panel.

22.4.1.2 Selected Weapon Indication. The gun is the only A/A weapon, and only gun simulation is available. As a result, GUN is the only legend that can be displayed, and it only appears when the GUN option is selected.

22.4.1.3 Selected Wingspan. This indicates the selected wingspan as entered using the WSPN option and the DEP. The wingspan value is displayed in feet.

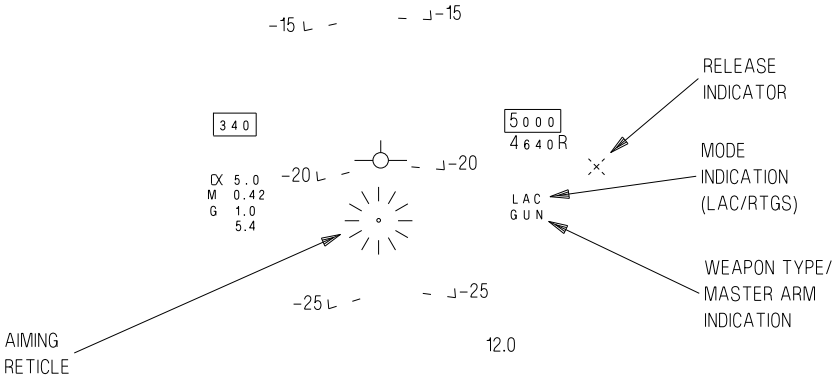
22.4.2 A/A Stores Display Options. A/A submode selection, weapon selection, and entry of aircraft wingspan are the functions available using the A/A stores display options. See Figure 2-4.

22.4.2.1 GUN Option. Selecting the GUN option enables the simulation of the gun. Gun simulation is selected/deselected by alternate actuations of the GUN option.

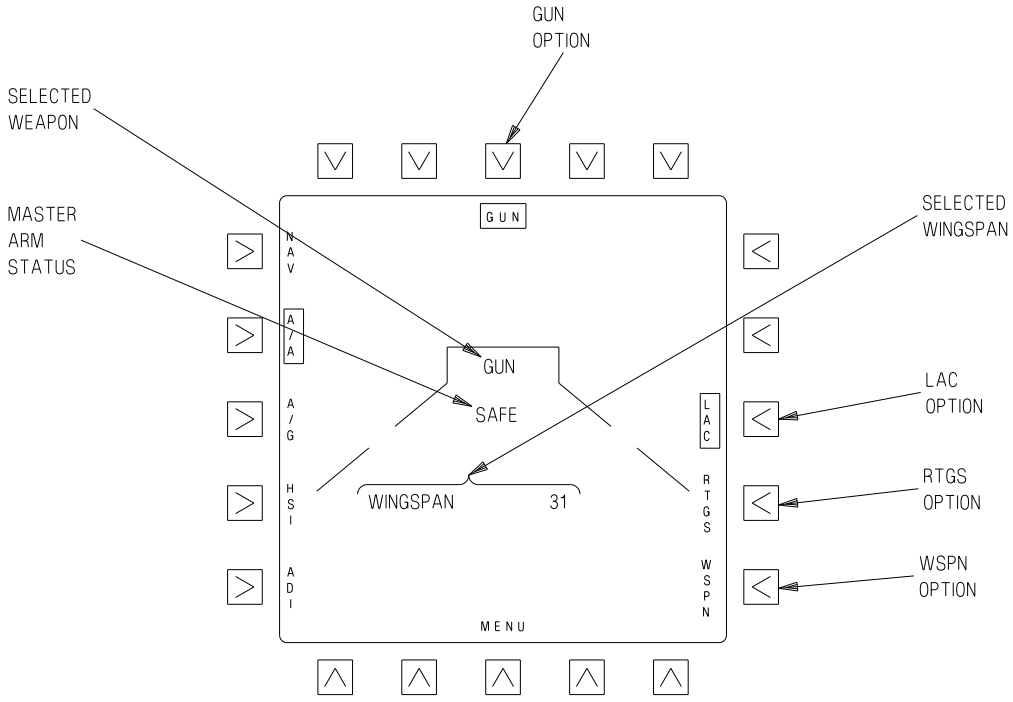
22.4.2.2 LAC Option. Selecting the LAC option commands the LAC submode, boxes the LAC option, and deselects (unboxes) the RTGS mode (option).

22.4.2.3 RTGS Option. Selecting the RTGS option commands the RTGS submode, boxes the RTGS option, and deselects (unboxes) the LAC mode (option).

22.4.2.4 WSPN (Wingspan) Option. This option allows the aircrew to enter target aircraft wingspan data in feet. When the desired wingspan data is entered, the size of the aiming reticle



HUD DISPLAY



STORES DISPLAY

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Figure 22-4. A/A Displays

is adjusted accordingly. Actuating the WSPN option boxes the option, brings up the scratchpad on the HUD and stores display, and initializes the DEP for data entry. When the data has been entered, the WSPN option is unboxed, the scratchpad is removed, the new wingspan value appears on the stores display, and the aiming reticle is modified. The wingspan default is 31 feet.

22.4.3 A/A HUD Symbology. Selection of the A/A master mode can be identified on the HUD by the appearance of the mode indication and weapon type.

22.4.3.1 Mode Indication. Indicates the selected mode, LAC or RTGS.

22.4.3.2 Weapon Type/Master Arm Status. Gun is the only type of A/A weapon and only a simulated gun is available. GUN is the only cue displayed in this location. MASTER ARM SAFE is indicated with an X through the GUN legend. MASTER ARM status is indicated by the absence of the X.

22.4.3.3 Aiming Reticle. The size of the aiming reticle is adjusted using the WSPN option on the stores display. The entered wingspan data and a 1,000 foot fixed range is used to calculate the diameter of the reticle.

22.4.3.4 Weapon Release Cue. This cue appears as a small X to the right of the selected weapon. It is displayed for 2 seconds when the trigger is actuated.

22.4.4 LAC Submode. In addition to the normal gear up NAV symbology on the HUD, the LAC mode provides the LAC mode indication, selected weapon indication (GUN), master arm status, and the aiming reticle.

The LAC submode is used for tracking a non-maneuvering target by keeping the target inside the aiming reticle pipper. Target wingspan should be kept on the inner radius of the reticle, thus ensuring that the target is at a range of 1,000 feet. Once the target has been tracked approximately 1 second, the target can be engaged with pipper indicating the shell impact point.

22.4.5 RTGS Submode. In addition to the normal gear up NAV symbology on the HUD, the RTGS mode provides the RTGS mode indication, selected weapon indication (GUN) , master arm status, and the aiming reticle.

The RTGS submode is used for tracking a maneuvering target by aiming and keeping the reticle pipper ahead of the target (snapshot). The aiming reticle is software positioned on the point that a shell would reach if it had been fired "tf" seconds ago, where "tf" is the time it takes the shell to travel 1,000 feet. The aircraft should be maneuvered so that target wingspan is the same size as the inner radius of the reticle, thus ensuring that the target is at a range of 1,000 feet. The pilot should use the display to anticipate when the reticle and target are going to coincide in 1/3 of a second. The RTGS aiming reticle must lead the target to account for target motion during the time it takes the shell to travel 1,000 feet. The pilot can then start firing by squeezing the gun trigger on the control stick.

22.5 SUSPENSION EQUIPMENT/EXTERNAL STORES

The aircraft employs a pylon on each wing and a centerline pylon. The wing pylons allow the carriage of rockets and practice bombs. The centerline pylon only provides carriage of a baggage pod. The following is a description of the suspension equipment and external stores.

22.5.1 Suspension Equipment. The suspension equipment consists of one centerline pylon and two wing pylons. Each pylon has a parent rack mounted inside for carriage and release of external stores.

22.5.1.1 Centerline Pylon. The centerline pylon (Figure 22-5) consists of forward and aft support fittings, sandwiched between two sideplates, which support an ERU-119 ejector release unit (ERU) for carrying the baggage container. The sideplates are enclosed at the ends with aerodynamically shaped nose and tail fairings, and the upper side has a fairing attached for closing the pylon mounting access hole in the bottom of the fuselage. The left sideplate has an access panel at each end of the ERU for access to the inside of the pylon. The ERU is not electrically connected; therefore, the external store cannot be jettisoned.

22.5.1.2 Wing Pylons. The inboard pylons (Figure 22-5) provide the necessary mechanical and electrical interface between the aircraft wing structure and the stores to be carried. The pylon consists of an aluminum alloy housing with steel attach fitting which supports an ERU-119 ejector release unit for carrying and release of stores, and connector cable for connection to the stores. The front of the pylon is enclosed by an aerodynamically shaped fairing. The sideplates and fairings have access panels for access to the external store, connectors, ERU, and other attachments for servicing and pylon removal.

22.5.1.3 Parent Rack. Each pylon is equipped with an ERU-119 ERU (Figure 22-6). The unit is attached to the aircraft pylon and is referred to as the parent rack. The ERU is in the form of a beam incorporating a pair of sway braces at each end. Two suspension hooks located at 14-inch centers are connected by internal linkage to opposite ends of a partially rotating operating arm in such a way that when the hooks are in the closed or “cocked” position, the connecting links and operating arm are in an almost straight horizontal line. A compression spring assembly tends to maintain an overcenter geometric lock in the linkage system, in either the hooks-closed or hooks-open position. An actuator piston and cylinder assembly situated over the forward operating arm is in communication with one of a pair of interconnected cartridge-operated combustion chambers. Fore and aft gas tubes on top of the ERU connect the combustion chambers via gas-regulating throttles (orifices) to ejection feet assemblies, situated between each pair of sway braces, which assist in thrusting the store clear of the pylon. The twin cartridges, which are housed in a common breech block, are fired by two entirely independent electrical circuits. When release action is initiated, the actuator piston partially rotates the operating arm, which in turn withdraws the suspension hooks to the open position; simultaneously, expanding gases operate the ejection feet pistons. When the ERU is loaded, the release mechanism can be held safe by installing the ground safety pin/manual release tool. This passes through a hole in the sideplate, under one pivot of the operating arm, so that it cannot rotate. A square socket in the center of the operating arm enables the manual operation of the hook mechanism using the square end of the ground safety pin/manual release tool. The ERU is designed to carry and forcibly eject stores weighing up to 2,000 pounds.

22.5.1.3.1 CCU-44/B Impulse Cartridge. The CCU-44/B impulse cartridge (Figure 22-7) provides a power source for ejection of weapons/stores from the parent rack.

The power generated by the cartridge forces the ejector rack hooks open and imparts a downward force on an ejector foot. The cartridge is electrically initiated by the aircraft weapon release circuits.

22.5.1.4 A/A37B-3 Practice Multiple Bomb Rack (PMBR). The A/A37B-3 PMBR (Figure 22-8) consists of a body assembly and six release

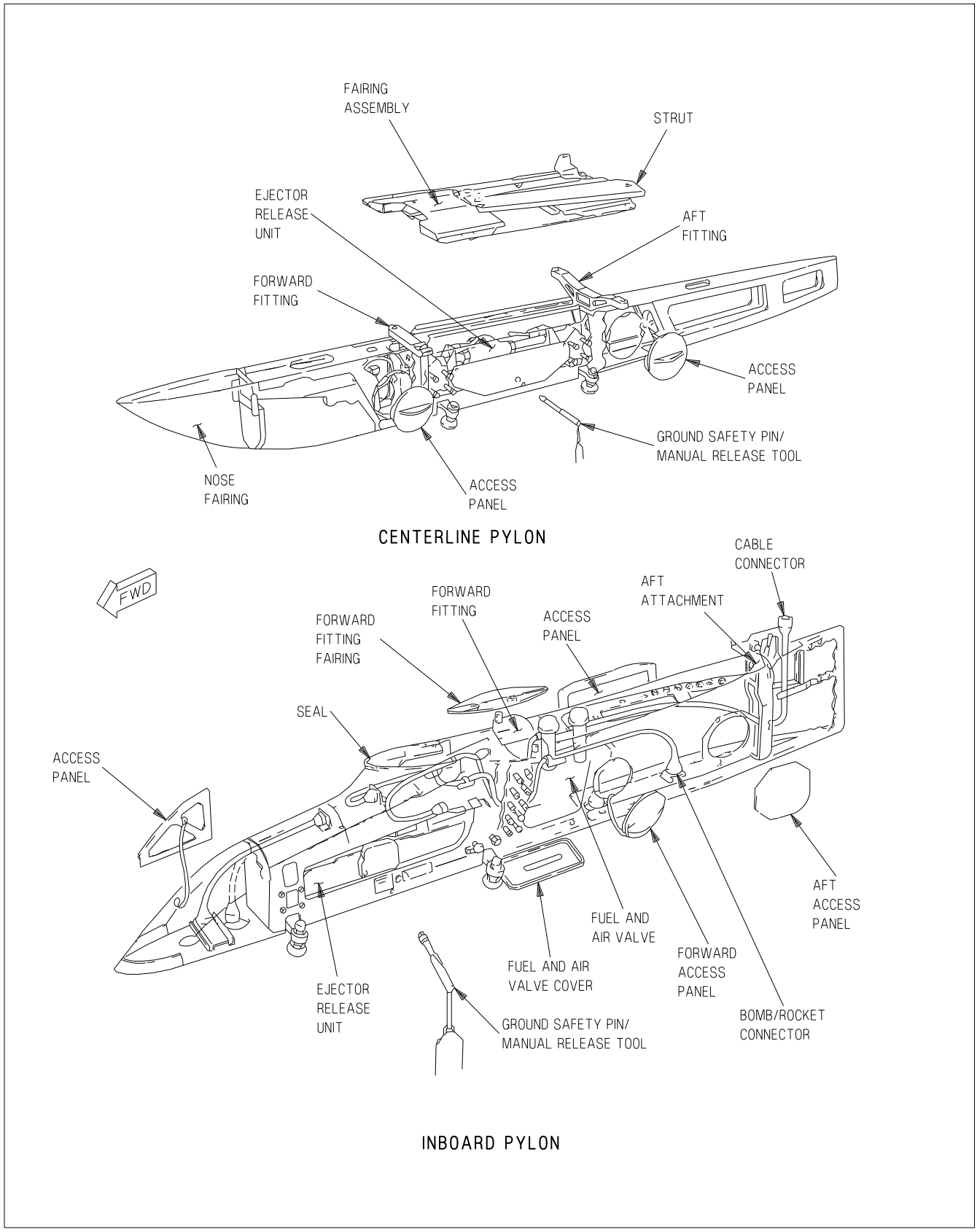

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Figure 22-5. Pylons

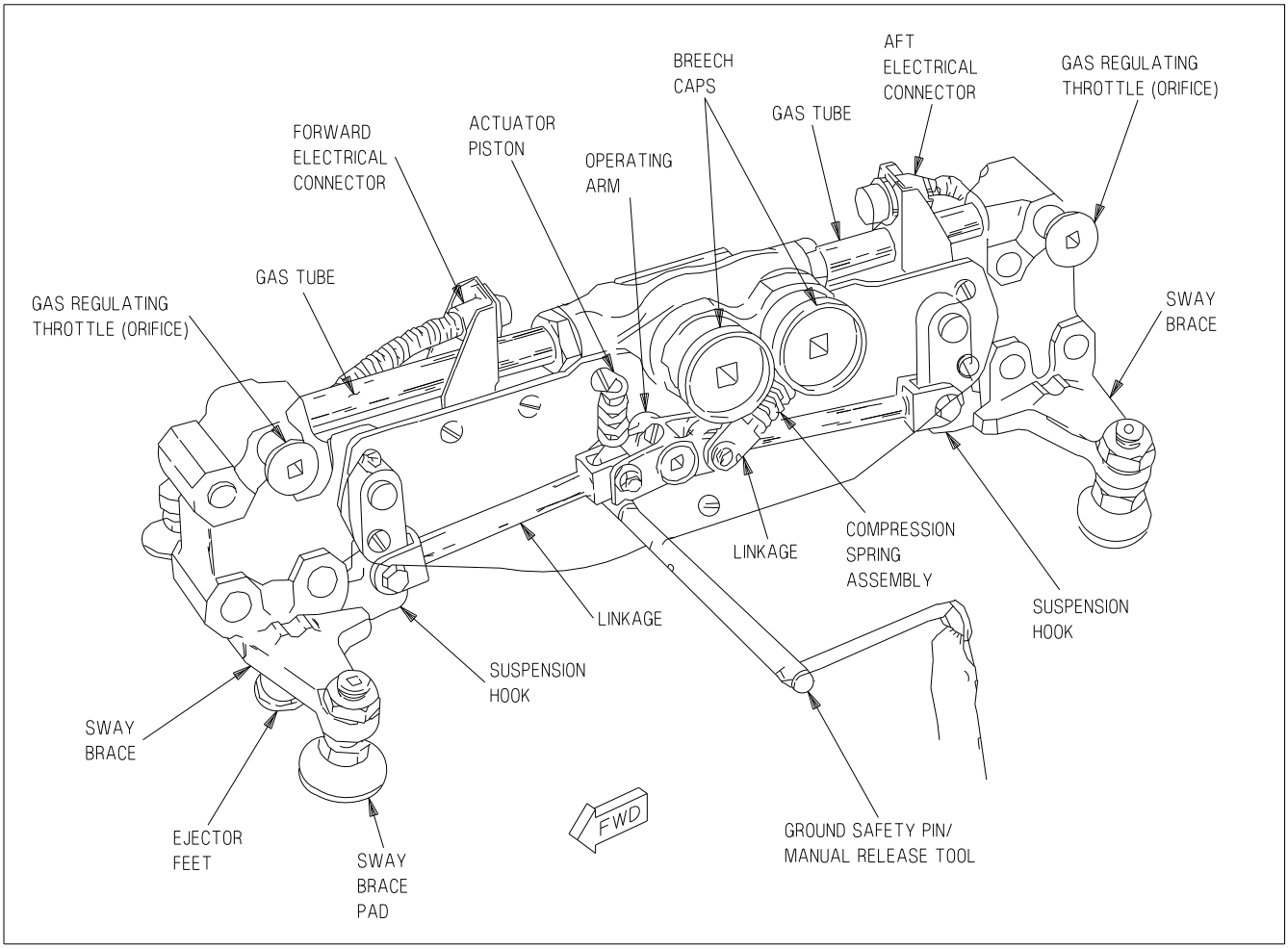

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Figure 22-6. ERU-119 Ejector Release Unit

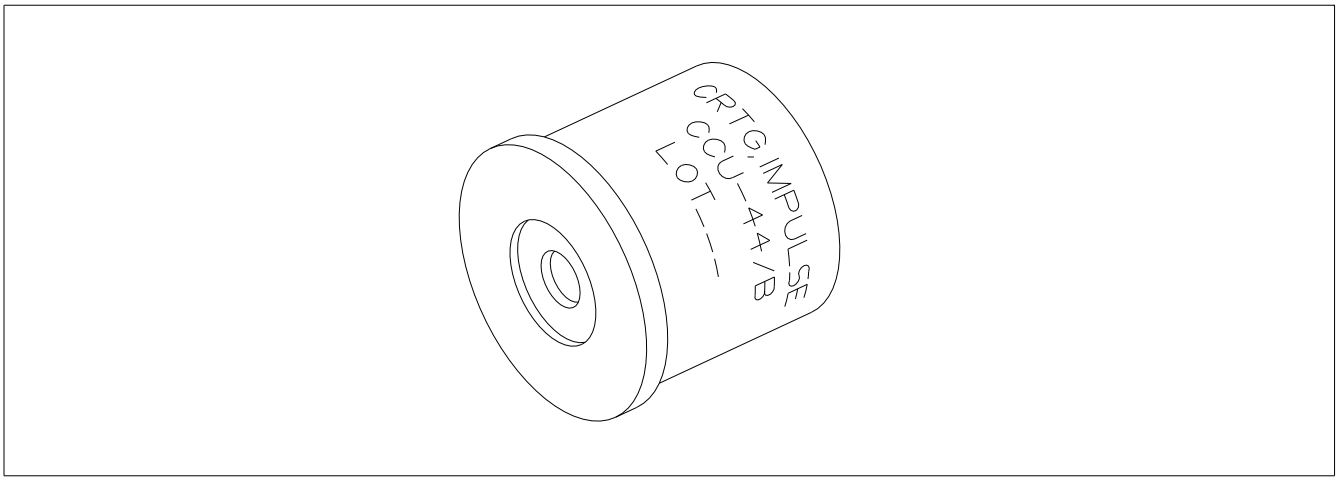

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Figure 22-7. CCU-44/B Impulse Cartridge

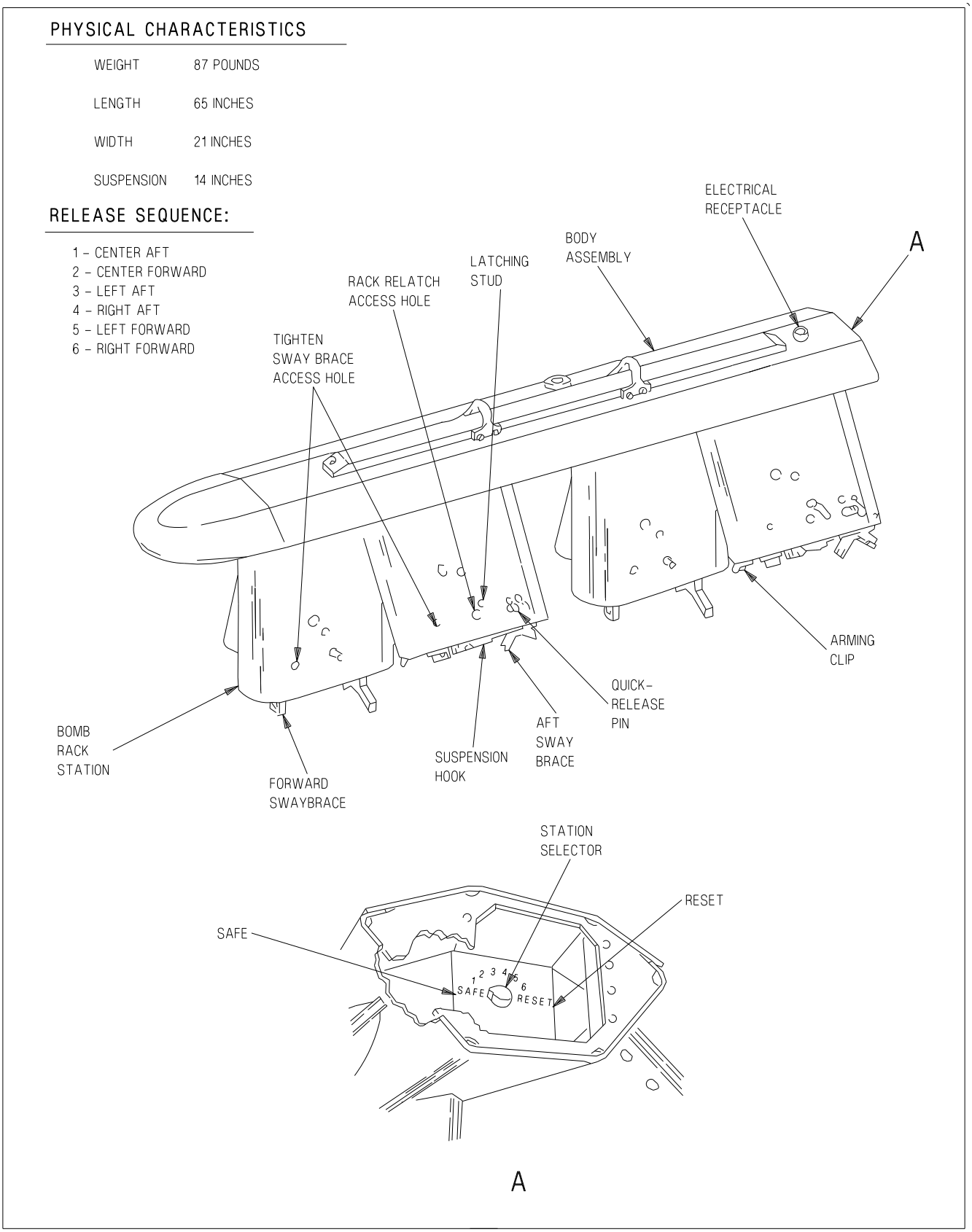


Figure 22-8. A/A37B-3 Practice Multiple Bomb Rack

assemblies and is designed to carry from one to six practice bombs. The body assembly is constructed of aluminum alloy skin and bulkheads. The lower skin plate, which is fixed in place, provides mounting pads for the six release assemblies. The upper skin plate is removable for access to the electrical components and contains an aluminum alloy bar used for attachment of the suspension lugs for either 14- or 30-inch spacing. A receptacle is located on the upper skin plate for electrical connection of the PMBR cable assembly to the aircraft pylon bomb/rocket release connector. The release assembly is a single-hook bomb rack with two integral sway braces. The hook is actuated by a solenoid. The aft sway brace is positioned prior to loading and held in place by a quick release pin. The forward sway brace is spring-loaded to the retracted position and is adjusted with an operating lever. The rack electrical system consists of a station selector and intercabling to each of the six release assembly receptacles and to the aircraft electrical system receptacle. Connectors on the release assemblies engage the receptacles on the body as the release assemblies are attached. The station selector provides for selective release of the weapons. The selector must be set prior to flight at position No. 1 when carrying six weapons or at position No. 2 when carrying three weapons. Four sway brace pads are required for installation of the PMBR on the ERU-119.

22.5.2 External Stores. External stores consist of the MK 76 and BDU-33D/B practice bombs, and the 2.75-inch folding fin aircraft rockets launched from the LAU-68 rocket launcher.

22.5.2.1 MK 76 Practice Bomb. The Mk 76 practice bomb (Figure 22-9) is a teardrop shaped bomb that has a cast metal body and is centrally bored. The fin assembly consists of four fin blades attached to the bomb inner cylinder. The inner cylinder extends to the forward end of the bomb. A firing pin assembly and signal (spotting charge) are retained in the forward end of the bomb inner cylinder with a cotter pin. A single lug is threaded into the bomb body for suspension.

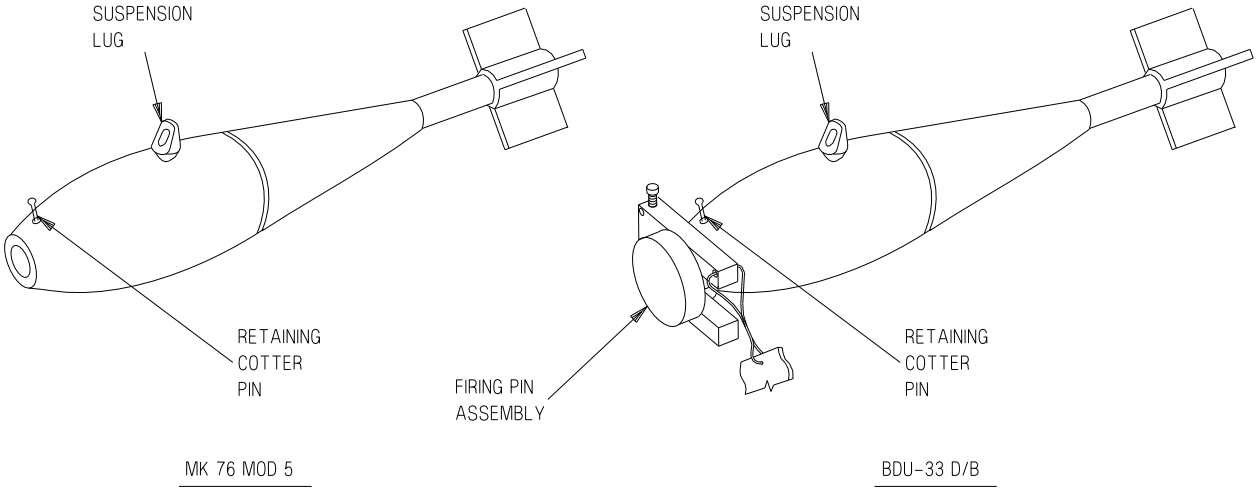
22.5.2.1.1 BDU-33D/B Practice Bomb. The BDU-33D/B practice bomb (Figure 22-9) has a teardrop shaped cast metal body that is centrally bored. The tail tube fits into the end of the bore. The conical afterbody covers the tail tube and is crimped to the body. The fin assembly is welded to the tail tube. The bomb is designed for impact firing. The firing pin assembly consists of a firing pin, a collar and a safety block. The firing pin and collar are held in the proper relationship to each other by a shear pin. The safety block, held on the firing pin head by a safety (cotter) pin, prevents the firing pin from moving aft and firing the signal (spotting charge) during ground handling operations. The firing pin assembly is retained in the bomb nose by a retaining cotter pin through the bomb body and the hole in the assembly. The hole diameter in the assembly is larger than the cotter pin diameter to allow the aft movement of the firing pin. When the safety block is removed, the collar of the assembly rests against the rim of the signal (spotting charge) but the firing pin is held away from the signal (spotting charge) primer by the shear pin. Upon impact, the shear pin holding the firing pin and collar is sheared which allows the firing pin to move aft and fire the signal (spotting charge).

22.5.2.2 Practice Bomb Signal Cartridges, MK 4 MOD 3, CXU-3/B, and CXU-3A/B. The Mk 4 Mod 3 practice bomb signal cartridge (Figure 22-9) consists of an aluminum case. The rim end has a percussion primer, and the opposite end is sealed with an aluminum disk. The cartridge produces a flash of light and a white smoke puff. The CXU-3/B and CXU-3A/B practice bomb signal cartridge consists of an aluminum case, closed on one end with a percussion primer, and the opposite end is closed with a crimped-in-place aluminum cover (cap). The cartridge produces a dense white smoke display for day missions.

22.5.2.3 LAU-68 Series Aircraft Rocket Launcher. The LAU-68 series aircraft rocket launcher (Figure 22-10) carries and launches seven 2.75-inch FFARs. The launcher is designed for reuse and consists of a center section, frangible nose fairing, and a tail fairing. The nose fairing is used to reduce aerodynamic drag and the tail fairing is designed to remain intact

PHYSICAL CHARACTERISTICS

	MK 76 MOD 5	BDU-33 D/B
WEIGHT	24.5 POUNDS	25.0 POUNDS
LENGTH	24.7 INCHES	23 INCHES
DIAMETER	4 INCHES	4 INCHES
SUSPENSION	SINGLE LUG	SINGLE LUG



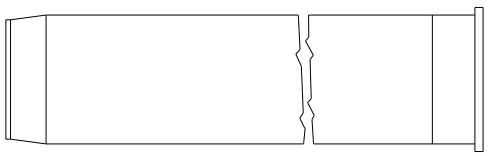
PRACTICE BOMB

PHYSICAL CHARACTERISTICS

LENGTH

MK 4 MOD 3	5 INCHES
CXU-3/B AND 3 A/B	6 INCHES

DIAMETER 0.85 INCHES



PRACTICE BOMB SIGNAL CARTRIDGE, MK 4 MOD 3, CXU-3/B, AND CXU-3A/B (Typical)

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Figure 22-9. Practice Bombs and Signal Cartridge

and direct debris away from the aircraft. The launcher center section contains the rockets, rocket tubes, and ignition system. Forward and aft electrical receptacles are provided for connection to the aircraft rocket release system.

WARNING

Mixing of rocket motors is prohibited.

This aircraft utilizes the aft receptacle for connection to the aircraft rocket release system. A safety pin is located on the top and near the rear of the launcher. When the safety pin is inserted, the launcher electrical system is grounded. A mode selector switch and intervalometer are located on the center section aft bulkhead. The mode selector switch has RIPPLE and SINGLE fire positions. The intervalometer control has L (load), A (arm), and 1 thru 7 numbered positions. The control must be set to the A position before the tail fairing is installed. The mode selector switch must also be set to the desired (RIPPLE or SINGLE) position before installing the tail fairing. When the SINGLE position is selected, a single rocket is fired with each firing pulse. When RIPPLE is selected, the intervalometer converts a single release pulse into a ripple rate with a delay interval of approximately 40 milliseconds between each rocket fired. After rockets have been loaded in the tubes, an RF barrier may be installed in the forward and aft end of the center section.

22.5.2.4 2.75-Inch Folding Fin Aircraft Rocket (FFAR) System. The 2.75-inch FFAR (Figure 22-11) is used to deliver a variety of warheads on ground targets. The complete round consists of a motor, warhead, and fuse.

The motor tube is made of seamless aluminum alloy tubing and is 32 inches long. The propellant used is an internal-burning grain ballistite, which builds up to a maximum peak pressure of approximately 930 pounds of thrust when the rocket is fired. The burning time of the propellant varies with the temperature, from 2.92 seconds at -50 °F to 1.42 seconds at 130 °F. The rocket motor is ignited by aircraft electrical power thru an igniter. Peak velocity of the rocket at motor burnout is approximately 2,300 fps. An electrical squib ignites the mixture of black powder and magnesium powder in the igniter.

The nozzle and fin assembly attached to the aft end of the motor tube consists of a nozzle plate, four nozzles, a fin actuating mechanism, four folding fins, and a fin retainer and contact disk.

Gas pressure from the motor operates a piston and crosshead, pushing the heals of the fins and causing the fins to open. The crosshead remains in its rearmost position, locking the extended fins against the force exerted by the airstream. The fins are shaped aluminum alloy plates, 6.5 inches long and 1.25 inches wide. When folded, they extend to the rear within the 2.75-inch diameter of the round.

Various combinations of practice warheads and fuses may be used to meet mission requirements. The fuse consists of a cone shaped steel body that encloses an arming mechanism, firing mechanism, and an explosive train. The explosive train consists of a primer, delay element, detonator, and booster. Approximately 20g's ensures the rocket travels 500 to 1,400 feet before the fuse arms. The fuse remains armed until detonation.

22.5.2.4.1 MK 66 Mods WAFFAR Rocket Motor (2.75 Inch). The MK 66 Mods WAFFAR (Wrap Around Folding Fin Aircraft Rocket) motor (Figure 22-11) has replaced the MK 4/40 FFAR motors; they can be carried and launched from both fixed-wing and rotary-wing aircraft. Mods 2 and 4 are considered HERO safe and do not require the use of an RF barrier on the aft end of the rocket launcher. The MK 66 Mods can only be used in LAU-61 C/A (19 shot) and LAU-68 D/A (7 shot) rocket launchers. The three spring-loaded, wrap-around fins in conjunction with the fluted exhaust nozzle provide controlled spin and stabilized flight. The motor produces an average thrust of 1,360 lbs. for a duration of 1.1 seconds. Approximate motor weight is 13.65 lbs.

The MK 66 Mods 1 and 3 WAFFAR motors are not HERO safe. The stabilization rod on the Mod 1 is a salt coated, solid rod instead of a

hollow rod as is on the Mod 2. The Mods 3 and 4 correct an internal design deficiency found in Mods 1 and 2, respectively. Navy uses Mods 2 and 4; Army uses Mods 1 and 3.

22.5.2.4.2 MK 67 (Smoke) Warhead. This warhead is used to provide smoke for target marking and is available in two Mods: 0 and 1. The Mod 0 filler is White Phosphorus (WP) that requires special handling. The Mod 1 contains Red Phosphorus (RP) that has improved cook-off characteristics and does not require special handling. The warhead casing is constructed of aluminum alloy. An explosive burster charge of Composition B disperses the 2.6 lbs. of WP/RP. Total weight is approximately 5.2 lbs.

NOTE

Both MK 67 warheads expel white smoke.

22.5.2.4.3 WTU-1/B (Practice) Warhead. This warhead is a dummy configuration used for training to represent service warhead M151 configured with service fuze M427. Due to its similarity in shape and weight when compared to the service configuration, its ballistic characteristics are also considered similar. For 2.75-inch rocket motor MK 66 Mods application, the WTU-1/B MUST BE DELIVERED using the same safety of flight parameters as defined for the M151 service warhead.

22.5.2.4.4 M427 Impact (PD) Fuze. The M427 nose fuze is identical to the M423 fuze with the exception of a longer arming distance of 800 to 1,250 feet that requires a time to arm of 1.09 to 1.34 seconds at 40 G's. It was designed for use with high-speed aircraft; however, it may be used on slow-speed aircraft by using a greater target standoff distance. The M423 fuze is designed for slow-speed aircraft only, due to its shorter arm distance.

PHYSICAL CHARACTERISTICS

WEIGHT	LAU-68 D/A	(LOADED)	241 POUNDS (MK-66 MOTOR), MAX WITH TAIL FAIRING (NOSE FAIRING ADDS 2 POUNDS)
		(EMPTY)	78 POUNDS
DIAMETER	LAU-68 D/A		10.22 INCHES
LENGTH			72.4 INCHES
CAPACITY			7 2.75-INCH FFAR
SUSPENSION			14 INCHES

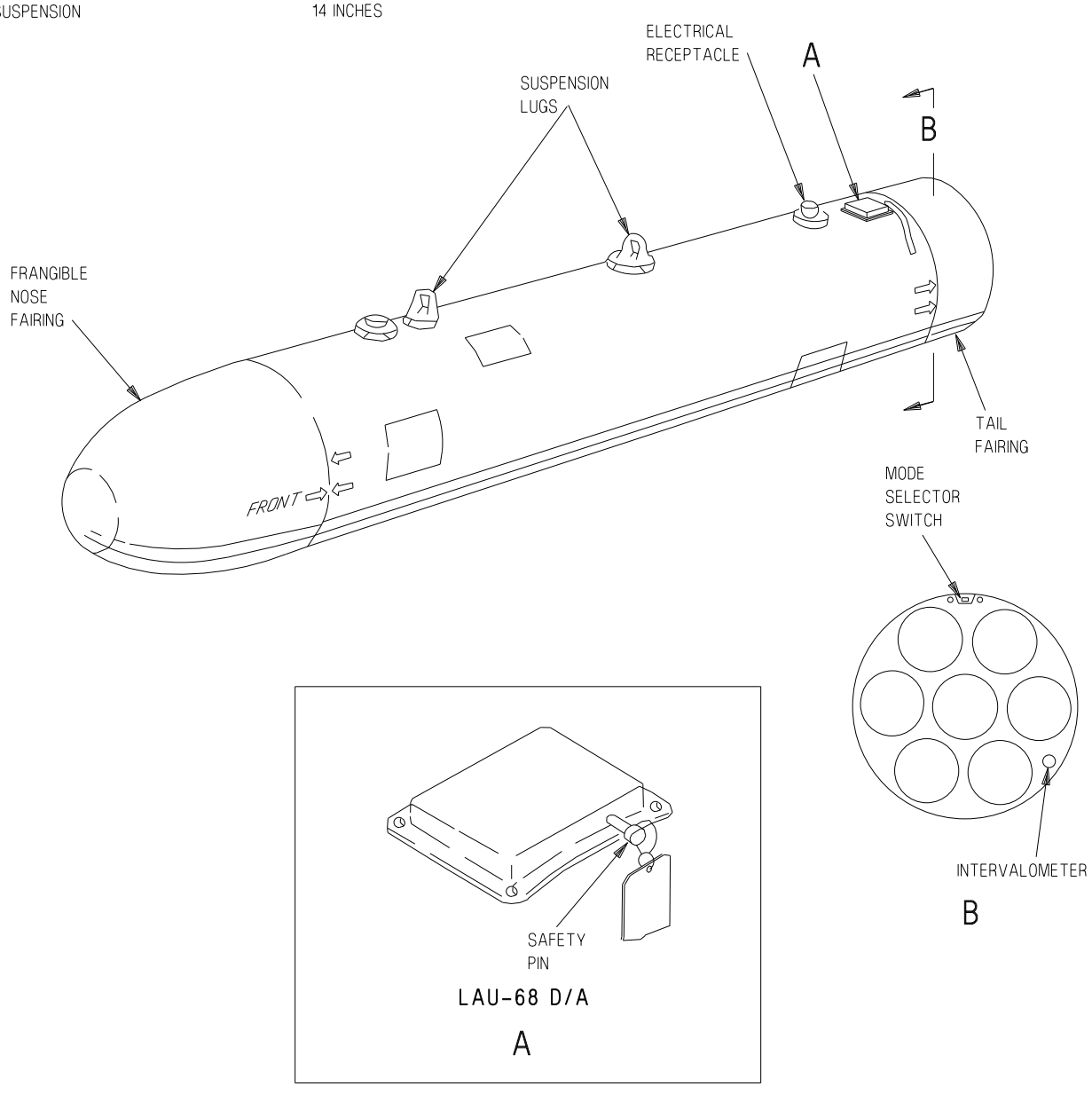

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Figure 22-10. LAU-68 Rocket Launcher

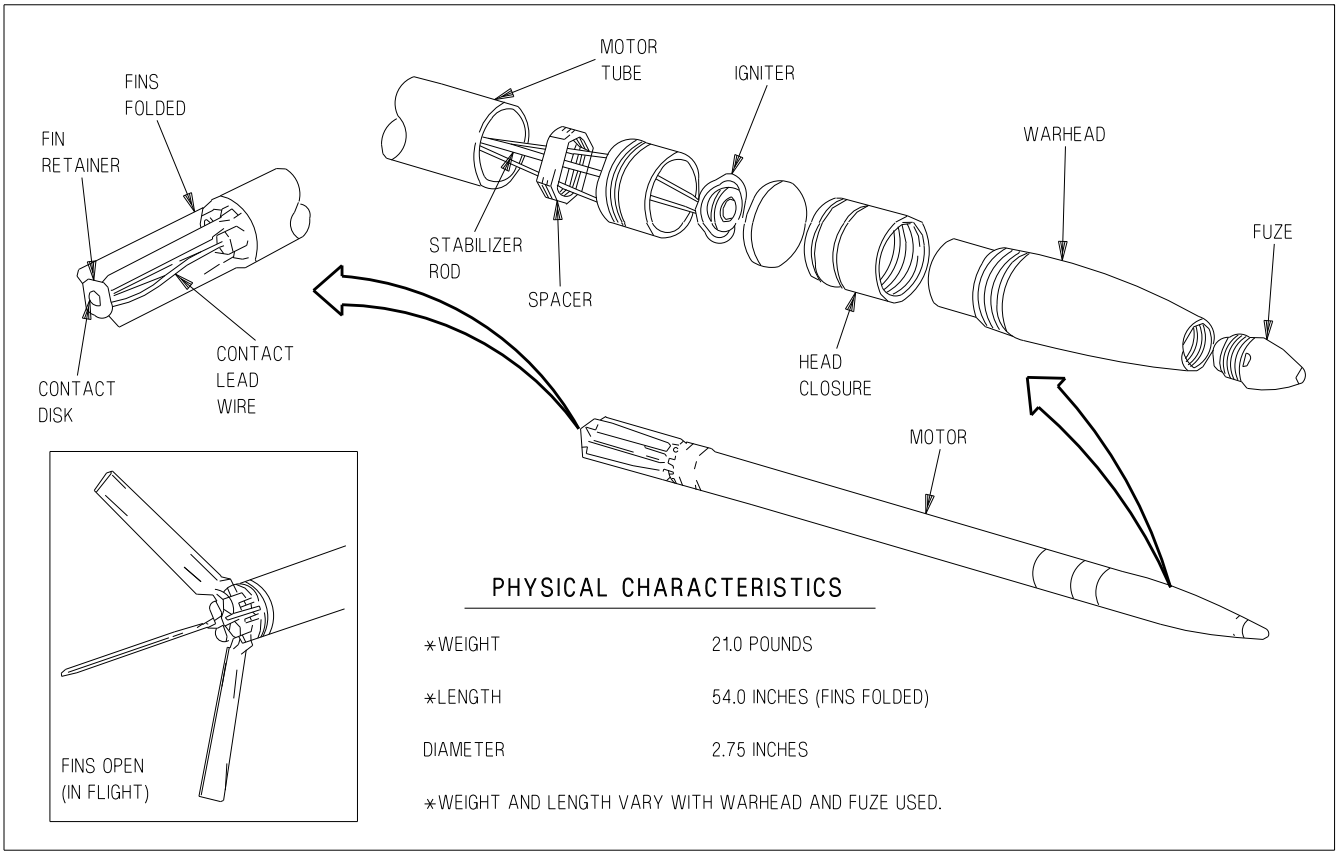

Figure 22-11. 2.75-Inch Rocket Motor MK 66 Mods

22.6 OPERATION

22.6.1 PMBR/Practice Bombs Preflight.

1. All cockpit armament switches - OFF, SAFE or NORMAL
2. Parent rack:
   a. Safety pin - INSTALLED
   b. Sway braces - ADJUSTED
   c. Ejector feet - POSITIONED
   d. Cartridges - INSTALLED; BREECH CAPS TIGHT
3. PMBR:
   a. Electrical cable - CONNECTED TO BOMB/ROCKET CONNECTOR
   b. Station selector - SAFE
   c. Bomb locked to PMBR and secure.
4. Practice bombs:
   a. Bomb signal, firing pin assembly and retaining pin - INSTALLED
   b. (BDU-33D/B) Safety block with safety pin - INSTALLED ON FIRING PIN ASSEMBLY

22.6.2 Rocket Launcher Preflight

1. All cockpit armament switches - OFF, SAFE, or NORMAL
2. Parent rack:
   a. Safety pin - INSTALLED
   b. Sway braces - ADJUSTED
   c. Ejector feet - POSITIONED

d. Cartridges - INSTALLED; BREECH CAPS TIGHT

3. LAU-68 Launcher:

a. Safety pin - INSTALLED

b. Aft electrical receptacle - NOT CONNECTED TO BOMB/ROCKET CONNECTOR

c. Rockets - FULL AFT AND LOCKED IN PLACE

d. Mode selector switch - AS REQUIRED

e. Intervalometer - AS REQUIRED

f. Nose/Tail Cone - INSTALLED (As Applicable)

22.6.3 Normal Bomb Release -

1. A/G master mode - SELECT
2. BOMB option - SELECT (Left/right station)
3. Bomb quantity - AS REQUIRED

NOTE

Must reflect actual bomb quantity.

4. Submode - SELECT (CCIP/MAN)
5. Mil depression (MAN) - SET
6. Master arm switch - MASTER ARM
7. Weapons release button - PRESS
   An audio tone sounds in both headsets for 2 seconds.

22.6.4 Normal Rocket Firing.

1. A/G master mode - SELECT
2. RKT option - SELECT (Left/right station)
3. Rocket quantity - AS REQUIRED

NOTE

Must reflect actual rocket quantity.

4. Submode - SELECT (CCIP/MAN)
5. Firing mode - AS REQUIRED (Ripple/single)

NOTE

Must reflect selection on LAU-68.

6. Target height (CCIP) - AS REQUIRED
7. Master arm switch - MASTER ARM
8. Weapons release button - PRESS
   An audio tone sounds in both headsets for 2 seconds.

22.6.5 Gun Simulation.

1. A/A or A/G master mode - SELECT
2. GUN option - SELECT
3. Submode - SELECT (MAN, CCIP, LAC, or RTGS)
4. Master arm switch - MASTER ARM
5. Gun trigger - PRESS

   A gunfire simulation sounds in both headsets.

22.6.6 Emergency Release.

1. Emergency jettison button - PRESS

   PMBR/rocket launchers are jettisoned from pylons.

NOTE

Centerline store cannot be jettisoned.

22.6.7 2.75-Inch Folding Fin Aircraft Rocket (FFAR) Delivery Data. Refer to Figure 22-12 for ballistic table.

22.6.8 T-45 Delivery Data Tables - Bombs and Rockets. Refer to Figure 22-12 for delivery data tables for 2.75-inch rockets configured with MK 66 motor and MK 67 smoke and WTU-1/B practice warheads.

Refer to Figure 22-13 for delivery data table for MK 76 practice bombs. The delivery data tables provided are for a straight path dive release with the following assumptions:

1. Aircraft gross weight 13,875 lbs.
2. Straight flight path during release
3. 1.0 second pilot/aircraft response delay after weapon release
4. Wings level, G build-up to 4 G's in 1.25 seconds
5. 15 degree flight path run-out angle
6. Constant throttle setting during release and recovery
7. Single weapon release
8. Sea level target
9. Standard day as given in U.S. Standard Atmosphere, 1962

WARNING

Releases below the altitudes provided in the delivery data tables for 2.75-inch rockets are prohibited due to rocket motor, warhead and case debris and their ricochet potential.

22.6.9 Basic Air-To-Ground Ordnance Theory. Reference T-45C Flight Training Instruction (FTI).

22.6.10 Air-To-Air Ordnance Theory. Reference T-45C Flight Training Instruction (FTI).

DELIVERY DATA
2.75 INCH FFAR: MK 66 MODs 2 AND 4 MOTOR: MK 67 SMOKE WARHEAD

RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)	TIME OF FALL (SEC)	DOWN RANGE TRAVEL (FT)	SLANT RANGE (FT)	SIGHT ANGLE (MIL)	TRAJEC-TORY DROP (MIL)	ANGLE OF ATTACK (MIL)	PAR-ALLAX (MIL)
-10	400	1000	738	2.1	5197	5293	33	19	15	2
		1100	838	2.3	5687	5793	34	20	15	2
		1200	938	2.5	6171	6287	35	21	16	2
	425	1000	716	2.1	5192	5288	30	18	12	2
		1100	816	2.3	5682	5788	30	19	12	2
		1200	916	2.5	6166	6282	31	20	12	2
	450	1000	694	2.1	5189	5285	26	17	9	2
		1100	794	2.3	5680	5785	27	18	9	2
		1200	894	2.5	6164	6280	28	19	9	2
-20	400	2000	1311	2.2	5179	5552	36	22	15	2
	425	2000	1254	2.2	5176	5549	33	22	12	2
	450	2000	1196	2.2	5174	5547	30	21	8	2
-30	400	3000	1725	2.3	4932	5772	38	26	13	2
	425	3000	1596	2.3	4930	5771	35	25	10	2
	450	3000	1468	2.2	4928	5769	32	25	7	2

NOTE: 1. ONLY MK 67 WARHEAD PERMITTED.
2. APPLICABLE CONFIGURATIONS:
MK 67 MOD 0 w/M427 FUZE, NALC H861
MK 67 MOD 1 w/M427 FUZE, NALC H893
MK 67 MOD 1 w/MK 352 FUZE, NALC H892

Figure 22-12. Delivery Data Table, 2.75-Inch Rockets (Sheet 1 of 2)

DELIVERY DATA
2.75 INCH FFAR: MK 66 MODs 2 AND 4 MOTOR: WTU-1/B WARHEAD

RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)	TIME OF FALL (SEC)	DOWN RANGE TRAVEL (FT)	SLANT RANGE (FT)	SIGHT ANGLE (MIL)	TRAJEC-TORY DROP (MIL)	ANGLE OF ATTACK (MIL)	PAR-ALLAX (MIL)
-10	400	1000	738	2.4	5103	5200	36	22	15	2
		1100	838	2.6	5577	5684	37	23	15	2
		1200	938	2.8	6043	6161	39	25	16	2
	425	1000	716	2.3	5103	5200	33	21	12	2
		1100	816	2.5	5578	5685	34	22	12	2
		1200	916	2.8	6045	6163	35	24	12	2
	450	1000	694	2.3	5105	5202	29	20	9	2
		1100	794	2.5	5580	5688	31	22	9	2
		1200	894	2.7	6049	6167	32	23	9	2
-20	400	2000	1311	2.5	5126	5502	40	26	15	2
	425	2000	1254	2.4	5126	5502	36	25	12	2
	450	2000	1196	2.4	5126	5503	33	24	8	2
-30	400	3000	1725	2.6	4895	5741	41	29	13	2
	425	3000	1596	2.5	4895	5741	38	28	10	2
	450	3000	1468	2.5	4895	5741	35	27	7	2

NOTE: 1. ONLY WTU-1/B WARHEAD PERMITTED, NALC H663

Figure 22-12. Delivery Data Table, 2.75-Inch Rockets (Sheet 2)

DELIVERY DATA
MK 76 MOD 5 PRACTICE BOMB

RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)	TIME OF FALL (SEC)	DOWN RANGE TRAVEL (FT)	SLANT RANGE (FT)	SIGHT ANGLE (MIL)	TRAJEC-TORY DROP (MIL)	ANGLE OF ATTACK (MIL)	PAR-ALLAX (MIL)
-10	400	1000	738	5.2	3252	3402	142	124	15	3
		1100	838	5.6	3471	3641	151	132	15	3
		1200	938	5.9	3681	3871	159	141	16	3
	425	1000	716	5.1	3365	3511	129	114	12	3
		1100	816	5.4	3595	3760	137	122	12	3
		1200	916	5.8	3816	4000	145	130	12	3
	450	1000	694	5.0	3472	3613	117	106	9	3
		1100	794	5.3	3712	3872	125	114	9	3
		1200	894	5.7	3943	4121	132	121	9	2
-20	400	2000	1311	6.4	3754	4253	158	140	15	2
	425	2000	1254	6.2	3858	4346	143	129	12	2
	450	2000	1196	6.0	3954	4431	130	119	8	2
-30	400	3000	1725	7.1	3833	4868	156	140	13	2
	425	3000	1596	6.9	3925	4940	141	129	10	2
	450	3000	1468	6.7	4008	5006	128	119	7	2

Figure 22-13. Delivery Data Table, MK 76 Practice Bomb

PART IX

FLIGHT CREW COORDINATION

Chapter 23 - Flight Crew Coordination

CHAPTER 23

Flight Crew Coordination

23.1 CONTROL OF AIRCRAFT

During the normal cycle of events in a training sortie, the opportunity for confusion concerning control of the aircraft and aircraft systems does exist. Therefore, passing control of the aircraft may include passing control of aircraft subsystems and should be accomplished in an unambiguous and simple manner.

Passing control of the aircraft shall be accomplished by positive verbal communication over the ICS system initiated by the pilot in control stating “YOU HAVE THE AIRCRAFT”. The pilot receiving control shall state “I HAVE THE AIRCRAFT”. The pilot relinquishing control confirms by restating “YOU HAVE THE AIRCRAFT”. In the event of intercom failure, the pilot requesting control shall shake the control stick. The pilot relinquishing control shall raise both hands.

23.2 DIVISION OF RESPONSIBILITY

Division of responsibilities shall be thoroughly covered in the preflight brief including control of radios, navaids, and radar altimeter use. Procedures and areas of responsibility during emergencies or system failures shall be thoroughly covered in the preflight brief.

23.3 CHALLENGE AND REPLY

Items requiring a challenge and reply between cockpits are:

1. Prestart ICS check
2. Aft cockpit checks complete
3. Movement of canopy
4. Movement of ejection seat safe/armed handle

23.4 REQUIRED ICS TRANSMISSIONS

1. Takeoff checklist
2. Landing checklist
3. Actuation of MASTER TEST switch

PART X

NATOPS EVALUATION

Chapter 24 - NATOPS Evaluation

CHAPTER 24

NATOPS Evaluation

24.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating the T-45C aircraft. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS program is achieved only through the vigorous support of the program by commanding officers as well as flight crew members.

24.2 DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

24.2.1 NATOPS Evaluation. A periodic evaluation of individual flight crew member standardization consisting of an open book examination, a closed book examination, an oral examination, and a flight evaluation.

24.2.2 NATOPS Re-Evaluation. A partial NATOPS evaluation administered to a flight crew member who has been placed in an Unqualified status by receiving an Unqualified grade for any ground examination or the flight evaluation. Only those areas in which an unsatisfactory grade was given need be observed during a re-evaluation.

24.2.3 Qualified. That degree of standardization demonstrated by a very reliable flight crewmember who has a good knowledge of standard operating procedures and thorough understanding of aircraft capabilities and limitations.

24.2.4 Conditionally Qualified. That degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. This individual is considered safe enough to fly as pilot in command or to perform normal duties without supervision, but more practice is needed to become qualified.

24.2.5 Unqualified. That degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. This individual should receive supervised instruction until the individual has achieved a grade of Qualified or Conditionally Qualified.

24.2.6 Area. A routine of preflight, flight, or postflight.

24.2.7 Sub-Area. A performance subdivision within an area, which is observed and evaluated during an evaluation flight.

24.2.8 Critical Area. Any area or sub-area which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

24.2.9 Emergency. An aircraft component, system failure, or condition which requires instantaneous recognition, analysis and proper action.

24.2.10 Malfunction. An aircraft component or system failure or condition which requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

24.3 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. Pilots desiring to attain/retain qualification in

the T-45A shall be evaluated initially in accordance with OPNAVINST 3710.7 series, and at least once during the 12 months following initial and subsequent evaluations. Individual and unit NATOPS evaluations will be conducted annually; however, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS coordinators, evaluators, and instructors shall administer the program as outlined in OPNAVINST 3710.7 series. Evaluees who receive a grade of Unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a re-evaluation. A maximum of 60 days may elapse between the date the ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

24.4 GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a grade of Qualified on the open and closed book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS instructors may use the bank of questions contained in this section in preparing portions of the written examinations.

24.4.1 Open Book Examination. Up to 50 percent of the questions used may be taken from the question bank. The number of questions on the examination will not exceed 40 or be less than 20. This examination should require use of Part XI, Performance Data (A1-T45AB-NFM-300), and provide a comprehensive review of the flight manual in general. No time limit.

24.4.2 Closed Book Examination. Up to 50 percent of the closed book examination may be taken from the question bank and shall include questions concerning normal procedures and aircraft limitations. The number of questions on the examination will not exceed 40 or be less than 20. Questions designated critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of Unqualified being assigned to the examination.

24.4.3 Oral Examination. The questions may be taken from this manual and drawn from the experience of the instructor/evaluator. Such questions should be direct and positive and should in no way be opinionated.

24.4.4 OFT/IFT Procedures Examination (If Conducted). An OFT/IFT (operational/instrument flight trainer) is used to assist in measuring the crewmember's efficiency in the execution of normal operating procedures and reaction to emergencies and malfunctions and should include flight procedures insofar as practicable.

24.4.5 Grading Instructions. Examination grades shall be computed on a 4.0 scale and converted to a grade of Qualified or Unqualified.

24.4.5.1 Open Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.5.

24.4.5.2 Closed Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.3.

24.4.5.3 Oral Examination and OFT/IFT Procedure Check (If Conducted). A grade of Qualified or Unqualified shall be assigned by the instructor/evaluator.

24.5 FLIGHT EVALUATION

The number of flights required to complete the flight evaluation should be kept to a minimum, normally one flight. The areas and sub-area to be observed and graded on an evaluation flight are outlined in the grading criteria with critical areas marked by an asterisk (*).

24.5.1 Flight Evaluation Grade Determination. The following procedure shall be used in determining the flight evaluation grade. A grade of Unqualified in any critical area will result in an overall grade of Unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each sub-areas. Only the numeral 0 , 2 or 4 will be assigned in sub-areas. No interpolation is allowed.

Unqualified..... 0.0
Conditionally Qualified 2.0
Qualified 4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the sub-areas and divide this sum by the number of sub-areas graded. The grade shall then be determined on the basis of the following scale:

0.0 to 2.19 - Unqualified
2.2 to 2.99 - Conditionally Qualified
3.0 to 4.0 - Qualified

Example: (Add sub-area numerical equivalents)

$$\frac{4+2+4+2+4}{5} = \frac{16}{5} = 3.20 = \text{Qualified}$$

24.6 FINAL GRADE DETERMINATION

The final NATOPS evaluation grade shall be the same as the grade assigned to the evaluation flight. An evaluee who receives an Unqualified on any ground examination or the flight evaluation shall be placed in an Unqualified status until he/she achieves a grade of Conditionally Qualified or Qualified on a re-evaluation.

24.7 RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV Form 3510/8) (Figure 24-1) shall be completed for each evaluation and forwarded to the evaluee's commanding officer.

This report shall be filed in the individual flight training record. In addition, an entry shall be made in the pilot's flight logbook under "Qualifications and Achievements" as follows:

Qualification	Date	Signature
NATOPS Evaluation T-45C Pilot	(Date)	(Authenticating Signature) (Unit which administered evaluation)

24.8 FLIGHT EVALUATION GRADING CRITERIA

The following areas are provided and may be evaluated during the NATOPS check flight. Momentary deviations should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

1. Mission Planning / Flight Preparation
2. Preflight
3. Start / Taxi Procedures
4. Takeoff Procedures
5. Mission Procedures
6. Simulated Emergencies
7. Arrival Procedures
8. Landing
9. Postflight

24.9 NATOPS EVALUATION QUESTION BANK

The following questions are intended to assist the unit NATOPS instructor/evaluator in the preparation of ground examinations and to provide an abbreviated study guide. These questions cover material presented in this manual. The questions from the bank should be combined with locally originated questions encompassing individual squadron standard operating procedures in the preparation of ground examinations.

24.9.1 General Questions.

1. What is the EGT limit for engine start?
2. What is the MAX allowable overshoot (temperature and time) during engine start?
3. What is the MAX idle EGT?
4. What is the normal idle RPM with the bleed valve closed?

NATOPS EVALUATION REPORT
OPNAV 3510/8 (REV.7-78) S/N 0107-LF-035-1040

REPORT SYMBOL OPNAV 3510-3

NAME (Last, first initial)	GRADE	SSN

SQUADRON/UNIT	AIRCRAFT MODEL	CREW POSITION

TOTAL PILOT/FLIGHT HOURS	TOTAL HOURS IN MODEL	DATE OF LAST EVALUATION

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE		
		Q	CQ	U
OPEN BOOK EXAMINATION				
CLOSED BOOK EXAMINATION				
ORAL EXAMINATION				
EVALUATION FLIGHT				
FLIGHT DURATION	AIRCRAFT BUNO	OVERALL FINAL GRADE		

REMARKS OF EVALUATOR/INSTRUCTOR

☐ CHECK IF CONTINUED ON REVERSE SIDE

GRADE, NAME OF EVALUATOR/INSTRUCTOR	SIGNATURE	DATE

GRADE, NAME OF EVALUEE	SIGNATURE	DATE

REMARKS OF UNIT COMMANDER

RANK, NAME OF UNIT COMMANDER	SIGNATURE	DATE

*AST, OFT, COT, or cockpit check in accordance with OPNAVINST 35;0.0

EDA815-128-1-01

Figure 24-1. NATOPS Evaluation Report (OPNAV Form 3510/8)

5. What is MAX continuous RPM and EGT?

6. What are the MRT RPM and EGT?

7. What is the MAX EGT for an airstart?

8. What is the MAX allowable overshoot (temperature and time) during airstart?

9. What are the MIN airspeed and MAX altitude limits for a unassisted airstart?

10. What is the maximum airspeed for landing gear and/or flap/slats extension?

11. What is the maximum gross weight for takeoff?

12. Below what altitude (AGL) will a pilot eject if the aircraft is in uncontrollable flight?

13. How is a failure of the connecting the undervoltage sensing unit confirmed?

24.9.2 True or False Questions.

14. The F405-RR-401 engine installed develops 5,527 pounds of thrust at standard sea-level conditions. True or False

15. The OIL PRESS light on the Caution/ Warning Panel (CWP) illuminates if the differential pressure increases. True of False

16. Protection circuits within the starting system automatically shut down the GTS if the GTS idle speed is not achieved within 30 seconds. True or False

17. During engine start, the GTS will shut down automatically at approximately 45 percent engine RPM. True or False

18. The HUD is an electro-optical device located only in the front cockpit that projects flight and weapon delivery information in symbolic form into the pilots instantaneous field of view on a combining glass. True or False

19. During ground starting, allow an interval of 3 minutes between each GTS start, and 20 minutes after three consecutive GTS starts. True or False.

20. During ground starting, engine ignition units are continuously energized for 30 seconds after the GTS start button is released. True or False.

21. Engine light-off normally occurs within 10 seconds (15 seconds maximum) of selecting IDLE. True or False.

22. After the bleed valve is closed, the engine should stabilize at 55 ±1 percent RPM at sea level. (Increase 1 percent for every 1,500 feet above sea level.) True or False

23. Immediate airstarts may be attempted at any airspeed and altitude. True or False

24. After an airstart, when the engine has accelerated and stabilized, the GEN and HYD 2 should be reset. True or False

25. The BIT display will automatically display upon system power-up. True of False

26. An unassisted airstart should be conducted below 25,000 feet with a minimum airspeed of 250 knots. True or False

27. The aircraft MAX crosswind computed for takeoff and landing is 30 knots. True or False

28. The F PRES caution light will illuminate when the fuel pressure falls to 3 psi above dynamic pressure. True or False

29. The negative-g compartment of the engine fuel feed tank will provide for 30 seconds of inverted flight, with maximum power, at sea level. True or False

30. During engine start, the fuel boost pump is powered by the Essential Services Bus for 30 seconds when the GTS start button is pressed. True or False

31. The F PRES caution light illuminates if the boost pump pressure rise is less than 4 psi. True or False

32. The LP PMP caution light will illuminate when the engine-driven low pressure pump fails. True or False

33. After an airstart, if the generator is not reset within 30 seconds, the F PRES light will illuminate when the bus automatically switches back to the GEN Bus. True or False

34. The FUEL caution light will illuminate when the fuel remaining is 350 ±50 lbs. True or False

35. A hot start is indicated by the EGT rapidly rising through 545 °C. True or False

36. The minimum and maximum fuel flow is 300 pph minimum/4,750 pph maximum. True or False

37. After start, the closure of the bleed valve is indicated by 3 percent increase of RPM and 50 °C drop in EGT. True or False

38. Once the bleed valve is closed, it will remain so until the GTS start button is pressed. True or False

39. The display system BIT monitors equipment status and notifies the aircrew if a failure or degraded conditions exist. It also allows for initiating BIT of individual aircraft equipment. True or False

40. During an airstart using manual fuel control, after the GTS start button is released, the bleed valve remains open for 60 seconds. True or False

41. To eliminate transient warnings caused by aircraft maneuvering, the OIL PRESS warning is delayed approximately 10 seconds with the landing gear up and locked. True or False

42. The only portion of the aircraft protected from icing by ducted engine air is the fan spinner. True or False

43. Ignition is inhibited when the throttle is advanced past the IDLE position. True or False

44. Manual fuel control, when selected, will provide for automatic fuel scheduling during an airstart. True or False

45. To use the GTS during an airstart, the engine RPM must be below 20 percent. True or False

46. An overvoltage of 30.2 ±0.1 volts or a voltage of less than 25 volts will cause the GENERATOR warning light to illuminate. True or False

47. The generator will reset automatically after an airstart. True or False

48. External electrical power, when used during ground starting, is automatically cut off when the engine reaches 45 percent RPM. True or False

49. If both inverters FAIL, the standby attitude indicator becomes the primary attitude instrument. True or False

50. The FIRE warning light illuminates at 300 °C. True or False

51. The GTS FIRE warning light illuminates at 300 °C. True or False

52. The TP HOT caution light illuminates at 150 °C. True or False

53. If the fire warning lights extinguish due to a temperature decrease, an automatic reset may take 45 seconds. True or False

54. The operating pressure for both hydraulic systems is about 3,000 psi. True or False

55. The HYD 2 bypass valve is powered open (to reduce engine loads during airstart), below 42 percent RPM. True or False

56. A hand pump is provided to charge the wheel brake accumulator prior to aircraft towing. True or False

57. Indications of RAT operation is a cycling HYD 2 pressure indicator between 2,500 and 3,000 psi as control stick demands are made. True or False

58. To ensure there is enough pressure to reset the RAT shuttle valve, the engine RPM should be above 76 percent. True or False

59. RAT extension is automatic whenever the HYD 2 pressure falls to 1,500 ±100 psi. True or False

60. The HYD 1 caution light illuminates when system pressure is 600±50 psi or less. True or False

61. The HYD 2 caution light illuminates when system pressure is 1,660±110 psi or less. True or False

62. The HYD FAIL warning light illuminates when HYD 1 and 2 systems drop below 600 psi. True or False

63. Yaw damping function is active at all airspeeds. True or False

64. The flap ranges are 50 degrees full down and 25 degrees at one-half. True or False

65. A SP BRK advisory light illuminates when the speed brakes are not fully retracted. True or False

66. On the ground (weight-on-wheels), inadvertently moving the landing gear handle from DN to UP will cause the landing gear to retract? True or False

67. A red WHEELS warning light will flash and a warning tone will sound if the landing gear is not down and locked and the throttle is below approximately 90 percent RPM, when:

    Altitude is 10,000 feet or less and airspeed is 170 knots or less

    OR

    At any altitude and either FLAPS/SLATS switch is not in the UP position. True or False

68. A RED wheels warning light located on the glareshield in both cockpits flashes and a tone is audible if the gear is not down and locked in the landing pattern. True or False

69. Auto retraction (blowback) of the flaps begins at approximately 200 knots. True or False

70. The speed brakes will not extend fully above 340 knots. True or False

71. If flap/slat selection disagrees between the forward and aft cockpit, the flaps/slats will move to the most extended position. True or False

72. In the event of a HYD 1 system failure, power to the flaps is available from the wheel brake/emergency flap accumulator. True or False

73. Following a generator failure the right MFD drops off line and the left MFD shows the ADI display. This is normal. True or False

74. Emergency hydraulic pressure prevents raising the landing gear handle with weight-on-wheels. True or False

75. The white aft facing light on the nose landing gear strut illuminates in flight to indicate landing gear position. True or False

76. In an actual emergency gear extension, the normal FINAL configuration should be:

    a. Emergency gear handle pulled.
    b. Normal landing gear handle DN.
    c. Gear DOOR light illuminated.

d. WHEELS warning light out.
e. Red light in the landing gear handle out.
f. White light on nose landing gear on.
True or False

77. If the SKID caution light illuminates in flight, the following procedure should be used:

a. Turn anti-skid off.
b. Use normal braking techniques.
True or False

78. Nose wheel steering is not normally used any time the ground speed exceeds 60 knots. True or False

79. In the event a nose wheel steering failure occurs, the system automatically shuts down and the yellow NWS caution light illuminates. True or False

80. The NWS is always in operation on the deck? True or False.

81. The launch bar will not extend if the nose wheel angle is greater than 30 degrees from center.
True or False

82. The OXYGEN warning light illuminates when:

a. Bleed air temperature 250 °C or above.
b. Oxygen concentration is low.
True or False

83. IFF Mode C altitude reporting works off the forward cockpit altimeter.
True or False

84. The forward Mach airspeed indicator provides an output to the landing gear warning system. True or False

85. The aft Mach airspeed indicator provides an output to the control augmentation system. True or False

86. During the preflight test of the COMM 1 UHF/VHF, the FREQ/CHAN indicator displays 888.888; COMM 1 requires service. True or False

87. While checking the IFF system, you set the MASTER Control Selector to NORM and the Mode Select/TEST 3A switch to TEST after the 2-minute warmup, and you observe the following:

GO light illuminates, therefore the IFF mode 3A is operational. True or False

88. While testing the COMM 2 UHF/VHF, you note the FREQ/CHAN indicator displays 6 5 1; COMM 2 requires service.
True or False

89. During the VOR/ILS system BIT check, the VOR bearing pointer indicates 90 degrees; VOR/ILS system requires service. True or False

90. After pressing the TEST button for 5 seconds during a TACAN BIT check, you observe the following:

a. HSI TACAN range counter indicates ±1 nm.
b. HSI TACAN bearing pointer indicates 180 ±2.5 degrees.
c. The TACAN system requires service.
True or False

91. During the preflight of the VOR/ILS system, you set the VOR/ILS control to a valid VOR frequency and observe the following:

a. VOR light is illuminated
b. The VOR bearing pointer indicates 315 ±3 degrees
c. The VOR signal is valid.
True or False

92. The STBY attitude indicator provides up to 3 minutes of attitude information after a total power failure. True or False

93. If the HOOK BYP switch is in the CARRIER position and the hook is not extended, the indexer lights in both cockpits will flash and the external approach lights will flash when the landing gear is down. True or False

94. The localizer and glideslope steering needles for ILS are in view when:

    a. ILS has been selected.
    b. Valid ILS frequency is tuned.

    True or False

95. A valid BIT check for the VOR/ILS is as follows:

    a. Bearing pointer pointing to 315 ±2.5 degrees.
    b. CDI moves left ±2 dots.
    c. Marker beacon lights illuminate.

    True or False

96. A valid BIT check for the TACAN is as follows:

    a. #2 needle pointing to 180 ±2.5 degrees.
    b. 1 NM DME. True or False

97. If cockpit pressure is lost, a warning is provided when the cockpit altitude exceeds 24,500 ±500 feet.

    True or False

98. Pressing the ADR push-button initiates a 10-second parameter record.

    True or False

99. The AV HOT light illuminates when the avionics bay temperature exceeds 153 ±5 °F on the ground.

    True or False

100. The landing gear handle light will remain illuminated until the landing gear have fully retracted and the gear doors have closed properly. True or False

101. If a launch bar malfunction is indicated, retraction of the landing gear will cause the indications of a L BAR malfunction to cease but may not correct the problem.

    True or False

102. The wheel brakes remain functional when the wheel brakes/emergency flap accumulator pressure gage displays 0 psi and HYD 1 pressure is normal.

    True or False

24.9.3 Multiple Choices

103. The engine bleed valve is

    a. Open during engine starting to prevent N_2 compressor stalling.
    b. Open during engine acceleration above 61 percent to prevent N_1 compressor stalling.
    c. Closed during engine starting to ensure maximum GTS pressure.
    d. Closed during engine acceleration above 80 percent to increase EGT.

104. The major components of the display system consist of

    a. Four MFDs, a DEU, two DEPs, and a HUD
    b. Four MFDs, a DEU, a DEP, and two HUDs
    c. Two MFDs, four DEUs, two DEPs and two HUDs
    d. Two MFDs, a DEU, two DEPs, and two HUDs

105. The LP fuel pump is powered by the

    a. 115 VAC Non Essential bus.
    b. 115 VAC Essential bus.
    c. Engine-driven gearbox.
    d. 28 VDC Generator bus.
    e. 28 VDC Essential bus.

106. The cockpit EGT indication comes from the

    a. ECA
    b. T6/T2 thermocouple junction box.
    c. FCU
    d. ADRS
    e. N_2 turbine temperature probe.

107. During the landing rollout, at what speed will anti-skid operation no longer be possible?

    a. 13 to 10 knots
    b. 35 to 32 knots
    c. 75 to 72 knots
    d. 90 to 87 knots

108. During a landing, the wheels must spin up to _____ knots before anti-skid operation is possible.

a. 20
b. 30
c. 75
d. 90

109. The Display Electronics Unit (DEU) acts as a _____ computer.

a. display and data
b. symbol generator and mission
c. display and mission.
d. display and position

110. The maximum airspeed for lowering the landing gear is

a. 190 knots
b. 200 knots
c. 210 knots
d. 230 knots

111. The emergency landing gear extension system is

a. Mechanically controlled and hydraulically operated.
b. Electrically controlled and hydraulically operated.
c. Mechanically controlled and gravity operated.
d. Electrically controlled and mechanically operated.

112. The maximum airspeed for flying with the landing gear extended is

a. 190 knots
b. 200 knots
c. 210 knots
d. 230 knots

113. The normal landing gear system is:

a. Electrically controlled and hydraulically operated.
b. Mechanically controlled and gravity operated.
c. Mechanically controlled and hydraulically operated.
d. Electrically controlled and mechanically operated.

114. During normal flight operations, the boost pump receives electrical power from the

a. 28 VDC Generator Bus.
b. 28 VDC Essential Services Bus.
c. 115 VAC Essential Bus.
d. 115 VAC Non-Essential Bus.

115. During engine start (ignition switch set to NORMAL and GTS start button depressed), the boost pump receives electrical power from the

a. 28 VDC Generator Bus.
b. 28 VDC Essential Services Bus.
c. 115 VAC Essential Bus.
d. 115 VAC Non-Essential Bus.

116. The MFD is used _____ and/or _____ data and each display has _____ selection options.

a. for navigation, attitude, system
b. for flight, mission, format-specific
c. to read, enter, twenty
d. to enter, change, operational

117. The FUEL or F PRES indications on the caution/warning panel will be accompanied by which tone from the intercom system?

a. Caution
b. Master alert
c. Wheels-up
d. Weapon release
e. Simulated gunnery

118. Select all that apply. The GENERATOR warning light will illuminate when

a. Generator output voltage exceeds 30.2 ±0.1 volts.
b. Voltage on the 28 VDC Essential Services Bus is 25 VDC or less.
c. The generator trips off-line.
d. Generator output is between 28.1 to 29.1 VDC.

119. Select all that apply. If the generator goes off-line in flight (aircraft 165093 AND UP),

a. Reset may be attempted by cycling the GEN RESET switch.
b. The GENERATOR light on the caution/ warning panel illuminates.
c. The AC INV light on the caution/ warning panel illuminates.
d. Reset may be attempted by cycling the AC RESET switch.

120. Select all that apply. When inverter No. 1 is off-line,

a. Reset may be attempted by cycling the AC RESET switch.
b. The AC INV light on the caution/ warning panel illuminates.
c. Reset may be attempted by cycling the GEN RESET switch.
d. The GENERATOR light on the caution/warning panel illuminates

121. The DEU operates as one computer with two capabilities. One of the capabilities of the DEU is to act as a display computer. What is the second capability?

a. Air Data Computer
b. Flight Control Computer
c. Mission Computer
d. All of the above

122. Select all that apply. Services connected to the 28 VDC Essential Services Bus include

a. Stabilator trim.
b. Flaps control.
c. AOA Indicator.
d. TACAN.
e. Radar altimeter.

123. Select all that apply. Services connected to the 28 VDC Generator Bus include

a. Control augmentation system.
b. Nose wheel steering control.
c. ILS.
d. Speed brakes.
e. Arresting hook.

124. Select all that apply. Instruments powered by the 115 VAC Essential Bus include

a. HSI.
b. ADI.
c. HUD.
d. VOR/ILS/MB.
e. Emergency lights.

125. Select all that apply. Components powered by the 115 VAC Non-Essential Bus include

a. Radar altimeter.
b. 5 VAC lighting dimmers.
c. Taxi/landing lights.
d. OBOGS heater
e. Standby AI.

126. Operation of the emergency jettison switch is inhibited by

a. Weight on wheels.
b. MASTER ARM switch set to OFF.
c. Airspeed below 170 knots and either flaps or gear down.
d. Generator Bus failure.

127. Select all that apply. Weight-on-wheels will inhibit operation of the

a. Emergency jettison switch.
b. Armament Bus services.
c. HUD.
d. Video cassette system.

128. The display system used hard-wired interfaces to transmit/receive _____, _____, and _____ data between the DEU and its system components.

a. sound, serial, digital
b. analog, video, discrete
c. digital, analog, sound
d. discrete, video, digital

129. Select all that apply. The STRS display selects the

a. Display mode of the HUD.

b. Type of weapon to be used.
c. Pylon that will launch the weapon.
d. Type of bomb launched from the PMBR.

130. Select all that apply. Power to the Armament Bus is controlled by the

a. Master Armament switch.
b. Master Armament Override switch.
c. PUSH TO JETT button.
d. Weapon options.

131. Select all that apply. With NAV selected on the STRS display,

a. The HUD will display a NAV mode.
b. Weapon release is inhibited.
c. The PUSH TO JETT button is functional.

132. Select all that apply. In addition to the weapons delivery symbology, the HUD displays symbols for the

a. AOA system.
b. Centralized Warning system.
c. RALT
d. ADR
e. VOR/ILS equipment.

133. What type of data words are transmitted/received between the DEU and the ADR, GINA, and MDL?

a. Analog
b. Discrete
c. Digital
d. None of the above

134. While attempting to start the engine, you see that the GTS advisory light does not illuminate. This is an indication of

a. GTS fuel supply failure.
b. Bleed valve failure.
c. Low oil pressure.
d. Engine stall.

135. You are sitting on the flight line preparing for a hop when the MASTER ALERT light illuminates. The plane captain points to the top of your aircraft with one hand and waves the other in a horizontal figure eight motion. Which one of the following accurately represents the situation?

a. GTS fire.
b. Engine fire.
c. Hydraulic fire.
d. Oil fire.

136. While starting the engine, you see the EGT rapidly approaching 550 °C. This indicates

a. A hot start.
b. A wet start.
c. A hung start.
d. A false start.

137. While starting the engine, you notice your RPM stagnating at 45 percent, yet your EGT slowly continues to rise after the GTS has shut down. These are indications of a

a. Hung start.
b. Wet start.
c. Hot Start.
d. False start.

138. While starting the engine, you will get what indication if the oil pump is not producing enough pressure for proper lubrications of engine parts?

a. OIL PRESS light
b. L.P. PUMP light
c. BOOST PUMP light
d. AV HOT light

139. While starting the engine, you receive no rise in EGT within 15 seconds after advancing the throttle, and the plane captain is pinching his/her nose and pointing at the tail pipe. What malfunction are you experiencing?

a. Wet start
b. Hung start
c. Engine icing
d. Hot start

140. The _____ controls and twenty _____ _____for the MFD are located on the _____.

a. Three, option push-buttons, MFD bezel
b. Four, control push-buttons, MFD bezel
c. Two, display controls, center console
d. Three, option push-buttons, center console

141. Select all that apply. Which of the following indicate an engine fire on start?

a. Plane captain makes figure eight motion
b. Rising EGT
c. MASTER ALERT and FIRE light
d. AV HOT light

142. With the battery switches on, the throttle at OFF, engine start switch at ON, and ignition switch at NORMAL, you depress the GTS start button. In 15 seconds the GTS advisory light illuminates, and you place the engine start switch to START. What is the next indication that you should receive?

a. OIL PRESS light illuminates
b. GTS light extinguishes
c. ECA 2 light illuminates
d. READY light illuminates

143. You are starting the engine and the RPM has stabilized. You advance the throttle through 65 percent and return it to IDLE. Checking your RPM and EGT, you find that they have not changed from their original position. What malfunction would give you these indications?

a. GTS fuel supply failure
b. Bleed valve failure
c. False start
d. GTS failure

144. NWS is

a. Electrically controlled and mechanically operated.
b. Mechanically controlled and electrically operated.
c. Mechanically controlled and operated.
d. Electrically controlled and hydraulically operated.

145. Each MFD has controls for selecting various display formats, options and submodes. There are ____ bezel push-buttons that when depressed will initiate the associated function for that display.

a. 03
b. 10
c. 20

146. Select all that apply. If the NWS fails,

a. The system shuts itself down.
b. The system serves as a hydraulic shimmy damper for the nosewheel.
c. The system will continue to steer in the last commanded direction.
d. The system generates the 2-second nosewheel centering command.

147. Select all that apply. After takeoff, with the gear handle up, what indications would you expect if the landing gear doors have failed to close and lock?

a. Landing gear handle red light
b. Landing gear DOOR light remains illuminated
c. Wheels warning light
d. HYD 1 pressure gage indicates loss in pressure

148. What has occurred if after retracting the landing gear, you notice the DOOR light and the gear handle light are illuminated but the NOSE, LEFT, RIGHT are extinguished?

a. The landing gear doors are closed and locked but the landing gear has failed to retract properly.
b. The landing gear system, including doors has retracted/closed normally.
c. One or more landing gear doors are not closed.
d. The landing gear is down and locked properly, but the gear doors have failed to close.

149. Select all that apply. The fuel system tanks are pressurized in order to

a. Suppress fuel boiling at high altitude.
b. Aid in fuel transfer.
c. Keep the collector tank full.
d. Prevent reverse fuel flow during aircraft maneuvers.

150. While in flight, you notice a loss of about 25 percent thrust. You have no indications of fire, no CWP lights illuminated, and your throttle is working normally. What condition could these indications represent?

a. Bleed valve failure
b. Tailpipe overtemp
c. Engine overspeed
d. ECA failure

151. You are flying through clouds at 10,000 feet and the outside ambient temperature is 5 °C when the engine begins to lose power and the EGT begins to rise. Which of the following malfunctions is indicated?

a. Engine surge
b. Engine fire
c. Engine icing
d. Tailpipe fire

152. The HUD is _____ device located in _____cockpit(s) that projects _____ and _____ information in symbolic form into the pilots instantaneous field of view on a combining glass.

a. a cathode-ray tube, both, navigation, attitude
b. a reflective-glass, the front, performance, ordnance delivery
c. an optical, both, attitude, control
d. an electro-optical, the front, flight, weapons delivery

153. A flashing MASTER ALERT light accompanied by an aural warning tone draws your attention to the CWP. You observe that the ECA 2 caution light is illuminated. Checking engine RPM, EGT, and fuel flow indicators, you observe that RPM, EGT, and fuel flow are increasing from previous readings. What condition do these indications represent?

a. ECA failure in a no trim condition
b. ECA failure in a full trim condition
c. ECA single lane failure
d. Bleed air valve failure

154. The major difference between engine malfunctions while in normal fuel control and engine malfunctions while in manual fuel control is that when in manual fuel control,

a. You need not pay attention to engine indicators.
b. Throttle movements must be made judiciously.
c. Engine malfunction indications occur at a faster rate.
d. Reaction time to malfunctions is increased.

155. Which one of the following may indicate an engine failure during takeoff?

a. Decreasing RPM and fuel flow.
b. Increasing airspeed.
c. Increasing EGT and fuel flow.
d. Stable EGT, RPM and fuel flow.

156. While rolling on takeoff, you hear a loud noise, feel a loss of acceleration, and see that your EGT is higher than normal. What is the probable cause?

a. Engine overspeed
b. Engine failure
c. Engine fire
d. Engine overtemp

157. What three electrical buses are used by the display system?

a. 28 VDC generator bus, 28 VDC essential bus, 115 VAC non-essential bus
b. 115 VAC essential bus, 28 VDC generator bus, 26 VAC essential bus
c. 26 VAC non-essential bus, 28 VDC essential bus, 115 VAC non-essential bus

d. 28 VDC non-essential bus, 26 VAC essential bus, 115 VAC essential bus

158. During a takeoff with throttle advanced to MRT, you check your gages and find the following: RPM is 85 percent, EGT is 510 °C and fuel flow is normal. All appear stable. What condition do these indications re present?

a. Engine reduced thrust
b. Engine overtemp
c. Engine flameout
d. Engine stall

159. In flight, an audible bang or series of bangs accompanied by an increase in EGT and a decrease in RPM indicates a ( )?

a. Engine stall.
b. AC inverter failure.
c. Bleed valve failure.
d. Oil pressure failure.

160. Which of the following indicates an engine overspeed condition?

a. EGT/RPM warning light ON
b. READY advisory light ON
c. EGT indicator light ON
d. F PRES caution light ON

161. In flight, the MASTER ALERT begins flashing, the aural tone sounds, and the EGT/RPM warning light illuminates. You observe that EGT is 550 °C, and RPM is 108 percent. What condition exist?

a. Engine stall
b. Engine overspeed
c. Engine overtemp
d. Engine flameout

162. A sudden loss of power accompanied by a GENERATOR warning light indicates what condition?

a. Engine flameout
b. Engine overtemp
c. Engine overspeed
d. Engine stall

163. Which of the following indicates an engine flameout?

a. Sharply decreasing RPM, EGT, and fuel flow
b. Sharply rising RPM, EGT, and fuel flow
c. Decreasing RPM with rising EGT and fuel flow

164. Select all that apply. The display system BIT does the following.

a. monitors equipment status
b. activates the MASTER ALERT light and caution tone
c. notifies aircrew of equipment failure or degraded condition
d. allows for initiating the aircraft system BIT

165. Which one of the following represents the primary indication(s) of an engine fire?

a. EGT indication of 600 °C
b. MASTER ALERT and FIRE lights with warning tone
c. TP HOT caution light
d. EGT/RPM warning light

166. During engine shutdown, the MASTER ALERT flashes while the plane captain points towards the aircraft with one hand and waves the other hand in a horizontal figure eight pattern. What condition do these indications represent?

a. Engine fire
b. Brake fire
c. Avionics fire
d. Normal shutdown

167. In flight, the FIRE light illuminates but then goes out. What indications would verify that you do have an engine fire? Select all that apply.

a. EGT indicates 710 °C and TP HOT caution light is on
b. EGT/RPM warning light is on and HYD 1 caution is on.

c. EGT indicates 480 °C, RPM indicates 85 percent, and fuel flow indicates 1640 pph.
d. EGT indicates 500 °C, RPM indicates 85 percent, and AC INV caution light is on

168. In normal flight, the caution tone sounds, the MASTER ALERT light flashes, and the HYD 2 light is on. HYD 1 pressure shows 600 psi. HYD 2 pressure is cycling between 2,500 to 3,000 psi. Which malfunction has most likely occurred?

a. RAT failure
b. HYD 1 and 2 failure (RAT operating)
c. HYD 2 failure only
d. Uncommanded RAT extension

169. The AUTO push-button selection will initialize a BIT on what equipment in order?

a. MDL, ADR, GINA, DEU, and RALT
b. GINA, DEU, ADR, MDL, and RALT
c. RALT, MDL, ADR, GINA, and DEU
d. DEU, GINA, ADR, MDL, and RALT

170. Select all that apply. In flight, you hear the caution tone, observe the MSTER ALERT, and notice that the HYD 2 light is on. HYD 2 is at 1300 psi, and HYD 1 is at 3000. Which malfunctions, either separately or together, could cause indications?

a. Fluid loss in HYD 2
b. Pump failure in HYD 2
c. RAT failure
d. HYD 2 accumulator failure
e. Total hydraulic failure
f. HYD 1 and 2 failure with RAT operating

171. Flight control accumulator pressure (for either hydraulic system) is sufficient when

a. Pressure reads 1,100 psi.
b. Pressure reads 3,000 psi.
c. System pressure is less than accumulator pressure.
d. System pressure is greater than accumulator pressure.

172. What malfunctions may have occurred, if cockpit hydraulic indications are normal and flight controls do not respond smoothly?

a. Failure of both FC accumulators
b. Failure of the FC accumulator in HYD 2 only
c. Slow pressure loss in HYD 1 only
d. Slow pressure loss in HYD 2 only

173. Select all that apply. Which hydraulic malfunctions could trigger the caution tone along with an inoperative speed brake?

a. Fluid loss in HYD 1
b. Pump failure in HYD 1
c. HYD 1 accumulator failure
d. Total hydraulic failure
e. RAT failure

174. Select all that apply. If you hear the caution tone in level flight and notice that the MASTER ALERT light is flashing and the HYD 1 light is illuminated on the CWP, which of the following malfunctions would you suspect?

a. Fluid loss in HYD 1
b. Pump failure in HYD 1
c. HYD 1 accumulator failure
d. Total hydraulic failure
e. RAT failure

175. Select all that apply. Under which conditions would you suspect that the RAT has deployed unnecessarily?

a. HYD 2 light off
b. Initial cycling of HYD 2 pressure between 2,600 to 3,050
c. HYD 1 light on
d. RAT light on
e. HYD 2 pressure below 1,500 psi, HYD 1 pressure 3,000 psi

176. The three types of BIT checks are

a. Start, Self-test, Maintenance
b. Initiated, Failure, Normal
c. Power-up, Initiated, Continuous
d. Notional, weight-on-wheels, Standard

177. If the RAT deploys and engine N_2 RPM has returned to 85 percent, what will be the effect of depressing HYD 2 RESET pushbutton?

a. The RAT will retract.
b. The RAT will remain deployed until HYD 2 pressure is 2,800 psi.
c. HYD 2 EDP will be switched off-line.
d. HYD 1 will supply both systems.

178. Under which conditions would you suspect that the RAT has deployed successfully?

a. HYD 2 light off
b. Initial cycling of HYD 2 pressure between 2,600 to 3,050
c. Another aircraft advises that RAT is extended
d. All of the above

179. Select all that apply. In the event of a HYD 1 failure, which flight control systems will remain operative?

a. Rudder
b. Slats
c. Stabilator
d. Flaps
e. Speed brake

180. Which flight control systems are hydraulically operated and have redundant power supplies?

a. Aileron system
b. Stabilator system
c. Rudder system
d. Flap system
e. All of the above

181. Select all that apply. The speed brake system

a. Has no redundant power source.
b. Is protected by pressure/thermal relief valves.
c. Has panels which blow back at airspeeds greater than 315 knots.
d. Has panels which are fully extended at 70 degrees.

182. In the event of a HYD 1 failure, what supplies a back-up to both flight control and general services?

a. Emergency (RAT) system
b. HYD 2
c. Wheel brake/emergency flap accumulator
d. None: no back-up

183. The MFD BIT display

a. will automatically display upon system power-up.
b. activates the MASTER ALERT and caution tone when a BIT failure is detected.
c. is only available with weight-on-wheels.
d. must be selected by the pilot.

184. Select all that apply. In the event of a HYD 2 EDP failure, what supplies a back-up to flight control services?

a. HYD 1
b. Emergency (RAT) system
c. Wheel brake/emergency flap accumulator
d. None: no back-up

185. Match each HYD description (left) to its associated pressure (right).

DESCRIPTION	ASSOCIATED PRESSURE
1) Normal operations	a) 3,000 psi
2) RAT extension	b) HYD 2 drop 1,500 psi
3) Loss of flt. cntl.	c) Both sys 600 psi
4) RAT operating	d) Cycles 2,500 to 3,000 psi
5) Gen. services lost	e) HYD 1 1,500 psi
	f) HYD 2 600 psi
	g) HYD 1 600 psi

186. Select all that apply. N_2 compressor bleed air is supplied to the

a. OBOGS
b. ECS and cockpit pressurization.
c. Fuel tank pressurization.
d. Wing and engine inlet anti-icing system.
e. Engine oil cooling.

187. Following a generator failure the _____ MFD drops off line and the _____ MFD reverts to the _____ display.

a. left, right, ADI
b. right, left , ADI
c. left, right, HSI
d. right, left, HSI

188. When the HOOK BYP switch is set to FIELD,

a. The flashing of the AOA indexer and approach lights is enabled when the aircraft is in the landing configuration and the hook is retracted.
b. The flashing of the AOA indexer and approach lights is inhibited when aircraft is in the landing configuration and the hook is retracted.
c. Operation of the arresting HOOK handle is inhibited.
d. Operation of the arresting hook is remotely controlled by the tower, LSO, or wheels watch personnel.

189. The launch bar system is

a. Electrically controlled, hydraulically extended, and mechanically retracted.
b. Electrically controlled, mechanically extended, and hydraulically retracted.
c. Mechanically controlled, hydraulically extended, and mechanically retracted.
d. Electrically controlled, mechanically extended, and hydraulically retracted.

190. When the launch bar is held by the deck shuttle mechanism, the launch bar RETRACT/EXTEND switch is set to EXTEND, and the throttle is advanced past intermediate power,

a. The launch bar RETRACT/EXTEND switch will remain in the EXTEND position until manually placed to RETRACT.
b. The launch bar RETRACT/EXTEND switch will automatically be reset to the RETRACT position.
c. The launch bar RETRACT/EXTEND switch will remain in the EXTEND position until the catapult shuttle reaches the end of the stroke.
d. The launch bar will automatically retract.

191. Select all that apply. Which services are completely lost (have no back-up) if HYD 1 fails.

a. Landing gear extension
b. Landing gear retraction
c. Tail hook extension
d. Tail hook retraction
e. Nosewheel steering
f. Wheel brakes
g. Anti-skid
h. Launch bar extension
i. All of the above

192. Select all that apply. Which services are inoperative when the generator fails?

a. Arresting hook up/down logic, warning lights
b. Anti-skid control
c. Landing gear control
d. Landing gear position indicator
e. Landing gear down and locked light
f. Launch bar control
g. NWS
h. All of the above

193. Select all that apply. Which functions are associated with aircraft weight-on-wheels?

a. Armament bus enabled
b. ECS ram air valve open
c. NWS enabled
d. Anti-skid enabled
e. Launch bar extension enabled
f. AOA probe and pitot tube heaters enabled

g. None of the above

194. Some indications of an MFD failure are

a. a blinking screen
b. a blank screen
c. a stuck push-button
d. all of the above

195. During flight, the MSTR ALERT flashes and the warning tone sounds. You check the CWP and see that the GENERATOR warning light is illuminated. Immediately you look to the Power Management panel and find that the voltmeter displays 28 volts. Which of the following units is malfunctioning (aircraft 165080 THRU 165092)?

a. Undervoltage unit
b. AC Inverter No. 1
c. AC Inverter No. 2
d. Both inverters

196. Select all that apply. Which of the following indicate or verify a generator failure with low voltage from both batteries?

a. Warning tone sounds
b. F PRESS light illuminates
c. Voltmeter at approximately 22 volts
d. Generator will not reset immediately
e. All of the above

197. During flight, the MASTER ALERT flashes and the warning tone sounds. You see that the GENERATOR warning light and the AC INV caution light on the CWP are illuminated. Searching for secondary indications of a suspected malfunction, you see that the voltmeter on the Electrical Power Control Panel displays 22 volts. Which one of the following accurately described the malfunction?

a. Generator failure with low battery voltage
b. Generator failure with high battery voltage
c. Single AC inverter failure
d. Dual AC inverter failure

198. While flying straight and level, you notice that the fuel quantity indicator is dropping to 0, and your navigation lights, Comm Management system, and AOA system have become inoperative. What malfunction is causing this type of condition?

a. 28 VDC Essential Services Bus failure
b. Undervoltage unit failure
c. Overvoltage unit failure
d. Double inverter failure

199. Which one of the following would be inoperable when a 28 VDC Essential Services Bus failure occurs?

a. Flap control
b. Caution/Warning System
c. GINA
d. Anti-skid control

200. If an MFD anomaly occurs to one MFD select _____, if the anomaly occurs to multiple MFDs select_____.

a. another display, Display Power ORIDE
b. MFD OFF, Display Power RESET
c. Display Power NORM, the MFDs OFF
d. generator RESET, Display Power RESTART

201. While flying straight and level, you suddenly experience a total electrical failure. Which one of the following would occur?

a. Hydraulic system inoperative
b. All cockpit lights extinguish
c. Stabilators uncontrollable
d. Engine stops running

202. The wheel brake/emergency flap accumulator provides pressure to fully extend the flaps in the event of

a. A HYD 1 failure.
b. A HYD 2 failure.
c. A failure in either hydraulic system.

203. After the arresting hook handle has been lowered, what does the intermittent illumination of the red light on the hook handle signify?

a. The hydraulic actuator/vertical damper has malfunctioned.
b. The arresting hook has failed to extend.
c. The arresting hook is extended.
d. The arresting hook bypass switch has been engaged.

204. What malfunction may have occurred if after a catapult launch, the red L BAR light illuminates, its associated caution tone sounds, and the HYD 1 pressure gage displays 3,000 psi.

a. The launch bar has failed to retract.
b. The launch bar has failed to extend.
c. The launch bar has failed to retract because HYD 1 has failed.
d. Emergency retraction of the launch bar is underway.

205. The major components of the GINA are the

a. GPS satellites, INS, and cockpit displays
b. GPS processor, INS, and DEU
c. GPS, DEU, MFD
d. GPS antenna, MFDs, and HUD

206. After the arresting hook handle has been lowered, what does the continued illumination of the red light on the hook handle signify?

a. The arresting hook has failed to extend.
b. The hydraulic actuator/vertical damper has malfunctioned.
c. The arresting hook is extended.
d. The arresting hook bypass switch has been engaged.

207. Select all that apply. The OBOGS system

a. Uses bleed air from the engine compressor.
b. Removes nitrogen and other contaminants through molecular sieves in the oxygen concentrator.
c. Reduces bleed air temperature in the oxygen plenum.
d. Analyzes the temperature of bleed air that has passed through the oxygen concentrator.

208. The OBOGS heat exchanger

a. Reduces the temperature of engine bleed air.
b. Reduces the pressure of engine bleed air.
c. Analyzes the temperature of bleed air that has passed through the oxygen concentrator.
d. Absorbs contaminants through molecular sieves.

209. Select all that apply. The oxygen monitor

a. Provides a BIT test using ambient cockpit air.
b. Provides a warning signal if the BIT test fails.
c. Heater allows rapid warmup during low cockpit temperatures.
d. Reduces bleed air temperature in the oxygen plenum.

210. The Display Electronics Unit (DEU) controls the

a. navigation display
b. weapons release logic
c. video tape recorder
d. MIL-STD-1553B Multiplex Data Bus

211. Most OBOGS system components are powered by the

a. 28 VDC Essential Services Bus.
b. 28 VDC Generator Bus.
c. 115 VAC Essential Bus.
d. Fifth stage bleed air pressure.

212. Select all that apply. Which of the following OBOGS components receive bleed air from the engine compressor?

a. Plenum
b. Anti-g valve
c. Concentrator
d. Emergency oxygen system

e. All of the above

213. Which of the following OBOGS components interface with the emergency oxygen system?

a. Manifold
b. Centralized warning system
c. Concentrator
d. Thermostat
e. Monitor

214. During maneuvers, you notice that your ADI and HSI show errors in heading, roll, and pitch. What system may have malfunctioned?

a. GINA
b. Pitot-static
c. AOA system
d. Caution/Warning system

215. Power to the MFDs is supplied by the

a. 115 VAC Essential Bus.
b. 115 VAC Non-Essential Bus.
c. 26 VAC Non-Essential Bus.
d. 26 VAC Essential Bus.

216. Select all that apply. Information displayed on the ADI and HSI is generated by the

a. GINA.
b. TACAN system.
c. VOR/ILS systems.
d. AOA system.

217. Select all that apply. Pitch and roll data are removed from the MFDs when

a. A power supply failure occurs.
b. Attitude signals from GINA are invalid.
c. The MFD fails.
d. Roll attitude exceeds 90 degrees.

218. When the HOOK BYP switch is in the CARRIER position and the arresting hook was not extended during landing sequence, a warning is signaled by the

a. AOA indexer and approach lights.
b. AOA indicator and approach lights.
c. AOA indexer and indicator.
d. AOA indicator

219. The anti-g system receives air pressure from which of the following?

a. OBOGS
b. Bleed air shutoff valve
c. Air conditioning
d. Pressurization

220. Select all that apply. Which of the following are controlled by the OBOGS/anti-g switch?

a. Bleed air shutoff valve
b. Anti-g
c. OBOGS
d. All of the above

221. Select all that apply. Under what conditions may a safe ejection be initiated?

a. Canopy fully open
b. Canopy closed and locked
c. After MDC firing handle shatters canopy
d. All of the above

222. Select all that apply. Which of the following will shatter the canopy?

a. Pulling the MDC firing handle
b. Pulling the seat firing handle
c. Impact of the seat canopy breakers
d. All of the above

223. Select all that apply. With throttle above 90 percent RPM, what indications would you expect in the event the canopy unlocks?

a. MASTER ALERT flashes
b. Warning tone sounds in headsets
c. CANOPY caution light illuminates
d. OPEN light illuminates on Caution/Warning panel

224. Select all that apply. After an ejection the electronic sequencer and barostatic release unit fail. What are the indications of this problem?

a. Seat has not separated
b. Parachute has not deployed
c. Both a and b
d. None of the above

225. Select all that apply. When the SEAT LIGHT switch is set to the SOLO position,

a. A pin must be installed in the switch.
b. The SEAT caution light is inhibited.
c. The MSTR ALERT and caution tone are inhibited during a SEAT UNARMED condition of the aft seat.
d. All of the above.

226. Select all that apply. When the eject mode selector is set in the SOLO position and the FWD seat initiates ejection,

a. The forward seat fires after a 0.4 second delay.
b. Only the forward seat fires.
c. Both seats fire.
d. The aft seat fires first.

227. Select all that apply. When the eject mode selector is set in the BOTH position and the FWD seat initiates ejection,

a. The aft seat fires first.
b. Both seats fire.
c. Both seats fire simultaneously.
d. Both a and b.

228. During a high altitude ejection, which of the following occurs immediately after the drogue chute is deployed?

a. The seat is stabilized by the drogue during descent.
b. The parachute deployment rocket fires.
c. The seat separates and falls clear.
d. The parachute deploys.

229. During ground emergencies, the emergency restraint release:

a. Provides immediate release of the lower torso and leg restraint harnesses.
b. Provides immediate release of the lower torso restraint harness only.
c. Provides immediate release of the upper torso restraint harness only.
d. Provides immediate release of the leg restraint harness only.

230. Select all that apply. When the eject mode selector is set in the FWD-BOTH/ AFT SELF position and the forward seat initiates ejection:

a. The aft seat fires first.
b. Both cockpits fire.
c. Only the forward seat fires.
d. The forward seat fires first.
e. Both seats fire simultaneously.

231. Select all that apply. Which indications would you expect to see in the event of an ILS localizer failure?

a. Vertical steering needle not displayed on the ADI
b. CDI removed from the HSI
c. LOCALIZER advisory
d. All of the above

232. Select all that apply. Which indications would you expect to see in the event of a TACAN bearing failure?

a. PLAN course line removed from HSI
b. CDI blanked
c. TACAN data block is blanked
d. TACAN moves around the perimeter of the compass rose

233. Select all that apply. Which indications would you expect to see in the event of a VOR failure?

a. VOR option removed form the HSI.
b. VOR bearing pointer removed.
c. OFF flag appears on the HSI.
d. VOR bearing pointer freezes.

234. Select all that apply. Which indications would you expect to see in the event of an ILS glideslope failure?

a. GLIDESLOPE advisory displayed on MFD
b. Glideslope steering needle removed.

c. HSI GS pointer erratic
d. All of the above

235. If all communications become garbled or lost during flight, what malfunction has occurred?

a. COMM 1 and COMM 2 failure
b. COMM control panel failure
c. COMM/NAV control transfer panel failure
d. ICS failure

236. IFF MODE C coded transmissions contain

a. Altitude information from the main altimeter in the fwd cockpit.
b. Heading information from the HSI.
c. Relative bearing from the SAHRS.
d. Airspeed information from the Airspeed-Mach indicator.

237. Outputs from the VOR/ILS and TACAN systems are displayed on the

a. ADI.
b. HSI and ADI.
c. Main altimeter.
d. Advisory panel.

238. The TACAN system operates with a fixed ground station or another TACAN-equipped aircraft and provides

a. Precise relative bearing and/or slant range distance to a TACAN ground station or range to a suitably equipped aircraft.
b. Emergency transmissions for relative bearing and course upon pilot ejection.
c. A short-range landing approach aid with glideslope.
d. An indication of marker beacon passage.

239. Select all that apply. The COMM/NAV Control Transfer panel

a. Allows transfer of fwd/aft cockpit command control of UHF/VHF radios.
b. Allows transfer of control between VOR/ILS and TACAN systems.
c. Both a and b.
d. Provides audio control of all inbound radio signals.

24.9.4 Completion Questions

240. The four basic steps of preparation for thunderstorm penetration are:

H _____

A _____

L _____

T _____

241. Describe the visual hand signal used to indicate a question.

242. Describe the day signal to put your flight into cruising formation.

243. Describe the visual signal to a wingman to have him turn his IFF to STANDBY.

244. The day HEFOE signal is a weeping signal followed by a numeral signal 1 to 5. What does each number stand for?

1. _____

2. _____

3. _____

4. _____

5. _____

245. What signal should the ground crew use to indicate hot brakes?

246. State the immediate action (*) of emergency procedures for the following:

a. FIRE - GROUND
b. FIRE - IN-FLIGHT
c. GTS FIRE - GROUND
d. GTS FIRE - IN-FLIGHT

247. What indications/verifications would you expect if, upon touchdown, the nose-wheel steering system fails?

a. _____

b. _____

c. _____

d. _____

248. Maximum permissible airspeed for:

a. Flaps:

Normal actuation_____

Emergency extension_____

b. Landing gear:

Normal_____

Emergency_____

249. State the following limitations:

Maximum MRT EGT_____

Maximum transient/acceleration EGT__

Maximum continuous EGT_____

250. State the following limitations:

Maximum MRT RPM_____

Maximum transient/acceleration RPM__

Maximum continuous RPM_____

251. State the following limitations:

Maximum EGT for ground start_____

Maximum EGT for airstart_____

252. Maximum allowable gross weight for:

Takeoff_____

Catapult_____

Landing (FCLP)_____

Arrestment_____

253. State the ranges of center of gravity for:

Forward limit_____

Aft Limit_____

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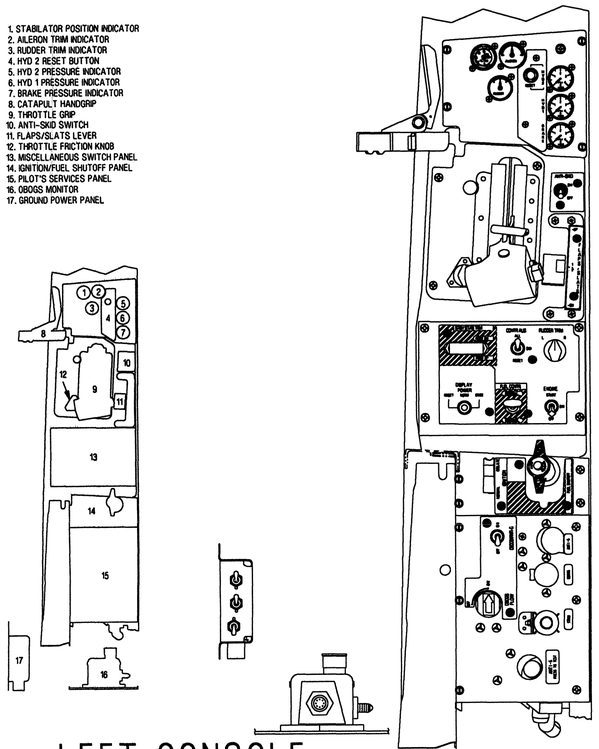
FOLDOUT SECTION

The purpose of the Foldout Section is to make these illustrations available for ready reference while reading the associated text. The illustrations are referenced from several sections of the manual and are referred to in the text by title and page number (i.e., see Electrical System foldout, FO-13).

FORWARD COCKPIT

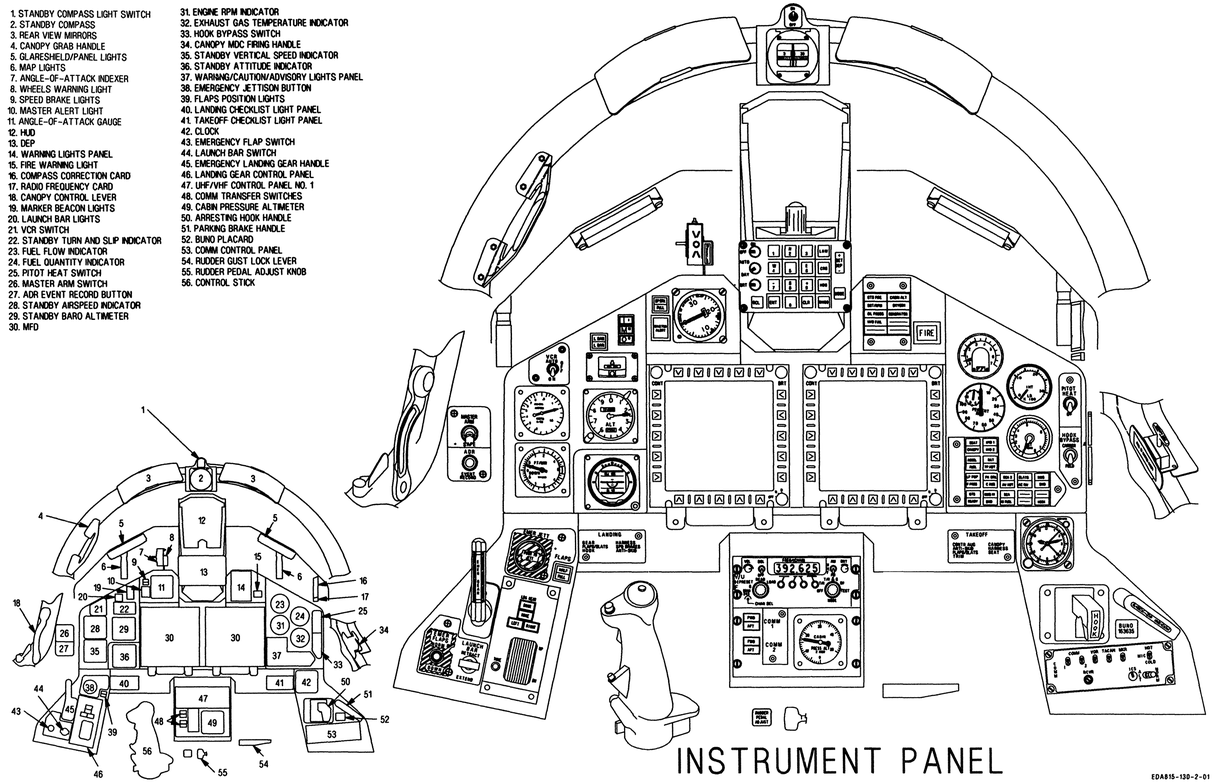
1. STABILATOR POSITION INDICATOR
2. AILERON TRIM INDICATOR
3. RUDDER TRIM INDICATOR
4. HYD 2 RESET BUTTON
5. HYD 2 PRESSURE INDICATOR
6. HYD 1 PRESSURE INDICATOR
7. BRAKE PRESSURE INDICATOR
8. CATAPULT HANDGRIP
9. THROTTLE GRIP
10. ANTI-SKID SWITCH
11. FLAPS/SLATS LEVER
12. THROTTLE FRICTION KNOB
13. MISCELLANEOUS SWITCH PANEL
14. IGNITION/FUEL SHUTOFF PANEL
15. PILOT'S SERVICES PANEL
16. OBOGS MONITOR
17. GROUND POWER PANEL



LEFT CONSOLE

EDAB15-130-1-01

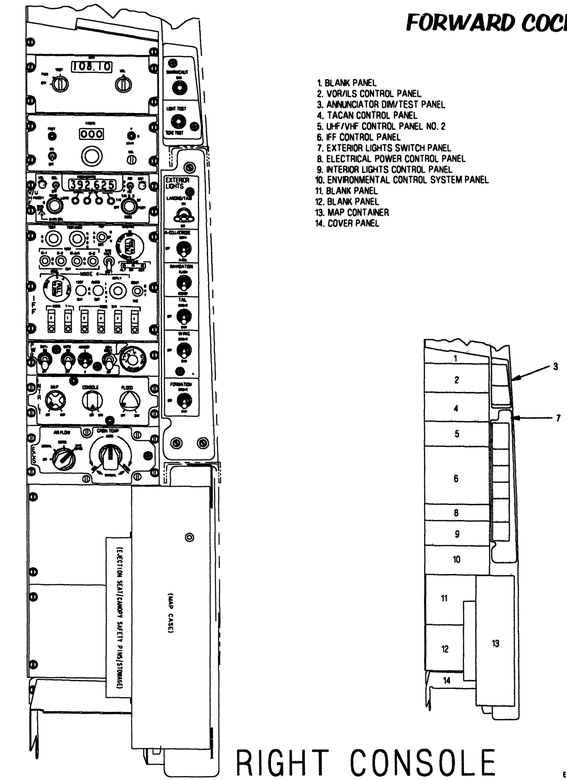
1. STANDBY COMPASS LIGHT SWITCH
2. STANDBY COMPASS
3. REAR VIEW MIRRORS
4. CANOPY GRAB HANDLE
5. GLARESHIELD/PANEL LIGHTS
6. MAP LIGHTS
7. ANGLE-OF-ATTACK INDEXER
8. WHEELS WARNING LIGHT
9. SPEED BRAKE LIGHTS
10. MASTER ALERT LIGHT
11. ANGLE-OF-ATTACK GAUGE
12. HUD
13. DEP
14. WARNING LIGHTS PANEL
15. FIRE 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 FIRING HANDLE
35. STANDBY VERTICAL SPEED INDICATOR
36. STANDBY ATTITUDE INDICATOR
37. WARNING/CAUTION/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. BUNO PLACARD
53. COMM CONTROL PANEL
54. RUDDER GUST LOCK LEVER
55. RUDDER PEDAL ADJUST KNOB
56. CONTROL STICK



INSTRUMENT PANEL

EDAB15-130-2-01

1. BLANK PANEL
2. VOR/ILS CONTROL PANEL
3. ANNUNCIATOR DIM/TEST PANEL
4. TACAN CONTROL PANEL
5. UHF/VHF CONTROL PANEL NO. 2
6. IFF 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



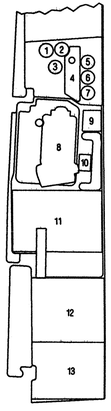
RIGHT CONSOLE

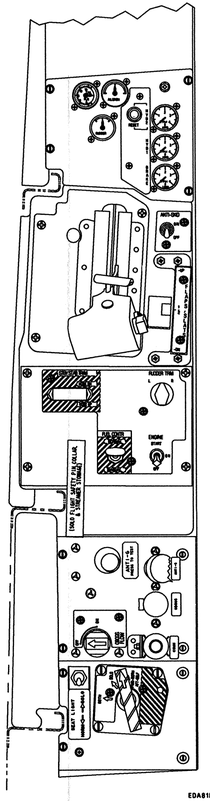
EDAB15-130-3-01

Forward Cockpit

AFT COCKPIT

1. STABILATOR POSITION INDICATOR
2. AILERON TRIM INDICATOR
3. RUDDER TRIM INDICATOR
4. HYD 2 RESET BUTTON
5. HYD 2 PRESSURE INDICATOR
6. HYD 1 PRESSURE INDICATOR
7. BRAKE PRESSURE INDICATOR
8. THROTTLE GRIP
9. ANTI-SKID SWITCH
10. FLAPS/SLATS LEVER
11. MISCELLANEOUS SWITCH PANEL
12. PILOT'S SERVICES PANEL
13. COMMAND EJECTION PANEL

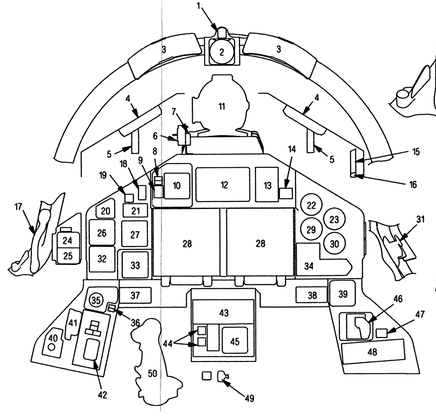


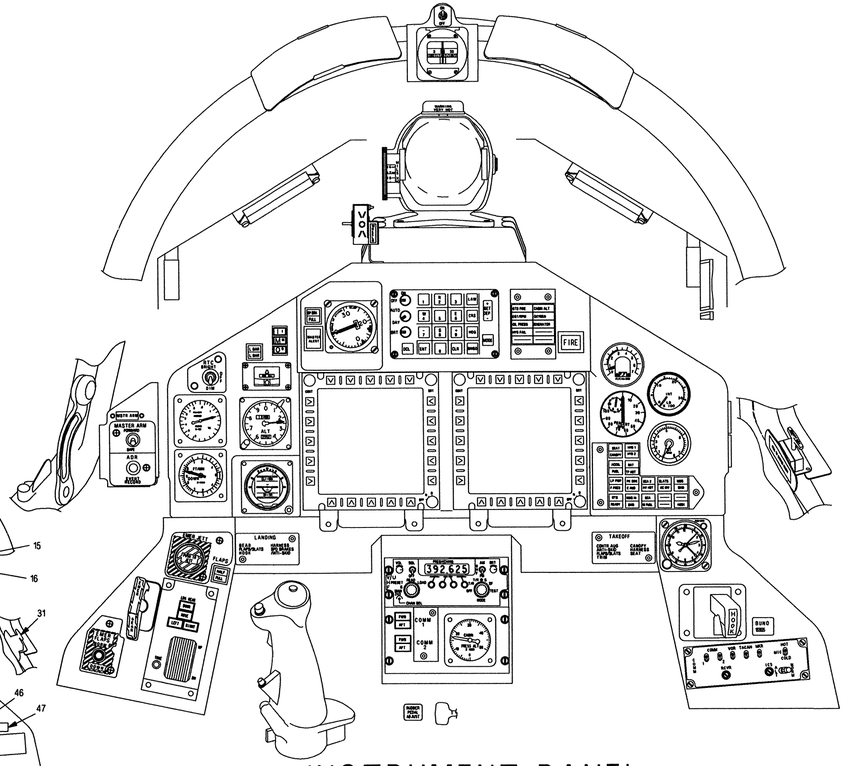


LEFT CONSOLE

EDA815-131-1-01

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





INSTRUMENT PANEL

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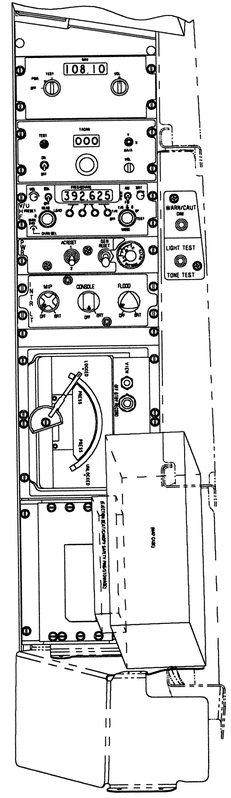
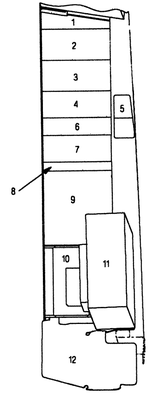


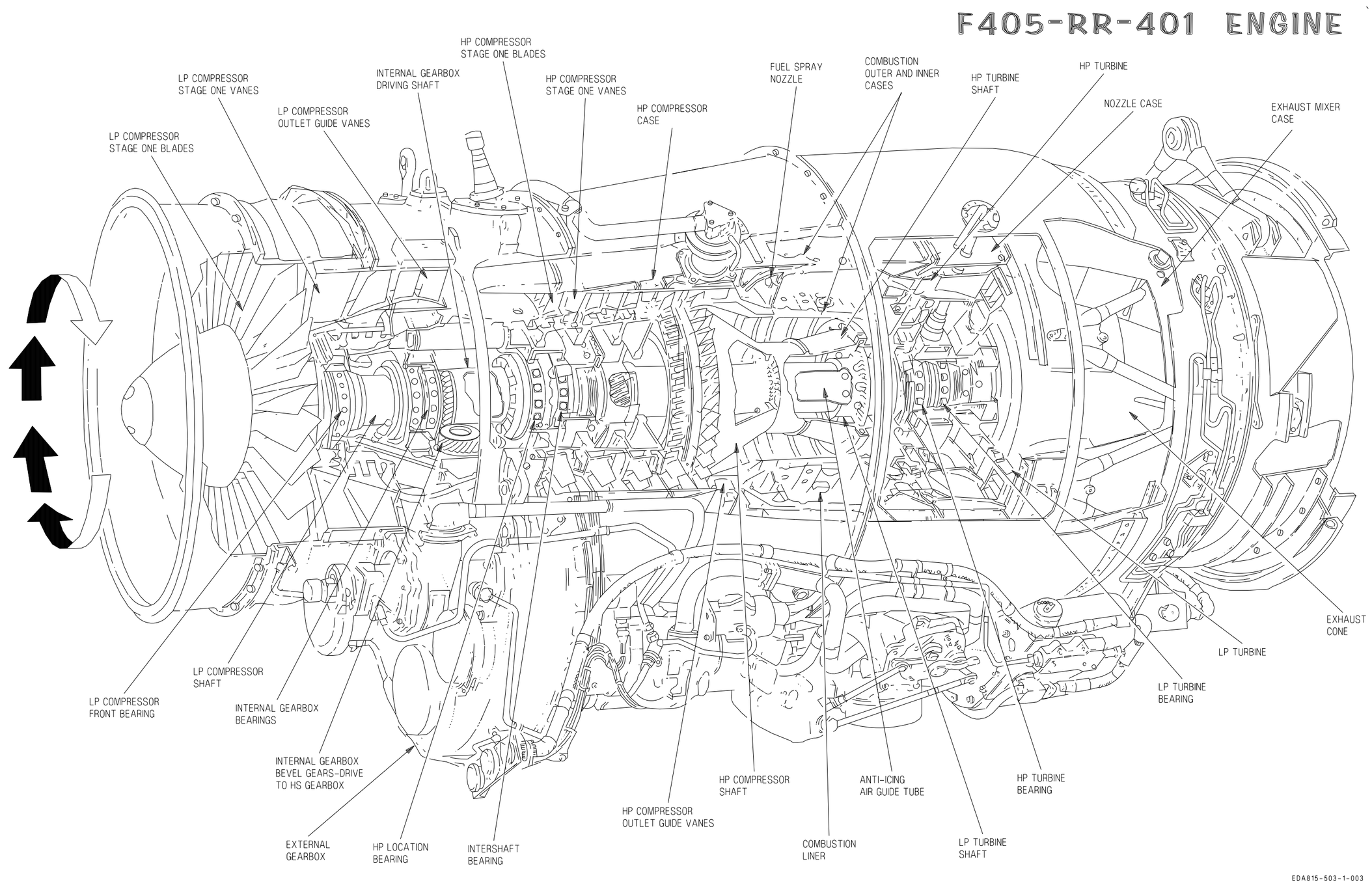
Aft Cockpit

1. BLANK PANEL
2. VOR/ILS CONTROL PANEL
3. TACAN CONTROL PANEL
4. UHF/VHF CONTROL PANEL NO. 2
5. ANNUNCIATOR DIM/TEST PANEL
6. ELECTRICAL POWER CONTROL PANEL
7. INTERIOR LIGHTS CONTROL PANEL
8. BLANK PANEL
9. VIDEO CASSETTE RECORDER
10. MISSION DATA LOADER
11. MAP CONTAINER
12. COVER PANEL



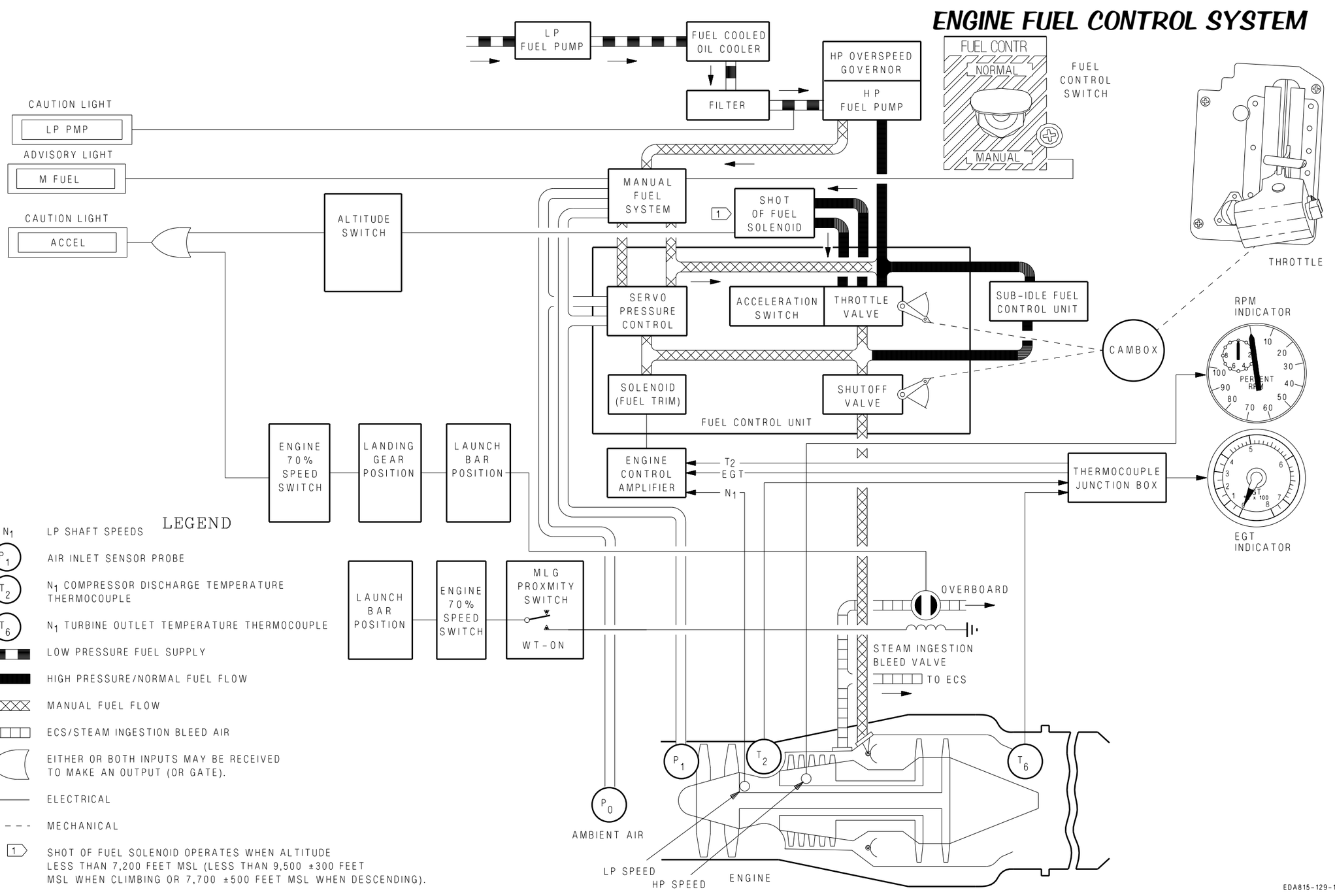
RIGHT CONSOLE

EDA815-131-3-01



F405-RR-401 Engine

ENGINE FUEL CONTROL SYSTEM



LEGEND

- N_1 — LP SHAFT SPEEDS
- P_1 — AIR INLET SENSOR PROBE
- T_2 — N_1 COMPRESSOR DISCHARGE TEMPERATURE THERMOCOUPLE
- T_6 — N_1 TURBINE OUTLET TEMPERATURE THERMOCOUPLE
- LOW PRESSURE FUEL SUPPLY
- HIGH PRESSURE/NORMAL FUEL FLOW
- MANUAL FUEL FLOW
- ECS/STEAM INGESTION BLEED AIR
- EITHER OR BOTH INPUTS MAY BE RECEIVED TO MAKE AN OUTPUT (OR GATE).
- ELECTRICAL
- MECHANICAL
- 1 — SHOT OF FUEL SOLENOID OPERATES WHEN ALTITUDE LESS THAN 7,200 FEET MSL (LESS THAN 9,500 ±300 FEET MSL WHEN CLIMBING OR 7,700 ±500 FEET MSL WHEN DESCENDING).

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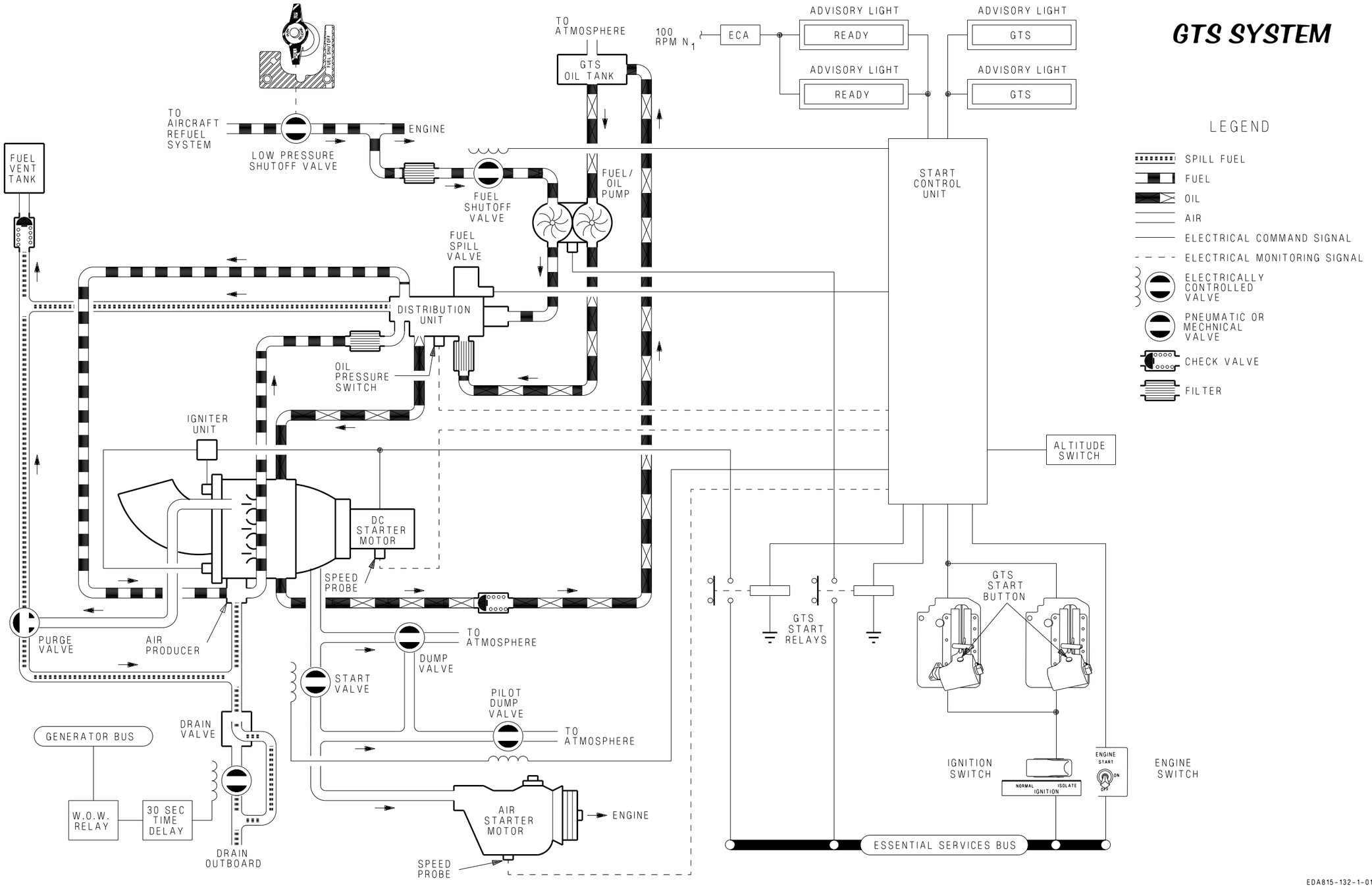
Engine Fuel Control System

GTS SYSTEM



LEGEND

- SPILL FUEL
- FUEL
- OIL
- AIR
- ELECTRICAL COMMAND SIGNAL
- ELECTRICAL MONITORING SIGNAL
- ELECTRICALLY CONTROLLED VALVE
- PNEUMATIC OR MECHNICAL VALVE
- CHECK VALVE
- FILTER

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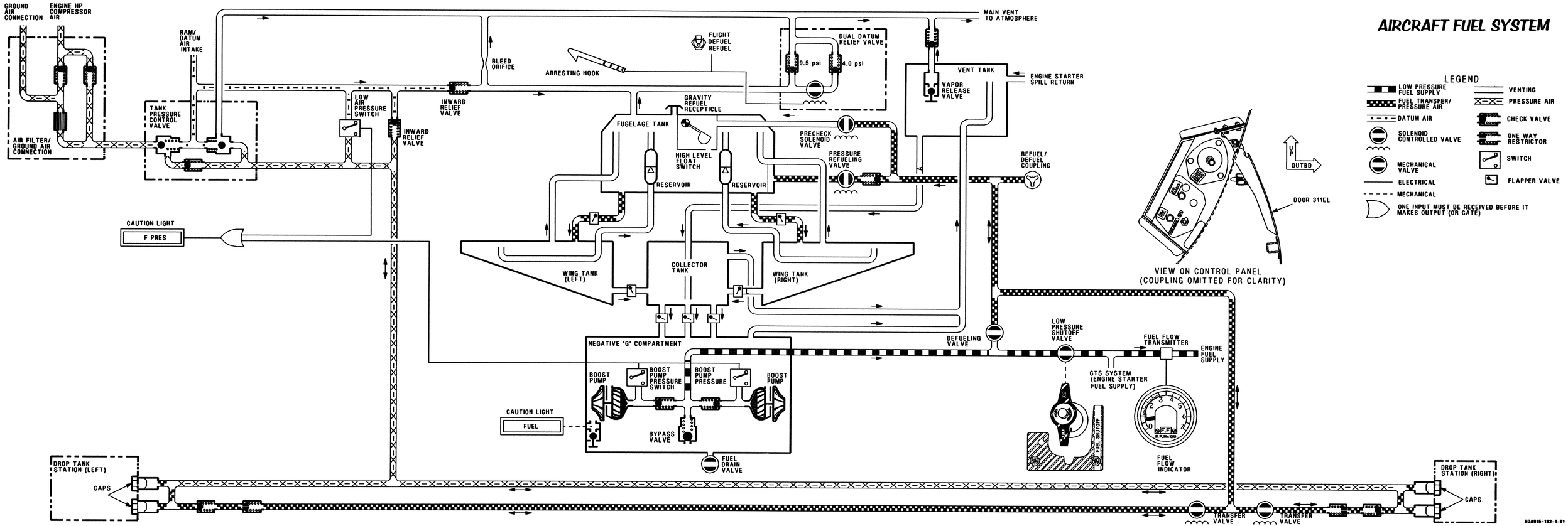
GTS System

AIRCRAFT FUEL SYSTEM



VIEW ON CONTROL PANEL
(COUPLING OMITTED FOR CLARITY)

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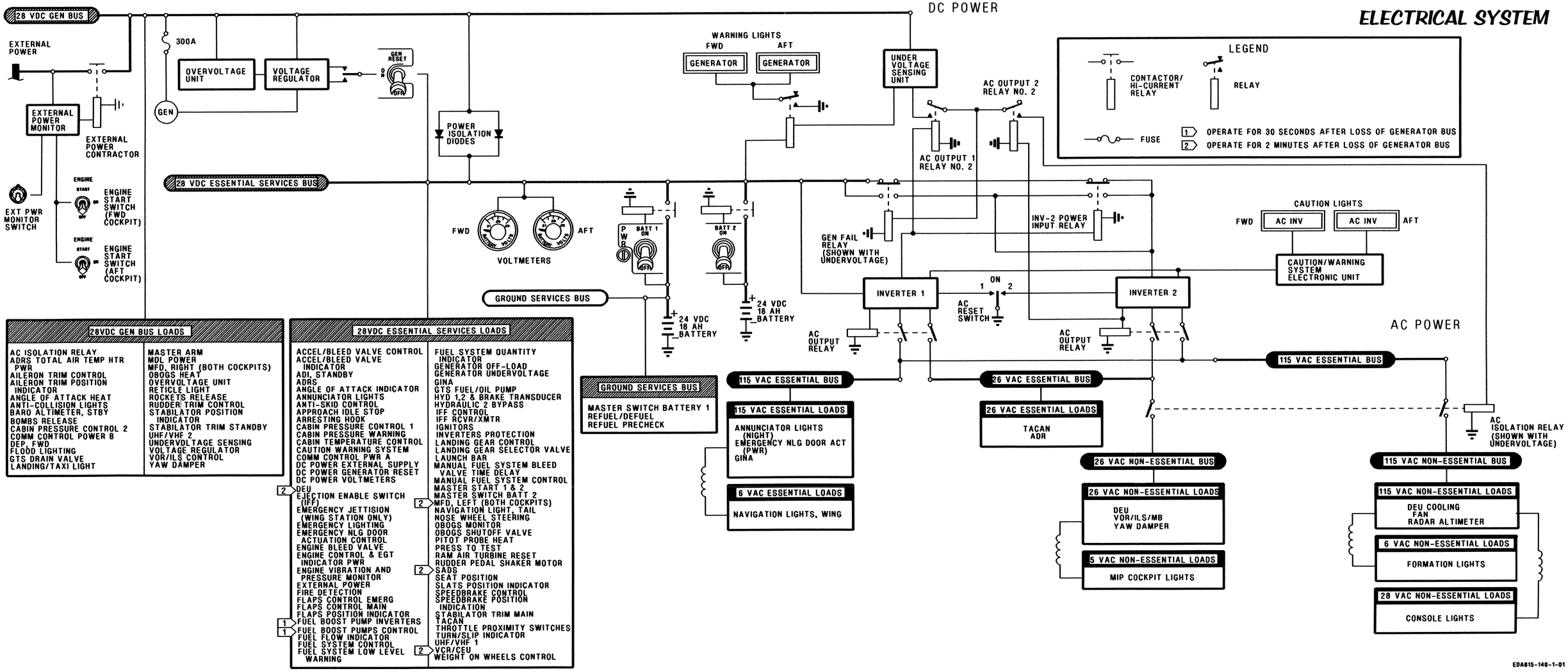
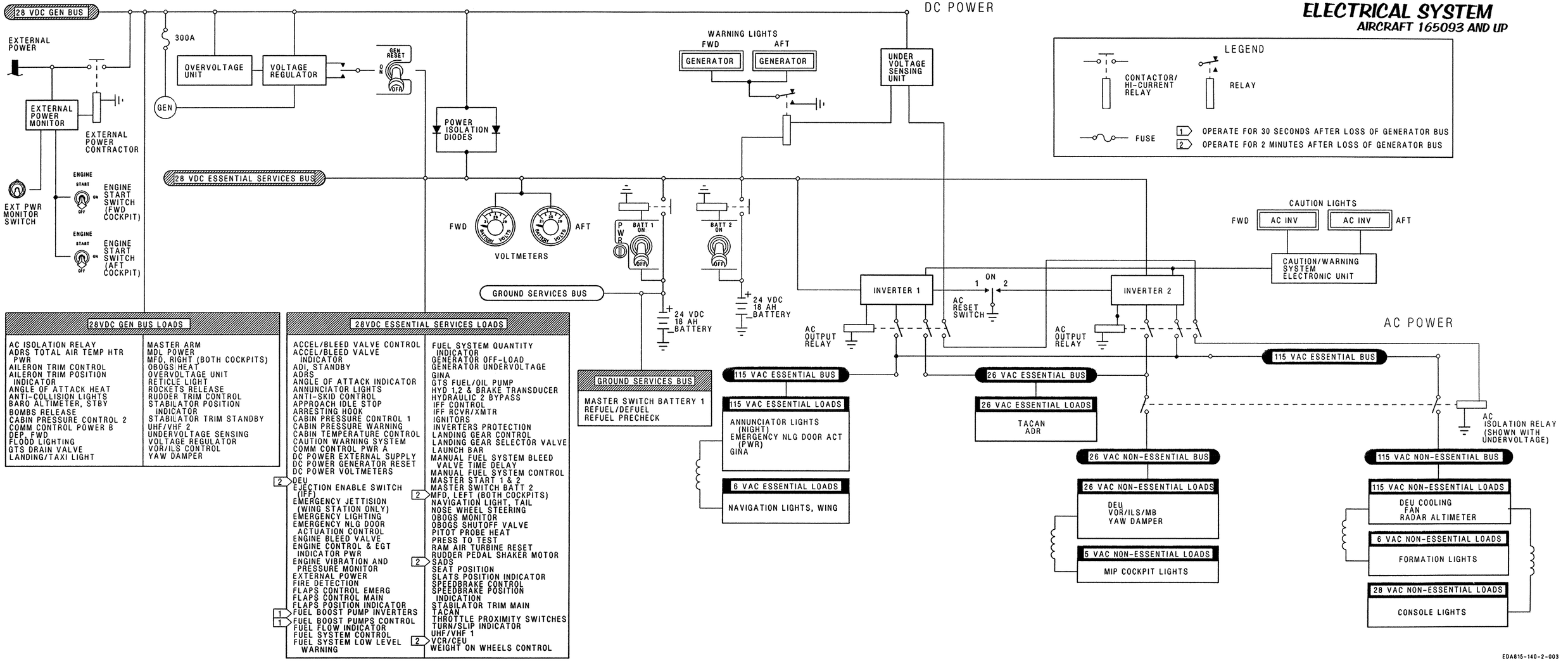
Aircraft Fuel System

ELECTRICAL SYSTEM

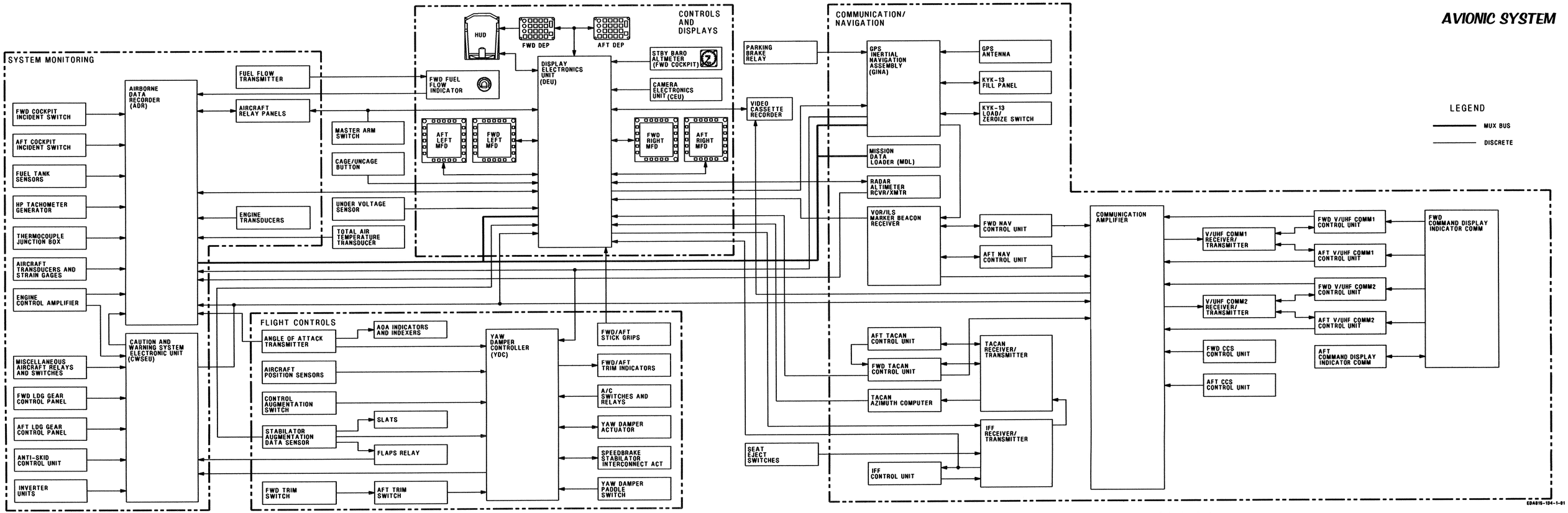


Electrical System

ELECTRICAL SYSTEM
AIRCRAFT 165093 AND UP



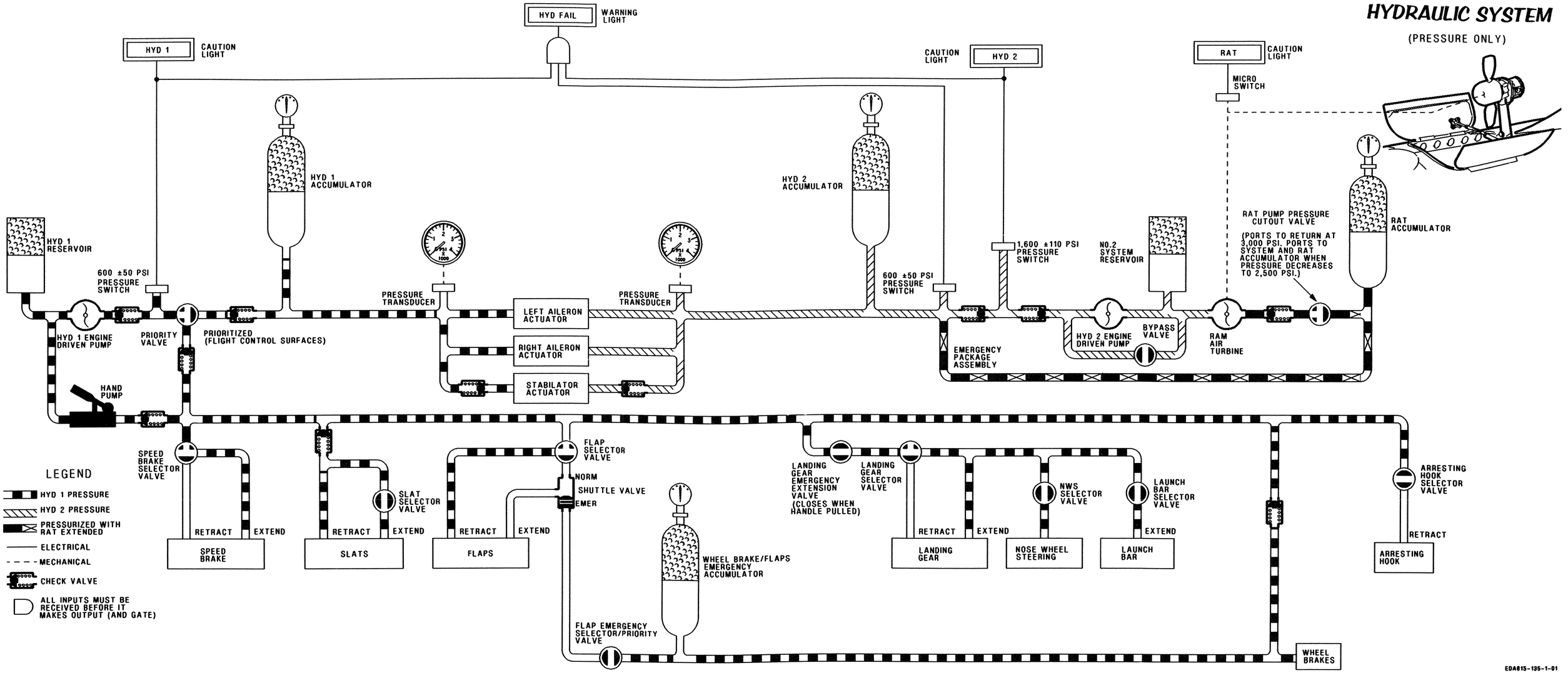
AVIONIC SYSTEM



Avionics System

HYDRAULIC SYSTEM

(PRESSURE ONLY)



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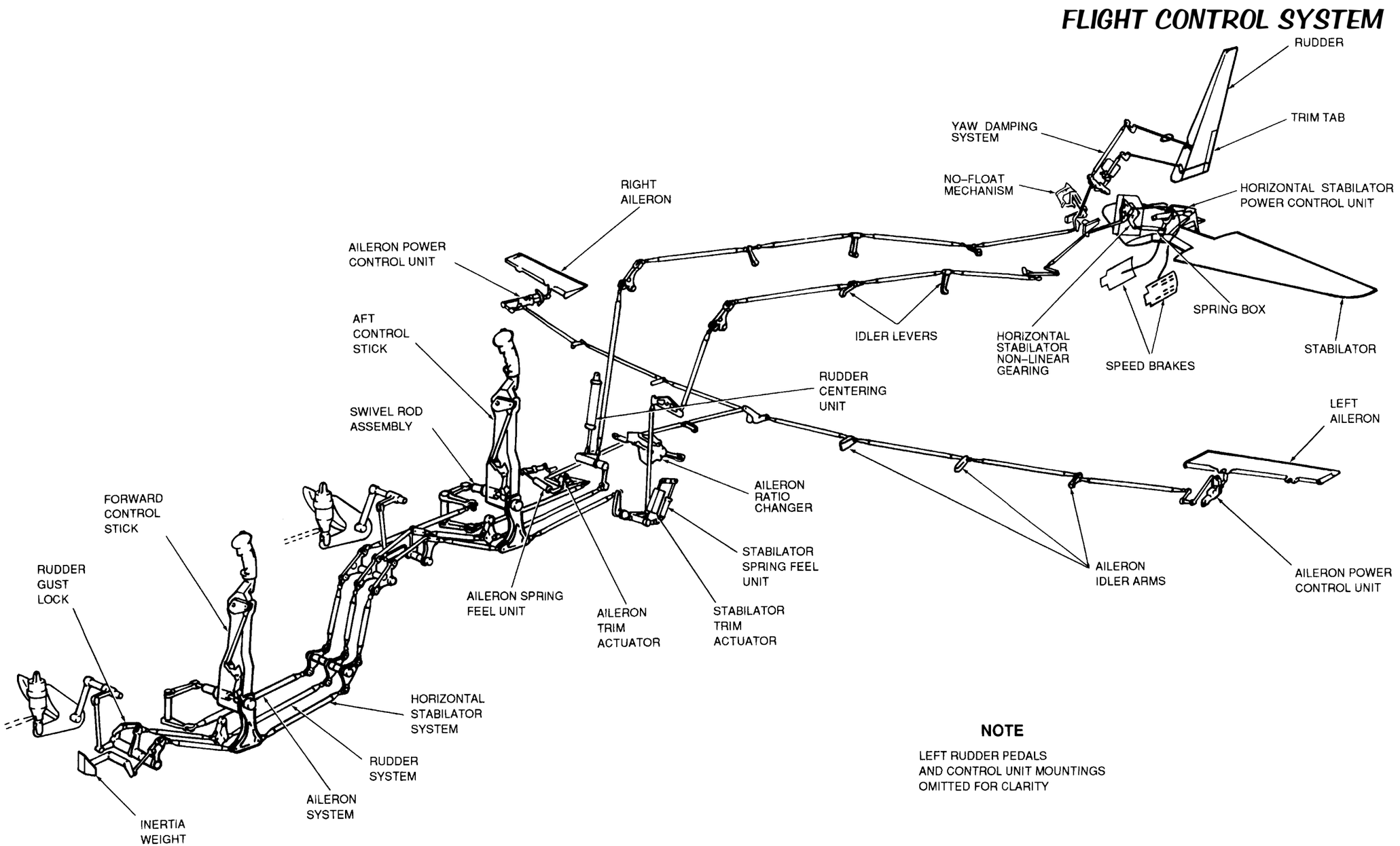
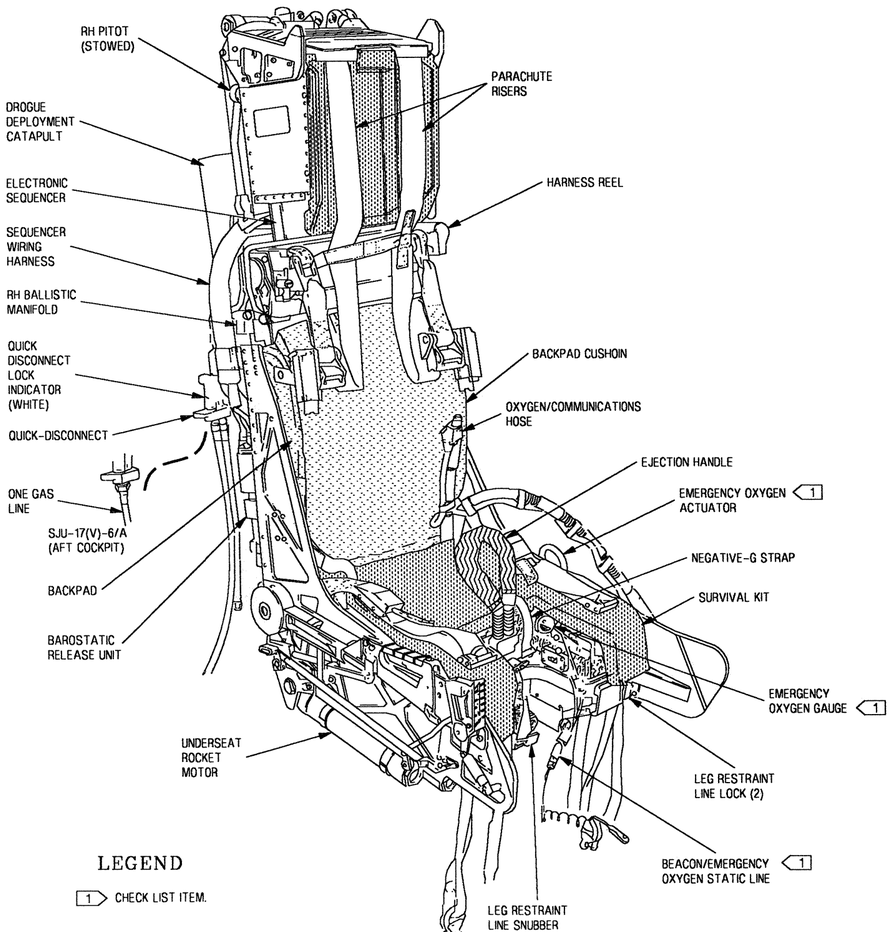
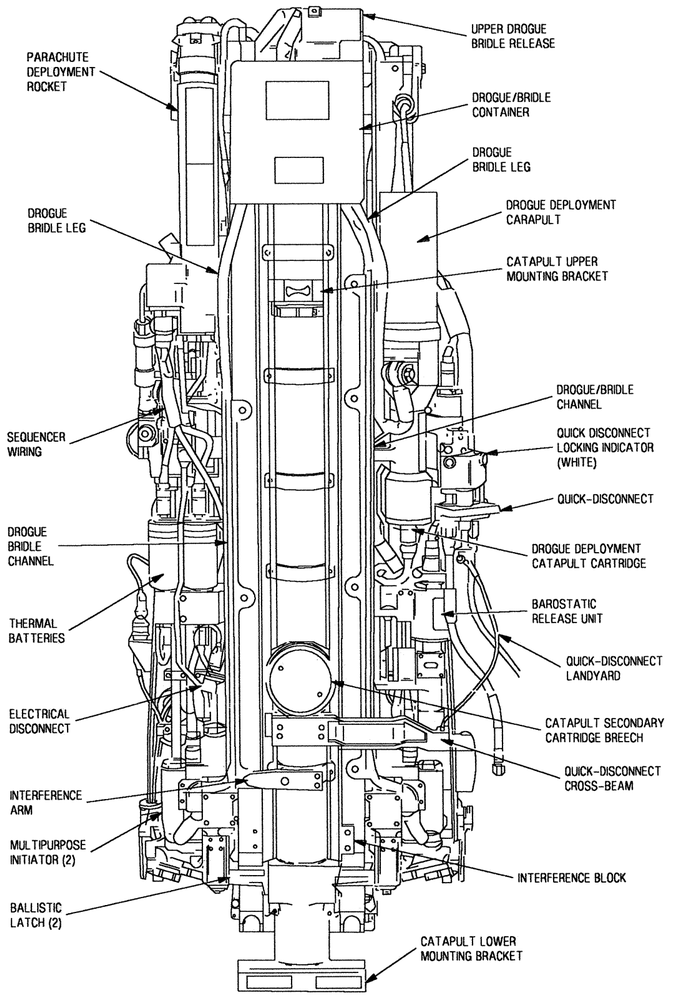
Hydraulic System



Flight Control System





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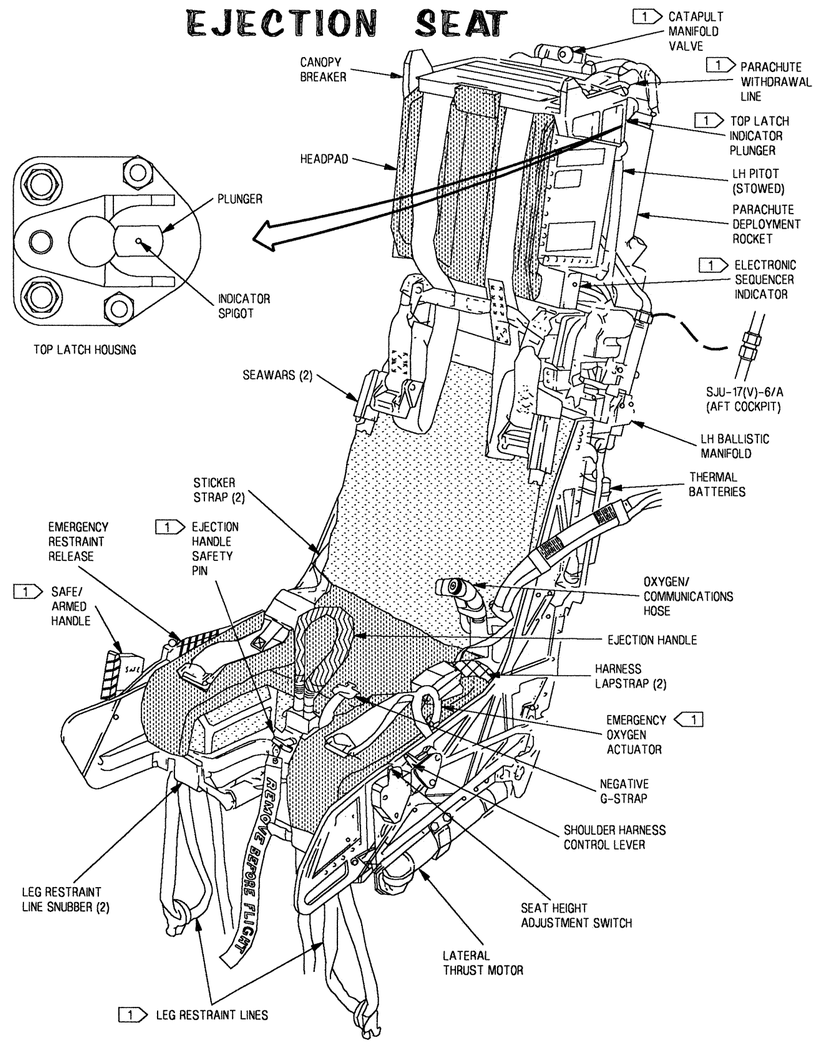

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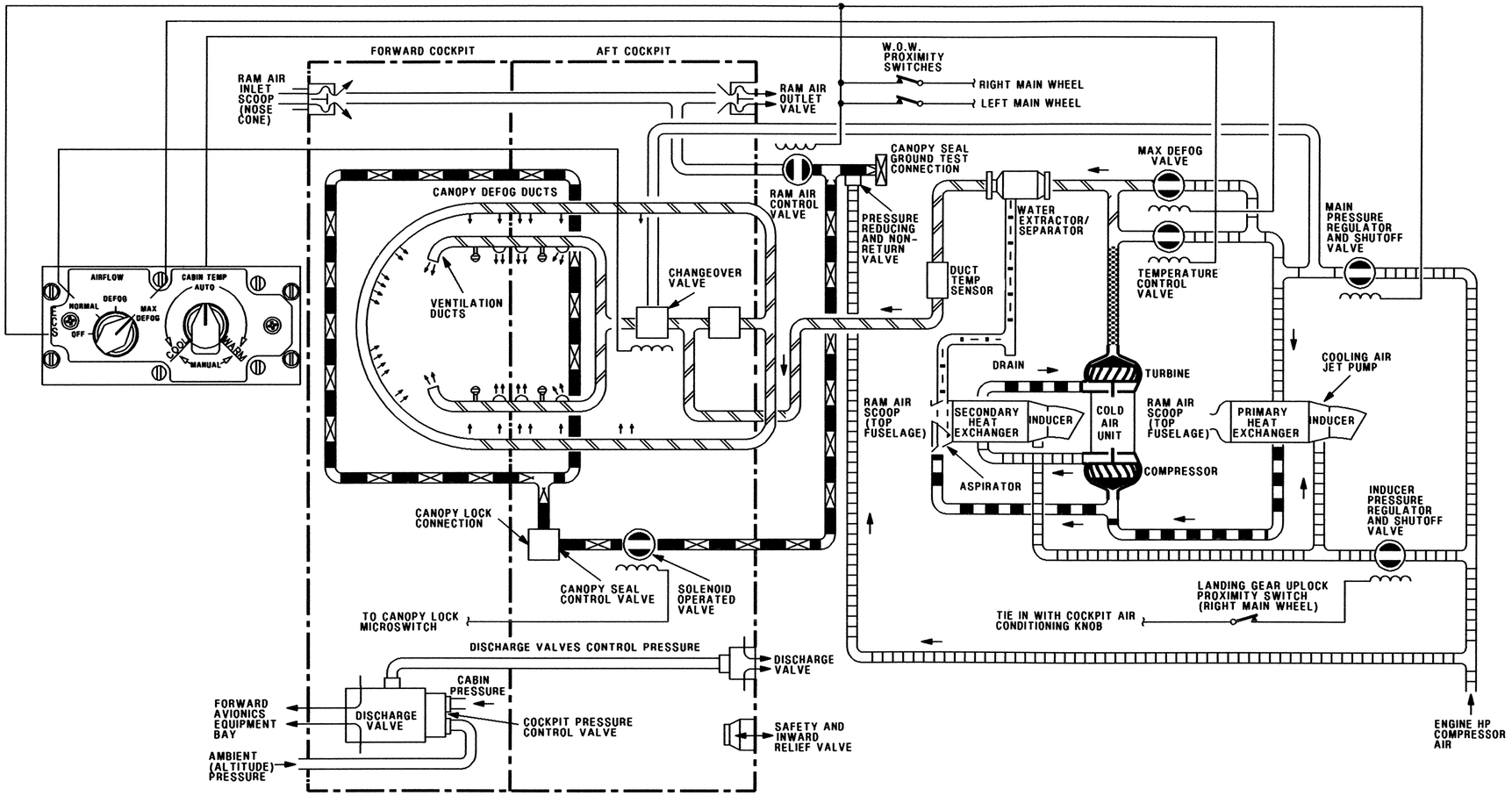
Ejection Seat

ENVIRONMENTAL CONTROL SYSTEM



LEGEND

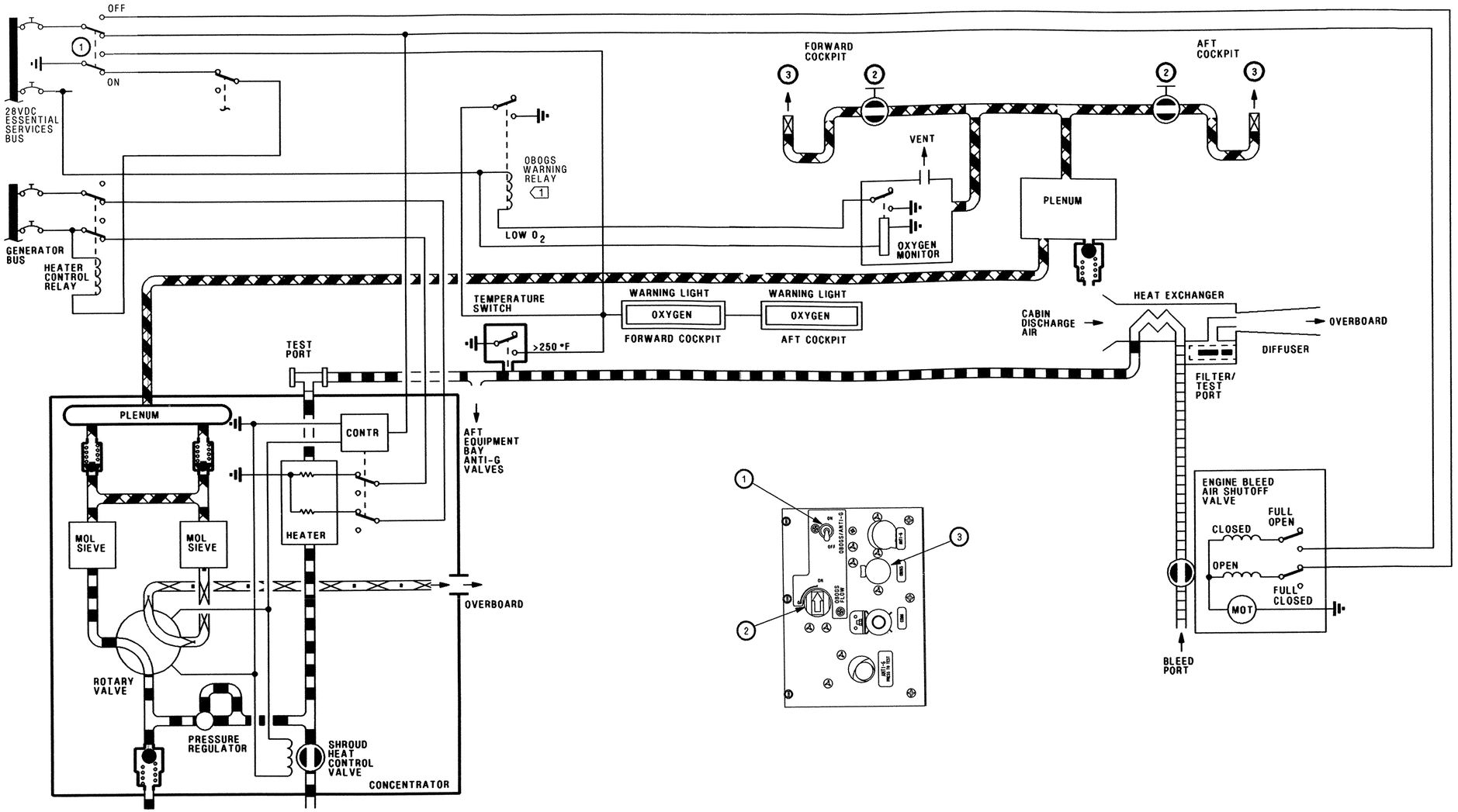
- HOT AIR
- WARM AIR
- COOLED AIR
- CONDITIONED AIR
- SERVO AIR
- CANOPY SEAL
- WATER
- MECHANICAL CONNECTIONS
- ELECTRICAL
- ELECTRICALLY CONTROLLED VALVE

AIRCRAFT ON THE GROUND WITH CANOPY CLOSED AND AIR CONDITIONING SYSTEM OPERATED AT NORMAL.

EDA815138-1-01

Environmental Control System

ON-BOARD OXYGEN GENERATING SYSTEM (OBOGS)



LEGEND

- BLEED AIR
- WARM AIR
- OXYGEN ENRICHED AIR
- OXYGEN DEPLETED AIR
- ELECTRICAL
- MECHNICAL
- CIRCUIT BREAKER
- CHECK VALVE
- RELIEF VALVE
- MANUAL SHUTOFF VALVE
- MOT — MOTOR

[1] ALTITUDE LESS THAN 7,200 FEET MSL (LESS THAN 9,500 ± 300 FEET MSL WHEN CLIMBING OR 7,700 ± 500 FEET MSL WHEN DESCENDING).

On-Board Oxygen Generating System (OBOGS)

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
CHANGE 4	1 (Reverse Blank)
CHANGE 4	1A (Reverse Blank)
CHANGE 4	3 Thru 20
CHANGE 4	20A Deleted (Reverse Blank)
CHANGE 4	21 Thru 26C (Reverse Blank)
ORIGINAL	27 (Reverse Blank)
CHANGE 4	29 (Reverse Blank)
ORIGINAL	31 (Reverse Blank)
CHANGE 2	33
ORIGINAL	34
CHANGE 2	35
CHANGE 2	36
CHANGE 4	37
CHANGE 2	38
CHANGE 2	39
ORIGINAL	40
ORIGINAL	41 (Reverse Blank)
ORIGINAL	I-1-1
CHANGE 2	I-1-2
ORIGINAL	I-1-3
ORIGINAL	I-1-4
CHANGE 4	I-2-1 Thru I-2-10A (Reverse Blank)
CHANGE 2	I-2-11
ORIGINAL	I-2-12
CHANGE 2	I-2-13
ORIGINAL	I-2-14 Thru I-2-17
CHANGE 2	I-2-18 Thru I-2-20A (Reverse Blank)
CHANGE 2	I-2-21 Thru I-2-23
ORIGINAL	I-2-24
CHANGE 4	I-2-25
CHANGE 2	I-2-26 Thru I-2-29
ORIGINAL	I-2-30
CHANGE 2	I-2-30A (Reverse Blank)
ORIGINAL	I-2-31
CHANGE 2	I-2-32
ORIGINAL	I-2-33
ORIGINAL	I-2-34
CHANGE 2	I-2-35 Thru I-2-37
CHANGE 4	I-2-38

Effective Pages	Page Numbers
CHANGE 2	I-2-39 Thru I-2-40A (Reverse Blank)
CHANGE 2	I-2-41
ORIGINAL	I-2-42
CHANGE 2	I-2-43
ORIGINAL	I-2-44 Thru I-2-46
CHANGE 2	I-2-47
CHANGE 2	I-2-48
CHANGE 2	I-2-48A Deleted (Reverse Blank)
CHANGE 2	I-2-49 Thru I-2-50A (Reverse Blank)
ORIGINAL	I-2-51 Thru I-2-56
CHANGE 2	I-2-57 Thru I-2-58A (Reverse Blank)
CHANGE 2	I-2-59
ORIGINAL	I-2-60
CHANGE 2	I-2-61
CHANGE 2	I-2-62
ORIGINAL	I-2-63 Thru I-2-72
CHANGE 2	I-2-73
CHANGE 2	I-2-74
ORIGINAL	I-2-75
CHANGE 2	I-2-76
ORIGINAL	I-2-77
CHANGE 2	I-2-78 Thru I-2-80A (Reverse Blank)
ORIGINAL	I-2-81 Thru I-2-86
CHANGE 2	I-2-87
ORIGINAL	I-2-88 Thru I-2-91
CHANGE 2	I-2-92 Thru I-2-92B
ORIGINAL	I-2-93 Thru I-2-111
CHANGE 2	I-2-112
CHANGE 2	I-2-113
ORIGINAL	I-2-114
CHANGE 2	I-2-115 (Reverse Blank)
ORIGINAL	I-3-1
CHANGE 2	I-3-2
ORIGINAL	I-3-3 Thru I-3-18
CHANGE 2	I-3-19
ORIGINAL	I-3-20 Thru I-3-34
CHANGE 4	I-4-1
CHANGE 2	I-4-2 Thru I-4-5
CHANGE 4	I-4-6

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
CHANGE 2	I-4-7
ORIGINAL	I-4-8
ORIGINAL	I-4-9
CHANGE 3	I-4-10
CHANGE 3	I-4-11 (Reverse Blank)
ORIGINAL	43 (Reverse Blank)
ORIGINAL	II-5-1
ORIGINAL	II-5-2
ORIGINAL	45 (Reverse Blank)
ORIGINAL	III-6-1
ORIGINAL	III-6-2
CHANGE 2	III-7-1
ORIGINAL	III-7-2
CHANGE 4	III-7-3 Thru III-7-4A (Reverse Blank)
CHANGE 2	III-7-5
ORIGINAL	III-7-6
CHANGE 2	III-7-6A (Reverse Blank)
CHANGE 4	III-7-7
ORIGINAL	III-7-8
CHANGE 4	III-7-9 Thru III-7-22
CHANGE 4	III-8-1
CHANGE 2	III-8-2
CHANGE 4	III-8-3
CHANGE 3	III-8-4
CHANGE 3	III-8-4A (Reverse Blank)
ORIGINAL	III-8-5
CHANGE 2	III-8-6 Thru III-8-8
ORIGINAL	III-9-1 Thru III-9-3
CHANGE 2	III-9-4
ORIGINAL	III-9-5
CHANGE 2	III-9-6
ORIGINAL	III-10-1
CHANGE 2	III-10-2
CHANGE 2	III-10-3
CHANGE 4	III-10-4
CHANGE 2	III-10-4A (Reverse Blank)
ORIGINAL	III-10-5
CHANGE 4	III-10-6 Thru III-10-8A (Reverse Blank)
CHANGE 2	III-10-9
ORIGINAL	III-10-10
CHANGE 2	III-10-11
CHANGE 4	III-10-12

Effective Pages	Page Numbers
CHANGE 2	III-10-13 Thru III-10-17 (Reverse Blank)
ORIGINAL	47 (Reverse Blank)
CHANGE 2	IV-11-1
CHANGE 4	IV-11-2
CHANGE 4	IV-11-2A (Reverse Blank)
ORIGINAL	IV-11-3
CHANGE 3	IV-11-4 Thru IV-11-4B
CHANGE 4	IV-11-5 Thru IV-11-6A (Reverse Blank)
CHANGE 2	IV-11-7
ORIGINAL	IV-11-8
CHANGE 2	IV-11-9 Thru IV-11-13
CHANGE 4	IV-11-14 Thru IV-11-16
CHANGE 2	49 (Reverse Blank)
ORIGINAL	V-12-1
CHANGE 4	V-12-2 Thru V-12-8
CHANGE 2	V-12-8A Deleted (Reverse Blank)
CHANGE 4	V-12-9
CHANGE 2	V-12-10
CHANGE 2	V-12-11 (Reverse Blank)
CHANGE 4	V-13-1
CHANGE 4	V-13-2
CHANGE 4	V-14-1
CHANGE 4	V-14-2
CHANGE 3	V-14-3 (Reverse Blank)
CHANGE 4	V-15-1 Thru V-15-6
CHANGE 2	V-15-6A (Reverse Blank)
CHANGE 2	V-15-7
CHANGE 2	V-15-8
CHANGE 4	V-15-9
CHANGE 2	V-15-10
CHANGE 4	V-15-11
CHANGE 4	V-15-12
CHANGE 2	V-15-13 (Reverse Blank)
CHANGE 2	V-16-1
CHANGE 4	V-16-2 Thru V-16-4
CHANGE 3	V-16-4A Thru V-16-4E (Reverse Blank)
CHANGE 2	V-16-5 Thru V-16-8
CHANGE 3	V-16-9
CHANGE 3	V-16-10
CHANGE 2	V-16-11

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
CHANGE 2	V-16-12
ORIGINAL	V-16-13 (Reverse Blank)
CHANGE 2	V-17-1
CHANGE 2	V-17-2
CHANGE 4	V-17-3
CHANGE 2	V-17-4
CHANGE 2	V-17-4A (Reverse Blank)
ORIGINAL	V-17-5 Thru V-17-12
CHANGE 2	V-17-13 Thru V-17-15 (Reverse Blank)
CHANGE 4	V-18-1 Thru V-18-4
CHANGE 2	V-18A-1 Thru V-18A-5
CHANGE 3	V-18A-6
CHANGE 2	V-18A-7
CHANGE 3	V-18A-8
CHANGE 3	V-18A-9
CHANGE 4	V-18A-10
CHANGE 4	V-18A-10A (Reverse Blank)
CHANGE 2	V-18A-11
CHANGE 3	V-18A-12
CHANGE 3	V-18A-13
CHANGE 4	V-18A-14
CHANGE 3	V-18A-14A
CHANGE 3	V-18A-14B
CHANGE 4	V-18A-15
CHANGE 4	V-18A-16
CHANGE 2	V-18A-17
CHANGE 2	V-18A-18
ORIGINAL	51 (Reverse Blank)
CHANGE 2	VI-19-1 Thru VI-19-6
ORIGINAL	VI-20-1 Thru VI-20-3
CHANGE 2	VI-20-4
ORIGINAL	VI-20-5
ORIGINAL	VI-20-6
ORIGINAL	53 (Reverse Blank)
ORIGINAL	VII-21-1 Thru VII-21-14
CHANGE 2	VII-21-15
CHANGE 2	VII-21-16
CHANGE 4	VII-21-17
CHANGE 2	VII-21-18 Thru VII-21-18C (Reverse Blank)
CHANGE 4	VII-21-19 Thru VII-21-22

Effective Pages	Page Numbers
CHANGE 2	VII-21-23 Thru VII-21-24A (Reverse Blank)
ORIGINAL	VII-21-25 Thru VII-21-28
CHANGE 2	VII-21-29 Thru VII-21-30A (Reverse Blank)
ORIGINAL	VII-21-31 Thru VII-21-36
CHANGE 2	VII-21-37
ORIGINAL	VII-21-38
ORIGINAL	VII-21-39
CHANGE 2	VII-21-40
ORIGINAL	VII-21-41 Thru VII-21-58
ORIGINAL	55 (Reverse Blank)
ORIGINAL	VIII-22-1 Thru VIII-22-4
CHANGE 2	VIII-22-5
ORIGINAL	VIII-22-6
ORIGINAL	VIII-22-7
CHANGE 2	VIII-22-8
CHANGE 2	VIII-22-8A (Reverse Blank)
ORIGINAL	VIII-22-9 Thru VIII-22-19
CHANGE 2	VIII-22-20
CHANGE 2	VIII-22-20A (Reverse Blank)
CHANGE 2	VIII-22-21 Thru VIII-22-26
ORIGINAL	57 (Reverse Blank)
ORIGINAL	IX-23-1 (Reverse Blank)
ORIGINAL	59 (Reverse Blank)
ORIGINAL	X-24-1 Thru X-24-4
CHANGE 2	X-24-5 Thru X-24-24
CHANGE 4	Index-1 Thru Index-10
CHANGE 4	Index-10A Deleted (Reverse Blank)
CHANGE 4	Index-11 Thru Index-15 (Reverse Blank)
CHANGE 2	FO-1 (Reverse Blank)
ORIGINAL	FO-3 (Reverse Blank)
ORIGINAL	FO-5 (Reverse Blank)
CHANGE 2	FO-6A (Reverse Blank)
ORIGINAL	FO-7 (Reverse Blank)
ORIGINAL	FO-9 (Reverse Blank)
ORIGINAL	FO-11 (Reverse Blank)
ORIGINAL	FO-13 (Reverse Blank)
CHANGE 2	FO-14A (Reverse Blank)

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
ORIGINAL	FO-15 (Reverse Blank)
ORIGINAL	FO-17 (Reverse Blank)
ORIGINAL	FO-19 (Reverse Blank)
CHANGE 2	FO-21 (Reverse Blank)
ORIGINAL	FO-23 (Reverse Blank)

Effective Pages	Page Numbers
ORIGINAL	FO-25 (Reverse Blank)
CHANGE 4	LEP-1 (Reverse Blank)
CHANGE 4	LEP-3 (Reverse Blank)
CHANGE 4	LEP-5 (Reverse Blank)
CHANGE 4	LEP-7 (Reverse Blank)