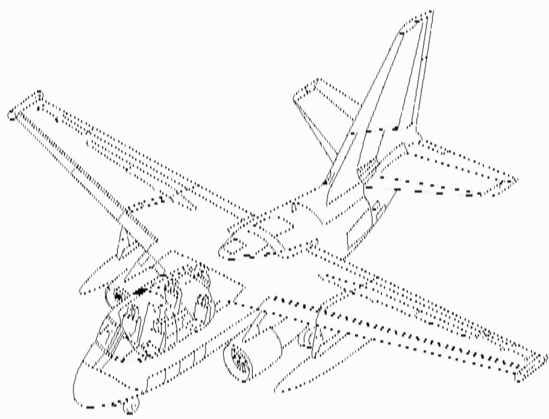
NATOPS FLIGHT MANUAL NAVY MODEL S-3B AIRCRAFT

THIS PUBLICATION IS INCOMPLETE WITHOUT NAVAIR 01-S3AAB-1.1 AND NAVAIR 01-S3AAB-1A.



ISSUED BY AUTHORITY OF THE CHIEF OF NAVAL OPERATIONS AND UNDER THE DIRECTION OF THE COMMANDER, NAVAL AIR SYSTEMS COMMAND.

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15 SEPTEMBER 2000

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

15 September 2000

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 than 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 operating 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.

J. B. NATHMAN
Rear Admiral, U.S. Navy
Director, Air Warfare

INTERIM CHANGE SUMMARY

The following Interim Changes have been cancelled or previously incorporated into this manual.

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 thru 20	Previously incorporated.

The following Interim Changes have been incorporated into this Change/Revision.

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE

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

RAAUZYUW RUENAAA0576 3381815-UUUU--RUENCGU.
ZNR UUUUU
R 041815Z DEC 01 ZYB
FM CNO WASHINGTON DC//N789J3//
TO ALL VIKING AIRCRAFT ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RHMFIUU/NAVOPMEDINST PENSACOLA FL//06//
BT
UNCLAS SECTION 01 OF 02
MSGID/GENADMIN/N789J//
SUBJ/INTERIM CHANGES TO S-3B AIRCRAFT NATOPS FLIGHT PUBLICATIONS//
REF/A/DOC/NAVAIR 01-S3AAB-1/YMD:20000915//
REF/B/DOC/NAVAIR 01-S3AAB-1B/YMD:20000915//
NARR/REF A IS NAVAIR 01-S3AAB-1 (S-3B NATOPS FLIGHT MANUAL (NFM)).
REF B IS NAVAIR 01-S3AAB-1B (S-3B NATOPS FLIGHTCREW POCKET CHECKLIST (PCL)).//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 21 TO REF A (S-3B NFM), AND INTERIM CHANGE NUMBER 20 TO REF B (S-3B PCL).
2. SUMMARY. CORRECTS ERRORS AND OMISSIONS INTRODUCED INTO REFS A AND B DURING PRODUCTION AND PRINTING.
3. CHANGE REF A (S-3B NFM), AS FOLLOWS:
A. CHAPTER 8, PAGE 8-23, PARAGRAPH 8.10 AFTER START CHECKLIST, STEP 8.G, WARNING THAT FOLLOWS SUBPARA (4):
   (1) DELETE WARNING:

WARNING

VISUALLY CHECK WINGS SPREAD PRIOR TO STOWING GUSTLOCK COVER.

   (2) ADD REPLACEMENT WARNING:

WARNING

FAILURE TO VISUALLY CHECK WINGS SPREAD PRIOR TO STOWING GUSTLOCK COVER CAN RESULT IN WING/FIN FOLD GUSTLOCK COVER BEING STOWED WITHOUT WING LOCKING PINS BEING PROPERLY RETAINED BY THE GUSTLOCK J-HOOK.

B. CHAPTER 10, PAGE 10-13, PARAGRAPH 10.6.12.2 31-301(A/A42R-1) CHECKLIST, WARNING:
   (1) DELETE WARNING LABEL.
   (2) REPLACE WITH CAUTION LABEL.
   (3) RETAIN TEXT OF CAUTION AS PUBLISHED.
C. CHAPTER 14, PAGE 14-20, PARAGRAPH 14.9.1.1 MAN/SEAT SEPARATION FAILURE, STEP 4:
   (1) DELETE: NA
   (2) ADD ASTERISK BESIDE STEP NUMBER, AS FOLLOWS:
      *4. PARACHUTE RIPCORD -- MANUALLY PULL.
D. CHAPTER 15, PAGE 15-1, PARAGRAPH 15.1.1 ENGINE FAILURE/FIRE/ EXPLOSION SHUTDOWN CHECKLIST, IN STEP 1 AFTER "IF AIRSTART WILL BE ATTEMPTED":
   (1) DELETE "PRIMARY METHOD/ASSISTED" AND "PARAGRAPH 16.3".
   (2) ADD (INSERT) "BEFORE" AND "PARAGRAPH 16.2", SO STEP READS:
      1. GO TO BEFORE AIRSTART CHECKLIST, PARAGRAPH 16.2.
E. CHAPTER 16, PAGE 16-1, PARAGRAPH 16.2 BEFORE AIRSTART CHECKLIST, AFTER STEP 9:
   (1) DELETE: NA
   (2) ADD NEW STEP 10:
      10. GO TO AIRSTART PROCEDURES, PARAGRAPHS 16.3 OR 16.4.
F. CHAPTER 16, PAGE 16-2, PARAGRAPH 16.4 SECONDARY METHOD, WINDMILL AIRSTART, AFTER STEP 3 NOTES:
   (1) DELETE: NA

(2) ADD NEW STEP 4:
4. REFER TO POSTSTART PROCEDURES, PARAGRAPH 16.5.

G. CHAPTER 12, PAGE 23-8, PARAGRAPH 23.5.1 FIELD EMERGENCY ARRESTING GEAR PROCEDURES, AFTER STEP 7 CAUTIONS:
(1) DELETE: NA
(2) ADD NEW STEP 8:
8. REVIEW HOOK SKIP CONTINGENCIES.

4. CHANGE REF B (S-3B PCL), AS FOLLOWS:

A. PAGE B, INTERIM CHANGE SUMMARY,
(1) IN TOP PORTION UNDER "THE FOLLOWING INTERIM CHANGES HAVE BEEN CANCELLED OR PREVIOUSLY INCORPORATED INTO THIS PUBLICATION", IN INTERIM CHANGE NUMBER(S) COLUMN:
(A) DELETE: NA
(B) ADD (INSERT): "1 THRU 14"
(2) IN MIDDLE PORTION UNDER "THE FOLLOWING INTERIM CHANGES HAVE BEEN INCORPORATED INTO THIS PUBLICATION", IN THE INTERIM CHANGE NUMBER(S) AND REMARKS/PURPOSE COLUMNS, RESPECTIVELY:
(A) DELETE: NA
(B) ADD (INSERT):
15 - EJECTION SEAT AIRCREW WEIGHTS
16 - OCF AND FLAMEOUT APPCH AIRCREW COORD/COMM
17 - OCF AND FLAMEOUT APPCH WITH IC SUMMARY PAGE ERRATA
18 - CATAPULT LAUNCH CROSSWIND LIMITATIONS
19 - MORE CATAPULT LAUNCH CROSSWIND LIMITATIONS

B. PAGE 16, DUAL-STARTER CAUTION LIGHTS IN FLIGHT PROCEDURE, STEP 2 (GENERATOR SWITCHES ...... OFF):
(1) DELETE: NA
(2) ADD (INSERT) AN ASTERISK BEFORE STEP NUMBER, SO STEP READS:
*2. GENERATOR SWITCHES .... OFF

C. PAGE 45, ENGINE FAILURE/FIRE/EXPLOSION SHUTDOWN CHECKLIST, IN FIRST STEP 1:
(1) DELETE "PRIMARY METHOD/ASSISTED" AND "PAGE 68".
(2) ADD (INSERT) "BEFORE" AND "PAGE 67", SO STEP READS:
1. GO TO BEFORE AIRSTART CHECKLIST, PAGE 67.

D. PAGE 67, AIRSTART CHECKLIST:
(1) IN CHECKLIST TITLE:
(A) DELETE: NA
(B) ADD (INSERT) "BEFORE" PRIOR TO "AIRSTART", SO CHECKLIST TITLE READS:
"BEFORE AIRSTART"
(2) AFTER STEP 9:
(A) DELETE: NA
(B) ADD NEW STEP 10:
10. GO TO AIRSTART CHECKLISTS, PAGE 68.

E. PAGE 68, SECONDARY METHOD, WINDMILL AIRSTART, AFTER STEP 3:
(1) DELETE: NA
(2) ADD NEW STEP 4:
4. REFER TO POSTSTART PROCEDURES, PAGE 69.

F. PAGE 109, FIELD EMERGENCY ARRESTING GEAR PROCEDURES:
(1) DELETE: NA
(2) ADD NEW STEP 8:
8. REVIEW HOOK SKIP CONTINGENCIES.

G. PAGE 171, ENGINE START CHECKLIST, INDENTED PARAGRAPH THAT FOLLOWS STEP 1:
(1) DELETE: NA
(2) ADD (INSERT) "WARNING" LABEL ABOVE INDENTED PARAGRAPH.

H. PAGE 173, AFTER START CHECKLIST, INDENTED PARAGRAPH THAT FOLLOWS

STEP 8.G:
(1) DELETE INDENTED PARAGRAPH THAT FOLLOWS STEP 8.G, AS FOLLOWS:
VISUALLY CHECK WINGS SPREAD PRIOR TO STOWING GUSTLOCK COVER.
(2) ADD (REPLACE WITH) WARNING:

WARNING

FAILURE TO VISUALLY CHECK WINGS SPREAD PRIOR TO STOWING GUSTLOCK COVER CAN RESULT IN WING/FIN FOLD GUSTLOCK COVER BEING STOWED WITHOUT WING LOCKING PINS BEING PROPERLY RETAINED BY THE GUSTLOCK J-HOOK.

I. PAGE 179, TANKER OPERATIONS CHECKLIST, INDENTED PARAGRAPH THAT FOLLOWS "31-301 (A/A42R-1) CHECKLIST" TITLE:
(1) DELETE: NA.
(2) ADD (INSERT) "CAUTION" LABEL ABOVE INDENTED PARAGRAPH.
(3) RETAIN TEXT OF CAUTION AS PUBLISHED IN INDENTED PARAGRAPH.

J. PAGE 180, 31-301 (A/A42R-1) CHECKLIST, POSTSTART CHECKLIST, INDENTED PARAGRAPH THAT FOLLOWS STEP 3.
(1) DELETE: NA
(2) ADD (INSERT) "WARNING" LABEL ABOVE INDENTED PARAGRAPH.

6. VS-41 POC IS S-3B NATOPS PROGRAM MANAGERS, LCDR MIKE ANGELOPOULOS OR LT CHRIS JONES AT DSN 735-7154 OR COMM (619)545-7154, OR EMAILS ANGELOPOULOS.MICHAEL@VS41.NASNI.NAVY.MIL OR JONES.SPENCER.C@VS41 .NASNI.NAVY.MIL.

7. THIS MESSAGE AND ALL OTHER NATOPS INTERIM CHANGES WILL BE POSTED AT THE NATEC WEBSITE, WWW.NATEC.NAVY.MIL, WITHIN 15 DAYS OF THE RELEASE OF THIS MESSAGE. IF UNABLE TO VIEW MESSAGE AT THE NATEC WEBSITE, INFORM CNO NATOPS OFFICE AT DSN 664-7763/7719 OR COMM (703)604-7763/7719.///

BT

Summary of Applicable Technical Directives/ECP Summary

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

ECP NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION
S3-400 (AFC-208)	Weapon Improvement Program		S-3B MOD
S3-402 (AFC-226)	Main Landing Gear Downlock Latch and Nose Landing Gear Catapult Aircraft Holdback Fitting Revisions (Retrofit)		Main Landing Gear and Nose Landing Gear
S3-411 (AVC-4129)	AN/ALE-39 ECM Programmer Panel Modification		Mk 9254/ALE-39 ECM Programmer
S3-397 S3-405 (AFC-231)	Off-Line On Top Position Indicator		AN/A44-78 AN/A4A-50

RECORD OF CHANGES

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

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LIST OF ABBREVIATIONS AND ACRONYMS

A

Note

Asterisked abbreviations are for AFC-279 modified aircraft only. Daggared abbreviations are for non-AFC-279 aircraft only.

A/C. Aircraft.

A/D. Analog to digital.

A/P. Autopilot.

AACS. Airspeed-altitude computer system.

ac. Alternating current.

ACK. Acknowledge.

ACLS. Automatic carrier landing system.

ACN. Aircraft classification number.

ACP. Armament control panel.

ACPS. Air-conditioning and pressurization system.

ACST. Acoustic.

ACT. Aircrew coordination training.

ACTVT. Activate.

ADF. Automatic direction finding.

ADV. Advance.

AE. Arithmetic element, altitude error, antenna electronics.

AEC. Arithmetic element controller.

AF. Audio frequency.

AFCS. Automatic flight control system.

AGC. Automatic gain control.

AGL. Above ground level.

AHRS. Attitude heading reference system.

AIDNAV. Aided navigation.

AIL. Active interest list.

ALN. Align.

ALN Q. Align quality

ALM. Almanac.

ALT. Altitude.

AMBIG. Ambiguous.

AME. Angle measuring equipment.

AMP or AMPTD. Amplitude.

ANCU. Airborne navigation computer unit.

ANEW. Army navy electronic warfare.

ANLG. Analog.

ANT. Antenna.

AOA. Angle of attack.

AOB. Angle of bank.

AOP. Area of probability.

AP. Arithmetic processor.

APC. Approach power control.

APS. Automatic pilot system.

APU. Auxiliary power unit.

ARA. Attitude reference assembly.

ARM. Armament.

ARMCON. Armament processing and control.

ARMCOS. Armament control system.

ARS. Air refueling store.

ARTFCT. Artifact.

AS. Anti spoofing.

ASMD. Antiship missile defense.

ASSEM. Assemble.

ASWOC. Antisubmarine warfare operations center.

ATS. Automatic thrust system.

AUTO. Automatic.

AUTO DET. Automatic detection.

AUX. Auxiliary.

AVAIL. Available.

AWCLS. All-weather carrier landing system.

B

B-SCAN. Azimuth versus range (radar) frequency versus bearing acoustics.

BALLS. Ballistics control.

BAR. Barometric.

BATT. Battery.

BBC. Back-up Bus controller.

BC. Broadcast or bus controller.

BCN. Beacon.

BINGO. Alternate landing field.

BIT. Built-in test.

BITE. Built-in-test equipment.

BIU. Bus interface unit.

BLNK. Blank.

BLP. Bearing to launch point.

BOL. Bearing only launch.

BOT. Beginning of type.

BRC. Base recovery course.

BRG. Bearing.

BRK. Brake.

BRT. Brightness.

BS. Bulk store.

BSC. Bulk store controller.

BSM. Basic storage module.

BW. Band width or beam width.

C

CAD. Cartridge activated device.

CAINS. Carrier aircraft inertial navigation system.

CANTCO. Cannot comply.

CB. Circuit breaker.

CBIT. Continuous built in test.

CC. Communications controller.

CCC. Channel control group.

CCG. Communications control group.

CCP. Control and correlation processor.

CCPSST. CCP scan sequence table.

CDB. Control distribution box.

CDNU. Control Display Navigation Unit.

CG. Center of gravity.

CGA. Compensator group adapter; control gain amplifier.

CHAR. Character or characteristics.

CI. Control indicator.

CILS. Carrier instrument landing system.

CIR. Circle.

CIW. Control interrupt word.

CLA. Control logic assembly.

CLASS. Classification.

CLG. Ceiling.

CLSFY. Classify.

CMD. Command.

CMOS. Complimentary metal oxide semiconductor.

CMPTR. Computer.

CNCT or CNTCT. Contact.

CNTRST. Contrast.

COD. Carrier onboard delivery.

COMM. Communication.

COMM CTRLR. Communication controller.

COMPAC. Communications processing and control.

CONT. Continued or control.

COORD. Coordinate.

CORLOAD. Core resident load.

CORR. Correct.

COSRO. Conical scan on receive only.

COTAC. Copilot tactical coordinator.

CP. Central processor.

CPA. Closest point of approach.

CPP. Continuous predict position.

CPR. Constant percentage resolution.

CPS. Control processor storage.

CPU. Central processor unit.

CR. Constant resolution.

CROS. Common real-time operating system.

CRS. Course.

CRT. Cathode ray tube.

CSB. Channel select bus.

CSS. Control stick steering.

CV. Aircraft carrier.

CVALN. Carrier alignment.

CVASWM. Carrier ASW module.

CVHDG. Carrier heading.

CVMAN. Carrier manual alignment.

CVSPD. Carrier speed.

CW. Continuous wave.

CWL. Continuous wave long.

CWM. Continuous wave medium.

CWS. Continuous wave short.

D

DA. Drift Angle.

D/A. Digital to analog.

DAC. Digtal to analog converter.

DATUM. Known or estimated position of submarine.

dB. Decibel.

dc. Direct current.

DCA. Digital computer autopilot.

DCAT. Display category.

DDS. Digital data set.

DECR. Decrease.

DEF. Defect.

DEG. Degrees.

DEP. Data extraction program.

DES. Descent (vertical) angle.

DESIG. Designate.

DESTEX. Desensitized tritonal.

DET. Detect.

DEV. Deviation.

DF. Direction finder; display function.

DFOC. Digital flight data computer.

DFT. Drift.

DGG. Display generator group.

DGVS. Doppler ground velocity system.

DIA/ORT. Diagnostics/operational readiness test.

DIAG. Diagnostics

DICASS. Directional command activated sonobuoy system.

DIFAR. Directional frequency analysis and recording.

DIST. Distance.

DL. Directional listening.

DLC. Direct lift control.

DLP. Distance to launch point.

DLRP. Data link reference point.

DMA. Direct memory access.

DME. Distance measuring equipment.

DMPR. Yaw damper and turn coordinator.

DMTU. Digital magnetic tape unit.

DOA. Direction of arrival.

DOP. Doppler.

DPIN. Doppler inertial.

DPOSIT. Deposit.

DPS. Data processing system.

DR. Dead reckoning.

DSPL. Display.

DSTRY. Destroy.

DTG. Date time group, distance to go.

DTK. Magnetic desired track.

DTS. Distance to go.

DVB. Data validity bits.

DW. Data word.

E

EAB. External address bus.

EAR. Error analysis routine.

EB. External bus.

EBIT. External built-in-test.

ECCM. Electronic counter-countermeasure(s).

ECM. Electronic countermeasure(s).

ECP. Engineering change proposal.

ECS. Environmental control system.

EDB. External data bus.

EDT. External dwell time.

EEPROM. Electrically erasable programmable read only memory.

EFCS. Emergency flight control system.

EFI. Electronic flight instrument.

EFIS. Electronic flight instruments system.

EGI. Embedded GPS/INS.

EGPS. Embedded GPS.

EHE. Estimated horizontal error.

EHP. Emergency hydraulic pump.

EINS. Embedded INS.

EMC. Electromagnetic compatibility.

EMCON. Emissions control.

EMER. Emergency.

EMI. Electromagnetic interference.

ENT. Enter.

EOT. End of tape.

ESMTD. ESM TMP diagnostic program.

ESR. Executive service report.

ESST. Expanded subsystem status tableau.

EST. ESM self-test.

ETA. Estimated time of arrival.

ETE. Elapsed time enroute.

ETI. Elapsed time indicator.

ETLP. Estimated time to the launch point.

E/W. East/West.

EW. Electronic warfare.

EXEC. Executive initialization and recovery.

EXP. Expendable.

EXT. External.

F

F. Friendly; time of frozen image display.

FA. Failure annunciator.

FAR. Failure annunciator panel.

FAP. False alarm rate.

FC. Frequency converter.

FCLP. Field carrier landing practice.

FC/NBR. Frequency converter/narrow band receiver.

FCTP. Flight control test panel.

FDC. Flight data computer.

FDCU. Fire detection control unit.

FDIS. Flight displays and interface system.

FEC. Far edge control.

FIFO. First in first out.

FIWA. Flight instrument wired assembly.

FLDT. Floodlight.

FLIR. Forward-looking infrared.

FLR. Failure.

FM. Frequency modulation.

FMOP. Frequency modulation on pulse.

FMSP. Flight mode selector panel.

FOD. Foreign object damage.

FOM. Figure of merit.

FOV. Field of view.

FPLN. Flight plan.

FPM. Feet per minute.

fps. Feet (or foot, or frames) per second.

FREQ. Frequency.

FRESCAN. Frequency scanning.

FRP. Feature recognition program.

FSB. Frequency same bearing.

FSK. Frequency shift keying.

FSW. Fault status word.

FTP. Fly-to point.

G

g. Gravity.

GHz. Gigahertz.

GEN. Generator.

GENTRK. Generated track.

GEO. Geographic.

GEO NAV or GEONAV. Geographic navigation.

GMT. Greenwich mean time or Zulu time (Z).

GND. Ground.

GNDALN. Ground alignment.

GPDC. General-purpose digital computer.

GPM. Gallons per minute.

GPS. Global positioning system.

GRU. Gridlock reference unit.

GS. Groundspeed.

H

H. Hostile.

HACLC Panel. Harpoon aircraft command and launch control panel.

HACLCS. Harpoon aircraft command and launch control system.

HATS. Hybrid avionics test set.

HCV. Harpoon configuration value.

HDG. Heading.

HF. High frequency.

Hg. Mercury.

HOD. Home on decoy.

HOJ. Home on jammer.

HOR. Horizontal.

HORIZ. Horizontal.

HOT. Home on target.

HRPN MSL. Harpoon missile.

HSI. Horizontal situation indicator.

HUA. Heads-up annunciator.

HYD. Hydraulic.

HYFIX. Hyperbolic fix.

Hz. Hertz.

I

I/F. Interface.

I/O. Input/Output.

IABIT. Initiated automatic built-in test.

IAS. Indicated airspeed.

IBIT. Initiated built in test.

ICAO. International Civil Aviation Organization.

ICLS. Instrument carrier landing system.

ICS. Intercommunication system.

ID or IDENT. Identification.

IF. Instantaneous frequency intermediate frequency.

IFA. In-flight align.

IFF. Identification friend or foe.

IFPM. In-flight performance monitoring.

IFU. Interface unit.

ILS. Instrument landing system.

IMBIT. Initiated Manual built-in test.

IMC. Instrument meteorological conditions.

IMN. Indicated Mach number.

IMPL. Initial microprogram load.

IMU. Inertial measurement unit.

INACT. Inactive.

INAV. Integrated navigation.

INBND. Inbound.

INCM. Incomplete.

INCOS. Integrated control system.

INCR. Increase.

IND. Indicator.

INHIBT. Inhibit.

INIT. Initiate or initialize.

INS. Inertial navigation system.

INSC. Inertial navigation system converter.

INTCPT. Intercept.

INTEN. Intensity.

INTSCTN. Intersection.

INTVL. Interval.

INU. Inertial navigation unit.

IOC. Input/output controller.

IOI. Input/output interface.

IP. Initial position.

IPL. Initial program load.

ips. Inches per second.

IRG. Interrecord gap.

IS. Initial search.

ISA. Inertial sensor assembly.

ISAR. Inverse synthetic aperture radar.

ISC. Input signal conditioner.

ISD. Input search depth.

ITL. Intent to launch.

ITT. Interturbine temperature.

J

JETT or JTSN. Jettison.

K

K. Kilo.

KEYPAC. Keyset processing and control.

KIAS. Knots indicated airspeed.

KTS. Knots.

L

L/L. Latitude/longitude.

LAH. Low-altitude hold.

LAT. Latitude.

LAU. Launcher.

LCP. Local control panel.

LE. Leading edge.

LED. Light emitting

LF. Low frequency.

LFM. Linear frequency modulation.

LIN. Line.

LINK. Link-11.

LOC TRK. Localization and tracking.

LOD. Light-off detection.

LOFAR. Low-frequency analysis and recording.

LOFIX. Comparative LOFAR fix.

LON or LONG. Longitude.

LOP. Line of position.

LORAN. Long-range navigation.

LORO. Lobe on receive-only.

LOS. Line of sight.

LOX. Liquid oxygen.

LSB. Lower sideband.

LSK. Line select key (CDNU).

LTI. Long-term integration.

LTI/STI. Long-term/short-term integration.

LWR. Lower.

M

MAC. Mean aerodynamic chord.

MAG. Magnetic.

MAGR. Miniaturized airborne GPS receiver.

MAGVAR. Magnetic variation.

MAN. Manual.

MDL. Mission data loader.

MDP. Maintenance display panel.

MDS. Minimum discernable signal.

MDT. Minimum dwell time.

MEM. Memory.

MGU. Mid-course guidance unit.

MHz. Megahertz.

MIC. Microphone.

MLG. Main landing gear.

MN. Maintenance microprocessor.

MON. Monitor.

MOT. Mark on top.

MPD. Multipurpose display.

MPIO. Microprocessor input/output.

MR/RS. Mission recorder/reproducer set.

MRS. Maximum range search.

msec. Millisecond.

MSL. Missile, mean sea level.

MSN. Mission.

MVAR. Magnetic variation.

MWOD. Multiple word of the day.

N

N/S. North/South.

N/T. Nose and tail.

NASO. Nonacoustic sensor operator.

NATOPS. Naval aviation training and operating procedures standardization.

NAV. Navigation.

NAVAIRSYSCOM. Naval Air Systems Command.

NBR. Narrow band receiver.

NCP. Navigation control panel.

NCS. Net control station.

NDCR. Navigation data converter repeater.

NDRO. Nondestructive readout.

NDS. Navigation display selector.

NEG. Negative.

NIR. Noise interference rejection.

NIU. Navigation interface unit.

NIWA. Navigation interface wired assembly.

NLG. Nose landing gear.

NM. Nautical mile.

NPRI. Normal pulse repetition interval.

nsec. Nanosecond.

NTDS. Navy tactical data system.

NUM. Number.

NVM. Non volatile memory.

NWS. Nosewheel steering.

O

OAC. Own aircraft.

OAT. Outside air temperature.

OFP. Operational flight program.

OHS. Other half-system.

OLCU. Off-line control unit.

OMNI. Omnidirectional.

OMP. Operational mission program.

OPER. Operator.

OPTNL. Optional.

OPIO. Other processor input/output.

OPLOAD. Operational load.

ORB. Orbit.

ORD. Ordnance.

ORT. Operational readiness test.

OT. On top.

OTH. Over the horizon.

OTPI. On top position indicator.

OVRLD. Overload.

P

P3. Compressor discharge pressure.

PATT. Pattern.

PBR. Practice bomb rack.

PCA. Point of closest approach.

PCN. Pavement classification number.

PCSS. Pitch control stick steering.

PCT. Pulse characterization table.

PDC. Proteus digital channel or practice depth charge.

PDIP. Preflight data insertion program.

PDM. PAC detect marks; pulse distribution module.

PDRS. Postflight data reduction software.

PGD. Pulse group duration.

PGRI. Pulse group repetition interval.

PHSRU. Parachute harness sensing release unit.

PID. Preflight inserted data.

PIM. Position of intended movement.

PLT. Pilot.

PMG. Permanent magnetic generator.

PMU. Parameter measurement unit.

POP. Pulse on pulse.

POS. Position.

PP. Postpressor; pulse pressor.

PPI. Plan position indicator.

ppm. Pounds per minute.

PPNT. PP navigation table.

PPRI. Precision pulse repetition interval.

PPSST. PP scan sequence table.

PRCS. Process.

PRD. Predicted range of the day.

PRED. Predict.

PRF. Pulse repetition frequency.

PRGM. Program.

PRI. Pulse repetition interval.

PRMTRS. Parameters.

PROM. Programmable read-only memory.

PROX. Proximity.

PS. Program store.

psig. Pounds per square inch gauge.

PTOR. Power turn-on reset.

PTT. Push to talk.

PU. Participating unit.

PUBIT. Powerup built-in test.

PW. Pulse width.

PWR. Power.

Q

QTY. Quantity.

QUAL. Qualification.

R

R/O. Range only.

RAAWS. Radar altimeter and altitude warning system.

RAD. Radius or radiate.

RAD ALT. Radar altimeter.

RAM. Random access memory.

RAT. Ram air turbine.

RBL. Range and bearing launch.

RCAP. Remote control advisory panel.

RCDR. Recorder.

RCF. Receiver calibration factor.

RCNTR. Recenter.

RCT. Remote compass transmitter.

RCU. Remote control unit.

RCVR. Receiver.

RDR. Radar.

REACQ. Reacquisition.

RF. Radio frequency.

RIU. Radar interface unit.

RLG. Ring laser gyro.

RLOAD. Reload.

RLSE. Release.

RLY. Relay.

RM. Redundancy management.

RNG. Range.

RNAV. Area navigation.

ROM. Read only memory.

RNZ. Reinitialization.

ROM. Read only memory.

RPU. Receiver processor unit.

RQ. Reception quality.

R/REV. Recorder/reproducer electronics unit.

RS. Reserved store.

RSCI. Radio set control indicators.

RST. Rest.

RT. Remote terminal.

RTC. Real-time clock.

RX. Receiver.

S

SA/AS. Selective availability/Anti spoofing.

S-A/CF. Safe-arm contact fuze.

SANAV. Stand alone navigation.

SAR. Search and rescue.

SAT. Static air temperature

SATS. Satellites.

SAV. Strike attack vectoring.

SC. Signal comparator; storage controller.

SCADC. Standard central air data computer.

SCH. Search.

SCM. Semiconductor memory.

SCT. SIP confidence test.

SDC. Signal data converter.

SDTP. Subsystem diagnostic test program.

SEL. Select.

SENSO. Sensor operator.

SEQ. Sequence.

SESCON. Search stores control.

SESCOS. Search control system.

SHAL. Shallow.

SIB. Standard interface bus.

SIG. Signal.

SIM. Simulation; simulator.

SINS. Shipboard inertial navigation system.

SIP. Signal integration processor.

SL. Selection loader.

SLC. Sonobuoy launch container; sonobuoy launch chute.

SLN. Straight and level noise.

SLNCE. Silence.

SLTA. Search, localization, track, and attack.

SMP. Sonobuoy monitor panel.

SNR. Signal-to-noise ratio.

SOI. Signals of interest.

SONB. Sonobuoy.

SONO. Sonobuoy.

SP. Self-protection.

SPCL. Special.

SPD. Speed.

spr. Seconds per rotation.

sps. Seconds per scan.

SRA. Shop replaceble assembly.

SRCE. Source.

SRCH. Search.

SRS. Sonobuoy reference system.

SRT. System readiness test.

SRX. Sonobuoy receiver system.

SSSC. Surface surveillance and sea control.

SST. Scan sequence table.

STA. Station.

STAE. Second time around echo.

STAR. System test and radiate.

STAT. Status.

STBY. Standby.

STC. Storage transfer controller.

STCO. Speedbrake and trim control unit.

STEER. Steering subprogram.

STHDG. Stored heading

STI. Short-term integration.

STP. System test program.

STR. Store.

SUB. Submarine.

SUMRY. Summary.

SURF. Surface.

SUS. Sound underwater signal.

SUW. Surface warfare.

SYNC. Synchronize.

SYS. System.

T

T. Threat.

T5. Interturbine termperature.

TA. Threat avoidance.

TAB. Tableau.

TAC. Tactical.

TAC PLOT. Tactical plot.

TACAN. Tactical air navigation.

TACCO. Tactical coordinator.

TACSATCOM. Tactical satellite communications.

TAMPS. Tactical air mission planning system.

TAS. True airspeed.

TC. Tape cartridge.

TCG. Time code generator.

TCN. Tacan.

TD. Tactical diagnostics.

TDS. Tactical display symbol; target designator symbol.

TE. Trailing edge.

TEMP. Temperature.

TER. Triple ejector rack.

TERM. Terminate or terminal.

TET. Tentative emitter rack.

TFWS. Task force warning and support.

TGT. Target.

THRESH. Threshold.

THUM. Tactical harpoon users manual.

TIMB. Time in main beam.

TLP. Time to launch point.

TMP. Tactical mission program.

TN. Track number.

TOA. Time of arrival.

TORP. Torpedo.

TPA. Trigger pulse amplifier.

TR. Transformer rectifier.

TRANS. Transmit.

TRK. Track.

TRKR. Tracker.

TSG. Test signal generator.

TTC. Tape transport cartridge.

TTG. Time to go.

TTGT. Time to target.

TIT. Time to intercept.

TTU. Tape transport unit.

TWS. Track while scan.

TWSRO. TWS receive-only.

TWT. Traveling wave tube.

TX. Transmitter.

U

U. Unknown.

UDG. Universal display generator.

UHF. Ultrahigh frequency.

UNAVAIL. Unavailable.

UNK. Unknown.

UNLK. Unlock.

UPS. Universal polar stereographic.

USB. Upper sideband.

USW. Undersea warfare.

UTC. Universal coordinated time.

UTM. Universal test message, universal transverse mercator.

V

VAST. Versatile avionics shop test.

VCO. Voltage controlled oscillator.

VCOCT. VCO display indicator.

VDI. Vertical display indicator.

VEC. Vector.

VEL. Velocity.

VERT. Vertical.

VHF. Very high frequency.

VLAD. Vertical line array DIFAR.

VMC. Visual meteorological conditions.

VNAV. Vertical navigation.

VOR. VHF omnidirectional range.

VSA. Video switching assembly.

VSWR. Voltage standing wave ratio.

W

WILCO. Will comply.

WND. Wind.

WPN. Weapon.

WOW. Weight on wheels.

WPNS. Weapons load indicators.

WPT. Waypoint.

WRA. Weapon replaceable assembly.

WS. Working store.

WSAR. WS address register.

WST. Weapon system trainer.

X

XFER. Transfer.

XMIT. Transmit.

XMTR. Transmitter.

XTK. Cross track.

Y

YD or YDS. Yard or yards.

YPM. Yards per minute.

Z

Z. Zulu time or Greenwich mean time.

PREFACE

SCOPE

The NATOPS Flight Manual is issued by the authority of the Chief of Naval Operations and under the direction of Commander, Naval Air Systems 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 operations. However, it is not a substitute for sound judgment. 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. Read this manual from cover to cover. It is your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-S3AAB-1A (Supplemental NATOPS Flight Manual)

NAVAIR 01-S3AAB-1B (NATOPS Pilot Pocket Checklist)

NAVAIR 01-S3AAB-1F (NATOPS Functional Checkflight Checklist)

NAVAIR 01-S3AAB-1.1 (Weapon System Manual)

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

Recommendation (Be specific.)

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Justification

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(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

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Routine change recommendations are submitted directly to the Model Manager on OPNAV Form 3710/6 (4-90) shown herein. The address of the Model Manager of this aircraft is:

Commanding Officer
Sea Control Squadron FOUR ONE
Naval Air Station, North Island
San Diego, California 92135
Attn: S-3B NATOPS Program Manager

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.

YOUR RESPONSIBILITY

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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.

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to WARNINGs, CAUTIONs, and Notes found throughout the manual.

WARNING

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

CAUTION

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

Note

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

WORDING

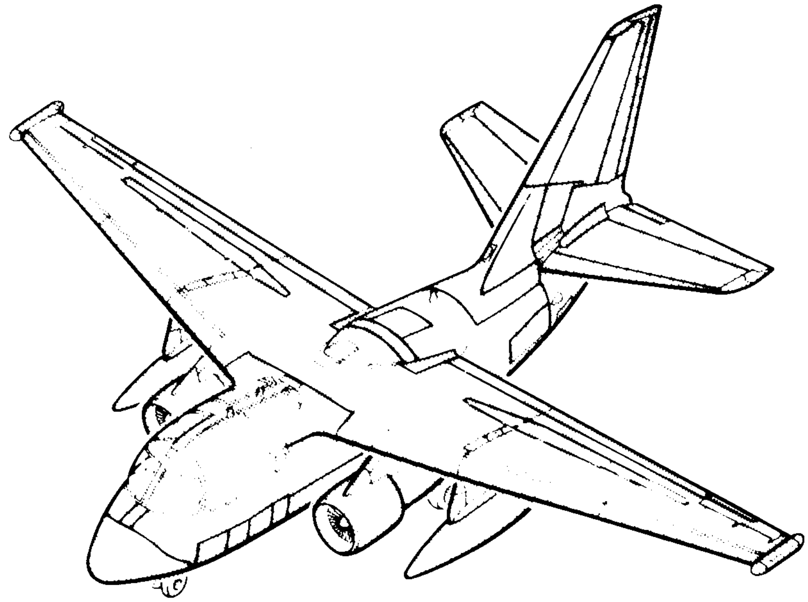
The concept of word usage and intended meaning adhered to in preparing this Manual is as follows:

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

2. Should has been used only when application of a procedure is recommended.

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

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



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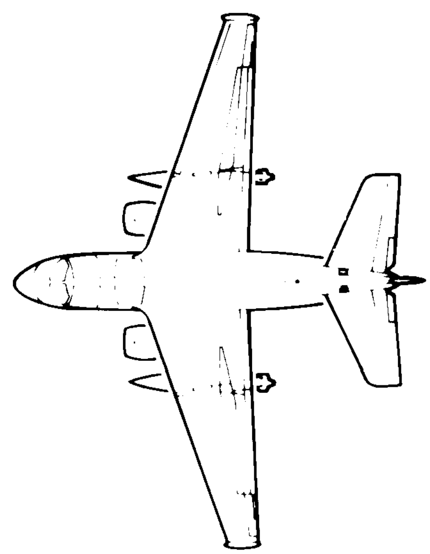
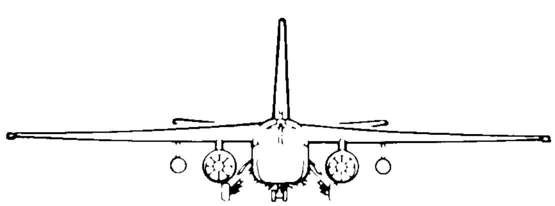
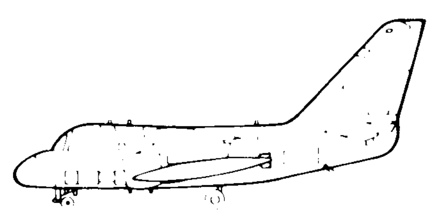






PART I

The Aircraft

CHAPTER 1

General Description

1.1 DESCRIPTION

The S-3B is a high-wing, jet-powered, twin-engine, carrier-based sea control aircraft equipped with folding wings, folding vertical fin, a launch bar for catapult takeoffs, and a tailhook. It carries surface search equipment with integrated target acquisition and sensor coordinating systems that can collect, process, interpret, and store surface warfare (SUW) sensor data. It has a direct attack capability with a variety of armament. Additional features include:

1. Inertial navigation system
2. Automatic carrier landing system
3. General purpose digital computer
4. Inverse synthetic aperature radar
5. Air refueling capability
6. Sequential crew ejection
7. Controlled cabin environment (pressure and temperature)
8. Auxiliary power unit
9. Tanker (aircraft incorporating AFC-220).

Two General Electric TF34 high-bypass turbofan engines are installed on pylons mounted under the wing, inboard of the wingfold stations. A door with integral stairs located on the forward right fuselage provides for crew entrance.

1.1.1 Dimensions. The principal dimensions are:

Wing span (spread) . . . . 68 feet, 8 inches

Wing span (folded) . . . . 29 feet, 6 inches

Horizontal stabilizer span . . . 27 feet, 0 inches

Length . . . . 53 feet, 4 inches

Length (tail folded) . . . . 49 feet, 5 inches

Height . . . . 22 feet, 9 inches

Height (tail fin folded) . . . . . . 15 feet, 3 inches

Height (maximum during wing fold) . . . . 31 feet, 1 inch

Tread, main landing gear (varies with weight) . . . . . . 13 feet, 9 inches

Wheel base (varies with weight) . . . . 18 feet, 9 inches

Turning radius (wings spread):

Towing . . . . 34 feet, 4 inches

Taxiing . . . . 41 feet, 2 inches

Turning Radius (wings folded):

Towing . . . . 26 feet, 8 inches

Taxiing . . . . 31 feet, 0 inches

Hoisting height (top of sling to wheel extended) . . . . 23 feet, 10 inches

Jacking height — nose and two wing jacks (wings and tail fin folded) . . . . 17 feet, 0 inches.

1.1.2 Weight. The S-3B is in the 35,000- to 50,000-pound gross weight class. For exact weights, refer to Part XI, Performance Data, or the aircraft Handbook of Weight and Balance Data (NAVAIR 01-lB-40).

1.2 GENERAL ARRANGEMENT

On a SUW mission, the S-3B is operated by a crew of four:

1. Pilot
2. Copilot/COTAC

3. Tactical coordinator

4. Sensor operator.

For a general arrangement diagram, see Figure 1-1. Figures 1-2 and 1-3 depict typical cockpit panels and controls. See FO-1, FO-2, FO-9, and FO-10 for the stations' instrument panel arrangement.

Note

Illustrations normally depict the latest aircraft configuration at date of publication; therefore, aircraft configuration may differ from that shown.

1.2.1 Cockpit. The pilot and copilot/COTAC seats are arranged side by side in the forward cabin with the pilot located at the left station. Dual controls are provided at the right station. The copilot/COTAC station is also equipped to control and operate the nonacoustic sensors, the navigation equipment, and communications.

1.2.2 Crew Stations

1.2.2.1 Tactical Coordinator. The tactical coordinator station, located aft of the copilot/COTAC station on the right side of the aircraft, comprises the systems necessary for control and tactical display of the tactical mission.

1.2.2.2 Sensor Operator. The sensor station, located aft of the pilot station on the left side of the aircraft, comprises the controls and display of nonacoustic systems necessary for the successful completion of the tactical mission.

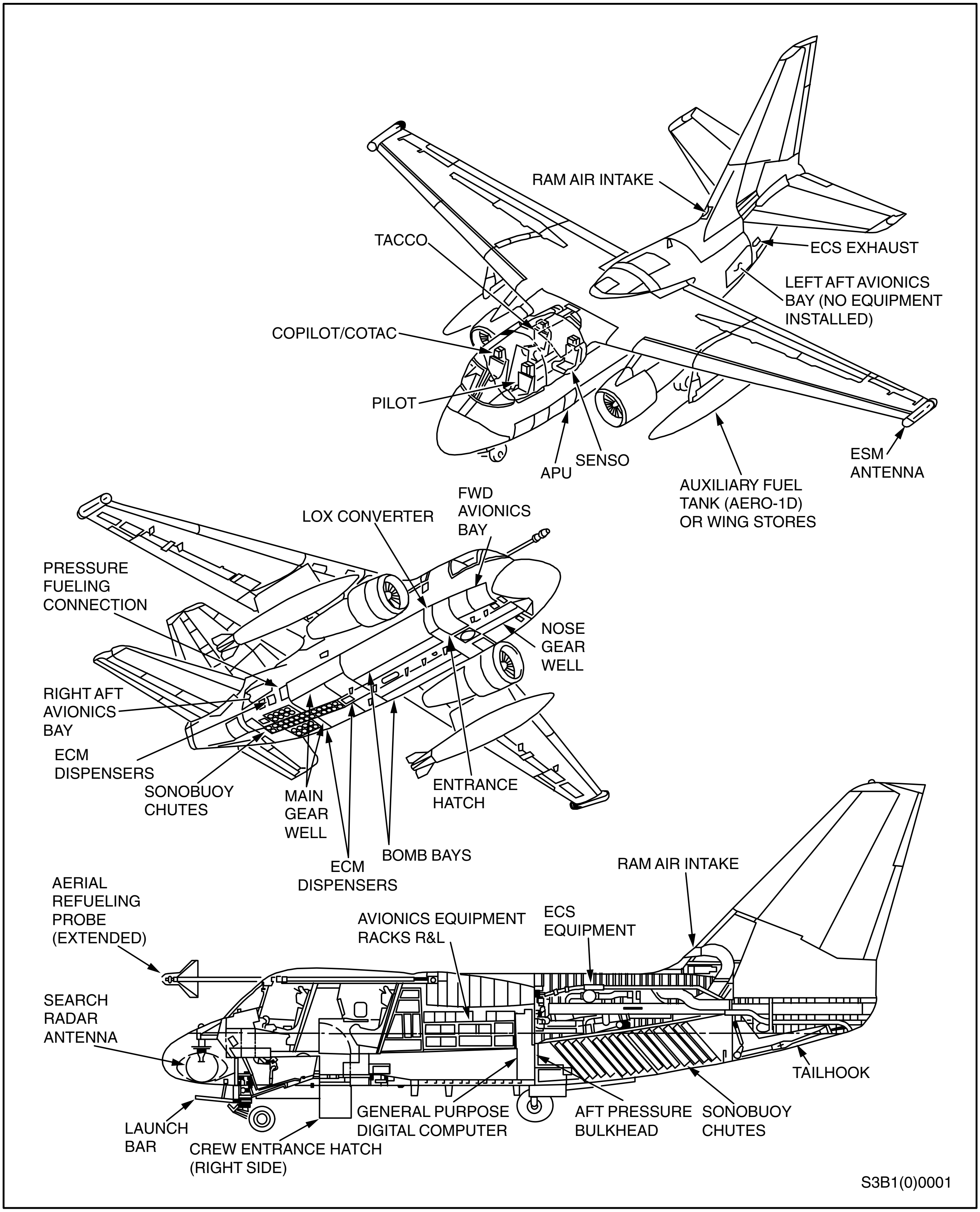


Figure 1-1. General Arrangement

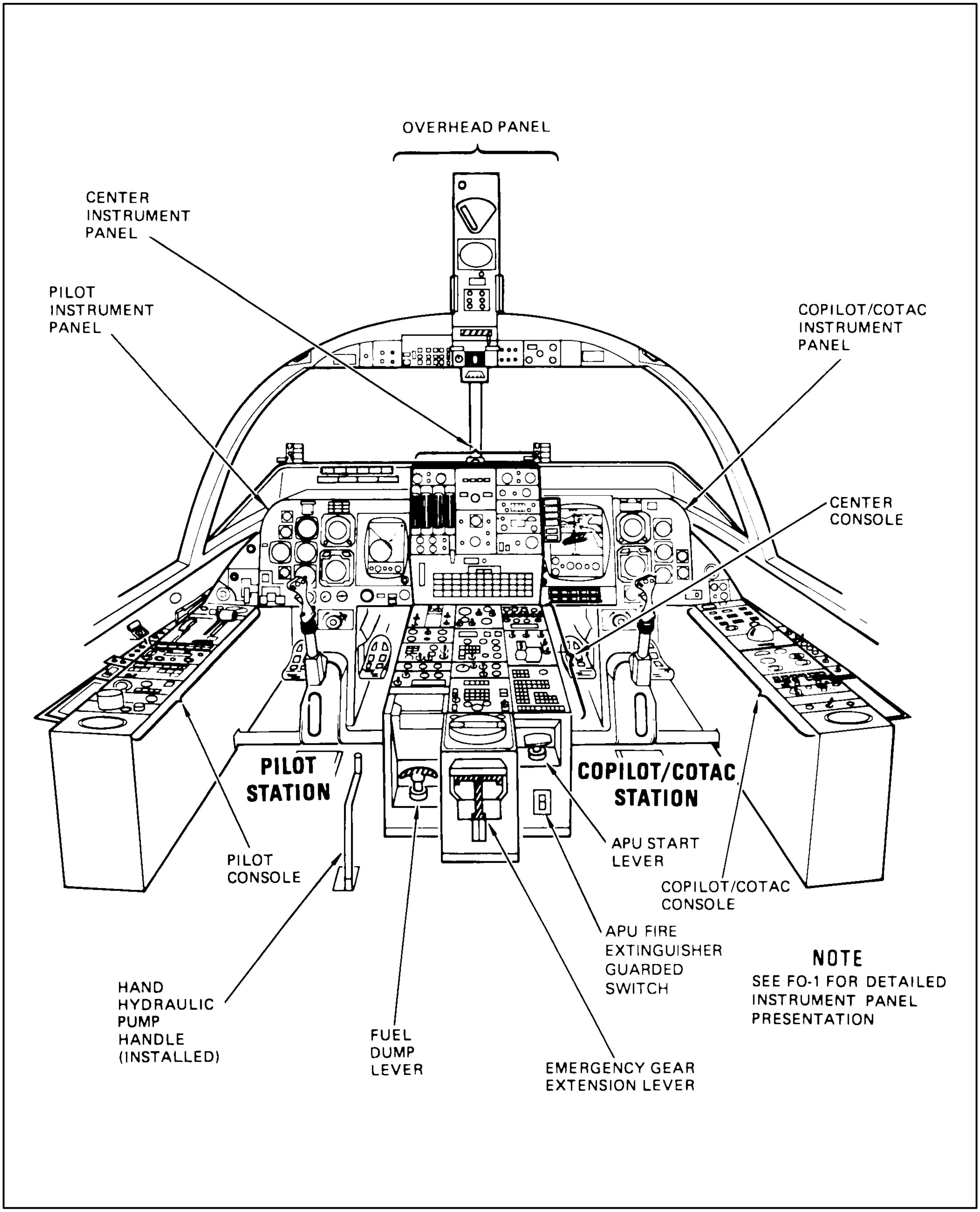
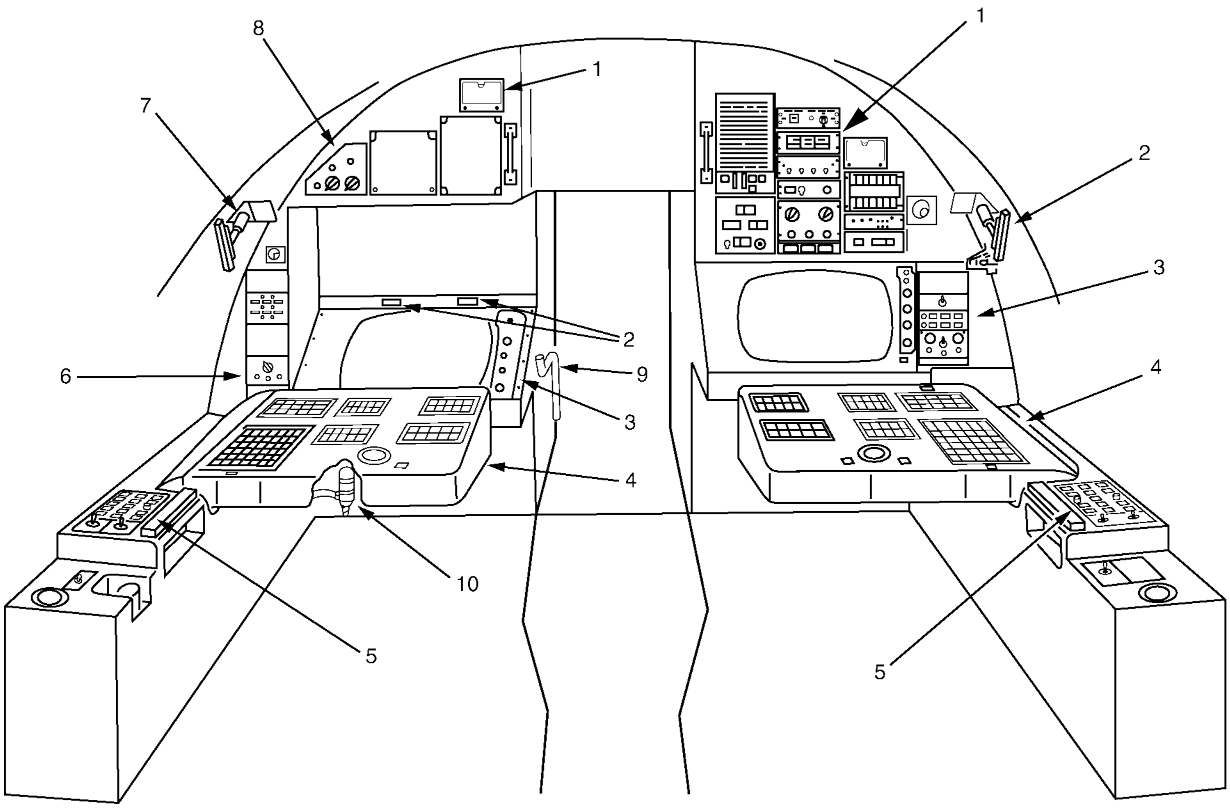


Figure 1-2. Cockpit (Typical)



NOTE

SEE FO-5 AND FO-6 FOR DETAILED INSTUMENT PANEL PRESENTATION.

SENSOR OPERATOR (SENSO) STATION

1. CHECKLIST HOLDER
2. EJECT ALERT WARNING AND GROUP EJECT ADVISORY LIGHTS
3. MPD AND CONTROL PANEL
4. INCOS SENSO TRAY
5. SENSOR SIDE PANEL
6. SONOBUOY MONITOR PANEL
7. HATCH SEVERANCE HANDLE
8. INTERIOR LIGHTS PANEL
9. HYDRAULIC HANDPUMP HANDLE
10. APU FIRE EXTINGUISHER ASSEMBLY AND GAUGE

TACTICAL COORDINATOR (TACCO) STATION

1. TACCO OVERHEAD PANEL
2. HATCH SEVERANCE HANDLE
3. TACCO FORWARD CONSOLE
4. TACCO INCOS TRAY
5. TACCO SIDE CONSOLE

N8/96

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Figure 1-3. SENSO/TACCO Stations (Typical)

CHAPTER 2

Systems Description

2.1 INTRODUCTION

Information contained in this chapter is intended as general systems descriptions. For more detailed descriptions, refer to NAVAIR 01-S3AAB-2 series.

2.2 POWER PLANT SYSTEMS

2.2.1 Engine. (See Figure 2-1.) The aircraft is powered by two axial-flow TF34 turbofan engines mounted beneath the wings. The engine is a dual-rotor, single-stage, front-fan configuration with a bypass ratio of 6.23 to 1. Each engine develops 9,275 pounds of thrust at sea level, standard day, static (uninstalled).

The engine consists of the following major sections:

1. Fan
2. Compressor
3. Combustor
4. Turbine.

2.2.1.1 Fan Section. The single-stage fan located at the front of the engine produces 85 percent of the thrust developed by the engine. The fan is driven by the low-pressure turbine and provides supercharged ram air for the compressor section. A fan rpm speed sensor provides signals to operate the N_f (fan speed) indicator on the center instrument panel in the cockpit. The engine fan speed indicator (N_f) is a dual vertical scale instrument with markings from 0 to 8,000 rpm. The scale from 6,000 to 8,000 rpm is expanded. The left channel indicates fan rpm of the No. 1 engine, and the right channel indicates fan rpm of the No. 2 engine. Each channel has a yellow overspeed caution light that comes on when N_f exceeds a preset rpm (refer to Chapter 4). An OFF flag is visible when power is removed from the instrument. In addition, an ENG LIMIT amber light, located on the master caution panel, comes on when the overspeed light goes on. This light is extinguished by pressing either the pilot or copilot/COTAC master CAUTION light or when the condition causing the engine instrument caution light to illuminate is corrected (see Figure 2-2).

2.2.1.2 Compressor Section. A 14-stage, axial-flow compressor is located aft of the fan section (see Figure 2-1). It provides compressed air for engine combustion, anti-icing, seal pressurization, and bleed air to operate pneumatic systems in the aircraft. The compressor consists of inlet guide vanes, stators, and rotors. Stages one through five use variable guide vanes. They control the airflow through the compressor. The variable geometry compressor inlet guide vanes and stators are controlled by a pair of variable geometry actuators. The actuators are powered by high-pressure fuel scheduled through the fuel control.

2.2.1.3 Combustor Section. The combustor section, located aft of the compressor section, is where the compressor discharge air and fuel are mixed and ignited. The combustor utilizes an annular configuration with a swirler-type injection system. It comprises the combustion casing, combustion liner, 18 swirler plates, fuel feed tubes, and the first-stage turbine nozzle. Ports are provided in the combustor section for two igniter plugs, 18 fuel feed tubes, 14th-stage bleed air, five primer fuel nozzles, and for borescope inspection.

2.2.1.4 Turbine Section. The turbine section consists of a high- and a low-pressure turbine. The two-stage, high-pressure turbine, located directly aft of the combustor section, drives the 14-stage compressor and the accessory section. The four-stage, low-pressure turbine, located just aft of the high-pressure turbine, drives the fan. An ITT indicator, located on the center instrument panel in the cockpit, is a dual vertical scale instrument with marks graduated from 0 to 1,000 °C. The scale is expanded from 600 to 900 °C. The left channel indicates ITT of the No. 1 engine, and the right channel indicates ITT of the No. 2 engine. A red overtemperature warning light is located above each channel and comes on when ITT exceeds the preset value. An OFF flag is visible when power to the

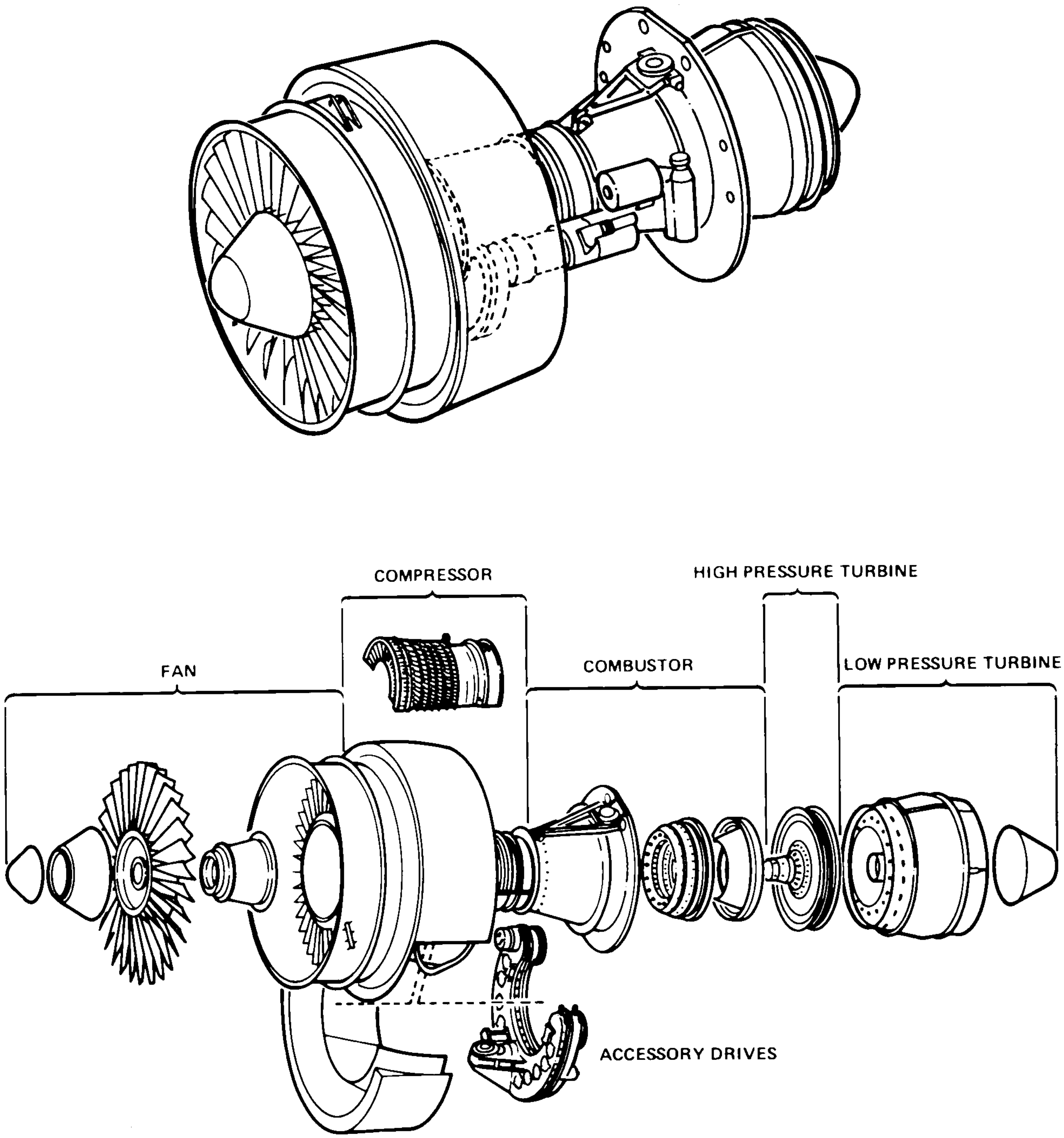
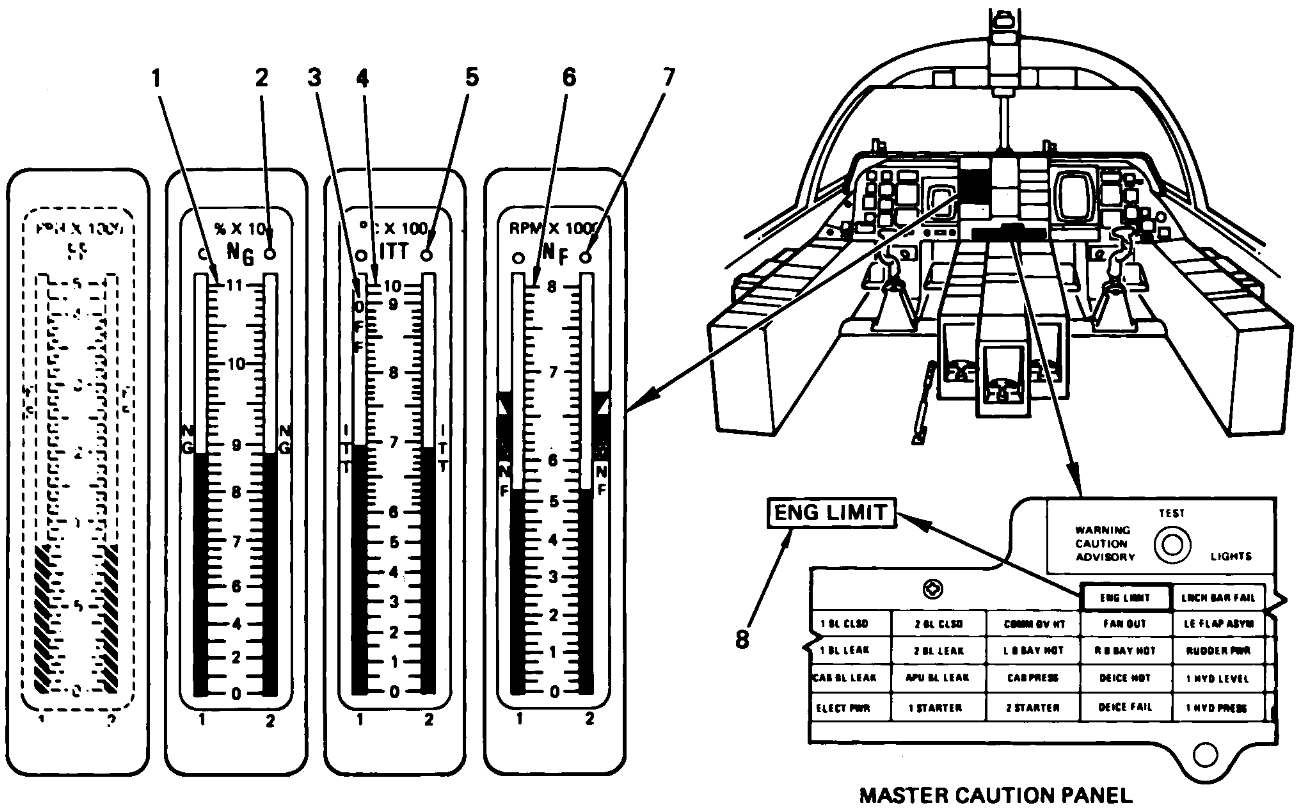


Figure 2-1. TF34 Engine



INDEX	CONTROL/INDICATOR	FUNCTION
1	(N_g) Gas generator speed indicator	Indicates gas generator speed of each engine in percent.
2	(N_g) Overspeed caution lights	Illuminates yellow when N_g exceeds 100%.
3	(ITT) OFF flag	Indicates when power to the instrument is removed.
4	(ITT) Interturbine temperature indicator	Indicates ITT of each engine in °C.
5	(ITT) Overtemperature warning lights	Illuminates red when ITT exceeds 835 to 843 °C.
6	(N_f) Fan speed indicator	Indicates fan rpm speed of each engine.
7	(N_f) Overspeed caution lights	Illuminates yellow when fan speed exceeds 7760 to 7825 rpm.
8	ENG LIMIT caution light	Indicates one or more fault conditions on individual engine instrument warning or caution lights (reset — press master CAUTION light).

Figure 2-2. Engine Indicators

instrument is removed. In addition, an ENG LIMIT amber light, located on the master caution panel, comes on when the overtemperature warning light goes on. This light is extinguished by pressing either the pilot or copilot/COTAC master CAUTION light or when the condition causing the engine instrument warning light to come on is corrected (see Figure 2-2).

2.2.2 Gas Generator. The gas generator consists of the compressor, combustor, and the two-stage, high-pressure turbine. Gas generator rpm is displayed on the N_g indicator (see Figure 2-2). The engine rpm (N_g) indicator is a dual vertical-scale instrument graduated from 0 to 110 percent. The left channel indicates rpm of the No. 1 engine, and the right channel indicates rpm of the No. 2 engine in percent (100-percent N_g equals 17,800 rpm). Located above each channel is a yellow overspeed caution light that comes on when N_g exceeds 100 percent. An OFF flag is visible when power to the instrument is removed. An ENG LIMIT amber light, located on the master caution panel, also comes on when the overspeed light goes on. This light is extinguished by pressing either the pilot or copilot/COTAC master CAUTION light or when the condition causing the engine instrument caution light to illuminate is corrected (see Figure 2-2). When engaged, the starter, mounted on the engine accessory gearbox, drives the gas generator. The gas generator drives the engine-mounted accessory gearbox which, in turn, drives the following accessories:

1. Hydraulic pump

2. Integrated drive generator

3. Fuel pump and fuel control

4. Tachometer generator

5. Engine lubrication and scavenge pumps

6. Control alternator.

2.2.3 Engine Fuel System. (See FO-11.) The engine fuel system includes a fuel pump, fuel filter, fuel control, primer system, two-position idle speed system, flowmeter, fuel-oil cooler, and a flow distributor. The fuel pump assembly consists of a centrifugal-type, engine-driven boost pump; a positive displacement primary pump; and a positive displacement secondary pump, all mounted on a common shaft. Fuel is supplied from the aircraft tank to the engine-driven boost pump where a portion of the flow is diverted to the secondary pump. This secondary pump returns high-pressure fuel to the fuel tanks where it powers the tank ejector pumps. These, in turn, transfer fuel to the engine feed tanks. An ejector pump in the feed tanks supplies fuel to the engine-driven boost pump. The undiverted engine fuel flow passes through the fuel filter, then to the inlet of the primary pump, which delivers fuel to the fuel control where required flow for engine operation is scheduled. Fuel in excess of scheduled flow is bypassed back to the inlet of the primary pump. Scheduled flow for engine operation passes from the fuel control through the flowmeter then through the oil cooler (oil/fuel heat exchanger) where heat is extracted from the oil by the fuel. The fuel then flows to the flow distributor where it is distributed to each of the 18 fuel-feed tubes in the combustor frame.

During engine start, fuel is scheduled from the fuel control to five primer nozzles. As the engine accelerates to IDLE, three of the primer nozzles cut off and the remaining two provide continuous flow during all ranges of engine operation. Positive shutoff of fuel flow to the engine is provided by movement of the pilot throttle to the OFF position. The fuel feed to each engine from the aircraft tanks is by gravity flow during engine starting and by ejector boost pumps in the tanks when the engines are operating at 52 percent N_g and above. Failure of a feed tank ejector boost pump to supply fuel pressure to the engine-driven boost pump is indicated by illumination of the 1 FUEL PRESS or 2 FUEL PRESS amber caution light on the master caution panel.

Note

Illumination of the fuel pressure light with simultaneous decrease in feed tank quantity and fuel remaining in the transfer tank indicates a probable engine-driven boost pump failure.

The light is on during engine starts until the engine accelerates to above 52 percent N_g. When the light comes on in flight, the pilot should monitor fuel flow, avoid abrupt power changes, and negative-g flight, and, if necessary, reduce altitude to maintain engine operation. Refer to Emergency Procedures, Part V. Two additional fuel filter amber lights, one for each engine, are located on the master caution panel. When illuminated, these lights indicate 1 FUEL FLTR and 2 FUEL FLTR. Illumination of either light indicates fuel filter inlet and outlet differential pressure is high and fuel filter bypass is impending for the respective engine. In addition, two fuel idle amber lights, one for each engine, are located on the master caution panel. When illuminated, 1 FUEL IDLE and 2 FUEL IDLE indicate that the respective engine fuel idle control has failed to select flight idle when airborne. A dual vertical-scale, fuel-flow indicator labeled FF is also provided on the center instrument panel. Each scale indicates fuel flow in pounds per hour × 1,000 for the respective engine. The scale reads from 0 to 5,000 and is expanded from 0 to 1,000 (see Figure 2-3).

2.2.3.1 Engine Fuel System Operation. The engine fuel system is operated by positioning the throttle at different positions to vary fuel flow. When the engine is not running, the engine-driven boost pump receives fuel from the aircraft fuel feed tank under gravity; when the engine is operating, fuel flows by ejector pump pressure. Fuel passes through the engine-driven boost pump where a portion is diverted to the secondary pump for ejector-pump motive flow, which returns diverted fuel to the aircraft internal fuel tanks during all operating conditions at or above 52 percent N_g. The undiverted engine fuel flow passes from the engine-driven boost pump, through the filter, then to the primary pump. During the initial starting cycle, the output flow of the primary pump may be insufficient to operate the engine; therefore, at engine speeds below 52 percent N_g, the secondary pump is placed in parallel with the primary pump, and the combined output flow is delivered to the fuel control. Above 52 percent N_g, the secondary pump supplies fuel for ejector pump motive flow. Fuel flows from the fuel control to the variable geometry actuators and to the fuel flow transmitter, the oil cooler, flow distributor, and tubes to the combustion section.

2.2.4 Engine Oil System. (See Figure 2-4.) The engine oil system is self-contained, having its own engine-mounted oil tank, main lubrication and scavenge pumps, oil cooler, oil filter, pressure relief valve, and drain plug. The dry sump system consists of a pressurized oil supply and a scavenge return. A sightglass indicates when the tank is properly filled. There is no readout for oil quantity in the cockpit. Foreign body contamination within the system is indicated by continuity in a magnetic chip detector. There are five chip detectors that are located in the oil tank, accessory drive gearbox, and A, B, and C sump lines. No visual indicator is provided to the pilot except manual inspection of the chip detectors during maintenance inspection. Oil pressure gauges, located on the center instrument panel in the cockpit, indicate the oil pressure (0 to 100 psi) of each engine. Oil pressure transducers (electrical sensors) in the oil system provide electrical signals for the oil pressure gauges. An ENG OIL PRESS light, located on the master caution panel, will illuminate when either engine oil pressure falls below approximately 30 psi. (See Figures 2-4 and 2-5.) Refer to Chapter 4 for oil pressure limitations.

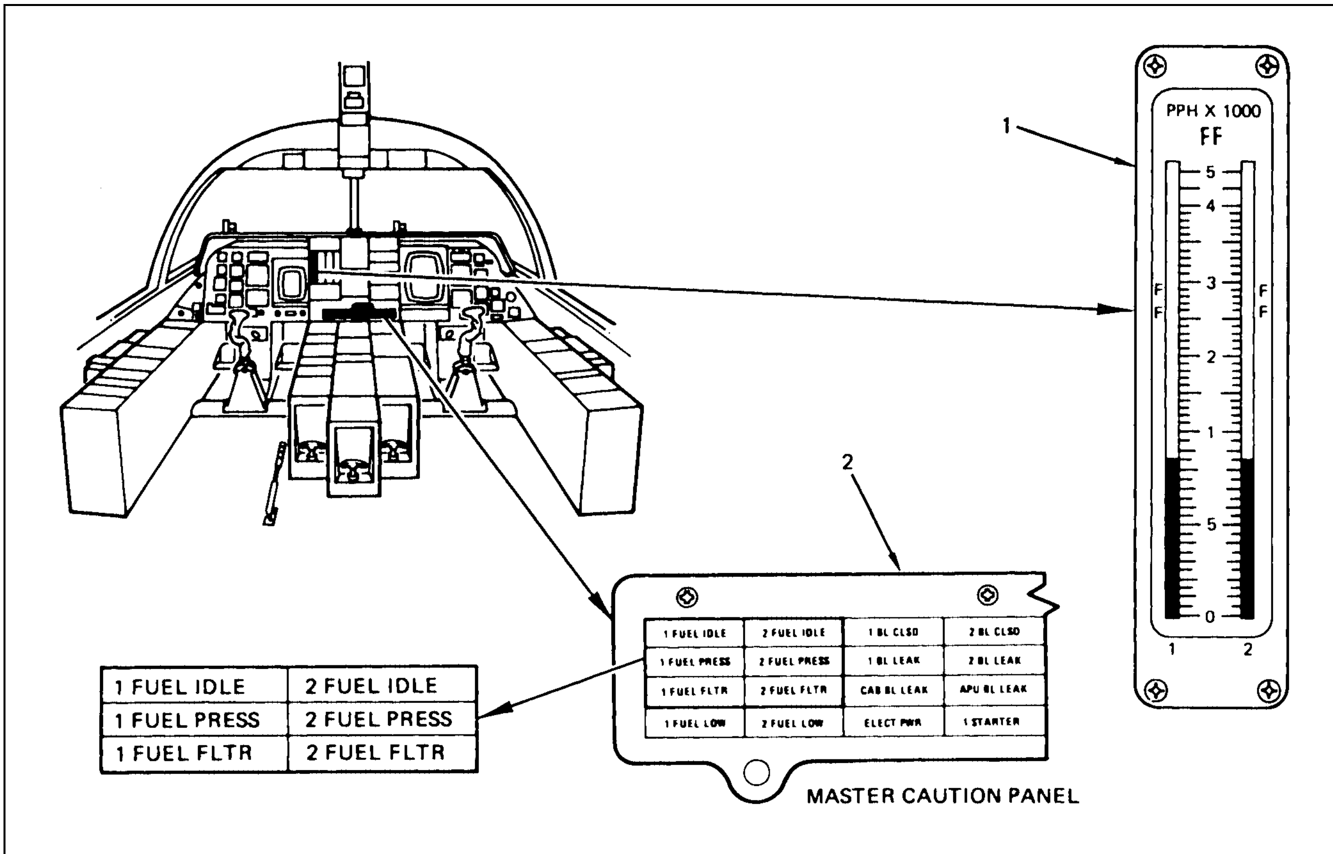
CAUTION

The engine rpm (N_g) speed transmitter is driven by the oil pump driveshaft; therefore, if N_g indication deteriorates, the oil pressure should be checked and monitored immediately. If a decrease in oil pressure is noted, the engine should be secured immediately.

Note

For proper oil pressure readings, refer to Chapter 4 (see Figure 4-9).

2.2.5 Engine Bleed Air System. (See Figure 2-6.) Engine bleed air is ducted into a bleed air manifold for distribution and use in the following functions: the air-conditioning pressurization system, wing and empennage deicing system, engine starting, and pressurization of external fuel tanks for fuel transfer. In addition, the engine anti-ice system extracts 14th-stage bleed air independent of the bleed air manifold and separate air supply sources, such as an APU and a ground air source, may be connected to this manifold. A manifold from the APU connects into the left side of the cross-ship manifold. Air can be supplied from the APU compressor for starting or for air-conditioning while the aircraft is on the ground. Ground air can be supplied from a ground cart into a receptacle located in the right wheelwell. This air can be used for starting engines or for operating the air-conditioning system while on the ground. A bleed air manifold pressure gauge, located on the environmental (ECS) panel on the center console (Figure 2-7), indicates the crossbleed duct air pressure. The gauge is marked in pounds per square inch from 0 to 30 × 10 (0 to 300).



INDEX	CONTROL/INDICATOR	FUNCTION
1	(FF) Fuel Flow indicator	Indicates fuel flow of each engine in pounds/hour.
2	Master Caution panel:	
	FUEL IDLE light	Indicates engine idle fuel schedule system failure.
	FUEL PRESS light	Indicates fuel pressure for respective engine is low.
	FUEL FILTER light	Indicates fuel filter inlet and outlet differential pressure high-fuel filter bypass impending.

Figure 2-3. Engine Fuel Indicators

2.2.5.1 Bleed Air Augmentation Valves. The valves act to maintain high pressure and/or temperature during all pneumatic system operations. This is accomplished by augmenting 10th-stage bleed air with 14th-stage bleed air according to the following programming.

These augmentation valves, one in each pylon, function as follows:

1. Automatically programmed to maintain bleed manifold pressure at an acceptable level for air-conditioning and pressurization operation when deicing is not selected.

2. Automatically programmed to maintain bleed manifold pressure and temperature at acceptable levels for proper wing and empennage deicing when deicing is selected.

3. Automatically programmed to maintain a minimum of 55 psi in the bleed manifold when either engine start switch is in the START position (provided affected engine 14th-stage pressure is 55 psi or greater, N_g greater than approximately 75 percent).

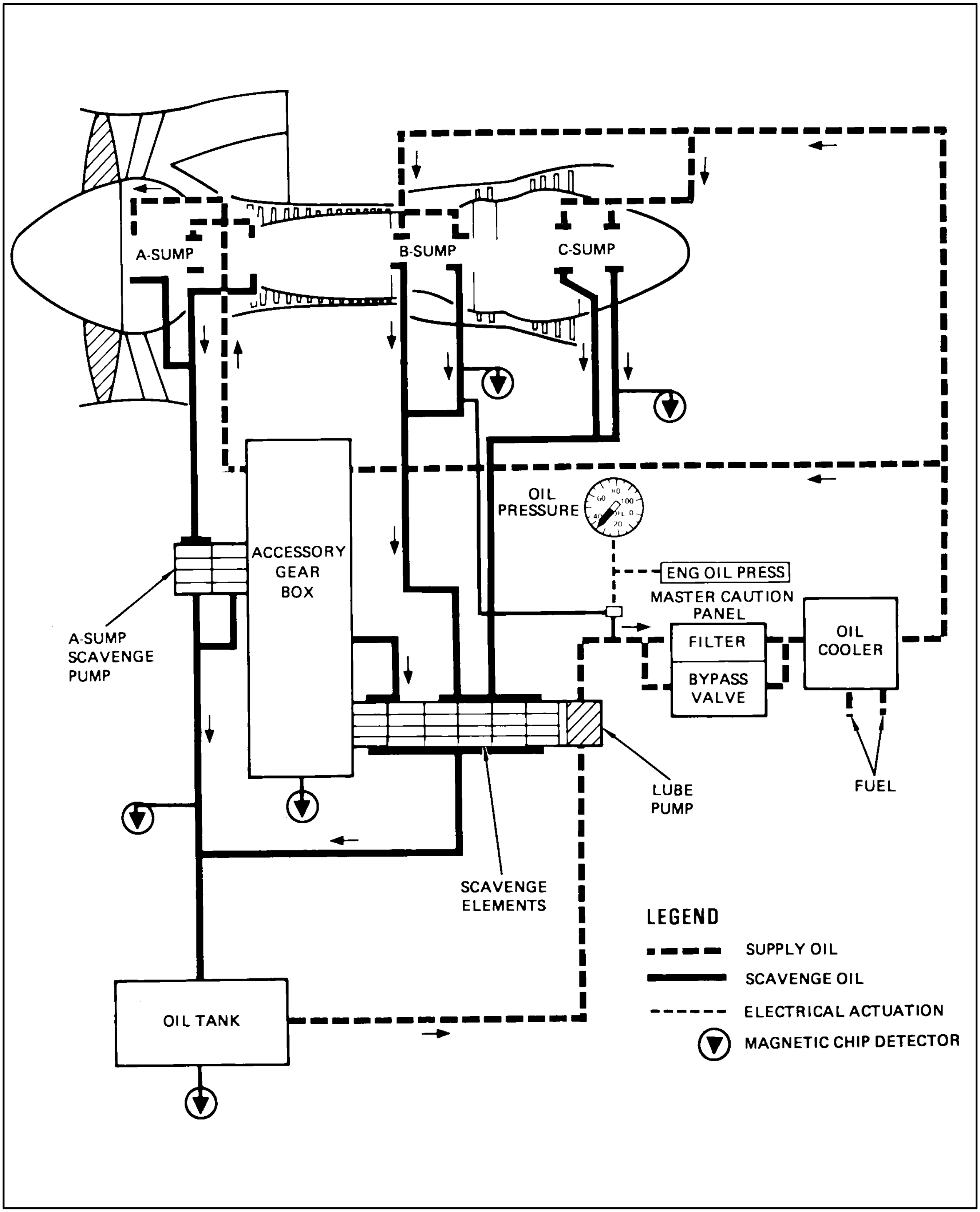
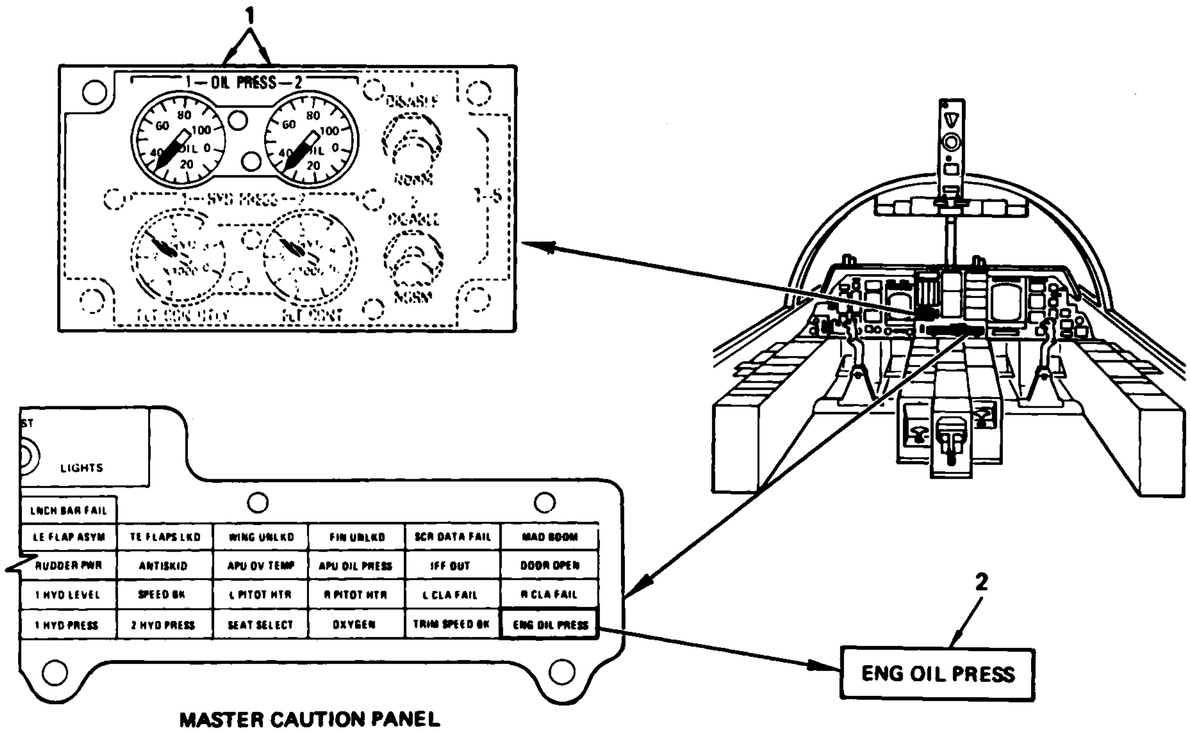


Figure 2-4. Engine Oil System



INDEX	CONTROL/INDICATOR	FUNCTION
1	OIL PRESS gauges	Indicates oil pressure of each engine in psi.
2	ENG OIL PRESS caution light	Indicates low oil pressure in either engine.

Figure 2-5. Engine Oil Indicators

2.2.5.2 Bleed Air Shutoff Valves. A bleed air shutoff valve is located in each wing pylon downstream of the engine bleed ports. Each valve is electrically energized and pneumatically opened to allow compressor bleed air, ground start air, or APU air to flow in either direction through the bleed air manifold. Two bleed air control switches, one for each engine, are located on the forward overhead panel (see Figure 2-7) and have two positions, ON and OFF. When ON, the bleed air valve solenoid is electrically energized and pneumatically opened. In the OFF position, the solenoid is deenergized and the valve, spring loaded to the closed (OFF) position, allows spring tension and duct pressure to close the valve and to shut off engine bleed air to the manifold. The bleed air shutoff valves are electrically actuated open during engine starts, regardless of switch position, by a signal from the CLA. The bleed air shutoff valve will fail to the closed position. If either master caution panel amber light (1BL CLSD or 2BL CLSD) is illuminated, the respective bleed air valve is closed.

2.2.5.3 Bleed Air Duct Isolation System Operation. A bleed air isolation system consisting of two check valves and a cross-bleed start bypass valve is installed at the union of the left and right bleed air manifold. Each check valve permits air to flow in one direction only and will prevent overbleed of both engines should a rupture occur in the left or right bleed air duct. During two-engine operation, rupture of a bleed duct on either side of the aircraft will require that the bleed air shutoff valve on the side of the rupture be closed. This will not affect the air-conditioning system, but deicing will be available on the side with the open bleed valve; therefore, the deicing system should not be used as asymmetrical deicing would result. During single-engine operation, duct rupture on the side of the operating engine will require that the remaining bleed air shutoff valve be closed. Under these conditions the air-conditioning pressurization system will not function and deicing will not be available. A thermal bleed air leak detection system is incorporated to monitor the

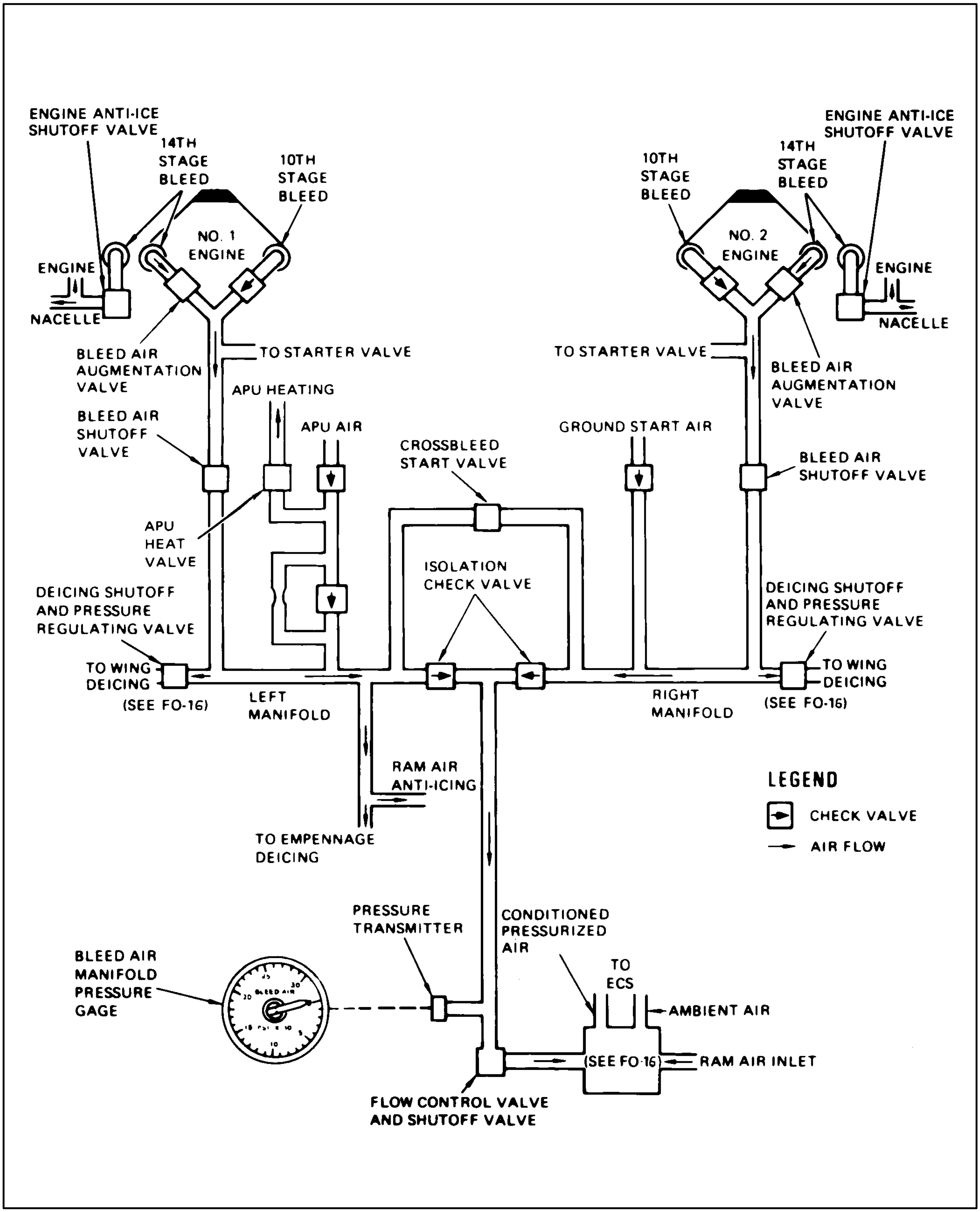
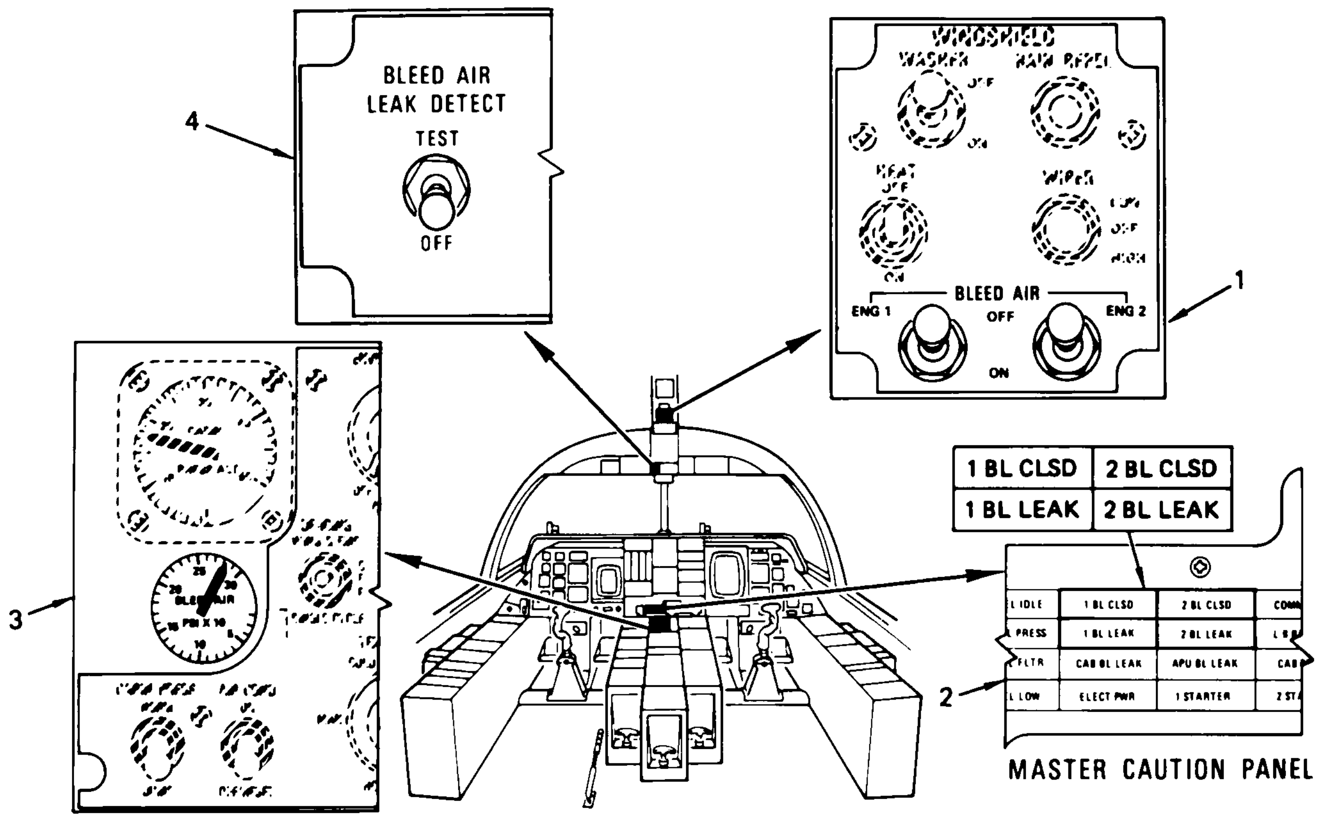


Figure 2-6. Bleed Air System



INDEX	CONTROL/INDICATOR	FUNCTION
1	BLEED AIR switches	Electrically energizes bleed air valve solenoid, allowing engine bleed air to reach the manifold.
2	Master Caution Panel:	
	BL CLSD light	Indicates respective bleed air valve is closed.
	BL LEAK light	Indicates an overtemperature condition [in excess of 127 °C (260 °F)] in the vicinity of an applicable bleed line. Generally caused by a broken or cracked line, seal, or fire in ECS compartment.
3	BLEED AIR manifold pressure gauge	Indicates pressure in bleed air manifold.
4	BLEED AIR LEAK DETECT switch	TEST — checks continuity of four detection circuits. Illuminates BL LEAK and master CAUTION lights. OFF — deactivates test circuitry and extinguishes light (spring-loaded).

Figure 2-7. Engine Bleed Air Controls and Indicators

bleed air system downstream of the bleed air valve. The bleed air leak detection sensors are set to illuminate their respective warning lights whenever the sensed temperature exceeds 127 °C (260 °F). If either master caution panel amber light (1BL LEAK or 2BL LEAK) is illuminated, the corresponding bleed air shutoff valve switch must be turned OFF. Simultaneous lighting of 1BL LEAK and 2BL LEAK may denote a break between the cross-ship duct and flow control valve, and both engines' bleed air switches must be turned OFF to prevent further damage to the aircraft.

CAUTION

Simultaneous illumination of 1BL LEAK and 2BL LEAK lights may indicate an ECS compartment fire. In this event, the crew should be alert to secondary indications that would confirm a fire.

2.2.6 Engine Electrical System. The engine has a completely independent, self-contained electrical power supply for the ignition system and engine control. The engine electrical system consists of a control alternator, ignition system exciter and igniter plugs, main fuel control, torque motor, control amplifier, and various engine condition sensing elements.

2.2.7 Engine Ignition System. The engine uses a low-tension ac capacitor discharge ignition system, consisting of a control amplifier; a self-contained, engine-driven alternator; a dual output exciter; two igniters; and logic circuits. The exciter creates the electrical spark required to ignite the fuel/air mixture in the combustion chamber. Two master control ignition switches, located on the forward overhead panel in the cockpit, are connected in series with the ignition switches on the throttle shaft of the fuel control. The switches, one for each engine, allow the ignition system to be energized (see Figure 2-8). Sparking (ignition) is provided during air or ground start with the ignition switch ON, the engine rpm above 9 percent N_g, and the throttle around the detent. Ignition ceases when engine rpm (N_g) exceeds 48 percent.

2.2.7.1 Automatic Ignition. Ignition is also activated (automatically) following a flameout or during armament firing. Flameout is sensed by a T_5 temperature difference (T_5 decay) signal within the control amplifier. When this decay exceeds a predetermined threshold, ignition is triggered. Ignition is also triggered when an armament firing circuit signal is received and continues for 5 to 15 seconds after firing ceases.

2.2.8 Engine RPM Events

N_g (percent)	Event
9	Ignition
47 to 54	Hydraulic pump cuts in
48	Ignition cutout
52	Motive flow starts (FUEL PRESS light out)
53	Generator comes on line
54 to 57	Starter cutout
57	Maximum rpm for starter engagement
64	Idle (changes with different OAT and altitude)
79	Automatic temperature control armed (T_5)

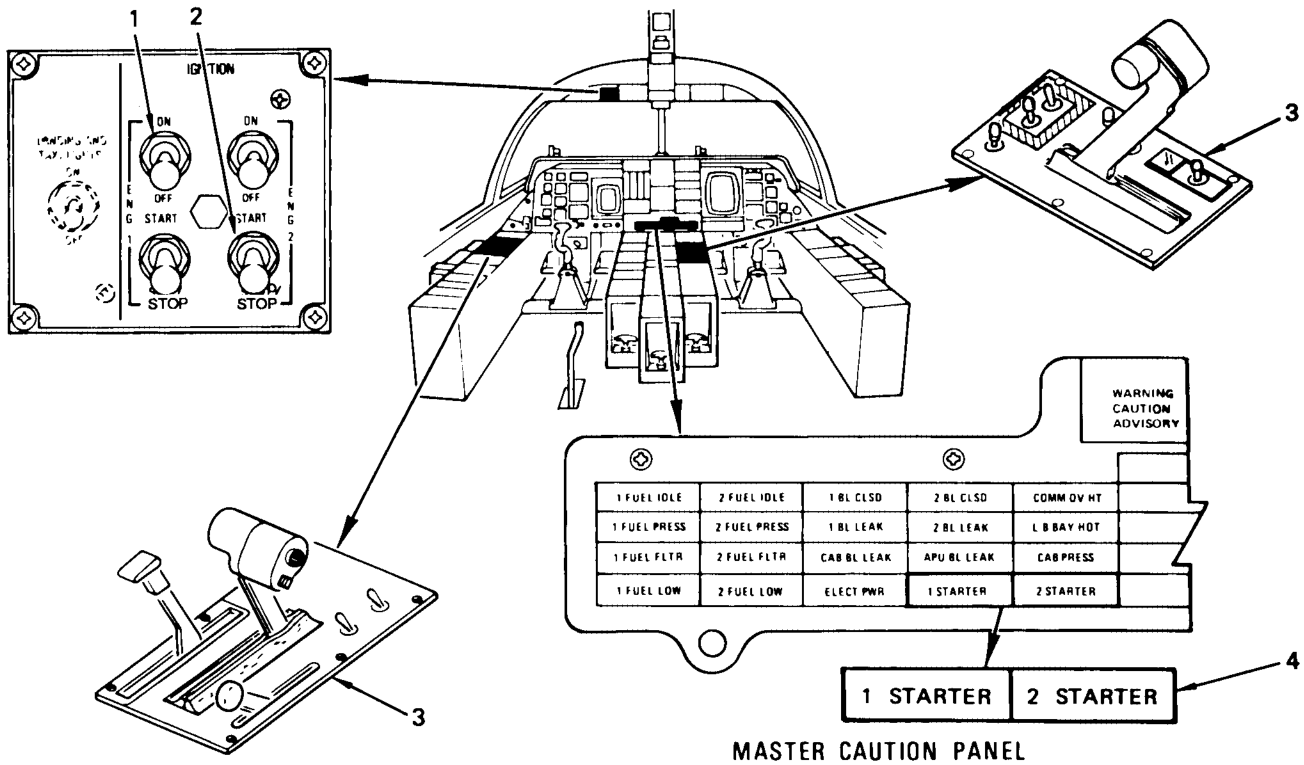
For maximum power, refer to Chapter 4.

2.2.9 Engine Starting System. Engine starting may be accomplished by the pilot:

1. With an external source of compressed air
2. By compressed air from the APU
3. By crossbleed air from an operating engine
4. By windmilling of the engine during airstart.

Left and right bleed air manifolds route bleed air to the engine starter valve. Engine starting components consist of two bleed air shutoff valves, a crossbleed valve, two start valves, two pneumatic starters, and two bleed air augmentation valves (see Figure 2-6).

2.2.9.1 Bleed Air Shutoff Valves. The bleed air shutoff valves are electrically connected to lights located on the master caution panel. The caution lights are illuminated when the valves are closed. Both bleed air shutoff valves and the crossbleed valve are automatically opened for starting by control logic circuitry whenever the engine start switch is operated.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Ignition switches	Allows the ignition system to be energized if throttles are not off and N_g is between 9 and 48 percent or a signal is received from either the rocket gas ingestion or automatic ignition system.
2	Engine start switches	Electrically energizes starter valve solenoids, crossbleed start valve, bleed air shutoff valves, and augmentation valves and permits pneumatic pressure to operate these valves.
3	Throttle switches	Throttle switches (one for each engine) actuated by throttle position. Provide ignition when throttle is advanced to IDLE and engine rpm is between 9 and 48 percent N_g, provided that the ignition switches on the eyebrow panel are in the ON position.
4	1 STARTER or 2 STARTER caution lights	Indicates START switch is positioned to START (starter valve open); START switch is not in the STOP position 4 seconds after increasing past 54 percent N_g (starter valve failed to actuate to closed position); respective starter valve is not closed regardless of START switch position.

Figure 2-8. Engine Ignition and Starter Controls

2.2.9.2 Crossbleed Start Valve. The crossbleed start valve connects the left and right bleed air manifolds. It is open during all engine starts, whether the air source is from the engines, APU, or external air. The valve is opened by positioning the start switch to START. This valve also opens with deice selected during single-engine operation to ensure deicing to both wings. The crossbleed valve closes when the start switch automatically returns to the STOP position at 54 to 57 percent N_g.

2.2.9.3 Start Valve. A start valve, installed in the starter air duct upstream of the starter for each engine, functions as an on/off valve for the starting air. Each valve is controlled electrically by the start switch located on the pilot side of the forward overhead panel. In the START position, the switch electrically energizes the respective engine starter valve solenoid to allow pneumatic pressure to open the valve. It also electrically energizes the bleed air shutoff valves and permits pneumatic pressure to operate the engine starter valve. The switch is solenoid-held in START position until N_g reaches 54 to 57 percent. In the STOP position the switch electrically deenergizes the respective starter valve solenoid, allowing pneumatic pressure to close the valve. An amber starter light, located on the master caution panel, indicates the engine starter valve is not fully closed, regardless of the start switch position. The starter caution light will illuminate anytime the starter valve is opened by positioning the start switch to START or the respective starter valve is open (malfunctioned) when the engine is above starter cutout speed regardless of the start switch position.

2.2.9.4 Pneumatic Starter. The starter is a turbine-type air motor used to drive the gas generator during engine starts. It is mounted on the accessory gearbox and is connected to the start valve by ducting. The starter is equipped with a switching mechanism that deenergizes the start valve solenoid closed when N_g speed reaches 54 to 57 percent rpm.

2.2.9.5 Engine Start System Operation. For engine starting, a source of air pressure must be available. The engine starting system is operated by placing the start switch in the START position. The starter valve solenoid is energized, and air pressure opens the valve. Air passes through the start valve and rotates the starter. As N_g reaches 54 to 57 percent, the start switch returns to the STOP position, and the start valve solenoid deenergizes, allowing air pressure to close the valve.

2.2.10 Engine Control System. The engine control system consists of the fuel control, temperature control, compressor variable-geometry control, and automatic ignition control. The engine control system is completely self-contained and requires no external power from the aircraft electrical system. Input signals to the control system are:

1. High-pressure turbine speed (N_g)
2. Compressor discharge pressure (P_3) and bleed flow sense (P_{BL})
3. Compressor inlet air temperature (T_{2C})
4. Interturbine temperature (T_5)
5. Variable stator position (VG)
6. Throttle position (PLA)
7. Armament firing signal (requires 28 vdc aircraft power)
8. Flight/ground idle signal.

Utilizing these signals, the engine control system regulates fuel flow and fuel pressure for positioning the stator vanes.

2.2.10.1 Engine Throttle Levers. The pilot throttles are located on the left side console, and the copilot/COTAC throttles are located on the center console (see FO-4). Both sets of throttles are interconnected and move in unison; however, they may only be moved to the OFF position using the pilot throttles. Both pilot and copilot/COTAC throttles have OFF, IDLE, and MAX PWR positions. A throttle quadrant stop mechanism prevents the throttle levers from being retarded to OFF simultaneously.

2.2.10.2 Engine System Operation. Engine power (thrust) is regulated by the position of the throttle. The throttle is connected to the power control shaft on the fuel control. At idle and low power conditions, fuel flow is established by hydromechanical speed control; at higher power conditions, fuel flow is established by the electronic temperature control. Therefore, it is not necessary for the pilot to continually monitor ITT (T_5). The temperature control, however, can be disabled by means of the T-5 DISABLE switches.

Engine ground idle speed is automatically reset as compressor inlet temperature changes. On a standard day, idle N_g is normally 64 percent; on a cold day, N_g decreases to maintain a low-idle thrust. On a hot day, idle speed is scheduled higher than 64 percent to permit the engine to accelerate more rapidly on a throttle burst.

2.2.10.3 Main Fuel Control. Engine rpm (N_g) is a function of throttle angle as measured at the fuel control. The fuel control shaft is mechanically linked to the throttle and provides inputs to a control amplifier 79 percent N_g and above as requested by throttle position. This input is compared in the control amplifier to the ITT (T_5) of the engine. Any difference between the two signals causes the fuel metering valve within the fuel control to modulate, bringing the ITT into agreement with that requested by the throttle position. The fuel control responds in direct relationship to throttle movement below 79 percent N_g. Above this rpm, electronic temperature control eliminates the necessity for the pilot to constantly monitor the ITT gauge with changes in power setting.

2.2.10.4 Adaptive Fuel Control. The engine also incorporates an adaptive fuel control that senses 14th-stage compressor bleed airflow (except engine anti-ice bleed flow) and adjusts the engine acceleration fuel schedule accordingly. Under heavy bleed airflow, the acceleration fuel schedule is increased up to 10 percent above the zero bleed schedule, thereby maintaining satisfactory engine acceleration and load carrying capability. A safety feature in the fuel control protects the engine by automatically disabling the capability for increased acceleration fuel schedules if a malfunction occurs that commands greater than an 11 percent increase in the schedule. The increased acceleration fuel schedule capability cannot be reset in flight (once disabled).

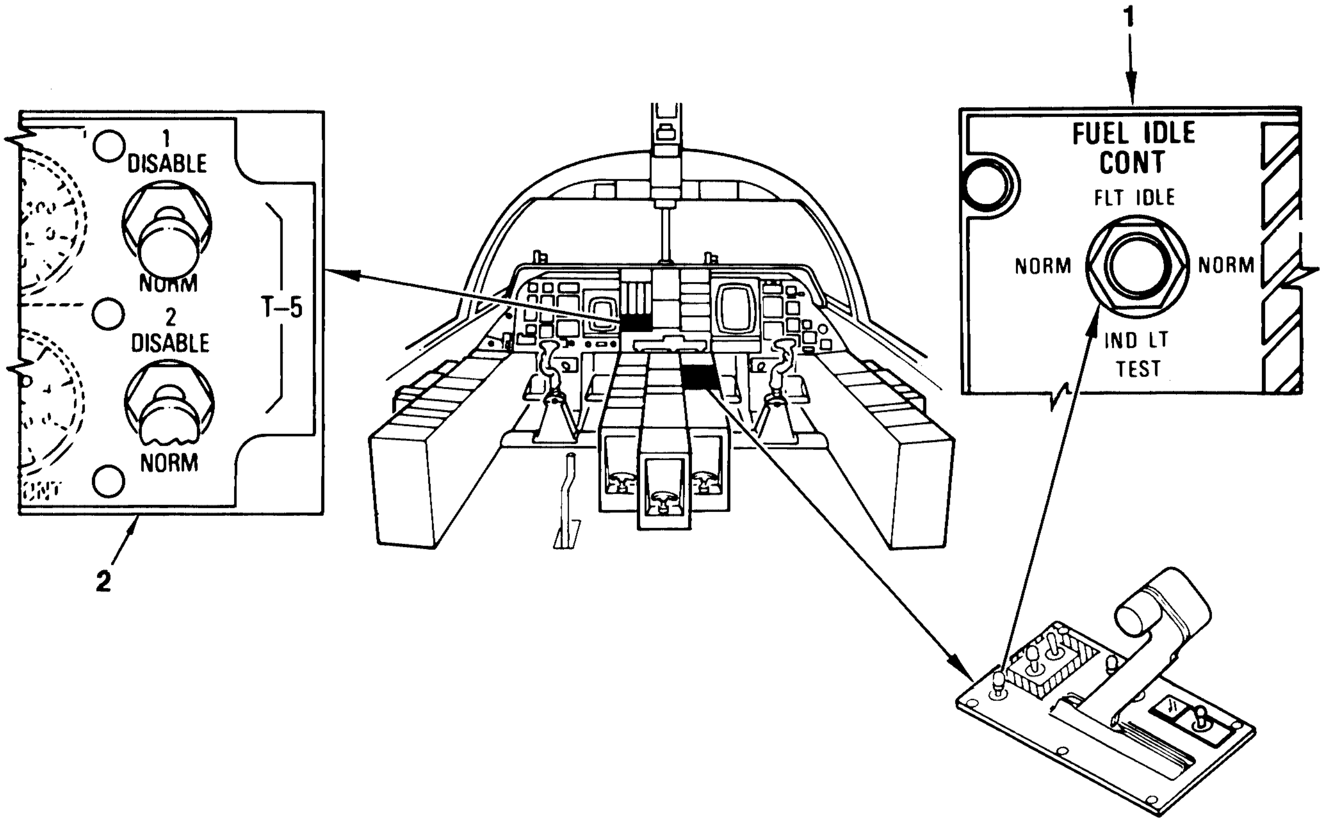
WARNING

Actuation of this safety feature (fuel control bleed sense) is very remote; however, no provision has been made to warn the pilot if this occurs. Under this condition, longer acceleration times and/or rollback can occur on the affected engine under heavy bleed air and electrical loading. If fuel control safety feature actuation is suspected and single-engine operation of the affected engine is subsequently encountered, fuel flow should be manually maintained above 550 pph when operating with the anti-icing system on.

2.2.10.5 Temperature Control. When the temperature control unit is the limiting function, it receives an ITT signal sensed by thermocouples and compares this signal to a reference temperature signal in the temperature amplifier. Fuel flow is then reset automatically until the engine temperature corresponds to the reference temperature established by throttle position. The temperature control unit receives its power supply from the engine-driven alternator. Provisions for additional control are provided by two T-5 DISABLE (ITT) toggle-type switches, one for each engine, that are located on the center instrument panel (see Figure 2-9). The DISABLE position disables the temperature control system by removing control amplifier signals from the fuel metering valve in the fuel control. The NORM position allows the temperature control system to provide automatic temperature control when the throttle is advanced to 79 percent N_g or greater.

2.2.10.6 Variable Geometry Control. The compressor variable geometry control consists of two actuators used in conjunction with the main fuel control to position the compressor variable geometry vanes and stators. The actuators position the vanes and stators by using fuel pressure scheduled from the fuel control. The vanes are scheduled open and closed to accommodate changes in compressor pressure ratio to prevent compressor stall.

2.2.10.7 Rocket Gas Ingestion. Provisions are made within the engine control system to minimize the effect of rocket gas ingestion on the engine. Upon actuation of the trigger when rocket firing, the engine ignition is activated and maintained for 5 to 15 seconds.



INDEX	CONTROL/INDICATOR	FUNCTION
1	FUEL IDLE CONT switch	FLT IDLE — allows manual (override) selection of flight idle. IND LT TEST — (momentary) allows ground check of FUEL IDLE light circuitry. NORM — idle speed is function of flight or ground through weight-on = wheels switches.
2	T-5 Disable (ITT) switches	NORM — provides fuel control automatic temperature control above 79 percent N_g. DISABLE — disables temperature control system, manual monitor necessary. Switch over to DISABLE only below 79 percent N_g.

Figure 2-9. Engine Protection Controls

2.2.11 Engine Idle Speed Control. The engine incorporates separate idle schedules for ground and flight operations. The ground-idle schedule varies engine idle speed with temperature and altitude as shown in Figure 2-10 so as to maintain a constant ground thrust. The flight-idle schedule varies engine idle speed in flight (dependent upon temperature) and increases with altitude as shown in Figure 2-10. The gas generator speed indicator may vary ±3 percent for ground operation up to 8,000 feet increasing to ±4.2 percent at 40,000 feet from the values shown in Figure 2-10. The variations are because of tolerances in the engine fuel control, compressor inlet temperature sensor, and the pilot's ability to read gas generator speed, OAT, and altitude from aircraft instruments. The flight idle schedule maintains sufficient engine idle rpm (N_g) to enable simultaneous operation of all aircraft bleed air, electrical, and hydraulic systems even under

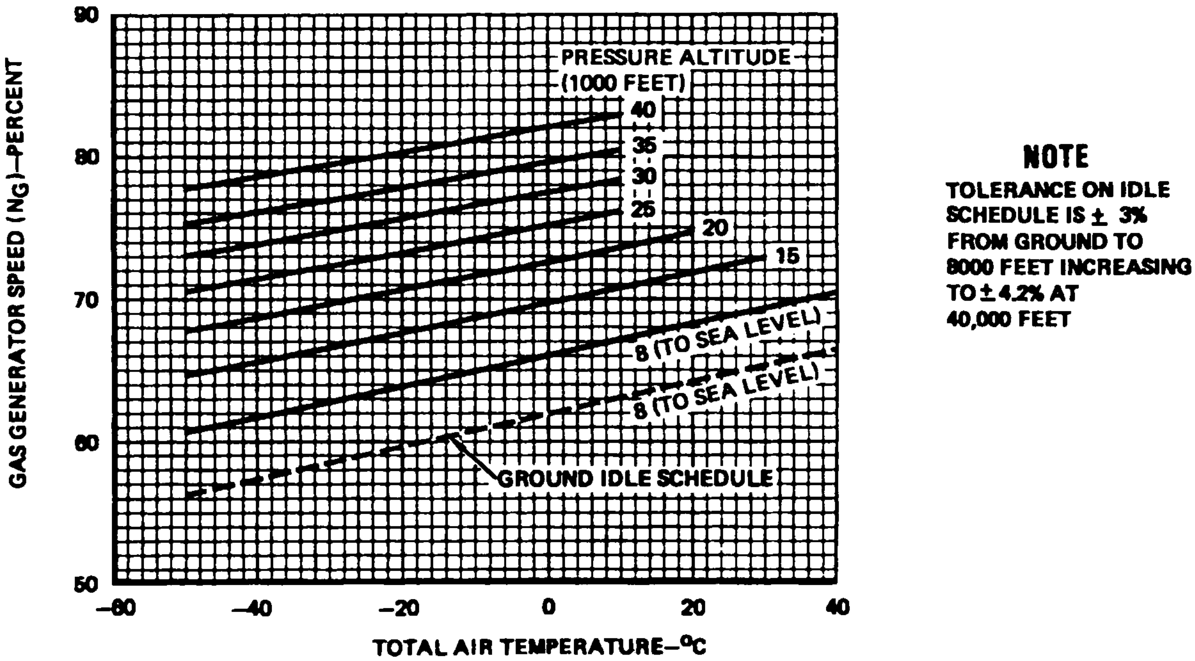
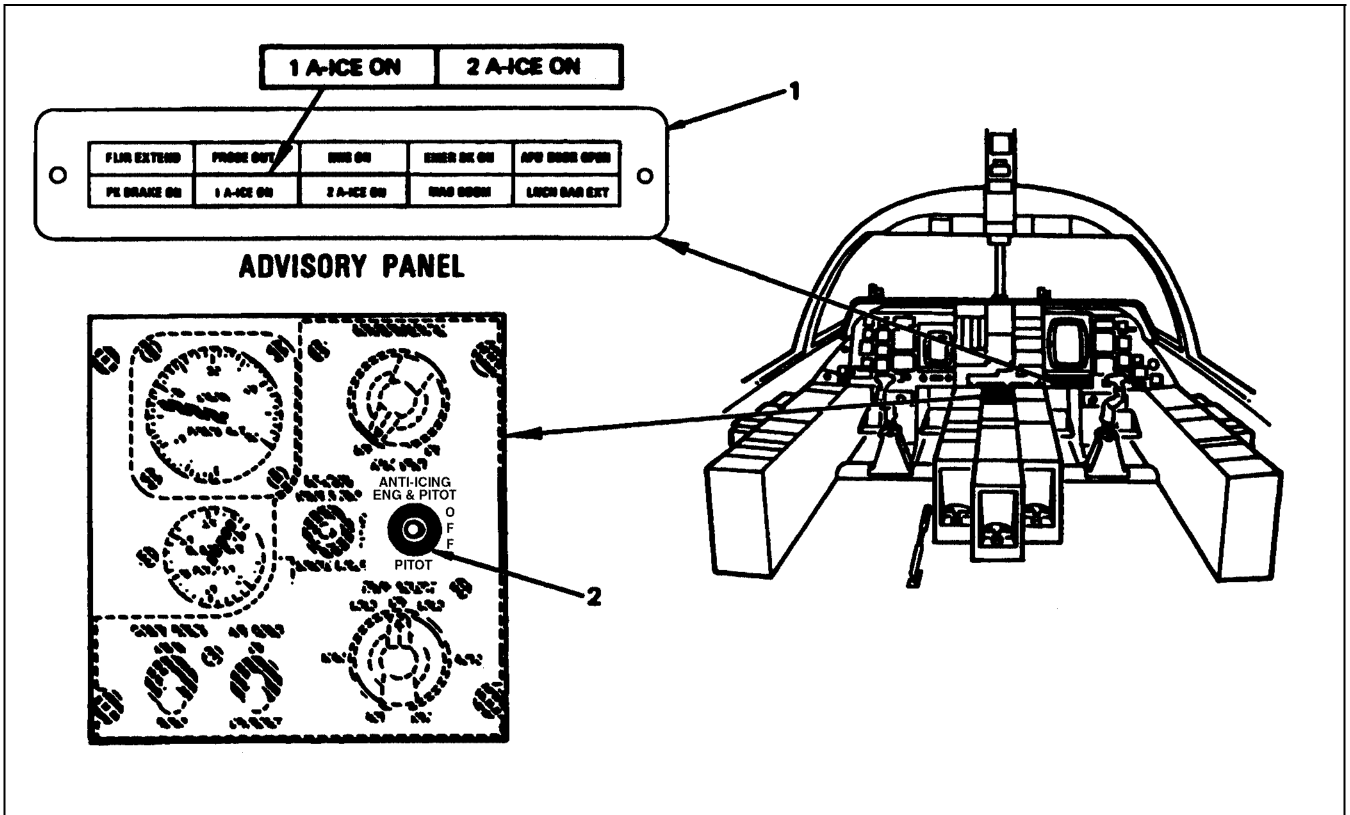


Figure 2-10. TF34-400 Flight Idle Schedule

single-engine conditions. With the fuel idle control switch (see Figure 2-9) in the NORM position, the engine idle schedule is automatically controlled by a weight-on-wheels signal from the CLA. The engines automatically shift to flight-idle schedule on lift-off and to the ground idle schedule on touchdown. An amber fuel idle light on the master caution panel (see Figure 2-3) illuminates when an engine has failed to switch to the flight-idle schedule after lift-off.

The fuel idle control switch can be placed in the FLT IDLE position to manually override the automatic switching logic and to select flight idle on both engines at any time. The IND LT TEST position of the switch simultaneously checks the FUEL IDLE caution lights and associated circuitry and is ground operable only.

2.2.12 Engine Anti-Icing System. The engine anti-icing control is provided by a solenoid operated anti-icing valve actuated by a three-position (ENG & PITOT, OFF, PITOT) ANTI-ICING switch located on the environmental control panel at the center console. When positioned to ENG & PITOT, the switch causes the anti-ice control valves to open allowing 14th-stage bleed air to anti-ice the engine inlet cowling. This also turns on the pitot, AOA, and total temperature probe heaters electrically. In addition, it provides bleed air for anti-icing the ram air inlet located at the base of the vertical stabilizer and enables the deicing system to operate when selected. Failure of electrical power causes the system to remain or revert to the anti-icing on condition. Two green lights, one for each engine, indicating A-ICE ON are located on the copilot/COTAC advisory lights panel. When illuminated, the light indicates the anti-ice valve is open to provide bleed air to anti-ice the engine (see Figure 2-11). Refer to paragraph 2.19.8, Adverse Weather System, for related information concerning the engine anti-icing system.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Advisory Panel: 1 A-ICE ON light 2 A-ICE ON light	 Indicates No. 1 engine anti-ice valve is open. Indicates No. 2 engine anti-ice valve is open.
2	ANTI-ICING switch	ENG & PITOT position opens anti-ice valve, which allows bleed air to anti-ice engine. Also turns on pitot, AOA, and total temperature probe heat electrically.

Figure 2-11. Engine Anti-Icing Controls and Indicators

WARNING

Continuous illumination of either engine anti-ice advisory light on deck regardless of anti-icing switch position creates the potential for injury to ground personnel and possible structural damage to the engine cowling and splitter ring.

2.2.12.1 Engine Anti-Icing System Operation. (See FO-16.) The engine anti-icing system is operated by placing the ANTI-ICING switch to the ENG & PITOT position. The anti-ice control valves are deenergized open, allowing hot 14th-stage bleed air to be distributed to the anti-iced sections of the engines. Illumination of the 1 A-ICE and 2 A-ICE lights provides a positive indication of anti-ice valve open position.

2.2.13 Engine Fire Warning System. Each engine of the aircraft has an independent fire warning system consisting of sensing elements, a control unit, and indicators. The continuous cable-type sensing elements sense an overheat or fire condition by changes in resistance caused by temperature changes. The control unit monitors the sensors for overheat conditions and activates red FIRE warning lights, located on the pilot and copilot/COTAC instrument panels and in the FIRE handles on the cockpit overhead panels, whenever a fire or overheat condition is sensed in either the No. 1 or No. 2 engine. Pressing either FIRE warning light tests the continuity of engine fire warning elements and illuminates both pilot and copilot/COTAC warning lights. Additionally, the FIRE #1 or FIRE #2 lights in the emergency (firewall) shutdown handles will illuminate upon pressing the pilot or copilot/COTAC respective FIRE warning lights.

Note

When the emergency shutdown handle is in the closed (pulled) position, lens construction of the light causes the light to appear to be off under certain conditions.

Two emergency shutdown handles/indicators, one for each engine, are located on the forward overhead panel (see FO-2). The handles are labeled and indicate FIRE #1 and FIRE #2. Pulling either handle mechanically shuts off fuel to the respective engine at the fuel feed shutoff valve and hydraulic fluid to the respective engine-driven hydraulic pump, isolating the engine from combustible fluids (see Figure 2-12).

2.2.13.1 Fire Warning System Operation. The fire warning system is activated when the sensing elements are exposed to an excessive temperature. The fire detector control unit illuminates both FIRE warning lights and the FIRE #1 or #2 handle light for the affected engine. The pilot pulls the illuminated FIRE #1 or FIRE #2 handle, which shuts off the fuel supply and the hydraulic fluid to the engine-driven hydraulic pump, thus isolating the engine from combustible fluids.

2.3 AUXILIARY POWER UNIT

An APU is located on the port side of the aircraft, just aft of the FLIR turret bay. The unit consists of the GTCP 36-201 gas turbine engine with a generator identical to the engine-mounted generators. The generator does not incorporate a constant speed drive assembly and utilizes the APU accessory gearbox oil for cooling.

The purpose of the APU is to provide start air for the main engines, ground air-conditioning, full electrical power for preflight or maintenance, and to provide start air and electrical power for in-flight emergencies.

When operating at rated speed, the APU automatically adjusts for electrical and/or bleed air load applications. If the EGT limit is reached because of loading and/or high ambient air temperature, the inlet guide vanes are modulated to a more closed position. This reduces the EGT by reducing the bleed air load on the APU.

The APU generator can provide up to 45 kVA (maximum continuous) electrical power and can be used to energize any or all buses. In addition, during single main generator operation, the APU generator will assume the electrical load requirements of the inoperative generator. (Refer to paragraph 2.5, Electrical Power Systems.)

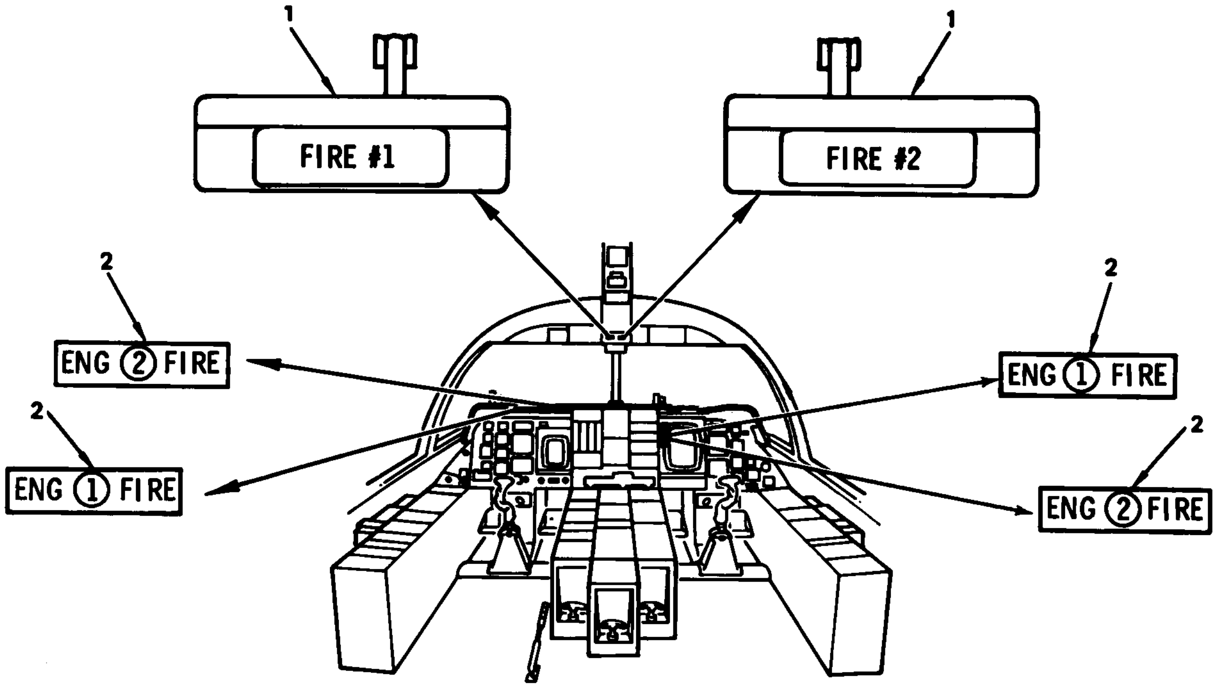
The APU consumes fuel supplied from the right feed tank at approximately 200 pph when fully loaded.

The APU starter is powered by hydraulic pressure stored in an APU accumulator charged by the No. 1 hydraulic system. A manually operated pump or the EHP can be used to charge the APU accumulator as long as No. 1 hydraulic fluid is available. (Refer to paragraph 2.8, Hydraulic Power System.) The pump handle is stowed behind the pilot ejection seat on the center passageway bulkhead. The handpump socket is located under an access cover between the pilot seat and the center console. Accumulator pressure is indicated by an APU accumulator gauge located on the deck to the left of the center console behind the pilot's right foot. The gauge is calibrated from 0 to 5,000 psi in increments of 200 psi. An external indicator for the APU accumulator is located in the right wheelwell for checking nitrogen precharge pressure.

2.3.1 APU Electronic Control Unit. The APU is controlled by an ECU that is located in the left electrical load center. The ECU is powered by a PMG driven by the APU. At approximately 8 percent APU rpm, the PMG voltage is sufficient to begin initial ECU functions during the start sequence.

The ECU monitors and controls all essential APU start and operating parameters. Monitored inputs include PMG voltage, APU rpm, EGT, oil pressure, engine start valve and ECS valve positions, and crew initiated normal and emergency stop commands.

ECU outputs include hour and start counter signals, fuel control commands, ignition enabling, load compressor inlet guide vane signals, APU start valve reset, surge valve dump, GCU enabling, and illumination of APU caution and advisory lights.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Emergency shutdown handle/indicators	FIRE handles mechanically shut off fuel to respective engine and hydraulic fluid to respective engine-driven hydraulic pump. Handle illuminates red during overheat condition on respective engine.
2	ENG 1 and ENG 2 FIRE warning lights	Indicates fire or overheat on indicated engine. Tested by pressing light — causes either FIRE # 1 or FIRE # 2 handle and both pilot and copilot/ COTAC warning lights to illuminate.

Figure 2-12. Engine Fire Controls and Indicators

2.3.2 APU Protection System. High exhaust gas temperatures, low oil pressure, or an overspeed signal (110 percent rpm) from the APU will initiate an ECU shutdown of the APU. Illumination of the APU OV TEMP amber light, located on the master caution panel, indicates the APU has exceeded the exhaust gas overtemperature limits. Illumination of the APU OIL PRESS amber caution light indicates the oil pressure of the APU has dropped below a set value in excess of a 30-second duration. The high exhaust temperature and low oil pressure protective features may be overridden only in flight.

Note

The overspeed protection feature cannot be overridden.

When continued operation of the APU is essential, pressing (illuminating) the switch light labeled AUTO SHUT DN will override the automatic cutoff for high exhaust temperature and low oil pressure and permit continuous operation of the APU. The automatic protection override AUTO SHUT DN switch light is located on the center instrument panel (see Figure 2-13). For normal operation, the light is not illuminated.

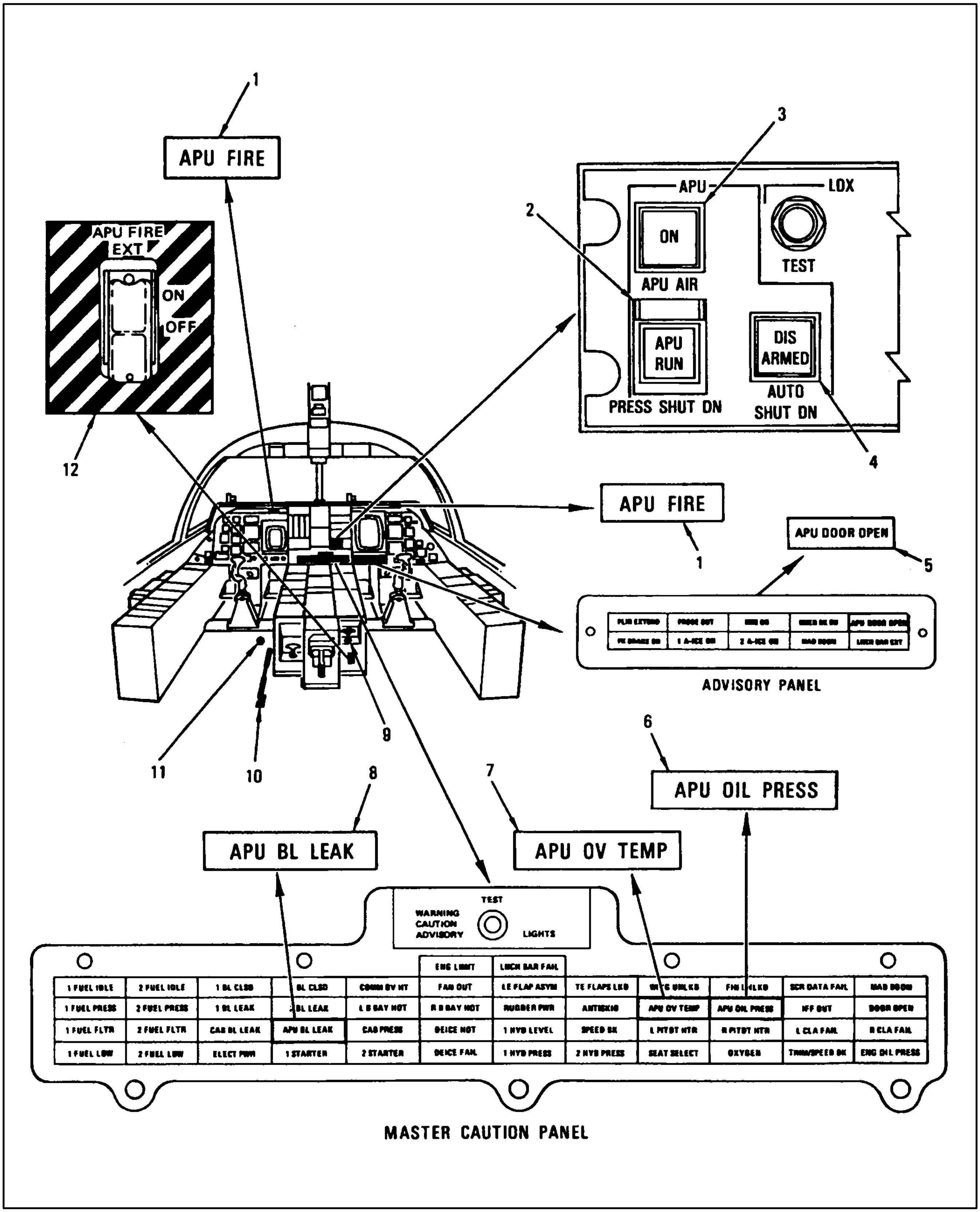


Figure 2-13. APU Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	APU FIRE light	APU FIRE illuminated — indicates APU compartment fire or excessive overheat.
2	PRESS SHUT DN switchlight	APU RUN illuminated — indicates APU ready to accept load. When press while APU is running, initiates a 10 percent overspeed signal in the ECU shutting down the APU (secondary method) by stopping fuel flow at the fuel control.
3	APU AIR switch light	ON illuminated — indicates APU is supplying air for ECS. During engine start indicates APU air is available for engine start operation. Off — indicates APU is not supplying air.
4	AUTO SHUT DN switchlight	DISARMED illuminated — indicates APU automatic protection of over-temperature and low oil pressure deactivated. Disarms automatic shutdown system.
5	APU DOOR OPEN light	Indicates the APU exhaust door is open.
6	APU OIL PRESS light	APU OIL PRESS illuminated — indicates an APU low oil pressure state has existed in excess of 30 seconds.
7	APU OV TEMP light	APU OV TEMP illuminated — indicates APU exceeds EGT over-temperature limits. APU shuts down if in excess of 2 seconds.
8	APU BL LEAK light	APU BL LEAK illuminated — indicates leak in APU bleed air supply. APU should be shut down.
9	APU T-handle	Up — starts APU, opens exhaust door of APU down — stops APU, closes exhaust door of APU (see Figure 2-15).
10	Hydraulic handpump	Used to charge APU accumulator if No. 1 hydraulic system pressure not available.
11	Accumulator pressure gauge	Indicates APU accumulator hydraulic pressure.
12	APU FIRE EXT switch	ON position electrically actuates APU fire extinguisher bottle.

Figure 2-13. APU Controls and Indicators (Sheet 2)

When the switch light is pressed, the DISARMED legend illuminates indicating the overtemperature and low oil pressure protective features of the APU are disarmed. Pressing the switch again will rearm the system.

Note

- When the APU is shut down automatically because of a malfunction, it will be necessary for ground maintenance personnel to check the BIT indicator (located on the ECU) to determine what corrective action will be necessary.
- The disarm function operates only with weight off wheels, APU T-handle full up, and essential bus powered.

2.3.3 APU Fire Detection and Fire Extinguisher System. The APU incorporates a continuous loop fire detection system that illuminates a red APU FIRE warning light on the pilot and copilot/COTAC instrument panels to warn the crew of a possible APU fire or excessive overheat condition in the APU compartment.

CAUTION

Essential dc power is required on the aircraft to test the APU FIRE warning light prior to starting the APU. However, the APU FIRE warning light should be checked immediately after the APU start is initiated, as power becomes available from the PMG.

CAUTION

Failure to secure the emergency lighting system will deplete the essential dc power source (7-volt battery pack) and will render the APU fire extinguisher inoperative when the essential dc bus is not powered.

A high rate discharge fire extinguishing system provides protection in the event of a confirmed APU compartment fire. The fire extinguishing agent is bromotriflouromethane supplied from a pressurized bottle located under the SENSO console. A gauge is provided on the bottle to ensure proper servicing. (Refer to Chapter 3.) The fire extinguisher is electrically activated by a guarded switch on the aft right side of the center console, just below the APU T-handle (see Figure 2-13).

WARNING

The APU fire extinguisher receives power from the essential dc bus or the emergency dc power supply. Activation of the fire extinguisher switch at any time will discharge the system.

Note

- The hydraulically actuated APU exhaust door should be closed to contain the fire and fire extinguishing agent.
- The APU accumulator must have at least 2,200 psi indicated on the cockpit gauge or No. 1 hydraulic system pressure available to close the door.

Pushing the APU T-handle down mechanically and electrically closes the fuel shutoff valves. An emergency APU shutdown switch is located on the forward side of the cabin entry door and provides an alternate means of shutting down the APU by sending a false overspeed signal to the ECU.

Note

The addition of the cabin door switch does not relieve operators of the requirement to remain at the flight station during APU operation in case of emergency.

A blow-in door is located on the APU access panel and can be used by ground personnel to discharge additional extinguishing agent into the APU compartment (see Figure 2-14).

The APU compartment is lined with a fire blanket to provide fire containment. A duct leak between the APU and main cross-ship duct can be detected by the bleed leak detection system. Upon sensing a bleed leak, an APU BL LEAK caution light will illuminate on the master caution panel.

2.3.4 APU Ground Operation. APU accumulator pressure should be 2,800 psi minimum for all start attempts. When accumulator pressure is applied to the starter, the starting sequence is automatic. When the PRESS SHUT DN switch light located on the center instrument panel (see Figure 2-13) illuminates APU RUN, the APU has reached 95 percent rpm and is in the ready-to-load mode. Ready to load means:

1. The pneumatic load for ECS or main engine starts can be applied.
2. An electrical load can be applied to the generator.

When the APU is running, pressing the PRESS SHUT DN switch initiates a 10-percent overspeed signal in the ECU shutting down the APU (secondary method) by stopping fuel flow at the fuel control.

Note

Utilization of the PRESS SHUT DN switch should be followed by pushing the APU T-handle down to mechanically close the tank-mounted fuel shutoff valve and to hydraulically close the APU exhaust door.

The overspeed and LOP BITs will set on the ECU when either the PRESS SHUT DN switch or cabin door switch is used to shut down the APU.

APU bleed air pressure will be indicated on the bleed air duct pressure gauge on the center console ECS panel.

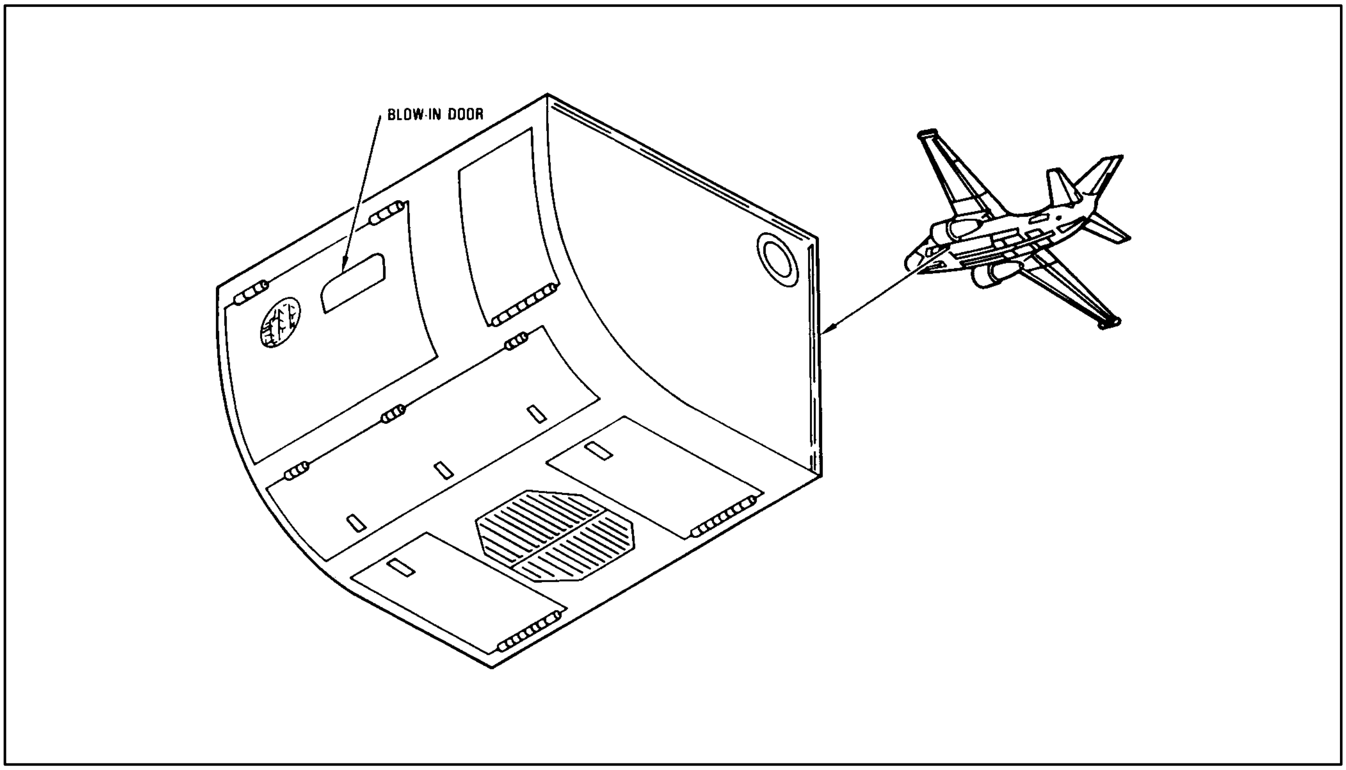


Figure 2-14. APU Access Panel

Note

- During APU only operation, there will be no pressure indicated on the center console gauge unless an air demand has been placed on the APU by either the ECS or engine start systems.

- The APU stops windmilling in approximately 40 seconds, at which time another start can be attempted.

The APU functions in a low airflow mode except during engine start or when the air-conditioning system is operating. When either engine starter switch is placed to the START position or the air-conditioning and APU air is turned on, the APU will automatically shift to the high airflow mode. This shift will be evidenced by a rise in indicated bleed air duct pressure to approximately 40 psi. Shift to high flow should be verified during engine starting to assure adequate bleed air supply.

2.3.5 APU In-Flight Operation. The APU is designed to start and supply primary bus power from sea level to 22,500 feet. There is a reduced probability of start between 15,000 and 22,500 feet. It is rated to supply essential bus power up to 30,000 feet. The APU can supply air for assisted main engine starts up to 22,500 feet. APU door operation is permissible up to 250 KIAS, and flight above 250 KIAS is permissible with the APU operating.

In cold temperatures, APU compartment heat is provided to improve start reliability. At –18 °C (0 °F) engine bleed air is ducted into the APU compartment for heating until the compartment temperature reaches –10 °C (+14 °F).

WARNING

Failure to start the APU airborne within 5 seconds of pulling the handle to the first detent may result in unsuccessful APU start.

2.3.6 APU T-Handle. The APU T-handle, located on the right aft face of the center console, is used for starting and stopping the APU. Pulling the T-handle (from the stowed position) to the first detent accomplishes the following (see Figure 2-15):

1. Opens exhaust door by spring action

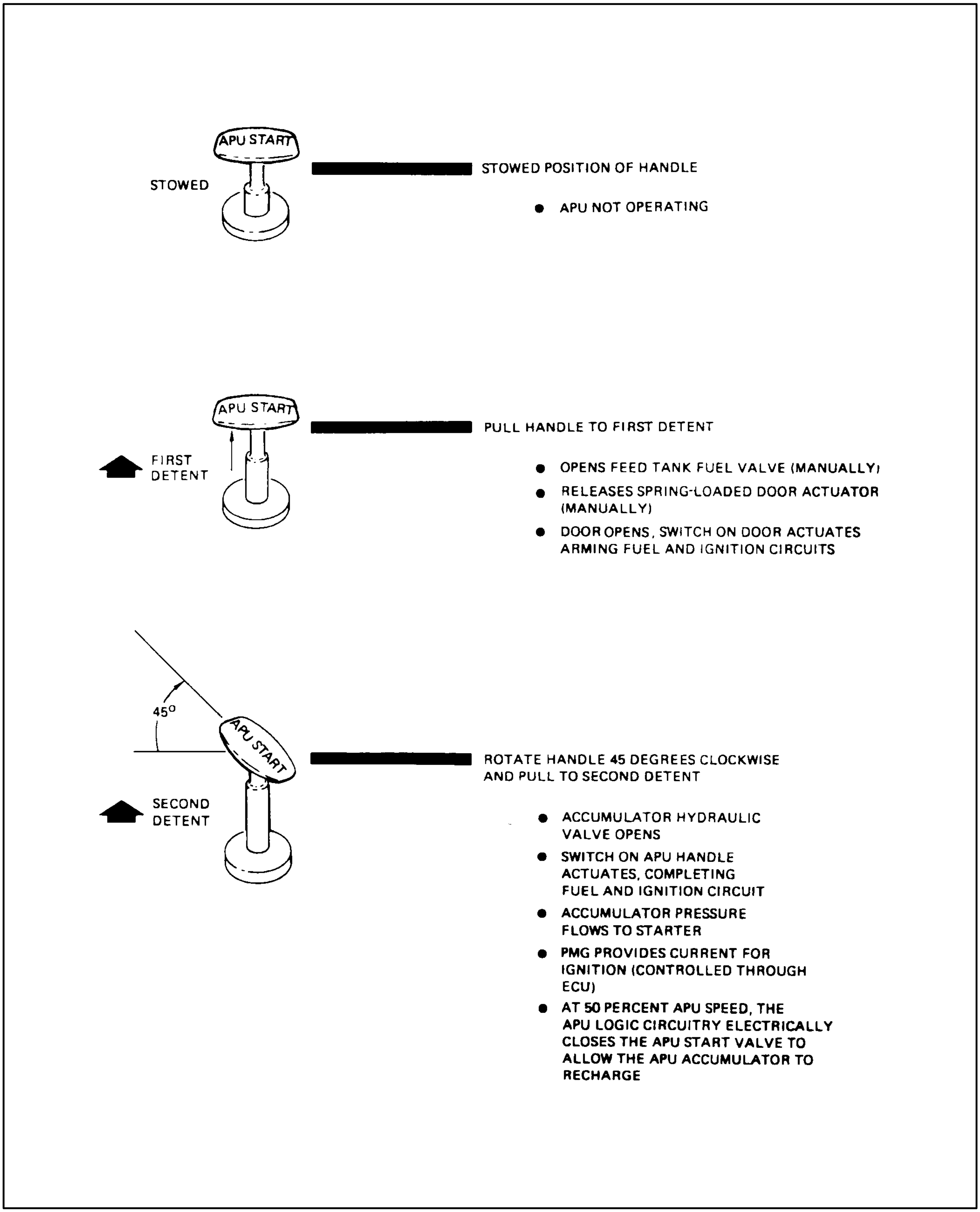


Figure 2-15. APU Operation (Sheet 1 of 2)

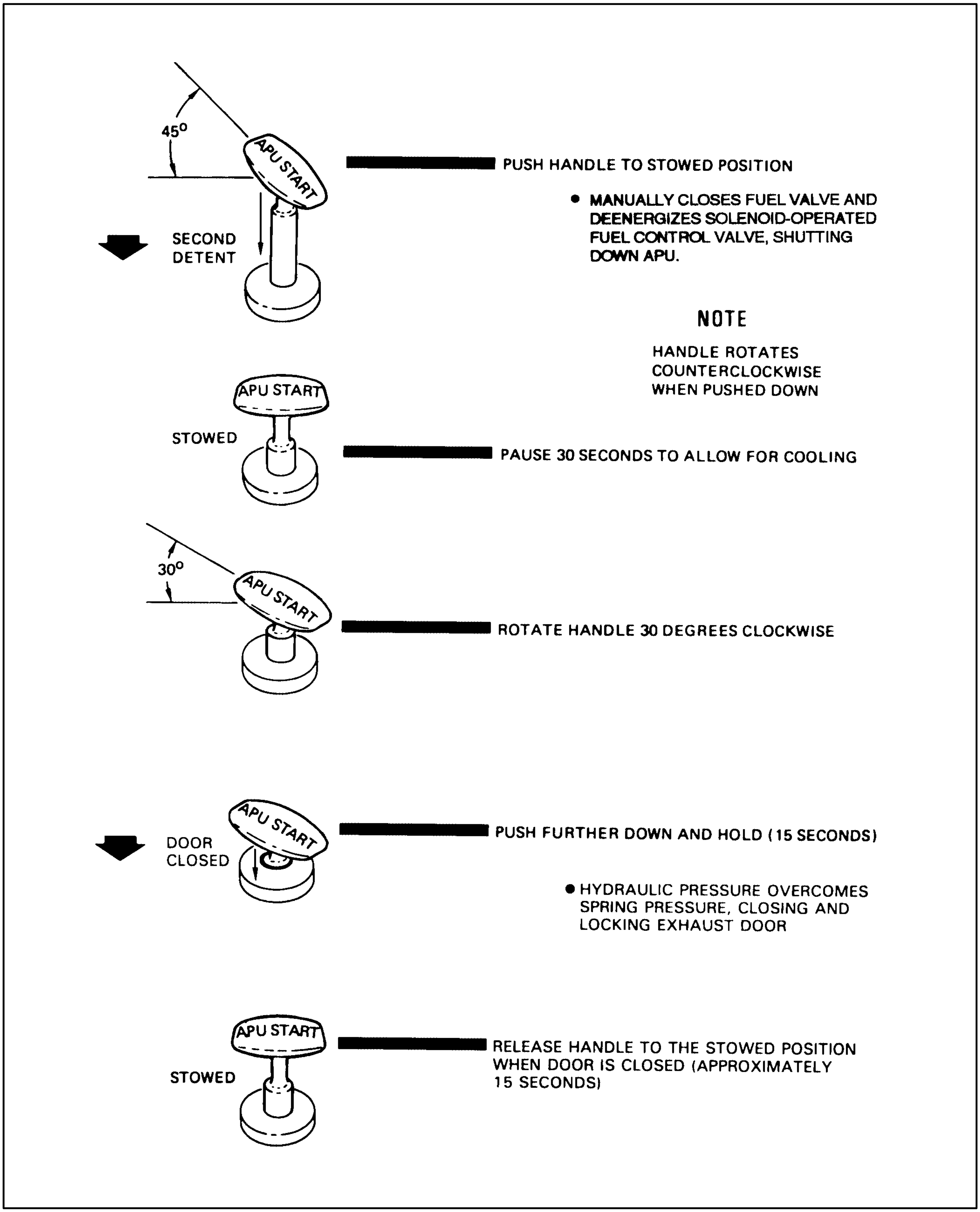


Figure 2-15. APU Operation (Sheet 2)

2. Opens the mechanical fuel valve at the fuel tank

3. Closes the start enable interlock switch in the APU door actuator when the door is fully open.

Note

The APU cannot be started unless the exhaust door is fully open.

Rotating the T-handle clockwise to its stop and pulling to the end of stroke (second detent):

1. Completes the PMG circuit

2. Opens the hydraulic start valve that ports hydraulic fluid from the APU accumulator to the APU start motor.

A false APU OIL PRESS caution light may result if the APU door is left open in flight and enough ram air is available to turn the APU at an rpm sufficient to energize the ECU. An attempt to start the APU under these circumstances will be unsuccessful.

Pushing the handle down:

Note

The handle should be pushed down without restraining its rotation as it passes through the first detent.

1. Pushing the handle to its stop at the floor shuts down the APU. (This is the stowed position of the handle.)

2. Turning the handle clockwise to a stop at 30° and pushing down approximately one-half inch against a spring and holding for a minimum of 15 seconds will close the exhaust door.

Note

- The APU accumulator must have at least 2,200 psi indicated on the cockpit gauge or No. 1 hydraulic system pressure available to close the door.
- If the APU fails to start, the T-handle must be put to the stop position to close the APU start valve and allow the accumulator to recharge.

2.4 FUEL SYSTEM

The fuel system is designed for simplicity of operation and requires minimum fuel management during a normal mission. Fuel is carried in four internal tanks located in the center wing section. For extended missions, fuel may be carried in two external drop tanks. See Figure 2-16 for usable fuel in each tank. The internal and external tanks can be pressure fueled simultaneously on the ground through a single-point fueling adapter. Overwing filler caps are not provided; however, if pressure fueling equipment is not available, the internal tanks may be gravity fueled as an emergency procedure by removing the second capacitance probe from the outboard end of each transfer tank. The external tanks may be gravity refueled through filler caps located on the upper forward section of each tank. In-flight refueling of the internal and external tanks can be accomplished from a tanker aircraft by means of probe-and-drogue type refueling equipment. Fuel can be dumped from the internal tanks through a gravity feed fuel dump system. External tank fuel can be dumped by transferring the fuel to the internal tanks, or the external tanks may be jettisoned. A fuel quantity indicating system measures the fuel supply in the internal and external tanks and displays the total fuel remaining in pounds on a totalizer gauge (see Figure 2-17).

A fuel vent system that is entirely automatic in operation is provided to vent the internal tanks to atmosphere during all fueling and defueling operations and all phases of flight and ground maneuvering. Fuel collected by the vent system is drained back into the transfer tanks to minimize fuel spillage. The external tanks are vented through the tank vent valve. The vent valve opens and depressurizes the tanks when the air pressure valve is closed. The valve also opens if an overpressurization or a negative pressure condition exists in the tank.

	GALLONS (USABLE)	POUNDS (USABLE)		
		JP-4	JP-5	JP-8
INTERNAL FUEL:				
Left Feed Tank	176.5	1,147	1,200	1,182
Right Feed Tank	176.5	1,147	1,200	1,182
Left Transfer Tank	790.0	5,135	5,372	5,293
Right Transfer Tank	790.0	5,135	5,372	5,293
Total Internal Fuel	1,933.0	12,564	13,144	12,950
EXTERNAL FUEL:				
Left Pylon Tank	265.0	1,722	1,802	1,775
Right Pylon Tank	265.0	1,722	1,802	1,775
Total External Fuel	530.0	3,444	3,604	3,550
AIR REFUELING STORE	265.0	1,722	1,802	1,775
AIR REFUELING STORE	**Note** On deck the capacity of the external stores is reduced because of the 7° decline of pylon stores. In-flight refueling will increase the external fuel loads in either external fuel tanks or an air refueling store to the following:			
	300.0	1,950	2,040	2,010

Figure 2-16. Fuel Quantity Data

2.4.1 Internal Fuel System. The four internal tanks are located two on each side of the wing center rib (see FO-12). The center rib separates the four fuel tanks into two symmetrical systems each containing a feed tank and a transfer tank. The transfer tank on the left side of the center rib automatically transfers fuel to the left feed tank, which supplies fuel directly to the No. 1 engine. The transfer tank on the right side of the center rib transfers fuel to the right feed tank, which supplies fuel directly to the No. 2 engine. Four motive-flow-operated ejector pumps are located one in each transfer tank and one in each feed tank. The transfer tank ejector pumps transfer fuel to the respective feed tank. The feed tank pump supplies fuel under pressure to its respective engine-driven boost pump. The motive-flow pressure is supplied by the secondary element of the engine-driven boost pump. Each feed tank ejector boost pump is capable of supplying sufficient fuel pressure to satisfy its respective engine demands at all power settings. The feed tank ejector pumps are located in a reservoir within the feed tank in order to provide fuel boost pressure for negative-g flight.

A low fuel pressure switch is located in the inlet fuel line to each engine-driven boost pump. When the feed tank supply fuel pressure drops below a predetermined value, the switch illuminates a FUEL PRESS caution light on the master caution panel. The caution light identifies which feed ejector boost pump output pressure is low. A mechanically actuated feed tank interconnect valve, located between the two feed tank sump compartments, allows the two feed tanks to be interconnected to provide gravity fuel transfer for crossfeed operation.

2.4.1.1 Internal Fuel System Operation. In normal operation, the internal fuel system functions automatically and requires no fuel management. During engine starts, fuel is fed to the engine by gravity flow until the engine has accelerated to 52 percent N_g at which point motive-flow fuel transfer pressure becomes available.

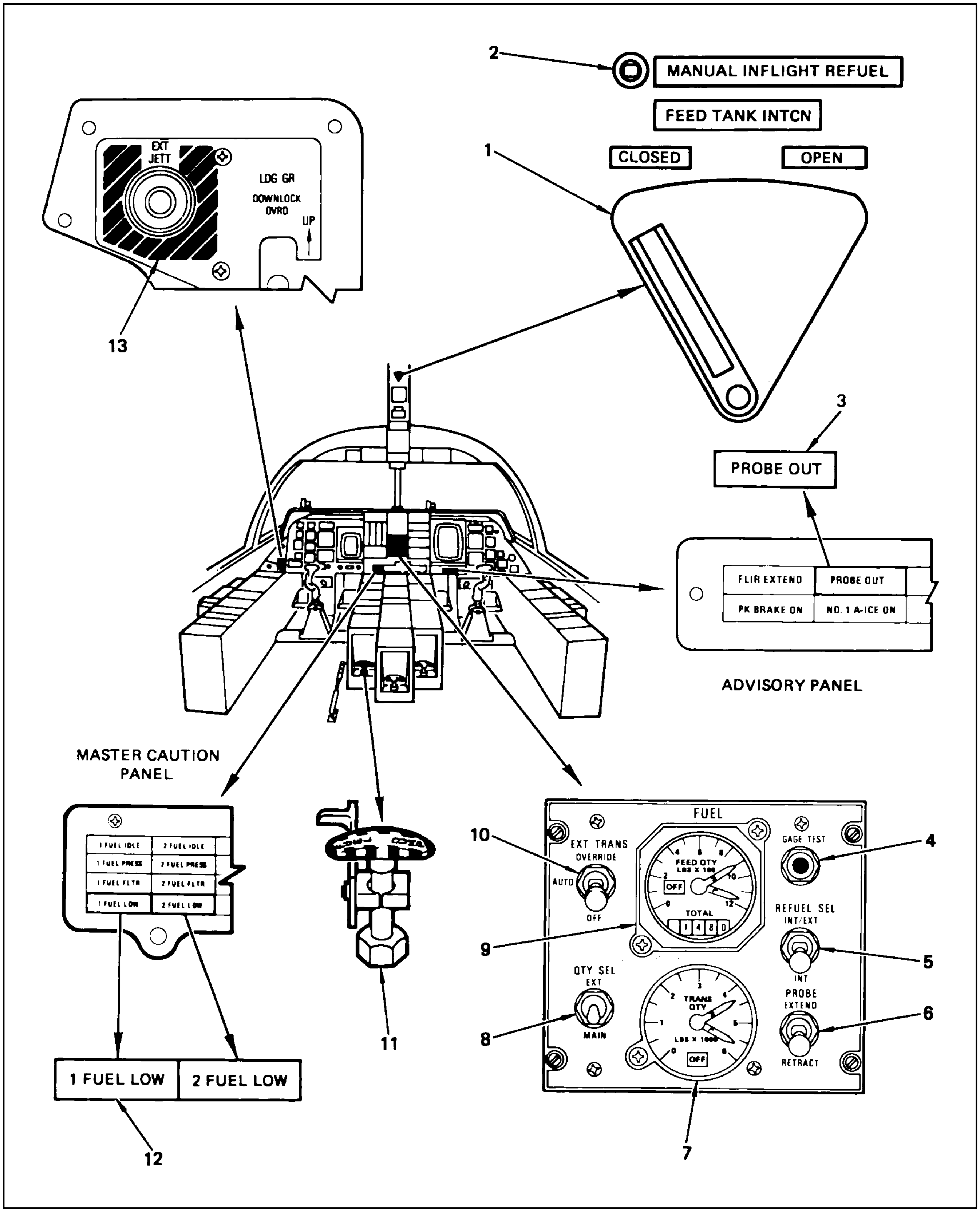


Figure 2-17. Aircraft Fuel System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	FEED TANK INTCN (interconnect) handle	OPEN — allows gravity transfer between feed tanks. CLOSED — prevents fuel transfer between feed tanks.
2	Hand crank (receptacle)	Extends and retracts refueling probe (handle located on bulkhead behind copilot/COTAC).
3	PROBE OUT advisory light	PROBE OUT illuminated — indicates refueling probe is fully extended or is retracting. Extinguished — indicates probe is extending or is fully retracted.
4	GAGE TEST switch	Pressed — illuminates both FUEL LOW lights on master caution panel, individual pointers on fuel gauges move to 1,000-pound marks, and fuel totalizer indicates 1,000 pounds. Released — pointers and totalizer indicate actual fuel quantities.
5	REFUEL SEL switch	INT — allows only internal tanks to be refueled. INT/EXT — permits fueling external tanks simultaneously with internal tanks.
6	PROBE switch	EXTEND — electrically extends probe to refueling position. RETRACT — returns probe to stowed position.
7	TRANS QTY (transfer quantity) gauge	Pointers indicate fuel weight in left and right transfer tanks or left and right external tanks, depending on setting of QTY SEL switch. OFF flag — indicates power is removed.
8	QTY SEL (quantity select) switch	EXT — TRANS QTY gauge displays external tanks' fuel quantity. MAIN — TRANS QTY gauge displays transfer tanks' fuel quantity.
9	FEED QTY (quantity) gauge and fuel totalizer	Pointers indicate fuel weight in left and right feed tanks. Totalizer displays total fuel weight in all tanks. OFF flag — indicates power is removed.
10	EXT TRANS (external transfer) switch	AUTO (landing gear up) — allows pressurized air to enter external tanks enabling fuel transfer. OVERRIDE — (landing gear down and locked) — allows pressurized air to enter external tanks enabling fuel transfer (switch must be held in OVERRIDE). OFF — external tanks are depressurized.
11	FUEL DUMP handle and trigger–lock	Pulled — opens fuel dump valve Pushed — valve closes.
12	FUEL LOW caution light	FUEL LOW illuminated — indicates approximately 400 pounds of usable fuel remaining in respective feed tank.
13	EXT JETT (external jettison) switch	Pressed — jettisons right and left external stores and sonobuoys, provided electrical power is available and weight is off either main landing gear.

Figure 2-17. Aircraft Fuel System Controls and Indicators (Sheet 2)

Note

The respective FUEL PRESS caution light will illuminate during engine start until N_g reaches 52 percent.

With motive-flow fuel pressure available, the transfer tank ejector pump transfers fuel from the transfer tank to the feed tank at a rate greater than engine consumption. Excess fuel transferred into the feed tank spills back into the transfer tanks through high-level interconnects that also serve to vent the tanks. If a transfer tank ejector boost pump becomes inoperative, flapper-type check valves permit transfer tank fuel to flow by gravity into the feed tank. Transfer tank ejector boost pump failure is indicated if the feed tank quantity gauge shows less than full while fuel remains in the transfer tank.

The feed tank ejector boost pumps automatically supply fuel to the respective engine under all conditions of flight and ground operations except for feed tank quantities of less than 600 pounds. With feed tank fuel below this level, nosedown attitudes or deceleration will cause the fuel to slosh forward in the tank and away from the ejector boost pump.

CAUTION

If prolonged nosedown attitudes or deceleration conditions are sustained with feed tank fuel below 600 pounds, the respective FUEL PRESS caution light may illuminate and loss of engine power can occur.

During single-engine operation, fuel can be gravity transferred from the shutdown engine supply tanks to the running engine tanks by temporarily positioning the feed tank interconnect handle to the OPEN position and using wing down/top rudder. The force of gravity will cause fuel to flow from the tanks in the high wing to the tanks in the low wing. If the aircraft is in balanced flight and the interconnect valve is opened, the crossfeed operation will be defeated. Fuel will actually transfer from the side of the operating engine to the failed side until the operating engine transfer tank is empty and the feed tank levels are equal. This is because the operating side feed tank is pressurized by the ejector pump, while the nonoperating side feed tank is not pressurized. During single-engine operation, the feed tank interconnect should not be opened without the use of wing down/top rudder or until the operating side feed tank quantity is equal to or less than that in the nonoperating side feed tank.

2.4.2 Internal Tank Fuel Transfer System. Each internal transfer tank contains a motive-flow ejector boost pump that operates on the same principle as the feed tank ejector pump. The pump operates whenever the engine is operating at or above 52 percent N_g. The pump supplies fuel to its respective feed tank at a rate greater than engine consumption.

2.4.2.1 Internal Tank Fuel Transfer Operation. The internal tank fuel transfer system automatically supplies fuel to the engine feed tanks at flow rates in excess of maximum engine demand during all phases of flight operation. Fuel transfer may be monitored by observing the fuel quantity indicating gauges that show the feed tanks full (1,200 pounds each) until the transfer tanks are empty. With a failed transfer tank ejector boost pump, fuel is available to the feed tanks by gravity flow. Should this condition exist, the feed tank quantity indicating gauge would show a feed tank quantity less than full while fuel remains in the transfer tank.

2.4.3 External Fuel System. Two Aero-1D external droppable fuel tanks can be carried on the wing stores pylons located just inboard of each wing fold. The external tank transfer system is controlled from the cockpit and utilizes engine bleed air to pressurize the tanks for fuel transfer. The tanks will pressurize in 2 to 3 minutes. Fuel is transferred directly to the feed tanks at approximately 150 ppm. Symmetrical transfer system plumbing and cross-ship pressurization lines provide equal tank pressurization levels to assure balanced outflow rates from each external tank. A switch for transferring fuel from the external tanks is located on the fuel control panel in the flight station. The switch is labeled EXT TRANS with placarded positions of AUTO, OVERRIDE, and OFF (see Figure 2-17).

Note

If internal fuel tank levels are low enough before transfer is commenced to receive all external fuel available, the external fuel will be transferred to only one feed tank initially and will spill over into the respective transfer tank. If external fuel is still available when the first feed tank and transfer tank are filled, external transfer will then automatically switch over to the opposite feed tank.

2.4.3.1 External Tank Fuel Transfer Operation. To transfer fuel from the external tanks with landing gear retracted, the EXT TRANS switch must be positioned to AUTO. To transfer fuel with the gear extended, the EXT TRANS switch must be held in the OVERRIDE position. These positions open the air pressure shutoff valve allowing the external tanks to pressurize for fuel transfer. The pressurized fuel opens the fueling/transfer valves, and fuel transfer begins when the fuel level in the transfer tanks drops sufficiently to allow fuel to transfer. Fuel flows into the feed tanks and spills into the transfer tanks and is shut off automatically by the level control/pressure shutoff valves when the transfer tanks are full. This process repeats until the external tanks are empty, at which time the fueling/transfer valves are closed automatically by air pressure. The tanks are depressurized when the EXT TRANS switch is positioned to OFF or the landing gear is extended with the switch in the AUTO position. Fuel transfer from the external tanks is monitored by selecting the QTY SEL switch to EXT and reading the fuel remaining in the left and right external tanks on the transfer quantity gauge. During normal operation, the internal tanks will indicate full until the external tanks are empty.

CAUTION

External fuel transfer should be terminated when 300 to 500 pounds of fuel remain in the drop tanks to avoid pressurizing the transfer tanks and dumping fuel through the tank vent system. When each transfer tank has 1,000 pounds or less remaining, continue the transfer operation until external tanks are empty. If at any time during external fuel transfer the totalizer quantity displays a rapid decrease, discontinue transfer until 1,000 pounds or less remain in the transfer tanks.

Note

Failure to discontinue transfer when either external tank quantity indicates 500 to 300 pounds of fuel remaining may result in venting fuel down to approximately 4,400 pounds remaining.

2.4.4 Fuel Vent System. Venting is provided through open-ended lines originating in the aft outboard end and the forward inboard end of each feed tank. The inboard vent line incorporates a vent float valve to prevent fuel from entering the vent system. During nosedown attitudes, turns, arrested landings, and negative-g operations, the fuel level may rise above the inboard vent line opening. If this occurs, the float mechanism of the valve will rise and block the vent line, isolating the vent system from the fuel supply. The vent lines are routed to prevent fuel slugging and terminate in the vent box. The vent box prevents fuel loss during transient maneuvers that cause fuel entry into the vent system. Fuel that does enter the vent box is drained to the associated transfer tank through the vent box flapper check valve. The vent box is connected to a vent tube that terminates in the aircraft tailcone fairing. The vent tube outlet is protected by the vent flame arrester.

2.4.5 Fuel Dump and Jettison System. Unwanted fuel in the aircraft transfer tanks can be jettisoned using the fuel dump system. This system, when operated, utilizes gravity fuel flow to jettison fuel from the external dump chute located in the tailcone of the aircraft. The manually operated trigger lock FUEL DUMP handle is located on the left aft end of the center console (see Figure 2-17). When pulled, fuel from the left and right transfer tanks is dumped. Once started, fuel dump can be stopped at any time by resetting the FUEL DUMP handle to the closed position. Refer to paragraph 10.5, Fuel Dump.

Note

The feed tanks cannot be dumped.

The dump rate of the transfer tanks (approximately 1,400 ppm maximum) is dependent upon aircraft attitude and the amount of fuel in the transfer tanks. The highest fuel dump rate will be achieved with high nose attitudes such as experienced after takeoff or during climbs. The fuel dump rate is decreased for level flight attitudes and is very low during descending flight or penetration. Lower transfer tank quantities have little effect on dump rate with high nose attitudes, but result in further reduction of the dump rate in level flight and nosedown attitudes. Following a complete dump operation, the amount of fuel remaining in the aircraft is approximately 1,200 pounds in each feed tank plus 300 pounds in each transfer tank. Fuel dump rates and quantities remaining can be monitored on the aircraft fuel gauges.

The above values of dump rate and transfer tank fuel remaining are representative for aircraft attitudes from +2° to +10° noseup. At aircraft attitudes below +2° noseup, the rate of dump flow decreases rapidly and the transfer tank fuel remaining increases.

Fuel in the external pylon-mounted fuel tanks can also be dumped through the external dump chute but must first be transferred to the internal tanks. This procedure is slow (external tanks transfer at 150 ppm each) and is of little use in achieving a rapid decrease in aircraft weight.

2.4.5.1 External Tank Jettison. In an emergency, the external fuel tanks can be jettisoned (if the weight is off either main landing gear) by pushing the EXT JETT button located adjacent to the landing gear handle (see Figure 2-17).

Note

In addition to the external fuel tanks, this action jettisons all sonobuoys except the store in the P2 position.

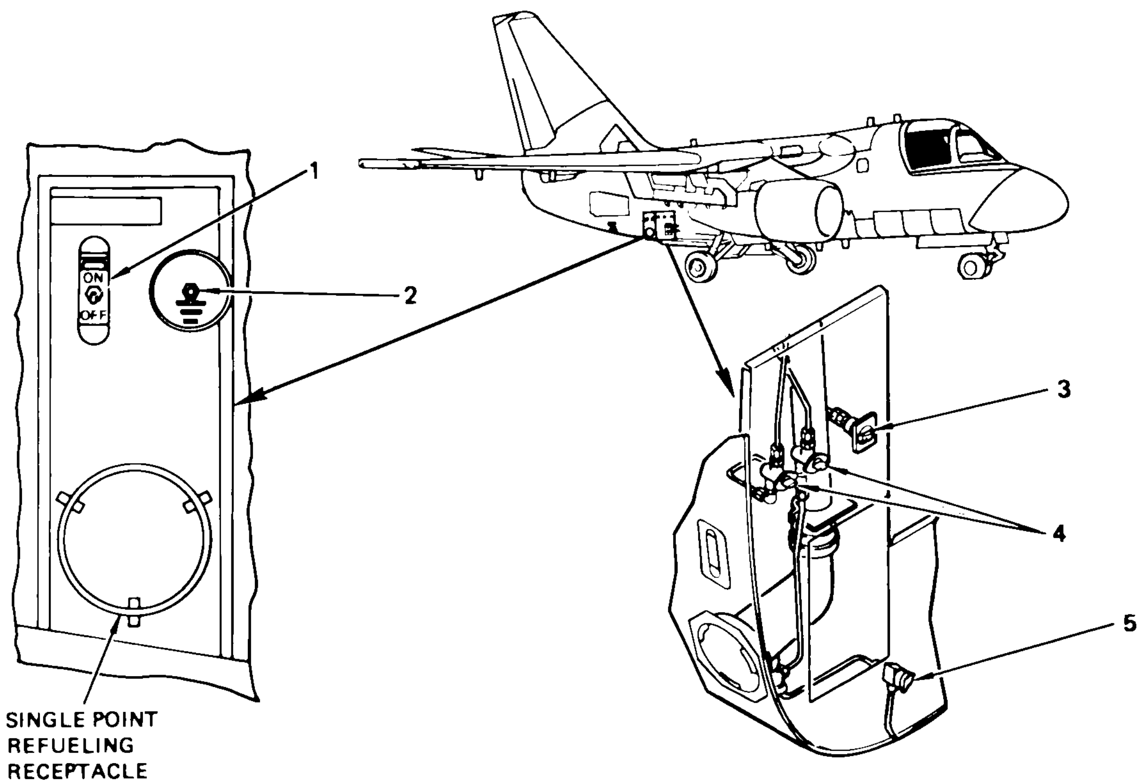
2.4.6 Fuel Quantity Indicating System. The fuel quantity indicating system measures the fuel density and displays the usable fuel weight in each tank and the total amount of fuel on board the aircraft at all times. A fuel feed tank quantity gauge and a transfer tank quantity gauge allow the pilot to monitor fuel burn-off, fuel transfer, in-flight refueling, fuel dumping, and crossfeed operation. The system is powered from the essential ac bus through the FUEL QTY SYS circuit breaker located on the left fixed circuit breaker panel.

The feed tank quantity gauge has dual pointers marked L and R and a fuel totalizer. The gauge pointers indicate the weight of fuel in the left and right feed tanks in hundreds of pounds and are calibrated to be accurate within ±8 percent of the total fuel remaining in each feed tank at the low fuel state. The fuel totalizer displays the total fuel, by weight, contained in all fuel tanks. The gauge incorporates an OFF flag to indicate when power is removed from the system. A fuel quantity gauge selector switch is provided on the fuel control panel (see Figure 2-17) to allow transfer tank fuel quantity or external tank fuel quantity to be selected for readout on the transfer quantity gauge. The switch has two positions, EXT and MAIN. When EXT is selected, the total weight of fuel contained in each external tank is displayed on the transfer quantity gauge. Selecting MAIN allows the total weight of fuel contained in each transfer tank to be read. The transfer tank quantity gauge also incorporates an OFF flag to indicate when power is removed from the system. The fuel control panel incorporates a fuel GAGE TEST switch. When pressed, it illuminates both FUEL LOW lights on the master caution panel and the individual pointers on the feed and transfer tank fuel quantity gauges will indicate 1,000 pounds. The fuel totalizer will read 1,000 pounds also. When the switch is released, the pointers and totalizers will return to their previous settings.

2.4.6.1 Low-Fuel Warning System. A low-fuel level thermistor, located in each feed tank, will illuminate the respective feed tank FUEL LOW caution light on the master caution panel when the feed tank quantity decreases to approximately 400 pounds of usable fuel remaining. This system is completely independent of the fuel quantity indicating system.

2.4.7 Ground Fueling. (See Figure 2-18.)

2.4.7.1 Pressure Fueling. Pressure fueling of the internal tanks is accomplished through a single-point fueling adapter flush-mounted on the right side of the fuselage just aft of the main landing gear wheelwell. No electrical power is required to fuel the internal tanks. Pilot valve controlled pressure shutoff valves are installed in each transfer tank to prevent overfilling. These valves can be checked for proper operation through use of the two fuel level precheck valves, mounted on the right main wheelwell aft bulkhead. Manually rotating a precheck valve to the open (vertical) position ports fuel pressure to the level control valve, simulating a full-tank condition, thus causing the pressure shutoff valve to close. The precheck valves are spring loaded to the closed (horizontal) position to prevent inadvertently leaving the valve in the open position preventing external tank fuel transfer and in-flight or ground refueling. A gauge located on the forward face of the right wheelwell aft bulkhead, indicates the air pressure in the fuel tanks during ground fueling. The gauge consists of a drum marked with a green band, a red band, and a black indicator bar. When the black indicator bar is in the green band, the pressure



INDEX	CONTROL/INDICATOR	FUNCTION
1	External tank fueling switch	ON — opens fueling/transfer valves located in wing pylons, allowing fuel to enter external tanks. OFF — close fueling/transfer valves in each wing pylon.
2	Static ground connection	Connected — grounds aircraft during refueling.
3	Tank pressure indicator gauge	Indicator bar in green band — pressure inside fuel tanks at safe level, OK to fuel aircraft. Indicator bar in red band labeled, STOP FUELING — pressure inside fuel tanks excessive and fueling operation must be stopped.
4	Precheck valves (right and left)	Rotate clockwise to vertical (open) position — initiates test operation of level control/pressure shutoff valves in respective transfer tanks. The valves are spring-loaded to the horizontal (closed) position.
5	Manual drain valve	Allows fuel to be drained from fuel manifold after fueling operations.

Figure 2-18. Ground Refueling Controls

in the fuel tanks is at a safe level for fueling. If the indicator bar is in the red band, the fueling operation must be terminated immediately. The external tanks also can be pressure fueled through the single-point fueling adapter; however, 28-vdc power is required to fuel the external tanks. The 28-vdc power is used to operate the external tank fueling/transfer valve located in each wing pylon. This valve controls the flow of fuel in and out of its respective external tank and allows the external tanks to be filled when the external tank fueling switch, located adjacent to the single-point fueling adapter, is in the ON position. (Refer to Chapter 3, Aircraft Servicing.)

2.4.7.2 Hot Pit Refueling.

Refer to Normal Procedures, Part III.

2.4.8 In-Flight Refueling

Note

Refer to Chapter 4, Aircraft Operating Limitations, for in-flight refueling limits.

In-flight refueling allows the internal and external tanks to be filled from a tanker aircraft by means of probe-and-drogue type refueling equipment. A selector switch labeled REFUEL SEL with placarded positions of INT and INT/EXT is provided to permit refueling of the internal tanks only or the internal and external tanks simultaneously. The in-flight refueling probe is mounted on the top centerline of the fuselage as shown in Figure 1-1. The probe is extended and retracted electrically by actuation of the PROBE switch on the fuel control panel. The probe requires approximately 70 seconds for extension or retraction. For manual extension or retraction, a handcrank, stored on the bulkhead outboard of the copilot/COTAC seat, may be inserted into the manual operation receptacle, located on the upper centerline of the cockpit between the pilot and copilot/COTAC seats.

WARNING

Failure to pull the IFR probe actuator circuit breaker prior to manual handcrank operation may result in injury if the probe motor actuates with the handcrank in the manual operation receptacle.

WARNING

If probe compartment overboard drain becomes clogged, the sealed probe compartment can fill with fuel. If this condition occurs, any additional fuel added to the compartment will overflow through the handcrank linkage hole into the eyebrow panel. This condition can expose aircrew to hazardous material and enhance the chance of a cockpit fire.

When the probe is retracted, the nozzle is covered by a door to reduce aerodynamic drag and to prevent icing of the probe nozzle. The door is opened by the probe through mechanical linkage when extended and closed by the same linkage when the probe is retracted. A PROBE OUT light, located on the advisory panel, illuminates when the probe is fully extended and extinguishes when the probe is fully retracted. The probe compartment is sealed and an overboard drain is provided to preclude fuel, fuel vapor, or water leakage into the cabin. An in-flight refueling probe red floodlight, located on the forward fuselage, is used to illuminate the probe nozzle during night in-flight refueling. The floodlight is turned on automatically when the probe is extended provided the master exterior light switch, located on the throttle, is on. The floodlight is turned off when the probe is returned to the fully retracted position. The light receives power through the IFR PROBE FLDT circuit breaker located on the primary dc bus.

2.4.8.1 In-Flight Refueling Operation.

To refuel the aircraft in flight, extend the probe by positioning the PROBE switch to EXTEND. The PROBE OUT light will illuminate when the probe is extended fully. Position the REFUEL SEL switch to INT or INT/EXT. If only the internal tanks are to be refueled, position the switch to INT. If the internal and external tanks are to be refueled, position the switch to INT/EXT. Float switches, located in the internal and external tanks, automatically shut off the fuel when the tanks are full.

Note

- To prevent fuel vapors from entering the cabin during in-flight refueling, the auxiliary vent/ram air valve is closed automatically when the refueling probe is extended.

- With the IFR probe extended, fuel transfer from external tanks is prevented if the REFUEL SEL switch is in the INT-EXT position.

Manual probe extension and retraction can be accomplished by inserting the refueling probe handcrank into the manual operation receptacle and turning counterclockwise for extension and clockwise for retraction. When manual probe extension or retraction is utilized, the PROBE switch must be positioned with the direction of probe travel to provide correct PROBE OUT light logic.

2.4.8.2 Air Refueling Store Operations. Aircraft with AFC-220 incorporated can operate D-704, 31-300, or 31-301 (NAVAIR designation A/A42R-1) stores from wing station W5. Aircraft modification consists of an external refueling store; an ARS store control panel; two aircraft-mounted, electric, motor-driven transfer pumps; a second bleed air selector valve; five additional circuit breakers; one safety disable switch; green anticollision lights; port wing tanker light, and four cockpit mirrors.

The ARS system receives power through the left primary ac and dc buses.

A red tanker roll light is mounted under the port wingtip on the ESM pod. This light illuminates the underside of the left wing for receiver reference. It is controlled by the FLOODS/TANKER light switch on the COTAC eyebrow panel.

Four mirrors are located at the flight stations in the cockpit. At the pilot station they are at the 9 and 11 o'clock position. The copilot/COTAC mirrors are located at the 1 and 3 o'clock positions. The mirrors can be used to observe receiver position prior to commencing tanker operations.

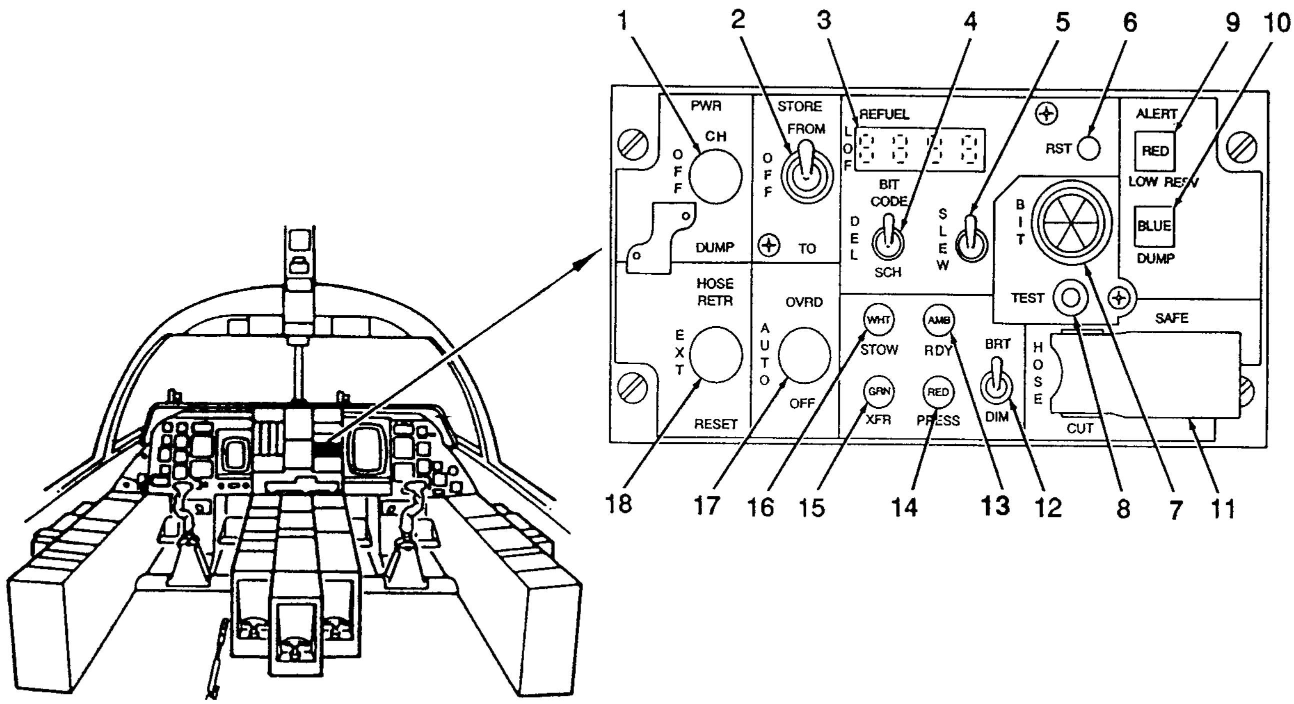
2.4.8.2.1 31-301 (A/A42R-1) Operation. The ARS control panel controls the functions of the external store, electrically driven transfer pumps, fuel transfer to and from the external store, and provides cockpit indications of the external store status (see Figure 2-19). The ARS control panel is electrically connected and located in place of the LF ADF control panel on the center instrument panel.

ARS fuel management is controlled through the ARS control panel and aircraft fuel system control panel. The replenishment system is powered by the left primary ac and dc buses. Two electric, motor-driven, transfer pumps, one located in each transfer tank, replenish the ARS. Output from both pumps (220 gpm total) is routed to the left-hand fuel transfer line through a connecting fuel manifold where it then passes through the pylon and into the ARS. Offload rate is 200 gpm. Transfer rate to the ARS (220 gpm) is sufficient to maintain the ARS fuel level during all refueling operations. A pressure operated fuel shutoff valve in the transfer line isolates the ARS transfer fuel system from the aircraft fuel system whenever either or both transfer pumps are operating.

Power to the transfer pumps is controlled by the ARS PWR and STORE switches on the ARS control panel. When the PWR switch is placed in the ON position and the STORE switch is placed to TO, both pumps start and automatic ARS replenishment occurs. When the ARS is full, the ARS high-level float switch will target, causing the left external fuel shutoff valve to close, isolating the ARS from transfer pump pressure. The transfer pumps will continue to run, with the pressure deadheading against the left external fuel shutoff valve, until the PWR switch is placed to OFF, the STORE switch is placed to OFF or FROM, the high-level float switch detargets, or the transfer tank fuel level drops below approximately 250 pounds.

When a transfer tank reaches approximately 500 pounds of fuel remaining, the transfer tank fuel level will be below the pump's bottom inlet and a pump low-pressure signal will turn off the respective transfer pump. The turnoff signal has a 5 second time delay to prevent a momentary slosh from shutting off the pumps. In the event a pump (or pumps) should shut down prematurely, cycling the STORE switch from TO to OFF and back to TO will restart the transfer pump. Fuel within the left and right feed tanks is not available for transfer into the ARS. This provides the capability to transfer all but 3,400 pounds of fuel to the receiver aircraft.

The ARS can be replenished while simultaneously transferring fuel from an Aero-1D drop tank (on W6) into the feed tank. A second bleed air selector valve, installed below the existing valve in the ECS compartment, provides the capability to pressurize the Aero-1D without pressurizing the ARS. Placing the PWR switch to ON, the STORE switch to the TO position, and the EXT TRANS switch on the fuel system control panel



INDEX	CONTROL/INDICATOR	FUNCTION
1	PWR switch	ON — provides electrical power to the store and unfeathers ram air turbine blades to provide pressure to the hydraulic system. Energizes a control relay, allowing the ARS replenishment system pumps to be turned on via the switch. OFF — removes electrical power and feathers ram air turbine (unless drogue and hose are extended). DUMP — illuminates dump light, feathers ram air turbine, and opens dump valve on bottom of store.
2	STORE switch	FROM — opens left bleed air selector valve to transfer fuel from the store to the internal wing tanks (EXT TRANS switch in AUTO or OVERRIDE). OFF — closes left bleed air selector valve. TO — opens left external fuel shutoff valve and turns on transfer tank ARS replenishment pumps (PWR switch in ON). Closes left bleed air selector valve.

Figure 2-19. 31-301 (A/A42R-1) ARS Control Panel (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
3	REFUEL display	A four-digit display indicating: malfunction BIT codes, pounds of fuel delivered, and pounds of fuel scheduled for delivery. Parameter displayed is controlled by the data display switch. With the data display switch in the DEL position, an “E” will appear as the last digit on the display when a BIT error is detected.
4	DATA DISPLAY	BIT CODE — a two- or three-digit switch number defining a malfunction is shown on the display. Malfunction codes are stored in the controller non-volatile memory until manually cleared (controller is mounted in the ARS tail section). DEL — display indicates pounds of fuel being transferred (in 25-pound increments). SCH — display indicates pounds of fuel to be delivered (this is the quantity at which automatic fuel transfer is terminated). On initial store power-up, 2,500 pounds will automatically be scheduled.
5	SLEW switch	Increases or decreases pounds scheduled (data display switch in SCH). Step increments and step rates vary as follows: 0 to $\pm$100 lb: 25-lb steps, 75 lb/sec $\pm$100 to $\pm$1,000 lb.: 100-lb steps, 300 lb/sec Greater than $\pm$1,000 lb: 200-lb steps, 600 lb/sec.
6	RST switch	Resets pounds delivered to zero and pounds scheduled to 2,500 (does not clear BIT malfunction codes).
7	BIT flag	Indicates a failure in the control indicator panel by changing from black to black and white. With electrical power available and the PWR switch in the ON position, depressing the indicator for 20 seconds will reset the BIT flag and clear any malfunction codes stored in the controller memory.
8	TEST switch	A momentary pushbutton used to start or stop the manual BIT test. With electrical power available, an electrical system test will be performed. With electrical and hydraulic power available and fuel in the store, a complete electrical, hydraulic, and fuel pump systems test will be performed (hose and drogue stowed).
9	LOW RESV	A red warning indicator that illuminates when hydraulic reservoir level drops below half full.
10	DUMP indicator	A blue indicator that illuminates when PWR switch is placed in DUMP.

Figure 2-19. 31-301 (A/A42R-1) ARS Control Panel (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
11	Hose cut/safe	CUT — severs hose, causing it to jettison, and crimps both severed hose ends to prevent fuel spillage (must be held in CUT position until hose severs).
12	Light switch	BRT — provides brightest intensity level of lights mounted on aft end of store for daytime operation. DIM — lowers intensity of lights on aft end of store for night operation.
13	RDY indicator	An amber indicator that illuminates when the hose is at full trail and ready for engagement.
14	PRESS indicator	A red indicator that illuminates when hydraulic pressure drops below 1,600 to 1,700 psi. Extinguishes when hydraulic pressure exceeds 2,000 psi.
15	XFR indicator	A green indicator that illuminates when a minimum of 20 gpm of fuel is being transferred to a receiver.
16	STOW indicator	A white indicator that illuminates when the hose and drogue are stowed.

Figure 2-19. 31-301 (A/A42R-1) ARS Control Panel (Sheet 3)

to AUTO, will pressurize the Aero-1D and actuate the transfer tank electric pumps. Fuel will transfer normally from the Aero-1D to the aircraft feed tanks and from the transfer tanks to the ARS.

When the STORE switch is in the OFF position , no fuel will transfer from the ARS to the aircraft or from the aircraft to the ARS. Placing the STORE switch to the FROM position allows the ARS to function as an Aero-1D drop tank. Fuel transfer from the ARS into the aircraft is accomplished by selecting FROM on the ARS control panel and AUTO on the EXT TRANS switch. When FROM is selected, fuel will transfer from the store and/or Aero-1D regardless of the position of the ARS PWR switch. ARS fuel transfers into the aircraft at 145 ppm, requiring up to 12 minutes to complete transfer of a full ARS.

Note

External fuel transfer can result in asymmetric transfer tank fuel loads up to 3,800 pounds, requiring feed tank interconnect transfer operations.

Failure of the bleed air selector valve for the Aero-1D (W6) will be identified by an uncommanded fuel transfer from the Aero-1D into the aircraft. If the bleed air selector valve for the ARS (W5) fails, the ARS will pressurize and replenishment will be at a reduced rate, depending on the configuration of the ARS control panel. Placing the STORE switch to the TO position will allow for continued air refueling operations; however, the rate of replenishment to the ARS will be reduced to 175 gpm. A single give of up to 8,400 pounds can be accomplished at the reduced replenishment rate without depleting the ARS.

2.4.9 Defueling System. The internal fuel tanks may be defueled through the pressure fueling system by applying suction to the single-point fueling adapter. When suction is applied, the fuel shutoff valves are opened and fuel is drawn from the feed tanks. As the fuel level in the feed tanks lowers, it is replenished by fuel flowing from the transfer tanks through the flapper check valves, thus defueling the feed and transfer tanks simultaneously. Electrical power is not required for the defueling operation. The aircraft can be suction defueled to the 110-gallon level providing the feed tank interconnect valve is open before and during the defueling operation. Residual fuel is drained through the tank fuel (water) drains located on the bottom of the wing. Fuel contained in the external tanks may be transferred into the internal fuel tanks for defueling. A ground air adapter, located in the right wheelwell, is provided to permit pressurization of the external tanks using a ground pressure source. The fuel under pressure opens the fuel/transfer valve, in the wing pylons, and transfers fuel into the feed tanks. When the external tanks are empty, air pressure closes the fueling/transfer valves. The tanks also contain a manual drain valve, located in the bottom of the tank, to drain the fuel when a source of pressurized air is not available.

2.5 ELECTRICAL POWER SYSTEMS

Electrical power is provided by two engine-driven ac generators. DC is produced from the ac sources by transformer rectifiers. An APU is provided for ground operation and emergency use. In addition, ac and dc receptacles are provided for connecting an external source of ac or dc power. (See FO-13.)

2.5.1 Alternating Current System. AC is supplied by two 75-kVA, engine-driven ac generators, one on each engine. The 115/200-volt, 400-Hz, three-phase current produced by these generators is distributed through two load centers located on either side of the aircraft aft of the TACCO and SENSO stations. In the event of failure of one generating system, the remaining system will assume all loads automatically. Each system is capable of supplying the entire requirements of the aircraft.

The generators are integrated with a constant speed drive that provides a constant speed output from a variable speed input, thus supplying a constant frequency source of ac power. The constant speed drive contains a thermally actuated disconnect to protect the unit in case of a cooling system malfunction and an input shaft shear section to protect the engine accessory gearbox in case of an internal failure of the unit.

Generator control units, located in the left and right load centers, control the functioning of the respective generator, and each performs the following specific functions:

1. Provides automatic bus transfer in the event of a generator malfunction.

2. Provides circuit protection by disconnecting the generator if any of the following malfunctions are sensed:

    a. Underspeed

    b. Overvoltage

    c. Undervoltage

    d. Overcurrent

    e. Overfrequency

    f. Underfrequency

    g. Differential current (feeder fault).

2.5.1.1 AC Ground Power Supply. External 115-volt, 400-Hz ground power can be connected to the aircraft ac system through the external power receptacle in the right side of the fuselage just aft of the crew door. The receptacle assembly includes a push-to-test, green indicating light that is illuminated when external power is being used. An external power monitor controls the external ac power input for correct voltage, frequency, and phase sequencing before permitting external power to be applied to the buses. The external power monitor is controlled by the external power switch located on the electrical control panel (see Figure 2-20).

2.5.1.2 Auxiliary Power Unit AC Power Supply. The APU generator is a 115-volt, 400-Hz, three-phase generator located in the lower left fuselage. This generator is available to provide up to 45-kVA ac power to the primary and essential ac buses when no other ac power source is available. An APU generator control unit, identical in function to those in the main engine generating systems, is located in the left load center. This GCU controls the functioning of the APU generator and provides logic to monitor its operation. The GCU has two BIT indicators, one identified as GCU that monitors the unit itself and another identified as IDG. The IDG indicator provides the status of APU generator operation in the APU generating system since there is no constant speed drive integrated into the APU generator drive system. When the APU is running and the APU GEN switch is ON, the APU generator will assume the load of the essential ac bus if the engine-driven generators are inoperative and no external ac power is available. Additionally, when the left or right bus switch is on, the APU generator will power the aircraft primary ac buses.

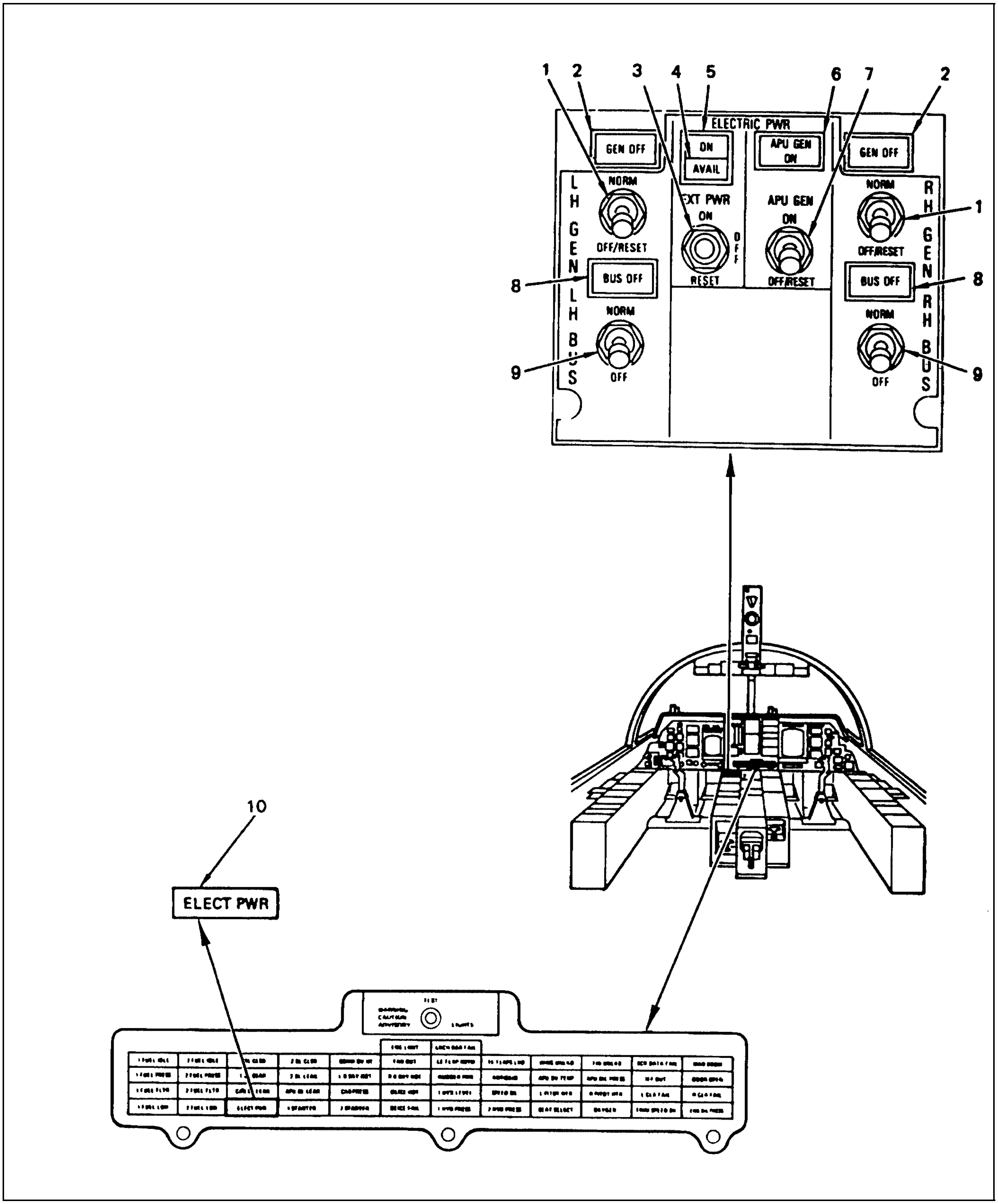


Figure 2-20. Electrical Power Controls and Indicators (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	LH GEN and RH GEN switches	NORM — provides power to generator control unit. OFF/RESET — deactivates ac generator. Resets all fault monitoring circuits in respective generator control unit.
2	LH and RH GEN OFF	Illuminated — indicates: • GEN switch is in OFF/RESET position • Generator has failed • Engine rpm below generator cut-in speed, 53% N_g • Primary ac bus is not being powered by its respective generator Extinguished — indicates generator capable of supplying ac power.
3	EXT PWR switch	RESET — activates external power monitor. ON — connects external ac power to the primary and essential ac buses when both engine driven generators are not on the line. OFF — disconnects external ac power from primary and essential ac buses and illuminates the EXT PWR AVAIL light if the external power monitor has been activated.
4	EXT PWR AVAIL light	Illuminated — indicates external ac power of proper phase, voltage, and frequency is connected to aircraft. Extinguished — indicates: • No power available at ac external power receptacle. • External ac power is not of proper voltage, frequency, or phase. • EXT PWR switch has not been positioned to RESET to activate external power monitor.
5	EXT PWR ON light	Illuminated — indicates one or both primary ac buses or the essential ac bus is powered by external power. Extinguished — indicates ac systems not powered by external power.
6	APU GEN ON light	Illuminated — indicates APU generator powering or available to power any or all buses. Extinguished — indicates APU generator not available for use.

Figure 2-20. Electrical Power Controls and Indicators (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
7	APU GEN switch	ON — places APU generator in standby position to automatically power any or all buses if other ac sources fail and illuminates APU GEN ON light. OFF/RESET — deactivates APU generator. Resets all fault monitoring circuits in respective generator control unit.
8	LH and RH BUS OFF lights	Illuminated — bus switch has been turned off. Extinguished — bus switch is in ON position and bus is powered.
9	LH BUS and RH BUS switches	NORM — permits primary ac bus connection and automatic bus transfer. OFF — disconnects respective primary ac bus, prevents automatic transfer for that bus.
10	ELECT PWR caution light	Illuminated — indicates generator or primary ac bus failure. Extinguished — indicates all primary ac systems normal.

Figure 2-20. Electrical Power Controls and Indicators (Sheet 3)

2.5.2 Direct Current System. DC is produced, from the ac sources, by two 100-ampere, 28-volt transformer-rectifiers and one 50-ampere, 28-volt transformer-rectifier. The 100-ampere transformer-rectifiers convert aircraft ac power or external ac power to 28-vdc for distribution to the left and right primary dc buses. During normal operation, the 50-ampere transformer-rectifier converts essential ac bus power from the left engine-driven generator to 28-vdc power for distribution to the essential dc bus. The 50-ampere transformer-rectifier also can convert external ac power or emergency ac generator power to 28 vdc for distribution to the essential dc bus. In aircraft incorporating AFC-279, the 100 ampere transformer-rectifiers are replaced by 200-ampere transformer-rectifiers and the 50-ampere transformer-rectifier is replaced by a 100-ampere transformer rectifier. However, the functions discussed in this section remain the same as the components they replaced, respectively.

2.5.2.1 DC Ground Power Supply. The external dc power receptacle, located on the right wheelwell overhead, allows a 28-vdc external power source to be connected to the aircraft. When connected and energized, the external power source will supply the essential dc start bus for single-point refueling of the external tanks or for an engine start; however, engine instruments are not available to monitor the start sequence.

2.5.2.2 Emergency DC Power Supply. Emergency dc power is supplied by a small battery located in the cockpit and is used to provide lighting during an emergency. Refer to paragraph 2.6, Lighting System. This battery also supplies power to the APU fire extinguisher system when there is no other power source available on the aircraft.

2.5.3 Power Distribution Control. Power distribution is controlled by contactors, labeled K-1 through K-6 and K-66. These contactors are powered by 28-vdc power provided by the PMG sections of the integrated drive generators and APU generator; power is available anytime these generators are rotating. K-66 is controlled by the external power monitor, to complete the connecting of external ac power to the aircraft electrical system. K-1 through K-6 are controlled by the generator control units and circuitry logic. These contactors direct power distribution, connecting available power sources to the primary ac and dc buses, based on circuitry logic priorities. It is these contactors that perform automatic bus transfer when necessary, and determine the source of power for each bus under various configurations of power source availability (see Figure 2-21).

LH GENERATOR	APU GENERATOR	RH GENERATOR
ON LH Primary Bus Essential Bus	OFF or ON	ON RH Primary Bus
OFF	ON LH Primary Bus Essential Bus	ON RH Primary Bus
ON LH Primary Bus Essential Bus	ON RH Primary Bus	OFF
ON LH Primary Bus RH Primary Bus Essential Bus	OFF	OFF
OFF	OFF	ON LH Primary Bus RH Primary Bus Essential Bus
OFF	ON LH Primary Bus RH Primary Bus Essential Bus	OFF

Figure 2-21. Aircraft Power — Bus Distribution

2.5.4 AC Power Distribution. AC power is distributed through the following buses:

1. Left and right primary ac bus
2. Primary instrument/synchronization transformer bus
3. Essential ac bus
4. Essential instrument/synchronization transformer bus.

The primary ac buses and the primary instrument/ synchronization transformer bus distribute ac power to equipment not absolutely essential for flight. The essential ac bus and the essential instrument/ synchronization transformer bus distribute ac power to equipment essential for flight.

2.5.4.1 Left and Right Primary AC Bus. The left and right primary ac buses normally receive power from their respective generators. If the respective generator fails, power will be supplied as described in Figure 2-21. AC power is distributed from the primary ac buses to the transformer-rectifiers to provide dc power to the electrical subsystems.

2.5.4.2 Primary Instrument/Synchronization Transformer Bus. The primary instrument/synchronization transformer bus receives ac power from the left primary or essential ac buses through the instrument transformer, which reduces single-phase, 115-vac power to 26-vac power.

Note

If power to the essential ac bus is lost and will not transfer to the right-hand generator, placing the left-hand generator switch to OFF/RESET will force the bus to transfer, unless the GCU is malfunctioning.

2.5.4.3 Essential AC Bus. The essential ac bus normally receives power from the left generator. If the left generator fails, the essential ac bus receives power from the right generator through the automatically controlled bus tie relays. The essential ac bus can receive power from an external ground ac power source during ground servicing or engine starting. If neither generator is operating and external ac power is not available, the essential ac bus can receive power from the APU generator. The essential ac bus distributes power to the 50-ampere (100-ampere in aircraft incorporating

AFC-279) essential transformer-rectifier to provide essential dc power to the essential dc bus.

2.5.4.4 Essential Instrument/Synchronization Transformer Bus. The essential instrument/synchronization transformer bus receives ac power from the essential ac bus through the essential instrument transformer, which reduces single-phase, 115-vac power to 26-vac power.

2.5.5 DC Power Distribution

2.5.5.1 Left and Right Primary DC Bus. The left and right primary dc buses normally receive converted power from the respective primary ac buses through the left and right transformer-rectifiers. If the associated primary ac bus fails or if the respective transformer-rectifier fails, the primary dc bus receives power from the opposite primary dc bus through a current-limited intertie connection. The primary dc buses supply power through current limiters (fuses) to the essential dc bus.

2.5.5.2 Essential DC Bus. The essential dc bus normally receives converted power from the essential ac bus through the essential transformer-rectifier or the primary dc buses. The essential dc bus distributes power to the essential dc start bus.

Note

The essential dc bus is prevented from supplying power to the primary dc buses by blocking diodes.

2.5.5.3 Essential DC Start Bus. The essential dc start bus normally receives power from the essential dc bus. This bus also receives power from an external dc source through the dc ground power receptacle located in the right wheelwell. The bus powers the equipment normally required for engine start, with the exception of the engine instruments. The bus also provides power for valve control during single-point refueling of the external tanks.

Note

The essential dc start bus is prevented from distributing power to the essential dc bus by a blocking diode.

2.5.6 Utility Outlets. A 115-vac, 400-Hz utility outlet is located below the right circuit breaker panel. A similar utility outlet and 115-vac, AMAC test set outlet are located below the left circuit breaker panel. The right outlet is powered by the right primary ac bus through a circuit breaker labeled R UTIL OUT. The left outlet is powered by the left primary ac bus through a circuit breaker labeled L UTIL OUT.

A 28-vdc utility outlet is located below the left circuit breaker panel and is powered by the dc essential bus through a circuit breaker labeled APU HEAT SOV/LH UTIL OUTLET (located on the right-hand fixed circuit breaker panel).

Two additional 115-vac, 400-Hz utility outlets are located at floor level outboard of the access to the ECS compartment. Power to the outlets is provided by the right primary ac bus through a circuit breaker labeled ECS COMPT UTIL OUT.

2.5.7 Circuit Breaker Panels. (See FO-14 and FO-15.)

2.5.7.1 Left Hinged Circuit Breaker Panel. (See Figure 2-22 and Figure 2-23) The left hinged circuit breaker panel faces inboard in the internal avionics bay just aft of the SENSO station. This panel contains the circuit breakers protecting equipment on the left primary ac bus, left primary dc bus, and the primary instrument/synchronization transformer bus. In addition, this hinged circuit breaker panel provides access to major electrical components in the left electrical load center.

2.5.7.2 Left Fixed Circuit Breaker Panel. (See Figure 2-24 and Figure 2-25.) The left fixed circuit breaker panel faces inboard in the internal avionics bay just aft of the left hinged circuit breaker panel. This panel contains the circuit breakers protecting equipment on the essential ac bus and the essential instrument/synchronization transformer bus.

2.5.7.3 Right Hinged Circuit Breaker Panel. (See Figure 2-26 and Figure 2-27.) The right hinged circuit breaker panel faces inboard in the internal avionics bay just aft of the TACCO station. This panel contains the circuit breakers protecting equipment on the right primary ac bus and the right primary dc bus. In addition, this hinged panel provides access to major electrical components in the right electrical load center.

2.5.7.4 Right Fixed Circuit Breaker Panel. (See Figure 2-28 and Figure 2-29.) The right fixed circuit

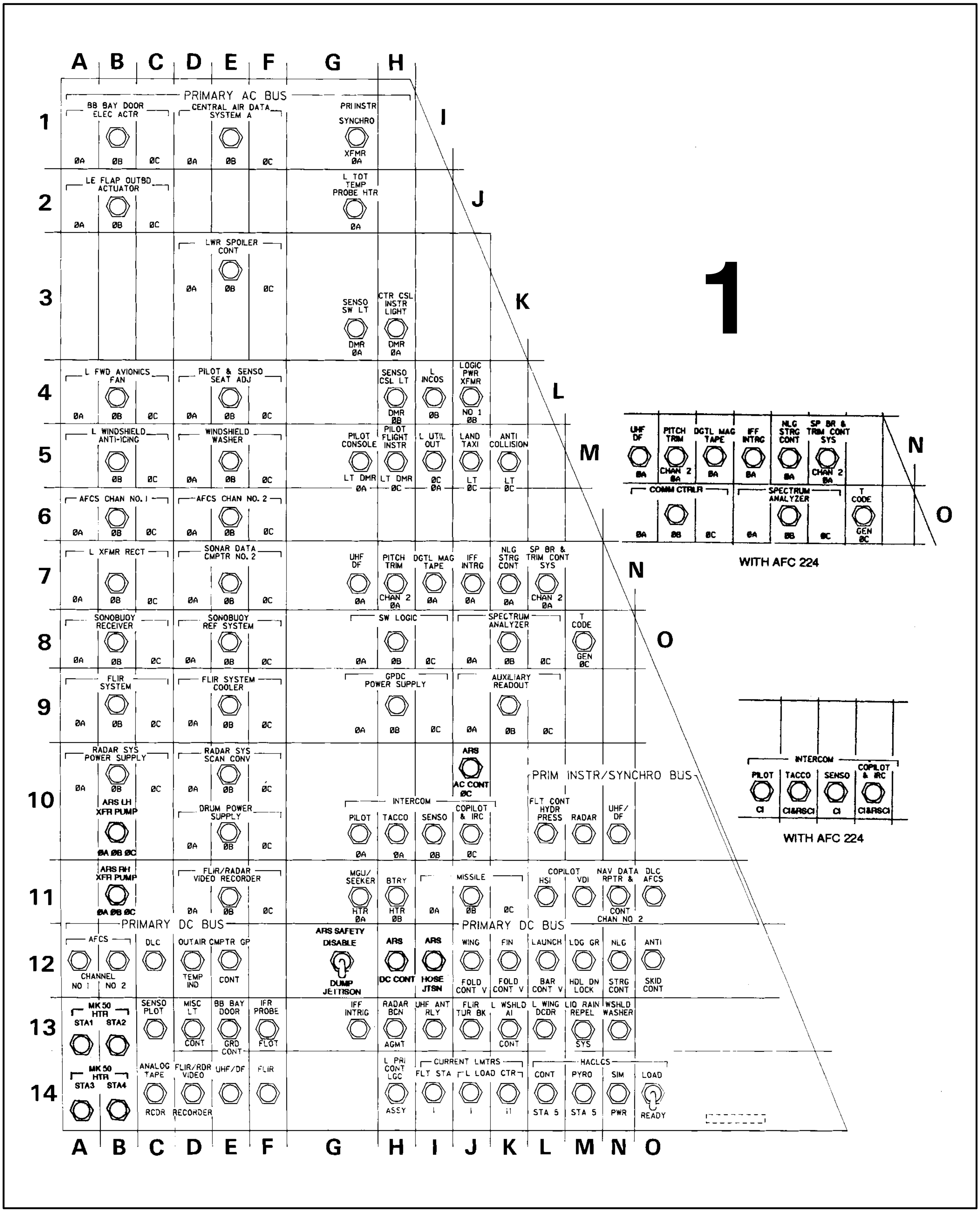


Figure 2-22. Left Hinged Circuit Breaker Panel (Aircraft Not Incorporating AFC-279)

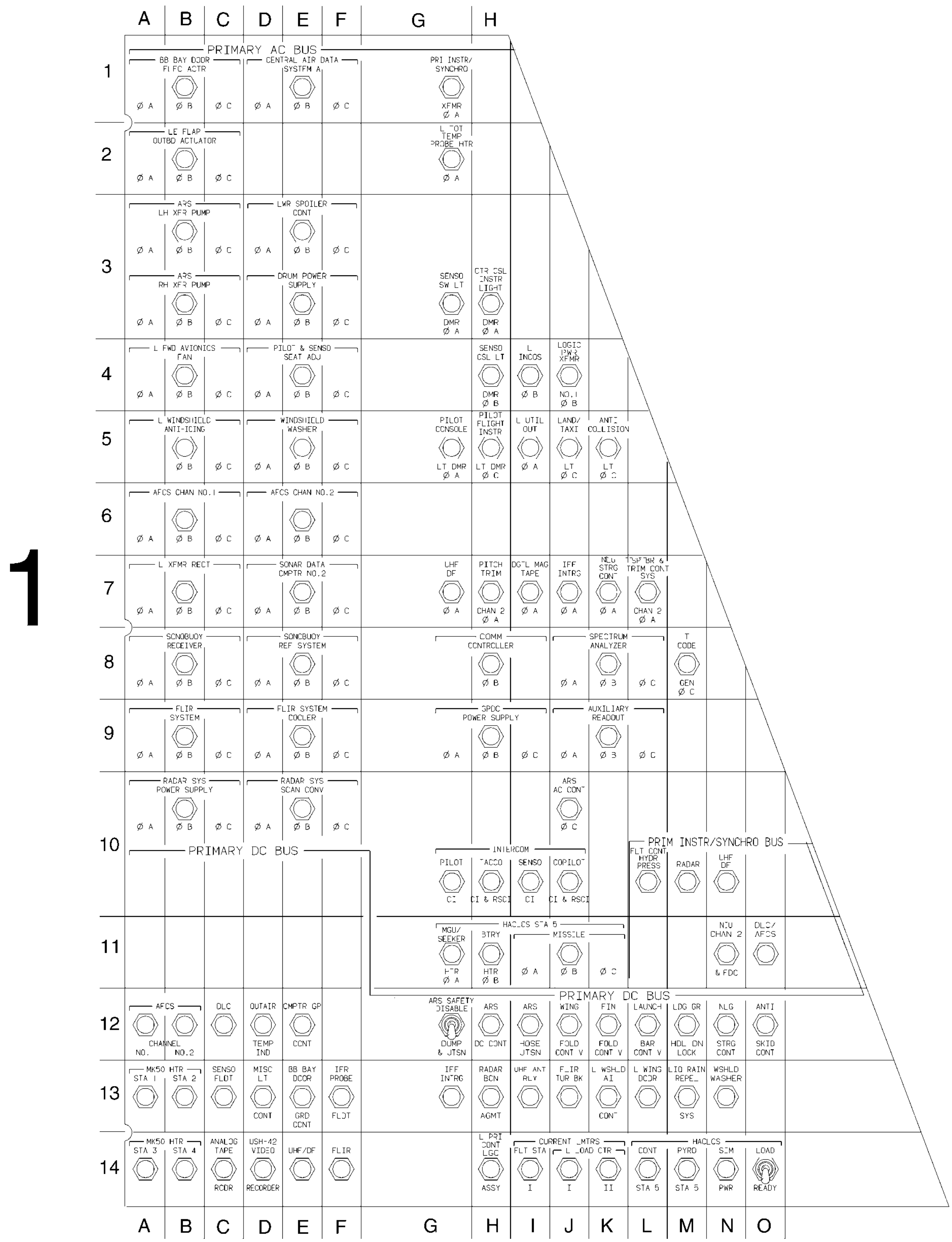


Figure 2-23. Left Hinged Circuit Breaker Panel (Aircraft Incorporating AFC-279)

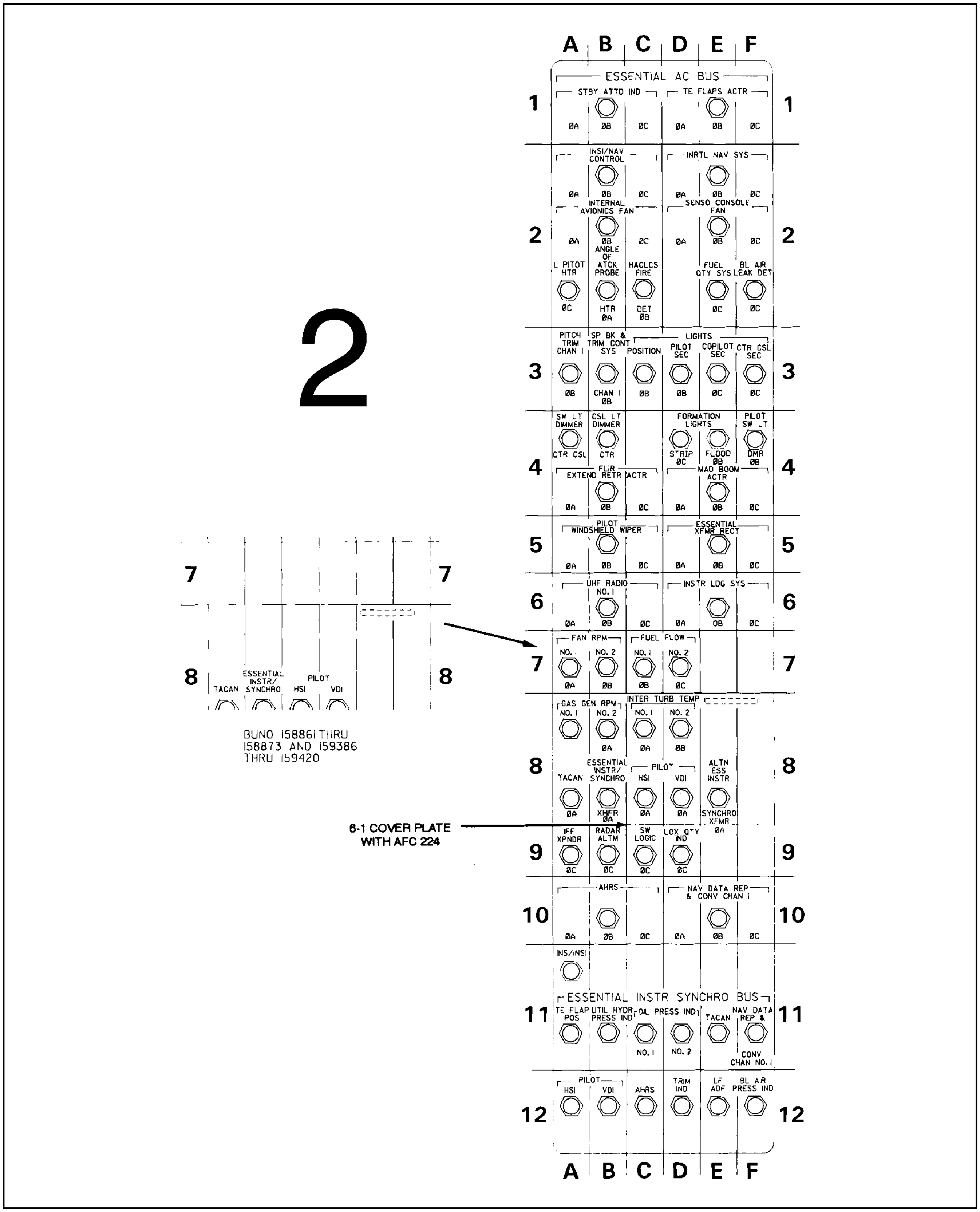


Figure 2-24. Left Fixed Circuit Breaker Panel (Aircraft Not Incorporating AFC-279)

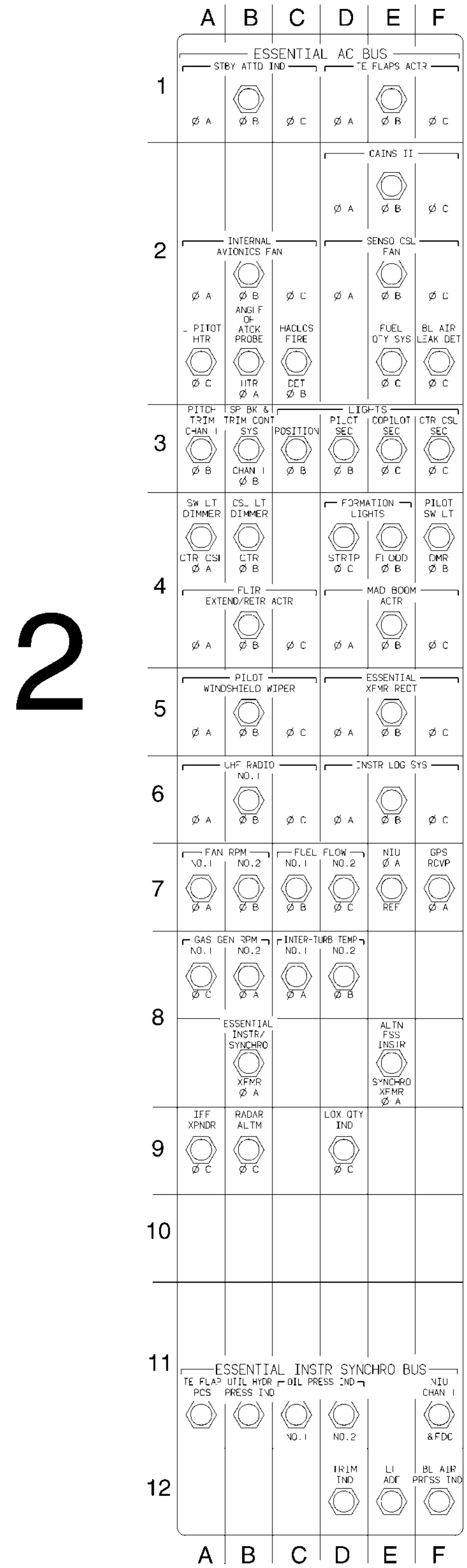


Figure 2-25. Left Fixed Circuit Breaker Panel (Aircraft Incorporating AFC-279)

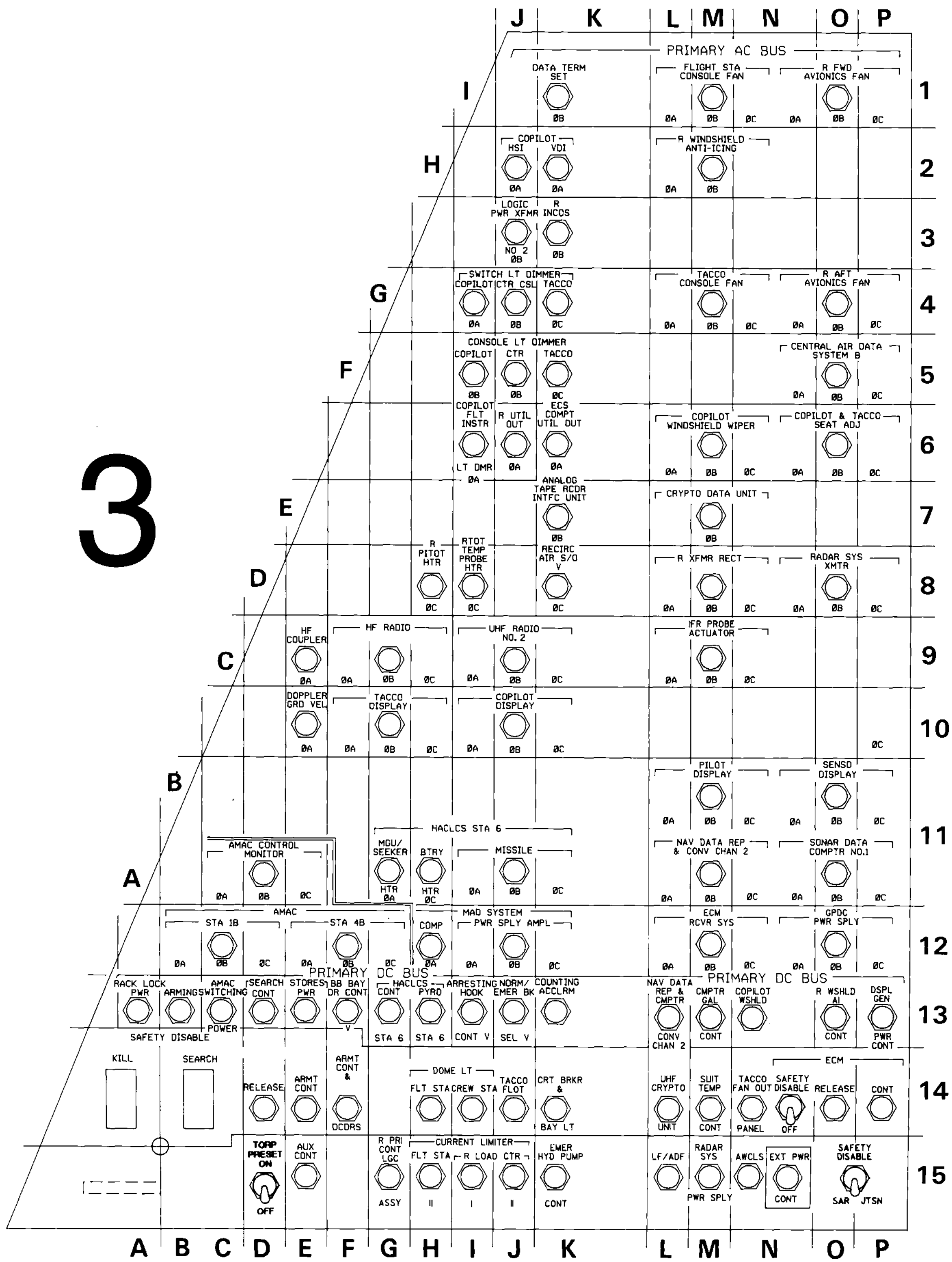


Figure 2-26. Right Hinged Circuit Breaker Panel (Aircraft Not Incorporating AFC-279)

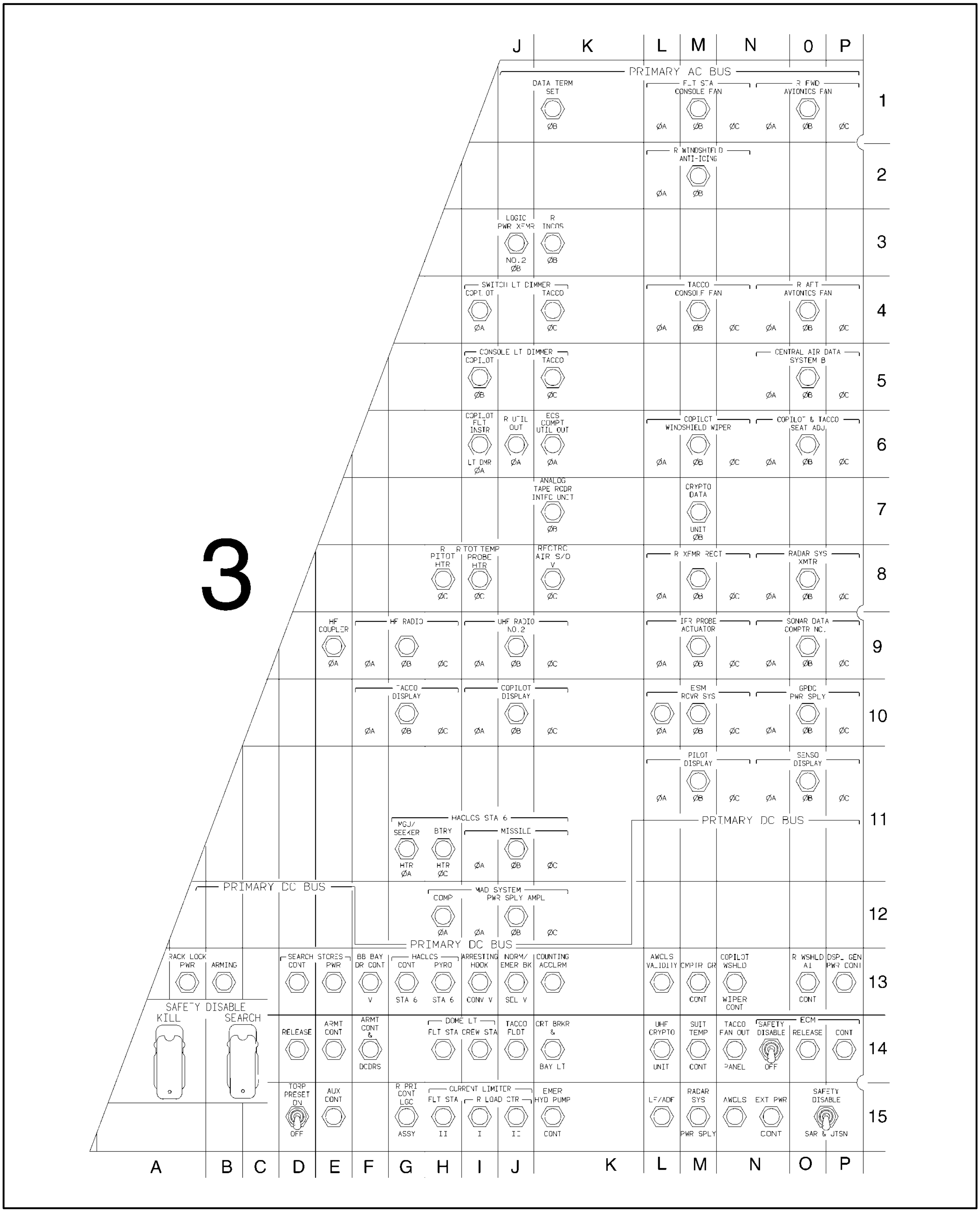


Figure 2-27. Right Hinged Circuit Breaker Panel (Aircraft Incorporating AFC-279)

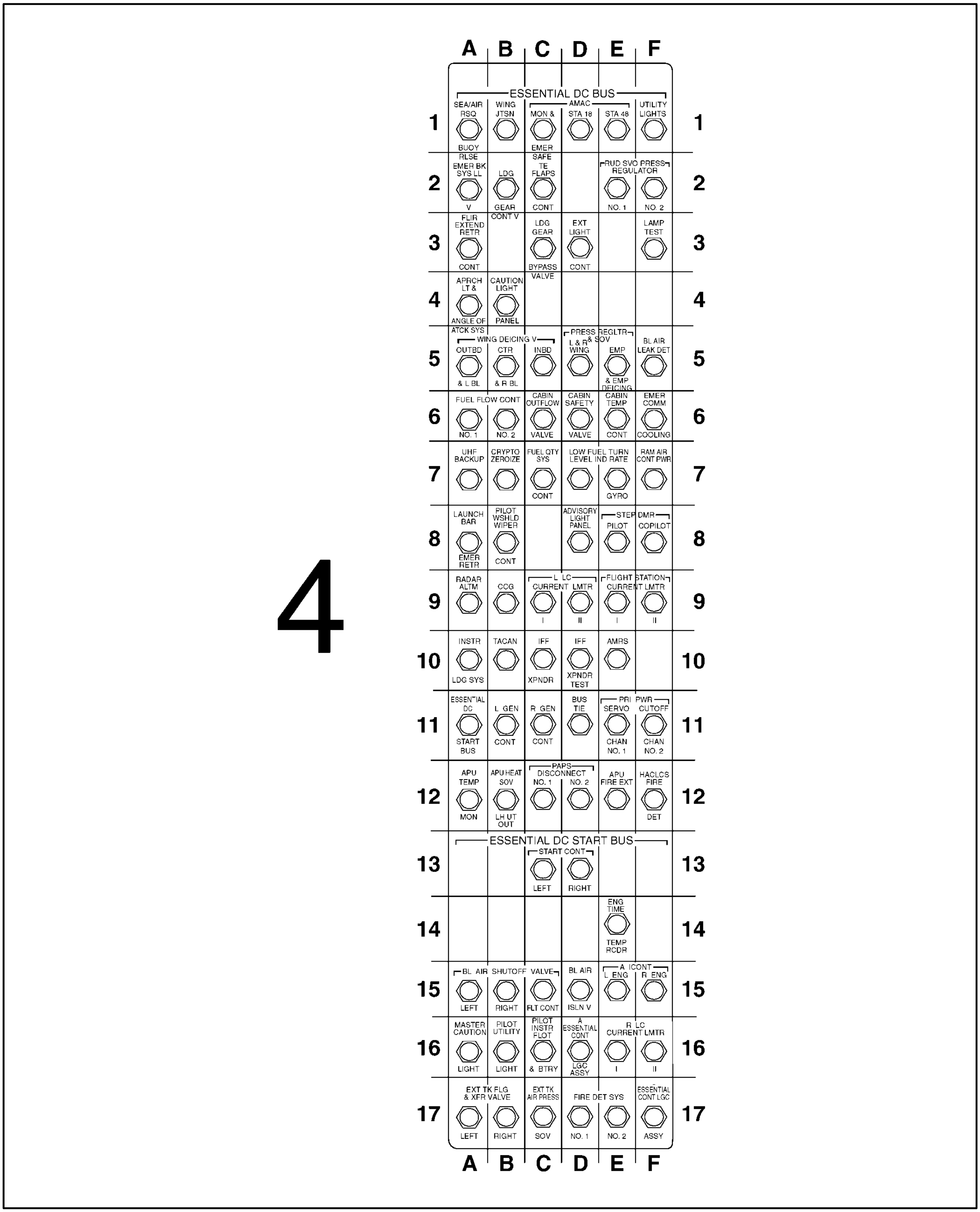


Figure 2-28. Right Fixed Circuit Breaker Panel (Aircraft Not Incorporating AFC-279)

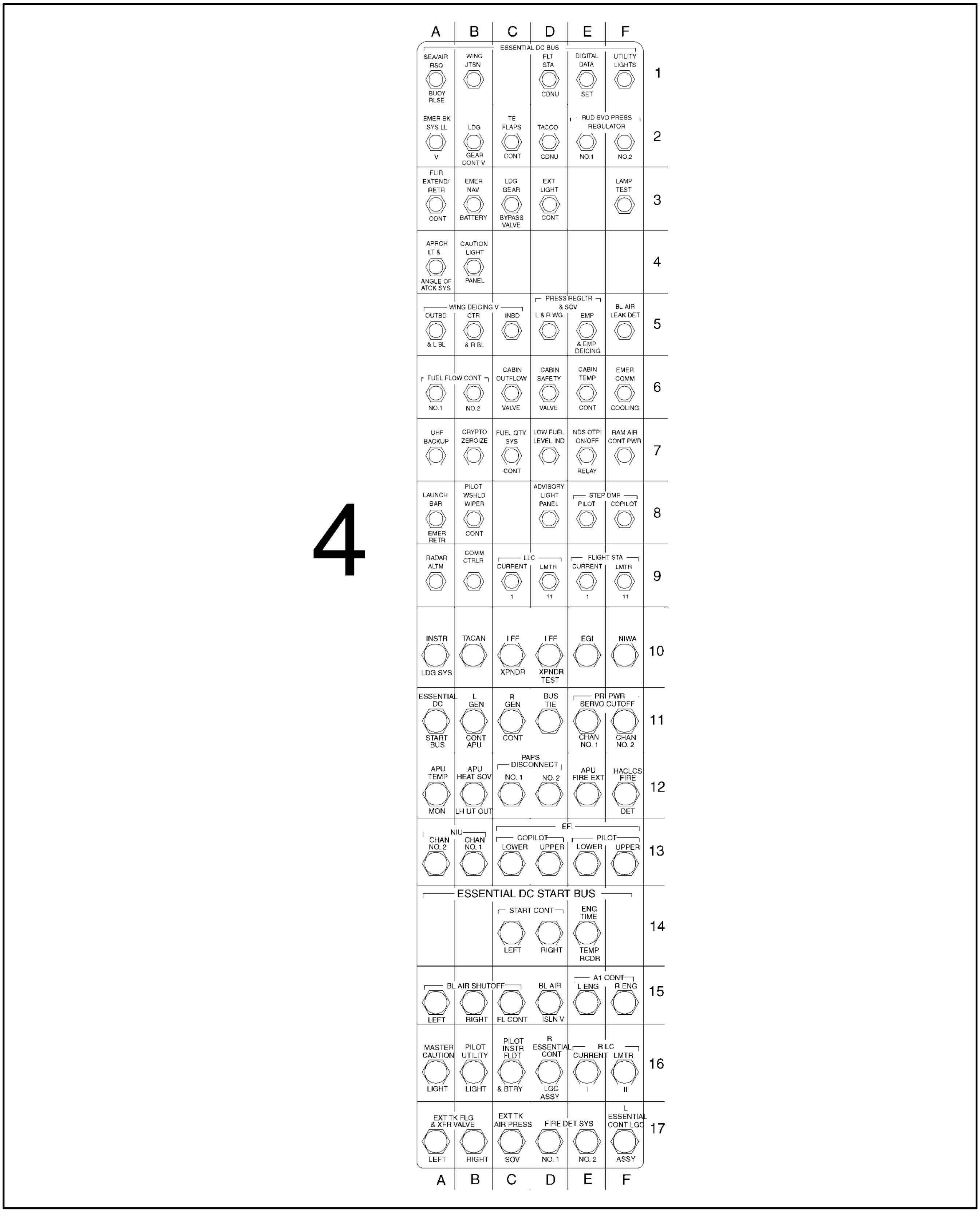


Figure 2-29. Right Fixed Circuit Breaker Panel (Aircraft Incorporating AFC-279)

breaker panel faces inboard in the internal avionics bay just aft of the right hinged circuit breaker panel. This panel contains the circuit breakers protecting equipment on the essential dc bus and on the essential dc start bus.

Note

Some equipment may have additional circuit breakers located directly on the equipment.

2.5.7.5 Explanation and Example. Figures 2-22 through 2-30 are illustrations of the four circuit breaker panels and a list of all circuit breakers in alphabetical order by name. Each circuit breaker panel is illustrated and has an alphanumeric grid superimposed. This grid was applied to facilitate circuit breaker location and is to be used with the alphabetical list that follows the circuit illustration. Each circuit breaker panel has been given a number and each bus a letter as follows:

1. Left hinged circuit breaker panel

   A. Left primary ac bus

   B. Primary instrument/sychronization transformer bus

   C. Left primary dc bus

2. Left fixed circuit breaker panel

   D. Essential ac bus

   E. Essential instrument/synchronization transformer bus

3. Right hinged circuit breaker panel

   H. Right primary dc bus.

   J. Right primary ac bus.

4. Right fixed circuit breaker panel

   F. Essential dc bus

   G. Essential dc start bus.

Each circuit breaker can be located by finding the circuit breaker name on the alphabetical list and then reading the location code. The first number of the code denotes the circuit breaker panel where the breaker will be found, the letter indicates the vertical row, and the second number the horizontal row. The letter preceding the circuit breaker name denotes the bus from which the circuit breaker receives its power.

2.6 LIGHTING SYSTEMS

2.6.1 Interior Lighting. (See Figures 2-31, 2-32, and 2-33.)

1. Flight instrument lighting
2. Console lighting
3. Switchlights
4. Floodlights
5. Dome lights
6. Utility lights
7. Emergency lighting.

2.6.1.1 Flight Instrument Panel Lighting. The pilot and copilot/COTAC flight instrument panels are illuminated using red indirect back lighting and red floodlights located beneath the glareshields.

2.6.1.2 Console Lighting. The side consoles are illuminated by red back lighting, red floodlights, and green and amber switchlights on certain specific panels. Lighting for the center control console consists of red back lighting, a single floodlight under the center instrument panel, and green and amber switchlights on specific panels.

2.6.1.3 Center Instrument Panel Lighting. The pilot center instrument panel lighting consists of red back lighting, yellow caution lights, and a red floodlight located beneath the glareshield.

2.6.1.4 Utility Lights. (See Figure 2-33.)

2.6.1.4.1 Dome Lights. Two dome lights are provided for cockpit and crew station illumination. One light is located on the overhead centerline of the cockpit. The other is located on the overhead centerline of the crew station. The lights are dual-element type allowing a selection of red or white lighting. Power for the lights is supplied by the right primary dc bus through circuit breakers labeled FLT STA DOME LT and CREW STA DOME LT.

LOCATION EXAMPLE:

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
D	FUEL QTY SYS	2-E-2	C	1.0

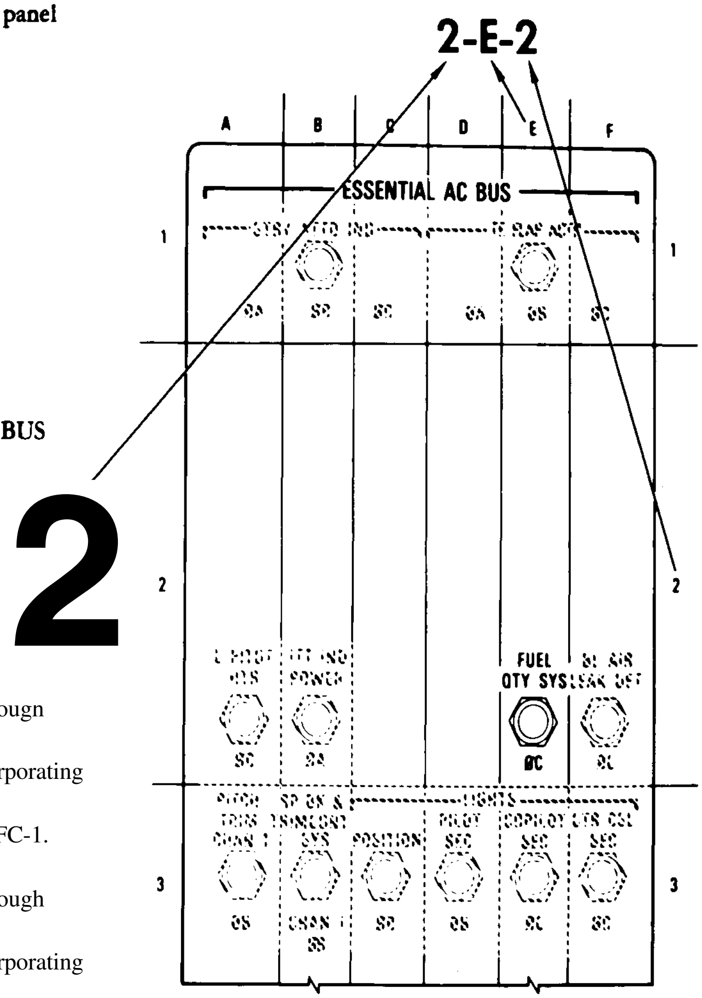
Breaker Name: Fuel quantity indicating system (FUEL QTY SYS)

Bus: Essential ac bus

Location: Left fixed circuit breaker panel
Vertical row E
Horizontal row 2

Phase: C

Rating: 1 amp



BUS IDENTIFICATION:

BUS	NAME
A	(LEFT) PRIMARY AC BUS
B	PRIM INSTR/SYNCHRO BUS
C	(LEFT) PRIMARY DC BUS
D	ESSENTIAL AC BUS
E	ESSENTIAL INSTR/SYNCHRO BUS
F	ESSENTIAL DC BUS
G	ESSENTIAL DC START BUS
H	(RIGHT) PRIMARY DC BUS
J	(RIGHT) PRIMARY AC BUS

SERIALIZATION NOTES:

1. BUNO 158861 through 158873 and 159386 througn 158420 not incorporating AFC-12.
2. BUNO 159421 and subsequent and aircraft incorporating AFC-12.
3. BUNO 158861 and subsequent incorporating AFC-1.
4. BUNO 158861 through 158873 and 159386 through 159406.
5. BUNO 159758 and subsequent and aircraft incorporating AFC-93.
6. BUNO 158861 through 158873 and 159386 through 159757 not incorporating AFC-93.
7. BUNO 159758 and subsequent and aircraft incorporating AFC-142.
8. BUNO 160604 and subsequent.
9. Deleted with AFC-193.
10. Added with AFC-193.
11. Modified with AFC-224.
12. Added with AFC-231.
13. Deleted with AFC-272.
14. Added with AFC-272.
15. Deleted with AFC-279.
16. Added with AFC-279.
17. Deleted with AFC-278.
18. Added with AFC-278.

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 1 of 11)

BUS	CIRCUIT BREAKER		LOCATION CODE	PHASE	RATING
F	ADVISORY LIGHT PANEL		4-D-8		2.5
A	AFCS CHANNEL NO. 1		1-B-6	3	5.0
A	AFCS CHANNEL NO. 2		1-E-6	3	5.0
C	AFCS CHANNEL NO. 1		1-A-12		7.5
C	AFCS CHANNEL NO. 2		1-B-12		7.5
J	AFT AVIONICS FAN (R)		3-0-4	3	15.0
F	AHRS	△15	4-E-10		2.5
E	AHRS	△15	2–C-12	3	1.0
D	AHRS	△15	2-B-8	A	2.5
G	AI CONT, L ENG		4-E-15		2.5
G	AI CONT, R ENG		4-F-15		2.5
D	ALTN ESS INSTR SYNCHRO XFMR		2-E-8	A	2.5
J	AMAC CONTROL MONITOR	△13	3-D-11	3	5.0
F	AMAC MON & EMER SAFE	△13	4-C-1		5.0
F	AMAC STA IB	△13	4-D-1		10.0
J	AMAC STA 1B	△13	3-C-12	3	10.0
J	AMAC STA 4B	△13	3-F-12	3	10.0
F	AMAC STA 4B	△13	4-E-1		10.0
H	AMAC SWTCHNG PWR	△13	3-C-13		5.0
C	ANALOG TAPE RCDR		1-C-14		2.5
J	ANALOG TAPE RCDR INTFC UNIT		3-K-7	B	2.5
D	ANGLE OF ATCK PROBE HTR		2-B-2	A	5.0
A	ANTICOLLISION LT		1-K-5	C	5.0
C	ANTI SKID CONT		1-0-12		2.5
F	APRCH LT & ANGLE OF ATCK SYS		4-A-4		5.0
F	APU FIRE EXT		4-E-12		7.5
F	APU HEAT SOV/LH UTIL OUTLET		4-B-12		7.5
F	APU TEMP MON		4-A-12		7.5
H	ARMING		3-B-13		5.0
H	ARMT CONT		3-E-14		5.0
H	ARMT CONT& DCDRS		3-F-14		5.0
H	ARRESTING HOOK CONT V		3-I-13		2.5
A	ARS AC CONT		1-J-10	C	3.0
C	ARS DC CONT		1-H-12		7.5
C	ARS HOSE JTSN		1-I-12		3.0
A	ARS LH XFR PUMP	△16	1-B-3	3	15.0
A	ARS LH XFR PUMP PHASE A, B, C	△15	1-B-10	3	15.0
A	ARS RH XFR PUMP	△16	1-B-3	3	15.0
A	ARS RH XFR PUMP PHASE A, B, C	△15	1-B-11	3	15.0
C	ARS SAFETY DISABLE DUMP & JTSN		1-G-12		Toggle Switch

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 2)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
H	AUX CONT	3-E-15		7.5
A	AUXILIARY READOUT	1-K-9	3	5.0
H	AWCLS	3-N-15		5.0
H	AWCLS VALIDITY △16	3-L-13		1.0
A	BB BAY DOOR ELEC ACTR	1-B-1	3	15.0
C	BB BAY DOOR GRD CONT	1-E-13		1.0
H	BB BAY DR CONT V	3-F-13		2.5
G	BL AIR ISLN V	4-D-15		2.5
F	BL AIR LEAK DET	4-F-5		2.5
D	BL AIR LEAK DET	2-F-2	C	2.5
E	BL AIR PRESS IND	2-F-12	A	1.0
G	BL AIR SHUTOFF VALVE FL CONT	4-C-15		2.5
G	BL AIR SHUTOFF VALVE LEFT	4-A-15		2.5
G	BL AIR SHUTOFF VALVE RIGHT	4-B-15		2.5
F	BUS TIE	4-D-11		5.0
F	CABIN OUTFLOW VALVE	4-C-6		2.5
F	CABIN SAFETY VALVE	4-D-6		2.5
F	CABIN TEMP CONT	4-E-6		5.0
D	CAINS II △16	2-E-2	3	5.0
F	CAUTION LIGHT PANEL	4-B-4		7.5
A	CENTRAL AIR DATA SYSTEM A	1-E-1	3	2.5
J	CENTRAL AIR DATA SYSTEM B	3-O-5	3	2.5
C	CMPTR GP CONT	1-E-12		2.5
H	CMPTR GR CONT	3-M-13		1.0
F	COMM CTRLR △16	4-B-9		3.0
J	CONSOLE LT DIMMER CTR △15	3-J-5	B	5.0
J	COPILOT & TACCO SEAT ADJ	3-O-6	3	5.0
J	COPILOT CONSOLE LT DIMMER	3-I-5	B	5.0
J	COPILOT DISPLAY	3-J-10	3	5.0
J	COPILOT FLT INSTR LT DMR	3-I-6	A	5.0
J	COPILOT HSI △15	3-J-2	A	2.5
B	COPILOT HSI △15	1-L-11	A	1.0
D	COPILOT SEC LIGHTS	2-E-3	C	2.5
F	COPILOT STEP DMR	4-F-8		5.0
B	COPILOT VDI △15	1-M-11	A	1.0
J	COPILOT SWITCH LT DIMMER	3-I-4	A	5.0
J	COPILOT VDI △15	3-K-2	A	2.5
J	COPILOT WINDSHIELD WIPER	3-M-6	3	5.0
H	COPILOT WINDSHIELD WIPER CONT	3-N-13		2.5
H	COUNTING ACCLRM △15	3-K-13		5.0

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 3)

BUS	CIRCUIT BREAKER		LOCATION CODE	PHASE	RATING
H	CREW STA DOME LT		3-I-14		5.0
H	CRT BRKR & BAY LT		3-K-14		5.0
J	CRYPTO DATA UNIT		3-M-7	B	1.0
F	CRYPTO ZEROIZE		4-B-7		5.0
D	CTR CONSOLE LT DIMMER		2-B-4	B	5.0
A	CTR CSL INSTR LIGHT DMR		1-H-3	A	5.0
D	CTR CSL SEC LIGHTS		2-F-3	C	1.0
D	CTR CSL SWITCH LT DIMMER		2-A-4	B	5.0
J	DATA TERM SET		3-K-1	B	2.5
A	DGTL MAG TAPE		1-I-7	A	5.0
F	DIGITAL DATA SET	△14	4-E-1		2.5
C	DLC		1-C-12		5.0
B	DLC/AFCS		1-O-11		1.0
J	DOPPLER GRD VEL	△15	3-E-10	A	2.5
A	DRUM POWER SUPPLY	△15	1-E-10	3	2.5
A	DRUM POWER SUPPLY	△16	1-E-3	3	2.5
H	DSPL GEN PWR CONT	△10	3-P-13		5.0
H	ECM CONT		3-P-14		5.0
J	ECM RCVR SYS	△15	3-M-12	3	5.0
H	ECM RELEASE		3-0-14		10.0
H	ECM SAFETY DISABLE/OFF		3-N-14		Toggle Switch
J	ECS COMPT UTIL OUT		3-K-6	A	7.5
F	EFI-COPILOT-LOWER	△16	4-C-13		5.0
F	EFI-PILOT-UPPER	△16	4-D-13		5.0
F	EFI-PILOT-LOWER	△16	4-E-13		5.0
F	EFI-PILOT-UPPER	△16	4-F-13		5.0
F	EGI	△16	4-E-10		2.5
F	EMER BK SYS LL V		4-A-2		2.5
F	EMER COMM COOLING		4-F-6		2.5
F	EMER NAV BATTERY		4-B-3		15.0
H	EMR HYD PUMP CONT		3-K-15		2.5
G	ENG TIME TEMP RCDR	△4	4-E-14		2.5
J	ESM RCVR SYS	△16	3-M-10	3	5.0
G	ESSENTIAL CONT LGC ASSY (R)		4-D-16		5.0
G	ESSENTIAL CONT LGC ASSY (L)		4-F-17		5.0
F	ESSENTIAL DC START BUS		4-A-11		20.0
D	ESSENTIAL INSTR/SYNCHRO XFMR		2-B-8	A	2.5
D	ESSENTIAL XFMR RECT		2-E-5	3	7.5
F	EXT LIGHT CONT		4-D-3		5.0

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 4)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
H	EXT PWR CONT	3-N-15		
G	EXT TK AIR PRESS SOV	4-C-17		2.5
G	EXT TR FLG & XFR VALVE LEFT	4-A-17		2.5
G	EXT TK FLG & XFR VALVE RIGHT	4-B-17		2.5
F	FAN RPM NO. 1	△2 2-A-7	△2 A	2.5
		△1 4-C-4		2.5
F	FAN RPM NO. 2	△2 2-B-7	△2 B	2.5
		△1 4-D-4		2.5
C	FIN FOLD CONT V	1-K-12		2.5
G	FIRE DET SYS NO. 1	4-D-17		2.5
G	FIRE DET SYS NO. 2	4-E-17		2.5
J	FLIGHT STA CONSOLE FAN	3-M-1	3	2.5
F	FLIGHT STA CURRENT LMTR I	4-E-9		5.0
F	FLIGHT STA CURRENT LMTR II	4-F-9		5.0
C	FLIR	1-F-14		5.0
D	FLIR EXTEND/RETR ACTR	2-B-4	3	5.0
F	FLIR EXTEND/RETR CONT	4-A-3		1.0
A	FLIR SYSTEM	1-B-9	3	7.5
A	FLIR SYSTEM COOLER	1-E-9	3	5.0
A	FLIR/RADAR VIDEO RECORDER	△3 △17 1-E-1-1	3	2.5
C	FLIR/RDR VIDEO RECORDER	△3 △17 1-D-14		5.0
C	FLIR TUR BK	1-J-13		2.5
B	FLT CONT HYDR PRESS	1-L-10	A	2.5
F	FLT STA CDNU	△14 4-D-1		2.5
H	FLT STA CURRENT LIMITER II	3-H-15		5.0
C	FLT STA CURRENT LMTR I	1-I-14		5.0
H	FLT STA DOME LT	3-H-14		5.0
D	FORMATION LIGHTS FLOOD	2-E-4	B	5.0
D	FORMATION LIGHTS STRIP	2-D-4	C	5.0
F	FUEL FLOW CONT NO. 1	4-A-6		2.5
F	FUEL FLOW CONT NO. 2	4-B-6		2.5
F	FUEL FLOW NO. 1	△2 2-C-7	B	2.5
		△1 4-E-4	B	2.5
F	FUEL FLOW NO. 2	△2 2-D-7	C	2.5
		△1 4-F-4	C	2.5
D	FUEL QTY SYS	2-E-2	C	1.0
F	FUEL QTY SYS CONT	4-C-7		2.5
A	FWD AVIONICS FAN (L)	1-B-4	3	15.0
J	FWD AVIONICS FAN (R)	3-O-1	3	15.0
G	GAS GEN RPM NO. 1	△2 2-A-8	△2 C	2.5

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 5)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
		△1 4-A-14		2.5
G	GAS GEN RPM NO. 2	△2 2-B-8	△2 A	2.5
		△1 4-B-14		2.5
F	GEN CONT (L)	4-B-11		7.5
F	GEN CONT (R)	4-C-11		7.5
J	GPDC PWR SPLY	△15 3-O-12	3	7.5
J	GPDC PWR SPLY	△16 3-O-10	3	7.5
A	GPDC POWER SUPPLY	1-H-9	3	7.5
D	GPS RCVR	△14 2-F-7	A	1.0
C	HACLCS CONT STA 5	1-L-14		5.0
H	HACLCS CONT STA 6	3-G-13		5.0
D	HACLCS FIRE DET	2-C-2	B	5.0
F	HACLCS FIRE DET	4-F-12		5.0
C	HACLCS-LOAD/READY	1-O-14		Toggle Switch
C	HACLCS-PYRO STA 5	1-M-14		5.0
H	HACLCS-PYRO STA 6	3-H-13		5.0
C	HACLCS SIM PWR	1-N-14		5.0
A	HACLCS STA 5 BTRY HTR	1-H-11	B	7.5
A	HACLCS STA 5 MGU/SEEKER HTR	1-G-11	A	7.5
A	HACLCS STA 5 MISSILE	1-J-11	3	7.5
J	HACLCS STA 6 BTRY HTR	3-H-11	C	7.5
J	HACLCS STA 6 MGU/SEEKER HTR	3-G-11	A	7.5
J	HACLCS STA 6 MISSILE	3-J-11	3	7.5
J	HF COUPLER	3-E-9	A	5.0
J	HF RADIO	3-G-9	3	10.0
A	IFF INTRG	1-J-7	A	5.0
C	IFF INTRIG	1-G-13		5.0
D	IFF XPNDR	2-A-9	C	5.0
F	IFF XPNDR	4-C-l0		5.0
F	IFF XPNDR TEST	4-D-l0		5.0
J	IFR PROBE ACTUATOR	3-M-9	3	5.0
C	IFR PROBE FLDT	1-F-13		2.5
A	INCOS (L)	1-I-4	B	1.0
J	INCOS (R)	3-K-3	B	1.0
D	INRTL NAV SYS	△15 2-E-2	3	5.0
D	INS/NAV CONTROL	△15 2-B-2	3	5.0
E	INS/INSI	△15 2-A-11	A	1.0
D	INSTR LDG SYS	2-E-6	3	2.5
F	INSTR LDG SYS	4-A-10		5.0
G	INTER TURB TEMP NO. 1	△2 2-C-8	△2 A	2.5
		△1 4-C-14		2.5

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 6)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
G	INTER TURB TEMP NO. 2	△2 2-D-8	△2 B	2.5
		△1 4-D-l4		2.5
D	INTERCOM COPILOT & IRC △11 CI & RSCI	1-J-l0	C	5.0
D	INTERCOM PILOT △11 CI	1G-10	A	5.0
D	INTERCOM SENSO △11 CI	1-I-10	B	5.0
D	INTERCOM TACCO △11 CI & RSCI	1-H-10	A	5.0
D	INTERNAL AVIONICS FAN	2-B-2	3	15.0
F	LAMP TEST	4-F-3		5.0
A	LAND/TAXI LT	1-J-5	C	5.0
C	LAUNCH BAR CONT V	1-L-12		2.5
F	LAUNCH BAR EMER RETR	4-A-8		2.5
F	LC CURRENT LMTR I (L)	4-C-9		5.0
G	LC CURRENT LMTR I(R)	4-E-16		5.0
F	LC CURRENT LMTR II(L)	4-D-9		5.0
G	LC CURRENT LMTR II(R)	4-F-16		5.0
F	LDG GEAR BYPASS VALVE	4-C-3		2.5
F	LDG GEAR CONT V	4-B-2		2.5
C	LDG GR HDL DN LOCK	1-M-12		2.5
A	LE FLAP OUTBD ACTUATOR	1-B-2	3	7.5
E	LF ADF	2-E-12	A	2.5
H	LF/ADF	3-L-15		5.0
C	LIQ RAIN REPEL SYS	1-M-13		2.5
C	LOAD CTR CURRENT LMTRS I (L)	1-J-14		5.0
C	LOAD CTR CURRENT LMTRS II (L)	1-K-14		5.0
H	LOAD CTR CURRENT LIMITER I (R)	3-1-15		5.0
H	LOAD CTR CURRENT LIMITER II (R)	3-J-15		5.0
A	LOGIC PWR XFMR NO. 1	1-J-4	B	5.0
J	LOGIC PWR XFMR NO. 2	3-J-3	B	5.0
F	LOW FUEL LEVEL IND	4-D-7		1.0
D	LOX QTY IND	2-D-9	C	5.0
A	LWR SPOILER CONT	1-E-3	3	5.0
D	MAD BOOM ACTR	2-E-4	3	5.0
J	MAD SYSTEM COMP	3-H-12	A	2.5
J	MAD SYSTEM PWR SPLY AMPL	3-J-12	3	2.5
G	MASTER CAUTION LIGHT	4-A-16		2.5
C	MISC LT CONT	1-D-13		5.0
C	MK 50 HTR STA 1	△12 1-A-13		5.0
C	MK 50 HTR STA 2	△12 1-B-13		5.0
C	MK 50 HTR STA 3	△12 1-A-14		5.0
C	MK 50 HTR STA 4	△12 1-B-14		5.0
D	NAV DATA REP & CONV CHAN 1	△15 2-E-10	3	2.5

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 7)

BUS	CIRCUIT BREAKER		LOCATION CODE	PHASE	RATING
E	NAV DATA REP & CONV CHAN 1	△15	2-F-11	A	1.0
J	NAV DATA REP & CONV CHAN 2	△15	3-M-11	3	2.5
H	NAV DATA REP & CMPTR CONV	△5 △15	3-L-13		1.0
H	NAV DATA REP & CMPTR CONV CHAN 2	△6 △15	3-L-13		1.0
B	NAV DATA RPTR & CONV CHAN 2	△15	1-N-11	A	1.0
F	NDS OTPI ON/OFF RELAY	△16	4-E-7		2.5
E	NIU CHAN 1 & FDC	△16	2-F-11		1.0
B	NIU CHAN 2 & FDC	△16	1-N-11		1.0
F	NIU CHAN NO. 1	△16	4-B-13		2.5
F	NIU CHAN NO. 2	△16	4-A-13		2.5
D	NIU REF	△16	2-E-7	A	1.0
F	NIWA	△16	4-F-10		2.5
C	NLG STRG CONT		1-N-12		5.0
A	NLG STRG CONT		1-K-7	A	5.0
H	NORM/EMERG BK SEL V		3-J-13		2.5
E	OIL PRESS IND NO. 1		2-C-11	A	2.5
E	OIL PRESS IND NO. 2		2-D-11	A	2.5
C	OUTAIR TEMP IND		1-D-12		1.0
F	PAPS DISCONNECT NO. 1		4-C-12		2.5
F	PAPS DISCONNECT NO. 2		4-D-12		2.5
A	PILOT & SENSO SEAT ADJ		1-E-4	3	5.0
A	PILOT CONSOLE LT DMR		1-G-5	A	5.0
J	PILOT DISPLAY		3-M-11	3	7.5
A	PILOT FLIGHT INSTR LT DMR		1-H-5	C	5.0
J	PILOT HSI	△15	2-C-8	A	2.5
E	PILOT HSI	△15	2-A-12	A	1.0
G	PILOT INSTR FLDT & BTRY		4-C-16		2.5
D	PILOT SEC LIGHTS		2-D-3	B	2.5
F	PILOT STEP DMR		4-E-8		5.0
D	PILOT SW LT DMR		2-F-4	B	5.0
G	PILOT UTILITY LIGHT		4-B-16		2.5
E	PILOT VDI	△15	2-B-12	A	1.0
D	PILOT VDI	△15	2-D-8	A	2.5
D	PILOT WINDSHIELD WIPER		2-B-5	3	5.0
F	PILOT WSHLD WIPER CONT.		4-B-8		2.5
D	PITCH TRIM CHAN 1		2-A-3	B	15.0
A	PITCH TRIM CHAN 2		1-H-7	A	15.0
D	PITOT HTR (L)		2-A-2	C	7.5
J	PITOT HTR (R)		3-H-8	C	7.5
D	POSITION LIGHTS		2-C-3	B	5.0

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 8)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
F	PRESS REGLTR & SOV EMP & EMP DEICING	4-E-5		5.0
F	PRESS REGLTR & SOV L&R WG	4-D-5		5.0
C	PRI CONT LGC ASSY (L)	1-H-14		5.0
H	PRI CONT LGC ASSY (R)	3-G-15		5.0
A	PRI INSTR SYNCHRO XFMR	1-G-1	A	2.5
F	PRI PWR SERVO CUTOFF CHAN NO. 1	4-E-11		2.5
F	PRI PWR SERVO CUTOFF CHAN NO. 2	4-F-11		2.5
H	RACK LOCK PWR	3-A-13		5.0
B	RADAR	1-M-10	A	2.5
F	RADAR ALTM	4-A-9		2.5
D	RADAR ALTM	2-B-9	C	2.5
C	RADAR BCN AGMT	1-H-13		5.0
A	RADAR SYS POWER SUPPLY	1-B-10	3	10.0
H	RADAR SYS PWR SPLY	3-M-15		5.0
A	RADAR SYS SCAN CONV	1-E-10	3	2.5
J	RADAR SYS XMTR	3-O-8	3	10.0
F	RAM AIR CONT PWR	4-F-7		2.5
J	RECIRC AIR S/O V	3-K-8	C	2.5
H	RELEASE	3-D-14		7.5
F	RUD SVO PRESS REGULATOR NO. 1	4-E-2		1.0
F	RUD SVO PRESS REGULATOR NO. 2	4-F-2		1.0
H	SAFETY DISABLE KILL	3-A-14		Toggle Switch
H	SAFETY DISABLE SAR & JTSN	3-O/P-15		Toggle Switch
H	SAFETY DISABLE SEARCH	3-B/C-14		Toggle Switch
H	SDRS △16	3-K-13		5.0
F	SEA/AIR RSQ BUOY RLSE	4-A-11		10.0
H	SEARCH STORES CONT	3-D-13		15.0
H	SEARCH STORES PWR	3-E-13		15.0
D	SENSO CONSOLE FAN	2-E-2	3	2.5
A	SENSO CSL LT DMR	1-H-4	B	5.0
J	SENSO DISPLAY	3-O-11	3	7.5
C	SENSO FLDT	1-C-13		2.5
A	SENSO SW LT DMR	1-G-3	A	5.0
J	SONAR DATA CMPTR NO. 1 △15	3-O-11	3	2.5
J	SONAR DATA CMPTR NO. 1 △16	3-O-9	3	2.5
A	SONAR DATA CMPTR NO. 2	1-E-7	3	2.5
A	SONOBUOY RECEIVER	1-B-8	3	5.0
A	SONOBUOY REF SYSTEM	1-E-8	3	2.5
D	SP BK & TRIM CONT SYS CHAN 1	2-B-3	B	1.0
A	SP BR & TRIM CONT SYS CHAN 2	1-L-7	A	2.5

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 9)

BUS	CIRCUIT BREAKER		LOCATION CODE	PHASE	RATING
A	SPECTRUM ANALYZER		I-K-8	3	10.0
G	START CONT LEFT	△15	4-C-13		5.0
G	START CONT LEFT	△16	4-C-14		5.0
G	START CONT RIGHT	△15	4-D-13		5.0
G	START CONT RIGHT	△16	4-D-14		5.0
D	STBY ATTD IND		2-B-1	3	1.0
H	SUIT TEMP CONT		3-M-14		5.0
D	SW LOGIC △11 CCG 4-B-9	△15	2-C-9	C	2.5
A	SW LOGIC △11 COMM CTRLR	△15	1-H-8	3	2.5
J	SWITCH LT DIMMER CTR CSL	△15	3-J-4	B	5.0
A	T CODE GEN	△7	1-M-8	C	1.0
F	TACAN		4-B-10		5.0
E	TACAN	△13	2-E-11	A	2.5
D	TACAN	△13	2-A-8	A	5.0
F	TACCO CDNU	△14	4-D-2		2.5
J	TACCO CONSOLE FAN		3-M-4	3	2.5
J	TACCO CONSOLE LT DIMMER		3-K-5	C	5.0
J	TACCO DISPLAY		3-G-10	3	5.0
H	TACCO FAN OUT PANEL		3-N-14		2.5
H	TACCO FLDT		3-J-14		2.5
J	TACCO SWITCH LT DIMMER		3-K-4	C	5.0
E	TE FLAP POS		2-A-11	A	1.0
D	TE FLAPS ACTR		2-E-1	3	7.5
F	TE FLAPS CONT		4-C-2		5.0
H	TORP PRESET	△12	3-D-15	Toggle Switch	5.0
J	TOT TEMP PROBE HTR (R)		3-I-8	C	5.0
A	TOT TEMP PROBE HTR (L)		1-G-2	A	5.0
E	TRIM IND		2-D-12	A	1.0
F	TURN RATE GYRO	△15	4-E-7		2.5
C	UHF ANT RLY		1-I-13		5.0
F	UHF BACKUP		4-A-7		1.0
H	UHF CRYPTO UNIT		3-L-14		2.5
A	UHF DF		1-G-7	A	2.5
B	UHF DF		1-N-10	A	2.5
C	UHF/DF		1-E-14		2.5
D	UHF RADIO NO. 1		2-B-6	3	2.5
J	UHF RADIO NO. 2		3-J-9	3	2.5
C	USF-42 VIDEO RECORDER	△18	1-D-14		10.0
E	UTIL HYDR PRESS IND		2-B-11	A	2.5

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 10)

BUS	CIRCUIT BREAKER	LOCATION CODE	PHASE	RATING
J	UTIL OUT (R)	3-J-6	A	7.5
A	UTIL OUT (L)	1-I-5	A	7.5
F	UTILITY LIGHTS	4-F-1		5.0
A	WINDSHIELD ANTI ICING (L)	1-B-5	B, C	35.0
J	WINDSHIELD ANTI ICING (R)	3-M-2	A, B	35.0
A	WINDSHIELD WASHER	1-E-5	3	2.5
C	WING DCDR (L)	1-L-13		5.0
F	WING DEICING V CTR & R BL	4-B-5		5.0
F	WING DEICING V INBD	4-C-5		5.0
F	WING DEICING V OUTBD & L BL	4-A-5		5.0
C	WING FOLD CONT V	1-J-12		7.5
F	WING JTSN	4-B-1		10.0
C	WSHLD A1 CONT (L)	1-K-13		1.0
H	WSHLD A1 CONT (R)	3-O-13		1.0
C	WSHLD WASHER	1-N-13		1.0
A	XFMR RECT (L)	1-B-7	3	15.0
J	XFMR RECT (R)	3-M-8	3	15.0

Figure 2-30. Power Distribution Circuit Breaker List (Sheet 11)

2.6.1.4.2 Pilot Utility Lights. A utility light with an integral rheostat control is located in the lower aft corner of the pilot and copilot/COTAC windows. The lights provide additional illumination, as required, and allow selection of either red or white filters. The pilot light is powered from the essential dc start bus through a circuit breaker labeled PILOT UTILITY LIGHT. The copilot/COTAC light is powered from the essential dc bus through a circuit breaker labeled UTILITY LIGHTS. BuNo 159758 and subsequent and aircraft incorporating AFC-10 have additional mounting brackets added to improve kneeboard illumination when using the utility lights.

2.6.1.5 TACCO/SENSO Interior Lighting. The TACCO and SENSO console lighting is controlled by the INTERIOR LIGHT control panel located at each station (see Figure 2-32). Light intensity and ON/OFF control of switchlights, floodlights, console, and panel lights are controlled by the station operator.

2.6.1.6 Circuit Breaker Panels and Avionics Bay Floodlights. The right and left circuit breaker panels are cross-illuminated by white floodlights located above the opposite circuit breaker panel. The avionics bay is illuminated by a red light located on the aft bulkhead of the bay. These lights use a common switch located on the aft overhead centerline of the crew station. Power is supplied by the right primary dc bus through a circuit breaker labeled CRT BRKR & BAY LT.

2.6.1.6.1 ECS Bay Dome Light. The ECS bay is illuminated by a dome light located on the left bulkhead directly above the access door. An ON/OFF switch is located adjacent to the light. Power is provided by the right primary ac bus through a circuit breaker labeled ECS COMPT UTIL OUT.

2.6.1.7 Emergency Lighting. In the event of electrical failure resulting in the loss of all aircraft electrical power, an emergency dc power supply consisting of a separate 7-volt battery pack will provide floodlighting for flight instruments and the APU accumulator pressure gauge for approximately 30 minutes. This same source is used to illuminate the TACCO and SENSO EJECT lights and activate the APU fire extinguisher system under total loss of electrical power. This lighting is controlled by a switch labeled EMER INSTR LIGHTS located outboard of the pilot flaps lever. The switch has marked positions of AUTO, OFF, and TEST. In the AUTO position, if the normal power supply fails, the emergency dc power supply is automatically connected to the pilot instrument floodlights and the APU accumulator gauge. In the OFF or AUTO positions, the emergency dc power supply is disconnected and a trickle charge from the aircraft system is provided for the battery. In the TEST position, the normal power supply to the pilot instrument floodlight is disconnected and the emergency dc power supply is connected to illuminate the pilot instrument floodlight, APU accumulator gauge, and the EJECT lights located at the TACCO and SENSO stations.

CAUTION

Failure to secure the emergency lighting system will deplete the emergency dc power supply (7-volt battery pack) and will render the APU fire extinguisher inoperative when the essential dc bus is not powered.

To assure that the battery is up to potential, a trickle charge is provided to the battery from the 28-volt essential dc start bus through a circuit breaker labeled PILOT INSTR FLDT & BTRY. Refer to paragraph 2.33, Emergency Equipment, concerning the emergency exit light.

2.6.1.8 Exterior Lighting. (See Figures 2-34 and 2-35.) Exterior lighting of the aircraft consists of:

1. Wing and tail position and wing roll lights

2. Anticollision lights

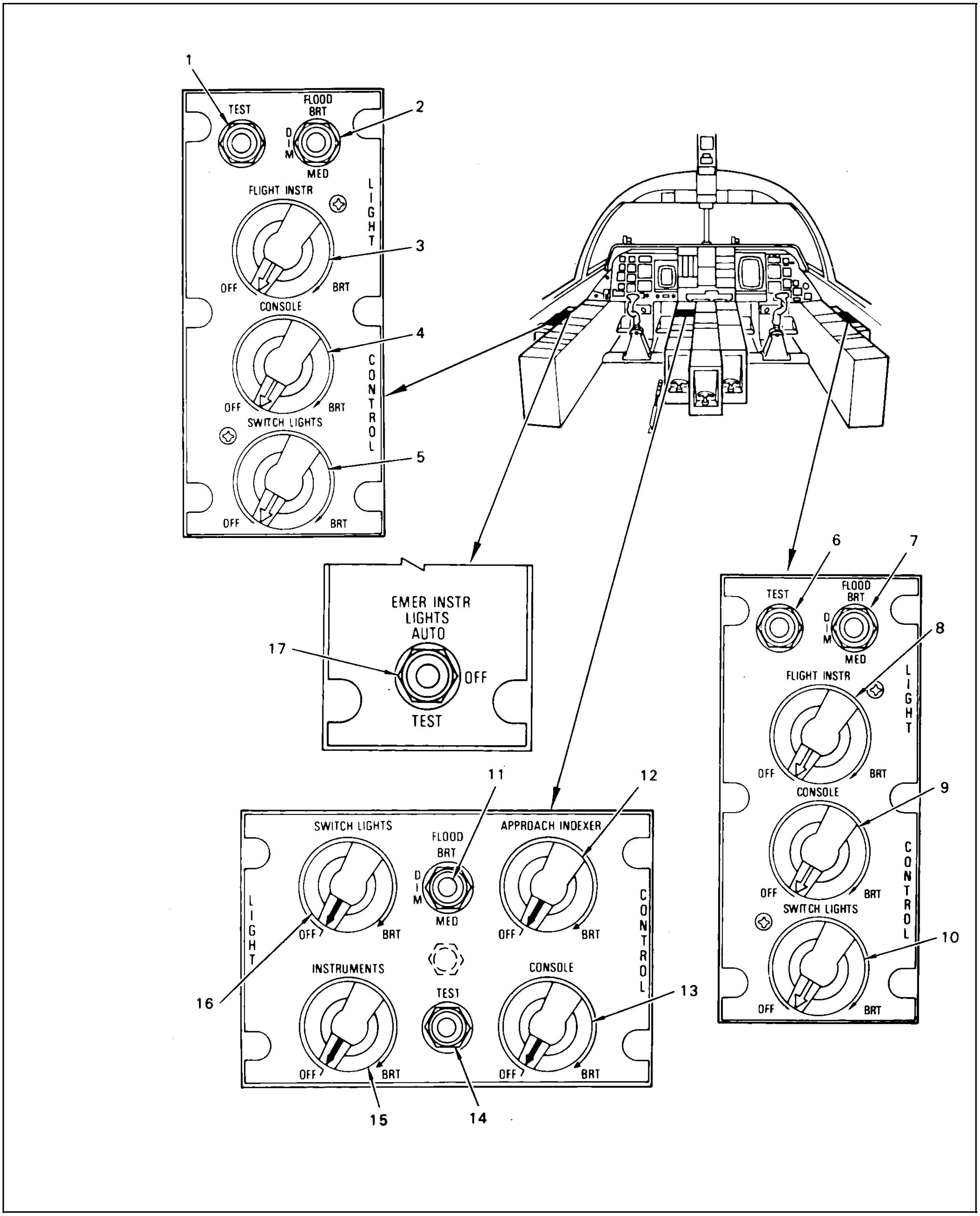


Figure 2-31. Cockpit Interior Lighting Control Panels (Sheet 1 of 5)

INDEX	CONTROL/INDICATOR	FUNCTION
1	TEST switch (pilot)	Pressed — illuminates all switchlights controlled by pilot SWITCH LIGHTS switch. **Note** Switch lights illuminate to intensity selected by the SWITCH LIGHTS switch.
2	FLOOD switch (pilot)	BRT — illuminates pilot console, instrument, and center instrument-floodlights to high intensity. DIM — illuminates pilot console floodlights to low intensity. MED — illuminates pilot console floodlights to medium intensity. **Note** The pilot CONSOLE light switch must be in any position other than OFF to achieve illumination of the console floodlights.
3	FLIGHT INSTR switch (pilot)	OFF (fully counterclockwise): • Resets pilot flight instrument dimmer control rheostat (necessary if power was removed with switch not set to OFF). • Extinguishes pilot flight instrument lights. • Sets MASTER ARM, SEARCH POWER, NWS ON, HSI advisory, CAUTION, ATR UNLOCKED, ECM READY (pilot and copilot/COTAC), MISSILE FIRE STA W5 and W6, RAWS, WHEELS, landing gear handle, and hook handle lights to high intensity mode. • Sets ACLS discrete word display panel lights (pilot and copilot/ COTAC), HUA panel lights (pilot and copilot/ COTAC), master caution panel lights, and advisory panel lights to high intensity mode. • Sets N_g and N_f overspeed, ITT overtemperature, APU, APU FIRE, engine FIRE, and EMER PUMP lights to high intensity mode. BRT (clockwise rotation): • Illuminates then increases intensity of pilot flight instrument lights. • Reduces intensity of MASTER ARM, SEARCH POWER, CAUTION, ATR UNLOCKED, ECM READY (pilot and copilot/COTAC), MISSILE FIRE STA W5 and W6, RAWS, WHEELS, landing gear handle, and hook handle lights.

Figure 2-31. Cockpit Interior Lighting Control Panels (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
	FLIGHT INSTR switch (pilot) (cont)	• Reduces intensity of WAVE–OFF, COUPLER OUT, and TILT lights in ACLS discrete word display panels (pilot and copilot/COTAC) and CPLR OUT and WAVE OFF lights in HUA panels (pilot and copilot/COTAC). • Initially decreases, then increases the intensity of the NWS ON, HSI indicator, master caution panel lights, and advisory panel lights with further clockwise rotation (NWS ON, master caution, and advisory panel lights do not go off when switch is set to OFF). • Initially decreases, then increases the intensity of the LANDING CHECK, ACL LOCK ON, COUPLER AVAIL, COMMAND CONTROL, 10 SECONDS, and VOICE lights on the ACLS discrete word display panels (pilot and copilot/COTAC) with further clockwise rotation (these discrete word display panel lights do not go off when switch is set to OFF). • Reduces intensity of N_g and N_f overspeed, ITT overtemperature, APU, APU FIRE, engine FIRE, and EMER PUMP lights.
4	CONSOLE switch (pilot)	OFF (fully ccw) — extinguishes pilot console floodlights, console panel lights, instrument floodlights, and center instrument floodlights BRT (cw rotation): • Illuminates, then increases intensity of pilot console panel lights. • Provides power to pilot FLOOD switch.
5	SWITCH LIGHTS switch (pilot)	OFF (fully ccw) — extinguishes switchlights on pilot ICS control panel, UHF control panel, and selected switchlights on pilot tactical display control BRT (cw rotation) — illuminates, then increases intensity of switchlights on pilot ICS, UHF and tactical display control.
6	TEST switch (copilot/COTAC)	Pressed — illuminates copilot/COTAC ICS switchlights and special lights on copilot/COTAC INCOS panel. **Note** Switch lights illuminate to intensity selected by the SWITCH LIGHTS switch. Selected switch lights on the copilot/COTAC INCOS panel are tested by GPDC.

Figure 2-31. Cockpit Interior Lighting Control Panels (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
7	FLOOD switch (copilot/ COTAC)	BRT — illuminates copilot/COTAC console and instrument floodlights to high intensity. DIM — illuminates copilot/COTAC console floodlights to low intensity. MED — illuminates copilot/COTAC console floodlights to medium intensity. **Note** The copilot/COTAC CONSOLE light switch must be in any position other than OFF to achieve illumination of the console floodlights.
8	FLIGHT INSTR switch (copilot/COTAC)	OFF (fully ccw) — extinguishes copilot/COTAC flight instrument lights and sets copilot/COTAC HSI lights to high intensity. BRT (cw rotation): ● Illuminates, then increases intensity of copilot/COTAC in-flight instrument lights. ● Reduces intensity of HSI light.
9	CONSOLE switch (copilot/ COTAC)	OFF (fully ccw) — extinguishes copilot/COTAC console floodlights, console panel lights, and instrument floodlights. BRT (cw rotation): ● Illuminates, then increases intensity of console panel lights and console floodlights. ● Provides power to copilot/COTAC FLOOD switch.
10	SWITCH LIGHTS switch (copilot/COTAC)	OFF (fully ccw) — extinguishes switch lights on copilot/COTAC ICS panel and INCOS (integrated control system) panel. BRT (cw rotation) — illuminates, then increases intensity of switch lights on copilot/COTAC ICS panel and increases intensity of switch lights on copilot/COTAC INCOS panel.
11	FLOOD switch	BRT — illuminates two center console floodlights at high intensity. DIM — illuminates two center console floodlights at low intensity. MED — illuminates two center console floodlights at medium intensity. **Note** The center CONSOLE light switch must be in any position other than OFF to achieve illumination of the console floodlights.
12	APPROACH INDEXER switch	OFF (fully ccw) — extinguishes pilot and copilot/COTAC approach indexer lights. BRT (cw rotation) — progressively increases intensity of approach indexer light. **Note** Indication on both approach indexers is controlled by signals from pilot angle-of-attack indicator.

Figure 2-31. Cockpit Interior Lighting Control Panels (Sheet 4)

INDEX	CONTROL/INDICATOR	FUNCTION
13	CONSOLE switch	OFF (fully ccw): • Extinguishes panel red back lighting on the center console, overhead panel and the eyebrow panel. • Extinguishes pilot and copilot/COTAC checklist lights (eyebrow panel). • Removes power to center console floodlights. BRT (cw rotation): • Illuminates, then increases intensity of above lights. • Provides power to center console FLOOD switch.
14	TEST switch	Depressed — illuminates switch lights controlled by center console SWITCH LIGHTS switch. **Note** Switch lights are illuminated to intensity Selected by control switch.
15	INSTRUMENTS switch	OFF (fully ccw): • Extinguishes red back lighting for center instrument panel and center console instruments and gauges. • Extinguishes red back lighting for the roll and pitch trim indicators, accelerometer, outside air temperature indicator, brake pressure gage and the standby compass. BRT (cw rotation) — illuminates, then increases intensity of above lights.
16	SWITCH LIGHTS switch	OFF (fully ccw) — extinguishes switch lights on the ARMCOS, navigation control, integrated radio control, and flight control test panels. BRT (cw rotation) — illuminates, then increases intensity of above switch lights.
17	EMER INSTR LIGHTS switch	TEST — disconnects normal power supply from pilot instrument floodlights and connects emergency dc power supply to pilot instrument floodlights, eject control panel lights, and APU pressure gauge light. OFF — disconnects emergency dc power supply from aircraft lighting and connects it to battery trickle charger. AUTO — permits emergency dc power supply to be automatically connected to pilot instrument floodlights, eject control panel lights, and APU pressure gauge light when normal power supply fails. **Note** In aircraft incorporating AFC-279, the EMER INSTR LIGHTS switch also controls power from the Emergency NAV Battery. In the AUTO position, it permits power to be supplied for basic navigation and flight display system in the event of dual generator failure.

Figure 2-31. Cockpit Interior Lighting Control Panels (Sheet 5)

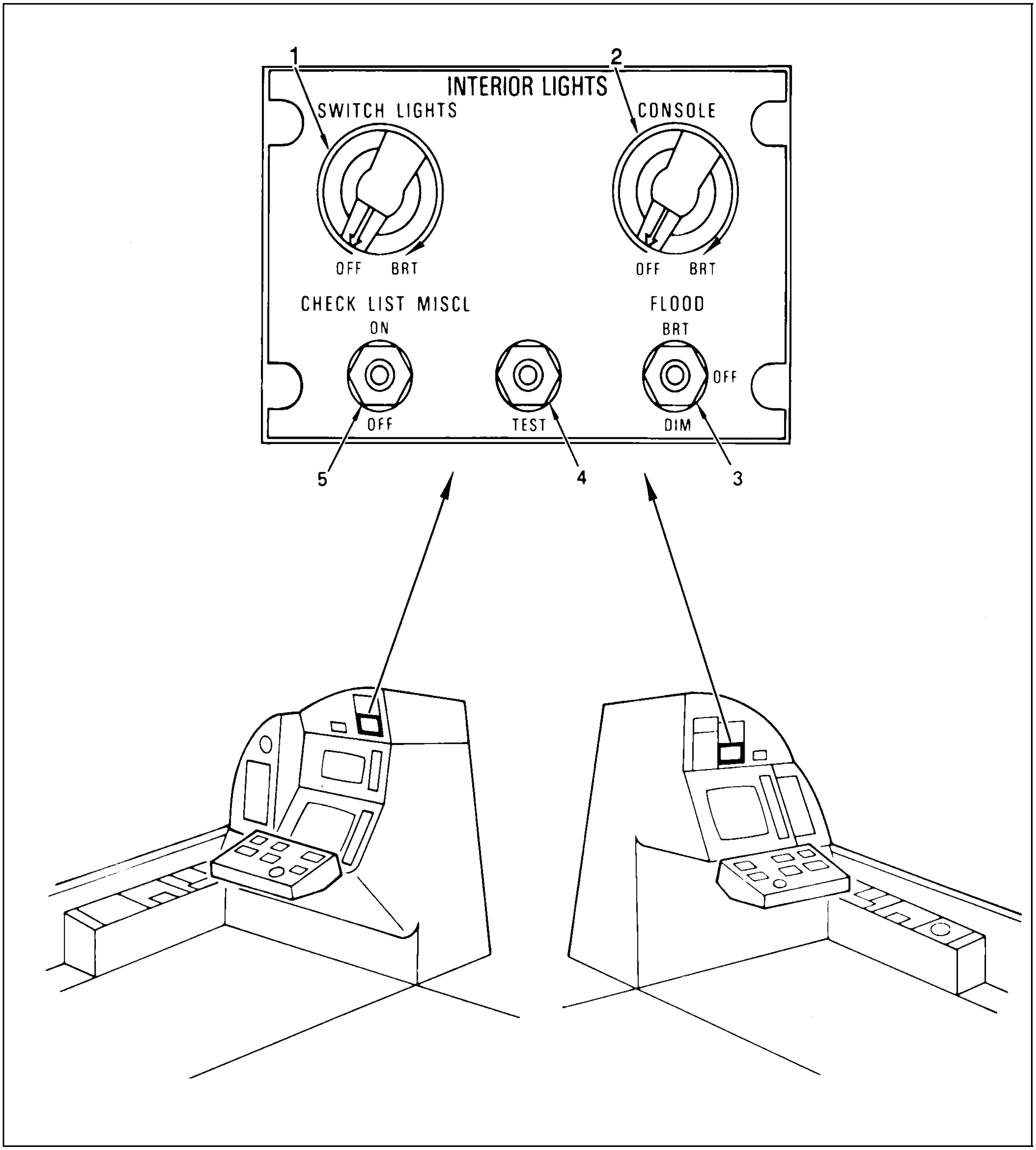


Figure 2-32. Crew Stations Interior Lighting Control Panels (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	SWITCH LIGHTS switch (TACCO)	OFF (fully ccw) — extinguishes switchlights on TACCO ICS panel, manual search stores control indicator, and TACCO INCOS tray. BRT (cw rotation) — illuminates TACCO ICS panel switch lights, then increases intensity of all above-listed lights. **Note** Some switch lights on these panels are illuminated by the GPDC.
1	SWITCH LIGHTS switch (SENSO)	OFF (fully ccw) — extinguishes switchlights on SENSO ICS panel and SENSO INCOS tray. BRT (cw rotation) — illuminates SENSO ICS panel switchlights, then increases intensity of all above-listed lights. **Note** Illumination of selected switchlights on SENSO INCOS tray is controlled by the GPDC.
2	CONSOLE switch (TACCO and SENSO)	OFF (fully ccw) — extinguishes (TACCO, SENSO) interior lighting control panel, oxygen panel, and seat control panel. BRT (cw rotation) — illuminates, then increases intensity of above-listed lights.
3	FLOOD switch (TACCO and SENSO)	BRT — illuminates (TACCO, SENSO) floodlight at high intensity. DIM — illuminates (TACCO, SENSO) floodlight at low intensity. OFF — extinguishes (TACCO, SENSO) floodlight.
4	TEST switch (TACCO and SENSO)	Pressed — illuminates EJECT light and switchlights at (TACCO, SENSO) stations. **Note** Switchlights controlled by GPDC are tested by program tapes.
5	CHECK LIST MISCL switch (TACCO)	ON — illuminates lights at TACCO checklist and manual stores panel. OFF — extinguishes same lights.
5	CHECK LIST MISCL switch (SENSO)	ON — illuminates lights at SENSO checklist. OFF — extinguishes same lights.

Figure 2-32. Crew Stations Interior Lighting Control Panels (Sheet 2)

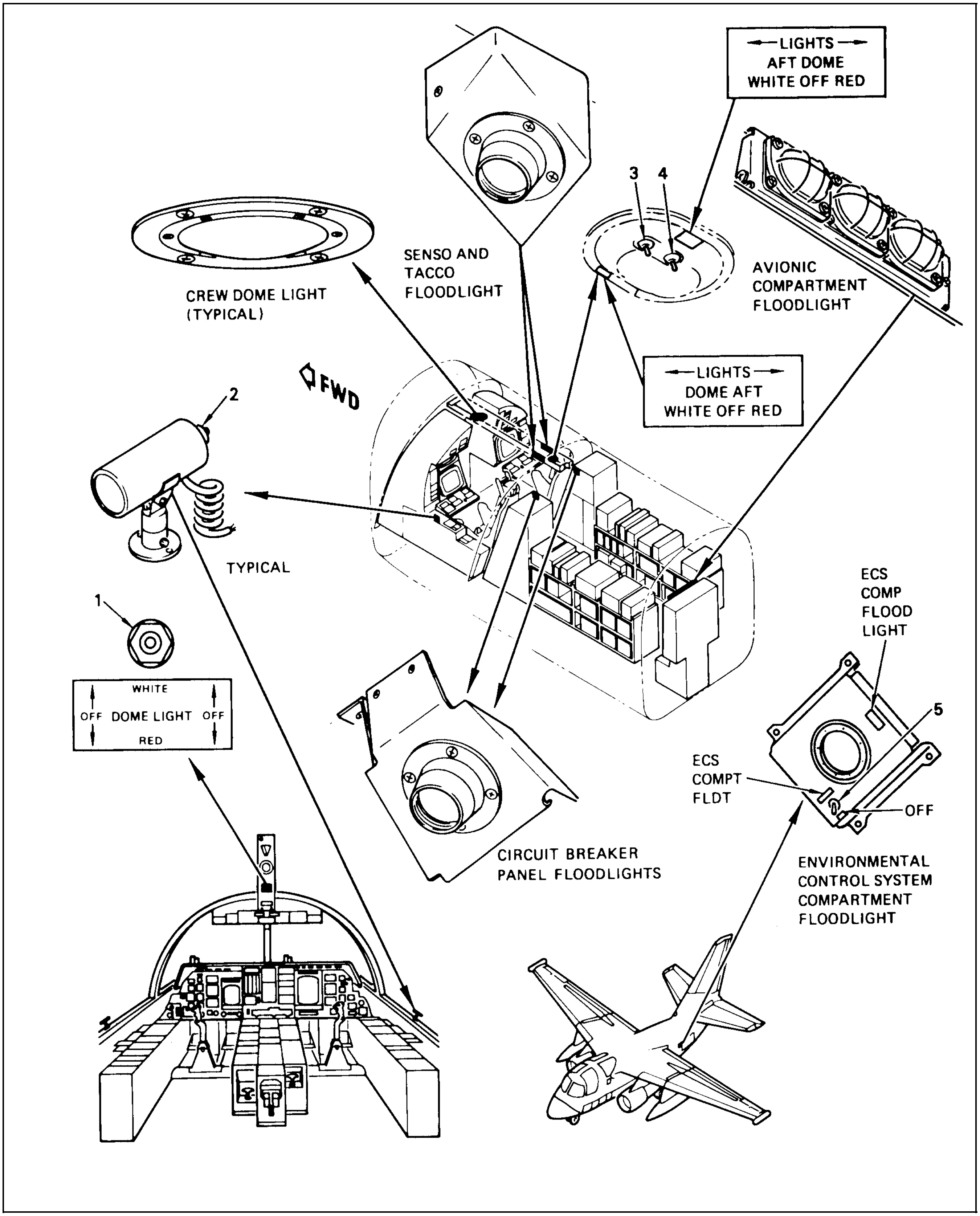


Figure 2-33. Utility and Dome Lighting System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Cockpit DOME LIGHT switch	WHITE (forward): ● Illuminates cockpit white dome light ● Overrides pilot flight instrument control step dimmer and sets cockpit warning, caution, and advisory lights to maximum intensity with the exception of APU RUN, APU auto shutdown DISARMED, and APU GEN on advisory lights RED (aft) — illuminates cockpit red dome light OFF (center) — extinguishes cockpit dome light
2	Utility light switch (pilot, copilot/COTAC, SENSO, and TACCO stations)	Rotary switches: ccw rotation — reduces intensity until light is extinguished cw rotation — increases intensity until light is full bright pressed — bypasses rotary switch to illuminate light at full bright released — permits rotary switch to control intensity.
3	Crew station dome light switch (on crew station overhead center line)	WHITE (forward) — illuminates crew dome white light only. RED (aft) — illuminates crew dome red light only. OFF (center) — extinguishes crew dome lights.
4	AFT AVIONICS LIGHT switch (on crew station overhead center line)	WHITE (forward) — illuminates two avionics bay white lights mounted on general purpose digital computer and illuminates right and left circuit breaker floodlights. RED (aft) — illuminates only avionics bay red light mounted on general purpose digital computer. OFF (center) — extinguishes avionics bay lights and right and left circuit breaker floodlights.
5	ECS DOME LIGHT switch (adjacent to ECS light in ECS compartment)	ON (up) — illuminates ECS light. OFF (down) — extinguishes ECS light.

Figure 2-33. Utility and Dome Lighting System Controls and Indicators (Sheet 2)

3. Aerial refueling probe light
4. Landing and taxi light
5. Approach lights
6. Direct lift control light
7. Formation lights.

2.6.1.9 Wing and Tail Position Lights. The wing and tail position lights are conventional, consisting of a red light mounted on the left wingtip, a green light mounted on the right wingtip, and a white light mounted on the aft portion of the tailcone assembly. The wing and tail position lights may be selected independently and can be illuminated steady or flashing. Power to the position lights is provided by the essential ac bus through a circuit breaker labeled POSITION LIGHTS; however, control is from the 28-volt primary dc bus. A green wing roll (position) light is provided on the right ESM antenna pod for wing position reference at night by the LSO. It is controlled by the WING POSITION exterior light switch.

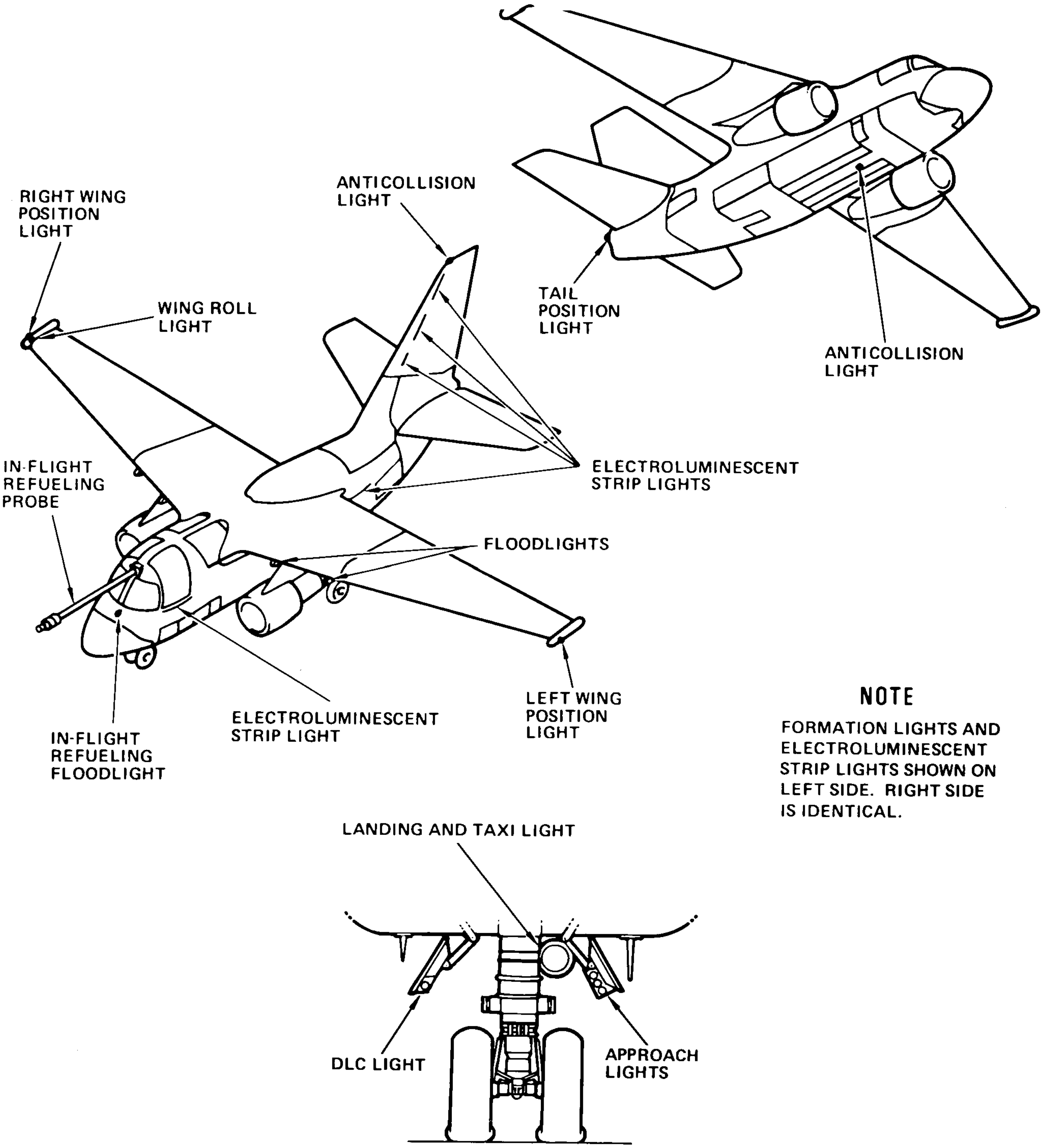


Figure 2-34. Exterior Lights Location

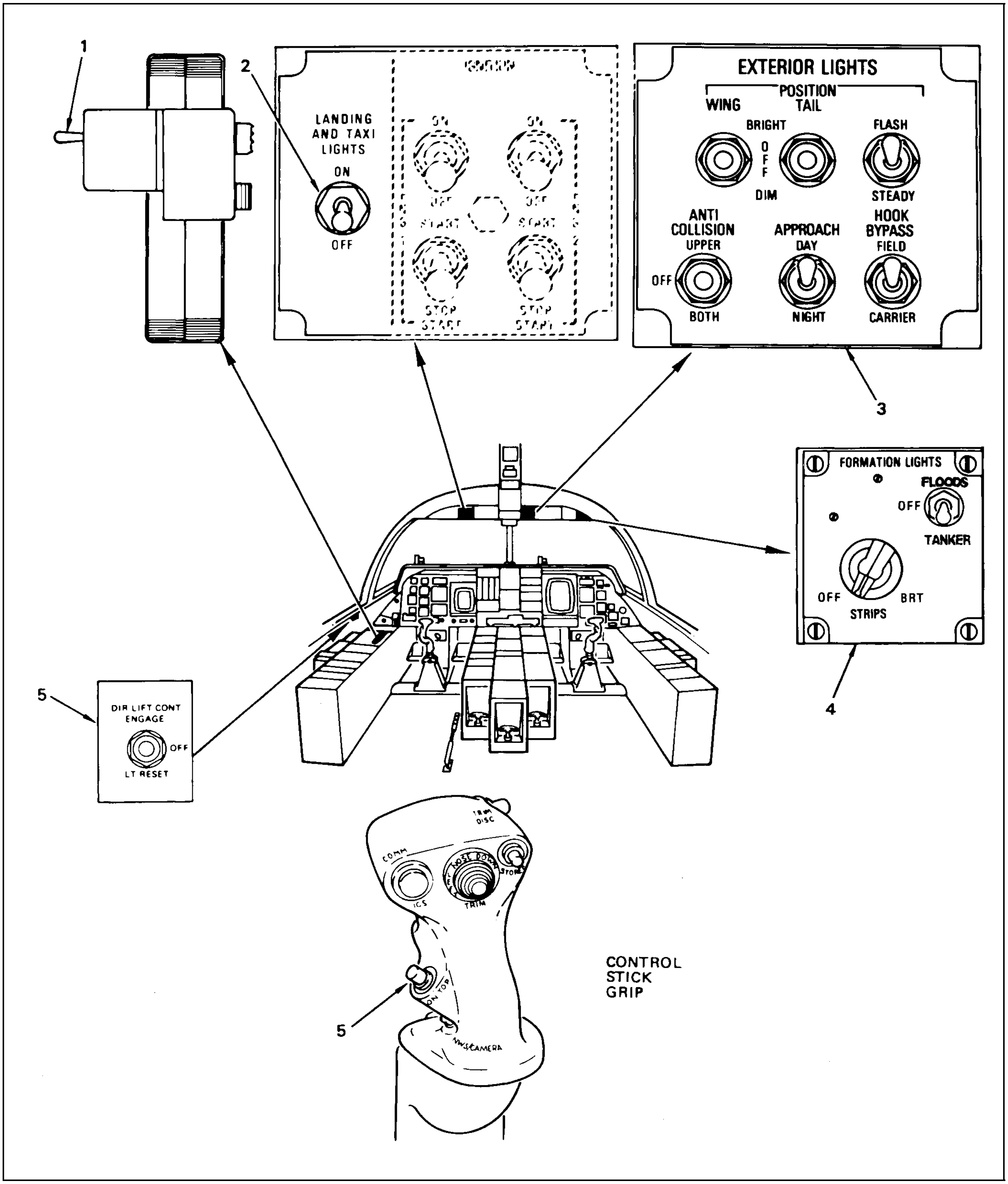


Figure 2-35. Exterior Lighting Control Panels (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Master exterior light switch	ON — (forward) provides power for exterior lights. OFF — (center) removes power from exterior lights. MOM — (aft) provides power for exterior lights as long as switch is held in this position. **Note** Master exterior light switch must be actuated to operate any exterior lights except approach lights and DLC light.
2	LANDING AND TAXI LIGHT switch	ON — illuminates landing and taxi light. OFF — extinguishes landing and taxi light.
3	EXTERIOR LIGHTS panel:	
	POSITION lights:	
	WING AND TAIL LIGHT switches **Note** Wing roll (position) light is controlled by the WING light switch.	BRIGHT — provides power to external position (and wing roll) lights at increased intensity. OFF — removes power from external position lights. DIM — provides power to external position (and wing roll) lights at decreased intensity.
	FLASH/STEADY	FLASH — causes wing and tail (and wing roll) light to flash. STEADY — causes wing and tail (and wing roll) light to remain steady.
	ANTICOLLISION	UPPER — illuminates and rotates upper anticollision light. OFF — extinguishes and stops rotation of both anticollision lights. BOTH — illuminates and rotates upper and lower anticollision lights.
	APPROACH light switch	DAY — illuminates approach lights to bright. NIGHT — illuminates approach lights to dim.
	HOOK BYPASS switch	FIELD — permits steady illumination of approach lights during field carrier landing practice with arresting hook up or down. CARRIER — causes steady illumination of approach lights with arresting hook down and flashing illumination with arresting hook up. **Note** The FIELD CARRIER switch automatically goes to the CARRIER position whenever the arresting hook is placed in the down position.

Figure 2-35. Exterior Lighting Control Panels (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
4	FORMATION LIGHTS panel:	
	FLOODS	FLOODS — the lights near the wing access panels illuminate the rounded forward section of the fuselage and radome. The lights near the pylon access door illuminate the engine nacelle and pod and the V pattern. OFF — removes power from the FLOOD LIGHTS/TANKER light. TANKER — illuminates TANKER light mounted under the port wingtip of the ESM pod and the four floodlights as described under FLOODS.
	STRIPS	BRT — provides power to the electroluminescent strips. OFF — removes power from the electroluminescent strips.
5	LIFT CON (DLC) switch and control stick ON TOP button	When the DLC switch is placed in the ENGAGE position, DLC is enabled if the gear handle is down and the weight is off the gear. Under this condition, pressing either pilot or copilot/COTAC ON TOP button will activate DLC and the exterior DLC approach light will illuminate, indicating to the LSO that DLC is in use.

Figure 2-35. Exterior Lighting Control Panels (Sheet 3)

2.6.1.10 Anticollision Lights. Two anticollision lights are provided, one mounted on the bottom of the fuselage forward of the bomb bay doors, and one mounted on the tip of the vertical stabilizer. The anticollision lights are rotating beacons that provide 70 to 90 flashes per minute when the master exterior light switch is on. Power is provided by the left primary ac bus through a circuit breaker labeled ANTI COLLISION LT. Selection is provided for the upper light only or both upper and lower lights simultaneously. During ARS tanker operations, the anticollision lights will be installed with green lenses for tanker identification.

CAUTION

Green anticollision lights are more vertigo inducing while flying in IMC conditions.

Note

During tanker operations, the lower anticollision light will not be readily visible to a rendezvousing receiver with less than 1,000 feet of stepdown because of the tanker's blade antenna and fuselage blocking the lower light.

2.6.1.11 In-Flight Refueling Probe Floodlight. This light, located forward of the windshield in the upper fuselage, illuminates the refueling probe nozzle when the refueling probe is extended. Illumination of this red light is automatic with initial probe extension provided the master exterior light switch, located on the outboard side of the pilot throttle, is actuated. Full retraction of the probe extinguishes the light. Power to the probe floodlight is provided by the left primary dc bus through a circuit breaker labeled IFR PROBE FLDT.

2.6.1.12 Landing and Taxi Light. The landing and taxi light, mounted on the left side of the nosewheel landing gear strut, provides illumination during night operation. The LANDING AND TAXI LIGHT switch is located outboard on the pilot eyebrow panel. When the switch is actuated with the master exterior light switch on, the light will illuminate if the right main landing gear is down and locked. Power to the light is provided by the left primary ac bus through a circuit breaker labeled LAND/TAXI LT.

2.6.1.13 Approach Lights. The approach lights consist of a vertical set of three lights (green, amber, and red) located on the leading edge of the nosegear left door. The approach lights illuminate when the launch bar is up, landing gear is down, and weight is off wheels. If the arresting hook is not down, the approach lights will flash. A HOOK BYPASS switch (FIELD, CARRIER) is provided to provide steady approach lights during a field landing when the hook is not extended. The approach lights are illuminated individually in response to signals from the AOA indicator and are coordinated with the approach indexers in the cockpit. Power is provided by the essential dc bus through a circuit breaker labeled APRCH LT & ANGLE OF ATCK SYS.

2.6.1.14 Direct Lift Control Light. The DLC light is a blue light located on the leading edge of the nosegear right door. The DLC light illuminates when the gear handle is down with weight off wheels, the DLC switch is engaged, and the DLC is operated by pressing the pilot or copilot/COTAC ON-TOP button.

2.6.2 Formation Lights. A system of floodlights and electroluminescent strip lights provide exterior illumination during night formation.

Formation lights receive power through three circuit breakers. Two circuit breakers located on the left fixed circuit breaker panel essential ac bus (labeled FORMATION LIGHTS, STRIP, and FLOOD) and one circuit breaker located on the right fixed circuit breaker panel essential dc bus (labeled EXT LIGHT CONT). For aircraft not incorporating AFC-279 see Figures 2-24 and 2-28. For aircraft incorporating AFC-279 see Figures 2-25 and 2-29.

2.6.2.1 Floodlights. Four blue/green floodlights are installed near the following locations (see Figure 2-34):

1. Left and right wing access panels
2. Left and right pylon access doors.

The inboard floodlights illuminate the rounded, forward section of the fuselage and radome. The outboard floodlights illuminate the V pattern on the engine nacelles and the inboard pod area.

The TANKER light is installed under the port wingtip ESM pod. The lens of the TANKER light is divided into a red and white lighted section. The red light illuminates aft, providing a wing position reference for the tanking aircraft when behind the tanker. The white section illuminates the forward section of the buddy store.

The FLOODS/OFF/TANKER control switch is located on the FORMATION LIGHTS control panel, located on the cockpit overhead eyebrow panel (see Figure 2-35). In the FLOODS position, all four floodlights are illuminated. In the TANKER position, the TANKER light and all four floodlights are illuminated.

2.6.2.2 Strip Lights. There are 10 electroluminescent strip lights in the following locations:

1. One 24-inch strip on the fuselage below the pilot and copilot/COTAC canopies
2. One 36-inch strip on each side of the fuselage, just forward of the external aft bay doors
3. Six strips, three on each side of the vertical fin (one 12-inch strip and two 24-inch strips) near the leading edge (see Figure 2-34).

The strip lights are activated by rotating the STRIPS rotary switch in a clockwise direction for the desired intensity.

2.6.3 Warning, Caution, and Advisory Lights. Warning, caution, and advisory information is provided visually to crewmembers for rapid fault analysis of aircraft system failure or to alert the operators of advisory or precautionary operations. Red (warning), amber (caution), or green (advisory) lighted legends (or lights) illuminate when the appropriate information is detected. A TEST pushbutton switch, located on the master caution panel in the cockpit, is provided to check all signal lights appearing on the master caution panel, the advisory panel, the electrical control panel, the discrete word display panel, the approach indexers, the failure annunciator panel, and the head up annunciator panel. It also tests the SRCH PWR light, MSTR ARM light, NWS light, HOOK light, EHP light, landing gear handle light, WHEELS light, RAAWS light, and engine overspeed and overtemperature lights. In addition, it causes the amber master CAUTION light to illuminate steady. The master CAUTION light, located on the pilot and copilot/COTAC instrument panels, also illuminates when a fault has been detected by one of the individual fault function sensors. When either switch light is pressed, both master caution lights extinguish and reset to a ready condition.

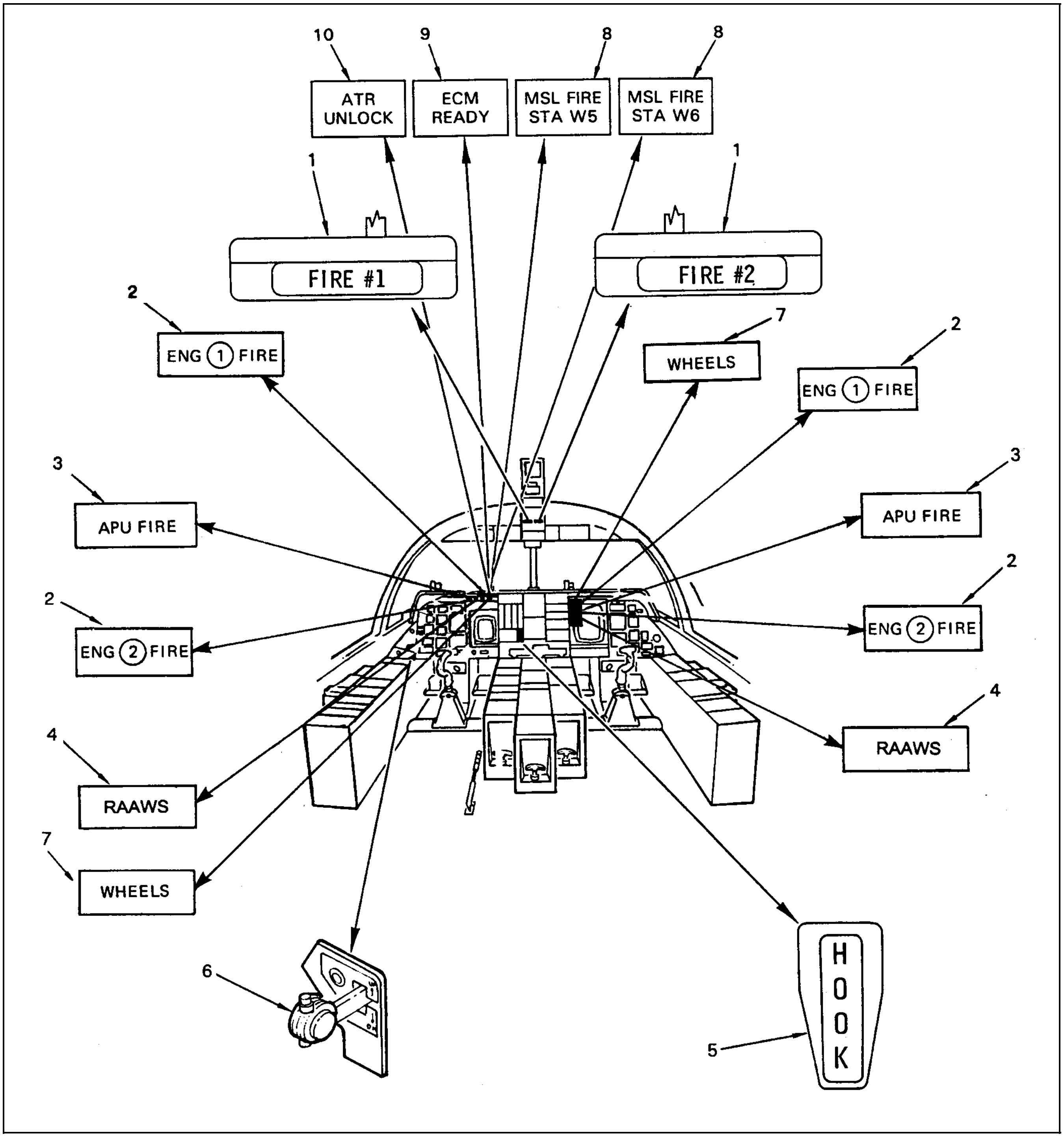


Figure 2-36. Warning Lights (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
1	FIRE #1 and FIRE #2	Indicates overheating or fire in indicated engine.
2	ENG 1 FIRE and ENG 2 FIRE	Indicates fire or overheating in indicated engine.
3	APU FIRE	Indicates fire or overheating in APU compartment.
4	RAAWS (flashing accompanied by 3-second 1000-Hz warning tone)	Landing gear extended or retracted — indicates to pilot or copilot/ COTAC that aircraft has descended to altitude marked by low altitude index triangle of respective radar altimeter. Landing gear retracted and flaps less than 57 percent: ● Indicates to pilot and copilot/COTAC that the aircraft has descended to 400 feet as indicated by the radar altimeter ● Indicates with a steady aural and visual warning to the pilot and copilot/COTAC that the aircraft is at or below 200 feet as indicated by the radar altimeter.
5	Hook handle light	Indicates hook is not in agreement with position of the hook handle.
6	Landing gear handle light	Indicates position of one or more landing gear or that landing gear relay* is different from position of handle.
7	WHEELS (flashing)	Illuminated flashing indicates all the following conditions have been met: ● Trailing edge flaps beyond 57 percent range of travel. ● Angle of attack midpositioned (centered). ● One or more gear indicate not down and locked.
8	MSL FIRE STA W5 and W6	Indicates fire on indicated wing station.
9	ECM READY	Indicates ECM dispensing is available.
10	ATR UNLOCKED	Indicates analog tape recorder on hinged rack, left internal avionics bay is not secured.
*Aircraft BUNO 159758 and subsequent and aircraft incorporating AFC-115.		

Figure 2-36. Warning Lights (Sheet 2)

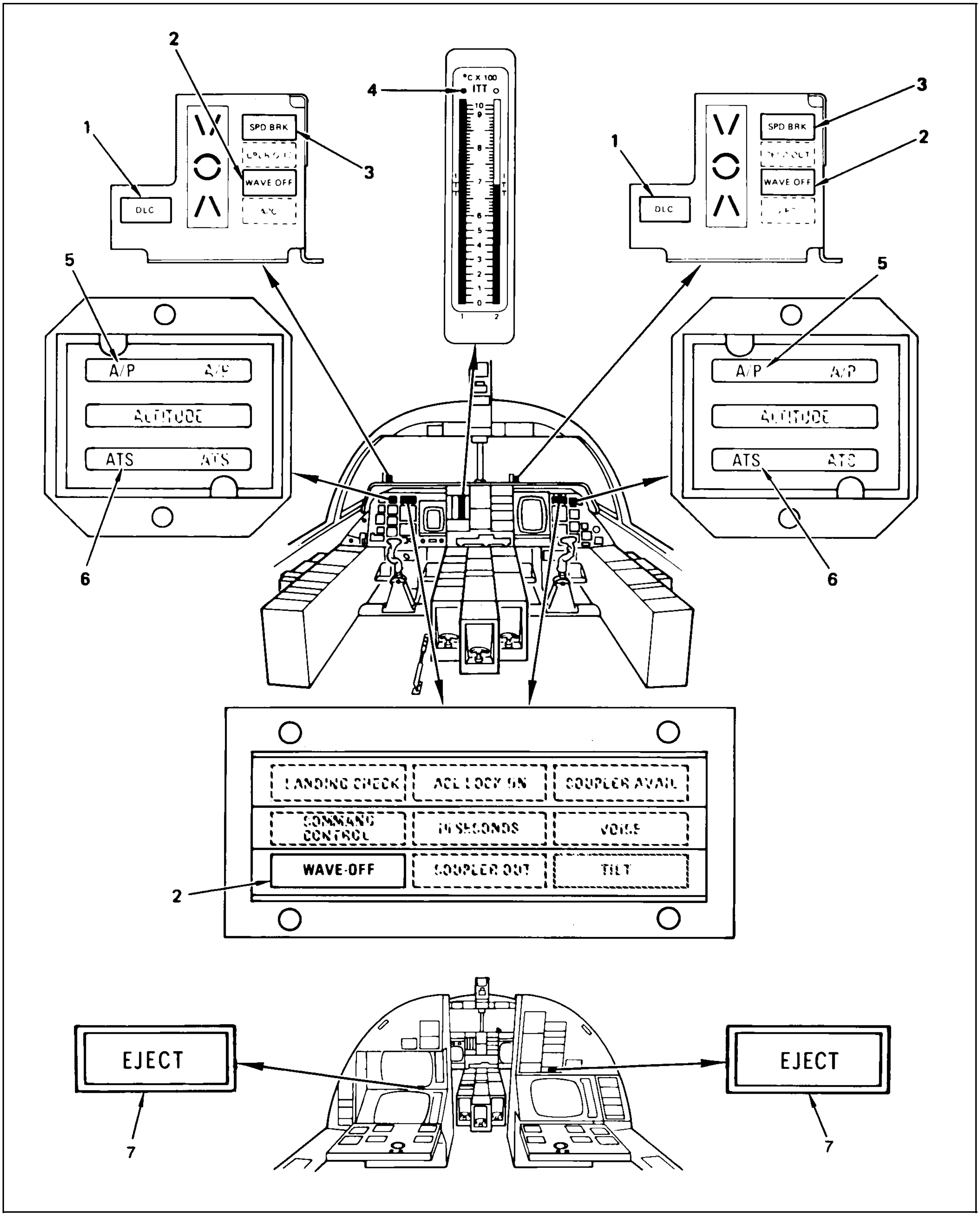


Figure 2-36. Warning Lights (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	DLC (flashing)	Indicates failure or disengagement of DLC system.
2	WAVE-OFF (flashing)	Indicates failure has occurred in shipboard ACLS equipment and landing system has been disengaged, or LSO commands wave-off.
3	SPD BRK	Indicates speedbrakes extended and either: 1) throttles advanced to full power; or 2) aircraft is at 17 units or greater angle of attack.
4	ITT	Indicates interurbine temperature has exceeded preset value of 835 to 843 °C.
5	A/P (flashing)	Indicates autopilot system disengaged by means other than switch on pilot or copilot/COTAC control stick or normal landing touchdown.
6	ATS (flashing)	Indicates autothrust system disengaged by means other than pilot NWS switch or normal landing touchdown.
7	EJECT (flashing)	Indicates EJECT alert switch is in ON position.

Figure 2-36. Warning Lights (Sheet 4)

The warning, caution, and advisory lights are displayed in Figures 2-36 through 2-38. Refer to the appropriate system description for additional information.

2.7 CONTROL LOGIC ASSEMBLY

The CLA is a solid-state control device designed to permit or inhibit the functioning of controlled systems and subsystems. The assembly receives and combines electrical inputs from switches, relays, and sensors to solve predetermined logic equations. The solution to these logic equations is the output used to control solid-state driver switches that, in turn, control the various functions.

Two control logic assemblies, left CLA and right CLA, are provided. The assemblies are similar in design but have different logic equations assigned for processing. A few logic equations are processed by both CLAs.

Each CLA has two independent 28-vdc power sources fed from separate buses. The left CLA is powered from the essential dc start bus and the left primary dc bus. The right CLA is powered from the essential dc start bus and the right primary dc bus.

WARNING

If electrical power is interrupted to the right CLA and subsequently reapplied, the wing racks will unlock (wing stores will not jettison). If electrical power is interrupted to the right CLA and the sonobuoy safety door is closed, the sonobuoys on the jettison circuit will jettison. Electrical power can be interrupted by securing then restoring all essential bus power or by cycling the right CLA circuit breakers (3-G-15 and 4-D-16). If it becomes necessary to interrupt power to the right CLA, jettison of sonobuoys can be prevented by pulling the search stores control circuit breaker (3-D-13) and wing rack unlock can be prevented by pulling the wing jettison circuit breaker (4-B-1).

See Part V for control logic assembly failure charts.

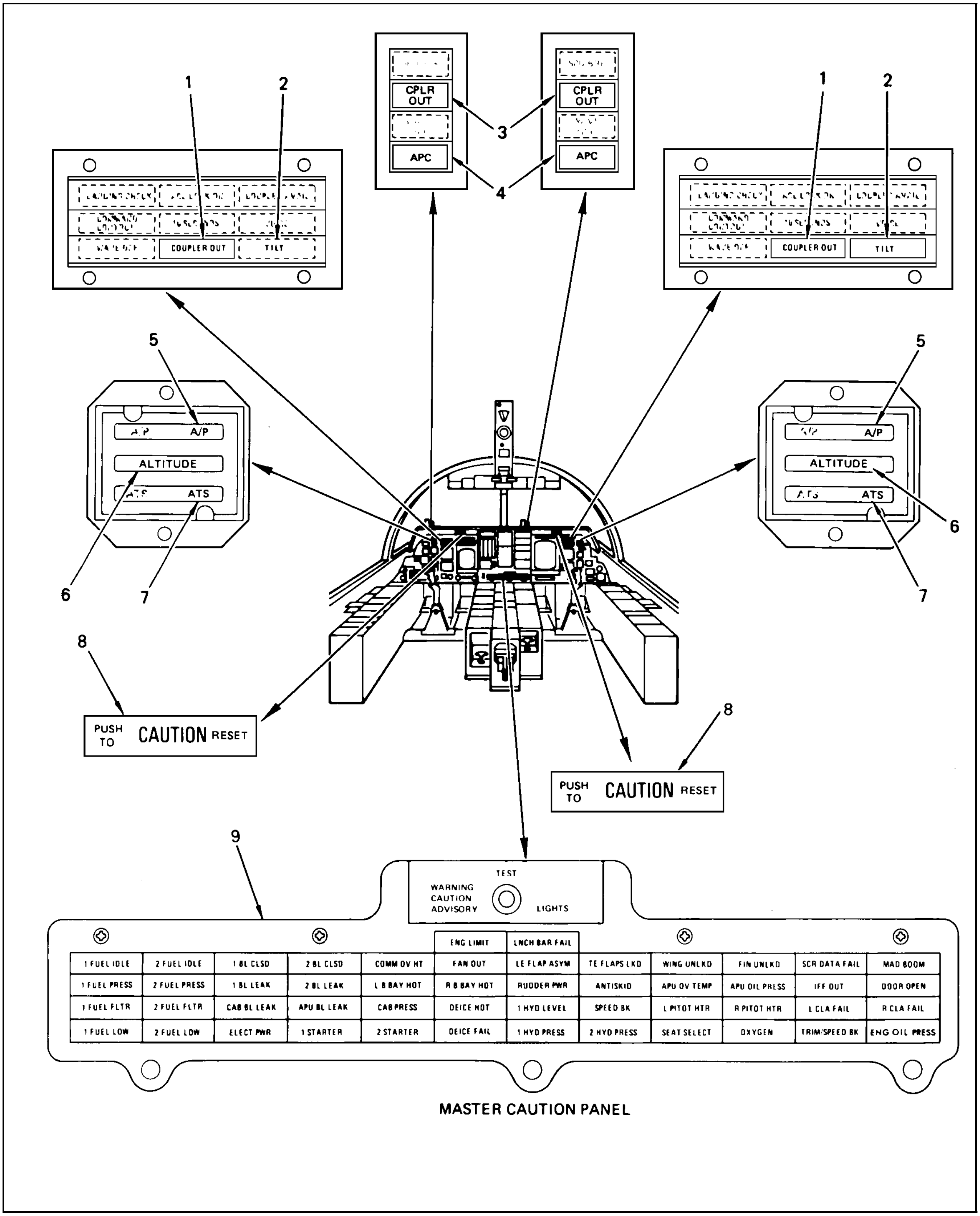


Figure 2-37. Caution Lights (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
1	COUPLER OUT (flashing)	Indicates that autopilot is no longer coupled to ASW-25 computer link, Mode I approach is not available, and approach must be made manually.
2	TILT	Indicates information stored in ACLS data link (ASW-25) has not been updated in last 2.5 seconds or aircraft receiver is inoperative.
3	CPLR OUT (flashing)	Repeats the caution of the COUPLER OUT caution light on the discrete word display.
4	APC (flashing)	Indicates that the automatic disengagement of APC mode has occurred.
5	A/P	Indicates that an axis or mode of APS is engaged in a non-fail-safe, single-channel configuration or that the attitude reference source switch for single-channel ACLS operation is *not* in the NORM position and pitch or roll APS is engaged.
6	ALTITUDE	Indicates that pitch APS is engaged, altitude hold mode is not engaged, or the APS and APC are operating and ACLS is not engaged.
7	ATS	Indicates that ATS is engaged in a non-fail-safe, single-channel configuration.
8	CAUTION (flashing)	Indicates that a fault has been detected by one of the fault function sensors.
9	Master Caution Panel	Refer to Master Caution Panel Lights/Action, Part V.

Figure 2-37. Caution Lights (Sheet 2)

2.8 HYDRAULIC POWER SYSTEM

Hydraulic power requirements for the S-3B aircraft are provided by two independent 3,000-psi systems (see Figure 2-39). System No. 1 supplies pressure to the flight controls and utility subsystem and is powered by the No. 1 engine-driven pump or the EHP. The EHP (2,850 psi) is used for takeoff, landing, functional checkouts, and in flight, if the No. 1 hydraulic pump fails. The EHP system includes safety devices to shut off the pump if leaks, overheating, or differential current draw occur. System No. 2 is powered by the No. 2 engine-driven pump and supplies pressure for the flight controls only. Independent self-pressurized reservoirs provide positive pressure to the engine-driven pumps regardless of aircraft attitude. Utility services supplied by the No. 1 system are:

1. Flaps (trailing edge)
2. Landing gear
3. Brakes (normal and antiskid)
4. Nosewheel steering
5. Launch bar
6. Wing and fin fold
7. Arresting hook retract

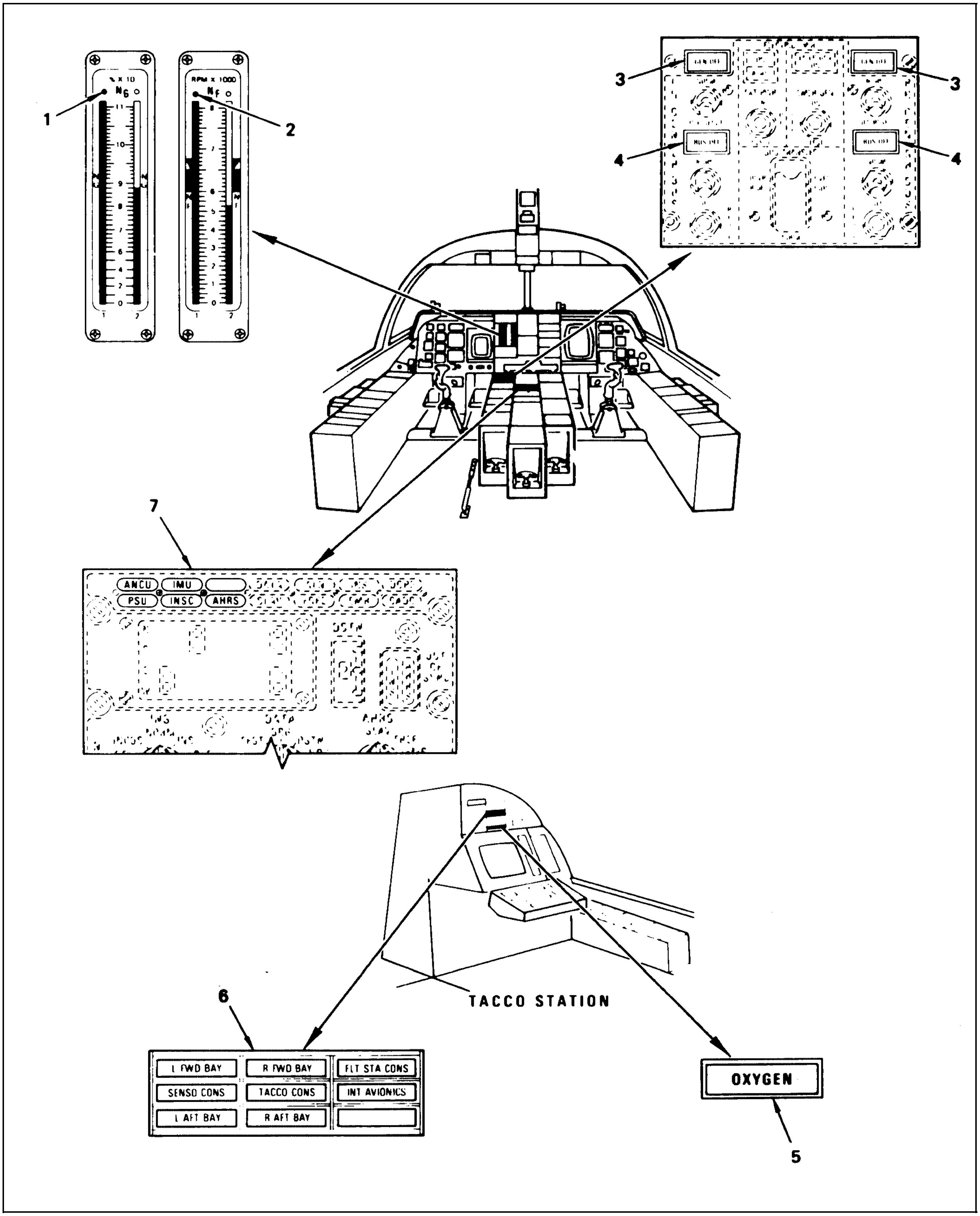


Figure 2-37. Caution Lights (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	N_g	Indicates engine rpm has exceeded preset value of 100%.
2	N_f	Indicates fan rpm has exceeded preset value of 7760 to 7825 rpm.
3	LH or RH GEN OFF	Indicates related GEN switch is in OFF/RESET position, generator has failed, or engine rpm is below generator cut-in speed.
4	LH or RH BUS OFF	Indicates primary ac bus is not powered.
5	OXYGEN	Indicates one of the following: ● Less than one liter remaining. ● Converter pressure low.
6	ECS Fan Fault Panel:	
	L FWD BAY (or) R FWD BAY	Indicates cooling fan in respective bay has failed.
	SENSO CONS (or) TACCO CONS	Indicates respective cooling fan has failed.
	INT AVIONICS	Indicates respective cooling fan has failed.
	FLT STA CONS	Indicates respective cooling fan has failed.
	L AFT BAY	Light inoperative (provisions only).
	R AFT BAY	Indicates cooling fan in right aft bay has failed.
7	Navigation Panel: (Aircraft not incorporating AFC-279)	
	ANCU	Indicates malfunction of the air navigation computer unit.
	IMU	Indicates malfunction of the inertial measurement unit.
	PSU	Indicates malfunction in the inertial navigation system power supply unit.
	INSC	Indicates malfunction of the inertial navigation system converter.
	AHRS	Indicates malfunction of the attitude heading reference system.

Figure 2-37. Caution Lights (Sheet 4)

8. Bomb bay doors
9. APU start accumulator
10. Emergency brake accumulator.

Systems No. 1 and No. 2 both power the following flight controls:

1. Spoilers and speedbrakes
2. Elevator
3. Rudder
4. Ailerons.

Both systems operate the flight controls by means of dual actuating cylinders. An isolation valve in hydraulic system No. 1 isolates the landing gear, brakes, nosewheel steering, launch bar, and wing/fin fold from the remaining utility subsystems, when the landing gear is retracted normally or extended by the emergency method. Two accumulators are located in the No. 1 system: one, a brake accumulator, provides 10 full brake applications in an emergency and parking brake pressure; the other provides pressure for starting the APU.

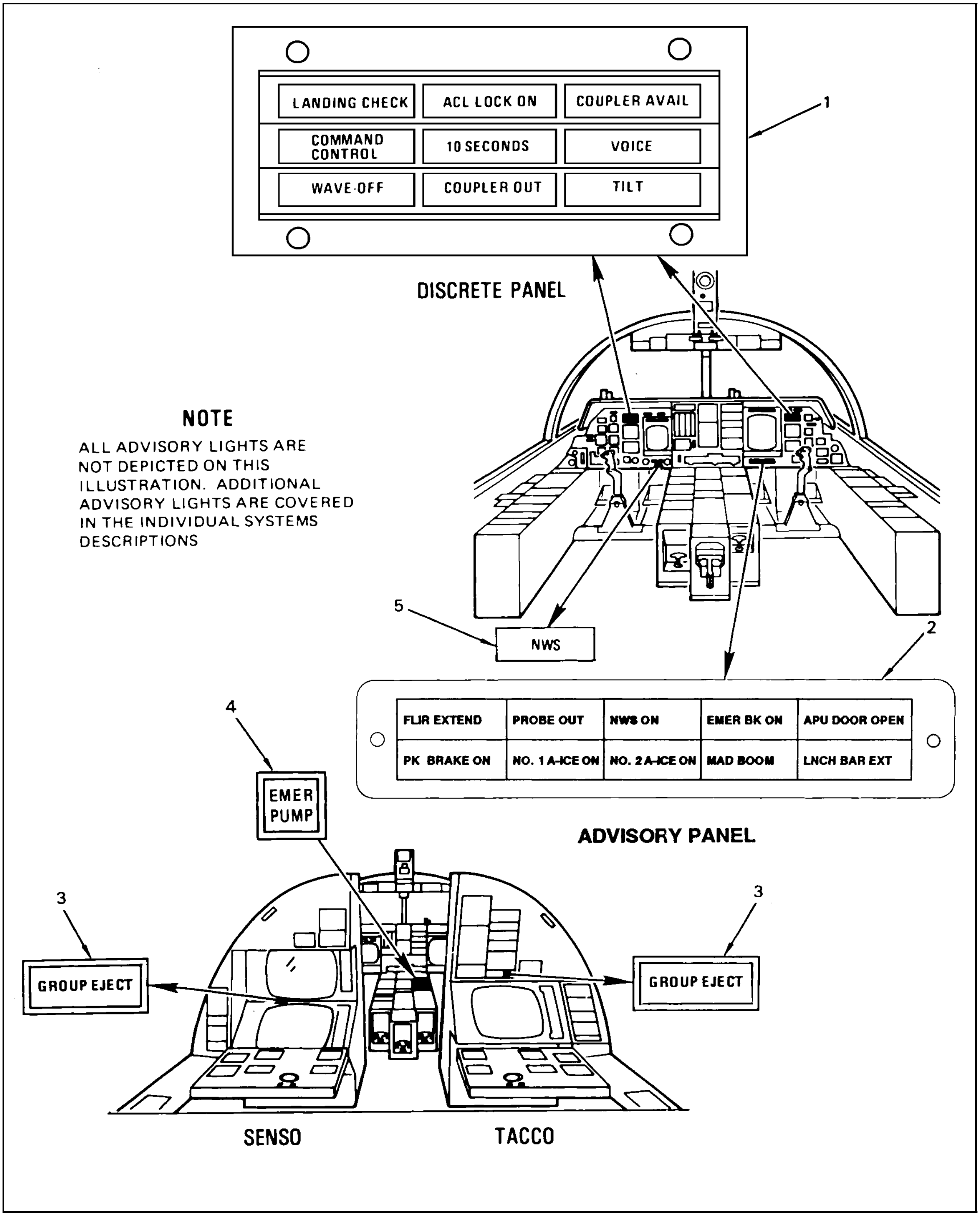


Figure 2-38. Advisory Lights (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Discrete Panel:	
	LANDING CHECK	Indicates that the CCA controller has inserted the aircraft address and the landing check should be completed.
	ACL LOCK ON	Indicates ACLS radar has locked on.
	COUPLER AVAIL	Advises pilot that commands from shipboard computer in Landing Control Central are in proper format to control aircraft in pitch and roll.
	COMMAND CONTROL	Indicates ACLS is controlling aircraft in pitch and roll.
	10 SECONDS	Advises pilot that deck motion compensation of the touchdown point has been added to the glidepath pitch commands from the Landing Control Central, and that the aircraft is within 12.5 seconds from touchdown.
	VOICE	Indicates signal format precludes Mode I and II approaches and that Mode III approach should be made with standard voice commands as in normal CCA recovery. Flickering during SINS alignment indicates receipt of data.
2	Advisory Panel:	
	FLIR EXTEND	Indicates the turret assembly has been fully extended or is retracting.
	PROBE OUT	Indicates refueling probe is fully extended or is retracting.
	NWS ON	Indicates nosewheel steering system has been selected.
	EMER BK ON	Indicates emergency brake system operation.
	PK BRAKE ON	Indicates parking brake is set.
	APU DOOR OPEN	Indicates APU exhaust door is open.
	1 and 2 A-ICE ON	Indicates engine anti-icing system valve is open allowing bleed air to be distributed to the anti-iced sections of the engine.
	MAD BOOM	Indicates that the MAD boom is fully extended or is retracting.
	LNCH BAR EXT	Indicates that the launch bar switch is positioned to EXT, the launch bar is extended or not up and locked.
3	GROUP EJECT	Indicates either pilot or copilot/COTAC command eject selection lever is in down (group ejection) position.
4	Copilot/COTAC Throttle Panel: EMER PUMP	Indicates the emergency hydraulic pump (EHP) is powered and running.
5	NWS	Indicates nosewheel steering is on.

Figure 2-38. Advisory Lights (Sheet 2)

The emergency hydraulic pump or a handpump installed in the cockpit can provide pressure for both accumulators when the No. 1 engine is not running or the No. 1 system is not pressurized by a ground source. The emergency hydraulic pump or the handpump may be used to pressurize the No. 1 system to retract the arresting hook if hydraulic fluid is available. Hydraulic fluid of both systems is cooled by air/oil heat exchangers. Each system is protected by relief valves and filters. Ground test couplings (pressure and return) for each system are located above the left and right main wheelwells; the systems may be replenished with fluid through these couplings. Hydraulic system pressure gauges, labeled HYD PRESS FLT CON/UTLY (No. 1) and FLT CONT (No. 2), located on the center instrument panel (see Figure 2-40), indicate system pressure in psi.

The control switch for the emergency hydraulic pump is located adjacent to the copilot throttles on the center console. Hydraulic system low-pressure warning lights, located on the master caution panel (see Figure 2-40), illuminate the legends 1 HYD PRESS and 2 HYD PRESS whenever their respective system pressure drops below 1,900 psi. A No. 1 hydraulic reservoir low-level (1 HYD LEVEL) light is located on the master caution panel and illuminates when fluid level in the No. 1 system reservoir decreases to 2 gallons or less. In addition, a signal is sent to the low-level shutoff valve isolating the APU start accumulator and brake accumulator from the No. 1 system. The EHP will be inoperable. This prevents loss of brake accumulator fluid and ensures braking if the No. 1 hydraulic system is further depleted of fluid. Quantity gauges are provided at the bottom of the reservoirs to provide fluid level indication for exterior inspection.

2.8.1 Emergency Hydraulic Pump. An electrically driven EHP, located in the ECS compartment near the No. 1 system reservoir, provides an alternate source of hydraulic pressure for the No. 1 hydraulic system in the event the No. 1 pump or engine fails. The pump output pressure is 2,850 psi and will operate all No. 1 hydraulic system flight control and utility hydraulic subsystems with the exception of the cockpit automatic wing fold system. The cockpit wing fold system requires a flow greater than the EHP can provide. Wing fold and spread operations can be conducted using the manual control valves of the wing fold module with no damage to the wing fold mechanism.

CAUTION

The wings should not be folded or spread from the cockpit with the EHP on, if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wing.

The EHP is powered by the right primary ac bus through a hydraulic pump isolation relay, hydraulic pump control relay, and a motor protector relay. The motor protector relay senses current draw in all three phases of power. If a differential current draw is sensed, the relay energizes, interrupting power to the hydraulic pump isolation relay. The hydraulic pump isolation relay is utilized to remove ac power from the EHP if the motor protector relay is energized or the EHP motor overheats. The hydraulic pump control relay connects three-phase, ac power to the pump motor when the EMER PUMP switch is placed ON, provided the No. 1 reservoir quantity is greater than 2 gallons. Control power for the EHP system is provided by the right primary dc bus through a circuit breaker labeled EMER HYD PUMP CONT.

A hydraulic fuse is installed (Figure 2-39) to prevent pump cavitation during initial start up. An emergency hydraulic pump pressure switch (Figure 2-39) causes the EHP light, located in the copilot/ COTAC throttle panel, to illuminate when pump output pressure is greater than 2,200 psi and to extinguish when pump output pressure drops below 1,750 psi.

Two hydraulic quantity low-level relays are incorporated into the No. 1 hydraulic system. The first closes the low-level shutoff valve and illuminates the 1 HYD LEVEL caution light, when 2 gallons or less is detected in the No. 1 reservoir. The second relay removes power from the EHP control relay should a No. 1 hydraulic low-level condition exist.

The EHP system also incorporates a thermal switch to deenergize the motor if an overheat occurs. The thermal switch resets automatically when the pump motor cools.

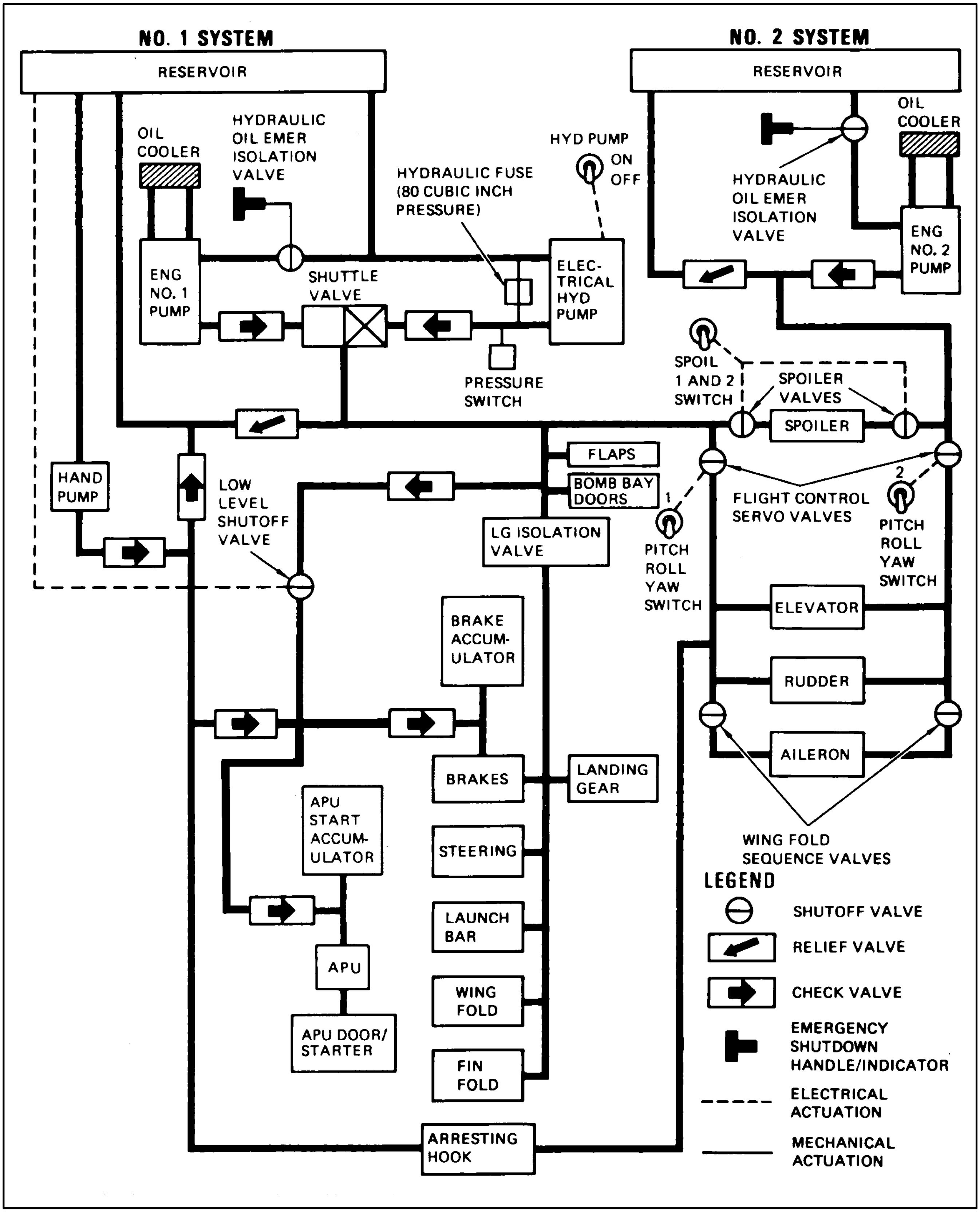
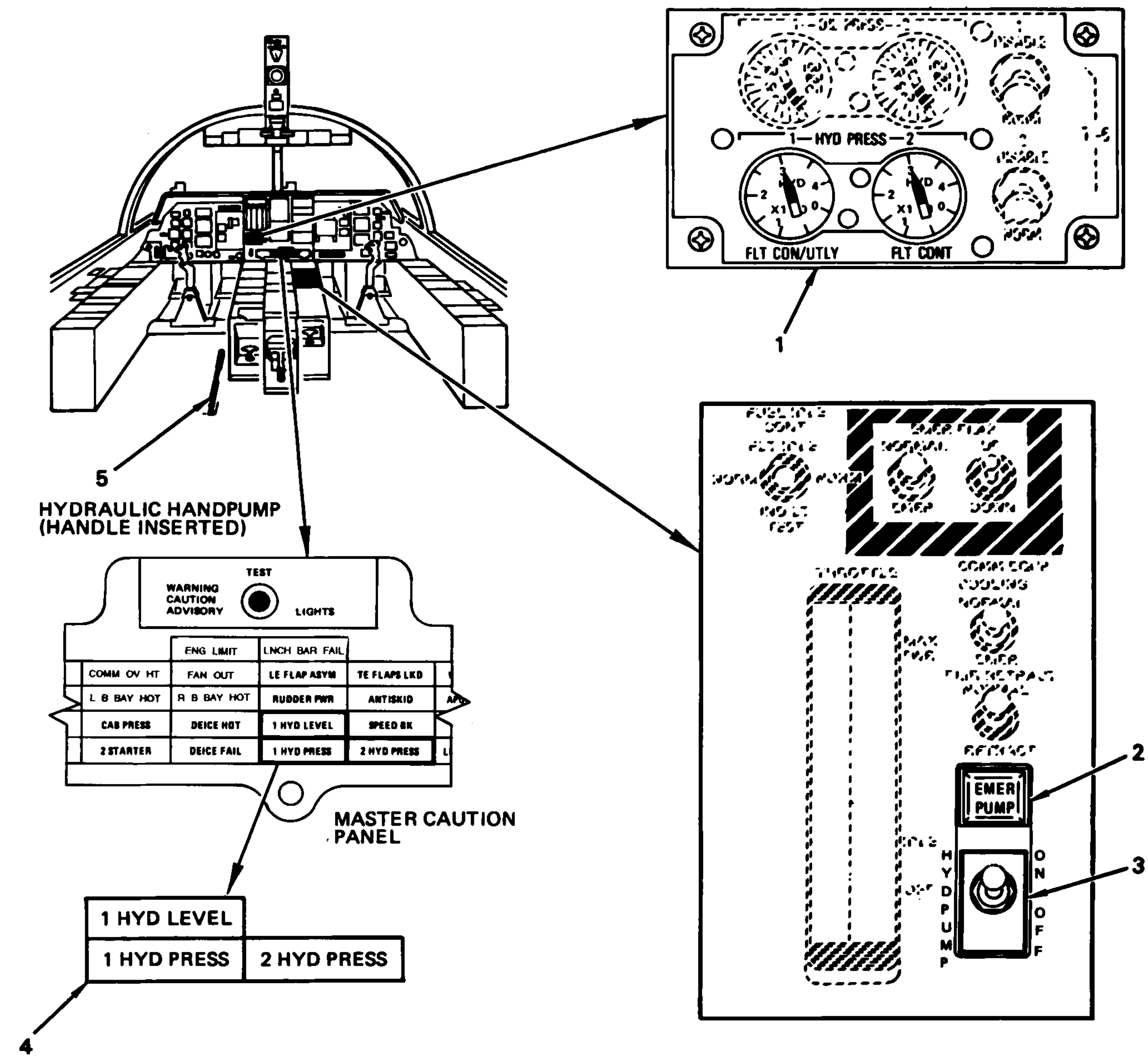


Figure 2-39. Hydraulic System



INDEX	CONTROL/INDICATOR	FUNCTION
1	Hydraulic systems pressure gauges:	
	FLT CON/UTLY indicator	Indicates No. 1 hydraulic system pressure.
	FLT CONT INDICATOR	Indicates No. 2 hydraulic system pressure.

Figure 2-40. Hydraulic System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
2	EMER PUMP light	Illuminated — indicates electrically driven hydraulic pump output pressure is greater than 2200 psi. Extinguished — indicates electrically driven hydraulic pump output pressure is less than 1750 psi. **Note** The EHP light will not illuminate when the HYD PUMP switch is placed ON if the No. 1 reservoir quantity is 2 gallons or less, pump motor is overheated, or differential current draw has been detected between phases.
3	HYD PUMP switch	ON — activates the emergency hydraulic pump and EHP light for No. 1 hydraulic system pressure when the No. 1 engine driven hydraulic pump is not available. OFF — deactivates the electrical pump. **CAUTION** Prior to activating the hydraulic pump when the system is connected to the carrier deck-edge power, deactivate avionic fans until pump motor is started, then reactivate.
4	Master Caution Panel: 1 HYD LEVEL light	Illuminated — indicates No. 1 system reservoir quantity 2 gallons or less and that the emergency brake and APU start accumulators are isolated from system number 1 charging pressure. The EHP will be inoperable. **CAUTION** Operation of the emergency handpump when the light illuminates may result in depletion of remaining hydraulic fluid if a leak in the line exists.
	1 HYD PRESS light 2 HYD PRESS light	Illuminated — indicates No. 1 system pressure below 1900 psi. Illuminated — indicates No. 2 system pressure below 1900 psi.
5	Hydraulic handpump	When handle is activated, pressurizes APU and brake accumulators and provides arresting hook retraction pressure (No. 1 system not pressurized).

Figure 2-40. Hydraulic System Controls and Indicators (Sheet 2)

2.8.2 Hydraulic Handpump. A manually operated hydraulic pump, mounted in the nose landing gear well, is hand driven from the cockpit to provide emergency brake accumulator, APU start accumulator, and arresting hook retraction pressure when No. 1 system hydraulic power is not available. The pump is operated through a handpump socket located under an access cover on the flight deck between the pilot seat and the center console. A pump handle is stowed behind the pilot along the ejection seat support rail.

2.8.3 Flight Control System. The primary flight control system (see Figure 2-41) consists of elevators and a trimmable, adjusted horizontal stabilizer, ailerons augmented by upper-and-lower-surface wing spoilers, and a rudder. The control surfaces (see Figure 2-42) are deflected by hydraulically powered, irreversible tandem actuators (no air-load feedback to controls). An artificial feel system is incorporated to give the pilot simulated feel of control surface deflection. Elevator-to-stick gearing is variable as a function of flap setting through the ratio changer. Each actuator is powered by the combined No. 1 and No. 2 hydraulic systems. Complete independence of the two hydraulic systems is maintained through mechanical separation, thus preventing the loss of both hydraulic systems through a single mechanical failure. If either system is inoperative, the remaining system has the capability of meeting all flight control requirements. The PRIM SERVO HYD PRESS (PITCH, ROLL, YAW) switches (Figure 2-43) for the No. 1 and No. 2 hydraulic systems control hydraulic power to the primary flight control servos. The SPOIL 1 and 2 switch controls the hydraulic power to the spoiler servos. The switches have two positions, OFF and NORM; the OFF position energizes solenoid valves to shut off the respective hydraulic power to the affected units. If a total loss of electrical power occurs, hydraulic power will still be available. The solenoid valves require electrical power to shut off hydraulic power to their respective systems.

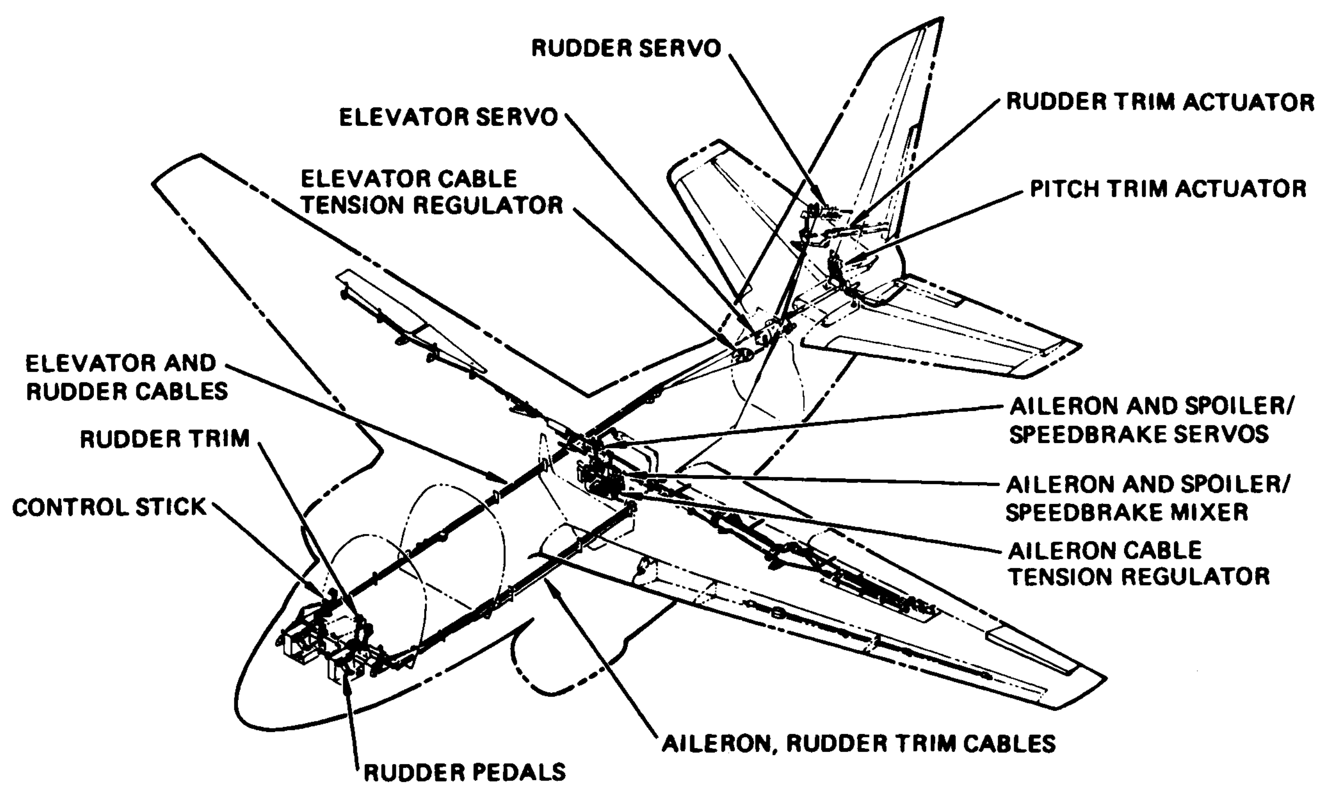


Figure 2-41. Flight Control System

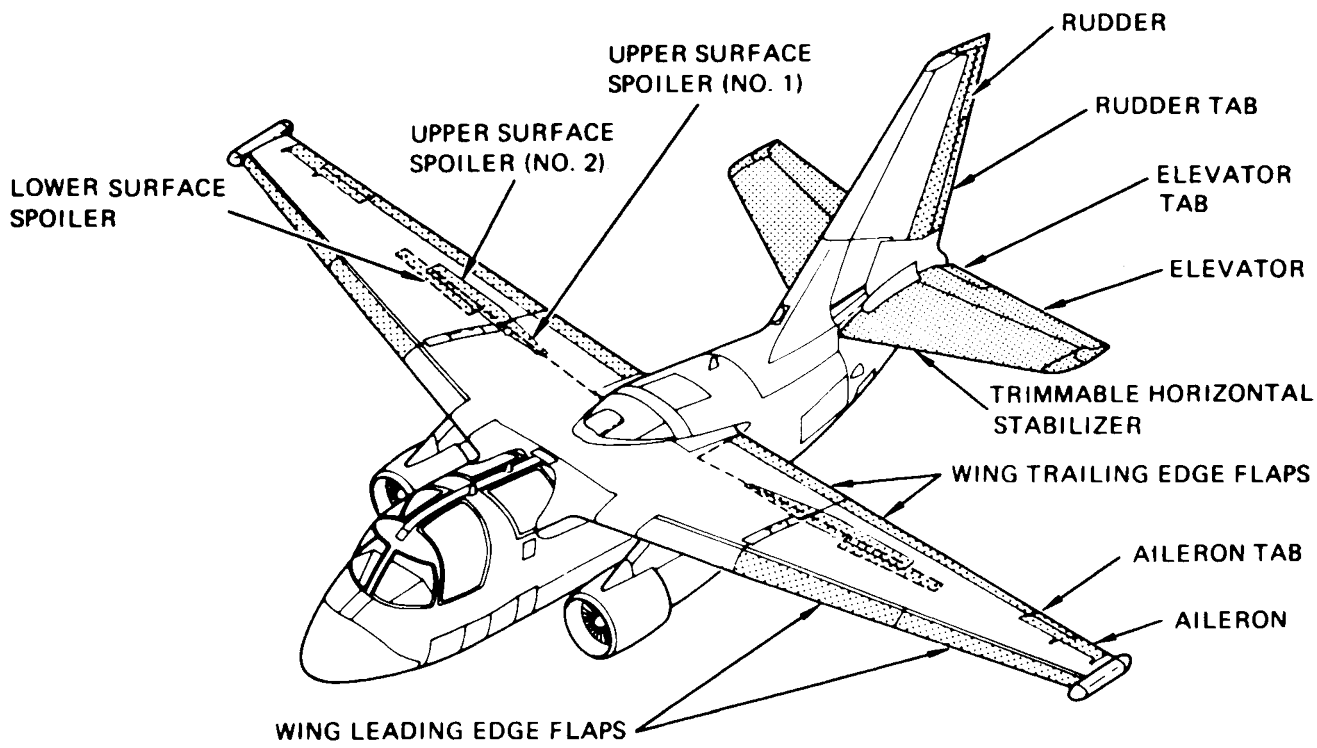


Figure 2-42. Control Surface Identification

If loss of both hydraulic systems occurs, automatic changeover to an EFCS will take place when hydraulic pressure drops below 800 psi. The EFCS is completely mechanical and with the aid of the independent trim system, will provide adequate control for flight.

Hydraulic power will no longer be available, the artificial feel system will be inoperative, and control surface movement will be the direct result of the manual forces provided by the pilot. Upon sensing loss of system pressure, a servovalve repositions, giving the pilot a greater mechanical advantage with which to operate the flight controls.

Note

Under certain failures in the servopackage, EFCS engagement may not occur unless action is initiated by the pilot to unload the control in the direction of motion.

The pilot control stick can be extended 5 inches to further improve the mechanical advantage and reduce stick forces. Control surface movement in the roll axis will require a moderate increase in control force input by the pilot; movement in the pitch axis will require considerably more effort. Rudder force requirements will be quite high and, in addition, control surface movement will be limited to approximately one-half deflection. Electrical horizontal stabilizer trim, manual rudder trim, and electrically actuated flaps will permit a reduction in heavier control forces required and permit transition to the landing configuration. Actuating aileron trim on EFCS will run the aileron trim motor, but is ineffective in reducing lateral control forces or repositioning the ailerons. The aileron trim indicator will still move when actuating the trim, and the control stick will move in a direction opposite to the trim indicator. Aileron trim disconnect may occur if control stick movement is opposed. Rudder trim can be used to reduce lateral stick forces by trimming toward the direction of lateral stick force input. Aileron trim should then be used to recenter the control stick.

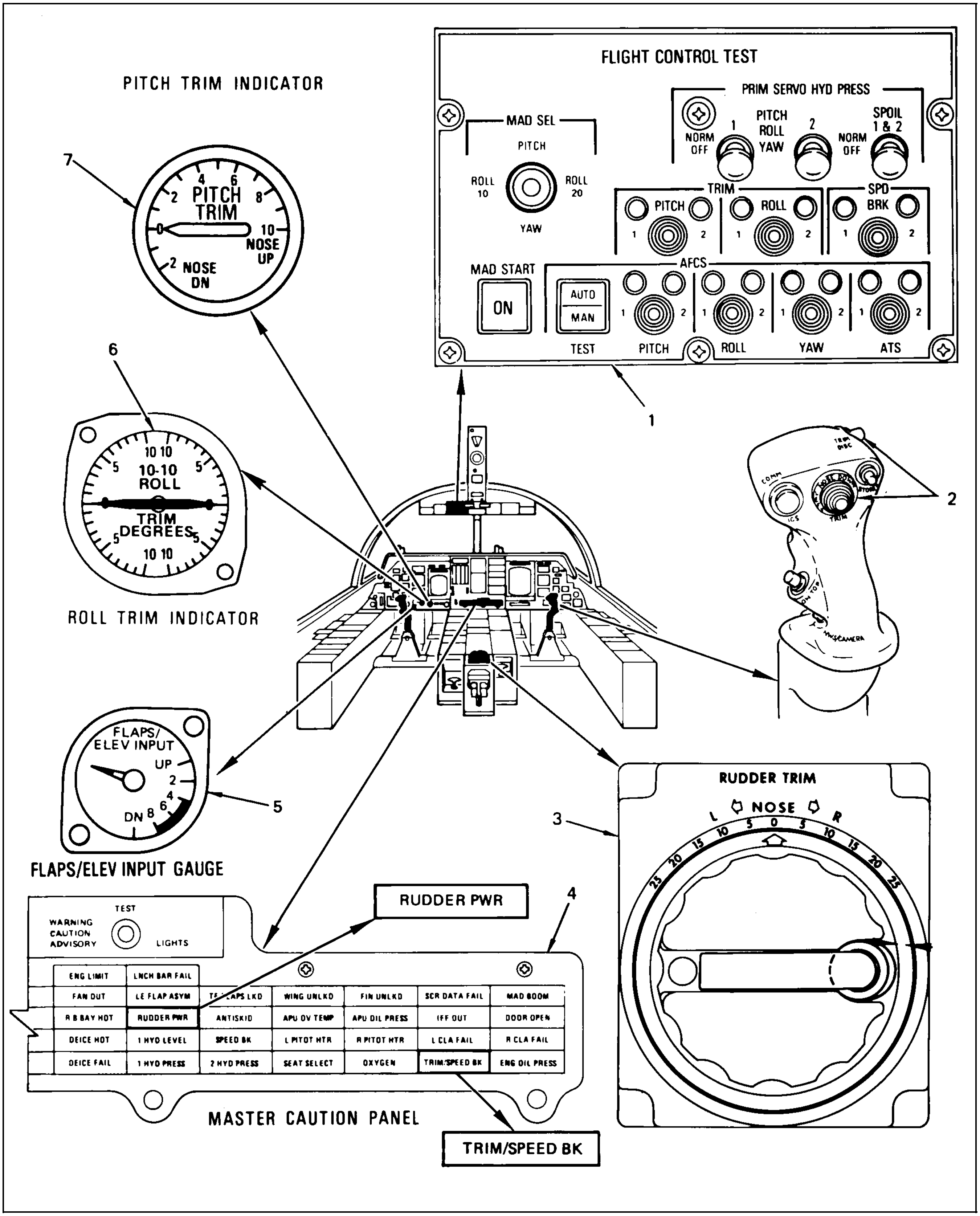


Figure 2-43. Flight Controls/Trim Controls and Indicators (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	FLIGHT CONTROL TEST Panel:	
	PRIM SERVO HYD PRESS switches	
	PITCH, ROLL, YAW	• No. 1 (left) NORM position — No. 1 hydraulic system powers No. 1 primary flight control servos. • No. 2 (right) NORM position — No. 2 hydraulic system powers No. 2 primary flight control servos.
	SPOIL 1 & 2	NORM position — No. 1 and No. 2 hydraulic systems power the spoiler servos.
	PITCH and ROLL TRIM channel lights (4)	Illuminated — indicates corresponding trim channel is disconnected. **Note** When operating on essential bus power, pitch and roll trim channel lights are not powered.
	PITCH and ROLL TRIM channel switches (2)	Momentarily activated toward illuminated light — reconnects the channel and extinguishes light. **Note** Continued illumination of light after switch actuation indicates failure precluding channel reenabling.
2	Control Stick switches:	
	TRIM switch	• Momentary activation — controls electrical actuators for pitch and roll trim. Moved up for nose-down, down for nose-up, right for right wing-down, and left for left wing-down. • When released — spring-loaded to center for no trim signal.
	TRIM DISC switch	Momentarily pressed — disconnects all channels for pitch and roll trim and speedbrakes, and illuminates corresponding pairs of lights on FLIGHT CONTROL TEST panel and the TRIM/SPEED BK light on the master caution panel. **Note** When operating on essential bus power, pitch and roll trim channel lights are not powered.
3	RUDDER TRIM knob	Rotated — actuates rudder and rudder tab to trim aircraft in yaw, and indicates amount of trim (clockwise, nose right).

Figure 2-43. Flight Controls/Trim Controls and Indicators (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
4	Master Caution Panel:	
	RUDDER PWR light	Illuminated — indicates one of the following: ● Failure of either hydraulic system pressure and trailing edge flaps beyond 57 percent. ● Failure of rudder servo to decrease operating pressure on one or both systems to 750 psi at flap positions less than 57 percent. ● Failure of rudder servo to increase operating pressure on one or both systems to 3000 psi at flap positions greater than 57 percent.
	TRIM/SPEED BK light	Illuminated — indicates a disconnect in pitch trim, roll trim, or speedbrakes circuits.
5	FLAPS/ELEV INPUT gauge	Indicates elevator angle for the present trailing edge flap setting.
6	ROLL TRIM indicator	Indicates roll trim angle.
7	PITCH TRIM indicator	Indicates stabilizer angle.

Figure 2-43. Flight Controls/Trim Controls and Indicators (Sheet 3)

2.8.4 Control Stick. Dual control sticks are installed to provide the pilot and copilot/COTAC with basic control of the pitch and roll axes. The pilot control stick can be extended using the extension lock release to increase its length and give increased leverage during operation on the emergency flight control system. Figure 2-44 lists the control stick switches and functions.

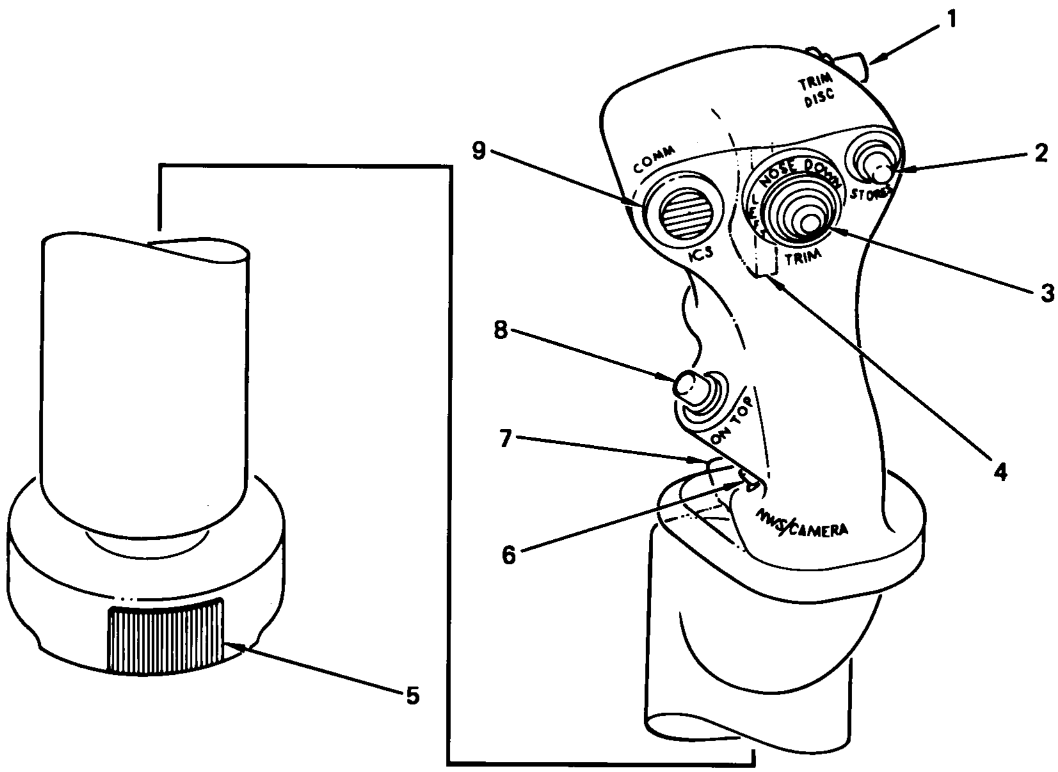
CAUTION

Do not stand on the covering located at the base of each control stick in the cockpit. Deformation of these covers could result in control stick binding.

2.8.5 Rudder Pedals. The rudder pedals are conventional and interconnected. Fore and aft rudder pedal adjustment is accomplished by turning a crank located between each pilot's knees. On the ground, nosewheel steering (when actuated) is controlled by movement of the rudder pedals.

2.8.6 Longitudinal (Pitch) Control System

2.8.6.1 Elevator. The pilot and copilot/COTAC sticks are interconnected through a torque tube and operate a single-loop cable system for elevator servo control. The elevator servo is provided with an auxiliary input capability so that the elevator-to-stick gearing varies as a function of flap position. The variable gearing is accomplished by the ratio changer mounted on the tension regulator. The gearing varies with flap setting through an interconnect between the flap actuator and the ratio changing mechanism. It causes the auxiliary input to add or subtract to the main servo input. With flaps up, the elevator-to-stick gearing is approximately 80 percent of the gearing without the auxiliary input to reduce control sensitivity and overstress potential. With landing flaps (35°/100 percent), the gearing is approximately 130 percent of the gearing without the auxiliary input to obtain more pitch change with less stick deflection, reducing pilot workload during approaches. The ratio changer also incorporates two other functions, a series input that biases the elevator (6° trailing edge up) and a variable aft stick stop that limits aft stick travel when the flaps are lowered (with full flaps extended, approximately one-half of the deflection available with flaps up is present). The elevator bias provides increased nose-down control authority for aircraft noseup mistrimmed takeoffs, waveoffs, and bolters and also tends to compensate for the trim changes required when flaps are lowered or raised. Elevator bias does not produce any apparent stick motion to the pilot. Since the elevator



INDEX	CONTROL/INDICATOR	FUNCTION
1	TRIM DISC switch (longitudinal and lateral)	Momentarily pressed — disconnects pitch trim, roll trim, and speed-brake systems.
2	STORES release (droppable kill)	Pressed — releases all weapons, except forward firing weapons, when the armament control panel is in the manual mode.
3	TRIM switch (longitudinal and lateral)	Neutral — normal flight (no trim inputs). Forward (up) — trims nose down. Aft (down) — trims nose up. Right — trims right wing down. Left — trims left wing down.
4	Trigger (rocket and flare release)	Pressed — fires forward firing weapons.
5	Extension lock release	Actuated — allows pilot control stick extension.

Figure 2-44. Control Stick Grip (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
6	NWS/CAMERA (nosewheel steering) switch	Pressed (on ground): ● Engages nosewheel steering. ● Disengages nosewheel steering, when pressed a second time. Pressed (in flight) ● Operates the film recorder (copilot/COTAC switch only). ● Disconnects APC or IAS hold mode (pilot switch only).
7	AFCS disconnect paddle switch	Momentarily pressed (aft): ● Disengages pitch, roll and yaw channels of AFCS. ● Extinguishes AFCS failure warning lights. ● Extinguishes WAVE OFF light.
8	ON TOP marker switch	Pressed — Geographic position is entered into the GPDC. Pressed — (DLC engaged) Speedbrakes extend at a nominal rate of 16° per second to an extension limit of 12° and pitch compensation is provided by the elevator servo. Released — DLC retracts.
9	COMM/ICS microphone switch	Up — keys radio transmitter for voice communication. Down — keys ICS for voice when in press-to-talk.

Figure 2-44. Control Stick Grip (Sheet 2)

is biased trailing edge up when flaps are extended, the variable aft stick stop limits further aft stick travel once full noseup elevator is reached. Proper biasing is shown by the flap/elevator input indicator, the purpose of which is to allow the pilot to verify that the trailing edge flap bias input to the elevator servo is functional prior to takeoff. An improper bias setting would result in a mistrimmed takeoff. The gauge indicates the elevator neutral position as a function of flap position. The elevator is partially mass-balanced and has a viscous damper on each side to prevent flutter during EFCS operation. The artificial feel system is provided in the pitch axis, but is automatically removed when operating on emergency flight control mode to minimize the pilot workload. The stick-to-elevator gearing is not variable in EFCS operation. Reversion to EFCS will also result in the removal of any elevator bias to the servo because of trailing edge flap extension.

WARNING

Reversion to EFCS with trailing edge flaps extended will result in a moderate nose-down pitching moment requiring high pull forces (80 pounds or more) and immediate retrimming of the stabilizer.

2.8.6.1.1 Elevator Tab. The elevator tab serves to decrease the elevator load during EFCS operation and is actuated by elevator movement only.

2.8.6.2 Horizontal Stabilizer. The horizontal stabilizer provides additional pitch control through a trim range of 1° trailing edge down to 6° trailing edge up of stabilizer deflection relative to the aircraft fuselage reference line. Dual electric motors drive the stabilizer. Horizontal stabilizer trim rate is a function of flap handle position and a function of stabilizer trim position with flaps up.

2.8.7 Lateral (Roll) Control System. Lateral control is provided by wing ailerons and upper and lower wing spoilers (see Figure 2-45).

2.8.7.1 Ailerons. The pilot and copilot/COTAC control sticks are interconnected to operate a single-loop cable system that controls the irreversible aileron servo. This servo actuates the ailerons directly through a push-rod system.

2.8.7.1.1 Aileron Tabs. Aileron servotabs are mechanically geared to the ailerons and deflect with the ailerons in both the hydraulically powered and mechanical (EFCS) modes of operation.

2.8.7.2 Spoiler/Speedbrakes Roll Control. In addition to ailerons, upper and lower wing spoilers provide increased lateral (roll) control and can be actuated symmetrically as speedbrakes. The aileron servo commands two spoiler servos (No. 1 and No. 2) through a mechanical roll-mixer that accepts roll commands for asymmetrical operation of the spoilers as well as symmetrical inputs from the speedbrake controls. Each spoiler servo positions the upper spoiler on one wing and the lower spoiler on the opposite wing. Without speedbrake command, the No. 2 spoiler servo retracts for right roll and the No. 1 spoiler servo retracts for left roll. Spoiler servo retraction causes the spoiler surfaces to extend. For roll control, all the spoiler surfaces perform as ailerons. Although speedbrakes extend 45° when commanded full out by the speedbrake control switch, additional deflection is available with control stick inputs to enhance roll authority. Each spoiler servo is powered by both hydraulic systems. (For speedbrake functions, both spoilers extend simultaneously in response to commands from the speedbrake actuator. See paragraph 2.8.12, Speedbrake System.) The spoilers move differentially for roll control from any intermediate speedbrake position. In addition, the lower spoilers are retracted when the trailing edge flaps are extended to prevent airflow interference over the flaps. Although the spoilers must be fully deflected for maximum roll performance at low speeds, the same deflections at high speeds would cause high roll rates with resulting increased g-forces; therefore, the roll authority of the control stick is limited by a mechanical stop as a function of trailing edge flap position.

Whenever the trailing edge flaps are in the MANUV (maneuver), TAKEOFF, or LDG (landing) position, full lateral stick is available. When the trailing edge flaps are less than 26 percent, the control stick is limited to 55 percent of travel. The following relative roll limiter (function of trailing edge flap actuator) values apply:

FLAP POSITION	AVAILABLE CONTROL STICK TRAVEL (Percent)
UP	55
MANUV	100
TAKEOFF/LDG	100

The roll authority limitation has no effect on spoiler deflection in the speedbrake mode; the speedbrake command comes from the independent speedbrake actuator. The spoiler servos are downstream of the aileron servo; therefore, the control sticks are isolated from all mechanical restrictions associated with the spoiler system. Total loss of hydraulic pressure disconnects the roll input to the spoiler servomechanism, allowing the pilot to operate only the ailerons manually on the EFCS. The spoiler servo design, in conjunction with aerodynamic loads, will cause the spoilers to return to the trail position if both hydraulic systems are lost. For emergency speedbrake/spoiler retraction, refer to paragraph 2.8.12, Speedbrake System.

2.8.8 Directional (YAW) Control System

2.8.8.1 Rudder. The rudder is normally deflected by conventional, adjustable pedals through a single-loop cable system that operates the servo located in the vertical fin. The servo in turn drives a push-pull rod connected to the rudder. During EFCS operation, the relationship between pedal and rudder is changed mechanically in the rudder servo to increase mechanical advantage.

Artificial feel is provided in the rudder servo package. On EFCS control, the artificial feel is eliminated and the pilot operates the rudder manually, reacting to all of the surface hinge moment loads. Rudder trim command is applied manually through the cable system to the irreversible mechanical rudder trim

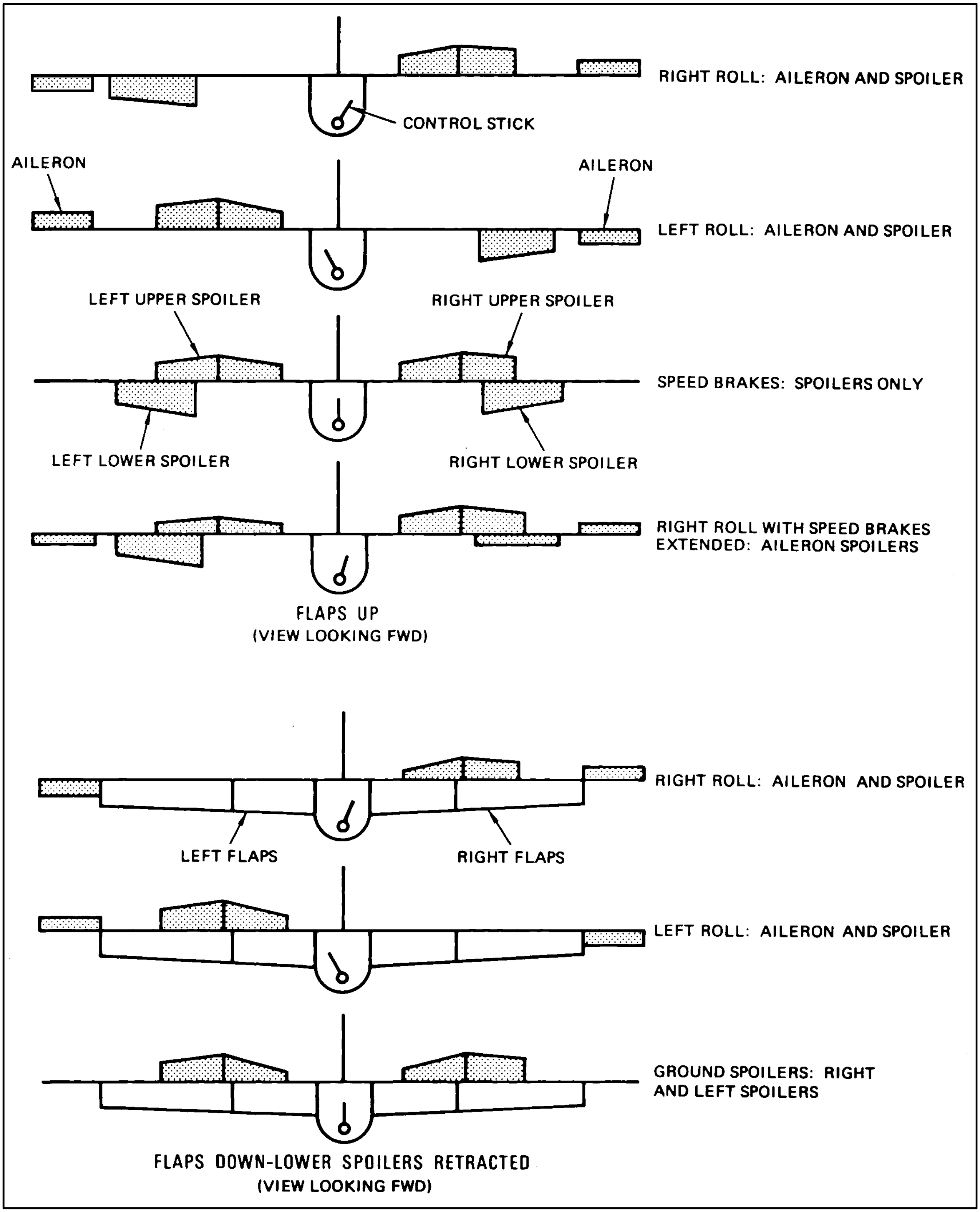


Figure 2-45. Lateral Control Surface Functions

actuator located in the vertical fin. The trim actuator gives a series of trim inputs to the rudder servo input, which permits the pilot to trim the pedals during powered flight. The trim actuator also positions the rudder tab, which achieves essentially a zero-rudder hinge moment in trimmed flight, thereby reducing the servoload and preventing large rudder transients when shifting to the EFCS. For emergency control, the rudder tab is used to provide essentially the same trim authority as attainable with hydraulic power. Hydraulic pressure to the rudder is reduced when flaps are extended less than 57 percent. When the trailing edge flaps are extended 57 percent, or more, the servo operating pressure is 3,000 psi; at less than 57 percent, the pressure is reduced to 750 psi. This limits rudder deflection at higher speeds, reducing rudder and fin loads. As airspeed increases, the rudder pedal deflection required to attain maximum available rudder deflection decreases from 3.5 inches at optimum approach airspeed to 1.0 inch at 450 KIAS.

WARNING

Do not make abrupt, uncoordinated rudder pedal inputs or alternating left and right pedal inputs above 250 KIAS. Although the rudder servo operating pressure is reduced from 3,000 to 750 psi with flap settings less than 57 percent, the rudder can generate enough sideslip to overstress and fail the vertical fin.

2.8.8.2 Pressure Regulator Failure Indication. If one or both rudder servopressure regulators fail to reduce system pressure when the flaps are less than 57 percent, the RUDDER PWR light on the master caution panel will illuminate, cautioning the pilot that the rudder servopressure regulator has failed to decrease the rudder operating pressure as determined by flap position, thereby indicating that too much rudder power is available. The RUDDER PWR light will also illuminate if one or both regulators fail to return the servopressures to 3,000 psi when the flaps are extended to more than the 57 percent position.

WARNING

Do not make uncoordinated rudder inputs when the RUDDER PWR light is illuminated with the flaps less than 57 percent. Uncoordinated rudder inputs can generate enough sideslip to overstress and fail the vertical fin.

2.8.9 Flight Control System Operation. After engine start, the primary flight control system is fully operational. The pilot moves the control stick and rudder pedals to check system operation. By utilizing the PRIM SERVO HYD PRESS switches on the flight control test panel, the pilot can check the No. 1 and No. 2 systems for proper operation. Turning both switches to OFF checks the EFCS mode for latchup and operation. When the trailing edge flaps are less than 57 percent, the rudder servo pressure automatically drops to 750 psi. When the trailing edge flaps are less than 26 percent, the control stick becomes limited in roll to 55 percent of full travel. In rolling maneuvers, the spoilers are automatically programmed by the roll mixer to augment the ailerons. For any malfunction of the No. 1 or No. 2 hydraulic system, the pilot can isolate the malfunctioning system by selective positioning of the PRIM SERVO HYD PRESS switches on the flight control test panel. A dual failure automatically reverts the system to EFCS when system pressure drops below 800 psi in both systems.

2.8.10 Trim Channel Status and Selection. The flight control test panel contains the status lights and the channel selection switches for the pitch and roll trim, the speedbrakes, and the AFCS (see Figure 2-43). Normally, each of the systems is automatically initiated in the dual channel configuration when electrical power is applied to the aircraft. Spring-loaded, momentarily actuated, reconnect switches and amber channel status lights are located on the flight control test panel. In addition, an amber TRIM/SPEED BK caution light and the master CAUTION light will illuminate with any channel disconnect. Pressing the master CAUTION light turns both lights out, directing attention to the channel status lights on the flight control test panel. When the associated channel status light is illuminated, the appropriate switch, momentarily actuated toward the status light, reconnects the selected disconnected trim channel and extinguishes the light. If the status light remains on after switch actuation, a trim or speedbrake channel failure precluding reconnection is indicated. The trim and speedbrake channel status lights are illuminated only when the specific system is disconnected by its failure detection monitors. Activation of the pilot or copilot/COTAC trim disconnect switch will illuminate all six lights. If a channel cannot be reconnected, the channel status light will remain illuminated to indicate the system status. All trim, speedbrake, DLC, or automatic bolter trim commands must be removed before the associated system can be reconnected. In the trim or speedbrake system, single channel operation will reduce the system rates to approximately one-half the normal rate, but full travel will be retained.

2.8.11 Trim Control System. The electrically powered pitch and roll trim and the mechanical yaw trim augment the primary controls during normal operations and provide an alternate control in the event of control cable failure or a jam in the pilot controls. A control stick trim switch, located on each pilot control stick grip, is a five-position, momentarily actuated, spring-loaded-to-center switch, that energizes electrical actuators to set trim conditions when positioned by the pilot. Actuated to NOSE UP, it drives the horizontal stabilizer leading edge down causing the aircraft to go nose up; actuated to NOSE DOWN, it drives the horizontal stabilizer leading edge up which causes the aircraft to go nose down. No signals apply in the center position. When positioned to left or right, ailerons and spoilers are positioned for respective trim. A speedbrake and trim disconnect button, located on the right top of each control stick grip (see Figure 2-44), disconnects both channels of the pitch trim, roll trim, and speedbrake controls. Momentarily pressed, the TRIM DISC (disconnect) switch disconnects power to the trim motors for pitch, roll, and speedbrakes (including automatic bolter trim and automatic trim) and illuminates corresponding lights on the flight control test panel and on the master caution panel. Following a disconnect, one or both channels may be selectively reconnected by switches on the flight control test panel providing all commands are removed.

2.8.11.1 Longitudinal (Pitch) Trim. Pitch trim is obtained by positioning the horizontal stabilizer with an electrically powered stabilizer actuator. The two actuator drive motors are controlled by a dual channel system that includes internal monitors to detect failures and to automatically disconnect the system. See Figure 2-46.

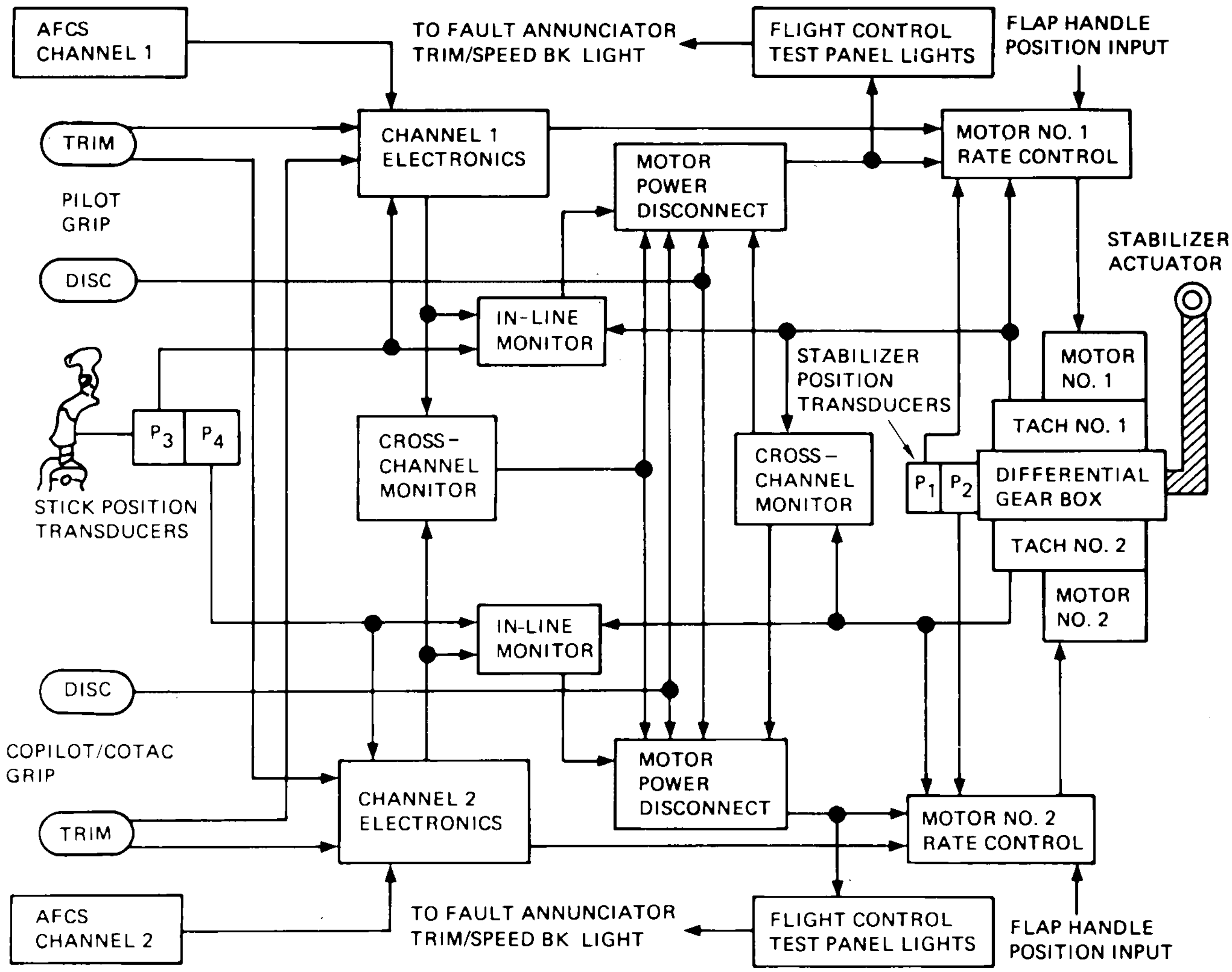
The pitch trim system can be operated in the following modes:

1. Manual — The aircraft is trimmed nose up or nose down with the trim switches on the pilot and copilot/COTAC control stick grips. When the flap handle is in the up detent, the stabilizer trim rate is a function of stabilizer position and varies between 0.1° to 0.7° per second. Specifically, as the noseup trim position increases, the trim rate increases. When the flap handle is moved out of the up detent, the trim rate is a constant 0.7° per second.

   Pitch trim rate (degrees per second):

MODE	FLAP HANDLE UP (degrees per second)	FLAP HANDLE OTHER THAN UP (degrees per second)
Dual channel	0.1 to 0.7	0.7
Single channel	0.05 to 0.35	0.35
APS[1]	0.1	0.1
[1]The APS mode is not affected by flap handle position and operates channel No. 1 only.		

2. Automatic bolter trim — The pitch trim system automatically trims the aircraft nose down when the stick is beyond 75 percent forward travel. The automatic bolter trim rate is the same as manual trim and is variable or constant depending upon the position of the flap handle. Automatic bolter trim is disabled when the primary controls are operating in the EFCS mode and when the aircraft weight is on the main gear. Automatic bolter trim can be ground-checked through use of the AUTO-BOLTER GROUND TEST switch on the pilot side console. (This switch overrides the aircraft weight-on-wheels switch for the pitch trim system and the DLC system only.)



NOTE

1. CHANNEL 1 IS POWERED FROM THE ESSENTIAL AC BUS AND CHANNEL 2 IS POWERED FROM THE LEFT PRIMARY AC BUS.
2. ACTUATION OF EITHER DISCONNECT SWITCH REMOVES ALL POWER FROM BOTH MOTORS OF THE PITCH TRIM, THE ROLL TRIM, AND THE SPEEDBRAKE ACTUATORS.
3. CROSS CHANNEL MONITORS FUNCTION ONLY DURING DUAL CHANNEL OPERATIONS AND WILL DISCONNECT IF A 10 PERCENT DIFFERENCE EXISTS FOR MORE THAN 1.5 SECONDS.
4. IN-LINE MONITORS FUNCTION DURING BOTH SINGLE AND DUAL CHANNEL OPERATIONS. THE IN-LINE MONITORS WILL DISCONNECT THE PITCH TRIM SYSTEM IF:
   A. THE PRESENCE OF A MOTOR TACH-SIGNAL EXISTS FOR MORE THAN 2.5 SECONDS IN THE ABSENCE OF AN INPUT COMMAND.
   B. THE PRESENCE OF AN INPUT COMMAND EXISTS FOR MORE THAN 2.5 SECONDS IN THE ABSENCE OF A MOTOR TACH-SIGNAL EXCEPT WHEN THE STABILIZER ACTUATOR IS AT ITS STROKE LIMIT.
   C. A DISAGREEMENT BETWEEN THE POLARITY OF THE MOTOR TACH-SIGNAL AND THE DIRECTION OF THE INPUT COMMAND EXISTS FOR MORE THAN 2.5 SECONDS.
   D. THE MOTOR TACH-SIGNAL IS NOT WITHIN 10 PERCENT OF THE VALUE SCHEDULED BY THE STABILIZER POSITION WHEN THE FLAP HANDLE IS IN THE UP-POSITION. THE SPEED MONITOR IS DISABLED WHEN THE FLAP HANDLE IS NOT IN THE UP-POSITION.
   E. THE STICK POSITION IS MORE THAN 1.0 INCH NOMINALLY FROM NEUTRAL IN A DIRECTION TO OPPOSE THE DIRECTION OF THE TRIM FOR MORE THAN 2.0 SECONDS.
5. AUTO BOLTER TRIM IS COMMANDED FROM THE STICK POSITION TRANSDUCERS AND ONLY COMMANDS AIRCRAFT NOSE-DOWN.

Figure 2-46. Pitch Trim System

3. Automatic trim — The pitch trim system is controlled by the AFCS when the pitch axis of the APS is engaged. The automatic trim mode moves the stabilizer at a constant 0.1° per second regardless of the flap handle position. The manual trim switches on the control stick grips are disabled while the pitch APS is engaged, and pilot or copilot/COTAC inputs have no effect.

The pitch trim system is normally operated dual channel but can be used single channel in any of the above modes. During single-channel operation, the trim rates are one-half the values noted above. If primary electrical power is lost, the APU supplies power for operation of channel 1 pitch trim at the normal single-channel rate.

Pitch trim system malfunctions are detected by cross-channel, in-line, and control-stick position monitors. The cross-channel monitors function only during dual-channel operation while the in-line and control-stick position monitors are effective during both single- and dual-channel operation. The cross-channel monitors assure that the two channels operate together and the in-line monitors compare the output response to the input command. The control stick position monitor works with the in-line monitor and will disconnect the system if the pilot moves the control stick in a direction that opposes the motion of the pitch trim. The disconnect criteria of the monitors are shown in detail in Figure 2-46.

CAUTION

The pitch trim fault monitor system is inactive following pitch trim connection until the first pitch trim command is exercised. Therefore, anytime pitch trim is connected, exercise at least one pitch trim command to activate the fault monitoring system and prevent pitch trim actuator motor burnout, in the event of an unmonitored pitch trim runaway.

A circular gauge, located on the pilot instrument panel, shows the position of the horizontal stabilizer in degrees. The instrument is calibrated from 2° stabilizer trailing edge down (aircraft nose down) to 10° trailing edge up (aircraft nose up). The system is limited, however, to a range of 1° nose down to 6° nose up. The scale marking corresponds to the takeoff trim marking on the aft fuselage below the horizontal stabilizer. The maximum allowable tolerance of the indicator system is ±1.0° in its operating range of 1° nose down to 6° nose up.

Proper operation of the pitch trim indicator must be checked before setting the takeoff trim. Refer to paragraph 8.10, After Start checklist. When electrical power to the indicator is lost, the indicator needle immediately goes off scale. If the indicator needle remains on scale but does not move when the pitch trim switches are activated, a malfunction in the pitch trim system has occurred and the takeoff should not be attempted until it has been corrected.

2.8.11.2 Lateral (Roll) Trim. Lateral trim is obtained by positioning the ailerons and spoilers as required to balance asymmetric stores or fuel loading. Actuating the trim button provides inputs to reposition the ailerons and spoilers in an amount proportional to the input. Actuation of roll trim on EFCS will displace the stick neutral position without affecting lateral trim. The subsequent reduction in available aileron deflection because of the displaced neutral position can result in significantly degraded roll authority. A circular gauge, located on the pilot instrument panel, indicates aileron trim in degrees. The instrument has a single, double-end pointer visually indicating the amount of trim from 0° to 10°. The system has a maximum capability of 7.5° in each direction.

2.8.11.3 Directional Rudder (Yaw) Trim. Manual rudder trim is provided by a trim wheel on the center console. This wheel inputs a series input command to the rudder servo and, through mechanical linkage, directly positions the rudder trim tab. Full rudder trim is available after loss of one or both hydraulic systems. The rudder trim knob (see Figure 2-43) has a pointer that relates to a fixed scale marked to indicate the amount of trim. During powered operation, the rudder servo series input permits the pilot to trim the pedals.

WARNING

Rudder trim can generate enough sideslip to overstress and fail the vertical fin at high airspeeds.

2.8.11.4 Trim Control System Operation

2.8.11.4.1 Normal Operation. Normal operation of the trim system is achieved through actuation of the TRIM switches and the rudder trim wheel. Electrical and hydraulic power is required to operate the roll trim system. Electrical power is required to operate the pitch trim system. The yaw trim system is completely mechanical.

CAUTION

Do not attempt to trim the roll or yaw axes of the aircraft while engaged on the AFCS. An aircraft transient may result on AFCS disengagement. If a configuration change necessitates a trim change in the roll or yaw axis, disengage the AFCS before setting trim.

Note

- With hydraulic power on, the control stick and rudder pedals will always be at the neutral position if the aircraft is in trim. During EFCS operations, the controls may be at other than neutral position when the aircraft is trimmed.
- The first manual trim command has authority and cannot be overridden except by a disconnect. All commands must be removed to reconnect.
- Rudder and aileron trim with the AFCS engaged is available but will not be effective.

2.8.12 Speedbrakes System. The speedbrakes consist of six spoiler panels: two panels located on each upper wing and one panel located on each lower wing area. All six panels are controlled by speedbrake (SPD BRK) control switches (Figure 2-47), located on the right side of the pilot and copilot/COTAC No. 2 throttles. The thumb-operated switch positions are center (hold), extend (momentary, spring loaded to center hold) which extends the speedbrakes, and retract (momentary, spring loaded to center hold) which retracts the speedbrakes. The pilot and copilot/COTAC switches are electrically interlocked to prevent simultaneous extend and retract commands. The last command in will override all previous commands. Speedbrake extension or retraction can be accomplished by moving either pilot or copilot/COTAC control switch aft (extend) or forward (retract) as desired. Partial extension can be accomplished by momentarily actuating either switch in the extend position. Normally, complete retraction is accomplished with one command; intermediate stops are available between the extended position and fully retracted.

The switch position last actuated by either the pilot or copilot/COTAC will govern speedbrake travel and position. A SPD BRK red warning light located on the pilot and copilot/COTAC glareshield indicates whenever the throttles are in MAX PWR (power) and the speedbrakes are extended or whenever the aircraft is greater than 17 units AOA with the speedbrakes not fully retracted. In addition, a TRIM/SPEED BK amber light on the master caution panel illuminates if a disconnect occurs in the speedbrake (or roll and pitch trim) circuits, directing attention to the speedbrake channel lights on the flight control test panel. The speedbrakes are electrically controlled through dual motors that actuate hydraulic servos. A single motor is capable of operating the servos. If either motor should fail, the system will continue to operate at approximately one-half the normal rate. The speedbrakes should be used with care in this situation. (Refer to paragraph 2.8.11, Trim Control System, for speedbrake channel status and selection discussion.)

If both speedbrake actuator motors fail with the speedbrakes extended, provision for retraction of the speedbrakes is provided by positioning the spoiler switch on the flight control test panel to OFF, thus allowing the speedbrakes to blow down by airflow. The speedbrakes can be operated only when hydraulic and electrical power is available on the aircraft. Speedbrake command actuator movement can be observed on the speedbrake position indicator, located on the lower left portion of the pilot instrument panel, that shows the commanded position of the speedbrakes. The SPD BRK indicator displays commanded speedbrake extension in degrees from 0° (IN) to 60°. If a speedbrake runaway malfunction should occur, the speedbrake command-actuator can be disconnected through depression of the trim disconnect switch on each pilot control stick grip.

WARNING

The speedbrake command actuator can be operated without speedbrake deflection if hydraulic power is not available or if the SPOIL 1 & 2 switch is off. If speedbrakes are commanded to extend and hydraulic power is then applied, the spoilers will instantaneously extend to the commanded position.

Note

Maximum speedbrake extension through the use of the pilot and copilot/COTAC speedbrake control switches is limited to 45°. At speeds above 350 KIAS, full deflection will be limited by aerodynamic loads (blowback).

To optimize lateral control characteristics, the lower spoiler panels are dwelled when the trailing edge flaps move from the UP position. In the dwelled condition, lateral control inputs and speedbrake commands operate only the upper spoiler panels. If the lower spoilers remain dwelled following trailing edge flap retraction, the SPEED BK caution light will illuminate. The speedbrakes must be cycled in and commanded to the extend position to undwell lower spoilers. The SPEED BK caution light illuminates when trailing edge flaps are UP and one or both lower spoilers are dwelled or when trailing edge flaps are not UP and one or both lower spoilers are not dwelled. In these conditions, lateral control characteristics may be degraded, speedbrakes should be used with caution, and DLC should not be used.

2.8.12.1 Speedbrake System Operation

2.8.12.1.1 Normal Operation. The speedbrakes can be operated anytime hydraulic and electrical power are available on the aircraft. They can be extended by either the pilot or copilot/COTAC by actuating the SPD BRK switch located on the No. 2 throttle. The last command input takes priority. Speedbrake command-actuator movement is observed in the SPD BRK indicator on the pilot instrument panel.

CAUTION

- Flap selection with speedbrakes out may result in a trailing edge, flap-locked condition.
- Care should be exercised in extending speedbrakes in accelerated flight or during rolling pullouts. Otherwise, the limit load factor may be exceeded.
- The speedbrakes can be extended with wings folded if hydraulic and electrical power are applied to the aircraft and the CLA senses weight off wheels. The speedbrakes can be retracted with the wings folded by raising the gustlock out of the up detent and commanding them in.

2.8.12.1.2 Emergency Operation. If the speedbrakes cannot be retracted with the speedbrake switch, they can be allowed to blow down by positioning the SPOIL 1 & 2 switch to OFF, which removes hydraulic pressure from the spoiler/speedbrake servos.

2.8.13 Direct Lift Control and Thrust Pitch Compensation Systems. The DLC system provides a method of decreasing aircraft lift for rapid downward flightpath corrections during carrier landing approach. The thrust pitch compensation system reduces aircraft pitch changes with power and provides pitch damping during landing approach. DLC configured aircraft incorporate:

1. Increased speedbrake extension/retraction rate
2. Deactivated upper outboard spoiler panels
3. AOA bias on pilot AOA indicator during DLC use
4. Increased lateral stick limits in cruise and maneuver configurations
5. Modification to the speedbrake warning system logic

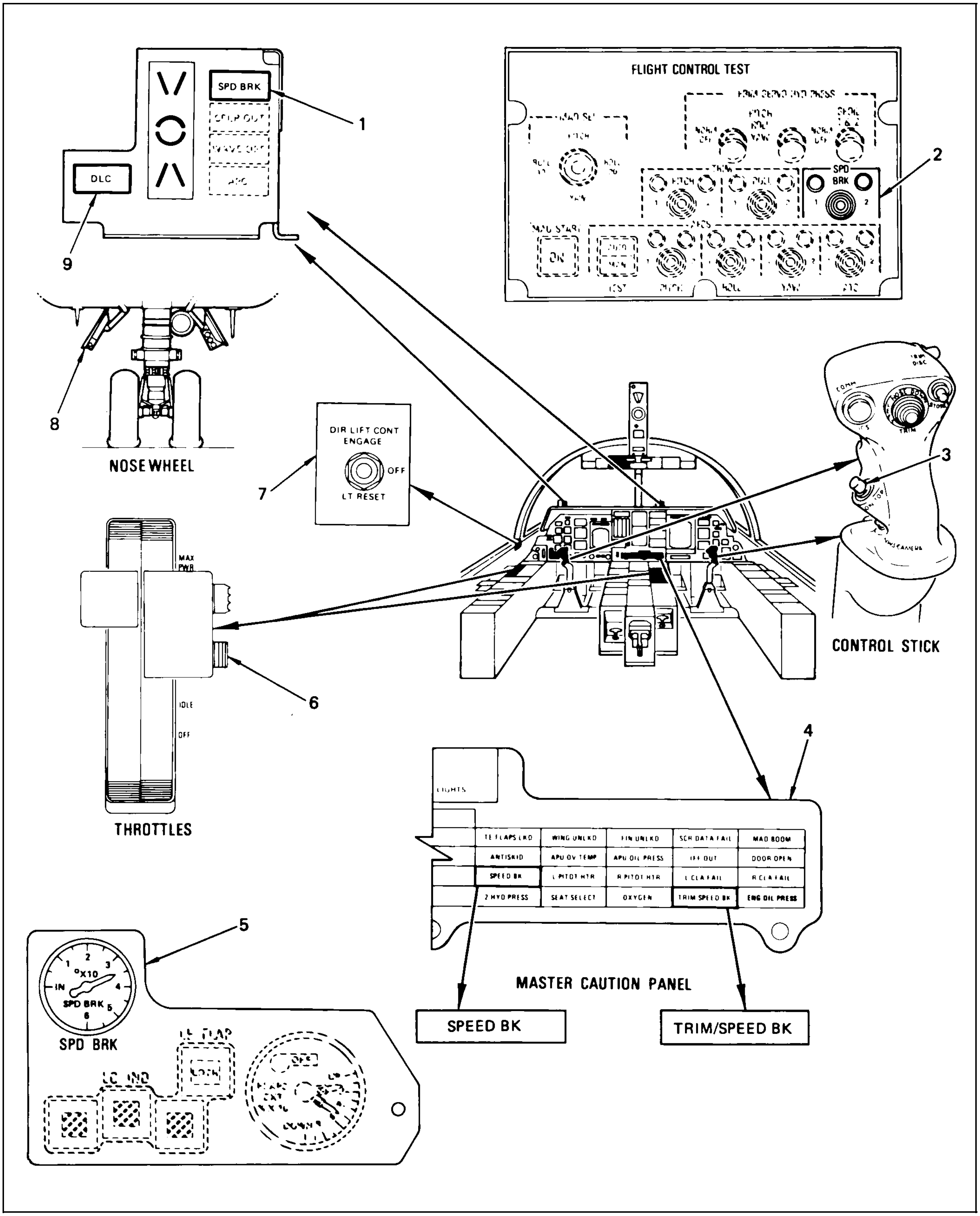


Figure 2-47. Speedbrake Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	SPD BRK warning light	Illuminated (flashing red): • When throttles are in MAX PWR and speedbrakes are not fully retracted. • When aircraft is at angle-of-attack greater than 17 units with speed-brakes not fully retracted.
2	FLIGHT CONTROL TEST Panel:	
	SPD BRK (speed-brake channel) status lights	Indicates disconnect of corresponding speedbrake channels. **Note** When operating on essential bus power, speed-brake channel status lights are not powered.
	SPD BRK reconnect switch	Momentarily moved (right or left) — reconnects channel and extinguishes status light. **Note** Light still illuminated after switch actuation indicates failure preventing reconnection.
3	ON TOP switch	Activates DLC when DIR LIFT CONT switch is positioned to ENGAGE (forward). Enters geographical position into GPDC.
4	Master Caution Panel:	
	SPEED BK light	Illuminated — indicates failure in lower spoiler dwell system which could cause a roll maneuver if speedbrakes are extended.
	TRIM/SPEED BK light	Illuminated — indicates a disconnect in pitch, roll trim, or speedbrake circuits.
5	SPD BRK indicator	Indicates in degrees the amount of speedbrake commanded.
6	SPD BRK switches (on pilot and copilot/COTAC throttles)	Thumb-operated (momentary switches): • Extend (aft position) — applies electrical power to speedbrake command-actuator to extend speedbrakes as long as switch is held aft. • Center position — removes electrical power from speedbrake command actuator and maintains selected position. • Retract (forward position) — applies electrical power to speedbrake-command-actuator to retract speedbrakes. A momentary switch actuation will cause the speedbrakes to completely retract. After retraction has started, a momentary aft switch actuation will stop the speedbrakes at the existing position.
7	DIR LIFT CONT switch	ENGAGE — activates thrust compensation and enables DLC. OFF — deactivates thrust compensation and disables DLC. LT RESET — resets DLC warning lights.
8	DLC approach light	Illuminated (blue) — indicates to LSO that DLC is in use.
9	DLC light	Illuminated (flashing red) — indicates failure or disengagement of DLC.

Figure 2-47. Speedbrake Controls and Indicators (Sheet 2)

6. DLC operating light on the right nose landing gear door (see Figure 2-47) for LSO observation during approach

7. DLC (pilot and copilot/COTAC) warning lights.

The DLC system is engaged by the pilot at his left console through a three-position DLC selector switch (see Figure 2-47). Following engagement, the system provides DLC spoiler extension to approximately 12° and retraction upon command by depression and release of either ON TOP button. With spoiler extension, the resultant loss in lift results in an immediate increased rate of descent. This downward motion results in an increase in AOA of approximately 2 units AOA. To preclude the pilot from making an unnecessary speed correction because of this increased AOA, the pilot AOA system is biased during DLC spoiler extension; no bias is supplied on the copilot/COTAC AOA indicator.

Note

On BuNo 157928 and subsequent and earlier modified aircraft incorporating AFC-88, momentary operations (less than 0.25 second) of the ON TOP DLC switch will cause the speedbrakes to open about 4°, then retract to the closed position.

2.8.13.1 DLC Pitch Compensation. Nose-down series elevator input (no stick movement) is provided coincident with DLC extension to compensate for the aircraft noseup pitch change because of spoiler extension. This input is in addition to whatever elevator is being commanded by the thrust compensation input. Elevator compensation is tailored to approach airspeeds and approach power settings.

2.8.13.2 Thrust Pitch Compensation. Thrust pitch compensation is provided whenever the DLC selector switch is engaged. This provides a series elevator input (stick does not move) as a function of throttle position to compensate for pitching moments caused by thrust changes. This compensation is effective from idle to approximately 4,500 fan (N_f) rpm in the landing configuration. Compensation is not provided for higher power settings. The relationship between throttle position and elevator input will provide proper compensation at approach airspeeds only. At higher airspeeds, overcompensation will result. A slight pitch transient may occur when the system is engaged or disengaged (switch on/off) if the throttles are not at an approach power position. These engage/disengage transients and overcompensation characteristics are mild at slow airspeeds. An interlock in the system prevents engagement with the gear handle in the UP position and will automatically disengage the system when the gear handle is moved from the DN to the UP position.

Note

- The gear handle interlock is designed to prevent inadvertent elevator compensation with the gear up. Raising the gear handle with the DLC switch ON will cause the DLC warning light to flash.

- The DLC system is automatically disengaged on touchdown with the weight-on-wheels signal, which transfers speed-brake control back to the speedbrake switches.

Note

Ground test of the system can be accomplished by overriding the weight-on-wheels signal using the AUTO-BOLTER GROUND TEST switch.

2.8.13.3 DLC Engagement and Disengagement. The following criteria are needed to latch the DLC selector switch in the engage position:

1. Both hydraulic systems operative

2. Dual channel speedbrake control

3. Throttles below approximately the 90 percent position

4. ON TOP buttons released

5. Landing gear handle down

6. Aircraft weight off wheels.

With engagement of the DLC selector switch, the following occurs:

1. Activates thrust pitch compensation

2. Activates pitch rate damping
3. Disables normal speedbrakes
4. Retracts speedbrakes, if extended
5. Enables DLC system.

DLC disengagement will take place with the following:

1. DLC selector switch OFF
2. Either throttle beyond approximately the 90-percent position
3. Either pitch-roll-yaw servo switch OFF
4. Trim disconnected on the control stick
5. Hydraulic failure
6. Speedbrake monitor trip
7. Weight on gear
8. Landing gear handle UP.

Note

Disengagement with throttle advance or weight on gear does not illuminate DLC warning lights.

With disengagement, the following occurs:

1. Releases DLC selector switch to OFF position
2. Deactivates thrust pitch compensation
3. Deactivates pitch damping
4. Retracts speedbrakes, if extended, except with trim disconnect or speedbrake monitor trip
5. Enables normal speedbrakes except with trim disconnect or speedbrake monitor trip.
6. Disables DLC.

2.9 WING FLAPS SYSTEM

The high lift configuration of the wing necessary for takeoff, slow speed maneuvering, and normal landings is achieved by extension of plain leading edge flaps and single slotted Fowler trailing edge flaps. Both leading and trailing edge flaps are normally controlled by a single flap control lever on the pilot side console near the throttles. The leading edge flaps are electrically powered from the left primary ac bus, and trailing edge flaps are powered hydraulically for normal operation and electrically for emergency operation. The emergency flap control receives electrical power from the essential ac bus, and the asymmetry detection subsystem is powered from the essential dc bus.

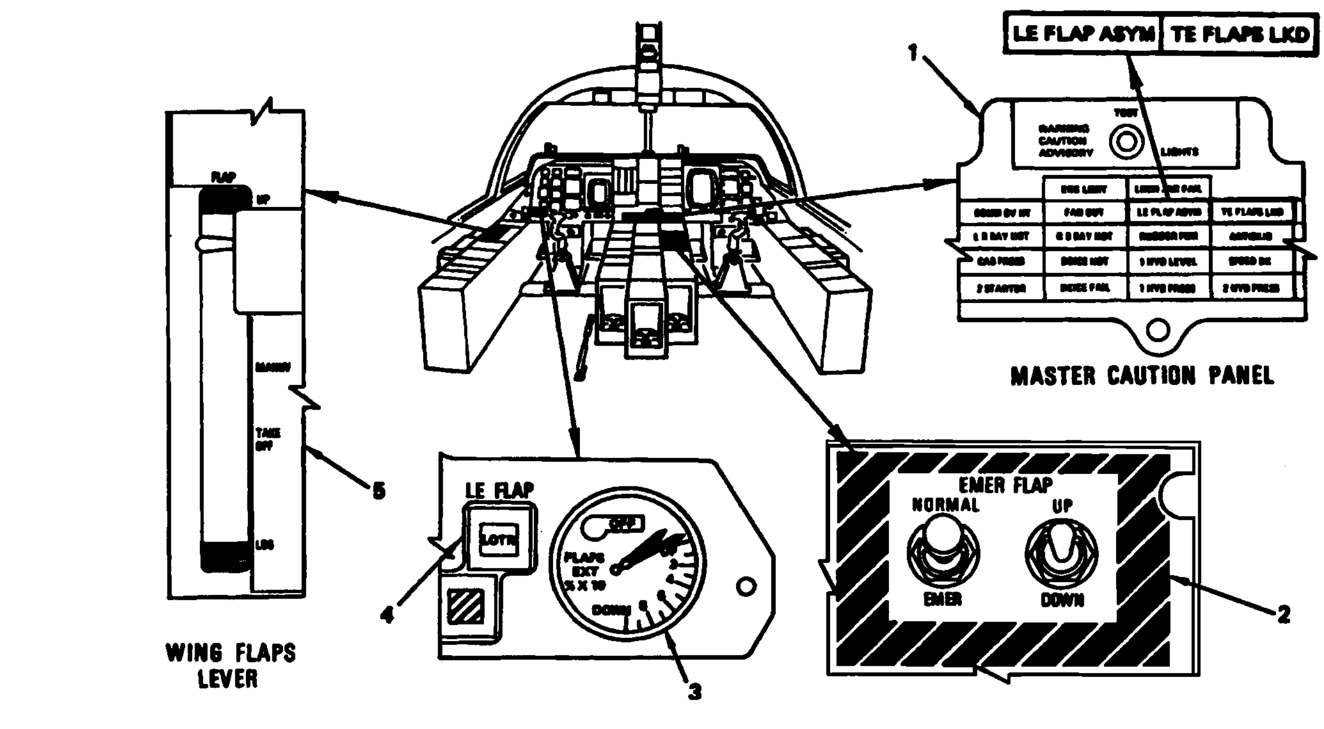
2.9.1 Flap Control Systems. The single flap control lever (see Figure 2-48) is located just outboard of the pilot throttles. The quadrant adjacent to the flap lever is marked with five flap positions that correspond to flap extension as follows:

Flap Lever Position	Trailing Edge Percent	Leading Edge Indication
UP	0	UP (0°)
LOTR (Loiter)	0	LOTR (5°)
MANUV (Maneuver)	36 (15°)	DN (25°)
TAKEOFF	65 (25°)	DN (25°)
LDG (Landing)	100 (35°)	DN (25°)

Notes

1. All indicator percentages subject to ±4 percent.
2. All degrees are nominal values.

Two flap emergency switches, labeled EMER FLAP (see Figure 2-48), are located forward of the copilot/COTAC throttles on the center console. The left switch has two positions, NORMAL and EMER. In NORMAL, the trailing and leading edge flaps are controlled by the wing flaps lever. In the EMER position, the trailing edge flaps are controlled by the second (right) switch. This three-position switch is placarded UP and DOWN. The switch is spring loaded to the center (off) position and operates the trailing edge flaps electrically only.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Master Caution Panel:	
	LE FLAP ASYM light	Illuminated — indicates asymmetrical leading edge flap extension.
	TE FLAPS LKD light	Illuminated — indicates trailing edge flaps are locked (will remain so until reset after landing).
2	EMER FLAP switches:	
	NORMAL-EMER switch	• NORMAL — provides normal hydraulic operation of TE flaps by actuation of FLAP control lever. • EMER — shuts off hydraulic pressure to flap power servo and transfers control of TE flaps to UP-DOWN switch.
	UP-DOWN switch	• UP — energizes electrical actuators to move TE flaps toward up position. • Center — removes electrical power from actuators. • DOWN — energizes actuators to move flaps toward down position.
3	Trading edge flaps position (gauge) indicator	Two separate needles indicate extension of right and left TE flaps, graduated from UP to DOWN in multiples of 10 percent.
4	LE FLAP position/indicator (window)	Indicates: • UP — LE flaps are retracted. • LOTR (loiter) — LE flaps are extended approximately 20 percent. • DN — LE flaps are extended 100 percent.
5	FLAP control lever	Positions LE and TE flaps.

Figure 2-48. Wing Flap Controls and Indicators

CAUTION

After actuation of the trailing edge flaps with the emergency electrical system, the flaps should be retracted by the emergency method and the FLAP control lever should be placed in the UP position before the NORMAL/EMER switch is returned to the NORMAL position. If this is not accomplished, the trailing edge flaps will immediately begin to move to the position commanded by the FLAP control lever. Also, if the FLAP control lever is in the LDG flap position and the NORMAL/EMER switch is returned to NORMAL, the flaps will begin to blow up to approximately the maneuver position before hydraulic pressure begins to put them back to the landing position. In this situation a flap lock may result.

2.9.1.1 Trailing Edge Flaps. The trailing edge flaps are segmented at the wing fold. A hydraulic actuator operates the flaps through a system of push rods and bellcranks. The normal extension or retraction time for full travel is approximately 14 seconds for extension and 10 seconds for retraction. If hydraulic power is lost, electrical operation of the actuator will allow emergency extension or retraction in approximately 50 seconds. If all electrical power is lost and the No. 1 hydraulic system is operable, the trailing edge flaps will operate normally; however, the trailing edge flap position indicator will be inoperative. The relative positions of the right and left flaps are shown by the two needles of the flap position (FLAPS EXT) indicator located on the pilot instrument panel. The indicator is graduated from UP to DOWN in percentage marks. The needles indicate trailing edge flap position from transmitters located internally in the flap dampers, one for the right trailing edge flaps and one for the left trailing edge flaps. The needles normally track together. In the event of a mechanical jam or linkage failure in the trailing edge flap actuating system, the asymmetry detection system will lock the flaps when a differential load of 1,200 pounds is sensed at the actuator and will illuminate the TE FLAPS LKD light in the master caution panel. When activated, the system sets brakes in the flap actuator and within each flap damper. The flaps will remain locked and the light will remain on until the system is reset after landing. This can be accomplished by resetting the flap brake or interrupting electrical power to the system via generators or circuit breakers. The locking mechanism is designed to prevent large flap asymmetries from developing. Unlocking the system in flight could defeat this feature and permit full-flap asymmetries to occur instantaneously. For this reason, the system should never be reset in flight. In certain failure conditions, such as linkage failure in one of the outboard flap panels while flaps are extended, a flap panel can fully retract without activating the asymmetry detection system.

Trailing edge flap asymmetries can occur because of normal system operation in which a force differential is detected by the flap actuator, thereby locking the flaps or through system malfunctions or failures that could permit a split-flap condition. In either case, the procedures used will depend upon the controllability of the aircraft.

WARNING

Do not cycle the flap lever or attempt to move the flaps with the emergency system. Do not reset the trailing edge flap control circuit breaker or interrupt total electric power by turning off the generators.

2.9.1.2 Leading Edge Flaps. There is no emergency control system available for the leading edge flaps if the normal leading edge actuation system fails. In addition to providing additional lift necessary for takeoff, slow-speed maneuvering, and normal landings, the leading edge flaps greatly enhance stall warning by altering airflow characteristics over the wing.

WARNING

Adequate stall warning or a clear indication of stall may not be provided with the leading edge flaps retracted. Therefore, extreme caution should be exercised during takeoff, slow-speed maneuvering, and normal landings if leading edge flaps are not available.

2.10 LANDING GEAR SYSTEM

The aircraft is equipped with a fully retractable, hydraulically actuated, electrically controlled landing gear. The nosegear retracts straight aft into the fuselage and the main gear retracts aft with a rotational motion into the fuselage. In the retracted position, all gears are covered by mechanically sequenced doors. The launch bar must be up and locked before the gear will retract. Normal gear retraction time in flight is approximately 10 seconds, and normal extension time is approximately 15 seconds. During normal operation, the landing gear is actuated by the No. 1 hydraulic system; however, it can be extended in an emergency by pulling the landing gear emergency extension T-handle in the cockpit, located on the aft side of the center console. When pulled, it positions the landing gear valve module in the bypass mode, which ports both sides of the landing gear actuators to the return line and mechanically releases the gear uplocks. Gravity and leaf springs then cause the landing gear to extend and lock. A positive latch on the left and right is provided to prevent inadvertent unlocking of the MLG downlock mechanism. This latch reduces the potential of MLG collapse in the event of MLG tire failure by increasing the deflection required to unlock the MLG.

Those utility systems normally isolated with the landing gear retracted are isolated from hydraulic system No. 1 pressure after an emergency gear extension. Actuation of the emergency landing gear reset switch (EMER LG RESET), located on the master armament switch panel on the pilot side console, is provided to electrically reset the landing gear bypass valve in flight. After an emergency extension has been performed, pressing this momentary contact switch will restore the subsystem to normal operation. The reset capability is inhibited if the emergency extension T-handle is not in the normal position and the landing gear lever is not in the down position. When the gear is retracted, the gear and other No. 1 hydraulic subsystems not required for flight are isolated by the landing gear valve module to inhibit No. 1 system reservoir depletion should a leak occur in one of the isolated subsystems. (See Figure 2-39.)

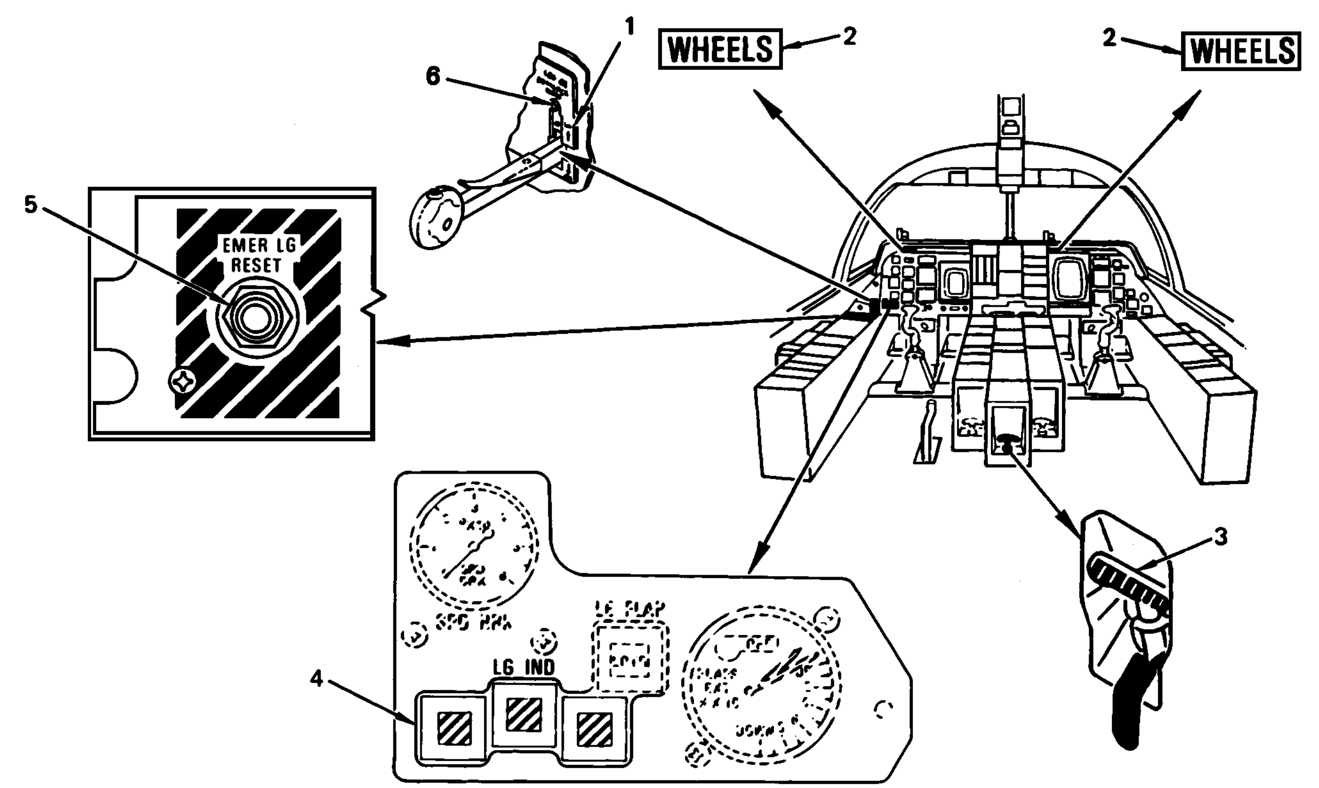
2.10.1 Landing Gear Handle. The landing gear is extended and retracted by operation of the landing gear handle, located to the left of the pilot instrument panel. A red light in the handle illuminates when there is disagreement between the position of the lever and any of the gear. On BuNo 159758 and subsequent and aircraft incorporating AFC-115, the red light also illuminates if an electrical failure occurs resulting in the improper sequencing of the landing-gear-up relay. When the weight of the aircraft is on the landing gear, the lever is locked in the down position by a solenoid-actuated mechanical downlock to prevent inadvertent raising of the landing gear handle and subsequent retraction of the landing gear on deck if the landing gear pins are not installed. If the solenoid lock malfunctions, pressing the override button just forward of the gear handle releases the lever lock so the gear handle can be raised. A landing gear position indicator, located on the pilot instrument panel (see Figure 2-49), has three windows, one for each gear. The windows display a miniature gearwheel if the corresponding gear is down and locked. If the gear is up and locked, UP will be displayed in the windows. A barberpole indication will be displayed in the windows if the gear is in an intermediate position or electrical power is not available. A landing gear warning light on the pilot and copilot/COTAC instrument panels, with the legend WHEELS, flashes when any of the three gears do not indicate down and locked, the trailing edge flaps are more than 57 percent, and if the AOA indicator is in midposition (centered).

WARNING

Do not raise the landing gear handle on deck with hydraulic/electrical power applied and the landing gear pins removed since it will result in retraction of the landing gear.

2.10.2 Landing Gear System Operation

2.10.2.1 Normal Retraction. The normal retraction of the landing gear is initiated by moving the landing gear control handle to the UP position. If the launch bar is sensed up and locked, the control handle UP position signals the left control logic assembly to provide electrical power to the gear-up solenoid of the landing gear selector valve until all gear are sensed up and locked. The gear handle UP position directs system pressure to the utility system landing-gear-up hydraulic lines, while connecting the landing-gear-down hydraulic lines to system return. During main landing gear retraction, the initial travel of the downlock linear actuating cylinder unlatches the positive latch. With the landing gear handle remaining in the UP position and the three gears indicated up and locked, electrical power is removed from the control valve. The control valve is returned to the isolation position by spring force, isolating the utility subsystems from system pressure. Normal gear retraction time is 10 seconds or less.



INDEX	CONTROL/INDICATOR	FUNCTION
1	LDG OR (landing gear) handle/indicator	● Down (DN) position — extends landing gear. ● UP position — retracts gear. ● Red warning light illuminated — indicates position of one or more landing gear or that landing gear up-relay* is different from position of handle **Note** When weight of aircraft is on either main gear, mechanical downlock holds handle in DN position. In this case, or if solenoid lock has malfunctioned, handle cannot be moved to UP position until mechanical override button above handle is pressed.
2	WHEELS warning lights	Illuminated flashing indicates all the following conditions have been met: ● Trailing edge flaps beyond 57 percent range of travel. ● Angle of attack midpositioned (centered). ● One or more gear indicate not down and locked.
*Aircraft BUNO 159758 and subsequent and aircraft incorporating AFC-115.		

Figure 2-49. Landing Gear System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
3	Landing gear emergency extension handle	Pulled: • Mechanically releases three landing gear uplocks. • Isolates those utility systems normally isolated with the landing gear retracted from system No. 1 pressure. • Ports both sides of utility system to return. **Note** Once gear is released, gravity loads and springs extend and lock it in place. Gear then cannot be retracted until EMER LG RESET switch resets the landing gear bypass valve.
4	LG IND (landing gear position indicators) (windows — each gear)	Indicates: • By miniature wheel — gear is down and locked. • UP — gear is up. • Barber pole — gear is in transit/power removed from indicator.
5	EMER LG RESET switch	Momentary actuation — resets landing gear bypass valve. **Note** The EMER LG reset switch will not function unless the gear handle is down, landing gear emergency extension handle is up and stowed, and No. 1 hydraulic system pressure is available.
6	LDG GR DOWNLOCK OVRD button	Pressed — released landing gear lever lock.
*Aircraft BUNO 159758 and subsequent and aircraft incorporating AFC-115.		

Figure 2-49. Landing Gear System Controls and Indicators (Sheet 2)

2.10.2.2 Normal Extension. The normal extension of the landing gear is initiated by moving the landing gear control handle to the down position. Electrical power is applied to the gear-down solenoid energizing the landing gear selector valve to the gear-down position. The control valve is detented in the gear-down position. With weight on wheels and the landing gear handle in the down position, electrical power is continuously maintained on the gear-down solenoid. The selector valve (detented in the gear-down position) maintains gear-down pressure on the system in the event electrical power is removed. The gear-down position directs system pressure to the utility system landing-gear-down hydraulic lines, while connecting the landing-gear-up hydraulic lines to system return. Normal gear extension time is 15 seconds or less.

2.10.2.3 Emergency Extension. Emergency extension is required if the landing gear fails to extend normally. Operation of the emergency gear T-handle isolates the landing gear system from No. 1 system pressure while releasing the gear for emergency extension. The initial movement of the control linkage from the T-handle manually releases a latch mechanism in the emergency bypass valve, permitting springs to drive the valve to the emergency bypass position. This bypass position blocks system pressure and connects both sides of the gear system to return. Once the gear is released, gravity loads and emergency leaf springs extend the gear and lock it in the down position. Airspeed should be below 140 KIAS, and up to 90 seconds may be required for emergency gear extension. Mechanical sequencing of the gear and doors is the same as for normal operation. After emergency extension, the normal landing gear system can be restored by use of the EMER LG RESET switch if the landing gear handle is down, the emergency gear T-handle is up and stowed, and No. 1 hydraulic system pressure is available. Caution must be used when resetting on the ground following landing gear extension system failure.

2.11 WHEELBRAKE SYSTEM

The aircraft is equipped with two independent brake systems: a normal and an independent emergency braking system. Antiskid braking is also available when operating on the normal system. During gear retraction, rotation of the main wheels is stopped automatically by gear-up hydraulic pressure. A three-position brake selector switch (see Figure 2-50) is located on the pilot throttle panel and has the following identified positions: ANTI SKID ON, OFF, and EMER BRAKE. In the ANTI SKID ON position, the brake system is powered through the normal brake valve with hydraulic pressure supplied by the No. 1 hydraulic system and modulated, as required, to prevent skid activity by the antiskid system. When placed to OFF, the antiskid system is deactivated and the brakes are powered directly from the No. 1 hydraulic system. In the EMER BRAKE position, electrical power is removed from the brake selector valve and brake accumulator pressure is directed to the emergency brake valves. In ANTI SKID ON or OFF position, whenever the No. 1 hydraulic system pressure drops below 750 psi, the brake selector valves shift automatically to the EMER BRAKE position. The normal brake system also provides automatic wheelbraking during gear retraction.

2.11.1 Antiskid System. The antiskid system comprises a left and right wheel speed transducer, an antiskid control box, and a modulation valve. The wheel speed transducers, driven by the wheels, are dc generators that produce a dc voltage proportional to their rotation speed. Outputs from these transducers are transmitted to the antiskid control box. The braking activity at each wheel is sensed by monitoring the speed and deceleration or acceleration of each wheel. When the antiskid control box detects a rapid deceleration indicating an imminent or actual skid in either wheel, it modulates and/or dumps the applied brake pressure to both wheels by means of an electrohydraulic pressure control valve. The system is designed to optimize the applied pressure (up to the amount applied by the pilot) to provide maximum braking efficiency for the existing runway conditions without skidding the wheels. Safety features incorporated in the antiskid system are:

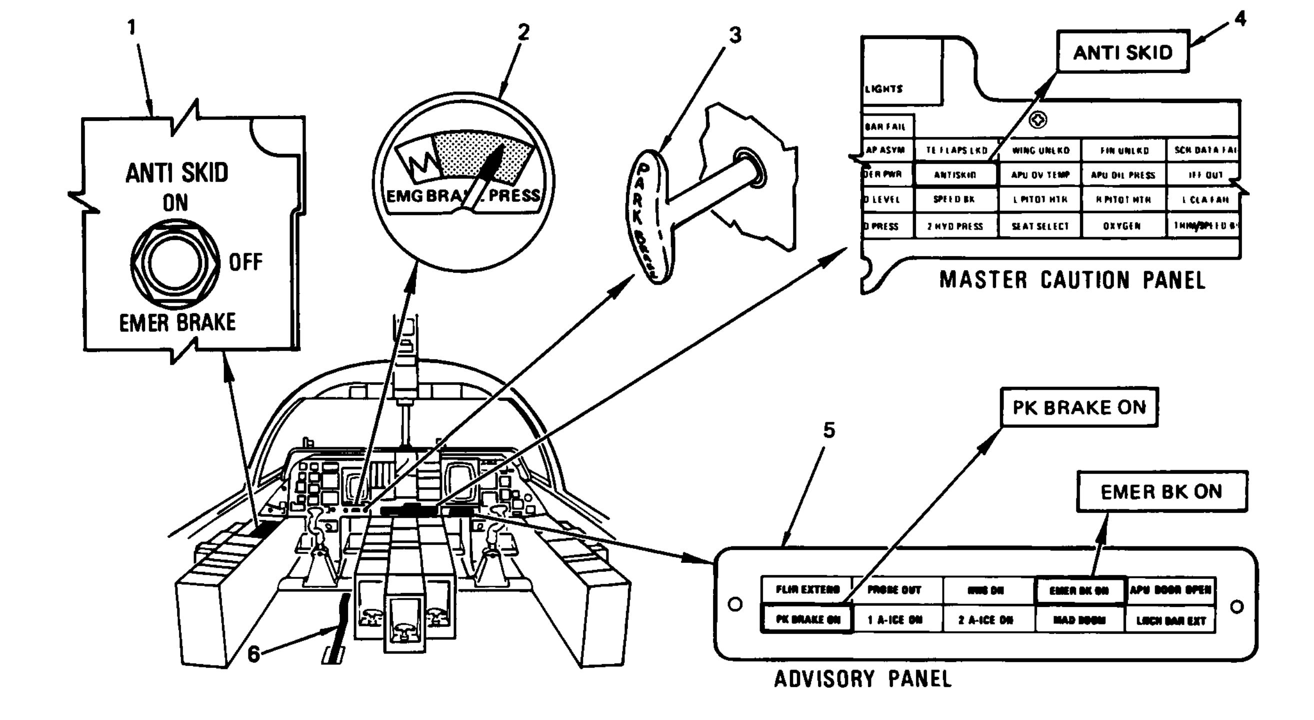
1. Touchdown protection (provides a dump until the weight is on the main landing gear)
2. Wheel spinup protection (prevents brake application at touchdown until the wheels accelerate to touchdown speed)
3. Bounced landing protection (precludes brake pressure being applied if aircraft bounces)
4. Strut walk protection (ignores false skid signals caused by MLG oscillations)
5. Locked wheel protection above 20 knots (provides a dump if a wheel stops rotating).
6. When the system senses a skid, the antiskid control valve dumps the pressure going to the brakes. This dump is a short duration dump and the control box then modulates the pressure to the brakes to obtain maximum braking efficiency. The antiskid system is inoperative below 10 knots, and the brakes revert to the normal system with no skid or locked wheel protection. Below 20 knots the system modulates the brake pressure, but locked wheel protection is inoperative.

The antiskid caution light indicates a potential malfunction in the antiskid system. This light function is derived from the antiskid control box and the control logic assembly. The logic that lights the light is landing gear handle down, antiskid switch in the ON position, and any one of the following:

1. Loss of normal brake pressure (pressure less than 400 psi)
2. A full dump of the brakes for longer than 1 second
3. Open or short circuit in the wheel speed transducers
4. Open or short circuits in the electrohydraulic antiskid control valve
5. An abnormal signal in the antiskid control box circuitry.

A false caution light may result under the following conditions:

1. If antiskid is selected at a taxi speed greater than 20 knots



INDEX	CONTROL/INDICATOR	FUNCTION
1	Brake selector switch	• ANTI SKID ON — arms antiskid braking system. • OFF — provides normal system braking without antiskid protection. • EMER BRAKE — enables emergency braking system.
2	EMG BRAKE PRESS indicator	Indicates pressure available for emergency braking; green band, sufficient; red band, not sufficient.
3	Parking brake handle	Pulled — engages mechanical linkage, locking normal and emergency brakes when both rudder foot pedals are rotated.
4	ANTISKID caution light	Refer to Master Caution Panel Lights/Action, Part V.
5	Advisory Panel: PK BRAKE ON light EMER BK ON light	Illuminated — indicates parking brake handle pulled to ON position. Illuminated — indicates the brake accumulator pressure directed to emergency brake valve when: • Pressure in No. 1 hydraulic system is less than 750 psi. • EMER BRAKE mode selected. • Parking brake on. • RH primary bus failure.
6	Hydraulic handpump	Handle actuated — pressurizes APU and brake accumulators, provides hydraulic pressure to retract arresting hook (No. 1 system not pressurized or No. 1 hydraulic system low level light is illuminated).

Figure 2-50. Wheelbrake System Controls and Indicators

2. Spinup of one wheel (to greater than 20 knots) with the other at less than 10 knots (for example, an aircraft with a dragging brake or an aircraft making a wingdown, top-rudder, crosswind landing)

3. Parking brake set with antiskid selected.

Upon selection of ANTI SKID ON, the antiskid system performs a self-test. This test checks the wheel speed transducers and aircraft wiring to the antiskid control box for open circuits and shorts. This self-test is verified by a momentary flicker of the antiskid caution light when antiskid is selected, with the landing gear handle in the down position.

The parking brakes operate exclusively off the emergency brake system irrespective of the brake selector switch when there is no hydraulic power on the aircraft. The manually operated parking brake handle, located on the left of the center instrument panel in the cockpit, is engaged when pulled aft. This action automatically shuttles the brake selector valve to the emergency brake position that ports the brake accumulator pressure to the brakes. If accumulator pressure is not available, the brakes will not be set; although, the parking brake control will remain out and the PK BRAKE ON light will illuminate.

The hydraulic handpump can be utilized for charging the accumulator. The PR BRAKE ON and EMER BK ON green advisory lights, located on the copilot/COTAC advisory panel, are illuminated when the parking brakes are engaged. Parking brakes may be released by pressing the brake pedals. This extinguishes the PK BRAKE ON and EMER BR ON lights, returns control to the brake selector switch, and returns the parking handle to its normal position. The emergency brakes are powered by the brake accumulator with a minimum of 10 full brake applications available from a fully charged brake accumulator.

The accumulator, normally charged by the No. 1 hydraulic system, can be charged manually with a handpump available in the cockpit. If the brake selector valve solenoid is deenergized or the No. 1 hydraulic system is not pressurized, the brake system will transfer automatically to the emergency mode of operation. To provide brake accumulator pressure indication, a pressure gauge labeled EMER BRAKE PRESS is located on the pilot vertical instrument panel (Figure 2-50). A pie-shaped section, red in color, indicates that very limited brake applications are available and that the brake accumulator must be recharged using the hydraulic handpump for safe braking operation. When the needle indicates in the green portion of the gauge, 2 to 10 (full) brake applications are normally available. As long as system No. 1 hydraulic pressure is available and the No. 1 hydraulic system low-level light is extinguished, the brake accumulator will be at and will remain at 3,000 psi because of the continuous recharging action of the No. 1 hydraulic system. The number of emergency brake applications is unlimited under these conditions.

The emergency brake (EMER BK ON) advisory light, located on the copilot/COTAC advisory panel, illuminates when the EMER BRAKE position is selected with the brake selector switch, providing brake accumulator hydraulic pressure is available, the landing gear handle is down, and either main gear is down and locked.

2.11.2 Wheelbrake System Operation

2.11.2.1 Normal Operation (ANTI SKID ON). The brake antiskid system operates automatically when the brake selector switch is in the ANTI SKID ON position and the landing gear handle is down. The system provides the most efficient braking, up to the pressure applied by the pilot. The response time of the system is such that the applied brake pressure is automatically optimized for all conditions including ice patches or alternate wet and dry patches on the runway, without skidding or locking a wheel. Automatic safety features are incorporated to prevent tire failure for various reasons (such as bounced wheel protection). Upon selection of ANTI SKID ON the system performs a self-test.

Note

Static torque braking characteristics of carbon brakes at elevated brake temperatures may not prevent the wheels from rolling. Elevated brake temperatures may be attained following extended taxi evolutions at high ambient temperatures or following landings or aborted takeoff.

2.11.2.2 Normal Operation (ANTI SKID OFF). Normal braking without antiskid is selected by positioning the brake selector switch to OFF. Electrical power is removed from the antiskid control box and the antiskid control valve.

2.11.2.3 Emergency Brake Operation. The emergency brake system is activated when the brake selector switch is placed in the EMER BRAKE position or automatically when the following conditions occur:

1. No. 1 hydraulic system failure
2. Right-hand primary bus failure
3. Parking brake engaged
4. Landing gear emergency extension handle down.

Emergency brakes are actuated by using the normal brake pedals, and emergency brake operation is indicated by illumination of the EMER BR ON advisory light on the copilot/COTAC instrument panel. Emergency hydraulic brake system pressure is supplied by the brake accumulator. The No. 1 hydraulic system charges the brake accumulator during normal operation. With a loss of the No. 1 hydraulic pump, the brake accumulator can be charged by the hydraulic handpump or EHP. The emergency brake accumulator, when fully charged, provides a minimum of 10 brake applications. A brake pressure gauge located in the cockpit, indicates when emergency brake pressure is available.

Note

- During emergency brake operation, the antiskid system is inoperative.
- If the brake selector switch is in the EMER BRAKE position and No. 1 hydraulic system pressure is available with the 1 HYD LEVEL light extinguished, the accumulator will be continuously charged by the No. 1 hydraulic system. There are no limitations on the number of brake applications.

2.11.2.4 In-Flight Wheelbraking During Gear Retraction. In-flight wheelbraking is automatically applied by gear-up pressure. This pressure actuates the normal brake valves causing gear-up pressure to be applied to the brakes, stopping wheel rotation in approximately 2 seconds. The brakes are automatically depressurized after landing gear retraction.

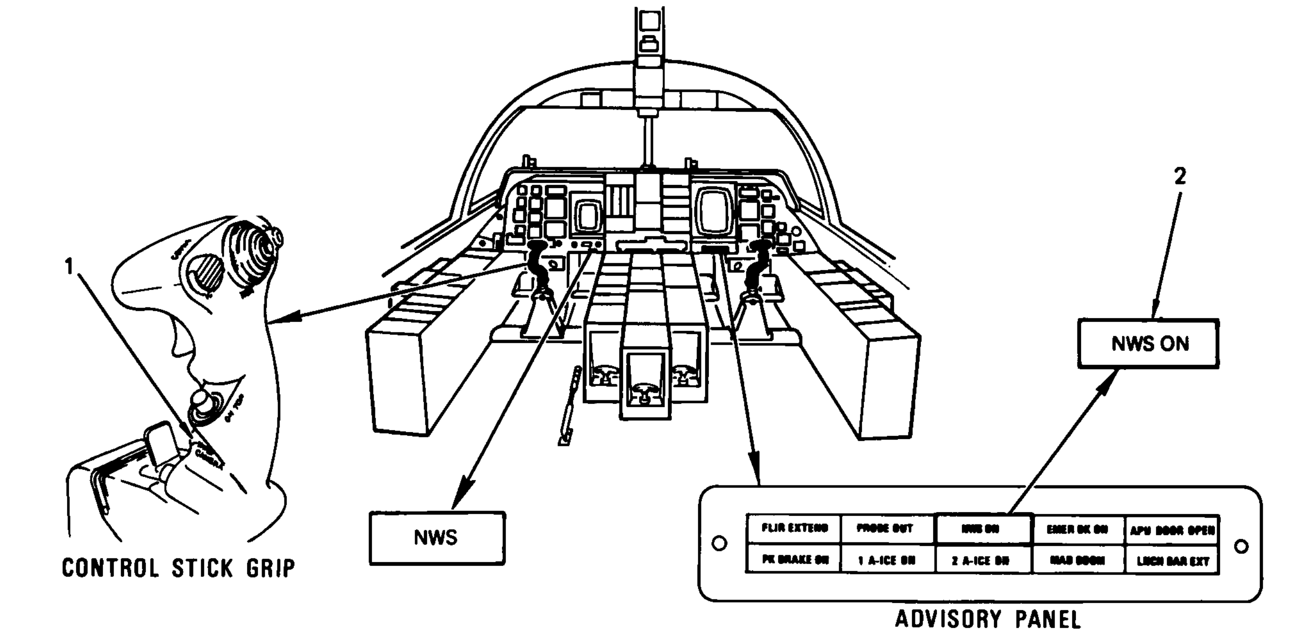
2.11.2.5 Parking Brake Operation. A manually operated parking brake is provided for the pilot. The parking brake handle operates a mechanical linkage that locks the normal and emergency brake metering valves in the applied position. The parking brake is applied by pressing both wheelbrakes fully and pulling the brake handle.

The parking brake will lock the brakes in the 75-percent applied position and will hold the aircraft through the normal brake system as long as the No. 1 hydraulic power supply system pressure is available. When the No. 1 system pressure is not available, the parking brake will hold the aircraft with emergency brake accumulator pressure. Parking brake pressure from the accumulators is adequate for a minimum of 8 hours. When the brake handle is in the applied position, the PK BRAKE ON and EMER BK ON green advisory lights illuminate on the copilot/COTAC instrument panel.

2.12 NOSEWHEEL STEERING SYSTEM

Nosewheel steering is hydraulically powered and electrically controlled. Momentary actuation of the pilot or copilot/COTAC NWS/CAMERA switch (see Figure 2-51) engages nosewheel steering and illuminates the NWS advisory light for the pilot and NWS ON advisory light on the cockpit advisory panel. Nosewheel steering can only be engaged with weight on one (or both) main landing gear wheels. Steering angle is controlled through movement of the rudder pedals. The range of nosewheel steering is 70° on either side of center with a maximum rate capability of 80° per second. When the NLG is fully extended during flight (and the arresting hook is not extended), the nosewheel will trail and be free to caster during a field landing. Damping of the nosewheel is provided by the nosewheel steering actuator in both the castering and steering modes. Nosewheel power-centering capability is also provided through a mechanical centering valve that ports hydraulic pressure to the nosewheel steering actuator to maintain the centered position. This power centering occurs:

1. During landing gear extension
2. During landing gear retraction
3. After landing gear extension whenever the arresting hook is extended in flight



INDEX	CONTROL/INDICATOR	FUNCTION
1	NWS/CAMERA switch	Momentarily pressed — engages NWS system or disengages system if previously engaged. **Note** In flight, copilot/COTAC only has camera function capability; pilot actuation will disconnect the APC or IAS hold mode.
2	NWS (pilot), NWS ON (copilot/COTAC) advisory lights	Illuminated — indicates NWS system is selected.

Figure 2-51. Nosewheel Steering System Control and Indicator

4. Whenever the aircraft is on the ground with the arresting hook extended and nosewheel steering is not selected.

Note

- If hydraulic system No. 1 pressure is not available, nosewheel steering and power centering will not be operable.
- On BuNo 159733 and subsequent aircraft and aircraft incorporating AFC-42, the nosewheel steering switch on the pilot control stick contains an additional function. When the nosewheel switch is activated without weight on wheels, the automatic thrust system is disengaged. The disengage time for throttle overpower on both pilot and copilot/COTAC is 1 second.

2.12.1 Nosewheel Steering System Operation

2.12.1.1 Normal Nosewheel Steering. With weight on either main wheel, nosewheel steering is engaged by momentarily pressing the NWS/CAMERA switch on the pilot or copilot/ COTAC control stick grip. Actuating this switch with weight on wheels provides nosewheel steering and illuminates the NWS and NWS ON green advisory lights. Steering the aircraft is accomplished by movement of the rudder pedals.

CAUTION

- On aircraft prior to BuNo 160162 and those not incorporating AYC-570, illumination of the NWS ON advisory light with the arresting hook extended may not mean control of the nosewheel steering system has been obtained. If the rudder pedals are more than 1 inch from center, momentary centering of the rudder pedals may be necessary to obtain nosewheel steering.

- Regardless of arresting hook position, selection of nosewheel steering will always result in the nosewheel being powered to the position corresponding to the rudder pedal deflection.

- If the tailfin is erect, the rudder servo artificial-feel mechanism provides pedal feel-forces during nosewheel steering. When the tailfin is in a position other than vertical, the rudder servo and force-feel system are disengaged from the rudder pedals. In this condition, rudder pedal deflections for nosewheel steering require essentially no force and positive rudder pedal centering must be initiated by the pilot.

Nosewheel steering can be deactivated at any time by momentarily pressing either NWS/CAMERA switch. With nosewheel steering deactivated and the arresting hook up, the nosewheel is free to caster to a mechanical stop at 110° on either side of center. If the nosewheel is forced beyond the 110° stop, failure of the stop shearpin will occur and will result in a full 360° castering capability. If subsequently selected, nosewheel steering will be inoperable although the NWS ON advisory light will be illuminated.

Note

There is no backup system for nosewheel steering. In the event of nosewheel steering failure, the rudder, wheelbrakes, or asymmetrical engine power are available for directional control.

2.12.1.2 Nosewheel Centering. In flight, the nosewheel is powered to the center position during landing gear retraction and extension, and at any time the hook is extended with the landing gear extended. Power-centering with the arresting hook extended is required to prevent castering of the nosewheel during rollback after arresting gear engagement. After touchdown and during ground operations, the selection of nosewheel steering takes precedence over nosewheel centering regardless of the arresting hook position. With the nosewheel steering deselected, the nosewheel will be powered to the center position if the arresting hook is extended.

On the ground, the nosewheel will be powered to the center position when nosewheel steering is not selected or deselected and the nosewheel is within approximately 64° of center with the centering mode engaged (that is, arresting hook extended). The nosewheel will be powered to the 110° stop in the direction of the initial displacement when the nosewheel is more than 64° off-center and then the centering mode engaged.

Although hydraulic pressure is removed from the actuator upon complete retraction of the landing gear, the nosewheel is held centered by a detent pin. During landing gear extension, the detent pin is disengaged by gear-down pressure and can be reengaged only by gear-up pressure.

If the landing gear is lowered by the landing gear emergency extension handle or in the event of hydraulic system No. 1 failure, nosewheel steering is not available when selected even though the NWS ON advisory light will be illuminated. Under this condition, the mechanical detent pin will be engaged, keeping the nosewheel centered. The detent pin is forced to the disengaged position as soon as a castering moment greater than 2,000 inch-pounds is applied to the nosegear.

2.13 LAUNCH BAR SYSTEM

The launch bar system provides nosegear guidance (with nosewheel steering not selected) and catapult attachments for catapult launch operations. The launch bar is controlled by a cockpit launch bar control switch and an electrically energized and hydraulically actuated valve module. The launch bar cannot be extended unless the NLG is down and locked. The launch bar valve module contains two manual controls located in the nose wheelwell (see Figure 2-52), a selector valve, an emergency retract valve, a pressure regulator that regulates the launch bar extend pressure to 590 psi, and a pressure switch that senses launch bar retract pressure. The cockpit launch bar control switch (see Figure 2-52) is located forward of the throttles on the pilot side console. With the NLG down and locked, placing the cockpit three-position toggle switch (EXT-RET-EMER RET) in the EXT position will energize the launch bar selector valve. This valve ports the 590 psi hydraulic pressure to the extend side of the launch bar actuator, which releases the actuator uplock feature and extends the launch bar. Once selected, a holding solenoid holds the switch in the EXT position (provided that weight is on both main gear and the hydraulic system No. 1 pressure is greater than 2,300 psi). In the RET position, the switch deenergizes the launch bar selector valve, which ports 3,000 psi hydraulic pressure to retract the launch bar. If the cockpit launch bar control switch is left in the EXT position during a catapult launch, the switch will automatically move to the RET position as soon as the weight-off-wheels signal is received from either main landing gear proximity switch.

In the EMER RET position, the cockpit launch bar control switch energizes the emergency retract valve in the launch bar valve module. This ports 3,000 psi hydraulic pressure directly to the retract port of the launch bar actuator to raise the launch bar (irrespective of the selector valve position).

If the launch bar has been retracted using the EMER RET position of the cockpit launch bar control switch, cockpit (pilot) control cannot be obtained until the EMER RET position is deselected and the emergency retract valve is reset by pressing the emergency retract valve reset button in the nose wheelwell (see Figure 2-52, index 4). If the launch bar has been extended using the launch bar manual extend control in the nose wheelwell, the cockpit (pilot) RET position of the launch bar control switch is inoperable until the manual extend control has been reset to the normal position (see Figure 2-52, index 5).

CAUTION

If the launch bar is not retracted and locked, the landing gear handle may be raised. However, wheels will not retract and AOA indexers and approach lights will be inoperative. Assume launch bar to be down regardless of LNCH BAR FAIL light illumination, unless visually confirmed up.

A launch bar extended (LNCH BAR EXT) green advisory light, located on the copilot/COTAC advisory panel, indicates the cockpit launch bar control switch is in the EXT position and that the launch bar is not up and locked. The LNCH BAR EXT advisory light extinguishes when the launch bar control switch is not in the extend (EXT) position or if the launch bar is up and locked.

A launch bar fail (LNCH BAR FAIL) amber caution light on the master caution panel illuminates when one of the following sets of conditions exist:

1. Launch bar not up and locked with the cockpit launch bar control switch not in EXT position, weight on either main landing gear, and pilot left throttle not in maximum position. Launch bar actuator has a retract pressure of greater than 1,750 psi.

2. The launch bar actuator has a retract pressure of less than 1,750 psi, the pilot left throttle is in the maximum position with the launch bar control switch not in EXT position, and weight on either main landing gear.

3. Launch bar not up and locked, weight not on either main landing gear, and greater than 3 seconds from weight off main landing gear.

2.13.1 Launch Bar System Operation

2.13.1.1 Normal Launch Bar Extension. When selected, the cockpit launch bar control switch will be magnetically held in the EXT position if the following conditions are satisfied:

1. Weight on both main gear

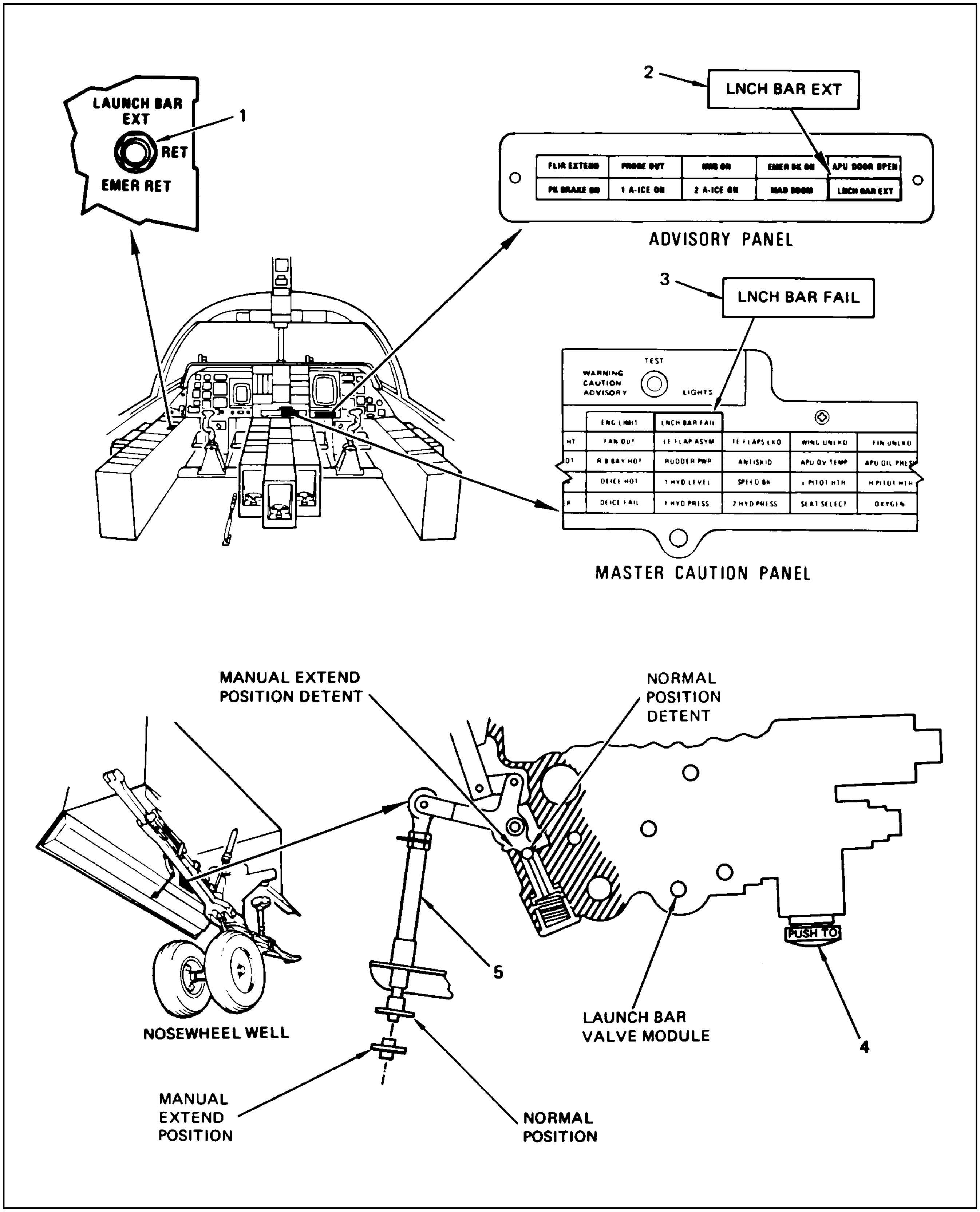


Figure 2-52. Launch Bar System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	LAUNCH BAR control switch	• EXT — energizes launch bar selector valve, allowing hydraulic pressure to extend launch bar. • RET — deenergizes launch bar selector valve and allows hydraulic pressure to retract launch bar. • EMER RET — shuttles emergency retract valve to direct system pressure to retract launch bar. **Note** Once selected, the launch bar cannot be extended until the emergency retract valve is manually reset.
2	LNCH BAR EXT advisory light	Illuminated — indicates launch bar switch in EXT position and launch bar not locked in RET (retract) position. Extinguished — indicates launch bar switch not in EXT (extend) position, or launch bar up and locked.
3	LNCH BAR FAIL caution light	Illuminated — indicates one of the following sets of conditions exist: • Insufficient hydraulic pressure for retraction if LAUNCH BAR control switch is in the RET position, launch bar in shuttle, and full power is applied. • Full power is not applied when launch bar is in shuttle, LAUNCH BAR switch is in RET or EMER RET position, and sufficient hydraulic pressure is present. • Launch bar is not up and locked 3 seconds after weight off wheels and LAUNCH BAR switch is in RET or EMER RET position.
4	Emergency retract valve reset	Pushed — resets emergency retract valve to restore cockpit control after EMER RET position on cockpit launch bar control switch has been deselected.
5	Launch bar manual extend control	• Normal position — permits normal operation from cockpit using the launch bar control switch. • Manual extend position — extends the launch bar (deck crew) and disables the normal launch bar retract mode.

Figure 2-52. Launch Bar System Controls and Indicators (Sheet 2)

2. No. 1 system hydraulic pressure greater than 2,300 psi.

Activation of the cockpit launch bar control switch to the EXT position and unlocking of the launch bar uplock mechanism will illuminate the LNCH BAR EXT advisory light; hydraulic pressure will extend the launch bar and hold it against the deck.

CAUTION

Failure of the LNCH BAR EXT advisory light to illuminate when the launch bar is extended may indicate a failure of the launch bar control circuitry. This may result in landing gear retraction with the launch bar extended.

As the launch bar is lowered, it is captured between the nose gear scissor link guides. As the aircraft approaches the catapult, the launch bar engages a lead-in track that permits the launch bar to steer the nosewheel for alignment with the catapult.

The launch bar will ride up and along the ramp to the catapult shuttle and drop to the deck in front of the shuttle. After the throttles have been advanced to the maximum position and before launch, the cockpit launch bar control switch should be placed in the RET position. The launch bar advisory light will extinguish.

Note

- Placing the cockpit launch bar control switch in the RET position after full tension allows hydraulic pressure to immediately raise the launch bar as the shuttle moves aft, if the launch has been suspended.

- If the cockpit launch bar control switch is placed in the RET position before advancing the throttles to maximum position, the LNCH BAR FAIL caution light will illuminate; however, upon advancing the throttles, this caution light will extinguish.

After the cockpit launch bar control switch is placed to the RET position and the pilot throttles are in the maximum position, a LNCH BAR FAIL caution light illumination indicates if retract pressure is less than 1,750 psi. If this occurs, suspend the launch and request that the deck crew verify that the launch bar manual extend control on the launch bar valve module in the nose wheelwell is in the normal position (see Figure 2-52, index 5). If the caution light does not extinguish upon reapplying full power, abort the launch and use the EMER RET position of the cockpit launch bar control switch to clear the catapult.

2.13.1.2 Normal Retraction On Deck. With the cockpit launch bar control switch placed in the RET position, the LNCH BAR EXT advisory light will extinguish and hydraulic pressure will retract the launch bar to the up-and-locked position.

Note

The LNCH BAR FAIL caution light will illuminate momentarily during launch bar retraction.

2.13.1.3 Normal Retraction After Launch. Prior to launch with the throttles at maximum power and the cockpit launch bar control switch in the RET position (LNCH BAR EXT advisory light out), the launch bar is held down by the shuttle while hydraulic pressure and the leaf springs are trying to raise the launch bar. As the launch bar disengages the shuttle after the catapult stroke, hydraulic pressure raises the launch bar within 3 seconds.

2.13.1.4 Extension By Deck Crew. If the launch bar does not extend (LNCH BAR EXT advisory light not on) after the pilot places the cockpit launch bar control switch in the EXT position, the deck crew can extend the launch bar by operating the launch bar manual extend control on the launch bar control valve in the nose wheelwell (see Figure 2-52, index 5). After the launch bar is engaged in the shuttle, the launch bar manual extend control in the nose wheelwell must be manually repositioned to the normal position.

CAUTION

- Failure to reset the launch bar manual extend control will result in a LNCH BAR FAIL caution light illumination when RET position is selected at the launch bar control switch in the cockpit and will prevent landing gear retraction after launch. If the landing gear handle will raise, wheels do not retract, AOA indexers and approach lights are inoperative, and LNCH BAR FAIL light does not illuminate, assume the launch bar is not fully up and locked.

- If the pilot has a LNCH BAR FAIL caution light illumination after repositioning the launch bar manual extend control to the normal position (with the switch in the RET position and with maximum throttle) abort the launch. The EMER RET position of the cockpit launch bar control switch should be used to retract the launch bar clear of the catapult.

2.13.1.5 Emergency Retraction During Flight. If the LNCH BAR FAIL caution light illuminates during flight with the landing gear down, the pilot may attempt to retract and lock the launch bar up by placing the cockpit launch bar control switch in the EMER RET position. If the launch bar does not lock in the up position, the LNCH BAR FAIL caution light will remain illuminated and the approach lights and indexers will be inoperative. Moving the landing gear emergency extension T-handle to the gear-down position (pulled) removes all hydraulic pressure from the launch bar valve package and allows leaf springs to raise the launch bar enough to clear the arresting gear. The leaf springs may not have sufficient tension to raise the launch bar to the up-and-locked position and extinguish the LNCH BAR FAIL caution light. An up indication is not required if a visual check by an outside observer can be performed.

Note

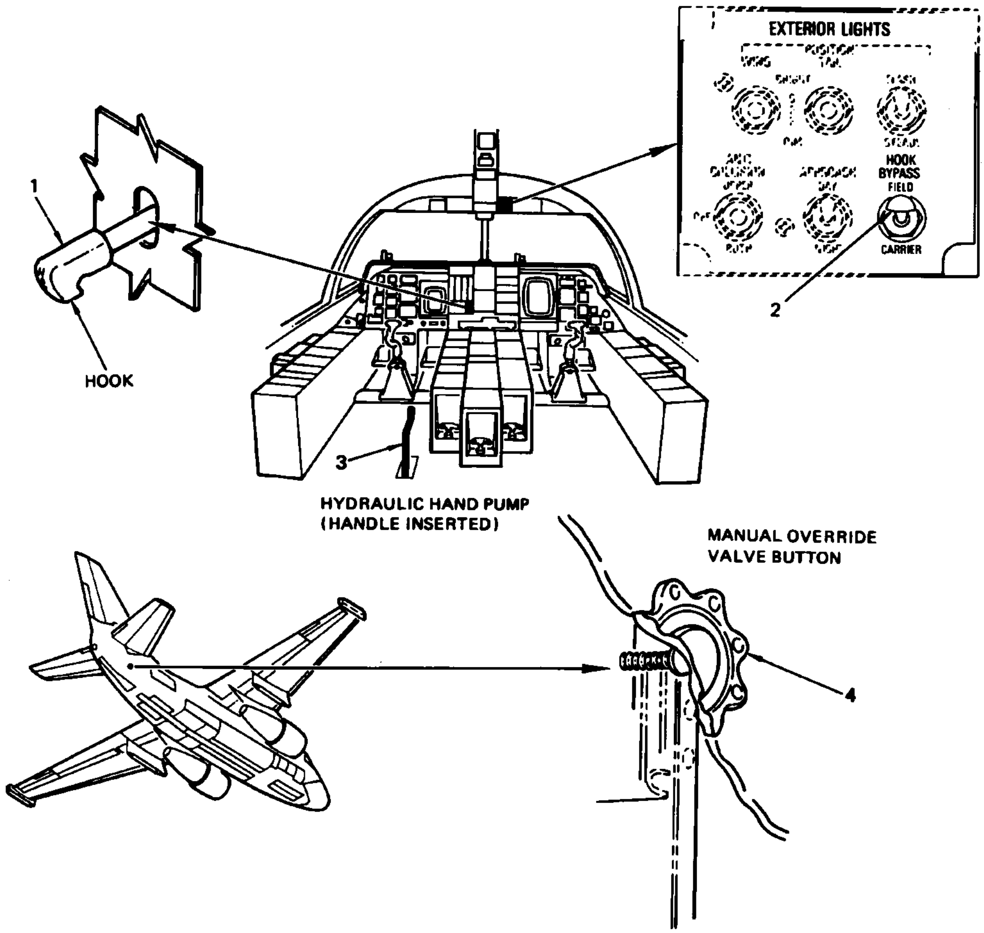
- Reset of the landing gear system may cause the launch bar to extend again.

- Normal brakes, nosewheel steering, nosewheel centering with hook extension, and gear retraction will be inoperable unless the landing gear system is reset.

Refer to Part V for emergency procedures.

2.14 ARRESTING HOOK SYSTEM

The arresting hook is mechanically actuated and extended by a nitrogen precharge and gravity. Normal retraction is electrically controlled and hydraulically actuated; in the event of a hydraulic failure in the No. 1 hydraulic system, it can be retracted manually by the deck crew or by the pilot using the hydraulic handpump in the cockpit. During retraction, the hydraulic actuator raises the hook and compresses the shock absorber. In the event of a hook bounce, a self-contained arresting hook bumper located on the hook mechanism prevents the hook from rebounding into the arresting hook trough during arrestment. An arresting hook control handle (see Figure 2-53), located on the center instrument panel, is used to raise and lower the arresting hook. It has two positions, up (detented) and down (spring-loaded). When moved down, the arresting hook uplock is released allowing the nitrogen charge in the shock absorber and gravity to extend the hook. When raised, the uplock is reset and hydraulic pressure retracts the hook. The handle must be pushed forward approximately one-quarter inch to unlock, at which point the handle will be pulled to its full-down position by the force in the cable to extend the hook. Retracting the hook is just the reverse. The arresting hook in-transit position light, located in the hook control handle, illuminates red if the hook and the control handle positions are not in agreement. It will not light during hook bounce or cable arrestment or when at rest on the carrier deck following a landing. The HOOK BYPASS switch, located on the forward overhead panel adjacent to the exterior light switches, has two positions, CARRIER and FIELD. In CARRIER, it causes the illuminated approach light to flash if the hook is not extended; in FIELD, it causes the approach lights to shine steady during a field landing, regardless of the hook position.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Arresting HOOK handle position warning light	• Pushed forward, then down — retracts hook uplock, arresting hook extended. • Moved up, aft and down — directs hydraulic pressure to actuating cylinder, raises hook. • Hook red warning light in handle illuminates when hook is not in agreement with hook handle position. **Note** Observing warning light out when hook handle is in full up or full down position does not provide positive assurance of hook position unless light has just been extinguished after a hook position change. While the hook is in transit (up or down), the warning light will be illuminated until the hook achieves the command position (up or down). Additional verification is obtained from the characteristic thump of the hook locking in position.

Figure 2-53. Arresting Hook System Controls and Indicator (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
2	HOOK BYPASS switch	• FIELD — causes approach lights to shine steady regardless of hook position. • CARRIER — causes illuminated approach light to flash if hook not extended.
3	Hydraulic handpump	Handle actuated — pressurizes APU and brake accumulators, provides hydraulic pressure to retract arresting hook (No. 1 system not pressurized, primary dc bus power available).
4	Manual override valve button	Pressed — allows hydraulic pressure (through the arresting hook control valve) to retract the hook externally.

Figure 2-53. Arresting Hook System Controls and Indicator (Sheet 2)

2.14.1 Arresting Hook System Operation

2.14.1.1 Normal Extension. To extend the arresting hook, the control handle is pushed forward approximately one-quarter inch to unlock and allowed to be pulled down by the force in the cable system. This action relaxes the hook uplock. The arresting hook is then extended by the shock strut and gravity. Normal extension time is approximately 2 seconds. The hook in-transit (warning) light is illuminated until the hook position is in agreement with the control handle position.

2.14.1.2 Normal Retraction. To retract the hook, the control handle is moved up to the limit of its travel and allowed to move aft and down, approximately one-quarter inch. This action signals the CLA to energize the arresting hook control valve and allows the hook to be locked mechanically, after retraction. The control valve directs hydraulic pressure to the arresting hook actuating cylinder, which raises the hook. When the uplock proximity sensor detects that the hook is up and locked, power is removed from the control valve solenoid. The hook-in transit light is illuminated until the hook position is in agreement with the control handle position.

2.14.1.3 Emergency Hook Extension. If normal shock absorber extend power fails (shock absorber stored fluid and/or pneumatic charge lost), gravity will lower the hook to a sufficient trail angle for cable engagement but not to the fully extended position. Failure of the hook to extend to the full-down position in flight will cause the hook warning light to remain illuminated.

2.14.1.4 Emergency Hook Retraction. Failure of the No. 1 hydraulic system or loss of primary dc bus power to the arresting hook control valve will prevent normal hook retraction. A retract button (manual override), located on the starboard side of the aircraft below the horizontal stabilizer, is an integral part of the arresting hook control valve and provides an emergency means of retracting the hook with either normal system or handpump hydraulic power. If necessary, hook extend force can be relieved by bleeding down the nitrogen charge in the arresting hook shock absorber.

2.15 WING FOLD SYSTEM

The outer wing panels of the aircraft are folded and spread by hydraulic motor gear-linkage assemblies. The wing fold operation normally requires electrical power and No. 1 hydraulic system pressure to operate the actuators located at the wing fold joint. The folding sequence is completely automatic; the spoilers are automatically retracted and deactivated in the retracted position and the wing lockpins are withdrawn. Initial movement of the wings to fold mechanically locks the outboard upper and lower spoilers in the fully retracted position. As the wing begins to fold, the ailerons are restrained in their last position by a mechanical clutch. While the wings are folding, trailing edge outboard flaps retract, if extended, in an amount proportional to wing movement until the wings are completely folded, at which point the flaps are fully retracted. During either the folding or spreading cycle, the direction of movement of the wings can be reversed by selecting the opposite command or stopped at an intermediate position by momentarily lifting the gustlock cover out of the up detent. The system is designed to fold or spread the wings in approximately 20 seconds with a 60-knot wind from 45° to aircraft heading. The wing fold system can be actuated from the cockpit or as a backup using a manual override at the wing fold valve in the left wheelwell. Emergency folding of the wings can be accomplished with No. 1 hydraulic system pressure only. The gustlock cover in the cockpit must first be raised and the wing lockpin and wing fold valves manually operated from the left wheelwell.

CAUTION

Cockpit control of the wing fold system is lost when emergency wing fold is initiated from the left wheelwell. Raising the gustlock cover out of the detent will not stop an emergency wing fold.

Note

On BuNo 159734 and subsequent and earlier modified aircraft incorporating AFC-65, the system provides actuation of the spoiler gustlocks as a function of wing rotation thereby eliminating the possibility of gustlock engagement when the wings are in the spread position.

Jury struts, one for each wing, should be installed between wings and fuselage to secure the wings in the folded position for severe weather conditions.

2.15.1 WING/FIN FOLD Gustlock Cover. The WING/FIN FOLD gustlock cover, located on the aft end of the center console (see Figure 2-54), accomplishes the following when raised and pushed down into the detent.

Mechanically:

1. Unlocks latches that hold the wing and fin lockpins in the extended position
2. Actuates gustlock linkage for elevators, ailerons, and rudder servos, provided neither hydraulic system is pressurized
3. Extends wing and fin mechanical warning flags
4. Exposes WlNG SPREAD/FOLD and FIN FOLD/ERECT switches.

CAUTION

Raising the gustlock cover out of the detent with the wings folded negates all the electrical actions listed in the following paragraphs. Speedbrakes can be commanded out and the inboard spoilers will extend with lateral stick motion. Either of these actions by the pilot can result in the inboard spoilers contacting the top surface of the folded wing if the SPOIL 1 & 2 PRIM SERVO HYD PRESS switch is in the NORM position.

Electrically (with weight on gear and electrical and hydraulic power applied to aircraft):

1. Disables the pilot/copilot speedbrake switch and removes speedbrake command (if any) from spoilers
2. Removes hydraulic power to the aileron servo thereby removing all roll inputs to the spoiler servos
3. Closes the No. 1 and No. 2 spoiler servo shutoff valves when spoilers are retracted (provided both hydraulic systems' pressure is applied to the aircraft)
4. Arms the WING SPREAD/FOLD and FIN FOLD/ERECT switches
5. Inhibits trailing edge flap brakes
6. Illuminates WING UNLKD and FIN UNLKD caution lights.

2.15.2 Wing Warning Flags. A red mechanical warning flag is installed on the upper leading edge of each wing and is visible from the cockpit. The flags indicate that the wing pin latches are not engaged.

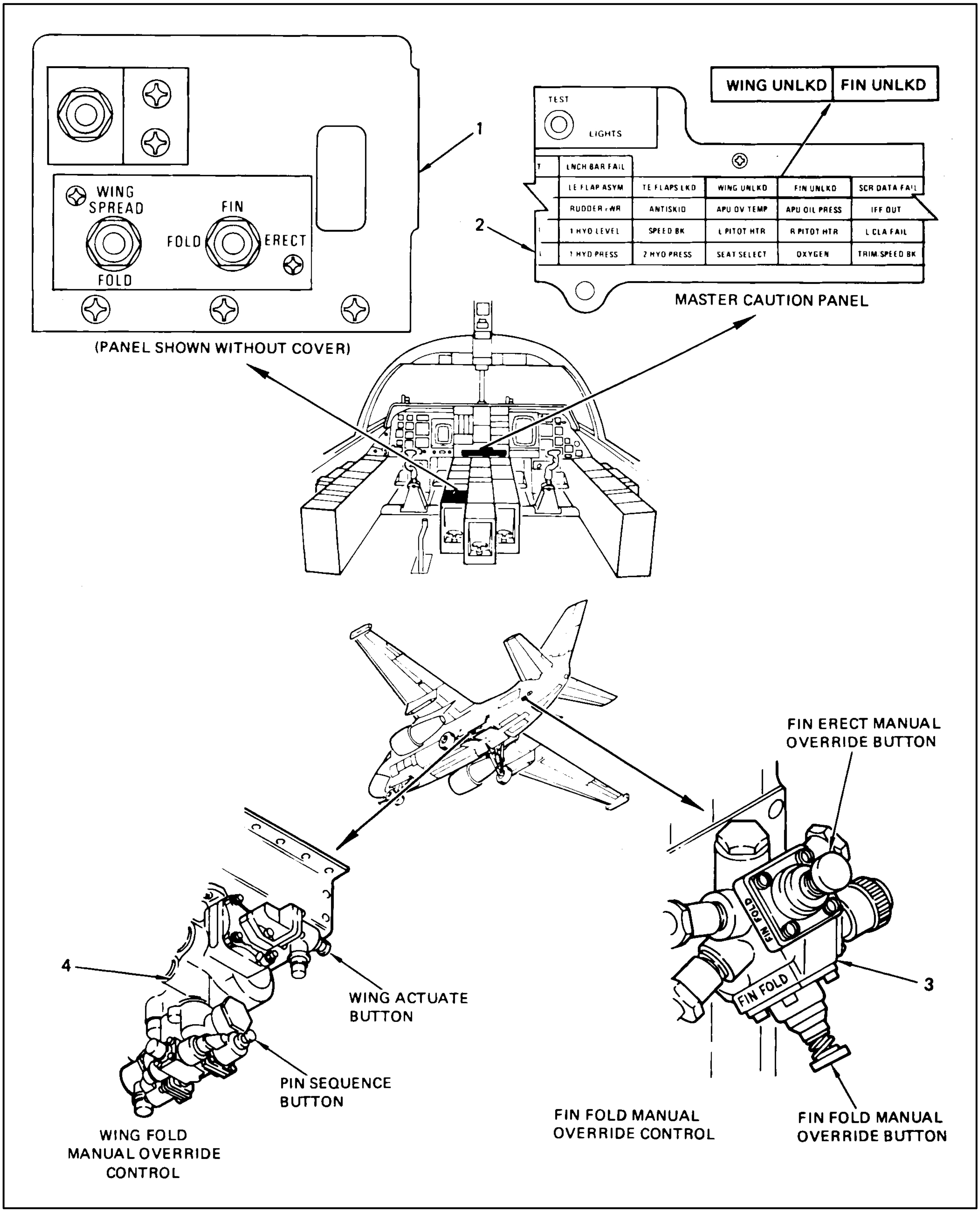


Figure 2-54. Wing/Fin Fold Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Wing and Fin Fold Control Panel:	
	WING/FIN FOLD gustlock cover	Pulled aft and raised — prepares the wing and tail fin for folding and applies the primary servo gustlocks
	WING SPREAD/FOLD switch	• SPREAD (momentary) — electrically energizes left CLA to automatically complete wing spread cycle. • Center — no inputs for wing fold actuation. • FOLD (momentary) — electrically energizes left CLA to automatically complete wing fold cycle.
	FIN FOLD/ERECT switch	• ERECT (momentary) — initiates complete automatic fin erect sequence. • Center — no inputs for fin fold actuation. • FOLD (momentary) — initiates complete automatic fin fold sequence.
2	Master Caution Panel:	
	WING UNLKD light	Illuminated — indicates one or more of four wing pin actuators not extended and engaged by lockpin latches.
	FIN UNLKD light	Illuminated — indicates one or both fin lockpins not extended and engaged by lockpin latches.
3	Fin fold manual control selector	Activation of appropriate button control causes fin to fold or erect as desired.
4	Wing fold manual override control	Activation of button control enables the wing fold system for ground emergency use.

Figure 2-54. Wing/Fin Fold Controls and Indicators (Sheet 2)

2.15.3 Wing Fold System Operation

2.15.3.1 Normal Fold Operation. The normal wing fold operation is initiated by lifting the WING/FIN FOLD gustlock cover. Momentarily placing the WING SPREAD/FOLD switch to the FOLD position starts the complete automatic wing fold sequence. The outer wing is held in the folded position by a hydraulically released, spring-applied brake in the wing fold motor.

2.15.3.2 Normal Spread Operation. The normal wing spread operation is initiated by momentarily placing the control switch to the WING SPREAD position. The spread cycle is completely automatic. When the wings are fully spread, close the gustlock cover. The cover normally cannot be moved to the closed position unless the wing spread sequence is complete and the wing lockpins are fully extended.

WARNING

Misrigged latch catches may allow the gustlock cover to be moved to the closed position without the wing locking pins being fully extended through the locking lugs.

WARNING

False targeting of the wing spread proximity switch will allow premature extension of the wing locking pins prior to completion of the normal wing spread evolution. The pilot will receive normal cockpit indications that the cycle has been completed and the gustlock may then be stowed. Caution lights will extinguish. It is imperative that the crew visually check the position of the wings prior to stowage of the gustlock.

2.15.3.3 Emergency Operation. The wing fold valve and the wing lockpin valve can be positioned for emergency manual override operation to fold or spread the wings if electrical power is not available; however, No. 1 system hydraulic pressure is required, and the folded wing and spoilers will be damaged if the spoilers are extended. The wing fold and lockpin valves are located in the wing fold package in the left main gear wheelwell. Manual operation of these valves for wing folding is for emergency operation only. The WING/ FIN FOLD gustlock cover must be up and the spoilers completely retracted. During emergency wing fold operation, hydraulic pressure to the actuator is reduced.

CAUTION

- If emergency wing folding is attempted without electrical power on the aircraft, the inboard spoilers will respond to roll stick inputs and may result in damage to the folded wing and upper inboard spoilers. Before attempting an emergency wing fold, all speedbrake and roll inputs must be removed.
- The gustlock cover should be raised or the SPOIL 1 & 2 switch on the flight control test panel moved to OFF before either hydraulic system pressure or electrical power is removed from the aircraft. If either engine is shut down without completing this action, one or both spoiler servo shutoff valves will remain open. If the hydraulic system is subsequently pressurized with the wings folded, inboard spoilers will respond to roll inputs and spoiler and wing damage can be incurred.
- If the wings have been folded using the emergency override, the inboard spoilers may respond to lateral stick inputs and cause damage to the spoiler panels and/or the wing.
- Before emergency wing fold operation, verify the spoilers are fully retracted and all speedbrake and roll inputs are removed.
- The wings should not be folded or spread from the cockpit with the EHP on if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wing.

Note

The wing lockpins cannot be extended after an emergency spread operation using manual override valves. The wings must be locked from the cockpit by raising the gustlock cover from its detent or selecting wing spread with hydraulic and electrical power on the aircraft.

2.16 FIN FOLD SYSTEM

The vertical fin is folded by a hydraulically powered, electrically controlled actuator in the upper portion of the vertical fin. The system requires No. 1 hydraulic pressure and the No. 1 hydraulic servo switch must be on to position the rudder approximately 15° to the right and fold the fin to a horizontal position above the left horizontal stabilizer. The cycle is completely automatic and may be reversed at any time by momentarily positioning the control switch to the opposite position. The cycle may be interrupted by pulling the gustlock cover out of the up detent. However, there is no brake on the actuator, and the fin will slowly settle to the folded position.

2.16.1 Fin Warning Flag. A red mechanical warning flag is installed in the leading edge of the vertical fin. The flag is not visible from the cockpit but warns ground personnel that the WlNG/FIN FOLD gustlock cover is in the raised position indicating that the lockpin is not mechanically locked.

2.16.2 Fin Fold System Operation

2.16.2.1 Normal Fold Operation. The normal fin fold operation is initiated by lifting the WlNG/FIN FOLD gustlock cover and momentarily actuating the FIN control switch to the FOLD position. The fold sequence is completely automatic. System pressure retracts both lockpins. Valve action inhibits hydraulic flow to the fold actuator until the rudder reaches approximately 15° right deflection. Movement of the rudder to the right is automatically provided to prevent interference with the elevator during the fold sequence. A time delay is initiated at the start of the fold sequence that removes all electrical power from the fin fold controls. With electrical power removed, the solenoid operated valves return to their neutral positions and port the entire subsystem to return pressure. Completion of the fin fold sequence requires approximately 24 seconds after rudder positioning. After completion of the cycle (electrical power removed) the solenoid operated valves return to their neutral positions and port the entire subsystem to return pressure.

Note

- With the fin folded, rudder pedal forces are essentially zero and there is no rudder pedal centering. Care should be exercised when folding or erecting the fin while using nosewheel steering. The nosewheel steering technique is different with the fin folded.

- The WING/FIN FOLD gustlock cover can be extremely difficult to stow with both wings confirmed down. If, after visual inspection, wings are spread and wing locking pins are properly seated, consideration should be given to folding then erecting the fin. This action will cause the fin locking pins to align properly, at which time the WING/FIN FOLD gustlock cover can be stowed.

2.16.2.2 Normal Erect Operation. Momentary actuation to the ERECT position of the control switch and release initiates the complete automatic erection sequence. A time delay is initiated as in the start of the fold sequence. Valve action permits system pressure to be ported to the fin fold actuator. When the fin reaches the erect position, full system pressure is ported to the fin lock cylinders causing the pins to extend. As the fin lockpins extend, the attached mechanical linkage repositions the rudder servo input linkage and trim linkage. Electrical power is removed from the fin fold controls during the time delay. For complete fin erection, the WlNG/FIN FOLD gustlock cover can be closed only if the wing and fin lockpins are in the extended position.

2.16.2.3 Manual Override Operation. Manual override operation is provided through the vertical fin fold selector manual override button on the selector valve. This valve is accessible in the aft fuselage of the aircraft, located on the port side below the horizontal stabilizer leading edge, and is accessible by removing a cover in the fuselage (see Figure 2-54). No electrical power is needed to fold or erect the vertical fin by this method. Prior to manual override operation of fin fold or fin erect, the WING/FIN FOLD gustlock cover must be raised to unlock the hinge pin latches.

2.17 BOMB BAY DOOR SYSTEM

There are two bomb bay doors for each bomb bay controlled from the cockpit center console or from an external panel adjacent to the left bomb bay. Hydraulic and electric motors simultaneously power the four doors during normal operation, completing normal operation from closed to open, or open to closed, in approximately 6 seconds with both the normal and EMER DOOR switch. If either motor fails, the other continues to operate the doors with the operating time approximately doubled. Normal operation of the doors is controlled by the pilot or copilot/COTAC, using the DOORS OPEN/TRANS switch, located on the armament control panel (see Figure 2-55). Pressing the switch alternately opens the four bomb bay doors or closes them; proximity switches ensure complete door closing. The EMER DOOR switch on the armament control panel overrides normal door control. Operation will interrupt or reverse a normal door control switch command.

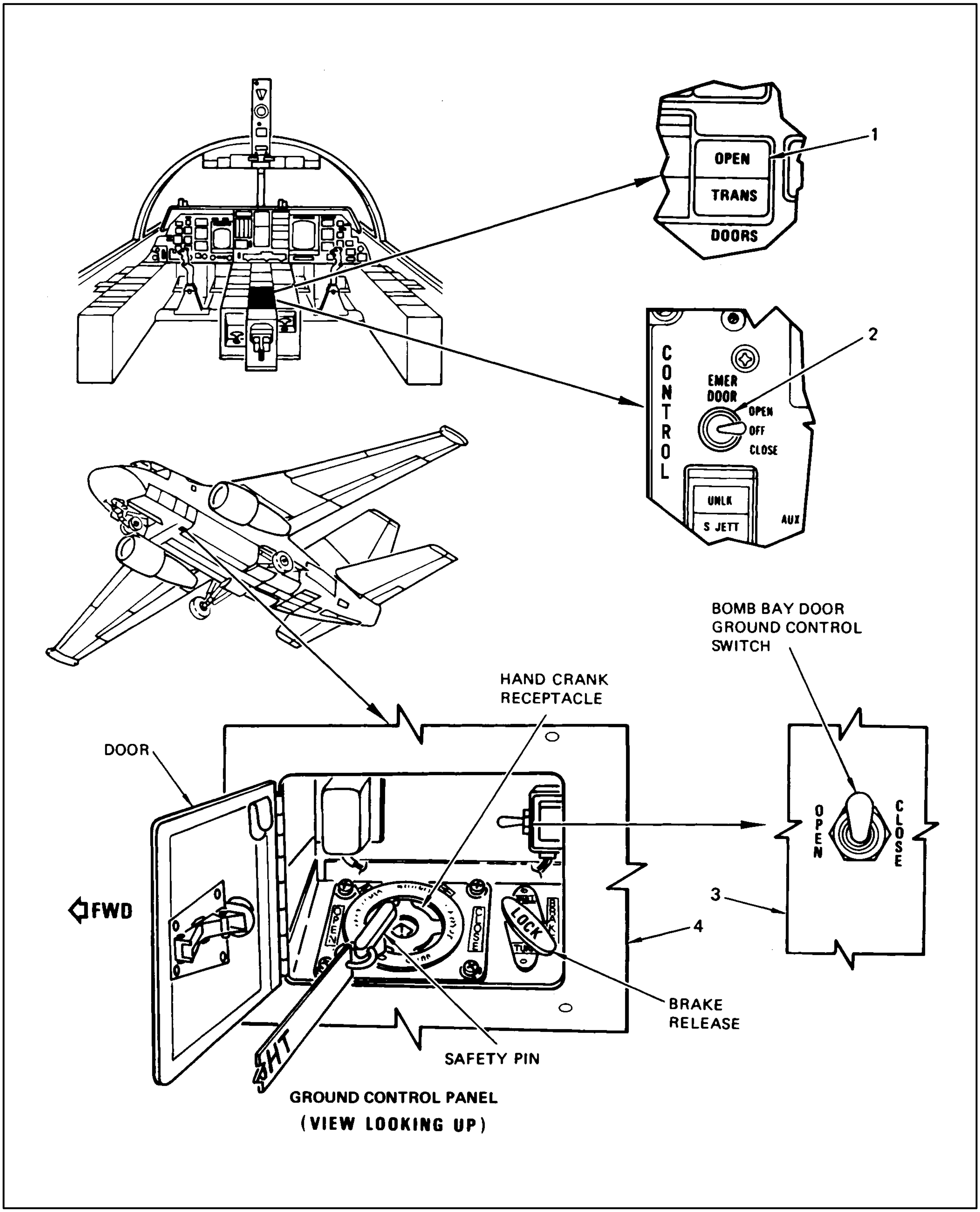


Figure 2-55. Bomb Bay System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Bomb bay DOORS switch light	• Momentarily pressed (doors closed) — energizes electric and hydraulic motors to open bomb bay doors, illuminates TRANS until doors in open position; when TRANS goes out, legend OPEN is illuminated. • Momentarily pressed (doors open) — energizes electric and hydraulic motors to close bomb bay doors from the open position, extinguishes OPEN and illuminates TRANS light until doors in CLOSED position, then TRANS light extinguishes.
2	Bomb bay EMER DOOR switch	To interrupt or reverse normal door cycle: • OPEN — energizes electric motor to drive doors to load position. • OFF — restores bomb bay door control to the normal DOORS control switch light. • CLOSE — energizes electric motor to drive doors closed from both the LOAD or OPEN position.
3	Bomb bay ground control switch	To actuate the doors externally: • OPEN — energizes electric motor to drive doors to load position. • Center — deenergizes electric motor. • CLOSE — Energizes electric motor to drive doors to the closed position.
4	Bomb bay ground control panel	Comprises a handcrank receptacle, provisions for a safety pin, and a brake release handle. (When the handle is pulled and turned, the brake is released allowing door operation with a handcrank.)

Figure 2-55. Bomb Bay System Controls and Indicators (Sheet 2)

WARNING

Do not press the DOORS OPEN/TRANS switch on the armament control panel when the bomb bay ground control panel door is open. Pressing the DOORS OPEN/TRANS switch inserts the command into memory and causes the bomb bay doors to open or close when the bomb bay ground control panel is closed.

Note

If opened from the cockpit, the doors will stop at the drop position.

2.17.1 Bomb Bay Doors Ground Control Panel. The bomb bay doors ground control panel is located in an access immediately forward of the left bomb bay. The panel contains an electric door control switch, a brake, a handcrank receptacle, and provisions for a safety pin (see Figure 2-55). When the access door is open and the landing gear handle is down, the bomb bay doors cannot be operated by the door controls in the cockpit. In addition, the actuator contains a detent that must be pressed to permit the door to open to the load position. The electric door control switch is used during ground operations (such as loading). It is a three-position toggle switch with the following positions:

1. OPEN — turns on the electric motor to drive the four bomb bay doors open to the load (extreme open) position when detent is pressed.

2. OFF — turns off the electric motor. The switch is spring loaded to the OFF position.

3. CLOSE — Turns on electric motor to the four bomb bay doors from the OPEN or LOAD position.

Note

If the ground control panel is inadvertently left open, the bomb bay door control from the cockpit will be enabled when the landing gear is raised.

The bomb bay doors can be opened or closed by a handcrank when the electrical power is not available and the brake control is manually released. The brake control operates as follows:

1. Handle in — allows normal motor-driven bomb bay door operation.

2. Handle out and turned — releases the brake allowing manual door movement by use of the handcrank receptacle.

WARNING

Use of the ground safety pin is essential for safety of personnel.

2.18 ENVIRONMENTAL CONTROL SYSTEM

Environmental control system (see FO-16) provides:

1. Air-conditioning

2. Avionics cooling

3. Sonobuoy and bomb bay stores heating

4. Cabin pressurization.

The ECS uses bleed air from the engines and APU, or high-pressure air from a ground unit. The air is routed to the air refrigeration package. There, it is initially cooled in a heat exchanger (using ambient air that enters through the ram air inlet and exits through the ECS exhaust). It is further cooled by the ECS turbine and then dehumidified by a water separator. After its temperature is adjusted, the air is routed into the cabin for cockpit air-conditioning and avionics cooling. Air is pulled through the avionics by fans, and some of it is then exhausted into the bomb bays for weapons heating. The rest is pulled out of the cabin by the internal avionics fan. Exhaust air is either recirculated back into the cabin for further cooling or routed aft through the cabin outflow valve to the sonobuoy chutes and then overboard.

Additional cooling can be provided by the manual (AUX VENT) or automatic opening of the auxiliary vent/ram air augmentation valve, which allows ambient air entering the ram air inlet to flow directly into the cabin.

Cabin pressurization is maintained by two valves that control the amount of air allowed to exit the cabin. The cabin safety valve is a backup valve and is normally closed. The cabin outflow valve modulates to maintain the predetermined pressurization schedule.

2.18.1 Bleed Air Supply. The primary source of air for operation of the ECS is bleed air from the 10th stage of the compressor on each engine. When 10th-stage bleed air is insufficient to meet ECS demands, 14th-stage air is automatically supplied through the 14th-stage augmentation valve. This valve also opens to help meet ECS demands during deicing operations.

A bleed air shutoff valve is installed in each engine pylon downstream of the 10th- and 14th-stage engine compressor bleed ports (Figure 2-6). These valves control the flow of engine bleed air to the bleed air manifold, or air from the manifold to the respective starter for engine start. The valves are electrically controlled by the BLEED AIR switches on the cockpit overhead panel (Figure 2-56) and are pneumatically actuated. Whenever the valves are closed, 1 and 2 BL CLSD master caution lights illuminate regardless of the position of the BLEED AIR switches.

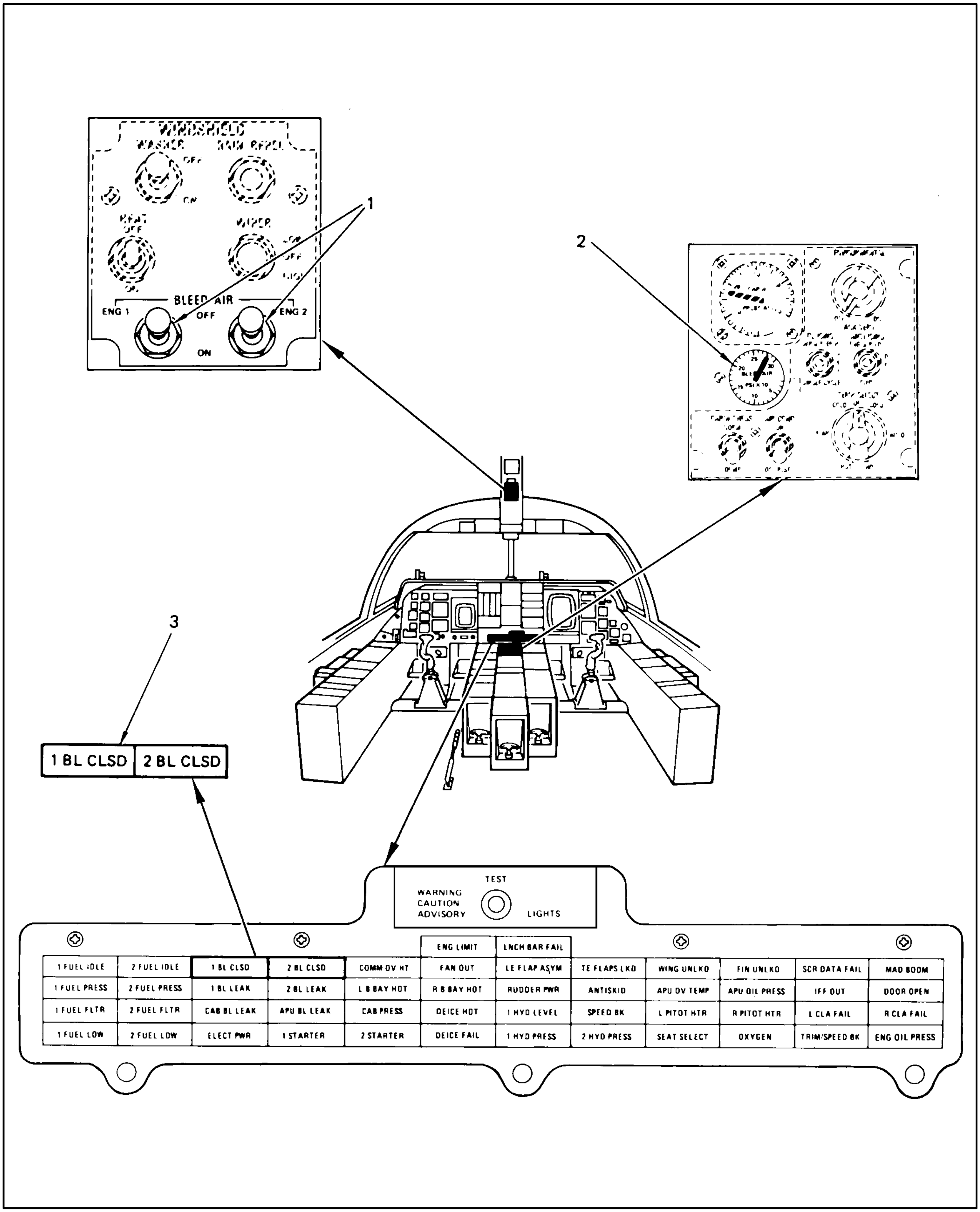


Figure 2-56. Bleed Air Controls and Indicator (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	BLEED AIR ENG 1, ENG 2 switches	ON — allows engine compressor bleed air, APU air, or ground start air to open the respective bleed air shutoff valve. OFF — allows spring tension and duct pressure to close the bleed air shutoff valve.
2	BLEED AIR manifold pressure gauge	Indicates: ● Availability of APU or ground start air pressure. ● Availability of engine bleed air from one or both engines for engine starting, air-conditioning, pressurization, and de-icing. ● Failure of bleed air shutoff valve to close. ● Unsafe overpressure condition (160 psi) caused by failure of overpressure limit switches in bleed air shutoff valve.
3	1 BL CLSD, 2 BL CLSD caution lights	Illuminated — indicates respective bleed air shutoff valve closed, regardless of position of BLEED AIR switch. Extinguished — indicates valve open.

Figure 2-56. Bleed Air Controls and Indicator (Sheet 2)

The bleed air shutoff valves will close automatically if electrical power is removed or the valve fails. Also, the valves are programmed to close whenever an overpressure or overtemperature condition exists in the bleed air manifold. The valves will reopen when either engine START switch is engaged.

Note

If the overtemperature or overpressure condition is removed, the bleed air shutoff valve will automatically reopen provided the BLEED AIR switch is ON.

The bleed air manifold distributes the compressor bleed air from the engines or APU into the air-conditioning and pressurization system. A bleed air isolation system is installed in the manifold to prevent overbleed of both engines in the event of a rupture in one side of the manifold. While the engine on the side of the rupture may encounter an overbleed condition, the other engine is protected and can be operated normally. The system consists of two isolation check valves and a crossbleed start valve. The isolation check valves are located at the junction of the left and right manifolds and only allow bleed air to flow away from their respective sides of the manifold. Thus, bleed air from the engine opposite the rupture cannot reach the rupture but can reach the ducting to the refrigeration package. The crossbleed start valve is installed in separate ducting that connects the left and right sides of the manifold, bypassing the isolation check valves. The valve only opens when either an engine START switch is engaged, or deicing is selected while operating single engine.

On the ground, the APU can supply bleed air for normal operation of the ECS system. When the APU is used, the No. 1 BLEED AIR switch must be ON to provide the air pressure necessary for proper control of the valves in the ECS system.

Available bleed air pressure is sensed by a pressure transmitter located in the manifold downstream of the isolation check valves and is displayed on the bleed air manifold pressure gauge (Figure 2-56).

Two alternate air sources, APU air and ground (external) air, also connect into the manifold. The APU air duct connects into the left manifold and supplies air from the APU compressor for engine starting or air-conditioning. Ground start air is supplied through a receptacle in the right wheelwell and is supplied to the right side of the manifold. This air is used for starting engines and operating the air-conditioning system on the ground.

2.19 AIR-CONDITIONING SYSTEM

The air refrigeration package receives bleed air from the engines and APU, or high-pressure air from an external ground unit, via the flow control and shutoff valve. This valve is electropneumatically controlled by the AIR COND switch (Figure 2-57) and is pneumatically actuated. The flow control and shutoff valve automatically schedules the amount of bleed air supplied to the refrigeration package utilizing two flow schedules: high (full open) or low (partially open).

Note

- The flow control and shutoff valve fails to the open position. Thus, if bleed air is available without dc power available, the system will operate at full cold, without temperature control.
- The flow control and shutoff valve closes when an engine START switch is engaged, regardless of the AIR COND switch position. Closing this valve is required to gain sufficient pressure to start an engine. If air-conditioning does not resume after starter cutout, cycle the AIR COND switch to open the flow control and shutoff valve.

After passing through the flow control and shutoff valve, the bleed air then passes through the heat exchanger where it is cooled by ambient air (which enters through the ram air inlet, goes through the heat exchanger, and then is exhausted overboard by a fan powered by the cooling turbine). The partly cooled air is then further cooled by the cooling turbine. Next, it is combined with bleed air in the anti-icing mixing muff to maintain air temperature just above freezing to prevent the formation of ice prior to entry into the water separator. After the air has been dehumidified, bleed air is combined with the cold air in the temperature control mixing muff to maintain desired temperature (16 to 27 °C). The air is then routed to the cabin through various ducts and vents. The air-conditioning system also includes provisions for air recirculation, ram air augmentation, and auxiliary ventilation.

2.19.1 High-Flow Schedule. The air-conditioning system normally operates in high flow (flow control and shutoff valve fully open). With the DE-ICING switch OFF, the system operates in high flow under any of the following conditions:

1. Weight on wheels
2. Operating outside of the low-flow temperature and altitude limits
3. AUX VENT knob not in the OFF detent
4. In-flight refueling probe extended.

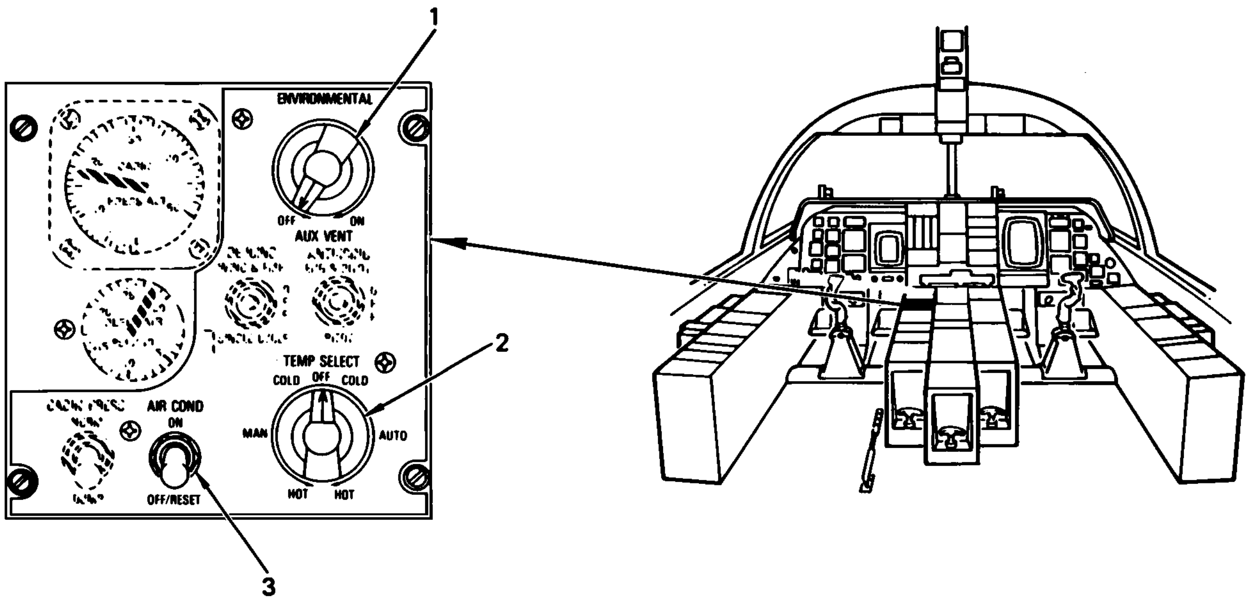
Note

Engaging the DE-ICING switch will always shift the system to low flow unless AUX VENT is not OFF or the in-flight refueling probe is extended.

2.19.2 Low-Flow Schedule. The low-flow schedule is designed to automatically increase aircraft endurance under certain conditions by using less bleed air from the engines for air-conditioning and using ambient air for additional cooling. The system achieves this by partially closing the flow control and shutoff valve to reduce the amount of bleed air extracted from the engines, and, at the same time, opening the auxiliary vent/ram air augmentation valve to allow ambient air entering through the ram air inlet to flow directly to the cabin, supplementing the reduced air refrigeration package output.

With the DE-ICING switch OFF, the system only operates in low flow if all of the following conditions exist:

1. Weight off wheels
2. Below 3,000-foot altitude (±600 feet)
3. OAT between –10 and +26 °C
4. AUX VENT knob in the OFF detent
5. In-flight refueling probe retracted



INDEX	CONTROL/INDICATOR	FUNCTION
1	AUX VENT control	ON — clockwise rotation from OFF controls the amount of air entering the cabin by varying the auxiliary vent valve opening. Depressurizes cabin pressure if air conditioning is off. OFF — counterclockwise rotation from ON, proportionately closes the auxiliary vent valve and returns the outflow valve to its normal controlling mode.
2	TEMP SELECT switch	AUTO — clockwise rotation from OFF automatically maintains cabin temperature within plus or minus 3 degrees of selected temperature between 16 and 27 °C (60 and 80 °F). MAN — counterclockwise rotation from OFF, controls position of cabin temperature control valve from closed (COLD) thru open (HOT). **CAUTION** Positioning the TEMP SELECT switch to full hot in the MAN (manual) mode can overheat and possibly damage the cabin air distribution ducting. OFF — deactivates cabin temperature controls and the system operates in full cold. **CAUTION** Selection of OFF stops routing of air through the water separator, and can lead to a build-up of water which can freeze, causing damage to ECS ducting.

Figure 2-57. Air-Conditioning and Temperature Controls (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
3	AIR COND switch	ON — opens bleed air flow control and shutoff valve for air conditioning and pressurization, provided pneumatic pressure is available. Allows operation of the following: ● Water separator anti-icing controls. ● Cabin temperature control system. ● Air recirculation system. OFF/RESET — closes the bleed air flow control and shutoff valve. Deactivates the following: ● Water separator anti-icing controls. ● Cabin temperature control system. ● Air recirculation system. ● Single-engine waveoff lockout relay if previously energized. ● Cabin pressurization if AUX VENT is on.

Figure 2-57. Air-Conditioning and Temperature Controls (Sheet 2)

6. AIR COND switch ON, essential power available.

Note

- If not operating the GPDC, aircraft endurance can be increased by setting the DEICING switch to SINGLE CYCLE or WING & EMP. This will force the flow control and shutoff valve to its low-flow position (partially closed), reducing demands on the engines. In this case, ram air augmentation will be available only if all conditions necessary for automatic selection of low flow exist.

- Selection of low flow by setting the DE-ICING switch to SINGLE CYCLE or WING & EMP is solely a function of switch position and does not require that deicing be operating (if DEICING is selected with the ANTI-ICING switch not set to ENG & PITOT, the deicing system will not operate but the flow control and shutoff valve will shift to low flow).

2.19.2.1 Cabin Temperature Control. The cabin temperature control system regulates the temperature of air entering the cabin from the air refrigeration package. Temperature is controlled, automatically or manually, using the TEMP SELECT knob on the environmental control panel (Figure 2-57).

Note

On very humid days, fog may form in the cockpit when air from the refrigeration package is cooled below ambient temperatures. This is likely to occur near sea level, at higher power settings, and when descending into humid climates. To prevent or reduce fog, increase cabin temperature using the TEMP SELECT knob.

2.19.2.1.1 Automatic Mode. The automatic mode of temperature control is selected by setting the TEMP SELECT knob to the desired position on the right side (AUTO) of the knob. Once selected, the cabin temperature control valve will automatically vary the amount of bleed air being mixed with cooled air to maintain temperature within ±3° of selected temperature from 16 to 27 °C (60 to 80 °F). If automatic temperature control fails, the cabin temperature control valve shuts off bleed air supply when inlet temperature exceeds 74 °C (l65 °F).

2.19.2.1.2 Manual Mode. If the automatic mode fails, the cabin temperature control system can be operated in the manual mode. Counterclockwise rotation of the TEMP SELECT knob from the OFF position manually adjusts the position of the cabin temperature control valve from closed (COLD) to open (HOT).

CAUTION

Positioning the TEMP SELECT switch to full hot in the MAN (manual) mode can overheat and possibly damage the cabin air distribution ducting.

Note

When operating in the manual mode, changes in power settings or altitude will change the temperature of air entering the cabin.

2.19.2.2 Ram Air Augmentation and Auxiliary Ventilation. The auxiliary vent/ram air augmentation valve is controlled either automatically or manually to allow ambient air to flow directly into the cabin. Ram air augmentation operates the valve automatically, under certain conditions, while auxiliary ventilation refers to manual control of the valve using the AUX VENT knob.

Note

Loss of essential dc bus power automatically opens the auxiliary vent/ram air augmentation valve.

2.19.2.2.1 Ram Air Augmentation. When specific conditions are met, the ram air augmentation system operates to supply ambient air directly to the cabin for cooling. This reduces the need for conditioned air from the refrigeration package, thus decreasing the requirement for bleed air from the engines and increasing aircraft endurance. When all conditions are met, the air-conditioning system shifts to low flow (flow control and shutoff valve partly closed) and the auxiliary vent/ram air augmentation valve automatically open.

Ram air augmentation operates whenever all of the following conditions exist:

1. AIR COND switch ON and essential power available
2. Weight off wheels
3. Below 3,000-foot altitude (±600 feet)
4. OAT between –10 and +26 °C
5. AUX VENT knob in the OFF detent
6. In-flight refueling probe retracted.

Note

If, while ram air augmentation is operating the AUX VENT knob is set to ON or the in-flight refueling probe is extended, the flow control and shutoff valve will be forced full open causing a change in air-conditioning airflow.

2.19.2.2.2 Auxiliary Ventilation. The auxiliary ventilation system is designed to be used as a backup source of air-conditioning (refrigeration package failure) or to provide maximum airflow through the cockpit to clear smoke or fumes. The system is activated by rotating the AUX VENT knob clockwise from the OFF detent. This opens the ram air augmentation valve to allow ambient air entering the ram air inlet to flow directly into the cabin. The system provides maximum ventilation through the cabin when AUX VENT is selected by automatically fully opening the flow control and shutoff valve, and, if the AlR COND switch is ON and the internal avionics fan is operative, opening the air recirculation valve.

WARNING

Setting the AUX VENT knob to ON with the AIR COND switch set to OFF will depressurize the cabin, requiring the crew to use oxygen at altitudes above 10,000 feet.

CAUTION

Setting the AUX VENT knob to ON with the AIR COND switch ON and the internal avionics fan operative automatically opens the air recirculation valve, which may cause the avionics to overheat during ground operation.

2.19.2.3 Operation With APU Air. To operate the air-conditioning system using APU bleed air, the

APU generator and AIR COND switches must be on. The APU AIR switchlight must also be selected to ON (illuminated). To permit temperature control, the No. 1 BLEED AIR switch must be on. Pneumatic pressure to operate the temperature control valve is tapped between the bleed air shutoff valve and the engine, requiring the bleed air shutoff valve to be open. If the bleed air shutoff valve is not open, the system will operate full cold regardless of the position of the TEMP SELECT knob.

2.19.2.4 Operation with Ground Start (External) Air. The ground start cart (huffer) provides a source of pressurized air, through a receptacle in the right wheelwell, for air-conditioning or engine starts. For temperature control, essential dc power is required and the No. 2 BLEED AIR switch must be on. Cabin temperature is then controlled by the TEMP SELECT knob.

Note

If no external power is available, the air-conditioning system will operate in full cold mode regardless of AIR COND switch position.

2.19.2.5 Operation with Ground Cooling Air. A ground cooling air cart can supply cooled air through a receptacle in the right wheelwell. The air is directed to the cabin, bypassing the aircraft air refrigeration package. The temperature can only be controlled at the cart.

2.19.2.6 Operation During Single-Engine Flight. In event of in-flight engine shutdown, sufficient bleed air is available from one engine to operate the entire air-conditioning and pressurization system.

2.19.2.7 Operation During Single-Engine Waveoff. To maximize aircraft performance during single-engine waveoff, control logic circuitry automatically closes the flow control and shutoff valve to stop extraction of bleed air from the engines. To provide a backup source of air-conditioning, the circuitry also automatically fully opens the auxiliary vent/ram air augmentation valve.

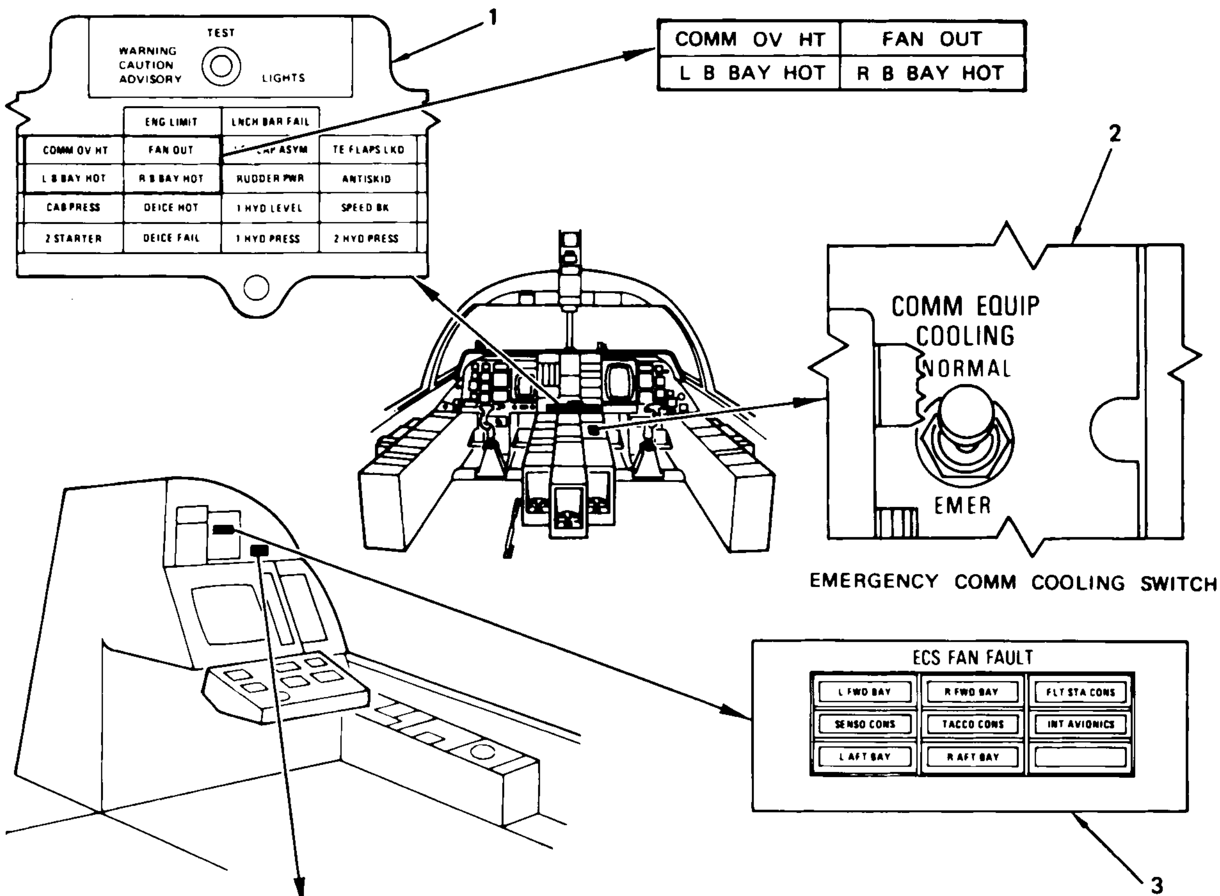
Criteria for activation of single-engine waveoff protection are nosewheel extended, operating engine N_g above 92 percent, and the secured engine Ng below idle. To return the flow control and shutoff valve and the auxiliary vent/ram air augmentation valve to their normal operating mode (and regain pressurization) requires that the good throttle be reduced below 92-percent N_g or the nosewheel be retracted and that the AIR COND switch be cycled to OFF/RESET and back to ON.

2.19.3 Cabin Air Distribution. Conditioned air from the air refrigeration package or from a ground cooling cart, as well as ambient air from the ram air inlet, enters the cockpit and aft cabin through outlets at each crewmember station from overhead panels and from a defogging manifold along the base of the cockpit windshields. A vent on the overhead panel between the aft seats directs air aft, and an overhead distribution duct just forward of the GPDC directs air to both sides in the internal avionics bay to provide additional cooling of avionic components. A thermometer is installed on the aft inboard edge of the left internal avionics rack to allow the TACCO to monitor cabin temperature.

CAUTION

Positioning the TEMP SELECT switch to full hot in the MAN (manual) mode can cause hot air to be supplied through the internal avionics bay overhead distribution duct instead of conditioned air normally supplied through this duct. This can overheat and possibly damage the cabin air distribution ducting.

2.19.4 Internal Avionics Cooling. The internal avionics and electrical equipment, located in the pressurized cabin, are cooled by cabin air that is drawn through the avionics racks and electrical equipment by fans. The air is then exhausted to the bomb bays and sonobuoy chutes where it is used to heat weapons and sonobuoys. The flight station and aft consoles each contain a cooling fan that operates automatically anytime its respective ac bus is powered. Sensors installed at each of the three consoles cause illumination of lights on the ECS fan fault panel (TACCO station) whenever a fan fails (Figure 2-58). Illumination of a light on the ECS fan fault panel illuminates the FAN OUT light on the master caution panel.



ECS FAN FAULT

WHEN ECS FAN FAULT IS INDICATED, PULL ALL COLORED CIRCUIT BREAKERS CORRESPONDING WITH FAN FAULT AREA

FAN FAULT AREA	COLOR	QTY	ACTN
L FWD BAY	RED 0,0 BLACK	5	
R FWD BAY	0 YELLOW	1	
SENSO CSL	0 BLUE	4	
TACCO CSL	0 WHITE	4	
FLT STA CSL	BROWN 0,0 ORANGE	5	1
INT AVIONICS	GREEN, YELLOW 0,0,0,0 BLACK, ORANGE	18	2,4
R AFT AVIONICS			3

ACTION:

1. NOTIFY CREW TO USE RADIO BACKUP MODES
2. ON PWR CONT PNL, TACCO CSL, TURN OFF TAPE RCDR, ACOUSTICS GP, & COMPUTER GP
3. NOTIFY COPILOT/COTAC TO PLACE COMM EQUIP COOLING SWITCH IN "EMER" POSITION
4. NOTIFY PILOT OR COPILOT/COTAC TO TURN AUX VENT CONTROL TO FULL OPEN IF ACPS IS OFF

4 [1]

NOTE

[1] REFER TO IN-FLIGHT ECS FAN FAULT EMERGENCIES CHART, PART 5, FOR IN-FLIGHT ACTION

Figure 2-58. ECS Fan Fault Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	COMM OV HT caution light	Illuminated — indicates right aft avionics bay overheated due to recirculation system or cooling fan failure. **Note** If cooling fan has failed, FAN OUT caution light and R AFT BAY fan fault light will also be illuminated. Extinguished — indicates compartment air temperature cooled sufficiently to operate communications equipment.
	FAN OUT caution light	Illuminated — indicates that any one of the three avionics bay cooling fan has failed. **Note** The pilot must ask the TACCO to identify failed fan on ECS fan fault panel. Extinguished — all fans are operating normally. The pilot or copilot/COTAC master caution light has been pressed after a fan failure. The COMM EQUIP COOLING switch is in the EMER position if FAN OUT light was caused by failure of right aft avionics bay fan.
	L B BAY HOT, R B BAY HOT caution lights	Illuminated — indicates temperature in respective bomb bay has reached 66 °C (150 °C).
2	COMM EQUIP COOLING switch	NORMAL — provides electrical power to the right aft avionics fan for normal cooling of the compartment. Electrically closes the emergency cooling door. EMER — opens emergency cooling door for compartment cooling, shuts off fan and deenergizes fan-out sensor, extinguishes FAN OUT caution light by extinguishing the R AFT BAY ECS fan fault light. Directs cooling air to communications area during flight.
3	L FWD BAY, R FWD BAY, R AFT BAY, L AFT BAY caution lights	Illuminated — indicates failure of cooling fan in associated bay. **Note** Left aft bay not used at this time.
	FLT STA CONS, SENSO CONS, TACCO CONS, INT AVIONICS caution lights	Illuminated — indicates respective cooling fan has failed. Extinguished — indicates respective cooling fan is operating.
4	ECS FAN FAULT PLACARD	Indicates action to be taken in case of an ECS fan fault during ground operation only.

Figure 2-58. ECS Fan Fault Controls and Indicators (Sheet 2)

Note

The FAN OUT master caution light can be extinguished by pressing the MASTER CAUTION light. The ECS fan fault light will stay on as long as the sensor detects a fan failure.

An internal avionics cooling fan in the cabin exhaust duct operates automatically anytime power is applied to its electrical bus. The fan exhausts cabin air through the cabin outflow valve. A sensor will cause illumination of the INT/AVIONICS light on the ECS fan fault panel and the FAN OUT master caution light whenever the fan fails.

Note

The INT AVIONICS fan fault light often illuminates during flight at low altitudes and high airspeeds. Climbing and/or reducing airspeed will usually extinguish the light.

Failure of an ECS cooling fan requires that the crew take the appropriate action (see Figure 20-1 and the NATOPS Pocket Checklist) to prevent overheating of the equipment associated with the failed fan.

2.19.4.1 Air Recirculation. The air recirculation system recirculates a portion of the cabin exhaust air back to the cabin to reduce engine bleed air demands when full cooling capacity is not required. An air recirculation shutoff valve is installed in the cabin exhaust duct downstream of the internal avionics fan. The valve opens automatically when all of the following conditions exist:

1. AIR COND switch ON
2. Altitude above 3,000 feet (±600 feet)
3. Internal avionics fan operating
4. Exhaust air passing through internal avionics fan below 25 °C (78 °F).

2.19.5 Bomb Bays and Search Stores Heating

2.19.5.1 Bomb Bays Heating. Cabin exhaust air is used to heat weapons carried in the left and right bomb bays. Air enters the bays at the aft end, traverses the bays, and exits through louvers at the forward end of the bays. A temperature sensor in each bomb bay will illuminate the L or R B BAY HOT master caution light when the respective bomb bay temperature exceeds 66 °C (150 °F). If either light illuminates, the bomb bay doors can be opened to cool the weapons in the bays.

2.19.5.2 Search Stores Heating. The sonobuoys are also heated by cabin exhaust air. The air circulates through a space between the individual sonobuoy container and the sonobuoy chute to maintain sonobuoy temperature between –20 and +55 °C (–4 and +131 °F). To ensure balanced circulation of air to the sonobuoys, all sonobuoy chutes must be loaded with either a packaged sonobuoy launch container or an empty SLC (empty SLCs must have an expended JAU-1/B initiator installed in order to eliminate intrusion of cold ambient air).

2.19.6 External Avionics Cooling. Cooling of the four unpressurized avionics bays (left forward, right forward, right aft, left aft) is provided by fan-induced ambient air that is drawn into the respective bay, circulated through the avionics, and discharged overboard through louvered outlets. Each bay contains an electrically powered cooling fan that operates anytime its respective electrical bus is powered.

Note

- Neither avionics nor a cooling fan are installed in the left aft avionics bay.
- A sensor in each bay illuminates the associated light on the ECS fan fault panel and the FAN OUT master caution light whenever the respective fan fails.
- The FAN OUT master caution light can be extinguished by pressing the MASTER CAUTION light. The ECS fan fault light will stay on for the duration of the fan failure.

2.19.6.1 Left and Right Forward Bays. The left forward bay contains the IFF, ICLS, FLIR, and UHF DF equipment.

The right forward bay contains components of the AN/APS-137(V) radar system. The bay also contains an air recirculation system that automatically recirculates a portion of exhaust air back into the bay when bay temperature drops below 2 °C (35 °F). The system prevents bay temperatures from decreasing below –7 °C (20 °F).

2.19.6.2 Right Aft Bay The right aft bay contains the UHF and HF communications equipment. Normally, ambient air is drawn by a cooling fan into the bay through a louvered inlet and is exhausted overboard through a duct and louvered outlet. A recirculation system, similar to the right forward bay, is used to recirculate air when the temperature drops below 2 °C (35 °F).

Since the communications equipment is considered important for safety of flight, an emergency cooling system is installed to ensure continued cooling in the event of a failure of the cooling fan or of the recirculation system (to the full recirculating mode). Failure of the fan would cause illumination of the R AFT BAY ECS fan fault light. Failure of the fan or the recirculation system could lead to illumination of the COMM OV HT master caution light (temperature in the bay above 77 °C (171 °F).

The emergency cooling system incorporates a door and an actuator in an alternate air duct in the bay. If the fan fails or the bay overheats, the crew can open the emergency cooling door by positioning the COMM EQUIP COOLING switch (Figure 2-58) to EMER. This allows ambient ram air to enter the bay and extinguish the R AFT BAY and FAN OUT lights. The COMM OV HT light will not extinguish until the bay cools down.

Note

The emergency cooling system cannot be used on the ground as sufficient airflow is not available.

2.19.7 Cabin Pressurization. Cabin pressurization is maintained by controlling the rate at which air is permitted to exhaust through the cabin outflow valve. When the CABIN PRESS switch (Figure 2-59) is set to NORM, a cabin pressure controller regulates cabin pressure, in accordance with a predetermined schedule (Figure 2-60) by pneumatically controlling the position of the cabin outflow valve. The system also incorporates a cabin safety valve that is normally closed but will open automatically to relieve overpressurization and negative pressure.

2.19.7.1 Cabin Outflow Valve. The cabin outflow valve is located in the cabin exhaust duct and allows air to escape through the sonobuoy chutes. The valve is positioned by the cabin pressure controller as necessary to maintain pressurization according to one of three pressurization modes.

2.19.7.1.1 Unpressurized Mode (0 to 5,000 Feet). The cabin outflow valve is kept fully open so that cabin altitude is the same as aircraft altitude.

2.19.7.1.2 Isobaric Mode (5,000 to 25,000 Feet). The cabin outflow valve is positioned as necessary to maintain cabin altitude at a constant 5,000 feet until approximately 25,000 feet, at which point cabin pressure has increased to 6.7 psi greater than ambient pressure.

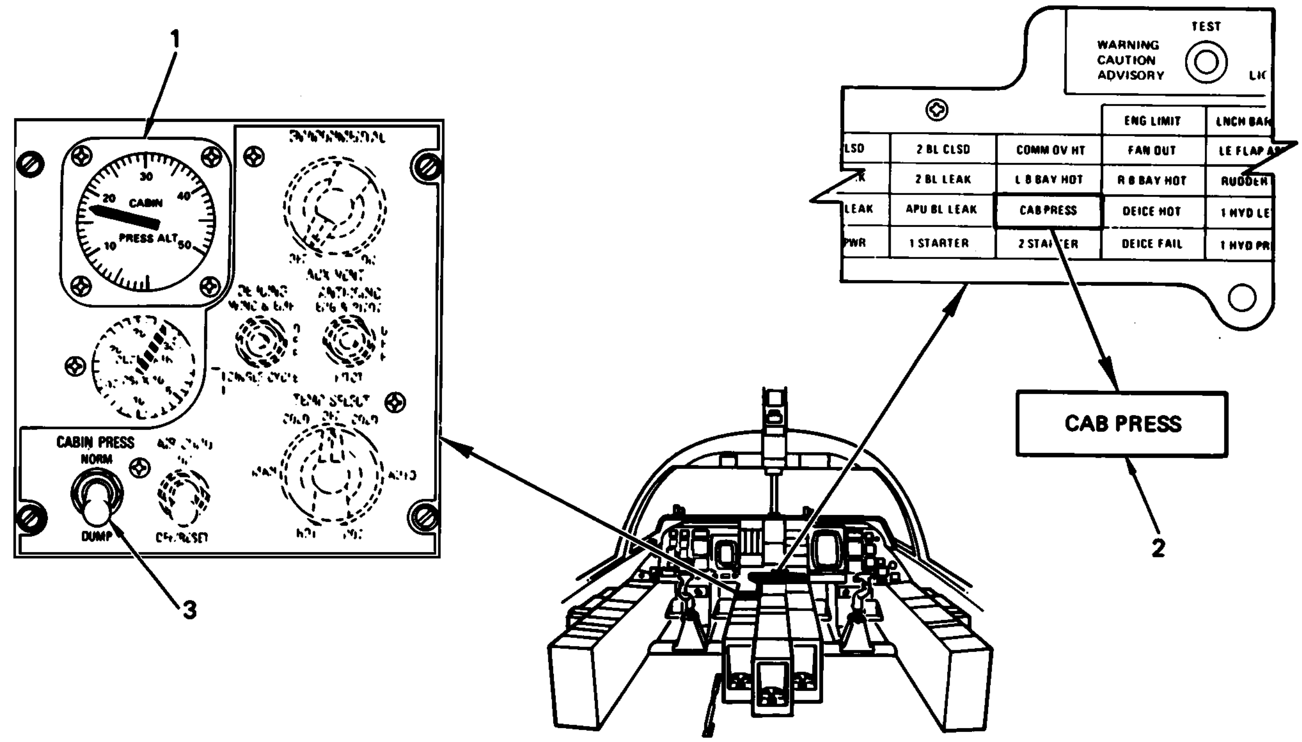
2.19.7.1.3 Differential Mode (Above 25,000 Feet). The cabin outflow valve is positioned as necessary to maintain cabin pressure at 6.7 psi above ambient pressure. Thus, increasing aircraft altitude above 25,000 feet will cause cabin altitude to begin increasing above 5,000 feet. The differential mode provides a cabin altitude of approximately 10,000 feet at an aircraft altitude of 35,000 feet. At the aircraft service ceiling of 40,000 feet, the cabin altitude should be approximately 12,000 feet.

2.19.7.2 Cabin Safety Valve. The cabin safety valve is designed to provide a backup method of relieving excess or negative cabin pressure. The valve operates independently of the cabin pressure controller and the cabin outflow valve and is located on the pressure bulkhead at the aft end of the cabin. The valve allows air to escape into the unpressurized ECS compartment. The valve opens when:

1. Cabin pressure is 7.2 psi or greater above ambient pressure
2. Cabin pressure is less than ambient pressure
3. The CABIN PRESS switch is set to DUMP.

2.19.7.3 Normal Operation. For the cabin pressurization system to operate, the refrigeration package must be operating and the AIR COND switch must be ON. The CABIN PRESS switch must be set to NORM to close the cabin safety valve and allow the cabin pressure controller to control the cabin outflow valve. Cabin altitude can be monitored on the CABIN PRESS ALT gauge (Figure 2-59). The CAB PRESS master caution light illuminates if cabin altitude increases through 13,000 feet. The light will extinguish when cabin altitude is reduced to below 11,000 feet.

2.19.7.4 Cabin Pressure Dump. To dump cabin pressure, set the CABIN PRESS switch to DUMP. This fully opens both the cabin outflow valve and the cabin safety valve. Both valves contain two-position, electrically energized latching solenoids that prevent the valves from closing if electrical power is removed after dumping cabin pressure.



INDEX	CONTROL/INDICATOR	FUNCTION
1	CABIN PRESS ALT gauge	Displays cabin pressure altitude.
2	CAB PRESS caution light	Illuminated — indicates cabin pressure altitude is 13,000 (+1600) feet or higher. Extinguished — when cabin pressure altitude is reduced to 11,000 (+ 1600) feet or lower.
3	CABIN PRESS switch	NORM — energizes latching solenoids in cabin outflow valve and cabin safety valve to normal position. Allows cabin pressure controller to regulate cabin pressurization. DUMP — opens cabin outflow valve and cabin safety valve to depressurize cabin.

Figure 2-59. Cabin Pressurization Controls and Indicators

Note

Cabin pressure cannot be dumped unless essential dc bus power is available. If necessary, dump cabin pressure before removing power from the bus.

The secondary method of dumping cabin pressure is setting the AIR COND switch to OFF/RESET and positioning the AUX VENT knob out of the OFF detent. This forces the cabin outflow valve full open and opens the auxiliary vent/ram air augmentation valve. The cabin safety valve will remain closed.

2.19.7.5 Cabin Repressurization. Repressurization of the cabin requires all of the following:

1. Essential dc bus power
2. AIR COND switch ON
3. CABIN PRESS switch NORM

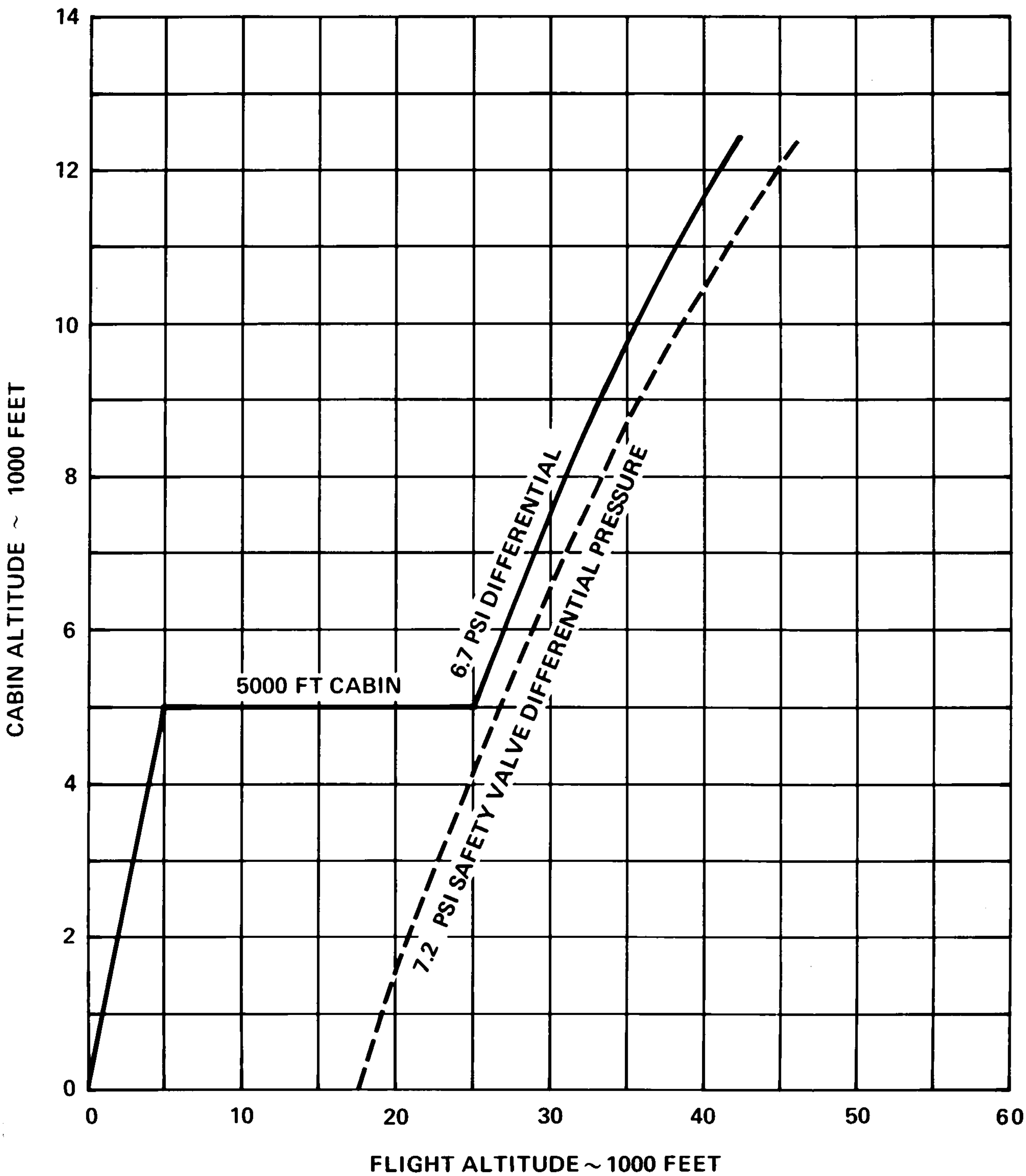


Figure 2-60. Cabin Pressurization Schedule

4. AUX VENT knob in OFF detent.

Once selected, repressurization will be regulated at 4,000 fpm by a repressurization rate controller.

2.19.8 Adverse Weather System. The adverse weather system of the aircraft comprises the following subsystems to provide all-weather capability:

1. Engine anti-icing
2. Wings and empennage anti-icing and deicing
3. Windshield and pitot/static probe anti-icing
4. Windshield heating and defogging
5. Windshield wipers
6. Rain repellent
7. Windshield washer system.

Engine bleed air is utilized for thermal deicing of the wings and horizontal stabilizer and anti-icing of the engine inlets and ECS ram air inlet. The windshields and pitot static probes are thermally anti-iced by electrical heaters. Windshield heating and defogging are also provided by conditioned air directed to the base of the windshields and side transparent canopies. The windshield wipers and rain repellent systems are designed to provide increased forward visibility in rain, and the windshield washer system is designed for cleaning salt spray and dirt from the windshields during or after low-altitude flight. (See Figure 2-61.)

2.19.9 Engine Anti-Icing. Engine anti-icing is discussed in paragraph 2.2.12, ENGINE ANTI-ICING SYSTEM.

2.19.10 Wings and Empennage Anti-Icing and De-icing System. The wing and empennage deicing system primarily utilizes 10th-stage compressor bleed air for deicing the wings and horizontal stabilizer and for anti-icing the ECS ram air inlet. Engine bleed air is pressure and temperature regulated by 14th stage bleed air augmentation to provide satisfactory performance of the system. If 10th-stage bleed air temperature or pressure is too low (such as might be encountered at low power settings during descents), 14th-stage bleed air is automatically added to maintain the required temperature and pressure. The system requires dc electrical power from the dc essential bus. During normal operation of the wings and empennage deicing system, the following prerequisites must be met:

1. The ENG 1 and ENG 2 BLEED AIR switches must be in the ON position (see Figure 2-56).
2. The ANTI-ICING switch must be placed to the ENG & PITOT position (see Figure 2-62).

The system is activated by placing the DE-ICING switch to either the WING & EMP position or the SINGLE CYCLE position. Placing the switch to either position sequentially de-ices each of the eight zones shown in Figure 2-61 for 30 seconds (maximum). The total cycle is 4 minutes at which the cycle will begin again if the switch is in the WlNG & EMP position. Valves and ducts of the system are shown in FO-16. Temperature sensing elements in each zone regulate the maximum temperature in each zone and thus deicing may occur for only a portion of the allotted 30 seconds. The de-ice timer, however, always runs 30 seconds for each zone whether or not deicing is actually taking place. The valves in the system are electrically controlled and pneumatically actuated to direct bleed air to ducts containing multiple air jets in the leading edge flaps (zones 1 to 4), the leading edge of the wings (zones 5 and 6) and the leading edge of the horizontal stabilizer (zones 7 and 8). Exhaust air from these ducts exits overboard through air passages located between the leading edge flap lower seal and the wing leading edge, and out the tips of the horizontal stabilizer. The ECS ram air inlet is anti-iced continuously through the empennage anti-icing pressure regulating and shutoff valve whenever the ANTI-ICING switch is in the ENG & PITOT position. The ECS inlet contains a jet pump that mixes bleed air with ambient air and directs the flow through the shroud located around the ram air inlet duct.

Two caution lights (DE-ICE HOT and DE-ICE FAIL) are associated with the de-ice system. The DE-ICE HOT light (see Figure 2-62) is illuminated anytime one or more of the eight overheat sensors (one located in each de-ice zone) is activated (see FO-16). The DE-ICE FAIL light (see Figure 2-62) is illuminated when any one of the eight cyclic valves or one of the three de-ice pressure regulator and shutoff valves has failed to open on command from the de-ice timer. If a pressure regulating and shutoff valve fails to respond to an open command, the DE-ICE FAIL light will remain on as long as the zones operated by that valve are activated.

If a cyclic valve fails to open when commanded, the DE-ICE FAIL light will illuminate and remain

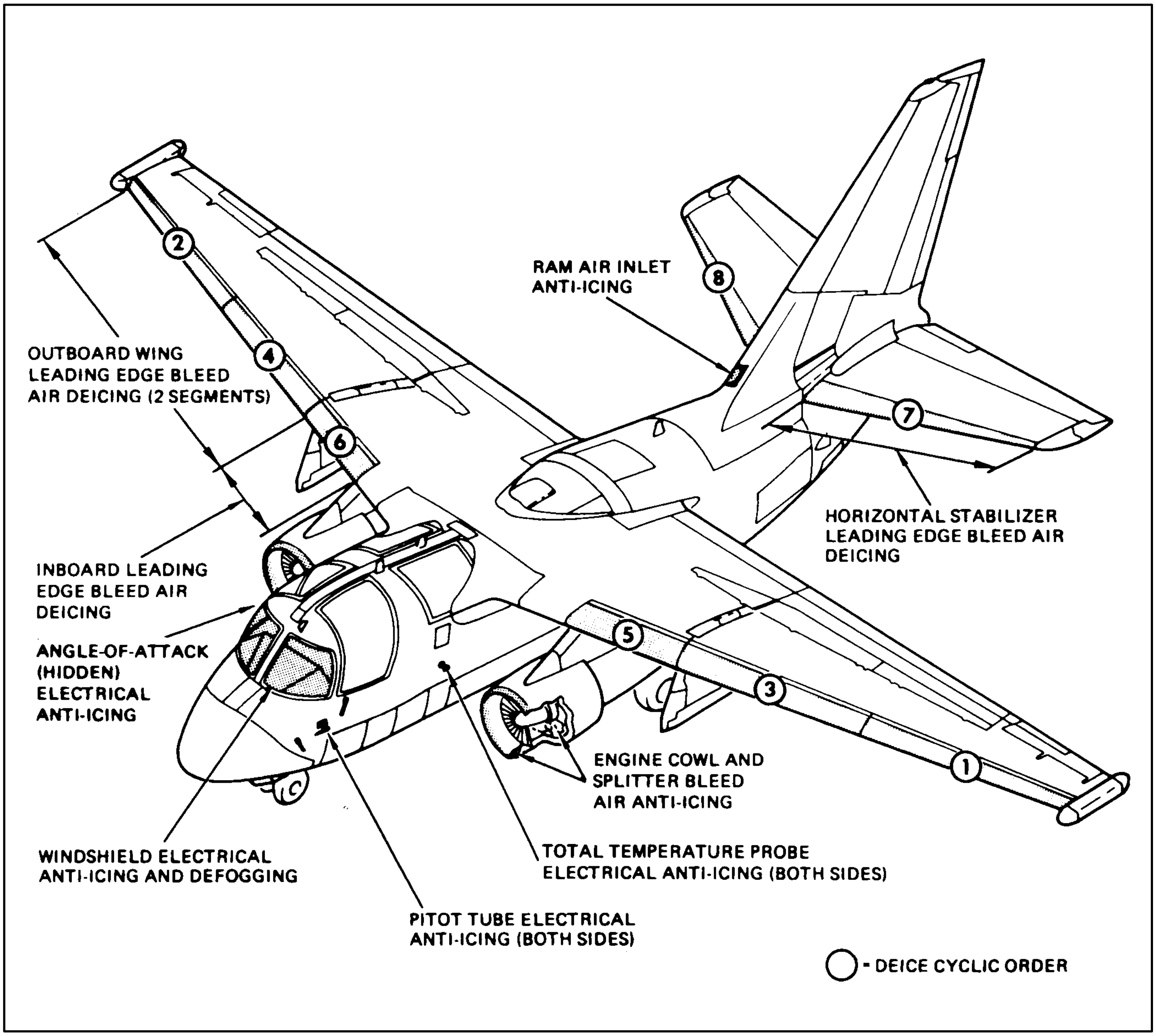


Figure 2-61. Ice Protected Areas

illuminated until the valve is commanded closed (approximately 30 seconds). At that time, the DE-ICE FAIL light will go out.

Monitoring of de-ice system performance is accomplished by utilizing a sweep second timer and observing pressure pulses on the bleed air manifold pressure gauge (see Figure 2-62). By noting a drop in bleed pressure in conjunction with time, the sequential opening and closing of the cyclic valves can be verified. Because the cyclic valves can be commanded to close by temperature sensing switches prior to the 30-second limit established by the timer, monitoring of the de-ice system will indicate how long each zone is actually deicing. Monitoring of de-ice system performance is important since failure modes of the de-ice timer exist that will not illuminate the DE-ICE FAIL caution light. Test and monitor of the de-ice systems on the ground can be accomplished using engine bleed air or APU bleed air. When testing the de-ice system using engine bleed air as the pressure source, the APU air source should be deselected using the APU AIR switchlight. This will preclude pressure surges in the APU bleed air system associated with high-low flow schedule changes.

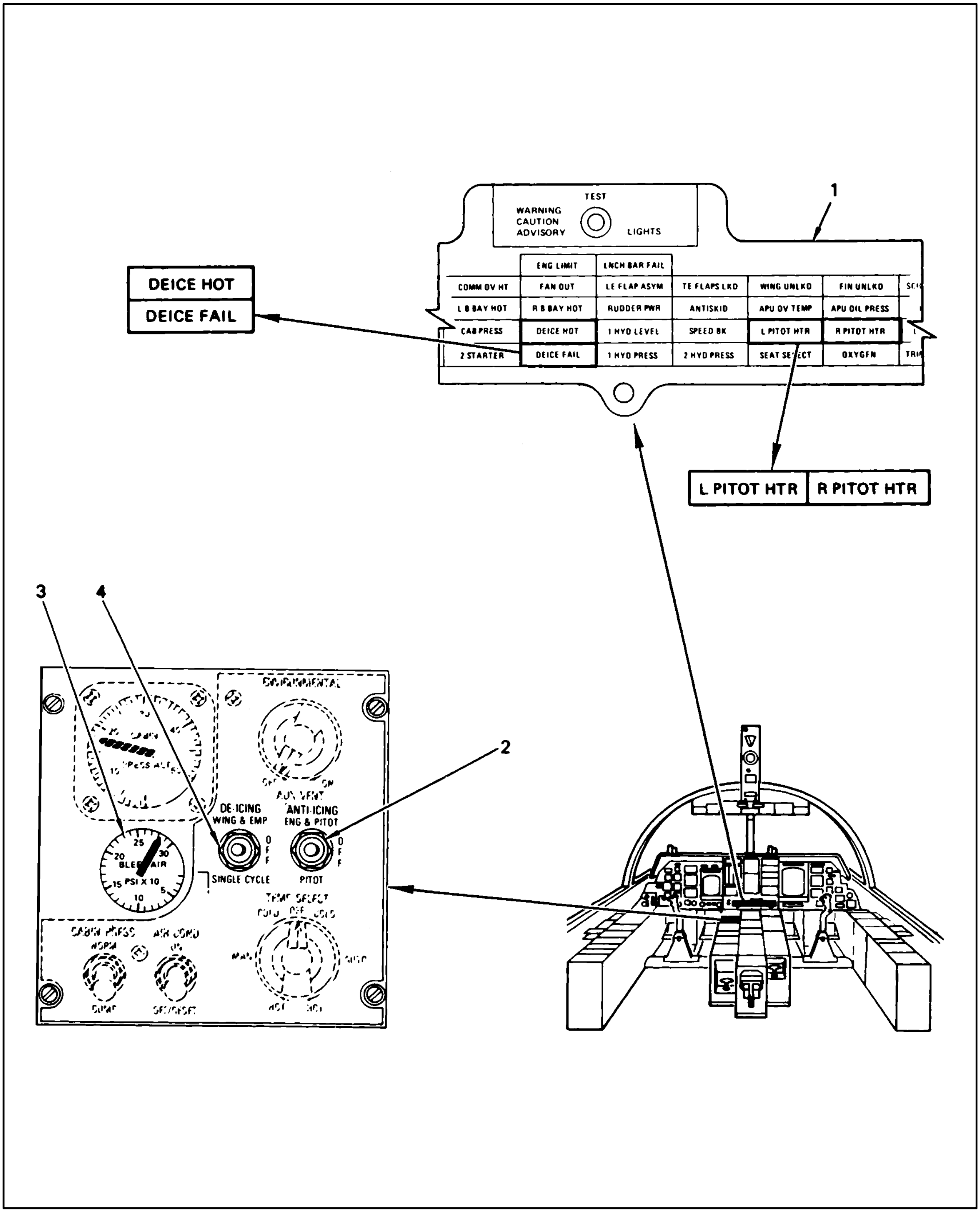


Figure 2-62. Anti-Icing/Deicing Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Master Caution Panel:	
	L PITOT HTR light or R PITOT HTR light	Illuminated — indicates respective pitot heater is inoperative (with ANTIICING switch positioned to PITOT or ENG & PITOT).
	DE-ICE FAIL light	Illuminate: ● Indicates that cyclic valves or pressure regulating/shutoff valves are not fully open. ● Deicing Selected without selecting anti-ice. ● (Single-bleed operation) Indicates de-ice timer has cycled to zone de-iced by the engine with the bleed air valve off. ● Deicing selected with the wings folded.
	DE-ICE HOT light	Illuminated — indicates that skin structural temperature exceeds safe limit in heated zones. Extinguished — when skin structural temperature cools to safe operating limit.
2	ANTI-ICING switch	PITOT — electrically anti-ices pitot/static, angle-of-attack, and total-air temperature probes. ENG & PITOT — anti-ices flight instrument probes, both engines, ram air inlet, allows deicing system to operate when selected. OFF — removes anti-icing electrical power from flight instrument probes, shuts off anti-icing air to engines and ram air inlet, and prevents deicing system from operating.
3	BLEED AIR manifold pressure gauge	Indicates pressure in bleed air manifold.
4	DE-ICING switch	WING & EMP — activates wing and empennage deicing system (with bleed air available). SINGLE CYCLE — activates wing and empennage deicing system through one complete cycle (with bleed air available). OFF — deactivates wing and empennage deicing system and returns timer to zero. **Note** ● ACPS shifts to low flow schedule with de-ice selected at any altitude. ● Deicing system cannot be operated in WING & EMP or SINGLE CYCLE position unless ANTI-ICING switch is selected to ENG & PITOT position.

Figure 2-62. Anti-Icing/Deicing Controls and Indicators (Sheet 2)

Testing using engine bleed air is accomplished by setting power above 68-percent N_g and selecting the ANTI-ICING switch to ENG & PITOT position and the DEICING switch to SINGLE CYCLE.

Testing using APU bleed air is accomplished by selecting the APU AIR switchlight to ON (illuminated), placing the AIR COND switch to OFF, selecting the ANTI-ICING switch to ENG & PITOT and the DEICING switch to SINGLE CYCLE, and then placing the AIR COND switch to ON. When the cycle is completed, select AIR COND, DEICING, and ANTI-ICING switches to OFF in that order. Testing using APU bleed air with the above procedure causes the air-conditioning to operate only in the low-flow mode.

Note

Failure of any valve in the system to operate properly may cause an APU pressure surge at the beginning of that valve's time cycle. Repeated testing on APU air with failed components should be avoided.

With weight on wheels, the temperature sensing circuits are overridden and each zone will de-ice for 30 seconds.

With weight off wheels, single-cycle operation is similar in all respects to wing and empennage (WING & EMP) operation except that only one cycle is performed. If the system is ground tested in the WING & EMP position (not recommended), the temperature control circuits are operative as in flight and each zone valve may open less than 30 seconds. When ambient temperatures are above 16 °C (60 °F), the valves will not open when commanded and the DE-ICE FAIL caution light is suppressed.

During single-engine or single-bleed operation, several aspects of system operation come into action to prevent overbleeding the engines and possible engine rollback. Considerations that must be understood by the pilot and evaluated in each individual situation are:

1. Bleed air is utilized to de-ice the left wing and horizontal stabilizer and anti-ice the ECS ram air inlet and is supplied by the left engine unless the left engine is shut down.
2. Bleed air is utilized to de-ice the right wing and is supplied by the right engine unless the right engine is shut down.
3. During single-bleed operation (one bleed valve closed), the crossbleed start valve will not open when deicing is selected unless one engine is below idle rpm. The DE-ICE FAIL caution light will illuminate whenever de-ice zones normally supplied by the secured bleed system are sequenced for operation, thus indicating which zones are not being de-iced.
4. If single-bleed operation is necessitated by a bleed air leak, caution should be utilized in selecting deicing since asymmetric wing deicing will result in asymmetric weight and airfoil shape and may cause changes in aircraft flying characteristics.
5. If the left bleed air shutoff valve is secured with the engine still operating, anti-icing of the ECS ram air inlet will not occur; thus, close monitoring of the ECS system performance is required.
6. During single-engine operation, the crossbleed start valve will open when deicing is selected in order to de-ice all zones. ACPS and deicing can be used simultaneously; however, air-conditioning operates in low flow.

Note

In deciding when to open the crossbleed start valve, the CLA checks of the N_g of each engine. If one (or both) engines is below idle rpm and deicing is selected, the crossbleed start valve will open. The CLA does not use the position of the bleed air switches or the bleed air shutoff valve in determining when to open the crossbleed start valve.

Evaluation of the above considerations, balanced against weather conditions and mission or emergency requirements, will determine employment of the de-ice system. The bus transfer logic of the electrical system with engine anti-ice and airframe de-ice selected should also be considered.

Note

With the in-flight refueling probe retracted, selection of deicing at any altitude shifts the air-conditioning system to low flow.

2.19.11 Windshield and Pitot/Static Probe Anti-Icing. The windshields and instrument probes (Figure 2-61) are electrically anti-iced using electrical power from several sources. The pilot windshield uses ac and dc power from the left primary ac and dc buses. The copilot/COTAC windshield uses ac and dc power from the right primary ac and dc buses. The pilot pitot heater and the angle of attack probe heater use power from the essential ac bus. The copilot/COTAC pitot heater and the total temperature probe heater receive power from the right primary ac bus while the pilot total temperature probe heater is powered from the left primary ac bus. The windshields are anti-iced whenever the HEAT switch on the windshield panel is on (see Figure 2-63). Since the heat is directed to the outside surface of the windshield, little heat can be felt on the inside of the windshield except around the electrical connections. The windshield requires 1 to 2 minutes to fully warm up. Windshield heat is designed to provide anti-ice protection and anti-fog protection. With glass windshields, flying with windshield heat on at all times increases life expectancy.

Pitot/static probe heating is on whenever the ANTI-ICING switch is in the PITOT or ENG & PITOT position (see Figure 2-62). Two caution lights (L PITOT HTR and R PITOT HTR) indicate that the respective pitot heater is not operative. The angle of attack probe heater and the total temperature probe heaters are not monitored.

2.19.11.1 Windshield Temperature Controllers. Windshield temperature control test switches and test status lights are located at the left and right lower electrical load centers. When each test switch is pressed, an amber status light will indicate the respective windshield temperature controller status as follows:

1. The windshield temperature controller operational light will flash at 1- or 2-second intervals for 10 seconds.

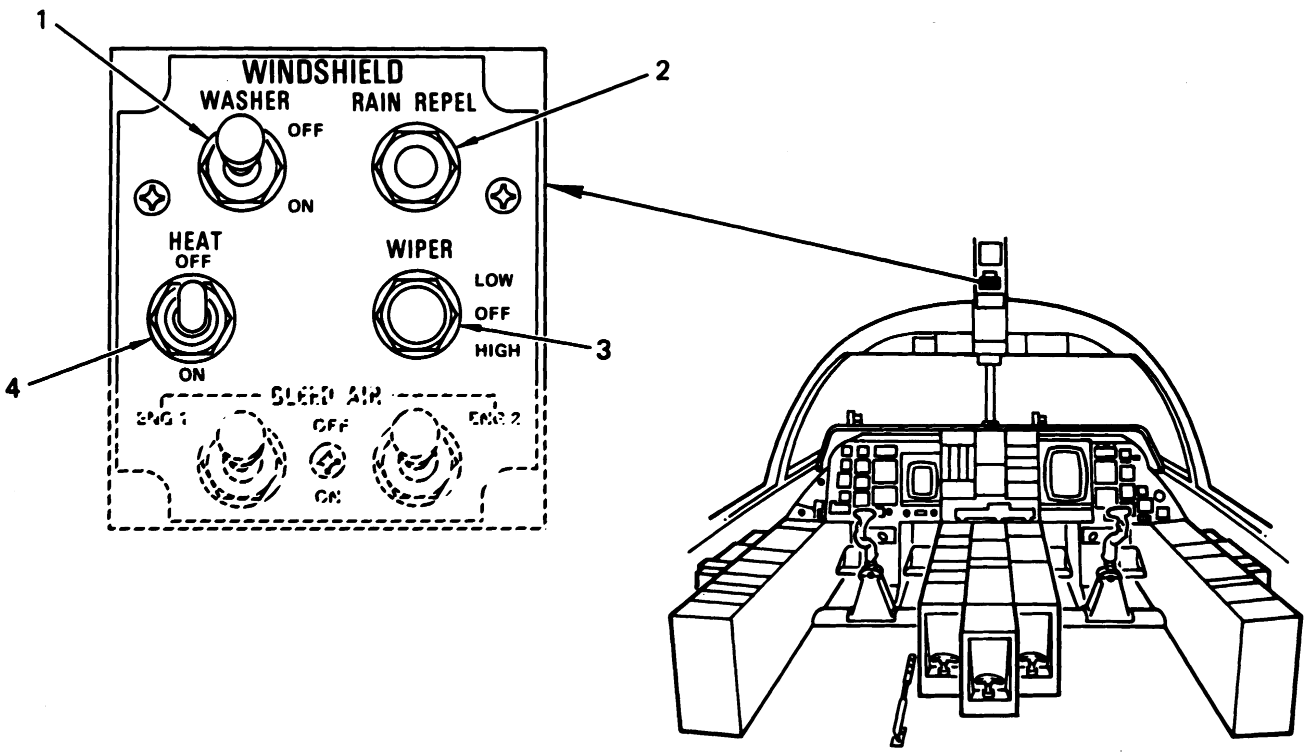
2. Fault in normal control — light illuminates steady for 10 seconds.

3. Fault in overheat control — light illuminates for 2 or 3 seconds, then extinguishes.

2.19.12 Cockpit Defogging. Whenever ambient humidity is high, the possibility of cockpit defogging exists. In the air cycle refrigeration package, moisture condenses from the air in the form of fog. On very humid days, fog will form when air is cooled slightly below the ambient temperature. The amount of fogging will increase as cooling is increased. This effect will be most noticeable near sea level, when at or near intermediate power, or when descending from altitude. The procedure for eliminating cockpit fog is to raise the temperature of the crew compartment and evaporate the moisture. This can be accomplished by either automatic or manual control of crew compartment temperature. To defog the cockpit on the ground, the TEMP SELECT rotary switch can be set to the 5-o'clock (HOT) position on the AUTO side and an increase in engine power should be accomplished until the BLEED AIR manifold pressure gauge reads 45 to 50 psi. This will result in maximum air-conditioning performance. If fog is still present, the TEMP SELECT switch should be turned to the MAN side of the switch and the temperature should be increased as required to clear the cockpit. Fog can be expected when engine power is advanced rapidly while flying in the high-humidity layer near the water.

During descent, it is recommended that the takeoff temperature setting be selected to maintain cockpit visibility if fogging occurs.

2.19.13 Windshield Washer System. The windshield washer system consists of a reservoir and pump assembly located in the unpressurized nose compartment at the base of the windshield. The windshield WASHER switch, located on the WINDSHIELD panel on the pilot overhead in the cockpit, is a two position (ON, OFF) toggle switch. The ON position energizes the pump motor causing fluid to be sprayed on both windshields. The spray will continue as long as the switch is held to ON. The washer pump supplies fluid for approximately 6 minutes when the fluid reservoir is full. The OFF position deenergizes the system. A reservoir dipstick indicates fluid quantity. Washer fluid is 80-percent isopropyl alcohol, 20-percent distilled water, and one-half ounce of CW100 per gallon of isopropyl alcohol and distilled water solution.



INDEX	CONTROL/INDICATOR	FUNCTION
1	WASHER switch	OFF — deenergizes pump and shuts off fluid supply. ON — energizes windshield washer pump to supply washer fluid to windshields.
2	RAIN REPEL switch	Pressed — releases rain repellent fluid on windshield for preset length of time provided windshield wipers are operating in high speed (currently inoperative on the S-3).
3	WIPER switch	LOW — provides low speed wiper operation. OFF — deenergizes the windshield wiper motor. HIGH — provides high speed wiper operation and allows rain repellent system to operate provided it is actuated.
4	HEAT switch	OFF — removes power. ON — applies electrical power to heat and defog pilot and copilot/ COTAC windshields.

Figure 2-63. Windshield Control Panel

2.19.14 Windshield Rain Removal System. The windshield rain removal system incorporates two electric, dual-speed windshield wipers, each with a separate motor for independent wiper operation. The motors are powered by 115/200-vac, 500-Hz power. Both wipers are actuated by one three-position (OFF, LOW, and HIGH) toggle switch, located on the WINDSHIELD panel on the pilot overhead in the cockpit. The wiper speeds at the LOW and HIGH switch positions are approximately 125 and 250 strokes per minute, respectively. The wiper motor contains a parking brake that parks the wiper blade and brakes the motor when the system is turned off.

2.20 IFF TRANSPONDER SYSTEM (AIMS)

The IFF transponder system is capable of automatically reporting coded identification and altitude signals in response to interrogations from surface (or airborne) stations so that the stations can establish aircraft identification, control air traffic, and maintain vertical separation. The system has five operating modes (1, 2, 3/A, C, and 4). Modes 1 and 2 are IFF modes, mode 3 (Civil mode A) and mode C (automatic altitude reporting) are primarily air traffic control modes, and mode 4 is the secure (encrypted) IFF mode.

Note

Mode 4 is not operational unless a KIT-1A/TSEC transponder computer is installed.

A suppression pulse from the transponder disables the IFF interrogator and tacan while the transponder is transmitting. The transponder is disabled by suppression pulses from the interrogator and tacan when they are transmitting.

The transponder system components are:

1. Control panel, C-6280A(P)/APX
2. Transponder, RT-859A/APX-72
3. Transponder test set, TS-1843A/APX
4. Antenna switching unit, SA-1769/A.

Mode C altitude inputs are supplied by:

1. Airspeed altitude computer, CP-1077/AYN-5A.

The IFF secure function is provided by:

1. Transponder computer, KIT-1A/TSEC (when installed)
2. IFF OUT caution light
3. Landing gear interlock (weight on wheels).

An antenna switching unit is provided that electronically switches the transponder between the top and bottom IFF antennas.

Most of the controls for the transponder system are included on the control panel mounted in the right side of the center console (see Figure 2-64). The REPLY light and the controls on the left side of the panel are concerned with mode 4. The TEST light and the remaining controls are associated with modes 1, 2, 3/A, and C, except that the MASTER switch controls all modes of operation.

2.20.1 Transponder Test Set. The transponder test set provides the self-test and monitor functions for modes 1, 2, 3/A, and C. The self-test functions, when actuated, interrogate the transponder and monitor the replies. The monitor function is accomplished, when selected, by monitoring the replies to external interrogations. The controls for the transponder test set are included on the control panel.

2.20.2 Transponder Operation. The MASTER switch applies power to all of the transponder system components except the altimetry components. A five-position (OFF, STBY, LOW, NORM, and EMER) rotary switch must be lifted over a detent to switch to EMER or to OFF. STBY should be selected for 2 minutes prior to switching to LOW or NORM to allow the transponder to warm up. In the NORM position, the transponder system is operational at normal receiver sensitivity. In the LOW position, the system is operational but the transponder receiver sensitivity is reduced. In EMER position, the transponder transmits emergency replies to mode 1, 2, or 3/A interrogations. The mode 3/A emergency reply includes code 7700. When EMER is selected, mode 4 and mode C are enabled regardless of the position of the selector switches.

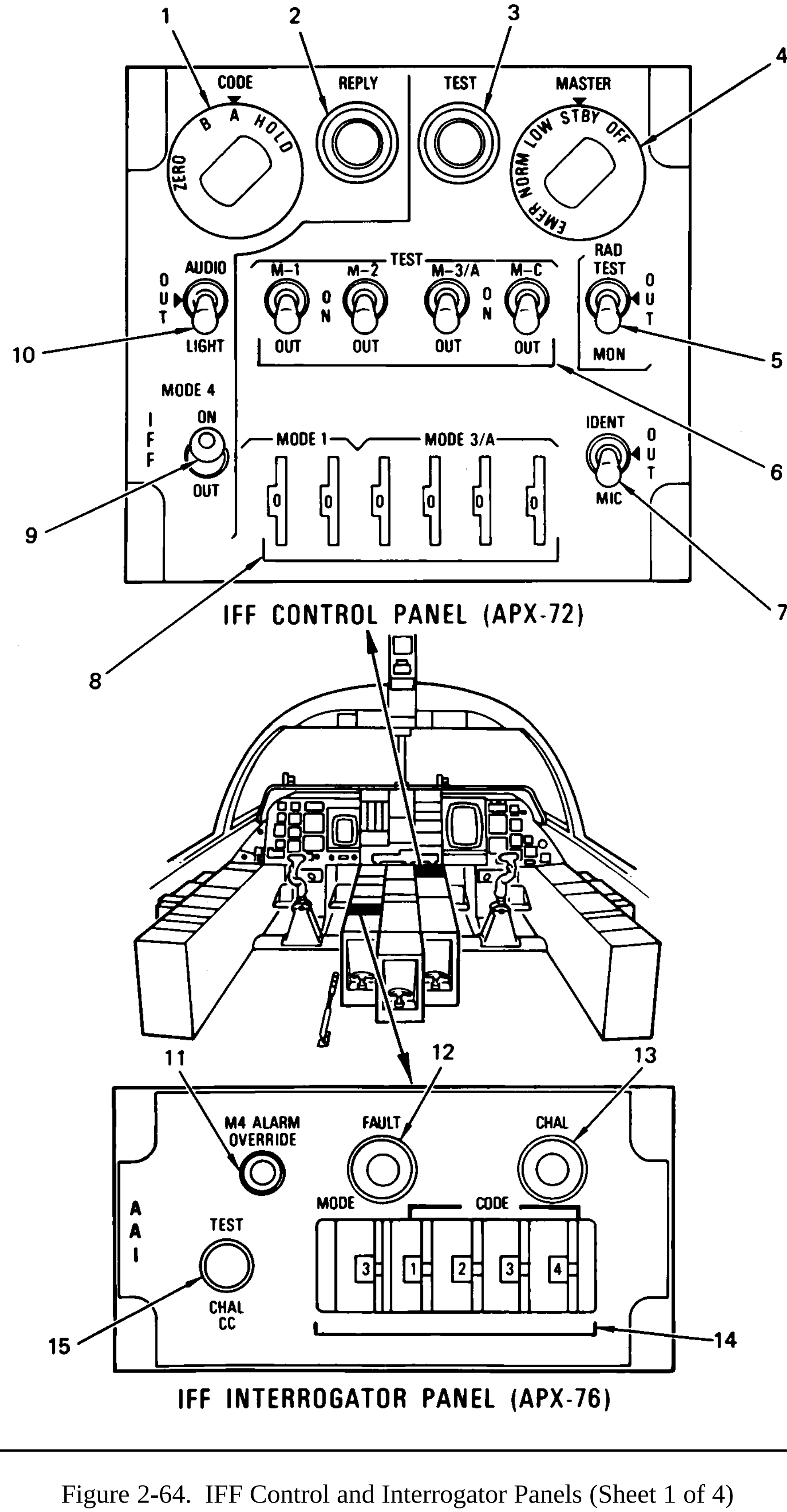


Figure 2-64. IFF Control and Interrogator Panels (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
1	CODE switch	Selects type of mode 4 operation: HOLD — Does not function in the S-3B. A — enables transponder system to respond to code A interrogations. B — enables transponder system to respond to code B interrogations. ZERO — cancels (zeroizes) mode 4 code settings from transponder computer provided other operational requirements are met.
2	REPLY light	Lights to indicate valid mode 4 replies when AUDIO/OUT/LIGHT switch is set to either AUDIO or LIGHT.
3	TEST light	Lights when transponder set responds properly to mode 1, 2, 3/A, or C test signal. **Note** Satisfactory mode C self-test indications are possible with a failed standard central air data computer.
4	MASTER switch	Turns transponder set on and off, selects receiver sensitivity, and selects emergency operation: OFF — removes power from transponder set and transponder computer. STBY — enables transponder receiver and computer; disables transponder transmitter. LOW — places transponder set in operation at reduced receiver sensitivity. NORM — places transponder set in operation at normal receiver sensitivity. EMER — causes automatic transmission of emergency reply signals to mode 1,2, or 3A interrogations only, regardless of mode switch settings (not affected by mode C or 4 interrogations).
5	RAD TEST/OUT/MON switch	Selects ground test signals: RAD TEST — (spring-loaded) enables transponder to reply to interrogations radiated by a ramp test set. The TEST light is inoperative during RAD TEST. MON — causes the TEST light to flash when the transponder replies to mode 1, 2, 3/A, or C interrogations. OUT — disables the MON and RAD TEST circuits.
6	M-l, M-2, M-3/A and M-C TEST switches	M-1: ON — selects mode 1 operation of transponder set. TEST — selects mode 1 test operation. OUT — turns off mode 1 operation.

Figure 2-64. IFF Control and Interrogator Panels (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
6 (cont.)	M-l, M-2, M-3/A and M-C TEST switches (cont.)	M-2: ON — selects mode 2 operation of transponder set. TEST — selects mode 2 test operation. OUT — turns off mode 2 operation. M-3/A: ON — selects mode 3/A operation of transponder set. TEST — selects mode 3/A test operation. OUT — turns off mode 3/A operation. M-C: ON — selects mode C operation of transponder set. TEST — selects mode C test operation. OUT — turns off mode C operation.
7	IDENT/OUT/MIC switch	IDENT — selects identifier pulse. MIC — permits selection of identifier pulse when microphone keying switch is closed. OUT — turns off identifier pulse circuit.
8	MODE 1 and MODE 3/A selector switches	MODE 1 — selects and indicates mode 1 two-digit reply code number. MODE 3/A — selects and indicates mode 3/A four-digit reply code number.
9	MODE 4 switch	ON — enables transponder system to reply to mode 4 interrogations OUT — disables mode 4 operation.
10	AUDIO/OUT/LIGHT switch	LIGHT — enables only REPLY light monitoring of mode 4 replies. AUDIO — enables aural monitoring with earphones (short burst 300 to 400 Hz buzz) of valid mode 4 interrogations and REPLY light monitoring of mode 4 replies. **Note** BUNO 159758 and subsequent and aircraft incorporating AFC-91 actuate the IFF tone audio signal (when selected) at the crewmember ICS whenever sidetone is activated during a mode 4 interrogation. OUT — disables aural and REPLY light monitoring.
11	M4 ALARM OVERRIDE switch	UP — removes mode 4 noise alarm from operator headset (Modes 1,2,3/A are not affected). DOWN — enables normal mode 4 alarm operation.
12	FAULT light	When illuminated, amber light advises operator of fault in system.

Figure 2-64. IFF Control and Interrogator Panels (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
13	CHAL light	This green light remains on while interrogation is being made.
14	MODE/CODE select switches	Allows operator to select desired IFF interrogation mode or standby.
15	TEST/CHAL CC switch (spring-loaded)	TEST — operator can interrogate his own transponder in the selected mode. A valid reply is displayed at four miles on radar display. FAULT light illuminates if fault in interrogator. CHAL CC — interrogation is transmitted in selected mode and CHAL indicator illuminates. If fault in interrogator, FAULT light comes on and CHAL light goes out.

Figure 2-64. IFF Control and Interrogator Panels (Sheet 4)

Note

The transponder automatically switches to emergency operation and the mode 4 codes zeroize when seat ejection occurs.

The IDENT-OUT-MIC switch, a three-position toggle switch, is spring loaded from the IDENT position and adds an identification of position pulse to modes 1, 2, and 3/A replies for a period of 15 to 30 seconds. In the MIC position, the identification of position function is activated for 15 to 30 seconds each time the UHF microphone switch is pressed. Two mode 1 thumbwheel selector switches allow selection of 32 mode 1 codes, and 4 mode 3/A thumbwheel selectors allow selection of 4,096 mode 3/A codes. Mode 2 code selector switches are located on the transponder and cannot be changed by the pilot during flight. Four mode switches (M-1, M-2, M-3/A, and M-C) each have OUT, ON, and spring-loaded TEST positions. The center (ON) position of each switch enables that mode. To test the transponder, press the mode switch of each mode to the TEST position. Illumination of the TEST light indicates proper operation of that mode. The MASTER switch must be set to NORM for the test function to operate. The mode switches of the modes not being tested should be OUT, when testing on the ground, to prevent unnecessary interference with nearby ground stations. The MON position of the RAD TEST-OUT-MON switch monitors the operation of modes 1, 2, 3/A, and C. When MON is selected, the TEST light will illuminate for 3 seconds each time an acceptable response is made to an interrogation in a selected mode. The spring-loaded RAD TEST position enables a mode 3/A code reply to a test-mode interrogation from a ramp test set. It also enables a mode 4 reply to a VERIFY 1 interrogation and is a modified mode 4 interrogation used for testing.

Note

Satisfactory mode C self-test indications are possible with a failed SCADC.

2.20.2.1 Mode 4 Operation. Mode 4 operation is selected by placing the mode 4 toggle switch to ON, provided that the MASTER switch is NORM or LOW. Placing the mode 4 switch to OUT disables mode 4. The mode 4 CODE switch (ZERO, B, A, and HOLD) must be lifted over a detent to switch to ZERO. It is spring loaded to return from HOLD to the A position. Position A selects mode 4 code for the present code period, and position B selects mode 4 code for the succeeding code period. Both codes are mechanically inserted into the transponder computer by a single insertion of a code changing key. The codes are mechanically held in the transponder computer regardless of the position of the MASTER switch or the aircraft power. Codes do not automatically zeroize under normal conditions. The HOLD position sends a hold signal, but serves no practical function since the code will not be automatically zeroized. Mode 4 codes can be zeroized anytime the aircraft power is on and the IFF MASTER switch is not off by turning the CODE switch to ZERO.

An audio signal, the REPLY light on the control panel, and the IFF caution light are used to monitor mode 4 operation. The AUDIO-OUT-LIGHT switch controls the audio signal and the REPLY light, but not the IFF caution light. In the LIGHT position, the REPLY light illuminates as mode 4 replies are transmitted. In the AUDIO position, an audio tone[1] in the pilot headset indicates that valid mode 4 interrogations are being received and the REPLY light illuminates if mode 4 replies are transmitted. In the OUT position, audio indications and the REPLY light are inoperative and the REPLY light will not press to test. The IFF OUT caution light, located on the master caution panel, lights to indicate when mode 4 is not operative. The light is operative whenever aircraft power is on and the MASTER switch is not off. However, the light does not operate if the transponder computer is not physically installed in the aircraft. When the IFF caution light illuminates, it also illuminates the master CAUTION lights. Illumination of the IFF OUT caution light indicates that the mode 4 codes have zeroized, the self-test function of the transponder computer has detected a faulty computer, or the transponder is not replying to proper mode 4 interrogations. If the IFF OUT caution light illuminates, switch the MASTER switch to NORM (if in STBY) and ensure that the mode 4 toggle switch is ON. If illumination continues, employ operationally directed flight procedures for an inoperative mode 4 condition.

2.20.3 IFF Interrogator System. The IFF interrogator is used to challenge targets observed on the radar displays for identification. The interrogator can challenge stations in modes 1, 2, 3/A, or 4. A transponder, located at a friendly target will respond with a properly coded reply that can be monitored on the copilot/COTAC, TACCO, or SENSO radar displays. Interrogations are transmitted through the IFF antenna on the radar/IFF antenna. A suppression pulse from the interrogator disables the IFF transponder and tacan while the interrogator is transmitting. The interrogator is disabled by suppression pulses from the transponder and tacan when they are transmitting. The interrogator system components are:

1. Control panel, C-7383/APX-76A(V)
2. Interrogator, RT-868A/APX-76A(V)
3. Switch amplifier, SA-1568A/APX-76A(V)
4. Electrical synchronizer, SN-416A/APX-76A(V).

[1] BuNo 159758 and subsequent and aircraft incorporating AFC-91 actuate the IFF tone signal (when selected) at the crewmember ICS whenever the sidetone is activated during a mode 4 interrogation.

The interrogator control is located on the left side of the center console (see Figure 2-64). The MODE thumbwheel switch selects the interrogation mode or standby. The four CODE thumbwheel switches are used to set in the desired code for modes 1, 2, or 3/A. Mode 4 codes are set in the mode 4 computer.

2.20.3.1 Interrogator Operation. When the momentary center-return TEST-CHAL CC switch is set to TEST, an aircraft loop test is made. The interrogator challenges the transponder installed in the aircraft and a valid reply appears on the radar displays at 4 miles. If there is a fault in the interrogator, the FAULT light illuminates when the switch is in TEST position. When the TEST-CHAL CC switch is set to CHAL CC, the interrogator transmits challenge pulses and the CHAL indicator goes on. If there is a fault in the interrogator when the switch is in the CHAL CC position, the FAULT indicator comes on and the CHAL indicator goes off.

2.20.3.2 Mode 4 Operation. The MODE 4 ALARM OVERRIDE toggle switch may be used to override the mode 4 noise alarm. Mode 4 operation is selected by the MODE thumbwheel switch on the control. Mode 4 codes are inserted into the computer with the code changing key. The code zeroize function operates the same as for the transponder computer for BuNo 159407 and subsequent aircraft. The code may be held by setting the CODE switch on the control to HOLD after the aircraft has landed (weight must be on wheels) in the same manner as for the transponder computer. For aircraft prior to BuNo 159407, the code zeroize function operates the same provided the APX-76 code hold function has been incorporated.

2.20.4 Data Terminal Set. The DTS, located in the right aft avionics bay, enables two-way, computer-to-computer exchange of information between the aircraft and other stations with similar equipment. The data terminal set has the following functions:

1. Accepts audio tones from the UHF-1, UHF-2, or HF receiver and converts them into a serial stream of data in Link-11 format (messages)
2. Transfers the received messages into the GPDC memory for storage
3. Accepts messages from the GPDC
4. Converts the computer messages into audio tones and transfers the tones to a communication transmitter for transmission.

The Link-11 system is used to exchange tactical information between ship, shore, and aircraft computers. The DTS is remotely controlled and capable of continuous, automatic, unattended operation. The operational status is monitored, and a latching BITE indicator is provided on the front of the data terminal set to indicate detection of a malfunction. The secure Link-11 data transmission is controlled by the KG-40 control panel (see Figure 2-65).

2.20.5 KG-40 Secure Data Unit. The KG-40 encrypts outgoing data received from the GPDC via the CC and sends it to the DTS for transmission on UHF or HF radios. The KG-40 decrypts incoming data received from the DTS and sends it to the GPDC via the CC.

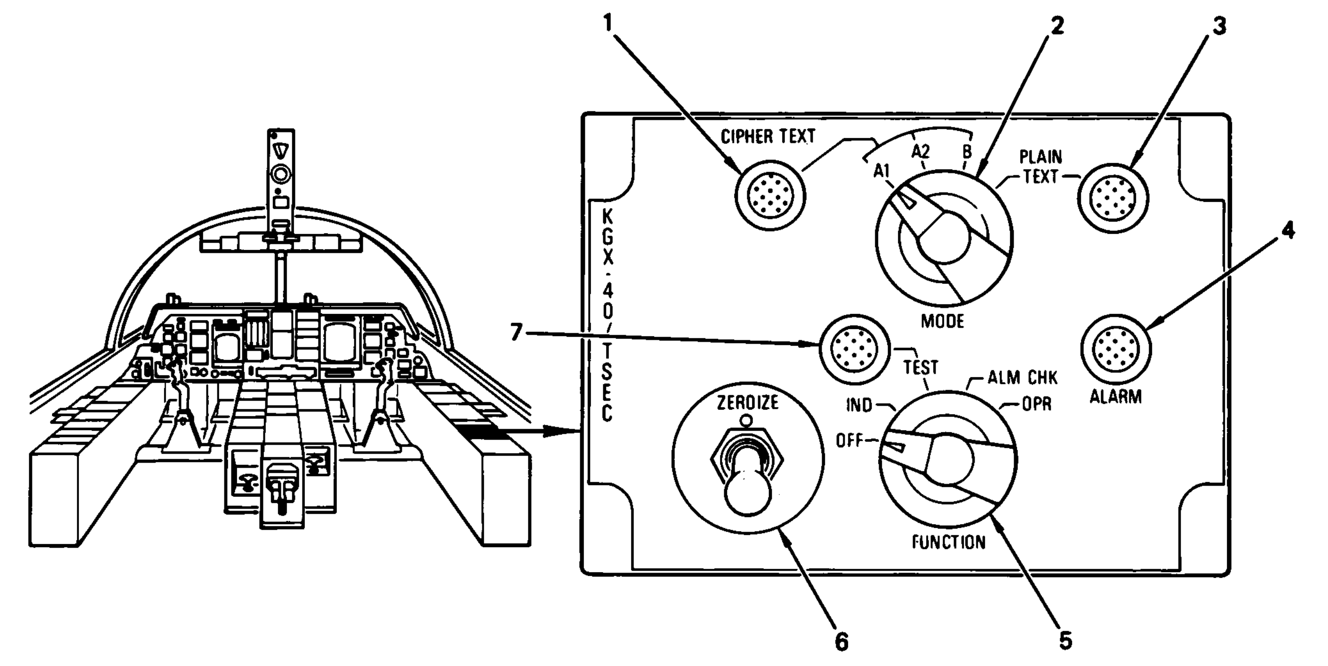
2.20.5.1 KG-40 Operation

1. Put the KOK-1/TSEC key card into the KG-40 (do not close the door).

2. Place the mode switch into the mode to be used. Mode A1 and A2 in the S-3A/B are identical.

3. Turn the FUNCTION switch to the IND and ensure CIPHER TEXT, PLAIN TEXT, TEST, and ALARM lamps are on.

4. Turn the FUNCTION switch to the TEST position. Lamps CIPHER TEXT, TEST, and ALARM will be on, and the PLAIN TEXT lamp will be off.



INDEX	CONTROL/INDICATOR	FUNCTION
1	CIPHER TEXT indicator	Indicates cipher text mode
2	MODE switch	Selects system mode
3	PLAIN TEXT indicator	Indicates plain text mode
4	ALARM indicator	Indicates alarm
5	FUNCTION switch	Selects system function
6	ZEROIZE switch	Zeroize system
7	TEST indicator	Indicates test

Figure 2-65. KG-40 Control Panel

Note

TEST light ON indicates the code in the permuter tray KOK-1/TSEC has been accepted as a good code by the KG-40 system.

5. Place the FUNCTION switch to the ALM CHK position. CIPHER TEXT and ALARM lamps remain on, and the PLAIN TEXT and TEST lights will be off.

Note

The SECURE DATA FAIL light on the master caution panel operates with the ALARM light on the KG-40 control.

6. Place the FUNCTION switch to the OPR position. Only the CIPHER TEXT lamp should be on. The KG-40 system is now operational.

Note

Whenever the mode switch is operated, the ALARM lamp will light. To clear the ALARM, return the FUNCTION switch to ALM CHK and back to OPR.

7. Close and secure the door on the KG-40/TSEC.

8. To zeroize the code in the permuter tray, toggle the ZEROIZE switch on the KG-40 control box or open the door on the KG-40/TSEC encoder.

2.21 COMMUNICATION SYSTEM

The communication system provides for transmission, reception, and processing of a variety of intelligence and tactical data, both internally and externally to the aircraft. Microphone selection is controlled by switches located on the side consoles as depicted in Figure 2-66.

In general, the communication system consists of the following:

1. A CC to perform all required switching and routing of communications control and information signals.

2. RSCIs to enable the operator to select the frequencies and/or operational modes of the radio systems.

3. CIs to connect the four crew stations and three maintenance stations.

4. Two UHF radio sets for transmission and reception of short-range communications of voice and Link-11 data and for backup reception of Link-4A data for ACLS and INS alignment and sonobuoy commands.

5. One HF radio set for transmission and reception of long-range communications of voice and Link-11 data.

6. An IFF system to identify the aircraft to ground radar stations and to permit interrogation of other air and surface vehicles.

7. A cryptographic system to provide security for voice and data messages.

8. A DTS to send and receive digital information (Link-11) to and from other aircraft, ships, and shore stations on HF or UHF.

9. A dual redundant (BUS A and BUS B) 1553B multiplex data bus to route data between the CC, RSCIs, and CIs.

The communication and navigation electronic equipment functions and locations are described in Figure 2-67. The communication system equipment interface is shown in the communication subsystem block diagram in Figure 2-68. Antenna locations are shown in Figure 2-69.

Note

- On aircraft incorporating AFC-278, the TACCO and SENSO ICS audio and radio transmissions are recorded if FLIR or radar video is being recorded.

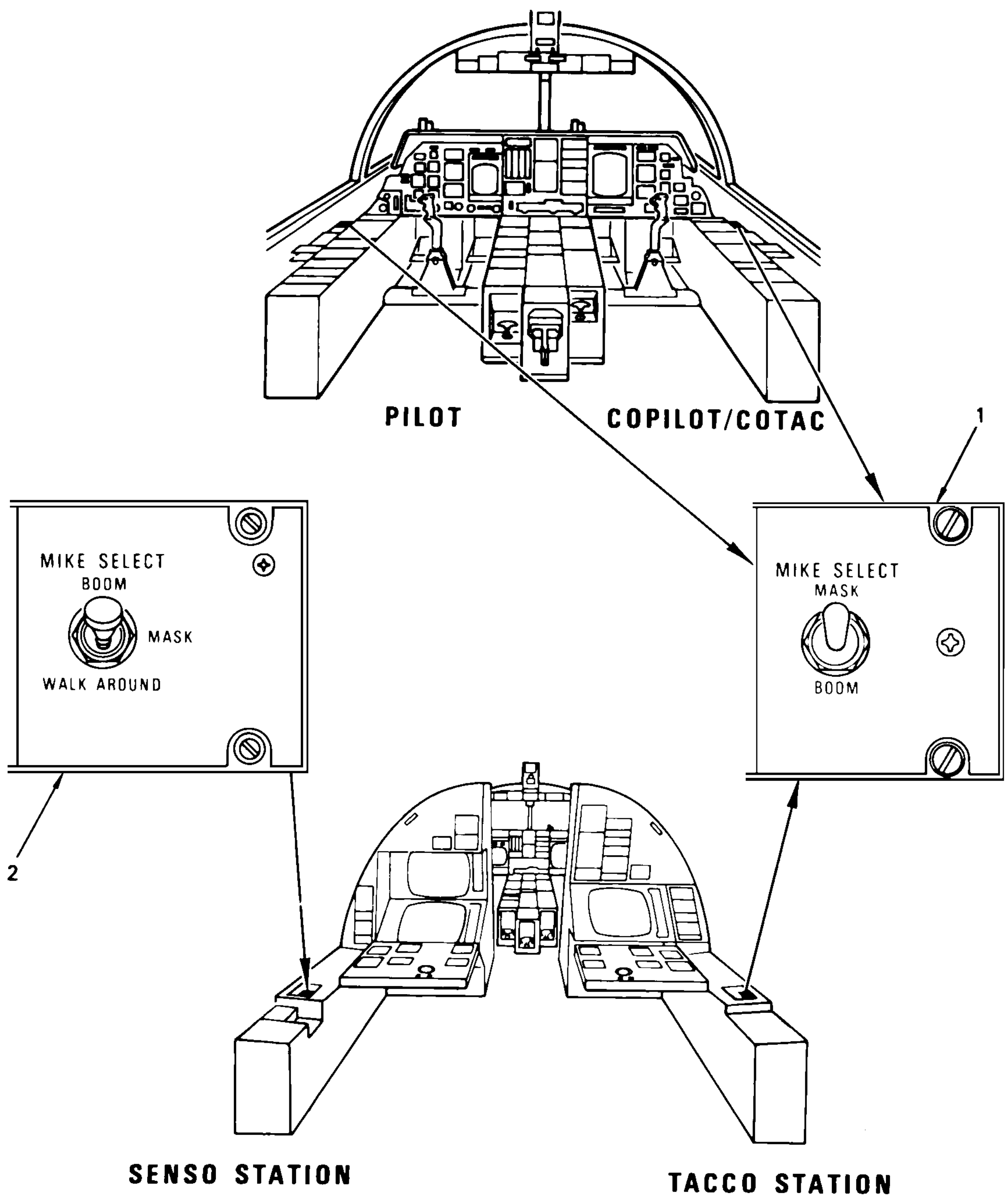
- Ensure that proper operational security procedures are maintained by treating the recorded video cassettes as classified material if classified radio or ICS transmissions are recorded.

2.21.1 Communication Control Group. The CCG integrates all aircraft communication systems. It consists of seven hardware WRAs connected via a 1553B bus. The hardware WRAs consist of the following:

1. One CC

2. Two RSCIs

3. Four CIs



INDEX	CONTROL/INDICATOR	FUNCTION
1	Pilot, copilot/COTAC TACCO MIKE SELECT switch	BOOM — selects boom microphone for ICS input. MASK — selects O_2 mask microphone for ICS input.
2	SENSO MIKE SELECT switch	BOOM — selects boom microphone for ICS input. MASK — selects O_2 mask microphone for ICS input. WALK AROUND — selects O_2 mask microphone for ICS input via O_2 walk around hose circuit.

Figure 2-66. Crew Microphone Select Panels

EQUIPMENT	DESIGNATION	FUNCTION	OPERATOR	LOCATION OF CONTROL
Control Indicator (CI) (AFC-224)	C 11434/AI	Intraplane communications	Crew	All crew stations
HF Transceiver	AN/ARC-153A	Two-way voice/data long-range communications	Pilot, Copilot/ COTAC, TACCO	Center console
UHF Transceiver No. 1	AN/ARC-156A	Two-way voice/data communications	Pilot, Copilot/ COTAC, TACCO	Center console
UHF No. 1 Frequency Selector	C-8881/ARC-156	Provides backup control for UHF-1	Pilot	Pilot side console
UHF Transceiver No. 2	AN/ARC-156A	Two-way voice/data communications	Pilot, Copilot/ COTAC, TACCO	Center console
UHF Voice Crypto	KY-58	Codes and decodes secure voice	Copilot/COTAC	Copilot/COTAC side console
Radio Set Control Indicator (RSCI) (AFC-224)	C11433/AI	Enables operator to change frequencies and/or operational modes of radio systems	Pilot, Copilot/ COTAC, TACCO	Center console TACCO front panel
Communication Controller (CC) (AFC-224)	C11432/AI	Performs all required switching of communica-tions command control and information signals	—	—
Data Terminal Set	CV-2830/AYC	Enables two-way computer-to-computer exchange of Link-11 data	—	—
Secure Data Keyer	TSEC/KG-40	Codes and decodes secure HF data	Copilot/COTAC	Copilot/COTAC side console
IFF Transponder	AN/APX-72	Receives interrogation and transmits identification	Pilot, Copilot/ COTAC	Center console
Interrogator	AN/APX-76	Transmits interrogation signals	Pilot, Copilot/ COTAC	Center console
Radar Altimeter and Altitude Warning Set (RAAWS)	AN/APN-201	Provides accurate altitude and automatic altitude warning signal if aircraft descends below a preset altitude	Pilot, Copilot/ COTAC	Pilot instrument panel, copilot/COTAC instrument panel

Figure 2-67. Communication and Navigation Electronic Equipment (Sheet 1 of 2)

EQUIPMENT	DESIGNATION	FUNCTION	OPERATOR	LOCATION OF CONTROL
Radar Beacon Transponder	APN-202	Provides accurate aircraft tracking information for the shipboard radar unit used in the ACLS	Pilot, Copilot/COTAC	Center console
Automatic Carrier Landing System (ACLS)	ASW-25B	Provides capability for all-weather landings and carrier alignment for CAINS	Pilot, Copilot/COTAC	Center instrument panel
Instrument Carrier Landing System (ICLS)	ARA-63	Provides capability for controlling the aircraft manually during an all-weather approach and landing	Pilot, Copilot/COTAC	Center instrument panel
Automatic Flight Control System (AFCS)	ASW-33	Provides automatic and pilot assisted flight control modes in navigation and tactical situations	Pilot, Copilot/COTAC	Center instrument panel, pilot overhead console
Embedded GPS/INS (EGI)	CN-1689(V)/ASN	Provides velocity, position, attitude, heading, altitude, UTC time.	Pilot, Copilot/ COTAC	Center console (aircraft incorporating AFC-279)
Miniaturized Airborne GPS Receiver (MAGR)	R-2414(U)	Provides position, altitude, speed, and time data	Pilot, Copilot/ COTAC	Center console (aircraft incorporating AFC-272)
Carrier Aircraft Inertial Navigation System (CAINS) (CAINS II on aircraft incorporating AFC-279)	AN/ASN-92(V) (AN/ASN-139 on aircraft incorporating AFC-279)	Furnishes position information in latitude and longitude with heading and attitude	Pilot, Copilot/COTAC	Center console
Attitude Heading Reference System (AHRS)	AN/ASN-107	Provides heading and attitude information	Pilot, Copilot/COTAC	Center console (Removed on aircraft incorporating AFC-279)
Doppler-Navigator System	AN/APN-200	Provides aircraft velocities in aircraft coordinates to CAINS and GPDC	Pilot, Copilot/COTAC	Center console (Removed on aircraft incorporating AFC-279)
Central Air Data Computer	AN/AYN-5A	Provides TAS and altitude for the GPDC, pilot displays, and other equipment	—	—
Tacan	AN/ARN-153	Indicates direction and distance to station	Pilot, Copilot/COTAC	Center console
Low Frequency Automatic Direction Finder (LFADF)	AN/ARN-83	Furnishes bearing indication to station	Pilot, Copilot/COTAC	Center instrument panel

Figure 2-67. Communication and Navigation Electronic Equipment (Sheet 2)

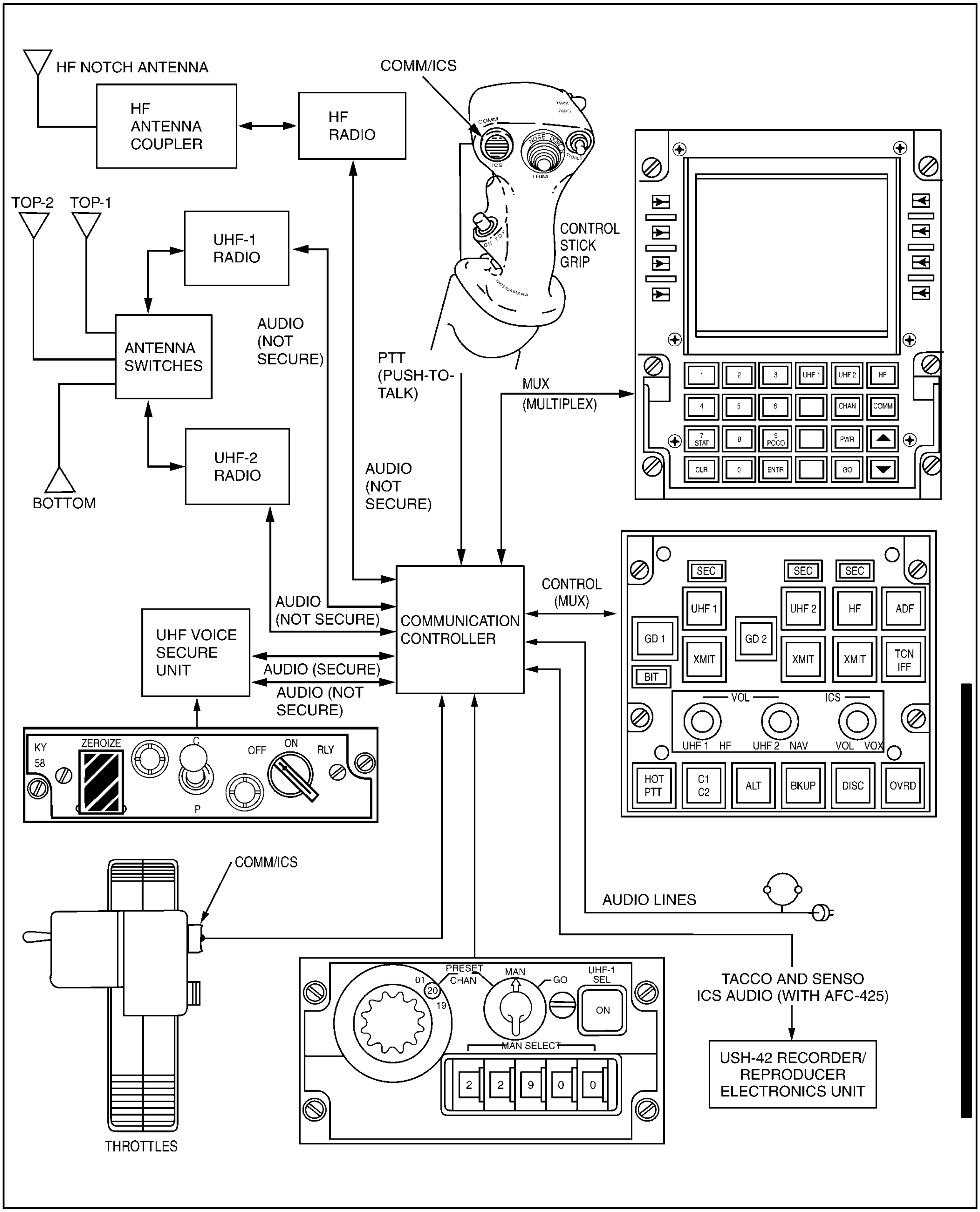


Figure 2-68. Communication Subsystem — Voice Mode Operation

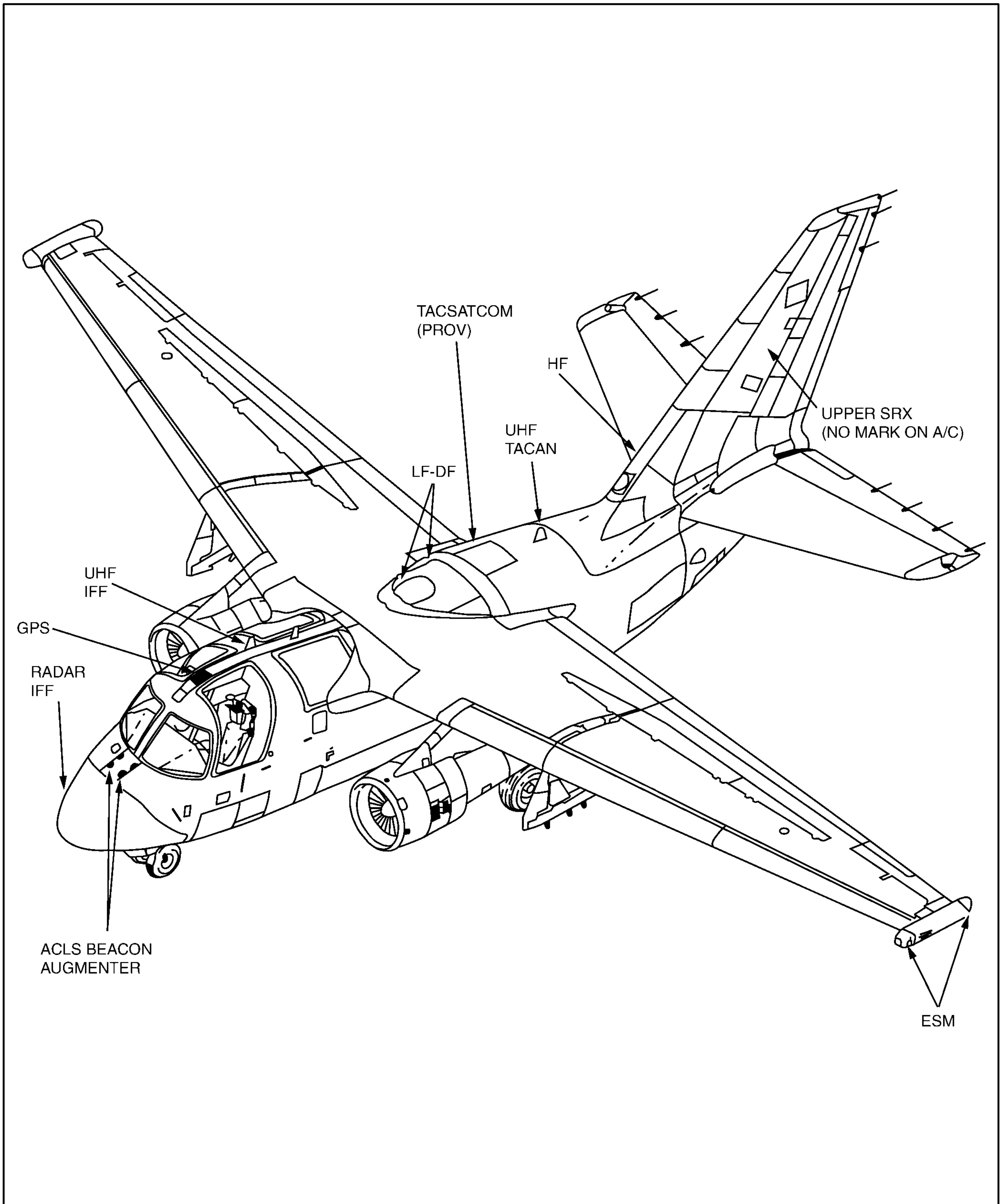


Figure 2-69. Antenna Location (Sheet 1 of 2)

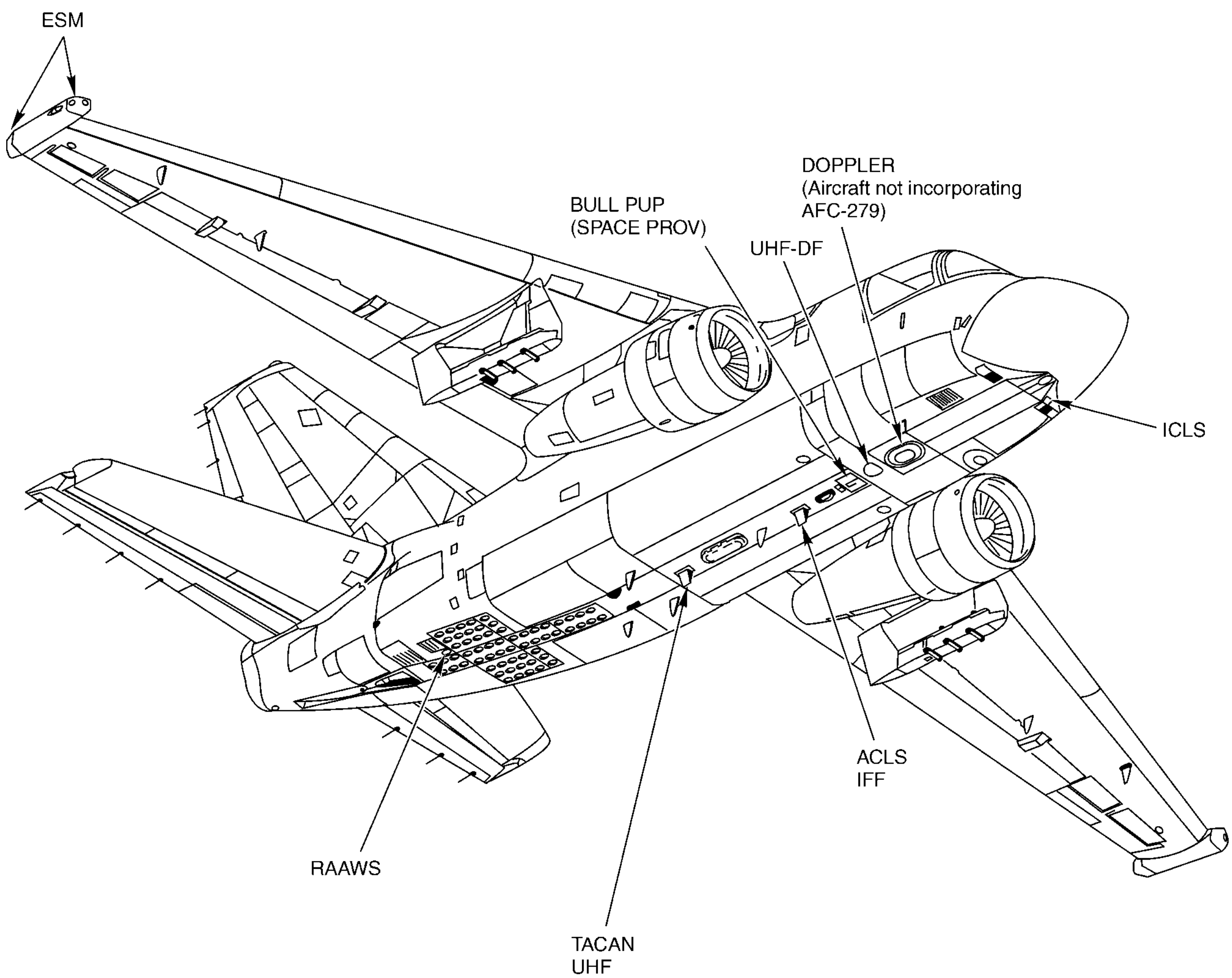


Figure 2-69. Antenna Location (Sheet 2)

The CC, located in the right aft external avionics bay, is the central junction point for all radio and ICS equipment. The CC acts as the controller of the 1553B bus and responds to requests from the GPDC, the RSCIs, and the CIs so as to connect and configure the radios and the ICS for the communication available options.

The RSCIs and CIs function as crewmen terminals. The 1553B bus remote terminal address assignments and the corresponding terminal number and position assignments for each terminal are as follows:

TERMINAL NAME	POSITION	RT ADDRESS
Copilot RSCI	Copilot	01
CI 1	Pilot	02
CI 2	Copilot	03
CI 3	TACCO	04
CI 4	SENSO	05
TACCO RSCI	TACCO	06

2.21.2 Radio Set Control Indicator. Primary control of the communications system is through the RSCIs (see Figures 2-70 and 2-71), located on the center console in the forward cockpit and the TACCO front panel. The RSCI provides control of the UHF-1, UHF-2, and HF radios. Emergency backup communication capabilities may be selected at the pilot (UHF) and copilot/ COTAC (HF) CIs in the event both RSCIs fail. UHF-1 and HF backup are hardwired through the CC directly to the respective radio.

2.21.2.1 Radio Set Control and Configuration. The radios have initialized settings that can be altered via the UHF and HF configuration control, channelization, status, and power pages. If the system power is interrupted for less than approximately 2 minutes, the system will be restored to its last configuration as held in the CCG memory by capacitor backup.

Note

- Link-11 is not automatically reestablished.
- The manual channelization is the only configuration change that will remain if power is interrupted for greater than 2 minutes.

2.21.2.1.1 UHF Configuration Control Page. The UHF-1 and UHF-2 configuration control pages are selected via the RSCI UHF-1 and UHF-2 keys, respectively. The initial condition is identical for both UHF radios as depicted in Figure 2-72.

Note

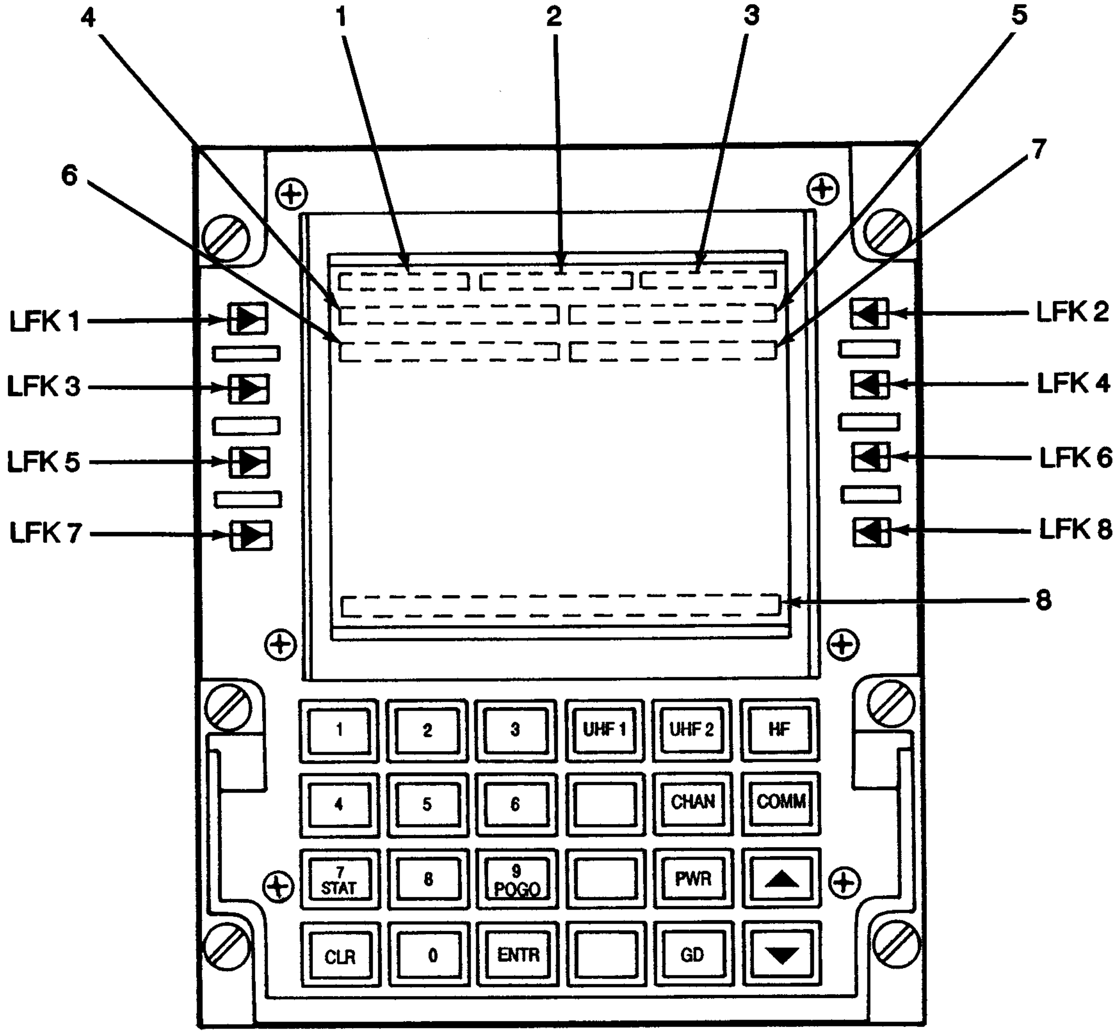
- In the VOICE mode, CIPHER will be displayed when the KY-58 control panel mode selector switch is in the C position.
- In the DATA mode, CIPHER will be displayed when the KGX-40 control panel function selector switch is out of the OFF position and the mode selector switch is in any of the cipher positions.
- CIPHER indicates that the cryptographic equipment is configured properly. A red SEC illumination on the CI ensures the radio is cleared for classified information.

2.21.2.1.2 HF Configuration Control Page. The HF configuration control page is selected via the RSCI HF key. The initial condition is depicted in Figure 2-73.

Note

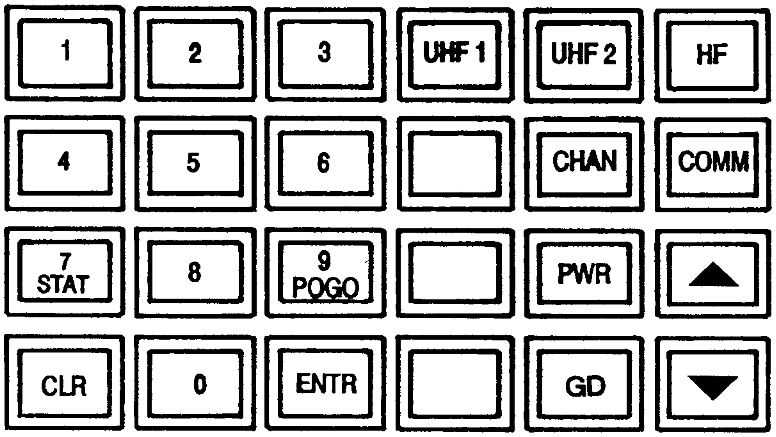
- In VOICE mode, CIPHER will not be displayed.
- In DATA mode, CIPHER will be displayed when the KGX-40 control panel function selector switch is out of the OFF position and the mode selector switch is in any of the cipher positions.
- CIPHER indicates that the cryptographic equipment is configured properly. A red SEC illumination on the CI ensures the radio is cleared for classified information.

2.21.2.1.3 UHF Channelization Pages. The three UHF channelization pages, with eight frequencies per page, provide the capability to maintain a nonvolatile button/frequency configuration. The UHF channelization pages are selected via the RSCI CHAN key. Page stepping is accomplished by depression of the CHAN key with a rollover occurring from page 3 to page 1. Only the first 22-button frequencies may be changed. Button 23 is dedicated to 291.4 (sonobuoy command) and button 24 is dedicated to 243.0 (UHF Guard) as depicted in Figure 2-74.



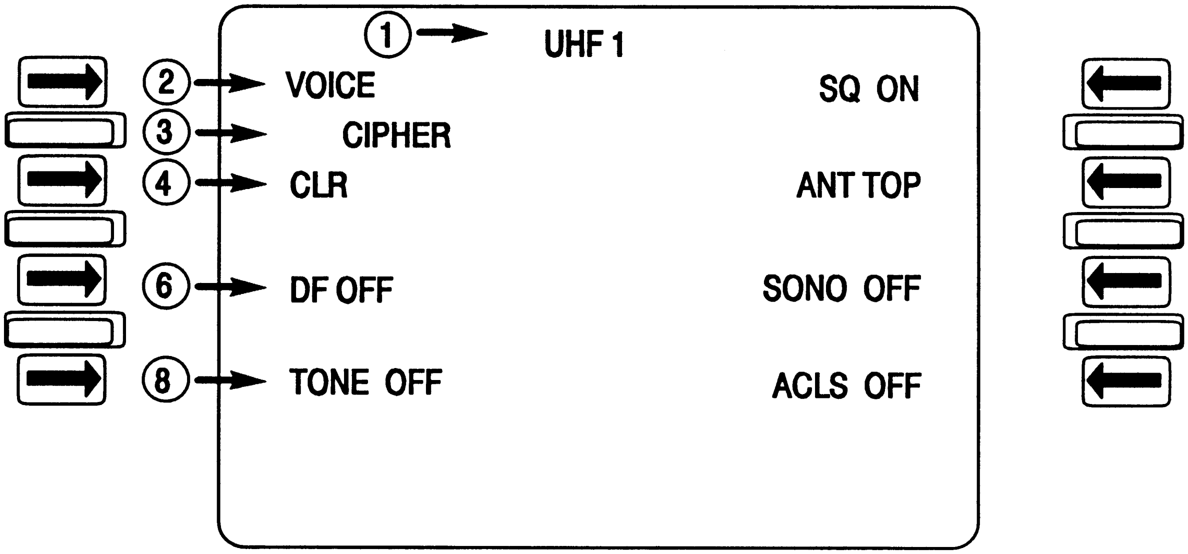
INDEX	FUNCTION
1	Reserved for operator advisories.
2	Reserved for page titles.
3	Reserved for advisory of system status (BIT) error.
4, 5	Active line areas used to select, change, or modify a function or mode. The line function key (LFK) controls the function or mode displayed next to the arrow.
6, 7	Advisories pertaining to the display line above.
8	Scratchpad area for prompt cueing area and data entry area.

Figure 2-70. Radio Set Control Indicator Display Organization



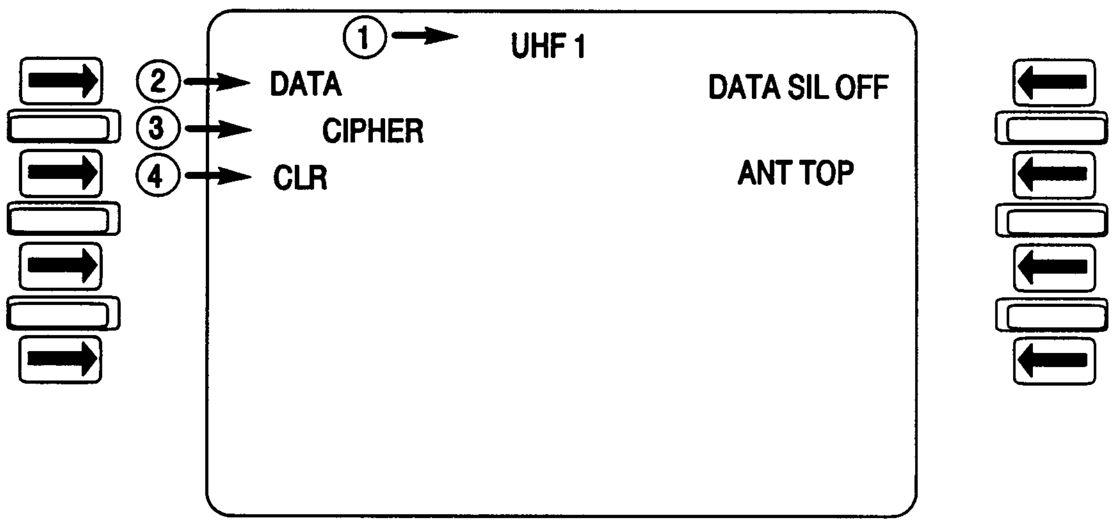
KEY	FUNCTION
1 to 6, 8, 0	Numeric data entry.
7/STAT	Numeric entry or selection of system status page. If the system expects a numeric entry, 7 will be entered; otherwise, the system status cueing sequence is initiated.
9/POGO	Numeric entry or selection of POGO. If the system expects a numeric entry, 9 will be entered; otherwise, the POGO cueing sequence is initiated.
CLR	Clears scratchpad cueing sequence if a mistake was made and the INV ENT and FAULT alerts.
ENT	Enters data from the scratchpad into the CC.
BLANK	Blank keys for future growth.
UHF1	Selects UHF-1 configuration control page.
UHF2	Selects UHF-2 configuration control page.
HF	Selects HF configuration control page.
CHAN	Selects UHF channelization pages.
COMM	Selects communication monitoring pages.
PWR	Selects radio power page.
GD	Selects UHF guard entry sequence.
UP/DWN	Increases/decreases display brightness. Holding either key will increment the display brightness continuously until the maximum/minimum value is reached.

Figure 2-71. Radio Set Control Indicator Keyset



INDEX	CONTROL/INDICATOR	FUNCTION
1	Page Title	UHF-1 or UHF-2.
2	LFK 1	Toggles the radio between the voice and data mode.
	LFK 2	Toggles squelch between ON and OFF.
3	LFK 1 ADVISORY	Toggles between plain and cipher and reflects the KY-58 control panel switch selection. CIPHER displayed whenever the mode selector switch C selected.
4	LFK 3	Toggles the antenna between CLR (clear) and SEC (secure) provided LFK 1 advisory is displaying CIPHER.
	LFK 4	Toggles the antenna between TOP and BOT (bottom). Only one radio may be assigned to the BOT position.
6	LFK 5	Toggles the radio in and out of direction finding mode.
	LFK 6	Toggles the radio in and out of sonobuoy command mode.
8	LFK 7	Toggles the radio in and out of tone mode.
	LFK 8	Toggles the radio in and out of automatic carrier landing mode.

Figure 2-72. UHF Configuration and Control Page (Voice Mode) (Sheet 1 of 2)



INDEX	CONTROL/INDICATOR	FUNCTION
1	Page Title	UHF-1 OR UHF-2.
2	LFK 1	Toggles the radio between voice and data mode.
	LFK 2	Toggles data silence between ON and OFF.
3	LFK 1 ADVISORY	Toggles between plain and cipher and reflects the KGX-40 control panel switch selection. CIPHER displayed whenever the function selector switch is out of the OFF detent and the mode selector switch has any CIPHER TEXT selected.
4	LFK 3	Toggles the radio between CLR (clear) and SEC (secure) provided LFK 1 advisory is displaying CIPHER.
	LFK 4	Toggles the antenna between TOP and BOT (bottom). Only one radio may be assigned to the BOT position.

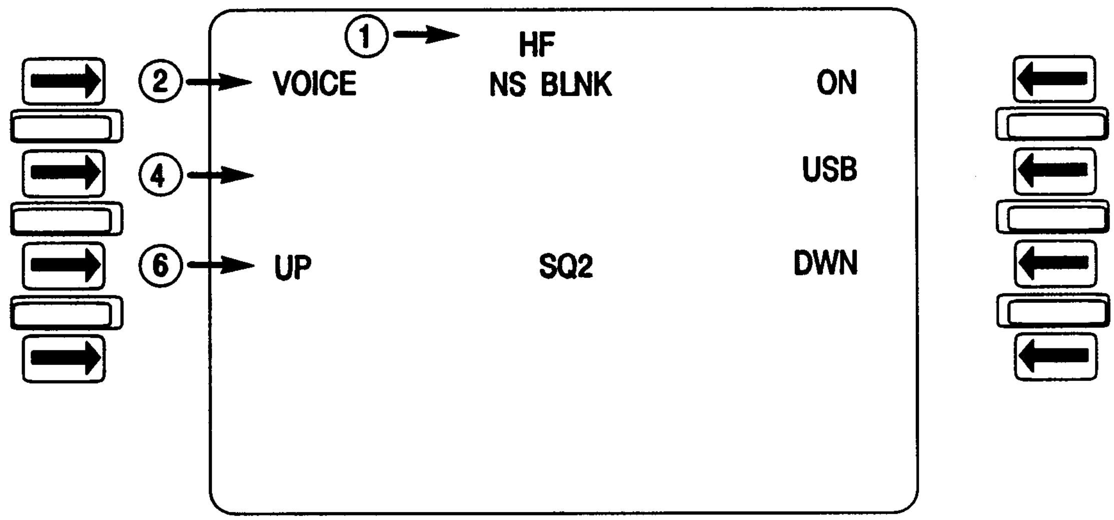
Figure 2-72. UHF Configuration and Control Page (Voice Mode) (Sheet 2)

2.21.2.1.4 Radio Power Page. The radio power page allows ON/OFF command of the UHF and HF radios and the UHF Guard radios. The radio power page, as depicted in Figure 2-76, is selected via the RSCI PWR key.

Note

- The only method available to the TACCO for turning the UHF Guard radios ON/OFF is via the PWR page.
- The ON/OFF indication is the last command sent and in no way reflects the current power status of the radio. Radio power status is unmonitored.

2.21.2.1.5 Communication Status Pages. The three communication status pages, COMM1, COMM2, and COMM3, allow the operator to monitor the configuration of two radios at a time and the ability to change channels/frequencies. Communication status



INDEX	CONTROL/INDICATOR	FUNCTION	
1	Page Title	HF	
2	LFK 1	Toggles the radio between voice and data mode.	
	LFK 2	Toggles noise blanker between ON and OFF.	
4	LFK 4	Toggles the frequency mode between USB, LSB, and AME, respectively.	
6	LFK 5	Toggles squelch UP.	Squelch level is displayed in the center of the line (range varies from 0 to 7).
	LFK 6	Toggles squelch DOWN.	

Figure 2-73. HF Configuration and Control Page (Voice Mode) (Sheet 1 of 2)

can be selected via the RSCI COMM key. Page stepping is accomplished by depression of the COMM key with a rollover occurring from the COMM3 to COMM1 page. As depicted in Figure 2-79, COMM1 monitors UHF-1/ UHF-2, COMM2 monitors UHF-1/HF, and COMM3 monitors UHF-2/HF. The only modifiable parameter is the channel/frequency by selection of the line function key (LFK) adjacent to the frequency and entering the channel number or frequency into the scratch pad as depicted in Figure 2-80.

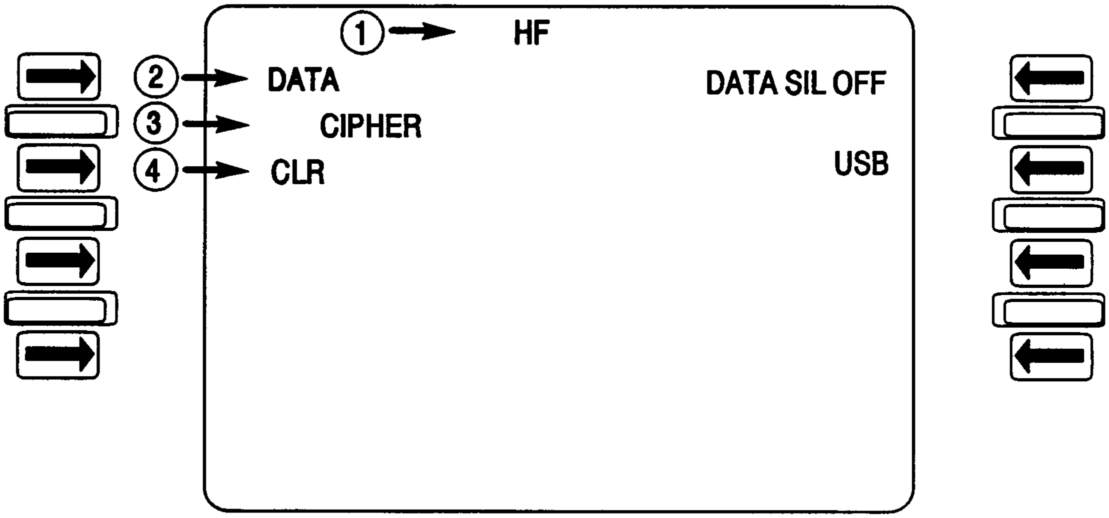
Note

When entering frequencies, the trailing zeros are not required.

2.21.2.1.6 System Status Pages. The system status pages, as depicted in Figures 2-81 through 2-89, are the only pages that are nested two levels below the main page. The first level of the status page allows monitoring of the system, selection of system test (ground operation only), selection of a display test, monitoring of the tacan, ADF, and IFF audio availability and a check to see the greatest number of times a frequency on one of the 22 channels has been manually changed.

Note

- The channel count indicates the greatest number of times any one of the 22 channels has been changed manually. The channel with the greatest number of changes is not identifiable by the operator.
- Upon change number 8000, the display will change from 7999 to MAINT REQD. This is not an immediate problem. This indicates that a manual channelization is not guaranteed to remain in the memory location that has changed greater than 8,000 times.



INDEX	CONTROL/INDICATOR	FUNCTION
I	Page Title	HF.
2	LFK 1	Toggles the radio between voice and data mode.
	LFK 2	Toggles data silence between ON and OFF. The data silence configuration will be reflected on the INCOS tray.
3	LFK 1 ADVISORY	Toggles between plain and cipher and reflects the KGX-40 control panel switch selection. CIPHER displayed whenever the function selector switch is out of the OFF detent and the mode selector switch has any CIPHER TEXT selected.
4	LFK 3	Toggles the radio between CLR (clear) and SEC (secure) provided LFK 1 advisory is displaying CIPHER.
	LFK 4	Toggles the antenna between USB, LSB, and BOTH respectively.

Figure 2-73. HF Configuration and Control Page (Voice Mode) (Sheet 2)

Note

The channel count will not increment unless the frequency entered for that channel was different than what was already being maintained in memory.

2.21.2.1.7 Special Functions. Two special functions, POGO and UHF Guard, are provided in the RSCI. POGO selects the last frequency used and is selected with the following procedures:

1. Select the appropriate COMM page.

2. Depress POGO (SEL RAD cue displayed in scratchpad).

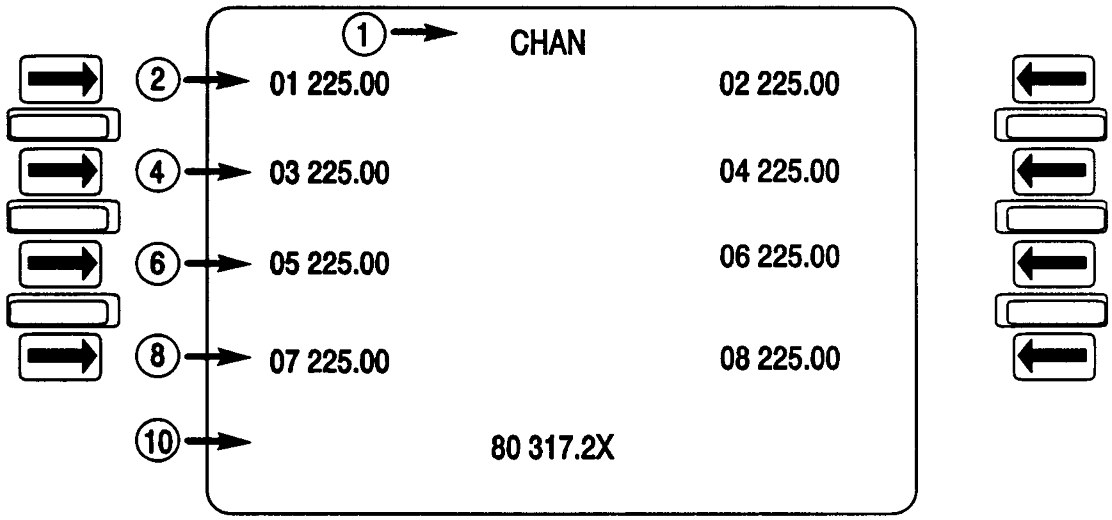
3. Depress the LFK adjacent to the frequency of the radio that is to be selected. (ENTR cue is displayed in the scratchpad).

4. Depress the ENTR key.

The second function selects UHF Guard on UHF-1 and places it in a transmit ready state unless the CCG recognizes that it is nonoperational (an F displayed next to UHF-1 in the system status page). If UHF-1 is recognized as failed then UHF-2 will be configured in the same manner using the following procedures:

1. Depress the GD key (ENTR cue is displayed in the scratchpad).

2. Depress ENTR key.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Page Title	CHAN (nonvolatile channelization; three pages with eight channels per page).
2, 4, 6, 8	LFK 1 thru 8	Selection allows manual channelization with the exception of channels 23 (291.40) and 24 (243.00).
10	Scratchpad	Used to change a channel/frequency assignment.

Figure 2-74. CHAN Pages

3. Select COMM1.

4. Verify the radio configuration.

Note

- Select XMIT on the CI to ensure a transmit ready state exists.

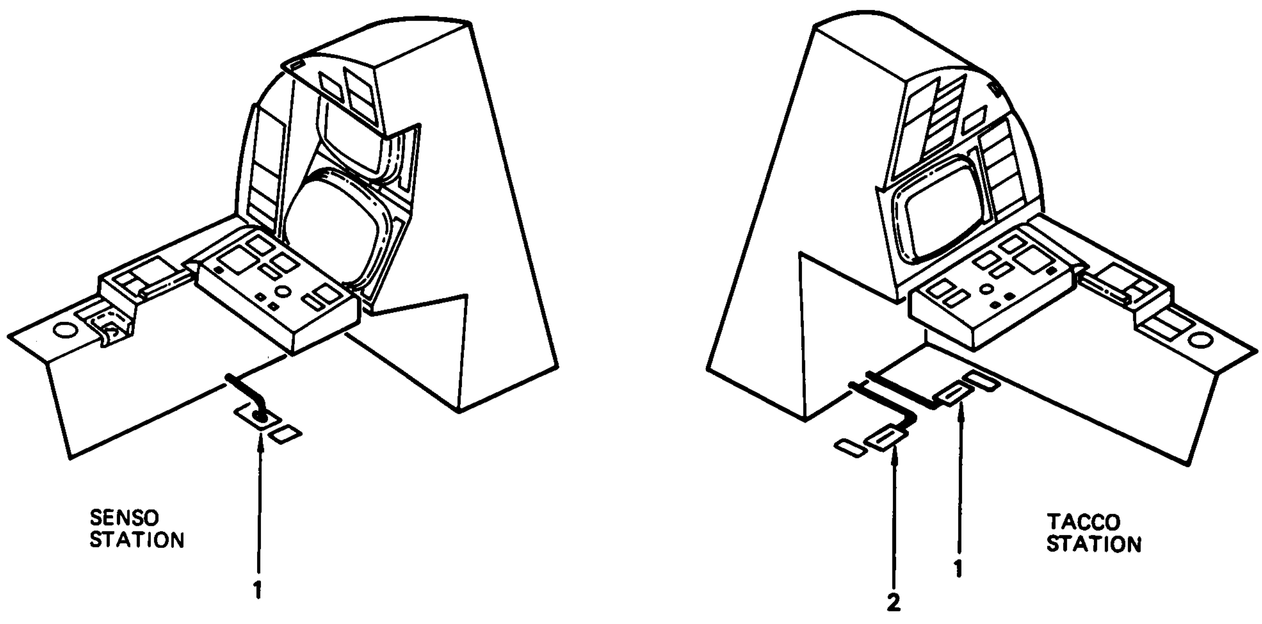
- The transmit ready state requires selection of the microphone switch to transmit.

2.21.3 Intercommunication System. The crew CIs provide the pilot, copilot/COTAC, and TACCO with functional access to the UHF transmitters and the HF radio transmitter. The CIs also provide access for all crewmembers to monitor the two UHF radios, the HF radio, and certain radio navigation systems. It provides monitor-before-break-in and conference line operation as well as complete ICS control between four crew CIs and three maintenance ICS stations. The CI is shown in Figure 2-90. The TACCO and SENSO have access to the ICS via foot pedals as depicted in Figure 2-75.

Note

Do not transmit classified information on ICS when other crewmembers are transmitting on the UHF or HF in the clear voice mode.

The CI control functions are interconnected by a 1553B bus through the CC. Audio interconnection is provided by hardwired circuits. Maintenance station audio is hardwired through the CC to the four CIs. The maintenance/ground handling ICS stations consist of a volume control and a connector to hook up the headset/mike. The stations provide ground personnel with intercommunications with the four crewmembers and ground maintenance personnel by depression of the ICS press-to-talk switch.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Crew ICS foot pedals (key)	Pressed — activates PTT ICS circuit at depressing station.
2	TACCO radio foot pedal (key)	Pressed — activates XMIT SEL RADIO SELECTED on TACCO crew ICS control panel.

Figure 2-75. Crew Communication Foot Pedals

Note

Communication between ground maintenance stations and crewmember stations cannot be heard by the station making the transmission. However, all other stations will hear the transmitter.

The ICS functions permit:

1. All seven ICS stations to communicate.

2. Two or more operators to communicate simultaneously without interfering with the remaining operator(s).

Note

Conference isolation can only be maintained via use of HOT MIKE. PTT will talk across conferences.

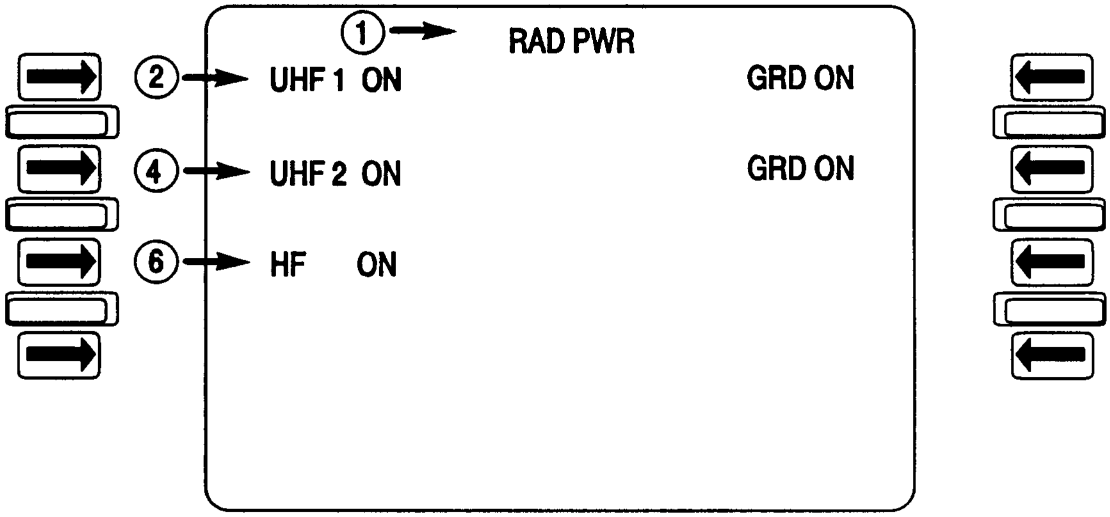
3. ICS disconnect enabling an operator to remove himself from the ICS to prevent the ICS from interfering with another communication or monitoring task.

4. ICS override enabling an operator to contact another operator who is in the ICS disconnect mode.

5. Bypass of a failed CI.

6. Push-to-talk or voice-operated control of all microphone inputs.

2.21.4 Communication System Initialization. The CCG initializes automatically provided the circuit breakers are in prior to the application of power. The system will perform a power on built-in-test (BIT) followed by RSCI display initialization to the COMM1 page.



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	RAD PWR.
2	LFK 1	Reflects the last power command sent to the UHF-1 radio; toggles between ON and OFF.
	LFK 2	Reflects the last power command sent to the UHF-1 Guard radio; toggles between ON and OFF.
4	LFK 3	Reflects the last power command sent to the UHF-2 radio; toggles between ON and OFF.
	LFK 4	Reflects the last power command sent to the UHF-2 Guard radio; toggles between ON and OFF.
6	LFK 5	Reflects the last power command sent to the HF radio; toggles between ON and OFF.

Figure 2-76. PWR Page

Note

Power transfers or initial power turn-on may exhibit the following peculiarities:

1. Initial configuration states following power application may be delayed for several seconds. The RSCI displays will remain blank until full initialization occurs. This situation is considered normal and requires no further action.

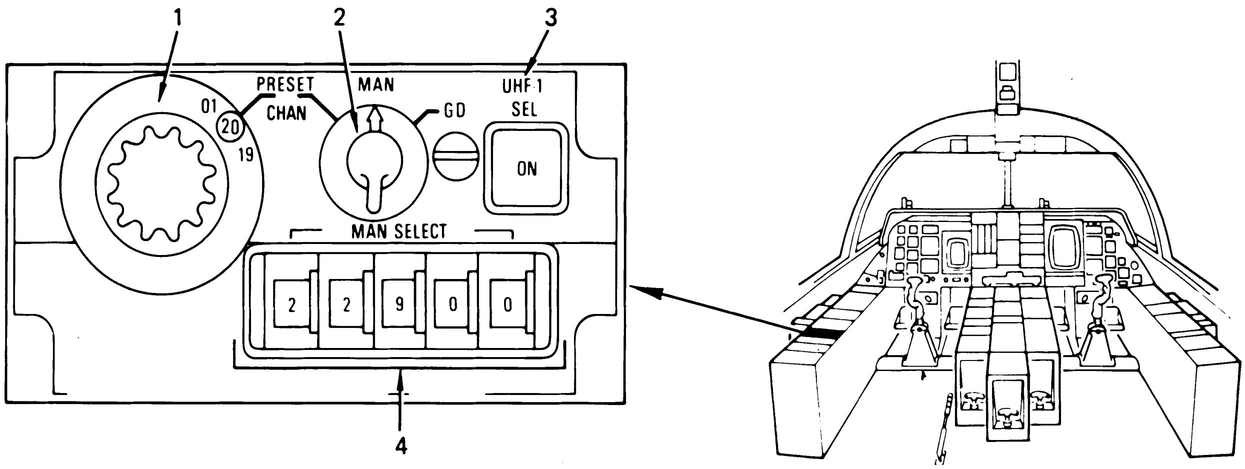
2. If CCG power is temporarily interrupted (more than 75 microseconds but less than 0.5 seconds), then the system will be restored to its last configuration as held in the CCG memory area designed with capacitor backup except that Link-11 is not automatically reestablished.

2.21.4.1 GPDC/CCG Interaction. When the GPDC initializes, the frequencies from the UHF CH-F tableau are automatically downloaded to the CCG.

Note

An audible clicking can be heard in the headset when the GPDC changes the UHF channelization.

Any changes to the channelization via the RSCI will be updated in the UHF CH-F tableau provided the CCG and GPDC are communicating.



INDEX	CONTROL/INDICATOR	FUNCTION
1	CHANNEL SELECTOR switch	This is a rotary switch, which selects any one of twenty preset frequencies. These preset frequencies cannot be changed in flight.
2	PRESET CHAN-MAN-GD switch	This three-position rotary switch has the following functions:
	PRESET CHAN	This position enables the CHANNEL SELECTOR switch for selection of any of twenty preset channels.
	MAN (Manual)	This position enables the MAN SELECT thumbwheel frequency selectors.
	GD (Guard)	This position automatically tunes the UHF-1 to the international UHF emergency frequency (243.00 MHz).
3	UHF-1 SEL switchlight	When pressed, this switch illuminates amber and selects the C-888 1 at the UHF-1 frequency control source. A second push extinguishes the switch and returns UHF-1 frequency control to the RSCI master control panel. When UHF-1 backup mode is active, this switch lights amber automatically.
4	MAN SELECT switches	Five thumbwheel switches enable the pilot to manually select any one of 3500 frequencies available between 225.00 MHz and 399.95 MHz.

Figure 2-77. UHF Control Panel

Note

Power interruptions greater than 0.5 second will cause the CCG UHF channelization to revert to the last manual entries.

2.21.5 UHF Radio Set. Two UHF radio sets (UHF-1 and UHF-2) are provided for transmission and reception of voice and data. Either serves for the transmission of coded signals to command active sonobuoys. In addition, the UHF serves as an alternate receiver for the ACLS. Antennas for the UHF sets are mounted on both the upper and lower surfaces of the fuselage to prevent signal blanking caused by aircraft maneuvers. Frequency band coverage is between 225.00 and 399.95 MHz. The UHF transceivers enable three CIs (pilot, copilot/COTAC, and TACCO) to transmit via UHF-1 or UHF-2. The SENSO station cannot transmit. Radio and mode selections are made via either the RSCI located in the forward cockpit center console or on the TACCO front panel.

A UHF control panel, depicted in Figure 2-77 and located on the pilot side console, provides the pilot with separate control of the UHF-1 radio set when the UHF-1 SEL button on that panel is set to ON. This control panel takes priority over UHF-1 frequency selection at the RSCIs.

Note

- When the pilot selects UHF-1 control on the UHF control panel, the pilot should inform the copilot/COTAC and TACCO that the UHF-1 cannot be controlled by the RSCIs.
- The RSCIs will reflect the frequency selected on the off-line UHF-1 control panel. Nonstandard characters (?, @, #, etc.) will be displayed when the knobs are selected between channels or numbers.
- Operation of the UHFs on the ground without sufficient cooling should be avoided. Although the radios and the CCG are powered in this mode, cooling air is not provided even if the emergency cooling air switch is operated. If the radios must be operated under this condition, the radio should not be keyed for extended periods.
- Channel assignments for off-line UHF-1 operation are preset by maintenance personnel and have no direct interface with the channel assignments as established within the RSCIs. Channel changes within the RSCIs will not be reflected in this control panel.

The following UHF modes of operation are available.

1. Clear voice for normal communications.
2. Secure voice for voice-coded communications.
3. Link-11 data (clear or secure) for normal data-link operations.
4. Link-4A reception only, for ACLS backup receiver.
5. Sonobuoy command from the ADP.
6. UHF direction finding for short-range navigation and rendezvous operations.
7. Separate guard receiver to enable simultaneous monitoring of operational and emergency channels.

Note

Interference to the UHF receiver from the aircraft HF or UHF transmitter may be experienced. This is especially noticeable when the UHF main or Guard receiver is tuned to a harmonic of the HF transmitter frequency or to the HF related frequency (multiples of 17.5 MHz) of the other UHF transmitter. Selection of the bottom antenna for the UHF receiver experiencing interference may reduce the interference. Operational frequencies may have to be adjusted to avoid interference.

2.21.6 KY-58 Security Unit. A KY-58 speech security unit is provided to transmit and receive secure voice communications through the UHF radio in accordance with preset codes. It must be set to the cipher (C) mode to transmit in the secure mode. The control panel, depicted in Figure 2-78, located on the copilot/COTAC side console, provides for operation of the KY-58. Under normal operation, the mode selector switch is set in the C position when the KY-58 is ON. The RSCI UHF-1/ UHF-2/HF configuration control page reflects CIPHER when the mode switch is in the C position and allows the CLR/SCR LFK on the RSCI to control the clear and secure modes of the UHF radios. When the mode selector switch on the KY-58 panel is in the P position, the RSCI will reflect PLAIN and the SCR selection will not be available.

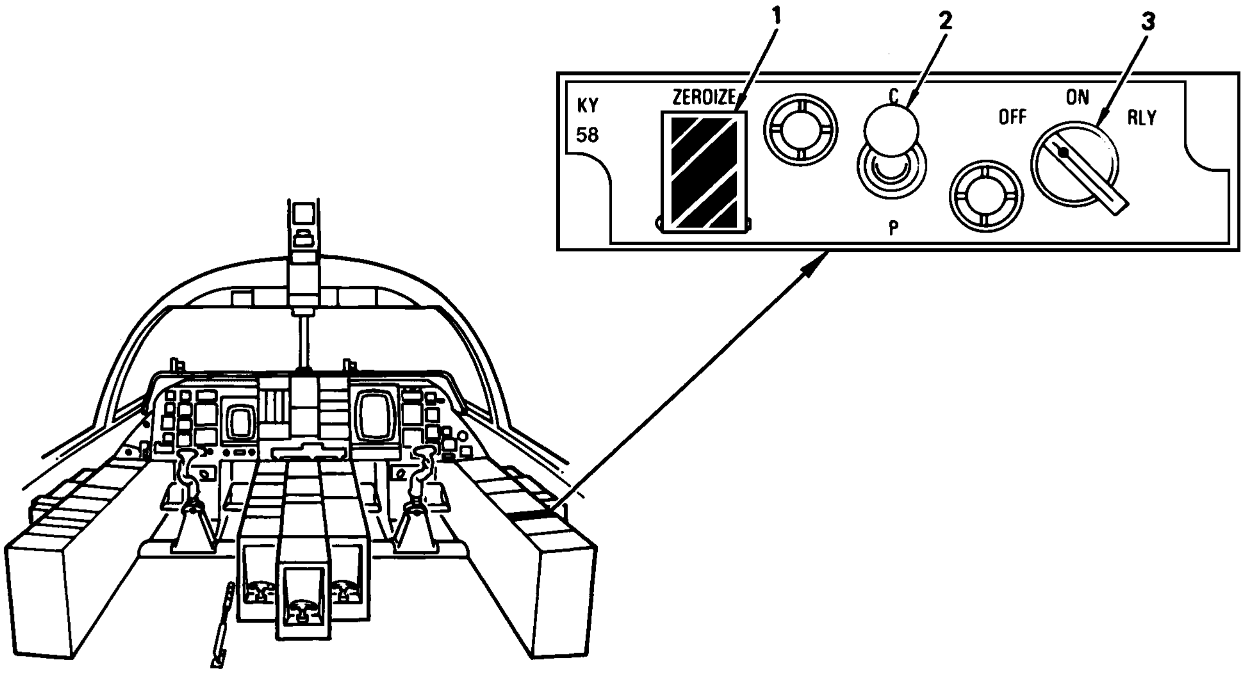
Note

With KY-58 equipment installed in the aircraft, procedures for handling classified/cryptographic equipment must be followed.

2.21.6.1 KY-58 Operation Procedure

2.21.6.1.1 Prelaunch

1. Set the proper code in the KY-58 equipment.
2. UHF radio — ON.
3. Function select switch — ON.
4. Mode select switch — P position.



INDEX	CONTROL/INDICATOR	FUNCTION
1	ZEROIZE switch	This guarded push button switch provides for the erasing of the preset KY-58 cipher (C) mode codes by pressing the switch.
2	Mode selector switch	The C (up) position selects cipher voice; the P (down) position selects plain voice. To select UHF secure voice at RSCI this switch must be set to C position.
3	Function selector switch	This three-position rotary selector (OFF/ON/RLY) applies operating voltage to the KY-58 system in the ON position. The RLY position is utilized to allow another station to relay messages. OFF position removes power from the system.

Figure 2-78. KY-58 Control Panel

5. If a ground test of the equipment is desired, (after a 2-minute warmup period) establish two-way plain text UHF radio communications with a suitable ground station and request an equipment check.

6. Mode select switch — C position.

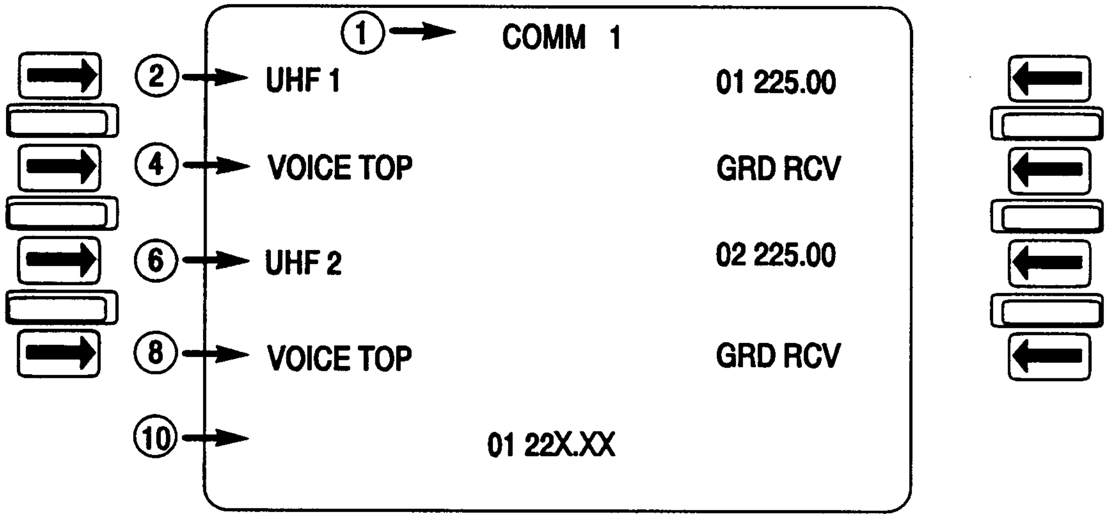
   a. Select SCR on the proper UHF configuration control page via LFK 3.

   b. Listen for a steady, unbroken tone in the headset followed by:

      (1) A double-pitched broken tone.

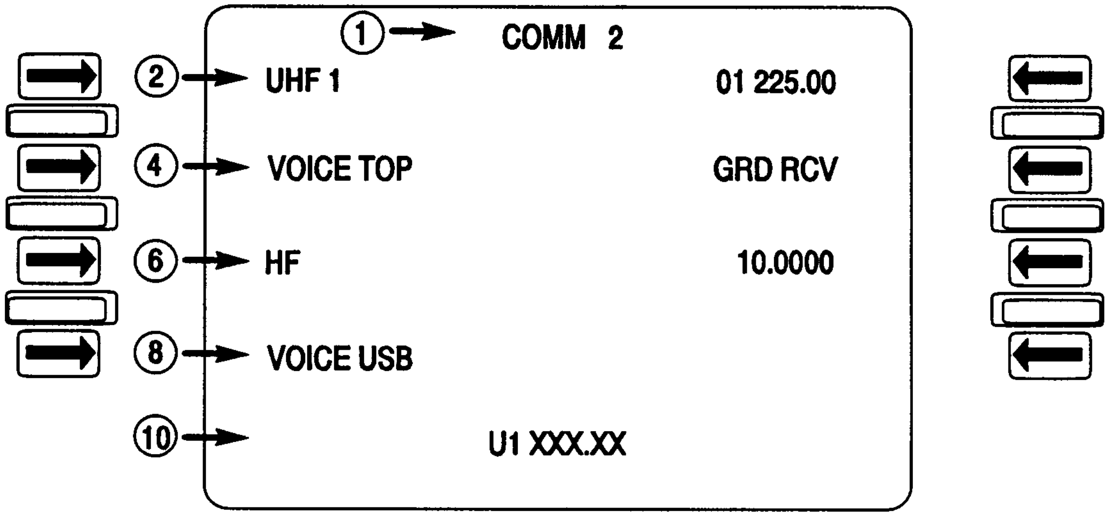
      (2) Secure light illuminated on the CI panel.

7. Press the MIC button, hold for approximately 2 seconds, and release. The double-pitched broken tone will cease and no sound will be heard.



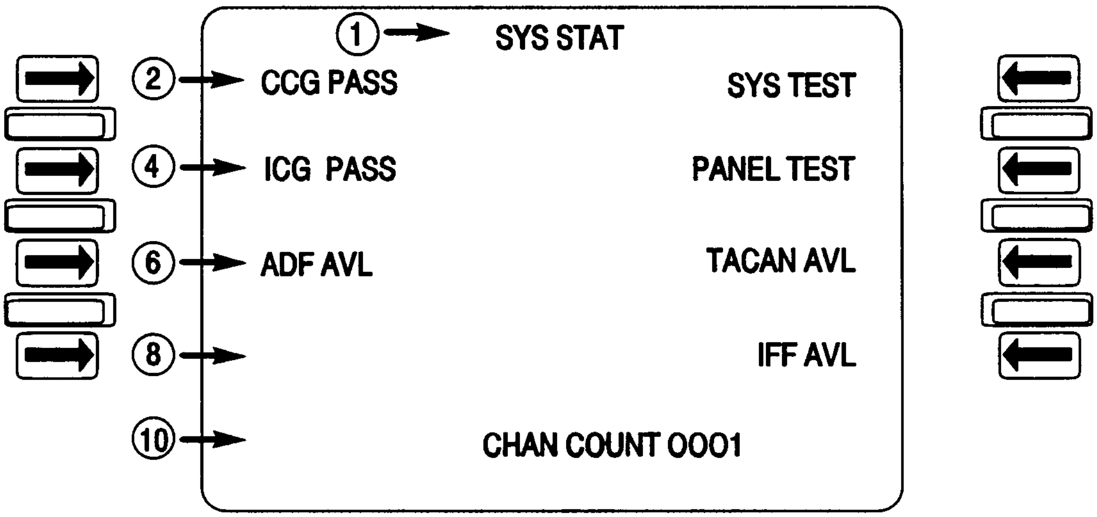
LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	COMM (1, 2, or 3).
2	LFK 1	Nonfunctional LFK that indicates UHF (1 or 2).
	LFK 2	Selection allows channel/frequency change for the radio identified adjacent to LFK 1. The UHF-1 radio initializes to channel 01.
4	LFK 3	Nonfunctional LFK that indicates the mode of operation and the antenna being used by the radio adjacent to LFK 1.
	LFK 4	Nonfunctional LFK that indicates the status of the Guard receiver for the radio adjacent to LFK 1.
6	LFK 5	Nonfunctional LFK that indicates UHF-2 or HF.
	LFK 6	Selection allows channel/frequency change for the UHF or a frequency change for the HF radio identified next to LFK 5. The UHF-2 radio initializes to channel 02 and the HF to 10.0000 kHz.
8	LFK 7	Nonfunctional LFK that indicates the mode of operation and the antenna being used by the UHF-2 radio or the mode of operation and the sideband being used by the HF radio.
	LFK 8	Nonfunctional LFK that indicates the status of the Guard receiver for the UHF-2 radio or whether the HF radio is coupled or uncoupled.
10	Scratchpad	Becomes active after selection of LFK 2 or LFK 6 to accept channel or frequency change.

Figure 2-79. COMM Pages



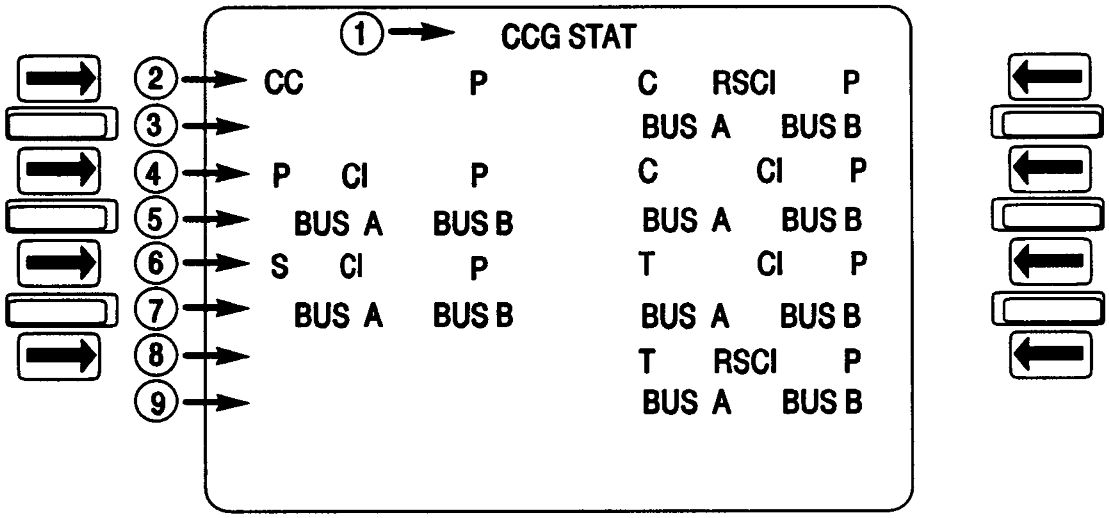
LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	COMM (1, 2, or 3).
2	LFK 1	Nonfunctional LFK that indicates UHF (1 or 2).
	LFK 2	Selection allows channel/frequency change for the radio identified next to LFK 1.
4	LFK 3	Nonfunctional LFK that indicates the mode of operation and the antenna being used by the radio adjacent to LFK 1.
	LFK 4	Nonfunctional LFK that indicates the status of the Guard receiver for the radio adjacent to LFK 1.
6	LFK 5	Nonfunctional LFK that indicates UHF-2 or HF.
	LFK 6	Selection allows channel/frequency change for the UHF radio identified next to LFK 5 or the frequency change for the HF radio.
8	LFK 7	Nonfunctional LFK that indicates the mode of operation and the antenna being used by the UHF-2 radio or the mode of operation and the sideband being used by the HF radio.
	LFK 8	Nonfunctional LFK that indicates the status of the Guard receiver for the UHF-2 radio or whether the HF radio is coupled or uncoupled.
10	Scratchpad	Becomes active after selection of LFK 2 or LFK 6 to accept channel or frequency change.

Figure 2-80. Channel/Frequency Entry



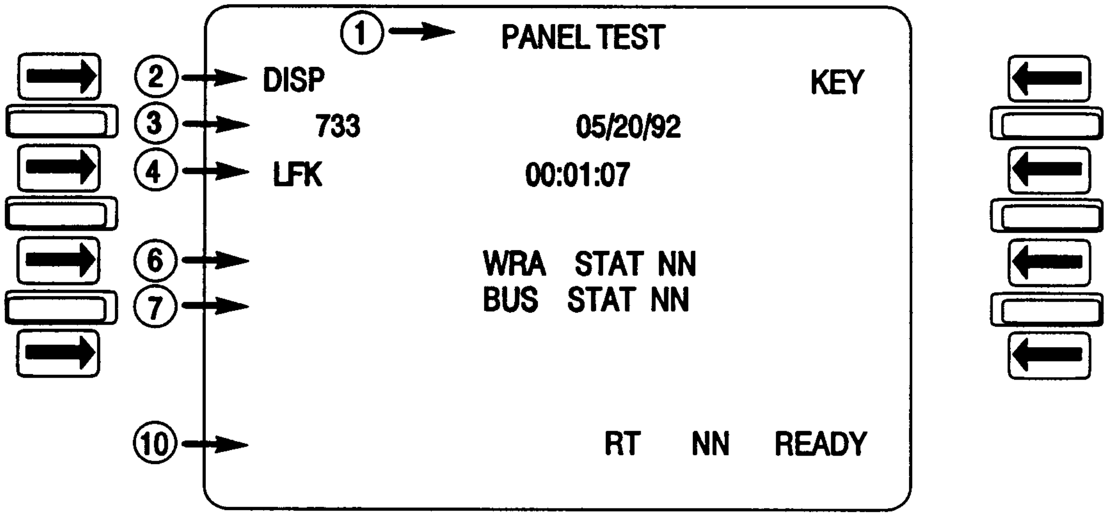
LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	SYS STAT.
2	LFK 1	CCG system status; selects WRA status page to identify failed WRA.
	LFK 2	Selection allows initiation of CCG system test. Only available for ground operations. Option is not displayed for weight off wheels.
4	LFK 3	Selects interface control group (ICG) status page.
	LFK 4	Selects panel test page.
6	LFK 5	Nonfunctional LFK that displays availability of ADF audio.
	LFK 6	Nonfunctional LFK that displays availability of TACAN audio.
8	LFK 8	Nonfunctional LFK that displays availability of IFF mode IV audio.
10	Scratchpad	Displays a number between 0000 and 7,999. This indicates the greatest number of times any one of the 22 modifiable channels has been manually changed. When the count exceeds 8,000, MAINT REQD is displayed. Channelization change greater than 8,000 times does not guarantee memory nonvolatility. The channel with the greatest number of changes is not viewable by the operator.

Figure 2-81. STAT Page



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	CCG STAT.
2	LFK 1	Indicates the status of the communication controller (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
	LFK 2	Indicates the status of the copilot/COTAC radio set control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
3	LFK 2 ADVISORY	Indicates BUS A, BUS B, or both to identify the failed 1553B bus.
4	LFK 3	Indicates the status of the pilot control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
	LFK 4	Indicates the status of the copilot/COTAC control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
5	LFK 3 ADVISORY	Indicates BUS A, BUS B, or both to identify the failed 1553B bus.
	LFK 4 ADVISORY	Indicates BUS A, BUS B, or both to identify the failed 1553B bus.
6	LFK 5	Indicates the status of the sensor operator control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
	LFK 6	Indicates the status of the tactical coordinator control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
7	LFK 5 ADVISORY	Indicates BUS A, BUS B, or both to identify the failed 1553B bus.
	LFK 6 ADVISORY	Indicates BUS A, BUS B, or both to identify the failed 1553B bus.
8	LFK 8	Indicates the status of the tactical coordinator radio set control indicator (“P” = Pass or “F” = Fail). Selection shows the failed SRAs.
9	LFK 8 ADVISORY	Indicates BUS A, BUS B,or both to identify the failed 1553B bus.

Figure 2-82. CCG STAT Page



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	PANEL TEST.
2	LFK 1	Selects display test.
	LFK 2	Selects key test.
3	Software version and date	The RSCI and CI software version and date of generation.
4	LFK 3	Selects line function key test.
	System test duration	Time required to complete a system test (HR: MIN: SEC format).
6	WRA status	Indicates the BIT result (normally 00).
7	Bus status	Indicates 1553B bus interface status (normally 02).
10	Scratchpad	Displays TESTING during the system test indicates remote terminal failures or a READY status at the completion of the system test.

Figure 2-83. SYS TEST Page

8. Press the MIC button and hold. A single-beep tone will be heard in approximately 1.5 seconds. When this tone is heard, the equipment is ready for cipher transmission.

9. After a tone is heard, establish two-way cipher UHF communications with a cooperating ground station and check for readability and signal strength.

10. Set the C/P switch in accordance with the tactical situation.

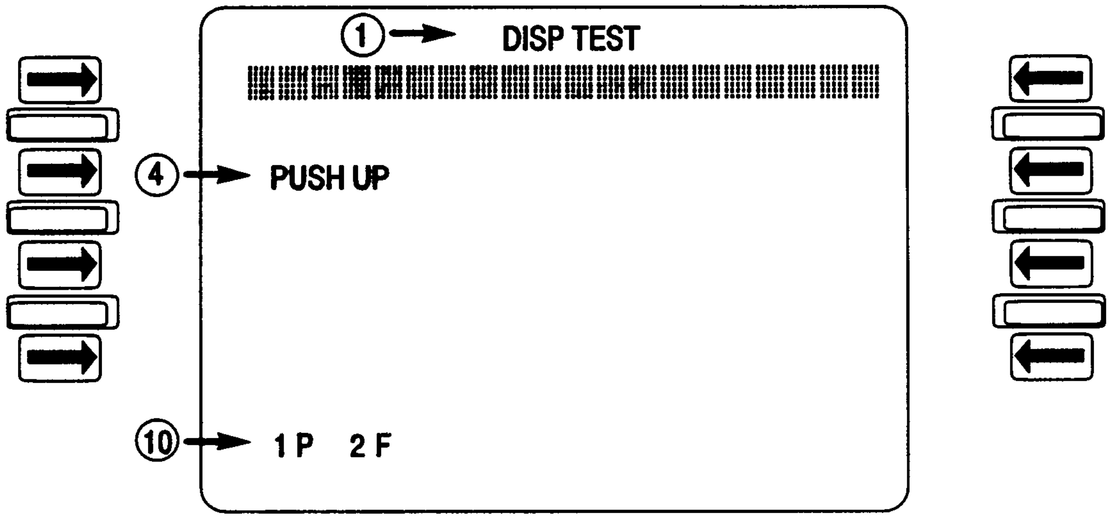
Note

If a ground check is not practical, the above procedures may be used to perform an in-flight check of the equipment.

2.21.6.1.2 Postlaunch. The speech security equipment will be operated as directed by the appropriate authority. After landing:

1. ZEROIZE switch — ZEROIZE (AS BRIEFED).

2. Function selector switch — OFF.



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	DISP TEST.
4	LFK 3	Selection cycles the pixel display line up one line per depression. After line 1 is displayed, the test cycles back to line 10.
10	Scratchpad	Initially this line illuminates all functional pixels. Upon line advance, displays a 1 P and a 2 F. This indicates that a selection of 1/2 on the keyset will send a Pass/Fail status command for the RSCI that is reflected on the CCG STAT display page. (3 RESET is displayed if conducted during a system test).

Figure 2-84. DISP TEST Page

2.21.7 HF Radio Set. The HF radio set provides long-range voice and data communication. The transceiver capabilities include:

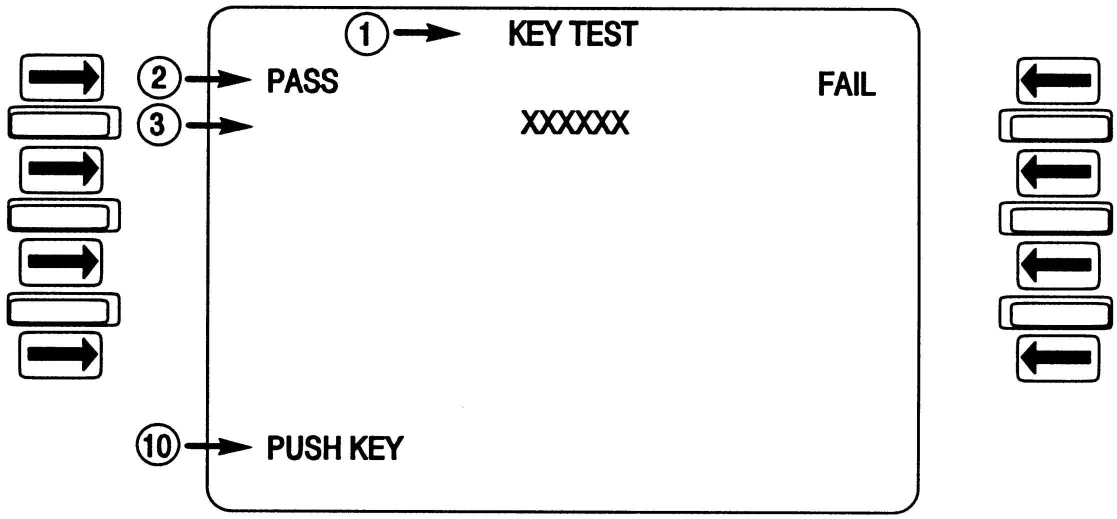
1. 2.0000 to 29.9999 MHz coverage in 280,000 channels.
2. Clear-voice or encrypted data communications
3. Noise blanking and squelch functions
4. Over-the-horizon range.

The HF transceiver provides for the following modes of communication:

1. Upper single-sideband for normal communication
2. Lower single-sideband for normal communication
3. Both sidebands for use in poor environmental conditions
4. AME for communication with a station that does not have single-sideband capability. AME is used for clear-voice communication only.

The HF transceiver accepts for transmission the following audio inputs:

1. Clear voice
2. Link-11 data
3. Secure Link-11 data.



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	KEY TEST.
2	LFK 1	Selection sends a PASS status command for the RSCI to the CCG STATUS display page.
	LFK 2	Selection sends a FAIL status command for the RSCI to the CCG STATUS display page.
3	Key Name	Displays the name of the key that was last depressed.
4	LFK 3	RESET is displayed during a system test only.
10	Scratchpad	Advisory to depress any key to test its functionality.

Figure 2-85. KEY TEST Page

WARNING

Burns or electrical shock can occur if personnel physically contact the HF radio antenna area on the tail fin when the HF radio is operating. The 1,000-watt transmitter keys automatically during a SRT procedure.

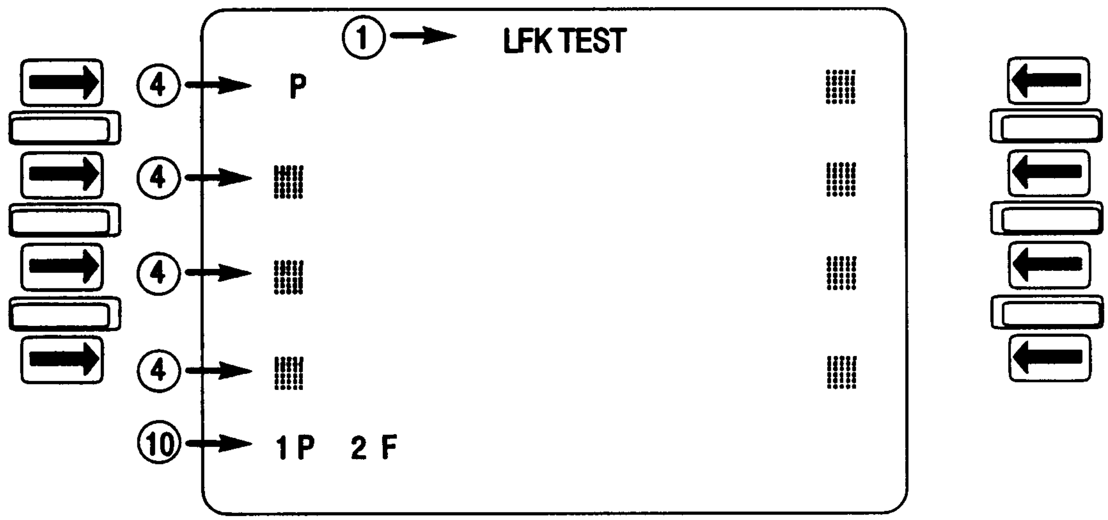
Note

There are two methods in which to couple the HF antenna. The first is by keying the HF via any MIKE switch. The second is by selecting XMIT on the CI.

Control of the HF radio is through the RSCIs HF configuration control page on the forward cockpit center console or the TACCO front panel. For HF clear voice function, the copilot/COTAC or TACCO sets up the desired controls on the RSCI. The controls involve the selection of voice mode, frequency AME, USB, or LSB. The HF secure voice mode (provision only) is controlled by the RSCI. The GPDC furnishes the data for HF data-link (clear/secure) transmissions. Refer to the RSCI configuration control page for HF control indicators and their functions.

Note

- The HF antenna coupler must be tuned to operational frequency in voice mode prior to initiating HF data-link operation.



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	LFK TEST.
2,4,6, 8	LFK 1, 2, 3, 4, 5, 6, 7, 8	Toggles between the selection of the pixel block to a P/F to indicate Pass/Fail.
10	Scratchpad	Displays a 1 P and a 2 F. This indicates that a selection of 1/2 on the keyset will send a Pass/Fail status command for the RSCI that is reflected on the CCG STAT display page. (3 RESET is displayed if conducted during a system test.)

Figure 2-86. LFK TEST Page

- When transmitting on the HF radio, the external power monitor may remove power from the aircraft because of its susceptibility to HF radiation. This problem may be avoided by routing the external power cable away from the rear of the aircraft. On the carrier deck with the aircraft wings and tail folded and with an HF transmitter frequency below 10 MHz, this power turnoff will usually occur regardless of external power cable routing.

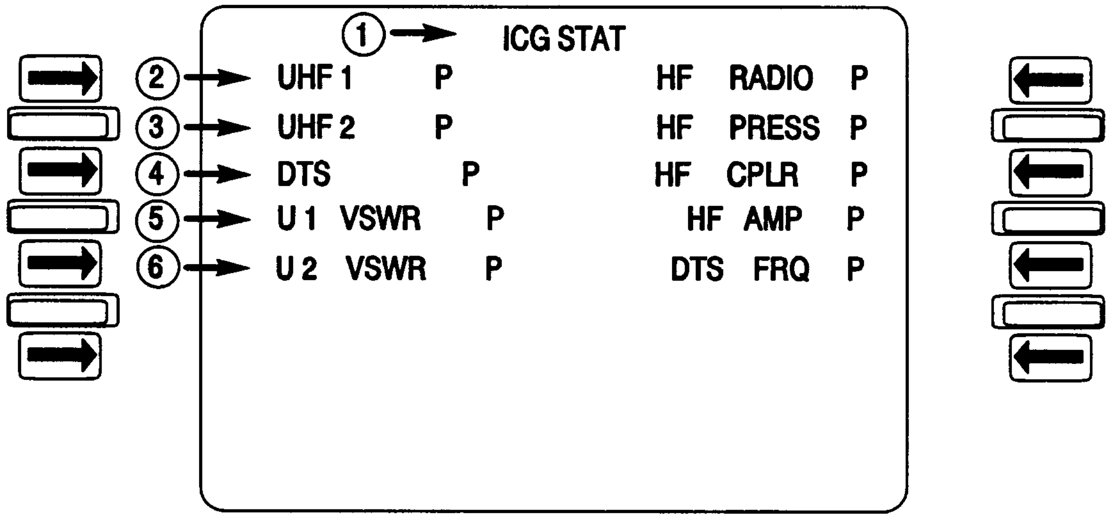
- Keying of the HF radio in the backup mode should be avoided when the coupler indicates a fault since the over-temperature circuit is overridden in this mode.

- The HF noise blanker should always be disabled unless it is desired to eliminate high-level, impulse-type noise.

- Noise may be encountered when operating the HF radio at or near 6, 12, 18, 24, and 29.9999 MHz because of interference from the 6 MHz and harmonics radiating from the GPDC Manchester multiplex channels. This may result in a small decrease in receiver sensitivity, and other frequencies should be used, if possible.

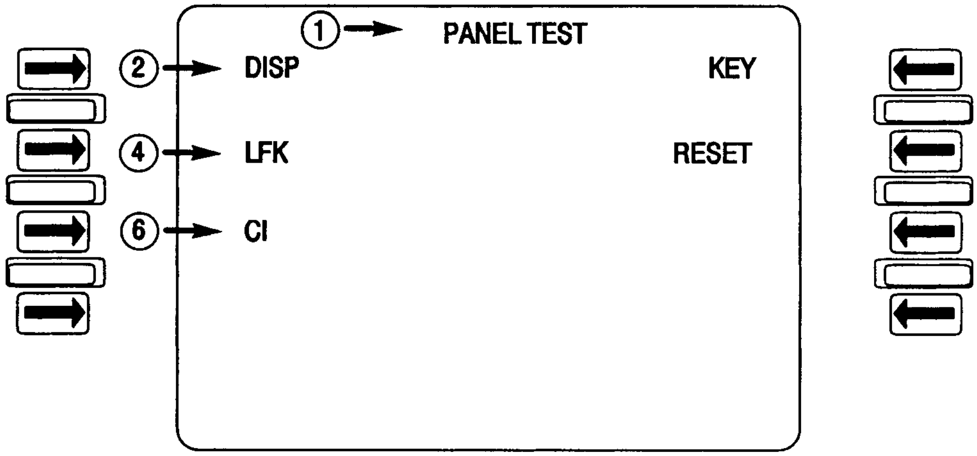
2.21.7.1 HF Radio Squelch Adjustment

1. Select the desired HF radio frequency and key the radio to tune the HF coupler. Verify that no RF signal is detectable prior to making a squelch adjustment as the setting should be made on noise only.



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	ICG STAT.
2	LFK 1	Nonfunctional LFK; indicates status of UHF-1 radio (“P” = Pass or “F” = Fail).
	LFK 2	Nonfunctional LFK; indicates status of HF radio (“P” = Pass or “F” = Fail).
3	LFK I ADVISORY	Indicates status of UHF-2 radio (“F” = Pass or “F” Fail).
	LFK 2 ADVISORY	Indicates status of HF radio coupler pressurization (“P” = Pass or “F” = Fail).
4	LFK 3	Nonfunctional LFK; indicates status of the data terminal set (‘P” = Pass or “F” = Fail).
	LFK 4	Nonfunctional LFK; indicates status of HF radio coupler (“F” = Pass or “F” = Fail).
5	LFK 5	Nonfunctional LFK; indicates status of the UHF-1 vertical standing wave ratio (“P” = Pass or “F” = Fail).
	LFK 6	Nonfunctional LFK; indicates status of the HF radio amplifier (“F” = Pass or “F” = Fail).
6	LFK 5 ADVISORY	Indicates status of the UHF-2 vertical standing wave radio (“F” = Pass or “F” = Fail).
	LFK 6 ADVISORY	Indicates status of the data terminal set frequency standard (“P” = Pass or “F” = Fail).

Figure 2-87. ICG STAT Page



LINE	CONTROL/INDICATOR	FUNCTION
1	Page Title	PANEL TEST.
2	LFK 1	Selects the radio set control indicator display test.
	LFK 2	Selects the radio set control indicator keyset test.
4	LFK 3	Selects the line function key test.
	LFK 4	Selection resets the status of the radio set control indicator to “P” (pass).
6	LFK 5	Selects the control indicator test page.

Figure 2-88. PANEL TEST Page

2. Select the HF configuration and control page on the RSCI.

3. Toggle the HF squelch control full down and adjust HF radio volume to the desired message level.

4. Toggle the HF squelch full up. The HF radio noise will disappear in approximately 5 seconds.

5. Toggle the HF squelch down, one step at a time, until the radio noise returns.

6. Toggle the HF squelch one step up. The HF radio noise will disappear in approximately 5 seconds. This is the correct HF squelch setting.

Note

When listening to a very weak signal it may be desirable to advance the squelch control one step down and have some noise present in the headset.

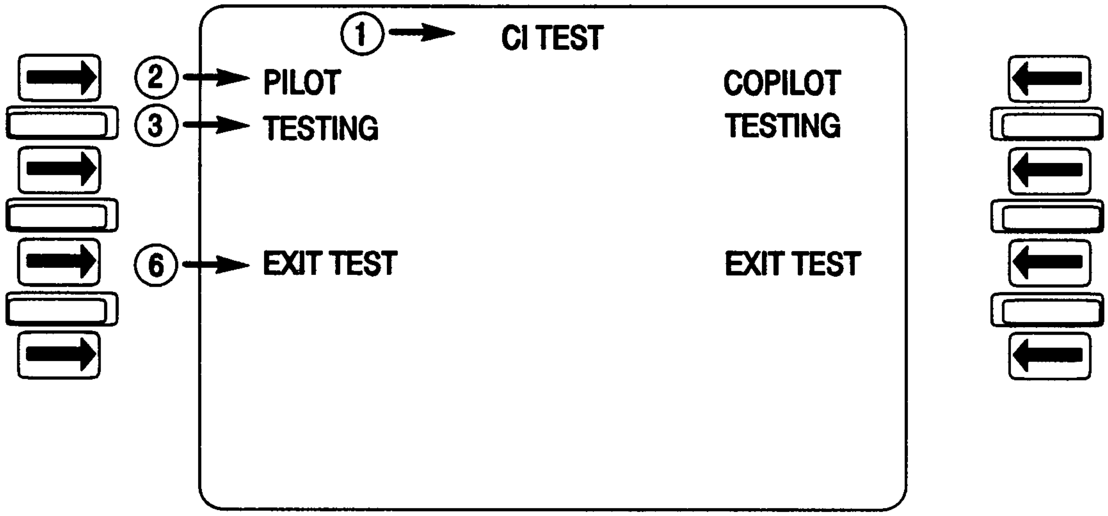
2.22 NAVIGATION SYSTEM

The navigation system provides precision, long-range, point-to-point navigation; airways and terminal navigation; short-range tactical navigation; radar altitude and low-altitude warning; and reference data for tactical subsystems. In general, the aircraft navigation system consists of the following:

1. FDIs (EDIs on aircraft incorporating AFC-279) to display navigation, heading, and attitude information

2. CAINS for precision long-range operation (CAINS II on aircraft incorporating AFC-279)

3. AHRS to provide a backup source of heading and attitude information to supplement the INS (on aircraft not incorporating AFC-279)



LINE	CONTROL/INDICATOR	FUNCTION
I	Page Title	CI TEST
2	LFK 1	Selection initiates pilot or SENSO CI test depending on if it is the front or rear RSCI.
	LFK 2	Selection initiates copilot/COTAC or TACCO CI test depending on if it is the front or rear RSCI.
3	LFK 1	Indicates TESTING if the CI test is currently running on the LFK 1 CI.
		Indicates TESTING if the CI test is currently running on the LFK 2 CI.
6	LFK 5	Selection allows termination of LFK 1 CI test. EXIT TEST is not displayed if test is not in progress.
	LFK 6	Selection allows termination of LFK 2 CI test. EXIT TEST is not displayed if test is not in progress.

Figure 2-89. CI TEST Page

4. Doppler radar to provide groundspeed and drift angle information (on aircraft not incorporating AFC-279)

5. Tacan set to provide short-range position information from a ground- or ship-based station

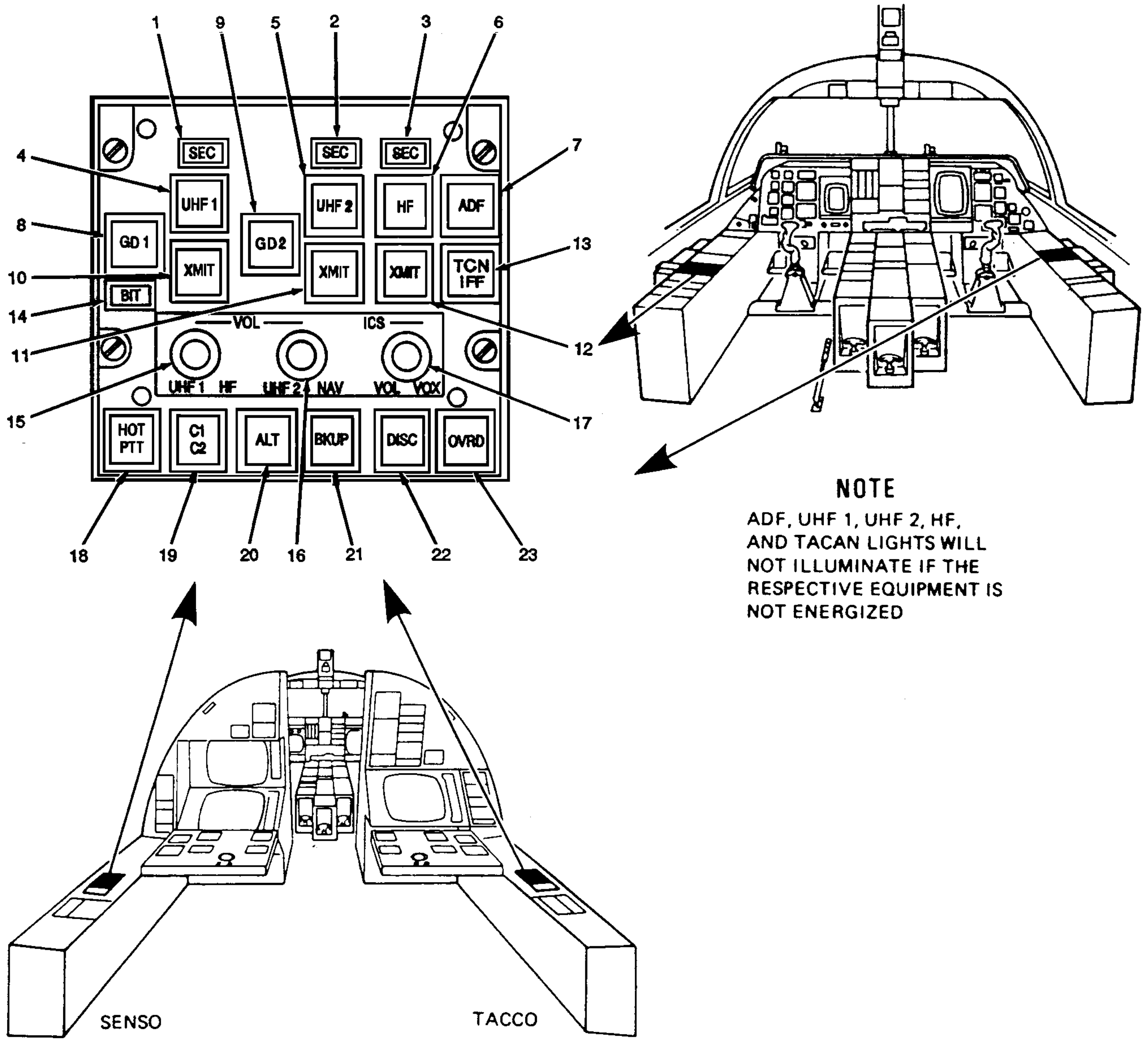
6. LF-ADF set to provide bearing information from conventional low-frequency ground stations

7. UHF direction finder to provide bearing information for navigation and tactical use

8. RAAWS to provide an accurate altitude signal and an automatic altitude warning signal if the aircraft descends below a preset altitude (aircraft not incorporating AFC-279)

9. SCADC for processing air pressure and temperature data to provide true airspeed and Aircraft heading (true or magnetic)

10. GPS will provide flight plan database, waypoint steering, and navigation parameter data.



LINE	CONTROL/INDICATOR	FUNCTION
1	UHF-1 secure light	Indicates UHF-1 is in a secure mode and secure equipment is on.
2	UHF-2 secure light	Indicates UHF-2 is in a secure mode and secure equipment is on.
3	HF secure light	Indicates the HF is in a secure mode and secure equipment is on.
4	UHF-1 switch light	Selects/deselects UHF-1 radio monitoring.
5	UHF-2 switch light	Selects/deselects UHF-2 radio monitoring.
6	HF switch light	Selects/deselects HF radio monitoring.
7	ADF switch light	Selects/deselects ADF monitoring.

Figure 2-90. Control Indicator (Sheet 1 of 3)

LINE	CONTROL/INDICATOR	FUNCTION
8	GD 1 switch light	Selects/deselects UHF-1 Guard radio for monitoring at the pilot and copilot/COTAC stations only. The TACCO and SENSO stations merely indicate whether UHF-1 Guard has been selected for monitoring by all stations.
9	GD 2 switch light	Selects/deselects UHF-2 Guard radio for monitoring at the pilot and copilot/COTAC stations only. The TACCO and SENSO stations merely indicate whether UHF-2 Guard has been selected for monitoring by all stations.
10	UHF-1 XMIT switch light	Selects the UHF-1 radio for transmission and automatically deselects XMIT on all other radios. If UHF-1 was previously unmonitored, then UHF-1 is selected for monitoring.
11	UHF-2 XMIT switch light	Selects the UHF-2 radio for transmission and automatically deselects XMIT on all other radios. If UHF-2 was previously unmonitored, then UHF-2 is selected for monitoring.
12	HF XMIT switch light	Selects the HF radio for transmission provided the antenna has already been coupled. If the antenna needs to be coupled, then selection automatically couples the antenna. The switchlight may go unlit for up to 10 seconds before display of amber (successful couple) or green (unsuccessful couple).
13	TCN/IFF switch light	Selects the TACAN audio for monitor with the first depression if it is available. The second depression selects the IFF audio if it is available. The third depression deselects all audio.
14	BIT light	Illuminates to indicate a failure in the CI. The system status pages should be checked for SRA failures and a CI test upon return from flight.
15	UHF-1/HF concentric volume controls	The inner knob adjusts UHF-1 radio volume, and the outer adjusts HF radio volume.
16	UHF-2/NAV concentric volume controls	The inner knob adjusts UHF-2 radio volume, and the outer adjusts navigation audio volume.
17	ICS concentric controls	The inner knob adjusts the ICS volume, and the outer knob adjusts the VOX sensitivity.
18	HOT/PTT switch light	First depression causes HOT to go from amber to green and PTT to go from green to amber indicating the press-to-talk mode. Second depression reverses this procedure to return to HOT mike mode.
19	C1/C2 switch light	First depression causes Cl to go from amber to green and C2 to go from green to amber indicating conference 2. Second depression reverses this procedure to return to conference 1.
20	ALT switch light	When depressed, the switchlight goes from green to amber and puts the pilot and copilot/COTAC (or TACCO and SENSO) headsets and microphones in parallel. The ICS modes of the crewmember who selects ALT are controlled by the adjacent CI.

Figure 2-90. Control Indicator (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
21	BKUP switch light	Selects the backup radio. The pilot switch selects UHF I in the clear voice mode using the bottom antenna with frequency control from the UHF I off-line control panel. The copilot/COTAC switchlight selects the HF in the clear voice mode using the USB with the frequency controlled by the preflight inserted frequency on the front of the CC. If the CC loses primary power, the system reverts to backup operation automatically. However, pilot and copilot/COTAC BKUP switchlights do not automatically become amber. During backup operation, the pilot headset and microphone are connected to the UHF-1 radio and the copilot/COTAC headset is similarly connected to the HF radio. ICS can be selected by depressing OVRD. During backup operation, only the pilot can transmit and monitor UHF-1 and only the copilot/COTAC can transmit and monitor the HF. The TACCO and SENSO BKUP switchlights have no function. **Note** Operation in BKUP (condition) could lead to RF interference with the DLC. Uncontrolled pitch maneuvers could result.
22	DISC switch light	When depressed, it goes from green to amber, other ICS functions go unlit, and only the radio inputs are heard. Crewmembers may break in with the OVRD switchlight.
23	OVRD switch light	When depressed, it goes from green to amber, all CI lights go unlit, and a hardwire connection of ICS is accomplished. This may be used to break in on a crewman in DISC or in BKUP. Audio level is increased 6 dB over the normal volume setting at each station. On second push, the switchlight goes back to green (normal).

Figure 2-90. Control Indicator (Sheet 3)

11. With AFC-279, EGI to provide aircraft latitude and longitude, attitude reference, and heading reference.

12. With AFC-279, two CDNUs to provide display of navigation data, flight plan database, and selection and control of navigation systems.

2.22.1 Flight Displays and Interface System (Aircraft Not Incorporating AFC-279). The FDIS consists of two sets of flight displays, one set each for the pilot and copilot/COTAC (see Figure 2-91), a control panel for each, and an interface unit. The flight displays are an HSI and VDI that display navigation, heading, and attitude information. Navigation display selectors (see Figure 2-92) provide control for selecting the various modes for display on the pilot and copilot/COTAC HSIs and VDIs. The interface unit is the navigation data converter repeater. Its function is to provide interfacing for the flight displays, AFCS, and GPDC. Additionally, an AUX NAV select panel provides an operator interface between the GPS/Tacan and the FDIS. (See FO-17 and FO-18 for flight display and interface system diagram.)

The flight displays will provide the following information to the pilot and copilot/COTAC:

1. Aircraft attitude
2. Vertical and lateral displacement (ACLS or ILS)
3. Tacan/GPS waypoint distance and bearing
4. Fly-to-point course, distance, and bearing
5. Course deviation
6. True airspeed and groundspeed
7. UHF/DF and LF/DF bearing
8. Heading commands
9. Aircraft track.

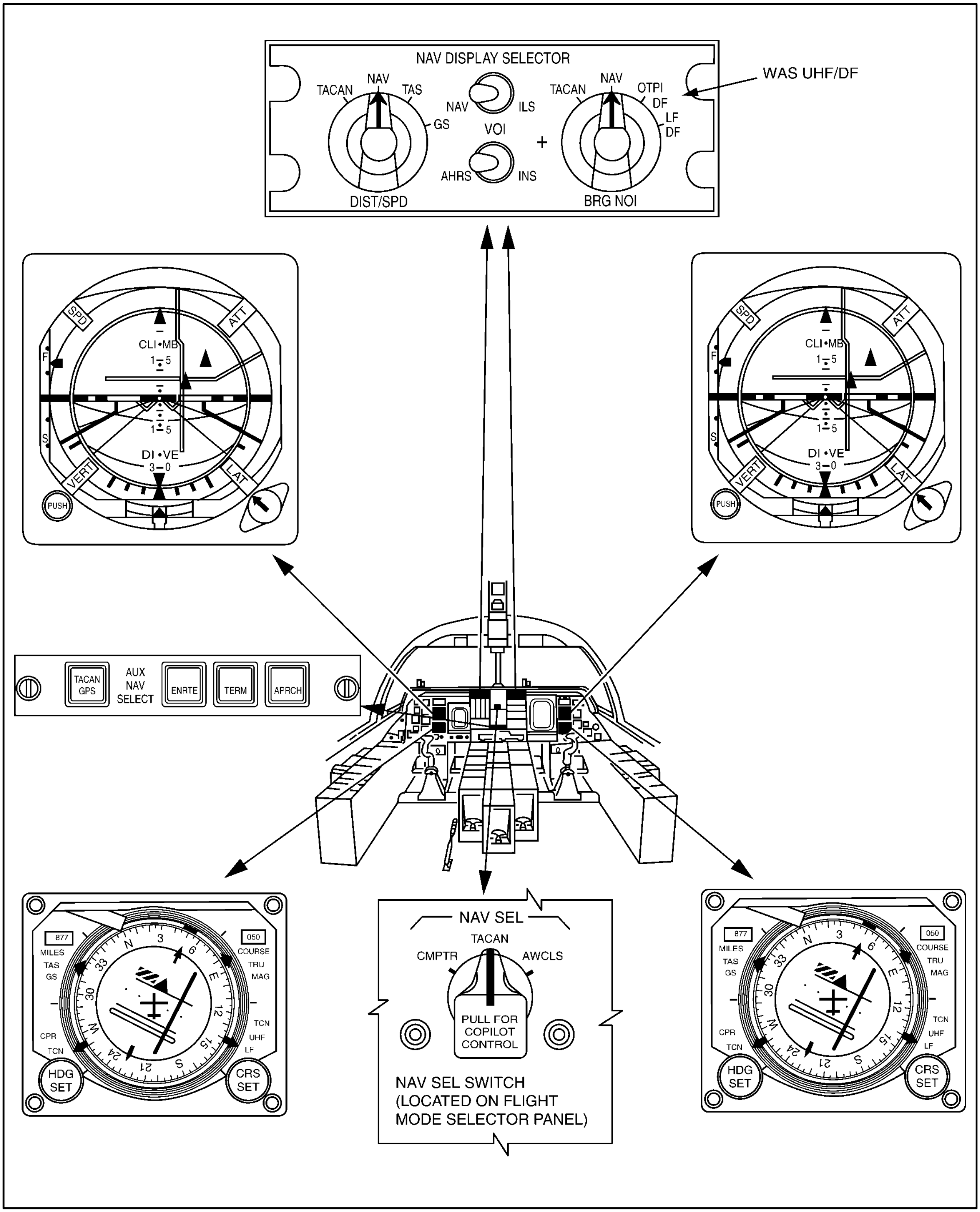


Figure 2-91. Flight Display Interface System

2.22.1.1 Vertical Director Indicator (Aircraft Not Incorporating AFC-279). A separate VDI (see Figure 2-93) is provided on the pilot and copilot/COTAC instrument panels. The indicators are identical and furnish a visual display of aircraft attitude and error signals. Pitch and roll attitude is read as a displacement of the pitch and roll sphere.

The amount of pitch (in degrees) can be determined by comparing the graduated scale on the sphere with the miniature aircraft symbol on the face of the instrument. The amount of roll is determined by comparing the roll (bank) angle pointer against the fixed bank angle scale. The INS or AHRS, selected on the navigation display selector panel, is the source for pitch and roll attitude information (see Figure 2-92).

Vertical deviation from glideslope is displayed by displacement of the vertical deviation pointer in respect to the fixed vertical scale. Lateral deviation from localizer is displayed by displacement of the lateral deviation pointer in respect to the fixed horizontal scale. The ACLS or ILS is the signal source for vertical and lateral displacement. When the AWCLS mode is selected at the flight mode selector panel, the ACLS is the signal source when the VDI toggle switch is in the NAV position; the ILS is the signal source when the VDI toggle switch is in the ILS position. Rate-of-turn indications are provided by the rate-of-turn pointer, which moves right or left in response to a signal from the rate-of-turn gyro.

The rate of turn (turn needle) can indicate accurately up to a standard rate (2 minutes) turn. This is indicated when the turn needle is aligned with either white portion of the scale. A one-half standard rate (4 minutes) turn is indicated when the needle is aligned with either black portion of the scale. The slip indicator is collocated with the turn needle at the bottom of the VDI.

Separate warning flags are provided on the VDI for lateral deviation, vertical deviation, attitude, and speed. The flags will come into view in case of a malfunction, unreliable signal, or power failure.

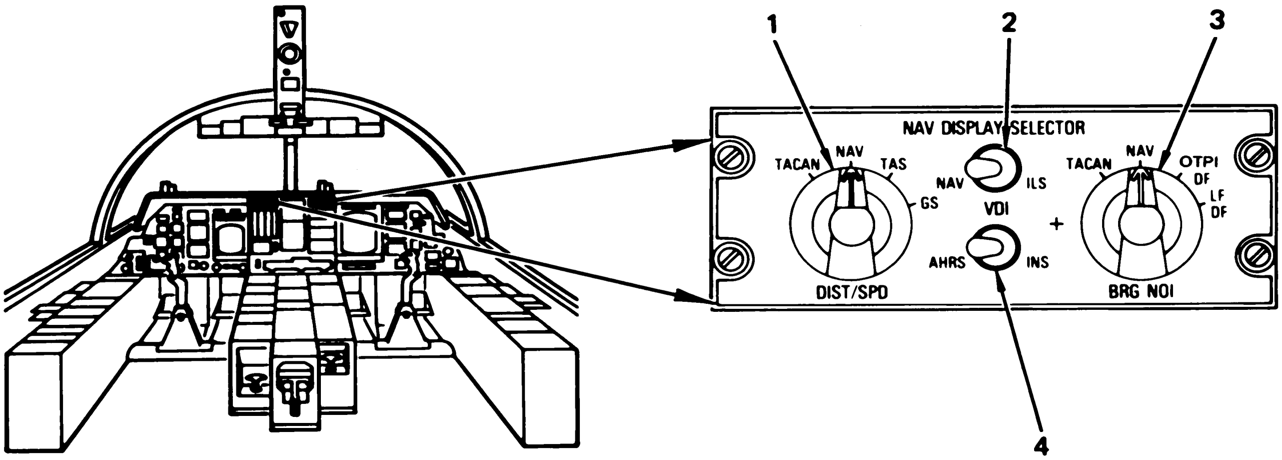
Note

BuNo 159758 and subsequent and aircraft incorporating AFC-93 have logic added between the ACLS and the NDCR that drives the VDI needles off scale and the flags on scale in the absence of error signals.

2.22.1.2 Horizontal Situation Indicator (Aircraft Not Incorporating AFC-279). The HSI (see Figure 2-94) presents a plan view of the navigation situation as if the pilot were looking down from above the aircraft. It uses navigation data from various sources to present the pilot with a symbolic display of the horizontal navigation situation. The operator may select any of the following for display.

DISTANCE	SPEED	BEARING	COURSE DEVIATION
TACAN	GS	TACAN	TACAN
FTP	TAS	FTP	FTP
GPS WPT		UHF-DF	GPS WPT
		LF-DF	
		GPS	
		WPT	

Annunciator lights illuminate on the HSI to indicate which of the above modes is being presented by the respective indicator. In addition, the No. 2 needle presents a continuous readout of aircraft ground track. The operator has the option of selecting either AHRS or INS as a heading and attitude source with the AHRS-INS switch on the navigation display selector panel (see Figure 2-92). When AHRS is selected, the compass card will indicate magnetic headings and all bearings, courses, and ground tracks will also be magnetic indications. True heading, bearings, courses, and ground tracks will be indicated only when INS is selected and the NAV SEL switch on the flight mode selector panel is in the CMPTR position. When either the TACAN or AWCLS positions are selected with the NAV SEL switch, the compass card is forced into a magnetic display. The HDG SET (heading set) knob is used to vary the heading marker with respect to the compass card and select a heading to which the aircraft will fly when the heading-select mode of the AFCS is engaged. If the NAV SEL switch is pushed in, the pilot HSI becomes the master controller and, as the pilot moves the heading marker on his HSI, the heading marker on the copilot/COTAC HSI will move to a corresponding position. If the NAV SEL switch is pulled out, the copilot/COTAC HSI becomes the master controller and, as he moves the heading marker in his HSI, the marker on the pilot HSI moves. One HSI always becomes the master controller; there can be no independent heading marker selection by either pilot.



INDEX	CONTROL/INDICATOR	FUNCTION
1	DIST/SPD (rotary switch)	TACAN — displays distance to the selected tacan station. Distances of less than 100 NM are indicated to the nearest tenth of a mile. Distances of 100 NM or greater are indicated to the nearest mile. NAV — if the NAV SEL switch is in the CMPTR position, displays distance along a GPDC computed course to the highest priority fly-to-point. Distances of 32 NM or greater are indicated to the nearest mile. Distances less than 32 NM are indicated to the nearest tenth of a mile. If the NAV SEL switch is in the TACAN or AWCLS position, displayed distance to the selected tacan station is as in TACAN above. TAS — displays TAS in knots as computed by the SCADC (Channel No. 1 for pilot HSI, channel No. 2 for copilot/COTAC HSI). GS — displays ground speed in knots from the GPDC if INS mode selector is in OFF or INCOS position, otherwise from the INS. **Note** All of the above readouts appear in the DIST/SPD window of the HSI.
2	NAV/ILS (toggle switch)	NAV — selects ACLS (ASW-25) for display on VDI deviation needles. ILS — selects CILS (ARA-63) for displays on VDI deviation needles. **Note** The needles will not be displayed unless the NAV SEL switch is in AWCLS position.

Figure 2-92. Navigation Display Selector Panel (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
3	BRG NO 1 (rotary switch)	TACAN — displays bearing to selected tacan station. NAV — displays bearing to the highest priority fly-to-point when NAV SEL switch is in CMPTR position. Otherwise, displays tacan bearings. OTPI DF — displays bearings to selected UHF station when DF selected on the RSCI panel. LF DF — displays bearing to selected LF station. **Note** All bearings are displayed on the No. 1 needle. Bearings are magnetic when the compass card is indicating magnetic and are true when the compass card is indicating true.
4	AHRS/INS (toggle switch)	AHRS — selects AHRS as the heading/attitude source. INS — selects INS as the heading/attitude source. **Note** • Magnetic heading is displayed when AHRS is selected or when INS is selected and the NAV SEL switch is in either TACAN or AWCLS position. True heading is displayed only when INS is selected and the NAV SEL switch is in CMPTR position. • The copilot/COTAC selector also determines the source of attitude information used for stabilization of the AN/APS-137(V) radar antenna and, unless the NDCR channel 1 has failed, the source of magnetic heading for input to the tacan.

Figure 2-92. Navigation Display Selector Panel (Sheet 2)

All bearing information is presented by the No. 1 needle. Bearing can be to a tacan station, a UHF transmitter, an LF transmitter, a GPS waypoint, or a GPDC FTP depending on the selections made on the navigation display selector panel and the flight mode selector panel. Bearing will be to a tacan station when either of the following conditions are met:

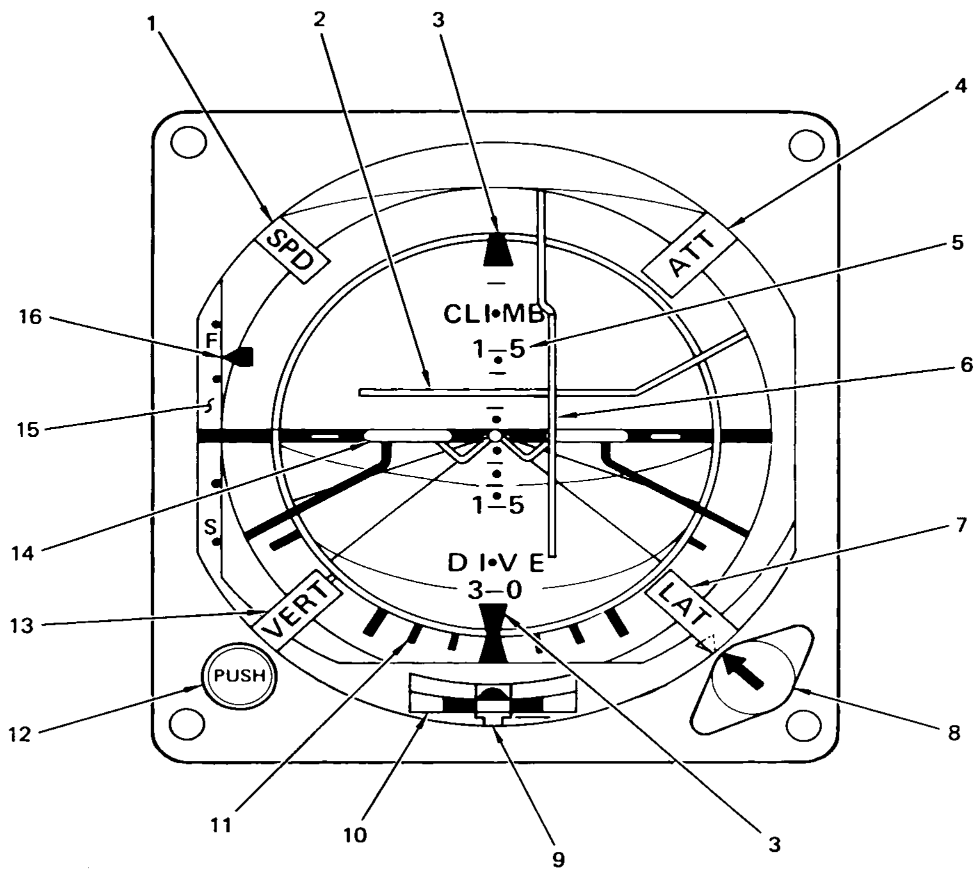
1. TACAN selected with the BRG No. 1 Switch.
2. NAV selected with the BRG No. 1 switch and the NAV SEL switch in the TACAN or AWCLS position.

Bearing will be to a FTP only if both of the following conditions are met:

1. NAV is selected with the BRG No. 1 switch.
2. CMPTR is selected with the NAV SEL switch.

Note

- UHF or LF bearing will be displayed when the respective position is selected on the BRG No. 1 switch regardless of the position of the NAV SEL switch.
- Bearing will be to a GPS waypoint only if both of the following conditions are met:
    1. GPS is selected with the AUX NAV SELECT panel TACAN/GPS switch.
    2. FLIGHT MODE SELECTOR panel NAV SEL switch is in the TACAN or AWCLS position.



INDEX	CONTROL/INDICATOR	FUNCTION
1	SPD (speed warning flag)	Indicates information to the speed pointer is not valid.
2	Vertical (elevation) deviation pointer	Indicates vertical error from ACLS or ILS glideslope.
3	Roll index	Provides roll indication when referenced to roll scale graduations.
4	ATT (attitude warning flag)	In view, indicates attitude information being supplied to the indicator is not valid.
5	Pitch scale	Provides pitch attitude reading.
6	Lateral (azimuth) deviation pointer	Indicates lateral error from ACLS or ILS centerline.
7	LAT (lateral deviation warning flag)	In view, indicates lateral deviation information is not valid.
8	Pitch trim knob	Moves pitch attitude scale.
9	Rate of turn pointer	Indicates turn rate. Alignment of the pointer with the white portion indicates a standard rate (3° per second) 2-minute turn.
10	Inclinometer	Indicates slip or skid.
11	Roll scale	A graduated scale providing roll indication when used in conjunction with the roll index.

Figure 2-93. Vertical Director Indicator (Aircraft Not Incorporating AFC-279) (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
12	PUSH (push-to-test) switch	Provides the following test indications: 45° pitch up, 45° right roll, lateral deviation to 1/2 scale right, vertical deviation to 1/2 scale up, speed error up to first dot, and all flags out of view. **Note** This switch also causes the HSI to indicate 45° heading, one dot to the right on the course deviation indicator, and all fail flags out of view. This switch is used during preflight and any time the pilot or copilot/COTAC suspects an HSI or VDI malfunction.
13	VERT (vertical deviation warning flag)	In view, indicates vertical deviation information is not valid.
14	Aircraft symbol	Provides orientation reference.
15	Speed error scale	Indicates error of auto thrust system (controlled by auto thrust switch on the flight mode selector panel) in IAS hold mode.
16	Speed error pointer	Indicates deviation from the reference indicated airspeed (IAS). Full scale deflection equals 10 knots.

Figure 2-93. Vertical Director Indicator (Aircraft Not Incorporating AFC-279) (Sheet 2)

Speed is displayed as both true airspeed and groundspeed. True airspeed is displayed as derived from the SCADC when TAS is selected with the DIST/SPD switch. When GS is selected, groundspeed is displayed in knots from the GPDC if the INS mode selector is in the OFF or INCOS position, otherwise from the INS. Distance is displayed as a digital readout to a tacan station, a GPS waypoint, or FTP depending on the selections made with the DIST/SPD switch on the NDS panel and the NAV SEL switch on the flight mode selector panel. Tacan distance will be displayed under either of the following conditions:

1. TACAN is selected with the DIST/SPD switch.
2. NAV is selected with the DIST/SPD switch and the NAV SEL switch on the flight mode selector panel is in either the TACAN or AWCLS position.

Tacan distance will be displayed to the nearest whole mile at distances of 100 nm or greater and to the nearest tenth of a mile at distances of less than 100 nm. Distance to a FTP will be displayed only when both of the following conditions are met:

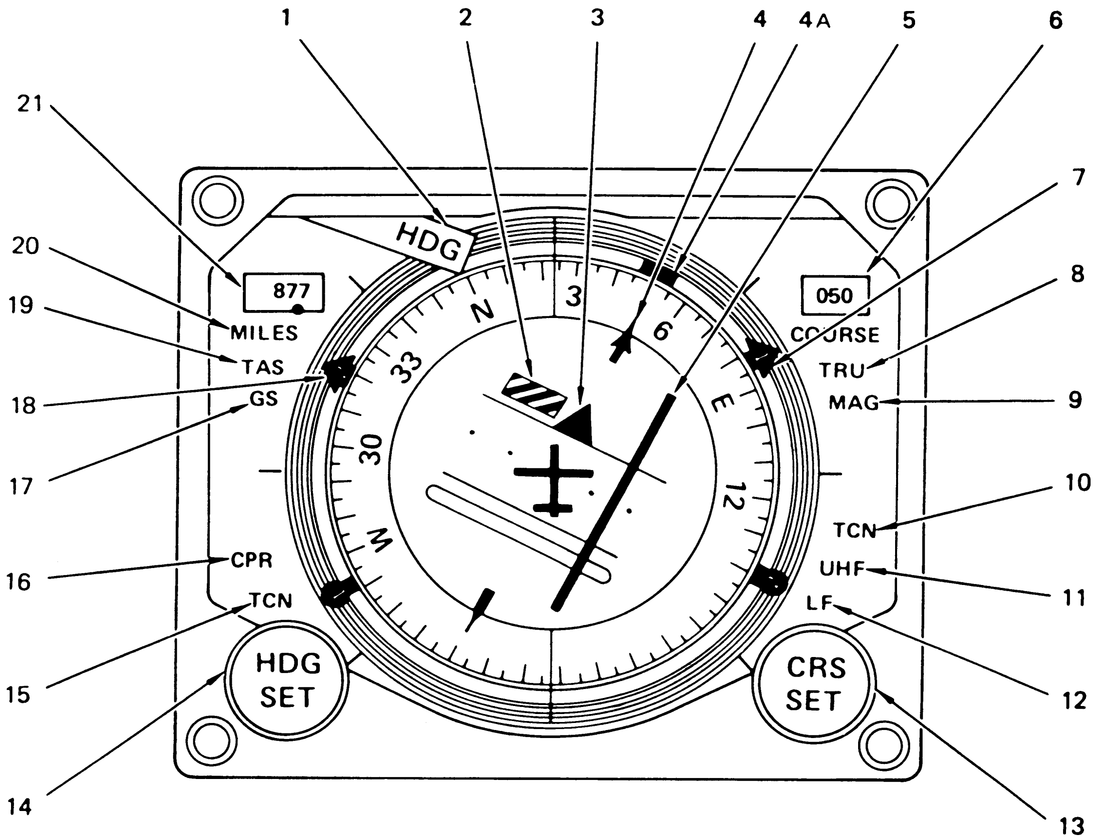
1. NAV is selected on the DIST/SPD switch.
2. CMPTR is selected with the NAV SEL switch.

FTP distance will be displayed to the nearest whole mile for distances of 32 nm or greater and to the nearest tenth of a mile for distances of less than 32 nm.

Note

GPS waypoint distance will be displayed to the nearest whole mile at distances of 100 nm or greater and to the nearest tenth of a mile at distances of less than 100 nm. Distance to a GPS waypoint will be displayed only when the following conditions are met:

1. GPS is selected with the AUX NAV SELECT panel TACAN/GPS switch.
2. FLIGHT MODE SELECTOR panel NAV SEL switch is in the TACAN or AWCLS position.
3. TACAN is selected with the DIST/SPD switch.



INDEX	CONTROL/INDICATOR	FUNCTION
1	HDG (heading flag)	Indicates that heading information is invalid.
2	Navigation fail flag	Indicates failure of the CDI-displayed navigation source, the NDCR channel, or the CDI.
3	To-From flag	Indicates "to" the tacan, GPS waypoint, or fly-to-point when it is pointing to the head of the course command arrow: indicates "from" when it is pointing towards the tail of the course command arrow.
4	Course command arrow	Indicates true or magnetic course as set by the CRS SET knob, GPDC, or desired track while in GPS mode.
4A	Heading select marker	Indicates heading to which aircraft will turn when AFCS heading select mode is engaged.
5	Course deviation bar	Indicates angular displacement from tacan radials or the lateral crosstrack error from the GPDC or GPS reference ground track. The dots represent 5 degrees/doi with tacan and 1000 yards/dot with the GPDC. With GPS, the deviation equals ± 2 nm/dot in the en-route mode, ± 0.50 nm/dot in the terminal mode, or ± 300 yards/dot in the approach mode.
6	Course window	Displays course to the nearest degree. Indicates same value as course command arrow.

Figure 2-94. Horizontal Situation Indicator (Aircraft Not Incorporating AFC-279) (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
7	No. 1 bearing pointer	Displays bearing to a selected tacan, UHF, LF station, GPS way-point, or GPDC fly-to-point.
8	TRU (true)	Indicates the HSI heading. No. 1 and No. 2 needles, and the course pointer are all referenced to true north. Navigation display selectors must be in INS position, and the flight mode selector NAV SEL switch must be in CMPTR position.
9	MAG (magnetic)	Indicates the HSI heading. No. 1 and No. 2 needles, and the course pointer are all referenced to magnetic north.
10	TCN (tacan)	When illuminated, indicates tacan bearing is displayed on No. 1 bearing pointer.
11	UHF (ultra high frequency)	When illuminated, indicates UHF bearing is displayed on No. 1 bearing pointer.
12	LF (low frequency)	When illuminated, indicates LF bearing is displayed on No. 1 bear-ing pointer.
13	CRS SET knob	Allows the pilot or copilot/COTAC (depending upon flight mode se-lector NAV SEL switch in/out position, respectively) to move and set both HSI course pointers and course windows. This knob is in-operative when the NAV SEL switch is in the CMPTR position or when GPS is selected on the AUX NAV SELECT panel TACAN/GPS switch.
14	HDG SET knob	Allows the pilot or copilot/COTAC (depending upon flight mode se-lector NAV SEL switch in/out position, respectively) to move and set both HSI heading select markers.
15	TCN (tacan)	When illuminated, indicates that the distance/speed window mile-age is being generated by the tacan.
16	CPR (computer)	When illuminated, indicates that the distance/speed window data are being generated by the GPDC.
17	GS (ground speed)	When illuminated, indicates that the distance/speed window is dis-playing GS in knots.
18	No. 2 bearing pointer	Displays ground track from the GPDC if INS mode selector is in OFF or INCOS position, otherwise from the INS.
19	TAS (true airspeed)	Indicates that the distance/speed window is displaying TAS.
20	MILES	Indicates that the distance/speed window is displaying nautical miles.
21	Distance/speed window	Displays mileage in nautical miles or speed in knots. The decimal point illuminates for distances less than 32 nautical miles when GPDC distance is displayed and for distances less than 100 nauti-cal miles when tacan or GPS distance is displayed.

Figure 2-94. Horizontal Situation Indicator (Aircraft Not Incorporating AFC-279) (Sheet 2)

The HSI course command arrow repeats the course selected in the course window on the compass card. Courses may be selected by using the CRS SET knob when the NAV SEL switch is in either the TACAN or AWCLS position, in which case the system is used as a normal course deviation indicator. If the NAV SEL switch is pushed in, the pilot CRS SET knob controls the course command arrows and course windows in both HSIs. If it is pulled out, the copilot/COTAC has control. When the NAV SEL switch is in the CMPTR position, command control is passed to the GPDC, which provides course commands to the highest priority FTP. In this mode, the CRS SET knob is inoperative. The CRS SET knob is also inoperative when GPS is selected with the AUX NAV SELECT panel TACAN/GPS switch. Course deviation information in either instance is provided by the course deviation bar. Deviation indicated from tacan courses will be 5° per dot, while deviation from FTP track will be 1,000 yards per dot. With GPS, the deviation depends on the flight mode. The deviation is (2 nm/dot in the en-route mode, ±0.50 nm/dot in the terminal mode, or ±300 yards/dot in the approach mode.

A to-from indication is provided by the “to-from” flag or triangle, relative to the course command arrow. When it is pointing at the head of the course command arrow, a to is indicated, and when it is pointing at the tail, a from is indicated. A navigation fail flag will be presented when one of the following occurs:

1. The course deviation indicator (CDI) fails.

2. The navigation source selected for display on the CDI becomes invalid.

3. A NDCR fails (No. 1 pilot HSI or No. 2 copilot/COTAC HSI, as selected).

The HDG flag will be presented if the heading/attitude source selected for display on the HSI becomes invalid.

2.22.1.3 AUX NAV SELECT Panel (Aircraft Not Incorporating AFC-279). The AUX NAV SELECT panel (see Figure 2-95) provides an interface between the GPS/tacan and the FDIS. When TACAN is selected on the TACAN/GPS switch, tacan-referenced data are displayed on the HSIs. When GPS is selected on TACAN/GPS switch, GPS-referenced data are displayed on the HSIs. The ENRTE, TERM, and APRCH annunciators indicate that the en-route, terminal, or approach flight mode has been selected on the FLT PLN page of the CDNU when GPS is selected on the AUX NAV SELECT panel.

2.22.2 Flight Display and Interface System (Aircraft Incorporating AFC-279). The FDIS consists of two sets of electronic flight instruments (EFIs); one set each for the pilot and copilot/COTAC, two nav display selector panels for the pilot and copilot/COTAC (see Figure 2-96), and a navigation interface unit (NIU). Each set of electronic flight instruments consists of an HSI and VDI that display navigation, heading, and attitude information, and an EFI control panel to control the data presented on the HSI and VDI. Each nav display selector panel also provides control for selecting various modes for display on the respective HSI/VDI. The navigation interface unit serves as the central interface for the AFCS, GPDC, peripheral navigation subsystems, and the EFIs. (See FO-17 for the Flight Display and Interface System diagram.)

The EFIs provide the following information to the pilot and copilot/COTAC:

1. Aircraft heading (true or magnetic)

2. Aircraft attitude

3. Vertical and lateral displacement (ACLS or CILS)

4. TACAN distance and bearing

5. Fly-to-point course, distance, and bearing

6. Course deviation

7. True airspeed and groundspeed

8. UHF/DF and LF/DF bearing

9. Heading commands

10. Aircraft track.

2.22.2.1 Electronic Flight Instruments (Aircraft Incorporating AFC-279). The EFIs (see Figure 2-96) provide a visual display of the data provided by the NIU. Each EFI functions as an HSI or a VDI, depending on the selection on the EFI control panel. The normal configuration is VDI displayed on the upper EFI and HSI displayed on the lower EFI.

The EFI that operates as an HSI (see Figure 2-97) provides the pilot and copilot/COTAC with heading, bearing, course deviation, airspeed, groundspeed, distance, validity, heading select marker, course command arrow, and bearing pointer No. 1 indications. Invalid data cause the respective data display area to be blank. The data displayed are dependent upon the selections made on the CDNUs, navigation display selector (NDS) panel, flight mode selector panel (FMSP), EFI control panel, and source availability.

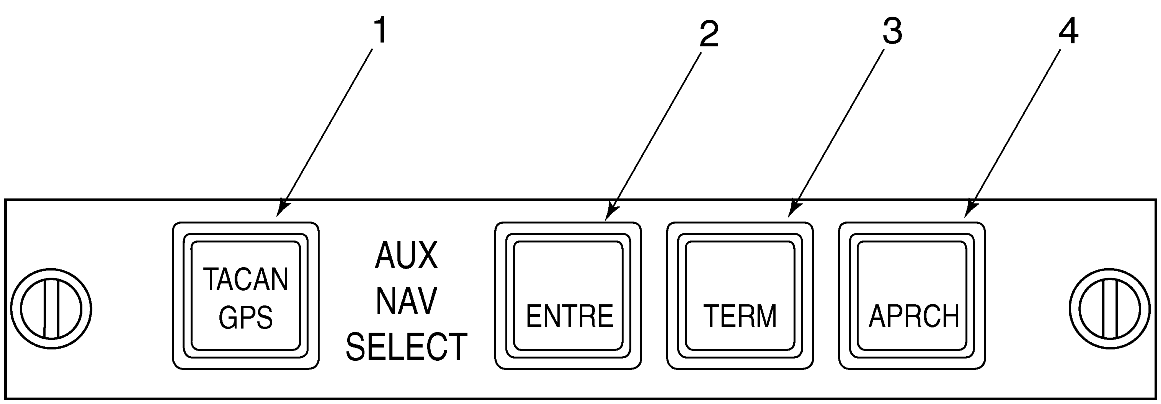
Heading information is displayed on the HSI/VDI heading indicators. The source of this data is the EGI, CAINS, or remote compass transmitter (RCT). The HDG switch on the EFI control panel is used to vary the heading select marker with respect to the compass card. Selected heading is also displayed as a digital readout. True or magnetic heading is displayed, depending on NDS and FMSP switch settings (see Figure 2-98).

Bearing information is displayed by bearing pointer No. 1. The bearing is to a TACAN station, GPDC fly-to-point, CDNU waypoint, or UHF transmitter, depending on the selections made on the NAV DISPLAY SELECTOR panel and the flight mode selector panel. Bearing is to a TACAN station when the following condition is met:

1. STBY is selected on the DF BRG No. 1 switch and TACAN is selected on the BRG/DIST NO. 1 switch on the NAV DISPLAY SELECTOR panel.

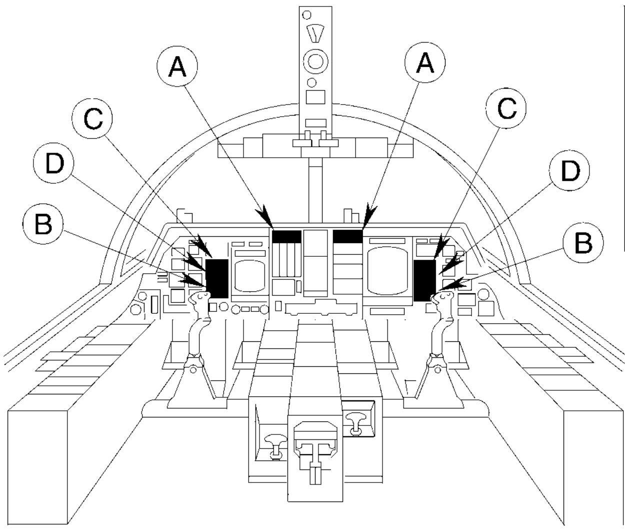
Bearing is for a GPDC fly-to-point if the following conditions are met:

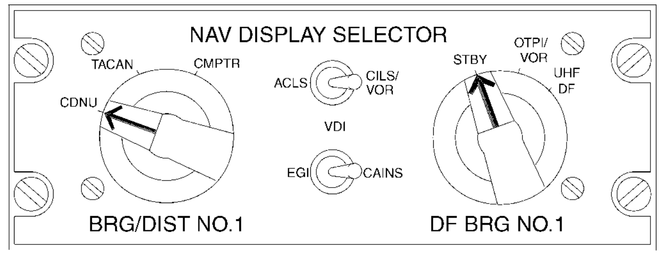
1. STBY is selected on the DF BRG NO. 1 switch and CMPTR is selected on the BRG/DIST NO. 1 switch on the NAV DISPLAY SELECTOR panel.



INDEX	CONTROL/INDICATOR	FUNCTION
1	TACAN/GPS	Selects TACAN or GPS as reference for FDIS displays.
2	ENRTE	Indicates en route flight mode has been selected on the FLT PLN page. HSI deviation is ±2 nm per dot.
3	TERM	Indicates terminal flight mode has been selected on the FLT PLN page. HSI deviation is ±0.5 nm per dot.
4	APRCH	Indicates terminal flight mode has been selected on the FLT PLN page. HSI deviation is ±300 yards per dot.

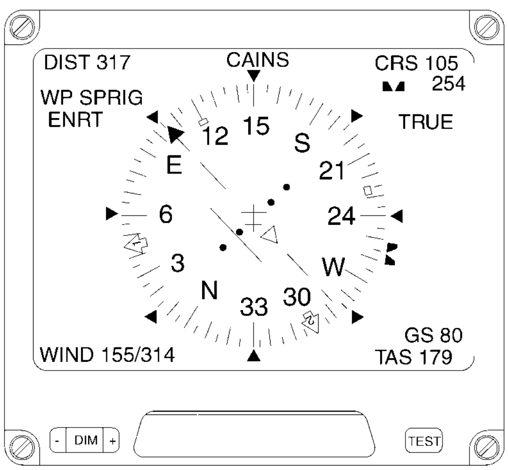
Figure 2-95. AUX NAV SELECT Panel (Aircraft Not Incorporating AFC-279)





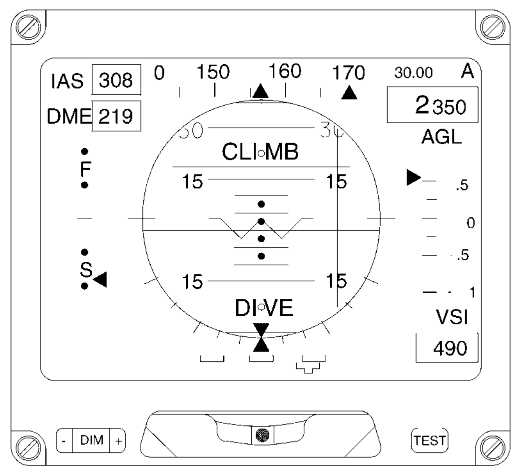
DETAIL A

NAVIGATION DATA SWITCH ASSEMBLY
SA-1792/A



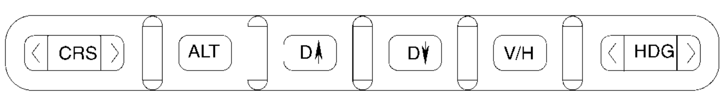
DETAIL B

ELECTRONIC FLIGHT INSTRUMENT
IP-1753/A



DETAIL C

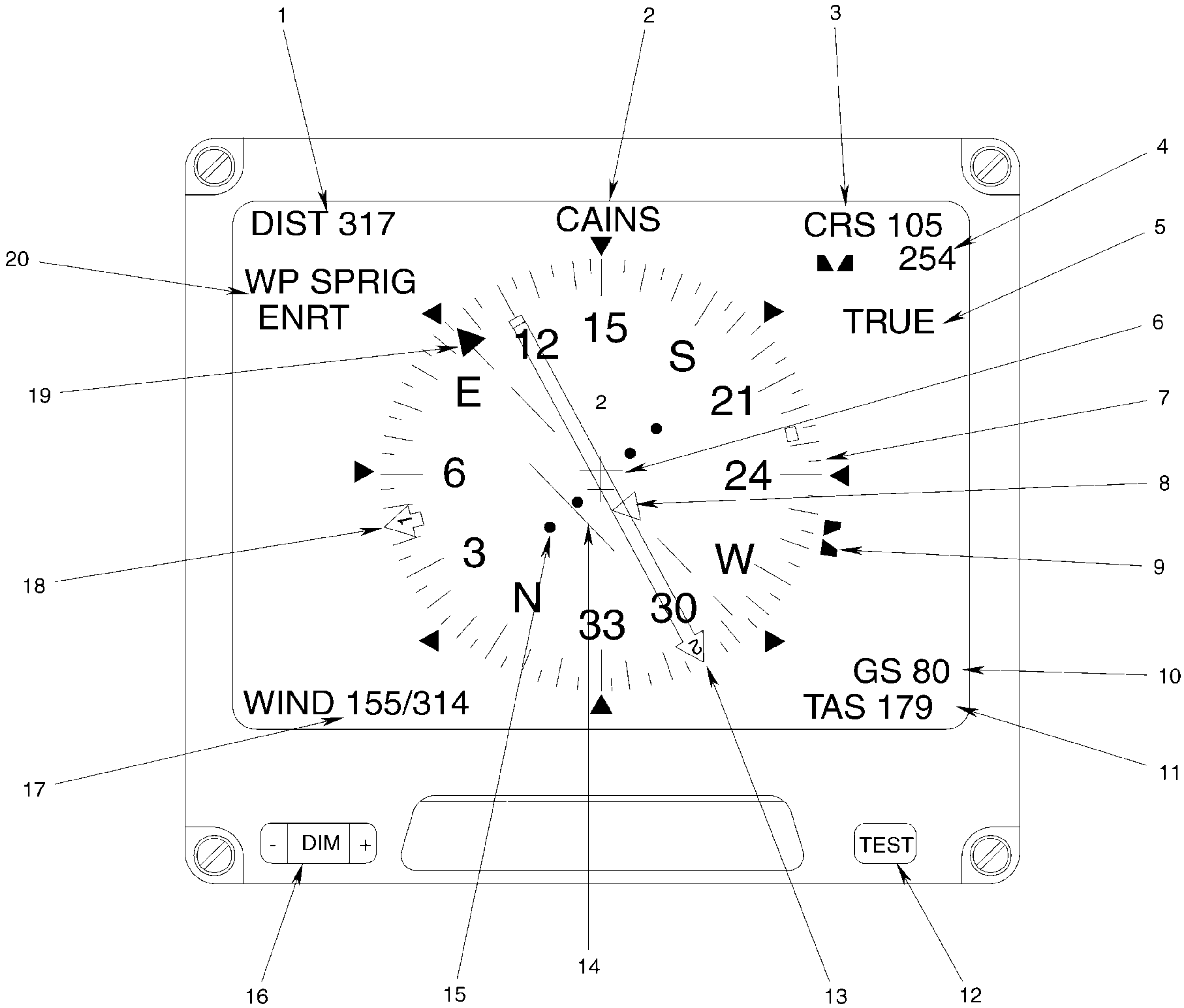
ELECTRONIC FLIGHT INSTRUMENT
IP-1753/A



DETAIL D

ELECTRONIC FLIGHT INSTRUMENT
CONTROL PANEL

Figure 2-96. Navigation Instrument Group Location Diagram (Aircraft Incorporating AFC-279)



INDEX	CONTROL/INDICATOR	FUNCTION
1	DIST	Displays distance in nautical miles from a fly-to-point, waypoint or TACAN station. Blank when data are invalid. **Note** The maximum distance displayed using CDNU or COMPUTER waypoint steering is 400 nm. When the distance is greater than 400 nm the distance display area is blank. Distances greater than 400 nm are accurately displayed on the CDNU PROG page.

Figure 2-97. Electronic Flight Instrument (HSI) (Aircraft Incorporating AFC-279) (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
2	Navigation source selection	Displays the selected navigation source. Automatic navigation sensor priority is in the following order: EGI CAINS/GPS CAINS EINS EGPS GPS Blank (none selected or dead reckoning)
3	Command course	Displays the command course from the GPDC, CDNU, or course set by the CRS switch on EFI control panel. Blank when data are invalid.
4	Selected heading	Displays the heading set by the HDG switch on the EFI control Panel.
5	Heading reference	Displays “TRUE” or “MAG” (magnetic) reference for selected heading. **Note** ● Magnetic heading is displayed when the GMSP NAV SEL switch is set to the TACAN or AWCLS position, or when the FMSP NAV SEL switch is set to the CMPTR position while TACAN and STBY are set on the NDS panel. ● True heading is displayed when the FMSP NAV SEL switch is in the CMPTR position, and the NDS panel switches are set to COMPTR and STBY, CDNU and STBY, OTPI, or UHF/DF.
6	Aircraft symbol	Stationary representation of aircraft.
7	Compass card	Displays 0–360° compass rose.
8	To/From indicator	Points to a fly-to-point or waypoint, or To/From a TACAN station.
9	Heading select marker	Indicates heading selected by the HDG switch on the EFI control panel.
10	GS	Displays groundspeed in knots (–99 –999). Blank when data are invalid.
11	TAS	Displays true airspeed in knows (0–999). Blank when data are invalid.
12	TEST switch	Initiates BIT **Note** Functional only when weight on wheels. If the TEST switch is pressed for more than 10 seconds, the EFI menu page is accessed.
13	Bearing pointer No. 2	Displays aircraft track over the ground.
14	Course deviation bar	Indicates lateral cross track error from reference ground track or displacement from selected TACAN course. **Note** The course deviation indicator is valid only when in the EGI, GPS/CAINS, EGPS, or GPS NAV mode.

Figure 2-97. Electronic Flight Instrument (HSI) (Aircraft Incorporating AFC-279) (Sheet 2)

<table>
<tr><th>INDEX</th><th>CONTROL/INDICATOR</th><th colspan="3">FUNCTION</th></tr>
<tr><td>15</td><td>Course deviation scale</td><td colspan="3">Indicates amount of deviation from selected course:
Source — Full Scale Deviation
GPDC — ±2,000 yards
CDNU (ENROUTE) — ±4 nm
CDNU (TERMINAL) — ±1 nm
CDNU (APPROACH) — ±600 yards
TACAN (HDG CRS CMD) — ±11.25°</td></tr>
<tr><td>16</td><td>DIM switch</td><td colspan="3">Controls brightness of display</td></tr>
<tr><td>17</td><td>WIND</td><td colspan="3">Displays wind direction (0–359°) and speed (0–999 knots).
Note
When navigating using EGPS, GPS, or dead reckoning, wind is not computed. The last valid wind remains displayed. When the wind is not computed or updated, the CHECK WIND alert flashes on the CDNU.</td></tr>
<tr><td>18</td><td>Bearing point No. 1</td><td colspan="3">Indicates bearing to the selected NAV source:
TACAN
GPDC fly-to-point
CDNU waypoint
UHF/DF
OTPI/DF</td></tr>
<tr><td>19</td><td>Course command arrow</td><td colspan="3">Indicates command course or course set by CRS switch on EFI control panel.</td></tr>
<tr><td rowspan="7">20</td><td rowspan="7">Bearing No. 1 source</td><td colspan="3">Displays source of bearing for pointer No. 1.</td></tr>
<tr><td>BEARING SOURCE</td><td>LINE NO.</td><td>DISPLAYED TEXT</td></tr>
<tr><td>VOR/ILS</td><td>1
2</td><td>Blank
“VOR/ILS”
(not available on S-3B aircraft).</td></tr>
<tr><td>Computer</td><td>1
2</td><td>“FTP ##” (fly-to-point is designated).
Blank (no fly-to-point is designated) CMPTR.</td></tr>
<tr><td>CDNU (Terminal)</td><td>1
2</td><td>“WP” waypoint name or ICAO identifier
“TERM”</td></tr>
<tr><td>CDNU (En route)</td><td>1
2</td><td>“WP” waypoint name or ICAO identifier
“ENRT”</td></tr>
<tr><td>CDNU (Approach)</td><td>1
2</td><td>“WP” waypoint name or ICAO identifier
“APPR”</td></tr>
</table>

Figure 2-97. Electronic Flight Instrument (HSI) (Aircraft Incorporating AFC-279) (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION		
		BEARING SOURCE	LINE NO.	DISPLAYED TEXT
		TACAN	1 2	"### X" (TACAN channel X) or "### Y" (TACAN channel Y) "TACAN"
		OTPI	1 2	Blank "OTPI"
		UHF/DF	1 2	Blank "UHF/DF"

Figure 2-97. Electronic Flight Instrument (HSI) (Aircraft Incorporating AFC-279) (Sheet 4)

Flight Mode Selector Panel NAV SEL Switch Selection	Navigation Display Selector Panel BRG/DIS No. 1 Switch	Navigation Display Selector Panel DF BRG No. 1 Switch	Type of Heading (True/ Magnetic)
CMPTR	CMPTR	STBY	True
	CDNU	STBY	True
	TACAN	STBY	Magnetic
	Any position	OTPI/VOR	True
	Any position	UHF/DF	True
TACAN/AWCLS	CMPTR	STBY	Magnetic
	CDNU	STBY	Magnetic
	TACAN	STBY	Magnetic
	Any position	OTPI/VOR	Magnetic
	Any position	UHF/DF	Magnetic

Figure 2-98. True/Magnetic Heading Display on VDI/HSI (Aircraft Incorporating AFC-279)

Bearing is to a CDNU waypoint if the following condition is met:

1. STBY is selected on the DF BRG NO. 1 switch and CDNU is selected on the BRG/DIST NO. 1 switch on the NAV DISPLAY SELECTOR panel.

Bearing is to a UHF emitter if the following condition is met:

1. UHF/DF is selected on the DF BRG NO. 1 switch on the NAV DISPLAY SELECTOR panel.

Distance is displayed as a digital readout. The distance is computed from a CDNU waypoint, a TACAN station, or a GPDC fly-to-point by selecting CDNU, TACAN, or CMPTR on the BRG/DIST NO. 1 switch on the NAV DISPLAY SELECTOR panel, respectively.

Note

The maximum distance displayed using CDNU or COMPUTER waypoint steering is 400 nm. When the distance is greater than 400 nm, the distance display area is blank. Distances greater than 400 nm are accurately displayed on the CDNU PROG page.

True airspeed (TAS) and groundspeed (GS) are also displayed as a digital readout. TAS data are derived from the SCADC. GS is computed from the north and east velocities of the selected navigation source.

The HSI course command arrow indicates the selected course when in a navigation submode, or a command course when in a computer track submode. The CRS switch on the EFI control panel is used to switch on the EFI control panel is used to select the course. Course deviation information is supplied by the course deviation bar. Course deviation is shown by displacement of the course deviation bar from the center position. The selected course is shown by the position of the course arrow relative to the compass card and by the digital command course display. To/from indication is shown by the to/from indicator.

The EFI that operates as a VDI (see Figure 2-99) provides the pilot and copilot/COTAC with a constant display of aircraft attitude. The VDI displays fast/slow error, itch and roll attitude, vertical/lateral deviation, turn rate, vertical velocity, altitude, distance, airspeed, angle of attack, bearing, heading, and validity indications. Invalid data are indicated by a blank data display in the respective area, or by a “No (data name)” alert displayed in the alert area. The data displayed are dependent upon selections made on the CDNUs, navigation display selector (NDS) panel, flight mode selector panel (FMSP), EFI control panel, and source availability.

Note

Fast/slow error indicators are displayed only when the FMSP switch is in AWCLS.

Pitch and roll attitude are read as a displacement of the pitch and roll sphere. The amount of pitch (in degrees) can be determined by comparing the graduated scale on the sphere with a miniature aircraft symbol superimposed in the center of the display. The amount of roll is determined by comparing the bank angle pointer against the fixed bank angle scale. The EGI or CAINS, as selected on the NAV DISPLAY SELECTOR panel, is the source for pitch and roll attitude information (see Figure 2-101).

Vertical deviation from glideslope is displayed by displacement of the vertical deviation bar relative to the fixed vertical scale. Lateral deviation from localizer glidepath is displayed by displacement of the lateral deviation bar relative to the aircraft symbol. The Automatic Carrier Landing System (ACLS) or the Instrument landing System (CILS) is the signal source for vertical and lateral displacement. When the AWCLS mode is selected on the flight mode selector panel, the ACLS is the signal source when the VDI toggle switch is in the ACLS position; the CILS is the signal source when the VDI toggle switch is in the CILS/VOR position. Rate-of-turn indications are provided by the turn rate pointer, which moves right or left on the turn rate scale in response to a signal from the rate-of-turn gyro.

Rate-of-turn is displayed by the turn rate-indicator. The turn rate scale consists of a series of white bars. The white turn rate pointer aligns with the center bar of the turn rate scale when not indicating a turn. When a standard 2-minute turn is being executed, the turn rate pointer aligns with the white bar on either side of center. When a double rate turn is being executed, the pointer moves to its outermost position (beyond the white bars) on either side of center. Skip or skid indications are provided by the inclinometer, which is located at the bottom of the VDI.

Separate warning indications are provided in the alert area in the lower left corner of the VDI for speed, attitude, heading, lateral deviation, and vertical deviation. The warning indications appear in case of a malfunction, unreliable signal, or power failure.

2.22.2.2 Electronic Flight Instrument Control Panel (Aircraft Incorporating AFC-279). The EFI control panel (see Figure 2-101) provides for control of the EFI display and course and heading settings. The D↑ and D↓ switches allow the operator to select declutter for the upper and lower EFIs respectively. Toggling the

ALT switch selects RAAWS as the source of displayed altitude if the aircraft is below 5,000 feet. In this case, an A is displayed in the upper right corner of the VDI, indicating that AUTO ALT (RAAWS) is enabled. If the altitude is above 5,000 feet, barometric altitude is displayed. The V/H switch switches the VDI and HSI displays between the upper and lower EFIs. Course (CRS) and Heading (HDG) rocker switches are used to select the desired course and heading. Pressing the right side of the rocker switch slews the course or heading clockwise. Pressing the left side of the rocker switch slews counterclockwise. Pressing the rocker switch for more than 40 but less than 200 milliseconds changes the setting in 1° increments. If the rocker switch is depressed and held for 400 milliseconds, the setting changes in 60° increments. The course and heading information are applied to both the HSI and VDI as applicable.

2.22.2.3 Navigation Display Selector Panel (Aircraft Incorporating AFC-279). The NAV DISPLAY SELECTOR (NDS) panel (see Figure 2-100) provides the pilot and copilot/COTAC with a means of selecting the desired information for display on the HSI and VDI EFIs. Two rotary switches are used to select the source of bearing information. The VDI ACLS CILS/VOR toggle switch selects the source for vertical and lateral information for display. The EGI/CAINS VDI toggle switch selects the source for attitude and heading information.

2.22.2.4 Navigation Interface Unit (Aircraft Incorporating AFC-279). The Navigation Interface Unit (NIU) is mounted in the right internal bay. The NIU serves as the central interface for signal conditioning and routing between the peripheral navigation subsystems and the EFIs.

The NIU provides Analog-to-Digital (A/D) and Digital-to-Analog (D/A) signal data conversion, mode and signal switch, signal conditioning, and electrical isolation required for the FDIS. The NIU interfaces the peripheral navigation systems with the GPDC and flight instruments, via the1553B data bus under the control of the CDNUs. The NIU contains redundant circuits (channels 1 and 2) and dual power supplies (one for each channel), so that a single system failure does not result in total loss of the FDIS.

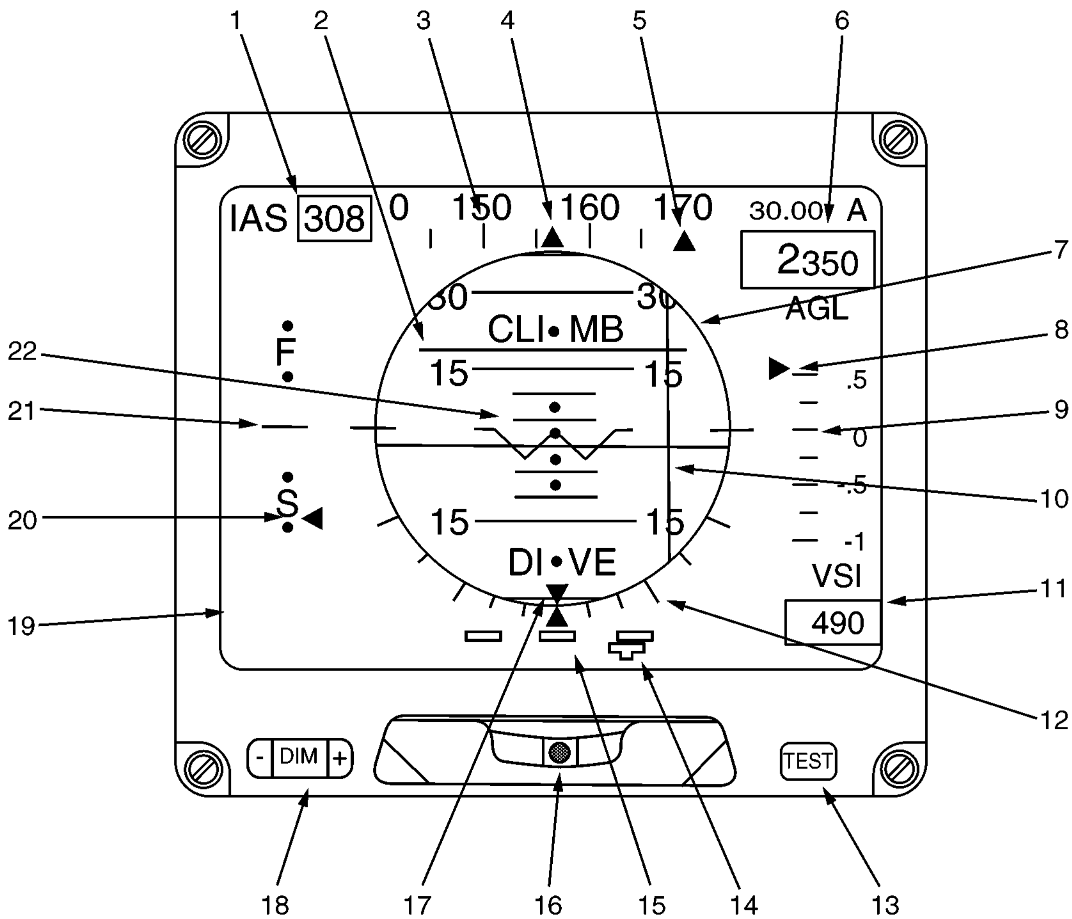
2.22.2.5 Navigation Interface Wired Assembly (Aircraft Incorporating AFC-279). The Navigation Interface Wired Assembly (NIWA) provides a 5 vdc bias signal to operate the GPS antenna receiver network. The NIWA also provides a 28 vdc bias signal to the NIU to prevent the display of AOA on the EFIs when the following conditions are not met: the landing gear is down and locked, weight is off the wheels, and the launch bar is up. When the signal is unbiased, the AOA signals are sent by the NIU, via the 1553 Bus, for display on the EFI. In addition, the NIWA provides parking brake set signals to the EGI and CAINS. Setting the parking brake applies a ground to the CDNUs and the NIWA to supply 28 vdc. The NIWA reduces the 28 vdc to 14 vdc, and the signal is sent to the EGI and CAINS signifying the parking brake is set. This allows for ground alignment of the EGI or the CAINS system.

2.22.2.6 Emergency NAV Battery (Aircraft Incorporating AFC-279). The emergency NAV battery is mounted on the emergency NAV battery tray located in the right internal bay. The Emergency NAV battery provides a 24 vdc 1.5 ampere-hour power backup to the EGI, flight station CDNU, pilot's upper EFI and channel No. 1 of the NIU.

This provides the pilot with attitude information during aircraft power failure. When the EMERGENCY INSTR LIGHTS switch on the emergency light and mike select panel is in AUTO, the emergency NAV battery is automatically connected when aircraft power is lost. The battery provides 3 minutes of back-up power. The unit is recharged by the aircraft electrical system, through the essential dc bus.

2.22.3 Inertial Navigation System

2.22.3.1 Carrier Aircraft Inertial Navigation System (Aircraft Not Incorporating AFC-279). The CAINS provides precision long-range navigation capability that is independent of outside sources and completely passive. The CAINS also provides the primary attitude and heading sources to the VDI and HSI, navigation information to the GPDC, receives (via the ASW-25) and displays Link-4A strike attack vectoring information, and interfaces with the SCADC indirectly through the GPDC to provide direct readout of navigation parameters. The INSC provides control for the CAINS and integrates its functions into all the other aircraft systems. The combination of the CAINS and INSC constitutes the INS.

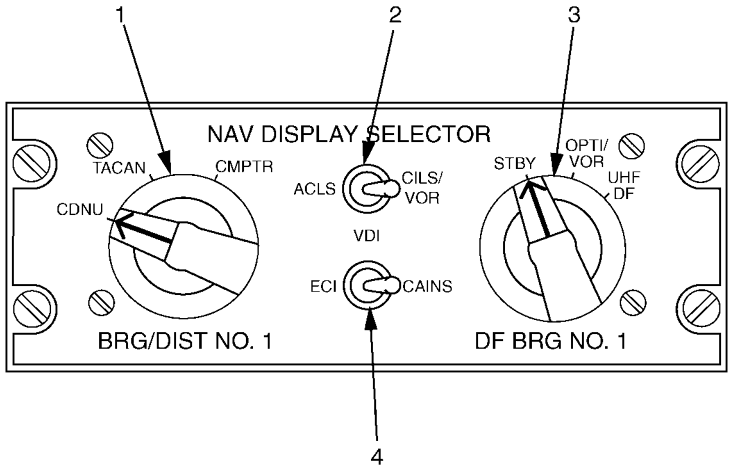


INDEX	CONTROL/INDICATOR	FUNCTION
1	IAS	Displays indicated airspeed (0–999 knots). Blank when data are invalid.
2	Vertical deviation bar	Indicates vertical deviation from glideslope.
3	Compass tape	Displays segment of 0–360° compass rose.
4	Bearing pointer No. 1	Indicates bearing to selected NAV source. TACAN GPDC fly-to-point CDNU way point UHF/DF OTPI/DF
5	Heading select marker	Indicates heading selected by the HDG switch on the EFI control panel.

Figure 2-99. Electronic Flight Instrument (VDI) (Aircraft Incorporating AFC-279) (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
6	Altitude	Displays aircraft altitude (–1500 to 80,000 feet) **Note** ● An “A” displayed above the right corner indicates AUTO ALT (RAAWS) is enabled and altitude is less than 5,000 ft AGL. ● “MSL” or “AGL” is displayed below the altitude box to indicate altitude source/reference. ● BARO correction is shown above the left corner of the altitude box (28.10 to 31.00 inches of Hg).
7	Attitude indicator	Indicates the pitch and roll attitude of the aircraft
8	Vertical velocity pointer	Indicates vertical velocity in feet/minute.
9	Vertical velocity scale	Used with vertical velocity pointer. Indicates vertical velocity in feet/minute $\times$ 1000).
10	Lateral deviation bar	Indicates lateral deviation from a glidepath.
11	Vertical velocity	Displays vertical velocity in feet/minute.
12	Bank angle scale	Fixed scale used with bank angle pointer to determine roll attitude. Scale is graduated in 0°, 10°, 20°, 30°, 45°, 60° and 90° divisions.
13	TEST switch	Initiates BIT.
14	Turn rate pointer	Indicates rate of turn.
15	Turn rate scale	Fixed scale used with turn rate pointer to determine rate of turn.
16	Inclinometer	Provides indication of skip or skid.
17	Bank angle pointer	Indicates roll attitude in degrees.
18	DIM Switch	Controls brightness of display.
19	Alert area	Indicates invalid data: INDICATION — DATA INVALID NO SPD — Speed NO ATT — Attitude NO HDG — Heading NO LAT — Lateral deviation NO VERT — Vertical deviation
20	Speed error pointer	Used with the speed error scale to indicate speed error ($\pm$10 knots) when in AFCS IAS hold mode.
21	Speed error scale/AOA marker area	When AFCS is in IAS hold mode the speed error scale is displayed. Indicates speed error ($\pm$10 knots) when in AFCS IAS hold mode. When in AWCLS mode the AOA marker is displayed. Indicates whether the angle-of-attack is high, low, or good during approach.
22	Pitch angle scale	Fixed scale used with vertical deviation bar to determine pitch attitude. Scale is graduated in 0°, 10°, 20°, 30°, 45°, 60° and 90° divisions.

Figure 2-99. Electronic Flight Instrument (VDI) (Aircraft Incorporating AFC-279) (Sheet 2)



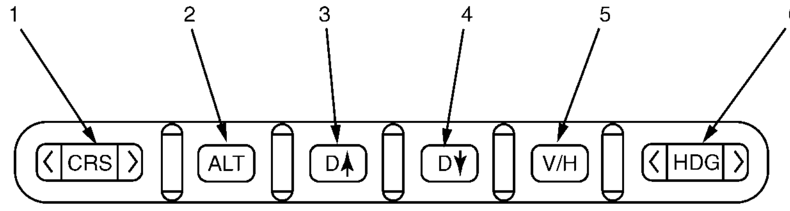
INDEX	CONTROL/INDICATOR	FUNCTION
1	BRG/DIST NO. 1	Selects bearing source for bearing pointer No. 1 and distance for display on the EFI. **SELECTION** — **BEARING/DISTANCE SOURCE** CDNU — CDNU waypoint TACAN — TACAN station CMPTR — CPDC fly-to-point
2	ACLS CILS/VOR	Selects AWCLS or CILS for display on VDI.
3	DF BRG NO. 1	Selects DF bearing source for bearing pointer No. 1 for display on the EFI. **SELECTION** — **BEARING/DISTANCE SOURCE** STBY — As selected by BRG/DIST NO. 1 switch OTPI/VOR — OPTI UHF/DF — UHF/DF
4	EGI/CAINS	Attitude and heading selector switch. Selects either EGI or CAINS as source for attitude and heading information displayed on the associated EFI.

Figure 2-100. Navigation Display Selector Panel (Aircraft Incorporating AFC-279)

The INS consists of the following separate units:

1. Inertial measuring unit
2. Airborne navigation computer unit
3. Power supply unit
4. Inertial navigation system converter
5. Navigation control panel
6. Remote compass transmitter.

The IMU contains gyros and accelerometers to sense aircraft movement and attitude. The ANCU is a computer programmed to provide the navigation outputs of the CAINS. It is also programmed to perform CAINS alignment and control the mode of operation. The PSU converts aircraft power as necessary to drive the INS components. It contains an emergency battery that protects the system during power transients or whenever ac power is not available to the PSU and the INS mode selector switch on the navigation control panel is not in the OFF position. The INS mode selector should be turned off before removing power from the aircraft to prevent depletion of the CAINS battery.



INDEX	CONTROL/INDICATOR	FUNCTION
1	CRS Switch	Selects the desired course. Pressing the right side of the rocker switch slews the course clockwise. Pressing the left side slews counterclockwise.
2	ALT Switch	Selects RAAWS as the displayed altitude if the aircraft is below 5,000 feet. **Note** • Toggling the ALT switch when the aircraft is below 5,000 feet displays an A in the upper right corner of the VDI, indicating that AUTO ALT (RAAWS) is enabled. • If the altitude is above 5,000 feet, barometric altitude is displayed.
3	D ↑ Switch	Select declutter mode for the upper EFI.
4	D ↓ Switch	Select declutter mode for the lower EFI.
5	V/H Switch	Switches the VDI and HSI displays between the upper and lower EFIs.
6	HDG Switch	Selects the desired heading. pressing the right side of the rocker switch slews the heading clockwise. Pressing the left side slews counterclockwise.

Figure 2-101. EFI Control Panel (Aircraft Incorporating AFC-279)

WARNING

Whenever a power interrupt to the INS occurs, as during bus transfer, power source transfer, generator failure, or a momentary IFPM failure, the INS can, as a result of a hardware design anomaly, initiate automatic fast-sync to the flux valve (magnetic heading). If this occurs during a turn, the flux valve output exhibits large errors; consequently, the automatic synchronization will cause the heading displayed on the HSI to be in error. Simultaneously, CAINS magnetic variation will also drive to an erroneous value.

WARNING

In flight — The pilot should closely monitor and compare the INS magnetic heading display with the magnetic compass for an erroneous INS heading. Whenever an error is detected, the aircraft should be flown wings level and a manual fast-sync initiated to correct the INS heading displayed on the HSI and magnetic variation displayed on the navigation control panel. It is recommended that the data switch on the NAV control panel be left in the MAG VAR or AUX 3 position as this can provide the first indication of a faulty INS.

WARNING

On the ground — During preflight, this condition will cause a momentary heading jump and momentary display of the attitude and heading flags. The heading will, however, be valid immediately thereafter and will require no pilot action.

The INSC provides for the exchange of information among the INS components and several other aircraft systems. The navigation control panel, located on the center console, provides controls and indicators for the INS as well as the AHRS and Doppler. The three systems are electrically independent and failures within any one system will not affect the others.

2.22.3.2 Inertial Navigation System Operation (Aircraft Not Incorporating AFC-279). The INS can be aligned in any of the following modes:

1. Ground alignment
2. Carrier deck alignment with SINS information via data link or umbilical cable
3. In-flight alignment
4. Handset alignment
5. Stored heading alignment.

Note

- In-flight alignment is a procedure requiring an operating Doppler.
- When the ALN light is on during in-flight alignment of the INS, the INS is not compatible with dual operation of the roll APS. The heading-hold function within the INSC is inoperative and can result in heading drift and subsequent monitored disengagement of the roll APS. The situation also will exist if the INS is selected to the emergency position. Under these conditions, use channel 2 roll APS only (single-channel operation).
- Alignment time is increased at higher latitudes and should be anticipated for pretakeoff planning.
- Alignment time is increased at low ambient temperatures because of the additional warmup time required.

The INS can store manually or automatically (through the ship SINS) up to 10 destination positions (unless SAV is operating, in which case destination one is reserved for SAV information), can mark and store up to 10 on-top positions, and display the following navigation parameters on the navigation control panel:

Note

The destination and on-top points are independent of the GPDC and cannot be utilized for navigation steering commands to the AFCS.

1. The true bearing and distance to any of the 10 destinations stored in the INS
2. The latitude and longitude of any of the 10 destinations stored in the INS
3. The true heading and baro-inertial altitude of the aircraft.

Note

If the GPDC is not on-line with the operational program, the altitude readout will display inertial altitude.

4. The magnetic variation in degrees, east or west, and the Doppler overland/oversea switch
5. The latitude and longitude of aircraft present position
6. The true track and groundspeed in knots of the aircraft
7. The range in nautical miles and the time in minutes to go to any of the 10 destinations stored in the INS predicated on aircraft present groundspeed
8. The true wind direction and velocity, providing the GPDC is on line with the operational program and the SCADC is operational.
9. The latitude and longitude of any of the 10 on-top positions stored in the INS

10. SAV magnetic command heading (both as received and corrected for aircraft drift angle)

11. Alignment status information

12. Auxiliary information.

The INS modes of operations are automatically selected by the ANCU when the INS mode selector switch is in the NORM position. The following navigation modes are available:

1. Inertial Doppler (INS DOP)

2. Inertial (INS)

3. Slave Doppler (SLAV DOP)

4. Slave Air Data (SLAV CADC).

In addition, the following nonnavigating modes are available for degraded mode operation:

1. Slave (SLAV)

2. Free (FREE)

3. Emergency (EMR).

2.22.3.2.1 Inertial Doppler Mode (Aircraft Not Incorporating AFC-279). The inertial Doppler mode is the normal operating mode. It is selected by placing the INS mode selector switch in the NORM position (see Figure 2-102). Operation in this mode is dependent upon the Doppler being turned on and generating valid Doppler velocities. Doppler inputs damp the inherent errors of the inertial platform and thus increase the long-range accuracy of the inertial navigation. All displays listed in Figure 2-102 are available in this mode of operation.

2.22.3.2.2 Inertial Mode (Aircraft Not Incorporating AFC-279). The INS mode position allows the operator to override the Doppler-inertial mode of navigation. The inertial mode is normally selected automatically by the ANCU if Doppler information becomes invalid. The function and capability of the INS is unchanged except that inertial errors are no longer Doppler-damped. When the INS mode is automatically or manually selected, all modes of the INS requiring Doppler navigation are bypassed.

2.22.3.2.3 Slave Doppler Mode (Aircraft Not Incorporating AFC-279). The slave Doppler mode is selected automatically by the ANCU as a result of a failure within the INS. Navigation is achieved using magnetic heading, entered magnetic variation, and Doppler velocities. The only display that is not automatically calculated and updated is the magnetic variation readout. Navigation accuracy depends on having a correct magnetic variation entered in the system since the INS utilizes magnetic heading and variation to get true heading and compute changes in latitude and longitude. Magnetic variation is entered, in this situation, through the lower register with the DATA switch in the VAR position (see Figure 2-102). The slave Doppler mode may be entered manually by placing the INS mode selector switch to the SLAV position.

1. When the INS is operating in the SLAV DOP, SLAV CADC, SLAV, or FREE modes, the N/S hemisphere switch and the latitude (LAT) control on the navigation control panel (see Figure 2-102) must be set correctly and updated for every degree of latitude change to compensate the system for apparent gyro drift caused by the Earth's rotation.

2. A detent requires the INS mode selector switch to be pulled out prior to selecting the FREE, SLAV, or EMR position since inertial navigation in the INS will be lost. Switching back to NORM or INS will not result in a return to these modes without realignment.

2.22.3.2.4 Slave Air Data Mode (Aircraft Not Incorporating AFC-279). The slave air data mode is only selected automatically by the ANCU as a result of a failure within the INS with an accompanying Doppler failure. Navigation is achieved by using magnetic heading and air data computer velocities. The displays that are not automatically calculated and updated are wind and magnetic variation. Navigation accuracy depends on having a correct wind and magnetic variation entered in the system since the INS utilizes magnetic heading and variation to compute true heading and changes in latitude and longitude, and wind to compute ground track. Wind is entered with the DATA switch in the WIND position by entering the true direction from which the wind is blowing in the upper register and the wind velocity in the lower register (see Figure 2-102). Magnetic variation is entered as in the slave Doppler mode.

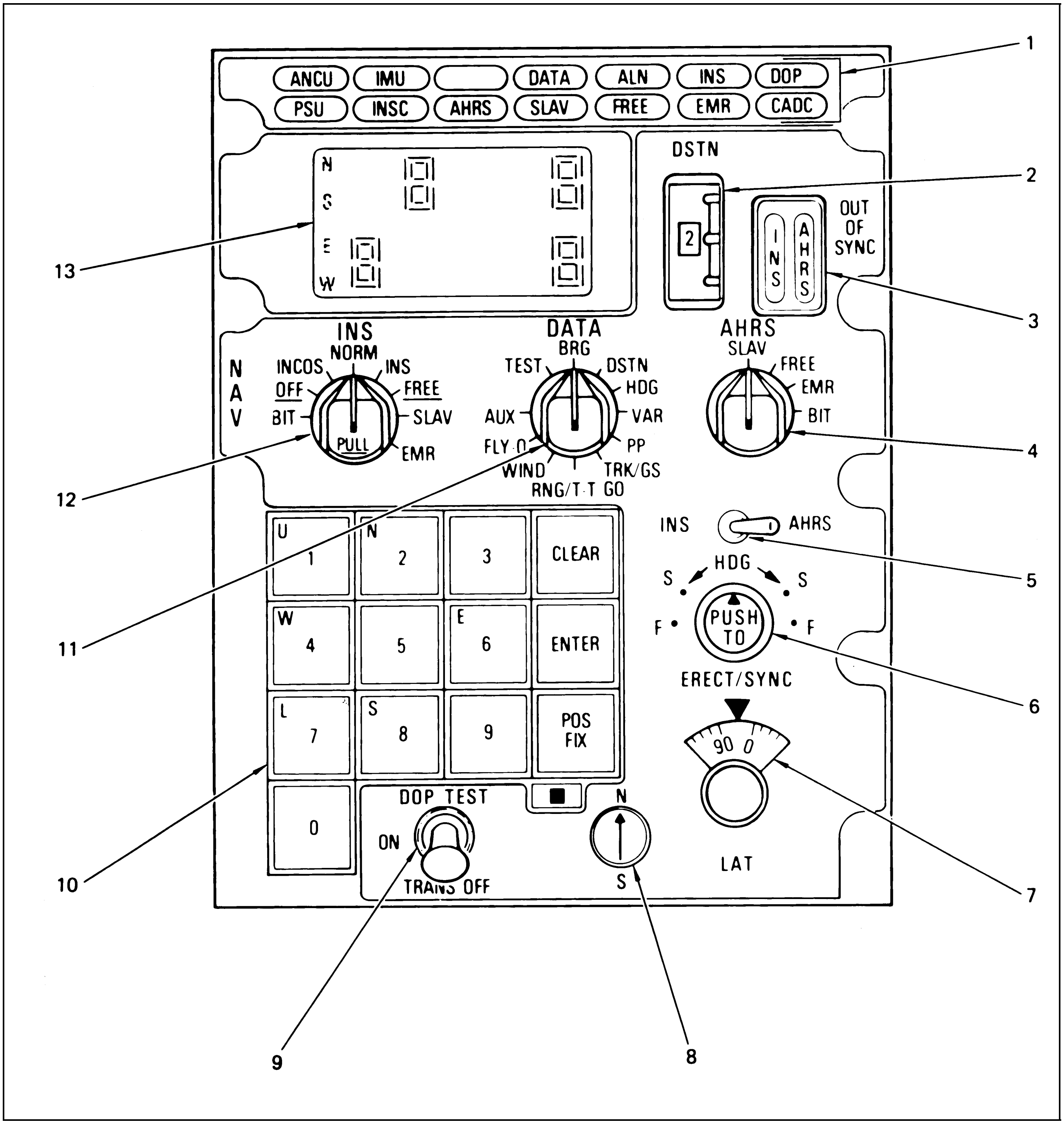


Figure 2-102. Navigation Control Panel (Aircraft Not Incorporating AFC-279) (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Systems status lamps	ANCU — illuminated amber, indicates malfunction of the air navigation computer (ANCU). IMU — illuminated amber, indicates malfunction of the inertial measurement unit (IMU). DATA — illuminated green, indicates data link information is being received (SINS or SAV). ALN — illuminated green, indicates that the inertial system is being aligned. INS — illuminated green without DOP light on, indicates that the system is in the inertial navigation mode. DOP — illuminated green with INS light on, indicates that the INS is in the doppler inertial mode. When illuminated green without INS light on and SLAV light on, indicates that the INS is in the slave doppler navigation mode. When illuminated green, with ALN light on, indicates that the INS is in the in-flight align (IFA) mode. PSU — illuminated amber, indicates that the INS power supply unit (PSU) has malfunctioned. INSC — illuminated amber, indicates malfunction of the INS converter. AHRS — illuminated amber, indicates malfunction of the attitude and heading reference system (AHRS). SLAV — illuminated green, indicates that the system is in the magnetic-slaved-heading and attitude reference mode. FREE — illuminated green, indicates that the system is in the free-heading and attitude-reference mode. EMR — illuminated green, indicates that the system is in the emergency-magnetic-heading-reference mode. Flashing indicates a malfunction of the IMU. CADC — illuminated green and SLAV illuminated green, indicates the INS is in the slave air-data navigation mode.
2	DSTN (thumbwheel switch)	This switch displays numerals 0 thru 9 and allows selection of up to 10 destination points, 10 stored on-top positions, or 10 auxiliary data, depending on DATA selector position.
3	OUT OF SYNC lights	When illuminated yellow, these lights indicate that the INS or the AHRS magnetic headings output differ from the respective flux valve input by more than 3.5°.
4	AHRS (rotary switch)	SLAV — allows the AHRS to operate in the pendulous vertical attitude reference and magnetic slaved heading reference mode. FREE — allows the AHRS to operate in the pendulous vertical attitude reference and free gyro heading reference mode. EMR — allows the AHRS to operate in the emergency flux valve heading reference mode. BIT — displays a test 225° heading plus HDG and ATT flags on any HSI and VDI displaying AHRS.

Figure 2-102. Navigation Control Panel (Aircraft Not Incorporating AFC-279) (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
5	INS/AHRS (toggle switch)	Used in conjunction with the HDG ERECT/SYNC switch to determine which system (INS or AHRS) receives the heading slew, sync command, or fast erect (AHRS only).
6	HDG ERECT/SYNC (spring-loaded rotary switch)	The spring-loaded rotary portion (spring returns switch to center) provides a method of ccw or cw slewing (fast or slow) of the INS or AHRS in the free-heading mode. Momentarily pressing the switch initiates INS or AHRS fast sync. When held down, fast-erects AHRS vertical reference.
7	LAT switch	Determines latitude used by the INS and AHRS for apparent gyro drift correction in slave (SLAV) and free (FREE) modes.
8	N/S (rotary switch)	Selects hemisphere for apparent gyro drift correction.
9	DOP TEST/ON/TRANS OFF (lever-lock toggle switch)	DOP TEST — initiates the doppler ground-velocity-set (GVS) BITE mode. The transmitter will be off for the duration of the BITE mode. The doppler GVS enters BITE mode on command of an internal timer for approximately 60 seconds. The switch can be returned to ON at any time. **Note** Once BITE has been initiated, the doppler GVS will stay in that mode until failure is detected or the BITE test sequence is successfully completed (approximately 60 seconds). ON — provides for normal operation. TRANS OFF — turns off the doppler transmitter. Used to command RF silence while maintaining the doppler in readiness.
10	Keyboard	0 to 9 — insert data into upper or lower display for subsequent transfer to ANCU memory. CLEAR — cancels data transfer to memory, restores display to original readout, initiates ground alignment. ENTER — transfers data to memory, updates display to reflect new memory contents. Stores present position as an on-top, in location determined by DSTN thumbwheel when pressed with DATA selector in FLY-O. POS FIX — compares present position with stored coordinates determined by DSTN thumbwheel, displays bearing and distance error, flashes until ENTER depression (updates present position) or CLEAR depression (cancels position update). Data selector must be in FLY-O.
11	DATA (11-position rotary switch)	TEST — illuminates all status and mode annunciators, all readout digits, INS and AHRS sync lights, and CLEAR, ENTER, and POS FIX pushbuttons (not through the ANCU). BRG — displays true bearing and distance to the destination point selected by the DSTN thumbwheel. DSTN — displays destination point coordinates selected by the DSTN thumbwheel.

Figure 2-102. Navigation Control Panel (Aircraft Not Incorporating AFC-279) (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
11 (cont.)	DATA (11-position rotary switch) (cont.)	HDG — displays true heading in the upper display and baro-inertial altitude in the lower display. VAR — Doppler over land oversea switch in upper display and magnetic variation in lower display. PP — displays present position coordinates. TRK/GS — displays aircraft true ground track on the upper display and aircraft ground speed in knots on the lower display. RNG/T-T GO — displays the range in nautical miles and time-to-go in minutes at present ground speed, to the destination point selected by the DSTN thumbwheel. WIND — displays true wind direction on the upper display and wind velocity in knots on the lower display. This readout will not be available unless the operational program is on-line. FLY-O — provides manual position update capability when visually flying over a known destination point; provides a record capability when flying over an unknown target. On deck prior to weight-off-wheels provides alignment information for operator and troubleshooters (see Figure 2-110). AUX — displays auxiliary data selected by the DSTN thumbwheel selector (see Figure 2-112).
12	INS (8-position rotary switch)	BIT — places the INS in a self test mode. OFF — turns off power supplied by the power supply unit to all INS units. INCOS — used during system readiness test (SRT), not for in-flight use. NORM — automatically selects an alignment mode, followed by a navigation mode, upon aircraft takeoff. INS computer automatically selects best mode (DOP-INS, INS, DOP-SLAV, CADC-SLAV). If INS computer fails, then an attitude/heading backup is selected automatically. INS — excludes doppler damping and in-flight inertial alignment, otherwise same as NORM. FREE — forces the free-heading reference mode. SLAV — forces the magnetic-slaved-heading reference mode. EMR — forces the emergency flux valve heading reference mode.
13	NAV DATA displays	The upper display shows up to five digits of N or S if applicable. The lower display shows up to six digits plus E or W if applicable. Data to be displayed is selected by the DATA selector and the DSTN thumbwheel.

Figure 2-102. Navigation Control Panel (Aircraft Not Incorporating AFC-279) (Sheet 4)

Note

The inertial system receives true airspeed and barometric altitude from the SCADC indirectly through the GPDC. If the GPDC is not on line with the operational program, the INS does not operate in the air data mode.

2.22.3.2.5 Slave Mode (Aircraft Not Incorporating AFC-279). The slave mode is a nonnavigating mode when Doppler or air data computer velocities are not available. This mode is normally selected automatically by the ANCU as a result of a failure within the INS when the aircraft is operating between 70° N (north) and 70° S (south). Because the system is not navigating, navigation readouts are not available. When operating in the slave mode, the INS is operating similar to (and providing the same information as) the AHRS. The slave mode can be entered manually by turning the INS mode selector to SLAV.

2.22.3.2.6 Free Mode (Aircraft Not Incorporating AFC-279). The free mode is a nonnavigating mode that is normally selected automatically by the ANCU as a result of a failure within the INS when the aircraft is operating at a greater than 70° N or S latitude. As in the slave mode, no navigation readouts are available.

As in the slave mode, the INS in the free mode operates similar to and provides the same information as the AHRS in the free mode. The free mode can be selected manually by rotating the INS mode selector switch to FREE.

2.22.3.2.7 Emergency Mode (Aircraft Not Incorporating AFC-279). The emergency mode is a nonnavigating mode that is normally selected automatically by the ANCU or by the INSC as a result of a failure of the IMU. In the emergency mode, the remote compass transmitter in the right wing provides magnetic heading through the INSC to the HSI, and attitude information is not available. The emergency mode can be selected manually by rotating the INS mode selector switch to EMR. As in the FREE mode, all navigation data will be lost.

2.22.3.3 CAINS Ground Alignment Procedures (Aircraft Not Incorporating AFC-279). The INS can be aligned by turning the INS mode selector switch to BIT, INCOS, NORM, or INS. The BIT and INCOS positions are used for ground testing the INS. For all operational uses, the INS is aligned in NORM. Alignment in the INS switch position, however, is the same as in NORMAL. The following steps are required for shore-based (ground) alignment (see Figure 2-103). Anytime the parking brake is released during a coarse alignment, the ANCU will terminate the alignment. A new coarse alignment will commence when the parking brake is reset. After coarse alignment is completed, the parking brakes may be released without affecting the accuracy of the final alignment. While taxiing, the INS will update present position. When the parking brake is reset, alignment continues; however, align time will be extended by taxi time plus 10 seconds. Until the first weight-off-wheels signal, the ALN (green) mode light will remain on whenever the parking brake is set.

2.22.3.4 CAINS Shipboard (Carrier) Alignment Procedures (Aircraft Not Incorporating AFC-279). INS alignment on board carriers is accomplished by use of SINS data transmitted by the carrier for use by the CAINS ANCU.

Alignment can be achieved in three input sensor configurations:

1. ASW-25 Link-4A (primary) — In this mode, the full capability of the ASW-25 is used.
2. UHF/ASW-25 (backup) — In this mode, the UHF receiver is utilized to either:
   a. Supplement a failed RF portion of the ASW-25
   b. Overcome a temporary frequency incompatibility between an uncoordinated change of the carrier Link-4 transmitter frequency and the preset receiver frequency in the ASW-25 control panel.
3. Umbilical SINS cable — In this mode, RF transmission is not required. This is the primary alignment source used during EMCON; SINS deck-edge data can be transferred directly to the ASW-25 converter and to the ANCU.

2.22.3.5 ASW-25 Setup Procedures (Aircraft Not Incorporating AFC-279)

1. ASW-25 setup
   a. Position the ASW-25 control panel DATA LINK power selector (ON/OFF/AUX ON) switch to ON for normal link alignment.

PROCEDURES	COMMENTS/RESULTS
1. Verify parking brake is set	Align will not start until brake is set.
2. Set NC MODE switch to NORM	Power applied to CAINS.
3. Verify CLEAR and ENTER flashing	No flashing indicates malfunction.
4. Set NC DATA switch to PP	Last manually entered present position displayed.
5. If displayed present position correct, press CLEAR	CLEAR and ENTER stop flashing, ALN illuminates.
6. If displayed present position not correct, enter correct value(s)	CLEAR and ENTER stop flashing, ALN illuminates.
7. Set LAT dial to present latitude and set N/S switch to present hemisphere	No effect on the alignment.
8. Verify into fine align within 4 minutes	AUX 9 UPPER reads 00004.
9. Verify NC INS light on within 8.5 minutes	Longer time may be required if brake released during fine align.

Note

- If EMR light comes on during alignment, check to be sure that the correct latitude is in present position. If the correct latitude is there, request troubleshooting aid.
- The ANCU-15 (SMAL) Program will not commence coarse alignment until present position has been entered or the CLEAR switch is momentarily depressed to command the system to accept the memorized present position. The DATA switch has to be in the PP position for the CLEAR switch to work.
- The critical parameter for alignment is correct latitude. Errors in latitude will prolong alignment as well as cause inaccuracy in navigation.
- The INS can be aligned with the wings folded.
- The alignment time and sequence can be monitored by using various AUX positions.

Figure 2-103. Ground Alignment (Aircraft Not Incorporating AFC-279)

a. Position the TEST/NORM/A-J selector switch on the ASW-25 control panel to NORM.

Note

The ASW-25 SINS reception frequency is preset on the back of the ASW-25 control panel by maintenance personnel and is not affected by the frequency select thumb-wheels on the front of the control panel. The UHF/ASW-25 (backup) or umbilical SINS cable can be used to overcome a preset frequency incompatibility.

10. ASW-25/UHF setup

a. On the RSCI, select the ACLS mode and carrier transmitter frequency on the desired UHF.

b. On the ASW-25 control panel, set the TEST/NORM/A-J selector switch to the NORM position and the DATA LINK power selector (ON/OFF/AUX ON) switch to the AUX ON position.

c. Refer to Figure 2-104.

11. ASW-25/umbilical setup

a. Connect the SINS cable to the aircraft ASW-25 receptacle in the right wheelwell.

PROCEDURES	COMMENTS/RESULTS
1. Set up ASW-25 to receive for SINS information.	Primary method — Set ASW-25 DATA LINK power selector switch to ON. Set TEST/NORM/A-J switch to NORM. Secondary method — Select the ACLS mode on the CCG. Set ASW-25 data power selector switch to NORM position and the DATA LINK power selector to the AUX ON position.
2. Verify parking brake is set	Align will not start until brake is set.
3. Set NC MODE switch to NORM	Power applied to CAINS.
4. Verify CLEAR and ENTER flashing	No flashing indicates problems.
5. Verify DATA illuminates, followed by ALN illumination	Both DATA and ALN should be on within 1 minute, CLEAR and ENTER stop flashing.
6. Verify into fine align within 4 minutes	AUX 9 UPPER reads 00004.
7. Monitor AUX 9 UPPER when ready to taxi	If 01004 appears during taxi, align will not continue when parking brake is reset.
8. Verify NC INS light on within 8.5 minutes	Longer time may be required if parking brake was released.

Note

- Do not press CLEAR switch prior to ALN light appearing on NCP. This will cause the ALN light to illuminate without the ANCU in the alignment mode.
- If the DATA light goes out, SINS alignment will terminate and handset alignment will take over. When the DATA light comes back on, the SINS alignment will begin again.
- If the CAINS is in the handset alignment mode, when the parking brake is released the ANCU goes into a navigating mode and will not go back to the alignment mode.
- The ANCU-15 program will not commence coarse alignment until present position has been entered. This occurs automatically via SINS data during a SINS alignment.
- The ACLS/RADAR/TEST switch on the copilot/COTAC instrument panel must not be positioned to ACLS during CAINS alignment.

Figure 2-104. SINS Alignment (Aircraft Not Incorporating AFC-279)

b. On the ASW-25 control panel, set the DATA LINK power selector (ON/OFF/AUX ON) switch to either ON or AUX ON and set the TEST/NORM/A-J selector switch to NORM.

c. Refer to Figure 2-104.

Note

Verify the VOICE lights on the pilot and copilot/COTAC annunciator panels are flickering indicating receipt of SINS data.

The automatic carrier align with data link requires continuously good SINS information (either RF or cable). No manual entry is required.

2.22.3.6 CAINS Carrier Align Without Data Link (Handset Align). (Aircraft Not Incorporating AFC-297). The CAINS handset mode is used when SINS information is not available for alignment. Handset alignment is a SINS backup mode. See Figure 2-105.

PROCEDURES	COMMENTS/RESULTS
1. Verify parking brake is set	Align will not start until brake is set.
2. Set NC MODE switch to NORM	Power applied to CAINS.
3. Verify CLEAR and ENTER flashing	No flashing indicates malfunction.
4. Set NC DATA switch to TRK/GS	
5. Enter carrier heading in degrees and tenths of degrees thru UPPER and enter carrier speed in knots and tenths of knots thru LOWER	TRK will shift around to follow “helmsman wander” or turns.
6. Set NC DATA switch to PP	
7. Enter carrier latitude and longitude	CLEAR and ENTER stop flashing, ALN illuminates.
8. Verify into fine align within 6 minutes	AUX 9 UPPER reads 00004.
9. If parking brake released in fine align, automatic switch by SMAL to navigate mode	Reapplication of parking brake does not continue alignment.
10. Verify NC INS light on within 14 minutes	ALN goes out and AUX 9 UPPER reads 01010.

Note

- If EMR light comes on during alignment, most likely the ship has changed speed. However, hardware problems or excessive error in handset data entry could also be the cause
- Errors in the manually entered values for handset align will propagate in well defined ways. An error in ship track up to 2 degrees will have negligible effect. An error in ship ground speed will primarily propagate into a position error which grows at approximately 1 nm/hr in aircraft position for each 1 knot of ship speed error.
- The ANCU-15 program will not commence coarse alignment until present position has been entered.
- In the handset mode, fine alignment terminates 8 seconds after the INS light illuminates.
- Anytime the parking brake is released during a coarse alignment the ANCU will terminate the alignment. A new coarse alignment will commence when the parking brake is set.

Figure 2-105. Handset Alignment (Aircraft Not Incorporating AFC-279)

2.22.3.7 CAINS In-Flight Align (Aircraft Not Incorporating AFC-279). The in-flight alignment mode is for use when it is necessary to launch before completion of the alignment (See Figure 2-106) or after a failure when airborne (See Figure 2-107).

CAUTION

Ensure the pitch roll and yaw axis of the autopilot system are disengaged prior to CAINS turnoff in flight, to preclude spurious and potentially hazardous autopilot commands.

2.22.3.8 Stored Heading Align (Aircraft Not Incorporating AFC-279). If a reference alignment (see Figure 2-108) has been completed and the aircraft has not been moved since that alignment, stored heading align (see Figure 2-109) provides a fast fine align capability. For carrier use, data link data (cable or RF) is required.

2.22.3.9 Navigation Functions (Aircraft Not Incorporating AFC-279). The INS can store 10 destination positions (if SAV is active, DSTN 1 will be reserved for SAV target coordinates and will not be operator modifiable), 10 on-top positions, and display parameters related to these positions. Data display on the navigation control panel is controlled by the 11-position DATA switch (Figure 2-102). To record and store an on-top position (Figure 2-110):

1. Select the desired location for data storage with the DSTN thumbwheel (0 to 9).

2. Turn the DATA switch to FLY-O.

3. When on top of the position, press ENTER.

4. The latitude and longitude will be displayed in the upper and lower display registers. Destination positions can be entered manually, similar to present position entry during shore-based alignment, via data Link-4 automatically during a shipboard alignment or SAV operation. For manual entry, the DATA switch must be in the DSTN position. The DSTN thumbwheel selects the storage position.

Note

The destination and on-top positions entered into the INS cannot be used by the GPDC and thus cannot be used for steering commands by the AFCS.

Should it become necessary to update the INS position, the following steps should be followed:

1. With the DSTN thumbwheel, select the storage position (0 to 9) that contains the geographic reference position to be used for the update.

2. Select DSTN with the DATA switch to check the position coordinates.

3. Select FLY-O with the DATA switch.

4. When on top the geographic position stored in DSTN, press POS FIX.

5. The POS FIX switch will flash and the direction and distance from the INS computed position to the geographic position stored in DSTN will appear in the upper and lower display registers.

6. Evaluate the error and, if correct or reasonable, press ENTER. If it is not correct, press CLEAR.

2.22.3.10 Strike Attack Vectoring (Aircraft Not Incorporating AFC-279). The CAINS can receive and display Link-4A SAV information while in flight. Figure 2-111 lists the steps for SAV operation. The NCP DATA light will illuminate anytime the CAINS is receiving valid SAV data. The DATA light will go out if valid SAV data has not been received within the last 20 seconds.

When the DATA light is illuminated, the contents of DSTN 1 will be continually updated and replaced with the most recent values of target latitude and longitude and a SAV magnetic command heading will be displayed in the AUX 1 display, as received in the upper display, corrected for aircraft drift angle in the lower display. AUX 1 can then be used as a heading-to-fly indicator, and DSTN 1 can be used for range, true bearing, and time to go information in the usual manner. If the DATA light goes out, the last values for target coordinates and command heading will remain in the DSTN 1 and AUX 1 displays (the AUX lower display will continue to be corrected for aircraft drift).

PROCEDURES	COMMENTS/RESULTS
1. Verify AUX 9 UPPER has last digit 4	Last digit 4 says SMAL in fine align.
2. Verify DOP TEST switch on NC is set at ON	Doppler radar on.
3. Set NC DATA switch to VAR	
4. Set overland/oversea switch to correct setting by pressing UPPER/I and ENTER	00000 = oversea 00001 = overland
5. Proceed with normal mission	No special maneuvers required.

Figure 2-106. Launch in Fine Align (Aircraft Not Incorporating AFC-279)

PROCEDURES	COMMENTS/RESULTS
1. Verify DOP TEST switch on NC is set at ON	Doppler radar on.
2. Begin flying straight and level	
3. Set NC MODE switch to NORM	Power applied to CAINS.
4. Set NC DATA switch to VAR	
5. Set overland/oversea switch to correct setting by pressing UPPER/1 and ENTER	00000 = oversea 00001 = overland
6. Enter local magnetic variation thru lower display	Must be entered before present position.
7. Set NC DATA switch to PP	
8. Enter best estimate of present position	
9. Maintain straight and level flight until GPDC accepts CAINS velocities	Needed to get platform to level usually 5 minutes.
10. Proceed with normal mission	If possible, use easy turns during first 30 minutes of align.
11. Whenever possible, update present position thru FLY-O	

Note

- Numerous POS-FIX updates will decrease alignment time.
- The DOP light may flash irregularly indicating either poor Doppler signals or alignment trouble. If flashing continues with straight and level flight during in-flight align, use SLAV or FREE.
- The reduction of errors in the navigation mechanization (and, hence, the progress of the alignment) can be observed in the AUX 3 displays. The upper display at the beginning of in-flight alignment will be 18.0. This value will slowly increase until it is approximately 27.0 and will then start to decrease. For an in-flight alignment oversea, this value will be approximately 4.7 when the NC INS light illuminates. For an in-flight alignment overland the value will be approximately 2.8 when the NC INS light illuminates.
- GPDC acceptance of CAINS data may be verified by monitoring the NAV STATUS tableau.
- If the Doppler inputs to the CAINS become invalid, the DOP LIGHT and the ALN lights will go off. They will again come on when the Doppler becomes usable.
- Changing of the overland/oversea switch is required only when the change is expected to last for 3 minutes or more.

Figure 2-107. CAINS Turn on In Flight (Aircraft Not Incorporating AFC-279)

PROCEDURES	COMMENTS/RESULTS
1. After the aircraft has been spotted, conduct a normal alignment until the NC INS light illuminates.	SINS data via RF or cable must be used on a carrier.
2. Turn off CAINS.	Necessary parameters are ready.

Figure 2-108. Reference Alignment (Aircraft Not Incorporating AFC-279)

PROCEDURES	COMMENTS/RESULTS
1. Verify parking brake is set.	If CAINS is turned on with parking brake released, necessary parameters will be lost.
2. Turn on ASW-25 if on carrier.	Must have SINS data via cable or one of the RF sensors.
3. Set NC MODE switch to NORM	Power applied to CAINS.
4. Set NC DATA switch to AUX.	
5. Set DSTN thumbwheel to 9.	If lower display is $^{E}0°00.0$, stored heading align cannot be used.
6. Wait for NC DATA light illumination if on a carrier.	If DATA light does not come one, handset (or inflight) align must be used.
7. Press LOWER/7 and ENTER.	CLEAR and ENTER stop flashing, ALN illuminates.
8. Verify into fine align in approximately 3 minutes.	When AUX 9 UPPER reads 10004, the CAINS is ready for launch with an approximate 2 nm/hr accuracy.
Note If EMR light comes on during alignment, alignment cannot proceed. Restart alignment by recycling CAINS power.	**Note** The ANCU-15 program will not commence coarse alignment until present position has been entered.

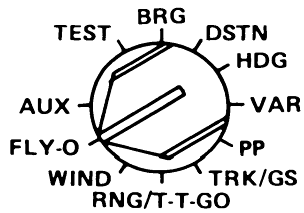
Figure 2-109. Stored Heading Alignment (Aircraft Not Incorporating AFC-279)

Note

- The SAV coordinator may initiate a cancel assignment. If this occurs, the NCP DATA light will remain on. Indications that this situation exists are the AUX 1 upper display becomes zero and the DSTN 1 target coordinates follow own-aircraft present position. The SAV coordinator should be contacted to verify this situation. SAV displays will be invalid until assignment is reestablished.
- Magnetic headings (in AUX 1) to the SAV target will be accurate (except in polar regions) even if CAINS has large position errors.
- Prior to launch, the program part and dash numbers are displayed in AUX 1.

If SAV operation is being attempted but the DATA light does not illuminate, the following steps should be taken:

1. Verify that steps 1 through 4 of Figure 2-111 have been properly completed.
2. Confirm that the SAV coordinator is transmitting data to the aircraft ACLS address.



A. AFTER LAUNCH, POS FIX NOT FLASHING

UPPER	LATITUDE	FOR "ON-TOP" RECORDING (USES DSTN THUMBWHEEL).
LOWER	LONGITUDE	

B. AFTER LAUNCH, POS FIX FLASHING

UPPER	BEARING	FROM CAINS PP TO FIX PT. (USES DSTN THUMBWHEEL).
LOWER	RANGE	

C. BEFORE LAUNCH

DSTN			
0	UPPER	TIME (MINUTES)	
	LOWER	SPOTTING ANGLE (DEG. & MIN.)	
1	UPPER	POSITION DIVERGENCES	DURING ALIGNMENT (FEET)
	LOWER		
1	UPPER	POSITION SEPARATIONS	DURING NAVIGATE (NAUTICAL MILES)
	LOWER		
2	UPPER	LAST FLIGHT CLOSE-OUT LATITUDE	
	LOWER	LAST FLIGHT CLOSE-OUT LONGITUDE	
3	UPPER		
	LOWER		
4	UPPER		
	LOWER		
5	UPPER	Z GYRO DRIFT (DEGREES/HOUR)	
	LOWER	SPARE	
6	UPPER	X GYRO DRIFT (DEGREES/HOUR)	
	LOWER	Y GYRO DRIFT (DEGREES/HOUR)	
7	UPPER	AZIMUTH ACCURACY EST (MRAD OR NMI/HR)	
	LOWER		
8	UPPER	STARBOARD LEVER ARM EST (FEET)	
	LOWER	FORWARD LEVER ARM EST (FEET)	
9	UPPER	VERTICAL LEVER ARM EST (FEET)	
	LOWER	AZIMUTH WANDER ANGLE (DEG & MIN)	

Figure 2-110. Alignment Information (Operators and Troubleshooters) (Aircraft Not Incorporating AFC-279)

If the DATA light still does not illuminate, then the problem could be one of the following:

1. Aircraft is not within transmitting range of the SAV coordinator.
2. Antenna shadowing because of the relative positions of the S-3 and the SAV coordinator. (The S-3 ASW-25 antenna is mounted on the bottom of the aircraft. If the SAV coordinator is at a higher altitude, a potential for shadowing exists.)
3. Hardware malfunctions.

2.22.3.11 Auxiliary Display (Aircraft Not Incorporating AFC-279). The AUX position on the DATA switch provides access to the ANCU program. Figure 2-112 lists the 10 locations that can be selected using the DSTN thumbwheel.

2.22.3.12 CAINS Closeout (Aircraft Not Incorporating AFC-279). At the completion of a flight, the CAINS cumulative drift can be displayed. See Figure 2-114.

2.22.4 Attitude and Heading Reference System (Aircraft Not Incorporating AFC-279). The AHRS is a conventional, pendulous, vertical system that serves as a backup system for the INS. The AHRS supplies digital pitch, roll, and heading data to the GPDC for flight management and navigation. Analog pitch, roll, and heading are supplied to the navigation data repeater and converted for selected distribution to the flight display system, search radar, autopilot (pitch and roll), and tacan (heading). Clutched heading error is furnished to the AFCS. The AHRS is capable of operation in three heading modes: slaved, free, and emergency.

WARNING

Whenever a power interrupt to the AHRS occurs, as during bus transfer, power source transfer, generator failure, or a momentary IFPM failure, the AHRS will, as a result of a hardware design anomaly, initiate automatic fast-sync to the flux valve (magnetic heading). If this occurs during a turn, the flux valve output exhibits large errors; consequently, the automatic synchronization will cause the heading displayed on the HSI to be in error.

WARNING

- In flight — The pilot should closely monitor and compare the AHRS magnetic heading display with the magnetic compass for an erroneous AHRS heading. Whenever a power transfer or momentary IFPM failure occurs, the aircraft should be flown wings level and a manual fast-sync initiated to correct the AHRS heading displayed.

- On the ground — During preflight, this condition will cause a momentary heading jump and momentary display of the attitude and heading flags. The heading will, however, be valid immediately thereafter and will require no pilot action.

2.22.4.1 Slaved Mode (Aircraft Not Incorporating AFC-279). In the slaved (SLAV) mode, the heading output is slaved to the output of a magnetic compass transmitter (flux valve). The magnetic heading output is compensated for magnetic deviation before input to the AHRS. When synchronized in this mode, the AHRS OUT OF SYNC light is extinguished. When the heading outputs are coincident with the magnetic heading of the aircraft as sensed by the remote compass transmitter, the heading output circuitry is synchronized.

If the output from the AHRS displacement gyro varies more than 3.5° from the flux valve input, the AHRS OUT OF SYNC light will illuminate. Normally, the slaving mode will maintain the synchronizing condition. The slaving rate is relatively slow, and, should the system get out of synchronization, the slow slaving process can be bypassed by pressing the ERECT/SYNC pushbutton. This initiates a fast slaving or synchronization function that quickly returns the system to a synchronized condition.

PROCEDURES	COMMENTS/RESULTS
1. Inform SAV coordinator of aircraft data link (ACLS) address	
2. Select the appropriate data link frequency on the ASW-25 control panel	
3. Turn CAINS on (if not already on)	SAV available in any primary or back-up CAINS navigation mode.
4. Turn on ASW-25 (power selector to ON, TEST/NORM/A-J to NORM)	DATA light on NCP illuminated indicates SAV data being received.
5. Target lat/long displayed on NCP in DSTN 1	Data previously stored in DSTN 1 will be erased.
6. Range, true bearing and a time to go may be calculated off INS in usual manner	
7. SAV magnetic command heading displayed in AUX 1 (as received in upper display, corrected for aircraft drift in lower display)	If AUX 1 upper reads consistently zero, SAV coordinator may have initiated a cancel assignment (see Note below).
8. If SAV reception goes down, last received values will be retained in DSTN 1 and AUX 1 (AUX 1 lower will continue to be corrected for aircraft drift)	NCP DATA light will go out if no valid SAV data received within last 20 seconds.

Note

- Aircraft must have weight-off-wheels before SAV data can be received.
- If DATA light does not illuminate, verify SAV coordinator transmitting to proper ACLS address, and verify correct Link-4A frequency selected.
- AUX 1 displays CAINS tape part number and dash number prior to launch.

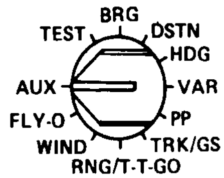
Figure 2-111. Strike Attack Vectoring (Aircraft Not Incorporating AFC-279)

2.22.4.2 Free Mode (Aircraft Not Incorporating AFC-279). This mode is used when the magnetic compass transmitter is unreliable. Only the azimuth signal from the directional gyro is utilized in the free mode to obtain gyro stabilized heading data corrected for Earth rotation. Since the gyro is randomly oriented, it senses displacement rather than direction. It must be referenced to the desired heading by use of the heading (HDG) slew control on the navigation control panel. Since only the azimuth signal from the directional gyro is utilized in the free mode, compensation for gyro drift must be introduced by use of the LAT control; otherwise, drift would appear as a heading change although the aircraft had not changed heading.

Gyro drift is of two types, real and apparent. Real drift is caused by the mechanical limitations of the gyro and cannot be entirely predicted. A compensation adjustment for mechanical limitations is provided on the gyro assembly. Apparent drift, caused by Earth rotation, varies with latitude and can be predicted. Compensation for apparent drift in both SLAV and FREE modes is controlled by the N/S hemisphere switch and LAT control on the navigation control panel. The setting of the LAT control should be changed every degree as the aircraft changes latitude.

If the free mode is used for extended periods of time, the real drift may cause a slight heading error. If this happens, the correct heading can be set in at any time with the HDG slew control. The AHRS OUT OF SYNC light is inoperative in this mode.

2.22.4.3 EMR (Compass) Mode (Aircraft Not Incorporating AFC-279). The EMR mode is strictly an emergency mode to be used only in the event the directional gyro is disabled. In this mode, only the flux valve output is used to provide heading data to the flight displays and GPDC.



DSTN POSITION	DISPLAY REGISTER	DISPLAY INFORMATION
O	U	Vertical velocity in feet per second.
O	U	Time from Turn-on or the first weight-off-wheels signal.
1	U	Prior to Launch ANCU program part number After Launch: SAV magnetic command heading (corrected for drift) in degrees and tenths of degrees.
2	U, L	Normally all zeros. Numbers in either display indicate malfunctions and should be recorded for maintenance.
3	U	Prior To Launch Displays the platform X-axis velocity in feet per second with two decimal places. After Launch: Displays the standard deviation of azimuth error.
3	U	Prior To Launch Displays the platform Y-axis velocity in feet per second with two decimal places. After Launch: Displays the velocity measurements used by the Smal Kalman filter during doppler inertial mode.
4	U	Displays the vertical lever arm in feet. This is the vertical distance between the ship's SINS and the aircraft IMU. This is an important parameter for shipboard alignment.
4	L	Displays the aircraft true heading in degrees and minutes, and tenths of minutes.
5	U, L	Displays the octal content of the ANCU memory that is set identified by the AUX-6 DISPLAY. The digits in the upper display precede the digits in the lower display.
6	U	Input address of an ANCU memory location.
6	L	Input scaling factor for the input address, if applicable.

Figure 2-112. Auxiliary Data Display (Aircraft Not Incorporating AFC-279) (Sheet 1 of 3)

DSTN POSITION	DISPLAY REGISTER	DISPLAY INFORMATION
7	U, L	Same as AUX-5 with the exception that AUX-7 allows the entry of octal values into specified unprotected memories.
8	U	Blank.
8	L	Direct numerical readout of address in 6 if scaling factor is correct.
9	U	Displays alignment status indicators (see Figure 2-113).
9	L	DISPLAYS SPOTTING ANGLE (A/C heading on land) for a stored heading alignment.

Figure 2-112. Auxiliary Data Display (Aircraft Not Incorporating AFC-279) (Sheet 2)

2.22.4.4 BIT Mode (Aircraft Not Incorporating AFC-279). BIT mode selection interrupts the HSI heading display (if selected to AHRS) to present a 225° simulated heading, along with HDG and ATT flags. This test provides a quick check of the AHRS heading circuits within the navigation control, AHRS converter, NDCR, navigation display selector, and HSI.

2.22.5 Doppler Ground Velocity Set (Aircraft Not Incorporating AFC-279). The Doppler set provides aircraft vertical velocity, along-heading velocity, across-heading velocity, and status indications. Doppler velocity data are stabilized in the GPDC and in the INS computer. Land-sea bias is corrected automatically.

The following service ceiling and roll/pitch constraints are current operating limits:

Altitude:

0 to 5,000 feet . . . . pitch 0° to ±30°
roll 0° to ±60°

5,000 to 40,000 feet . . . . . . pitch 0° to ±25°
roll 0° to ±45°

The Doppler antenna is flush-mounted on the underside of the fuselage and is fixed relative to the aircraft. The Doppler-derived velocities are used for damping the INS, for in-flight INS alignment, and for long-range and tactical navigation within the GPDC. The set also provides for end-to-end BITE test and for continuous in-flight performance monitoring with failure indications.

2.22.6 Global Positioning System (GPS). The global positioning system computes aircraft position coordinates, altitude, speed, and time information from signals transmitted by a network of NAVSTAR Global Positioning System satellites. The GPS satellites are arranged in three rings orbiting the earth twice a day to provide worldwide, continuous coverage.

Each GPS satellite broadcasts two radio frequency signals. Each RF signal is modulated with a unique code sequence for satellite identification and a navigation data message that provides information about the operation of the satellite. The navigation data messages are modulated on two types of codes: a precision code (P code) and a coarse/acquisition code (C/A code). A crypto key is needed to acquire the P code. The C/A code's shorter repeat sequence allows it to be acquired more quickly than the P code. Although the P code is more difficult to acquire, it allows for much greater accuracy of position calculations.

A GPS ground control system (consisting of various unmanned monitor stations and a control center) tracks the satellites, monitors and controls their orbits, and updates the navigation data messages. The control center uses tracking information received from the monitor stations to calculate each satellite's precise position and clock error (ephemeris data) as well as satellite position for all GPS satellites (almanac data). Once each day, the control center transmits the ephemeris and almanac data to each satellite to update its navigation data message.

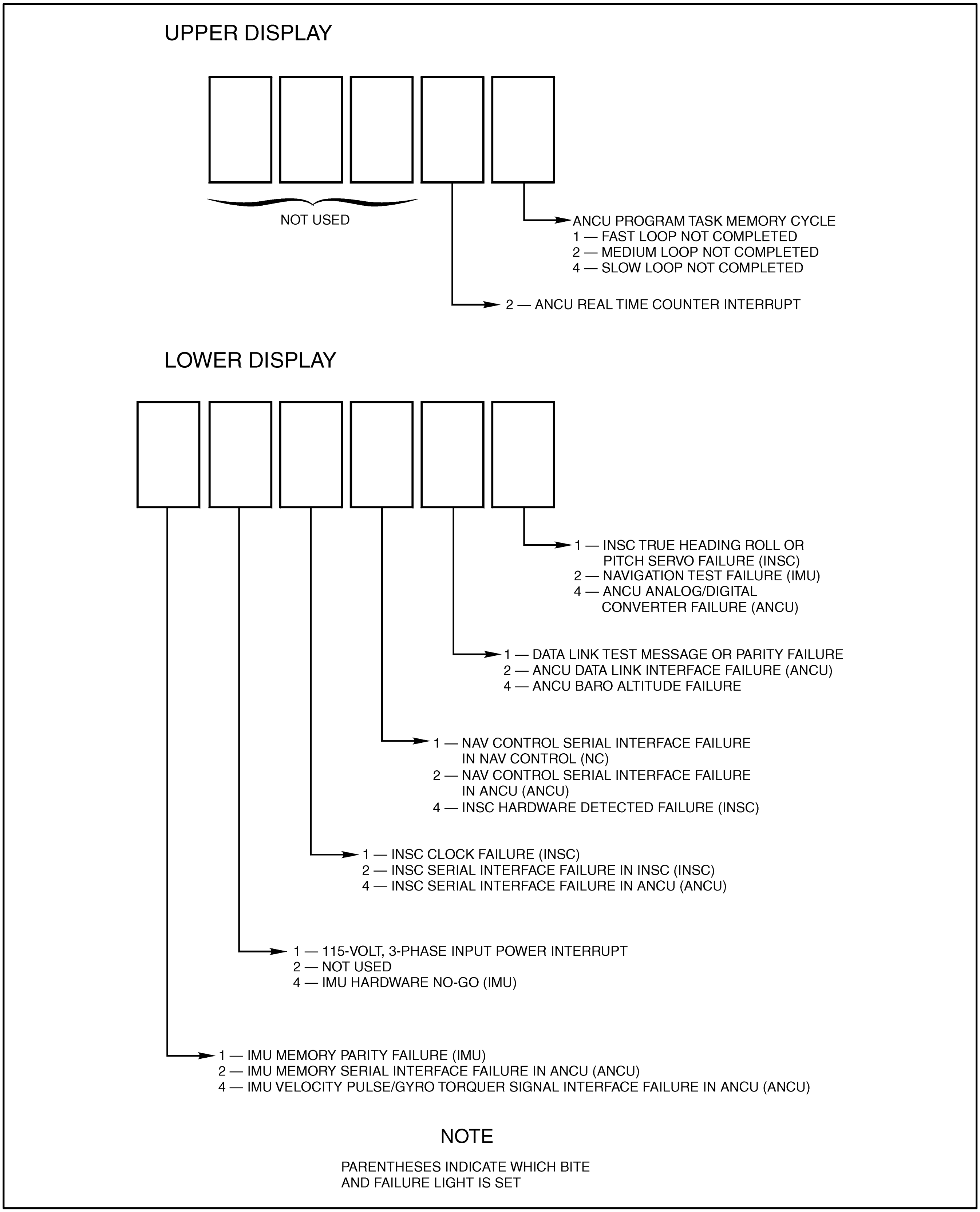


Figure 2-112. Auxiliary Data Display (Aircraft Not Incorporating AFC-279) (Sheet 3)

UD	INTERPRETATION
00000	Cage period, no align data entered.
00001	Cage period, align data entered.
00002	Coarse align, no taxi.
00004	Fine align, taxi okay.
00014	INS light on, still aligning.
00010	NAV mode, alignment terminated.
01002	Handset coarse align, no taxi.
01004	Handset fine align, taxi when ready to terminate weight-on-wheels alignment.
01014	Handset align complete.
01010	NAV mode entered from handset align, alignment terminated.
10002	Stored heading coarse align, no taxi.
10004	Stored heading fine align, taxi okay.
10014	Stored heading align complete.
10010	NAV mode entered from stored heading align, alignment terminated.
11002	Stored heading coarse align, data link lost, no taxi.
11004	Stored heading fine align, data link lost, taxi when ready to terminate weight-on-wheels align.
11014	Stored heading align complete, data link lost.
11010	NAV mode entered from stored heading align complete with data link lost, alignment terminated.

Figure 2-113. AUX 9 Readouts (Aircraft Not Incorporating AFC-279)

PROCEDURES	COMMENTS/RESULTS
1. Set parking brake.	
2. Set NC data switch to DSTN.	
3. Enter/verify actual current position.	
4. Set NC data switch to FLY-0	
5. Press POS FIX.	Record error.
6. Record AUX 2 LOWER readout.	Report errors exceeding 2.0 nm per flight hour and AUX 2 readouts to maintenance.

Figure 2-114. CAINS Closeout (Aircraft Not Incorporating AFC-279)

The GPS radio receiver calculates its exact distance from each satellite by using the precise time data broadcast by each satellite to measure the elapsed time the RF signals take to reach the receiver. This elapsed time is then multiplied by the speed of RF propagation to determine the aircraft to satellite distance. By calculating the distance to four satellites, precise three-dimensional aircraft position can be computed. Aircraft speed is calculated by measuring the rate of change of the received RF signals. The accuracy of this satellite ranging data is improved by compensating for the following three types of errors:

1. Satellite clock and position error
2. Atmospheric delay of satellite signals
3. GPS radio receiver clock error.

2.22.6.1 GPS Components. The global positioning system is powered by the essential ac bus, the essential dc bus, and the essential instrument/synchro bus. The GPS comprises the following nine components:

1. GPS antenna, AS-3822/URN
2. GPS antenna electronics unit, 622-8D84-001
3. Miniaturized airborne GPS receiver, R-2414/U
4. Control display navigation unit, C-12284/A (two units)
5. GPS crypto fill panel, C-12094
6. AUX NAV SELECT panel, 1223016
7. Digital data set, ASQ-215
8. Flight instrument wired assembly, 1223020
9. Signal data converter, CV-4138A.

2.22.6.1.1 GPS Antenna. The GPS antenna receives radio frequency signals transmitted by the NAVSTAR GPS satellites. This antenna is located in the center of the upper fuselage above the cockpit.

2.22.6.1.2 GPS Antenna Electronics Unit. The GPS antenna electronics unit amplifies and downconverts satellite radio frequency signals, which can be processed by the miniaturized airborne GPS receiver. The antenna electronics unit is located in the bulkhead aft of the copilot/COTAC. (On aircraft incorporating AFC-279, this unit was relocated to the battery tray on the right-hand internal avionics rack.)

2.22.6.1.3 Miniaturized Airborne GPS Receiver. The miniaturized airborne GPS receiver (MAGR) decodes received satellite signals and provides computed position coordinates, altitude, speed, and time data to aircraft systems. This unit is located in the right internal avionics bay.

2.22.6.1.4 Control Display Navigation Unit. (Figure 2-115) The control display navigation unit (CDNU) provides operator control of the GPS and tacan, and displays navigation data and system status. There are two CDNUs in the aircraft. CDNU1 is located on the cockpit center console, and CDNU2 is located on the TACCO's instrument panel.

2.22.6.1.5 GPS Crypto Fill Panel. The GPS crypto fill panel (Figure 2-118) is used to insert cryptological data for decryption and processing of encoded satellite signals by the GPS receiver. This panel is located on the bulkhead below the SENSO INCOS tray.

2.22.6.1.6 AUX NAV SELECT Panel (Aircraft Incorporating AFC-279). The AUX NAV SELECT panel (Figure 2-96) indicates the currently selected GPS flight mode and is also used to select either the GPS or the tacan as the source of data to be displayed on the HSIs. The AUX NAV SELECT panel is located on the center instrument panel, immediately below the fuel panel.

2.22.6.1.7 Digital Data Set. The digital data set (DDS), commonly called the mission data loader (MDL), comprises the CP-2092(D)/A interface receptacle unit and the MU-1053/A data transfer module. The interface receptacle unit is located below the SENSO INCOS tray. The data transfer module is a portable cartridge device that is inserted into the interface receptacle unit to load programmable mission and flight plan data into the CDNUs. The data transfer module is programmed externally to the aircraft using the Tactical Air Mission Planning System (TAMPS). TAMPS incorporates a 1553B bus-compatible computer to build waypoint databases and to construct and label flight plans during preflight planning.

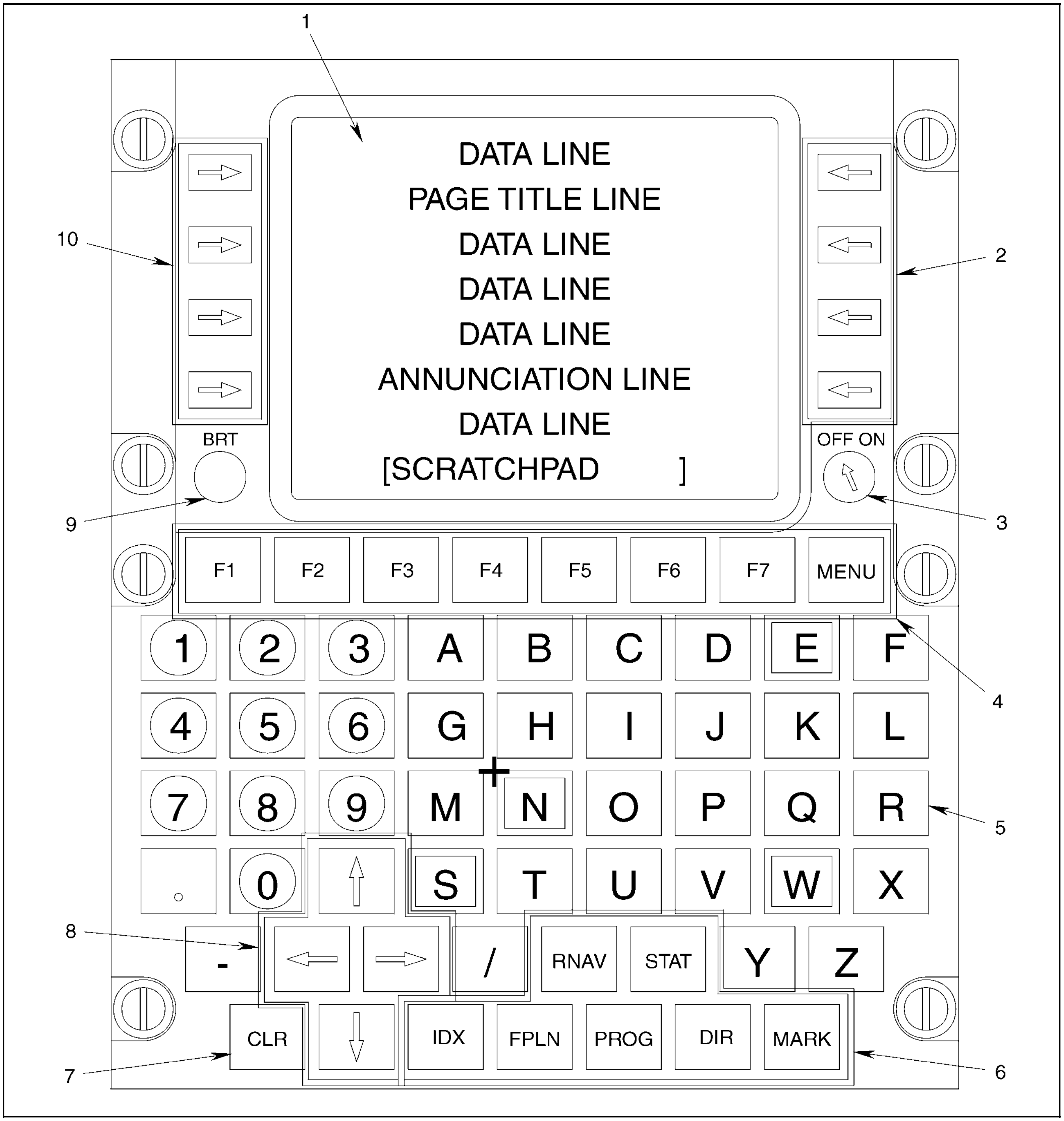


Figure 2-115. Control Display Navigation Unit (Aircraft Incorporating AFC-279) (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Display	Displays data and system annunciations on 8 lines of 22 characters each. Lines 1, 3, 4, 5, and 7 are data lines. Line 2 displays page title. Line 6 displays system annunciations. Line 8 is the scratchpad for holding all keypad entries.
2	Line select keys 5–8	Access lower level pages, toggle function modes, or enter data in the associated fields for lines 1, 3, 5, and 7, respectively (right side.)
3	OFF ON power switch	Removes or applies power to the CDNU.
4	Special function keys	F1–F7 keys select specific applications. **Note** For aircraft not incorporating AFC-279, F7 is the only special function key that is defined. MENU key accesses the MENU page, which displays definitions of special function keys F1–F7.
5	Alphanumeric keys	Enter data in the scratchpad/selected field. **Note** Entering "–" in the scratchpad and then pressing a line select key deletes data from the associate field. MENU key accesses the MENU page, which displays definitions of special function keys F1–F7.
6	Standard function keys	Display RNAV, SYSTEM STATUS, INDEX X/2 (last displayed), FLT PLN, PROGRESS X/3 (last displayed), DIRECT TO, and MARK LIST pages.
7	CLR key	Clears incorrect scratchpad entries.
8	Arrow keys	Control vertical and horizontal page scrolling and vertical line scrolling.
9	BRT knob	Controls CDNU display brightness.
10	Line select keys	Access lower level pages, toggle function modes, or enter data in the associated fields for lines 1, 3, 5, and 7 respectively (left side).

Figure 2-115. Control Display Navigation Unit (Aircraft Incorporating AFC-279) (Sheet 2)

The DDS menu on the CDNU is used to load data from the data transfer module into the interface receptacle unit. The DDS is capable of loading up to 12 flight plans of 50 waypoints each. The operator may select a flight plan already exiting in the DDS or create a flight plan in the CDNU using waypoints from the primary database or the reversionary database. The primary database resides in the DDS. When a data transfer module is inserted in the DDS, indices of selected waypoint identifiers are automatically transferred into CDNU memory to speed the search process when a specific waypoint identifier is requested. The reversionary database is stored in CDNU non-volatile memory for use when the DDS has failed or is not installed, or the requested data are not in the primary database on the data transfer module. The reversionary database contains 200 waypoint identifiers and can be transferred from the DDS into CDNU memory on operator request.

Additionally, magnetic variation coefficients are loaded with the DDS to permit the display of magnetic bearings on the CDNU. The DDS can also be used to download GPS Almanac data to the GPS receiver, allowing the receiver to quickly acquire its first satellite after battery replacement. The digital data storage set is powered by the essential dc bus through the DIGITAL DATA SET circuit breaker.

2.22.6.1.8 Flight Instrument Wired Assembly (Aircraft Not Incorporating AFC-279). The flight instrument wired assembly (FIWA), located behind the ARN-153 tacan on the right aft electronics rack, interfaces the GPS and tacan with the flight instruments. See FO-13 for more detailed information regarding FIWA signal flow.

2.22.6.1.9 Signal Data Converter (Aircraft Not Incorporating AFC-279). The signal data converter performs digital to analog conversion of some signals for display on the flight instruments and interfaces the GPS with the flight instruments. See Figure FO-13 for more detailed information on GPS signal flow.

2.22.6.2 GPS Operation. All GPS functions are controlled through the CDNU. For additional details on the GPS and its functions, see Global Positioning System S-3B GPS In-Flight Procedures Guide developed by Star Media Inc. and Sea Control Weapons School Atlantic, July 1999.

2.22.6.3 GPS Loading Procedures

PURPOSE:

Loads GPS S/A and A/S cryptographic codes into the GPS receiver to prevent degradation of GPS accuracy due to induced satellite clock error while selective availability is imposed.

PREREQUISITES:

1. Power is applied to the GPS on the POWER page of the CDNU.
2. Proper code is set in the KYK-13.

PROCEDURES:

1. Press line select key 7 (ZERO KEYS) twice on the GPS SA/AS page of the CDNU.
2. Connect the coded KYK-13 with its ON/OFF/CHECK switch in the OFF position to the FILL connector on the KYK-13 GPS crypto fill panel.
3. Set the KYK-13 switch to the desired fill register.
4. Set the KYK-13 ON/OFF/CHECK switch to ON.
5. Set the LOAD switch on the GPS crypto fill panel to the LOAD position.
6. Observe that the ACK light on the GPS crypto fill panel illuminates, indicating successful load of the GPS receiver.

DEACTIVATION:

1. Press line select key 7 (ZERO KEYS) twice on the GPS SA/AS page of the CDNU.
   a. SAFE KEYS is displayed on line 6 of the CDNU display.

2.22.7 Control Display Navigation Unit. The two control display navigation units provide integrated, on-line control of navigation data from the GPS, tacan, SCADC, and DDS through a MIL-STD-1553B data bus. The first CDNU that is turned on acts as the bus controller. The other CDNU acts as a backup bus controller that takes over if the bus controller CDNU fails. The function is transparent to the operator.

2.22.7.1 CDNU Description. The CDNU (Figure 2-115) comprises a display and various alphanumeric and function keys that are used to display and manipulate data. The CDNU contains two software programs: the Operational Flight Program (OFP) and the fixed program. The OFP executes flight plan management, navigation, and other operational tasks. The OFP may be loaded from the DDS into CDNU memory via the MIL-STD-1553B bus. The fixed program performs built-in test (BIT) and loading of OFPs.

The CDNUs are powered by 28 vdc from the essential dc bus. If the CDNU power supply voltage falls below the absolute steady state limits for less than 500 msec, random access memory (RAM) will be maintained through this period, and the CDNU will resume normal operation when normal steady state voltage levels are restored.

Note

If RAM has not been maintained, the CDNU will perform a power-on BIT while the display warms up. In this case, up to 30 seconds may be required for the CDNU to become operational.

2.22.7.1.1 CDNU Display. The CDNU display presents various pages of navigational and system data in a format consisting of 8 lines of 22 characters each. Standard CDNU menu pages are depicted in the S-3B GPS In-Flight Procedures Guide.

The bottom line of the display is a buffer, called a scratchpad, which holds all keystrokes prior to executing the input. Incorrect scratchpad entries may be cleared with the CLR key. A single press of the CLR key clears the last character entered. A second press (without intervening keystrokes) clears the entire scratchpad.

2.22.7.1.2 CDNU Line Select Keys. The eight line select keys, located four on either side of the display, are used to:

1. Access lower level pages

2. Select modes of a given function

3. Enter data in the associated field.

The CDNU responds to operator entries within 1 second. For certain functions, a given line select key may be used both for selecting a mode as well as entering the numeric values displayed in the scratchpad.

Functions that involve destruction of significant internal data require confirmation before execution. This is indicated by a CONFIRM XXX message in the scratchpad. The function is confirmed by pressing the appropriate line select key again or by pressing the CLR key if the function is not required.

2.22.7.1.3 CDNU Standard Function Keys. The CDNU has seven standard function keys. These keys are used to access the RNAV, SYSTEM STATUS, INDEX X/2 (last displayed), FLT PLN, PROGRESS X/3 (last displayed), DIRECT TO, and MARK LIST pages directly.

2.22.7.1.4 CDNU Arrow Keys. The CDNU arrow keys are used to scroll display pages, when a related set of data appears on more than one page. Double and four-headed arrow symbols adjacent to the scratchpad indicate if lateral, vertical, or lateral and vertical scrolling is available. Vertical line scrolling displays one new line with each press of an arrow key. Vertical or lateral page scrolling displays a new page of data with each press of an arrow key.

2.22.7.2 CDNU Standard Data Entry and Display Formats. Navigation related values may be expressed in either metric or English units, as selected by line select key 7 on the RNAV page. True or magnetic north bearing reference may be selected by line select key 6 on the RNAV page. Valid data entry ranges for a given field are limited by display resolution. When a computed value is too large to fit in a given field, the highest possible value is displayed.

Waypoints may be entered using one of three basic formats:

1. Position coordinates — using latitude/longitude or Military Grid Reference System coordinates

Note

Latitude and longitude are entered in degrees, minutes, and tenths of minutes.

2. Identifier — using five-character alphanumeric position label from waypoint database

3. Identifier/bearing/distance — using position defined at a specified bearing and distance from a database waypoint with the indicated identifier.

Bearings are entered in three digits optionally followed by a decimal point and another digit, with leading zeros. Distances are entered as up to four digits optionally followed by a decimal point and up to two additional digits. Courses are always entered as integers from 1 to 360 with leading zeros.

A user-defined label with up to five alphanumeric characters preceded by a / may be attached to latitude/longitude and MGRS waypoints coordinates in the flight plan and mark list. The initial / eliminates confusion between user-defined and identifier database waypoints.

Time is entered with no delineators among hours, minutes, and seconds. All times are entered as Universal Coordinated Time. Dates are entered with / delineators and written in the order of month/day/year.

Data may be deleted from most data entry fields by entering a (—) in the scratchpad and pressing the line select key adjacent to the desired field.

2.22.7.3 CDNU Annunciations. The CDNU alerts the crew of WRA failures, degraded operations, and operator entry errors. Three methods are used to display alerts:

1. System annunciations

2. Scratchpad messages

3. Master CDNU alert discretes.

System annunciations appear on line 6 of both CDNUs simultaneously. The annunciation line is divided into two fields, left and right justified, that have independent display queues and priorities. Higher priority annunciations pre-empt the display of lower priority annunciations. Annunciations are removed from the display queue automatically when the conditions causing them are eliminated. Pressing the CLR key on the CDNU also clears the highest priority annunciation from each field, and displays the next lower priority annunciations. Some annunciations are not clearable and are placed at the bottom of the display queue when the CLR key is pressed.

Scratchpad messages are displayed locally on the CDNU that caused the condition requiring the message. Some scratchpad messages are alternately displayed with the invalid scratchpad data, such as an invalid position and ERROR. The CLR key clears scratchpad messages before clearing annunciations on the annunciation line.

2.22.7.3.1 Flight Plan Database Transfer

PURPOSE:

Transfers the desired flight plan database from the DDS to the CDNU.

1. PREREQUISITES:

2. GPS START page is displayed on CDNU.

   Data transfer cartridge is inserted in DDS.

Note

When the data transfer cartridge is inserted in the DDS, approximately 20 seconds are required for the primary identifier database to be automatically transferred from the DDS to the CDNC.

PROCEDURES:

1. Press the down arrow key on the CDNU.

   a. DDS START page is displayed on CDNU.

2. Press line select key 8 (LOAD).

   a. FLT PLN SELECT 1/2 page is displayed.

3. Scroll to desired FLT PLN SELECT page, and press line select key corresponding to desired flight plan.

DEACTIVATION:

1. Press line select key 4 (ERASE) with DDS START page displayed.

2.22.7.3.2 Encrypting and Decrypting GPS SA/AS Keys

PURPOSE:

Encrypts or decrypts GPS selective availability/anti-spoof (SA/AS) keys.

PREREQUISITES:

1. Power is applied to the CDNU.
2. Power is applied to the GPS on the POWER page of the CDNU.
3. KYK-13 with proper codes is connected to the GPS crypto fill panel.

PROCEDURES:

1. Press IDX standard function key.
   a. Last displayed INDEX page is displayed.
2. Press down arrow to scroll down to INDEX 2/2 page, if necessary.
   a. INDEX 2/2 page is displayed.
3. Press line select key 2 (ZEROIZE) to display ZEROIZE page.
4. Press line select key 7 (GPS) to display GPS SA/AS page.
   a. GPS SA/AS page is displayed.
5. Enter storage code in scratchpad, and then press line select key 4 to accept code and encrypt/decrypt the SA/AS keys.

Note

- The storage code is limited to 16 characters maximum.
- The storage code is a password and is never displayed on line 5. The STORAGE CODE display remains on line 5.
- If the SA/AS keys are encrypted and an incorrect storage code is entered, the SA/AS keys will be erased.

6. To enter new mission duration, reducing number of valid keys stored in the GPS, enter the new number of days of mission duration in the scratchpad, and then press line select key 3 (DAYS) to accept.
   a. The new mission duration appears on line 5.

DEACTIVATION:

None

2.22.7.3.3 Clearing GPS SA/AS Keys

PURPOSE:

Zeroizes GPS SA/AS keys.

PREREQUISITES:

1. Power is applied to the CDNU.
2. Power is applied to the GPS on the POWER page of the CDNU.
3. KYK-13 with proper codes is connected to the GPS crypto fill panel.

PROCEDURES:

1. Press IDX standard function key.
   a. Last displayed INDEX page is displayed.
2. Press down arrow to scroll down to INDEX 2/2 page, if necessary.
   a. INDEX 2/2 page is displayed.
3. Press line select key 2 (ZEROIZE) to display ZEROIZE page.
   a. ZEROIZE page is displayed.
4. To zeroize all SA/AS keys in the GPS receiver press line select key 7 (ZERO KEYS).

Note

When there are no current GPS SA/AS keys loaded in the GPS, display of ZERO KEYS and STORAGE CODE is inhibited by the CDNU, and the associated line select keys 4 and 7 are not functional.

a. CONFIRM ZERO KEYS is displayed in the scratchpad.

5. Press line select key 7 (ZERO KEYS) again to confirm execution of the zeroize function.

   a. If the GSP SA/AS keys were zeroized, SAFE KEYS appears on the annunciation line.

   b. If the GPS SA/AS keys were not zeroized, NO KEYS ZERO appears on the annunciation line.

DEACTIVATION:

1. Press a standard function key when CONFIRM ZERO KEYS is displayed in the scratchpad. Do not press line select key 7 (ZERO KEYS) a second time.

Note

Encrypted keys can be saved in GPS non-volatile memory if power is removed from the system using the POWER page prior to securing aircraft power.

2.22.7.3.4 Control of System-Initiated Tests

PURPOSE:

Performs initiated built in test (IBIT) of WRAs upon operator command.

Note

IBIT can be commanded only when the ground/air discrete on the CDNU indicates GROUND, with the exception of the tacan.

PREREQUISITES:

1. Power is applied to CDNU.

PROCEDURES:

1. Press IDX standard function key.

   a. Last displayed INDEX page is displayed.

2. Press down arrow to scroll down to INDEX 2/2 page, if necessary.

   a. INDEX 2/2 page is displayed.

3. Press line select key 1 (SYS TEST) to display SYSTEM TEST page.

   a. SYSTEM TEST page is displayed.

Note

Test results on the SYSTEM TEST page reflect latest IBIT results, not current status.

4. To display individual WRA detailed test pages for DDS, GPS, CDNU1, CDNU2, and tacan, press line select keys 1 (DDS), 2 (GPS), 5 (CDNU1), 6 (CDNU2), and 7 (TACAN), respectively.

Note

SDC and SCADC do not have detailed test pages and their IBITs are commanded by pressing line select keys 3 (SDC) and 4 (SCADC), respectively on the SYSTEM TEST page.

   a. Detailed test page for the selected WRA is displayed.

5. To initiate IBIT for the given WRA, press line select key 1 (INITIATE TEST) on the applicable detailed test page.

   a. An asterisk appears on line 1 to the left of INITIATE TEST, indicating the IBIT is being executed.

   b. IBIT results are displayed on line 5.

Note

IBIT results are reported in 16 bits (IBIT words) arranged from left to right. A failure is indicated by a 1 in a given bit. See applicable maintenance publication for IBIT word definitions.

DEACTIVATION:

6. To return to the SYSTEM TEST page from an individual WRA detailed test page, press line select key 8 (SYSTEM TEST).

2.22.7.3.5 Loading Operational Flight Programs

PURPOSE:

Loads Operational Flight Program (OFP) to perform flight plan management, navigation, and other operational tasks.

Note

The CDNU contains two software programs, the OFP and the fixed program. The fixed program performs built-in test and loading of OFPs.

PREREQUISITES:

1. Power is applied to CDNU.
2. Cartridge is inserted in DDS.

PROCEDURES:

1. If no OFP is currently installed, the fixed program will automatically begin to run when power is applied to the CDNU. Skip to step 6.

Note

The CDNU must be executing the fixed program in order to load an OFP. When the OFP LOAD page is displayed, this indicates that the fixed program is executing and has taken control of the MIL-STD-1553B bus.

2. If an OFP is installed and is executing properly, perform the following to access the fixed program.

Note

It is possible to load an OFP that could cause the CDNU to lock up. If this occurs, the fixed program can be accessed by removing power from the CDNU and then pressing the CLR key while reapplying power with the CDNU ON/OFF switch.

3. Press IDX standard function key.
   a. Last displayed INDEX page is displayed.
4. Scroll, if necessary, to display INDEX 1/2 PAGE.
5. Press line select key 5 (DDS).
   a. DDS page is displayed.
6. Press line select key 8 (OFP LOAD).
   a. OFP LOAD page is displayed.

Note

Once the fixed program is executing, the DDS address (20) must be entered to establish communication between the DDS and the CDNU.

7. Enter the DDS (MDL) terminal address (20) in the scratchpad, and press line select key 1 (MDL ADR) to accept.
   a. The OFP label and software part number appear on lines 4 and 5, indicating that communication is established between the DDS and the CDNU.
8. To verify hardware status prior to loading the OFP, press the STAT standard function key.
   a. OFP LOAD STATUS page is displayed, showing results of CDNU and DDS CBIT on lines 4 and 5.
9. To perform CDNU IBIT, press line select key 4 (SELF TEST) on the OFP LOAD STATUS page.

Note

If CDNU IBIT id performed, all the contents of RAM memory, including the MDL address entered on the OFP LOAD page, are lost.

   a. CDNU SELF TEST page is displayed, showing results of CDNU IBIT on line 5.
10. To return to the OFP LOAD page, press line select key 8 (OFP LOAD) on either the OFP LOAD STATUS page or the CDNU SELF TEST page.

Note

If a zeroized or blank MDL cartridge is inserted in the DDS, the display under CARTRIDGE CONTAINS on line 4 of the OFP LOAD page will be blank. If this occurs, press line select key 4, even though the CANCEL indication will be missing. This will display the previous page.

11. Press line select key 8 (LOAD) to load a new OFP.

    a. CONFIRM LOAD OFP advisory appears in the scratchpad.

12. Press line select key 8 (LOAD) again to confirm the load of the new OFP.

    a. 120 KBYTES VERIFIED appears on line 7, indicating verification of memory is occurring.

    b. 120 KBYTES ZEROED appears on line 7, indicating zeroing of memory is occurring.

    c. 760 KBYTES ERASED appears on line 7, indicating erasing of memory is occurring.

    d. 230 KBYTES LOADED appear on line 7, indicating OFP is being loaded.

    e. After loading the OFP, a normal warm start of the OFP is executed, and the GPS START page is displayed. (For aircraft with AFC-279 incorporated, the CAINS control page is displayed).

Note

If a software version incompatibility is detected between the bus-controlling CDNU and the remote CDNU, a non-clearable VERSION ERR annunciation is displayed on line 6. To prevent data corruption in this case, the bus-controller CDNU will not send data to update the non-volatile memory of the remote terminal CDNU.

DEACTIVATION:

1. Press line select key 4 (CANCEL) instead of line select key 8 (LOAD) on the OFP LOAD page.

2.22.7.4 Carrier Inertial Navigation System II (Aircraft Incorporating AFC-279). The Carrier Aircraft Inertial Navigation System II AN/ASN-139 (CAINS II), provides precision long-range navigation capability. CAINS II is controlled by the Control Display Navigation Unit, C-12284/A (see Figure 2-116) via the MIL-STD-1553B Data Bus. CAINS II interfaces with other navigation systems via the 1553B data bus and the Navigation Interface Unit (NIU). (See FO-23).

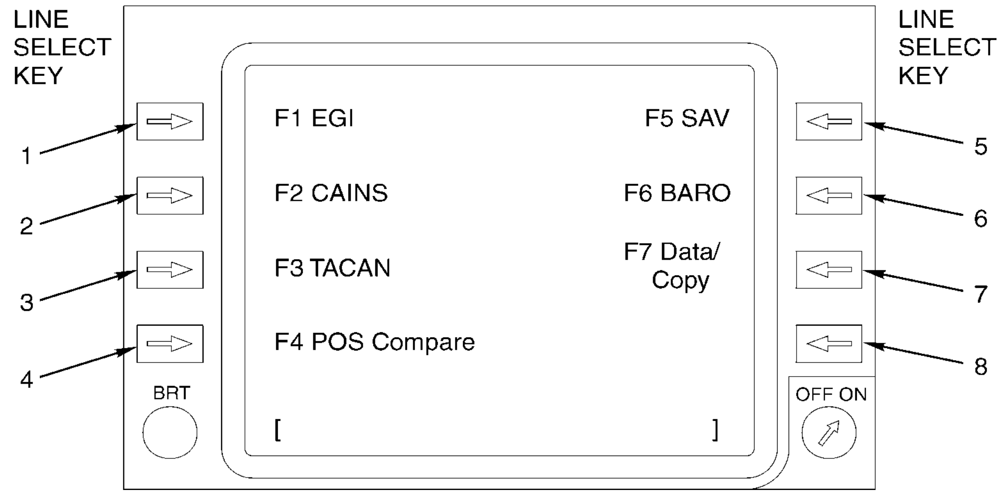
The CAINS II System comprises two navigation units, the Embedded Global Positioning System/Inertial Navigation System, CN-1689(V)/ASN (EGI) and the Inertial Navigation Unit, CN-1649/ASN-139, also commonly termed Carrier Aircraft Inertial Navigation Set (CAINS). The EGI is the primary navigation data source, and the CAINS is the backup source. CAINS II components are shown in Figure 2-117. The CAINS and EGI are controlled by the CDNUs. The CDNU operating controls and indicators are shown in Figure 2-115.

2.22.7.5 Carrier Inertial Navigation System II Components (Aircraft Incorporating AFC-279)

2.22.7.5.1 Embedded GPS/INS CN-1689(V)/ASN (Aircraft Incorporating AFC-279). The EGI is a self-contained navigation system providing outputs of linear and angular acceleration, velocity, Universal Transverse Mercator coordinates of position, attitude, magnetic and true heading, altitude, body angular rates, time tags, and Universal Time Coordinated synchronized time. The EGI is located under the floor between the TACCO and SENSO stations. There are no controls or indicators located on the EGI.

The EGI uses aircraft 28 vdc essential power. In case of a power failure, the emergency navigation battery provides 24 vdc backup power for 3 minutes to facilitate an orderly shutdown of the EGI. A self-contained 3.6 vdc battery is used for memory backup to retain cryptovariables, provide cold load of cryptovariables, perform cold zeroize functions, and hold up non-volatile RAM.

The EGI process turn-on signals, mode commands, initialization data and pressure altitude from the CDNUs via the 1553B data bus. Global Positioning System (GPS) satellite signals for GPS and GPS/INS system operation are received by the embedded GPS (EGPS) receiver from the Miniature Airborne GPS Receiver system (MAGR) antenna. A “parking brake set” signal used during the alignment mode to indicate a transition from ground to in-flight operation is received from the Navigation Interface Wired Assembly (NIWA). Cryptovariables used by the EGPS Precise Positioning Service Security module for selective availability (SA) and anti-spooging (AS) are loaded using the KYK-13 crypto fill panel and storage/fill device.



LINE SELECT KEY	FIELD	FUNCTION
1	F1 EGI	Displays EGI Control page.
	Menu	Page title.
2	F2 CAINS	Displays CAINS Control page.
3	F3 TACAN	Displays TACAN page.
4	F4 POS Compare	Displays POS Compare page.
5	F5 SAV	Displays strike attack vector (SAV) page.
6	F6 BARO	Displays Baro Set page.
7	F7 Data/Copy	Displays Data/Copy page.
8	Not used	Not used.

Figure 2-116. CDNU Display Page — Menu

The EGI GPS receiver module is a five-channel receiver with dual-port, random access memory (RAM) interface, capable of selective availability/anti-spoofing and anti-jam capabilities. The GPS receiver module receives, tracks, and processes GPS satellite signals from the MAGR antenna and provides appropriate position, velocity, and time information to the 1553B data bus for use by the associated navigation equipment. The receiver can track five satellites simultaneously and is capable of either stand-alone (GPS only) or aided (GPS/INS) operation.

The EGI Inertial Sensor Assembly (ISA) contains three ring laser gyros (RLGs) and three single-degree-of-freedom accelerometers mounted on a sensor block. The RLGs are single-axis rate intergrating gyoscopes that detect and measure angular rotation by measuring frequency difference between two counter-rotating laser beams. The RLGs are mounted with their input axes mutually perpendicular and collinear with the accelerometer axes on the sensor block.

The system processor (SP) provides the resources necessary to store and execute the operational flight program (OFP). Electronically erasable programmable read-only memory (EEPROM) provides OFP storage, and static random access memory provides data storage. The SP acquires data from the EGI modules via the serial buses, performs the necessary navigational computations, and transfers the data to the modules or into memory. The SP provides the capability to communicate over the 1553B data bus.

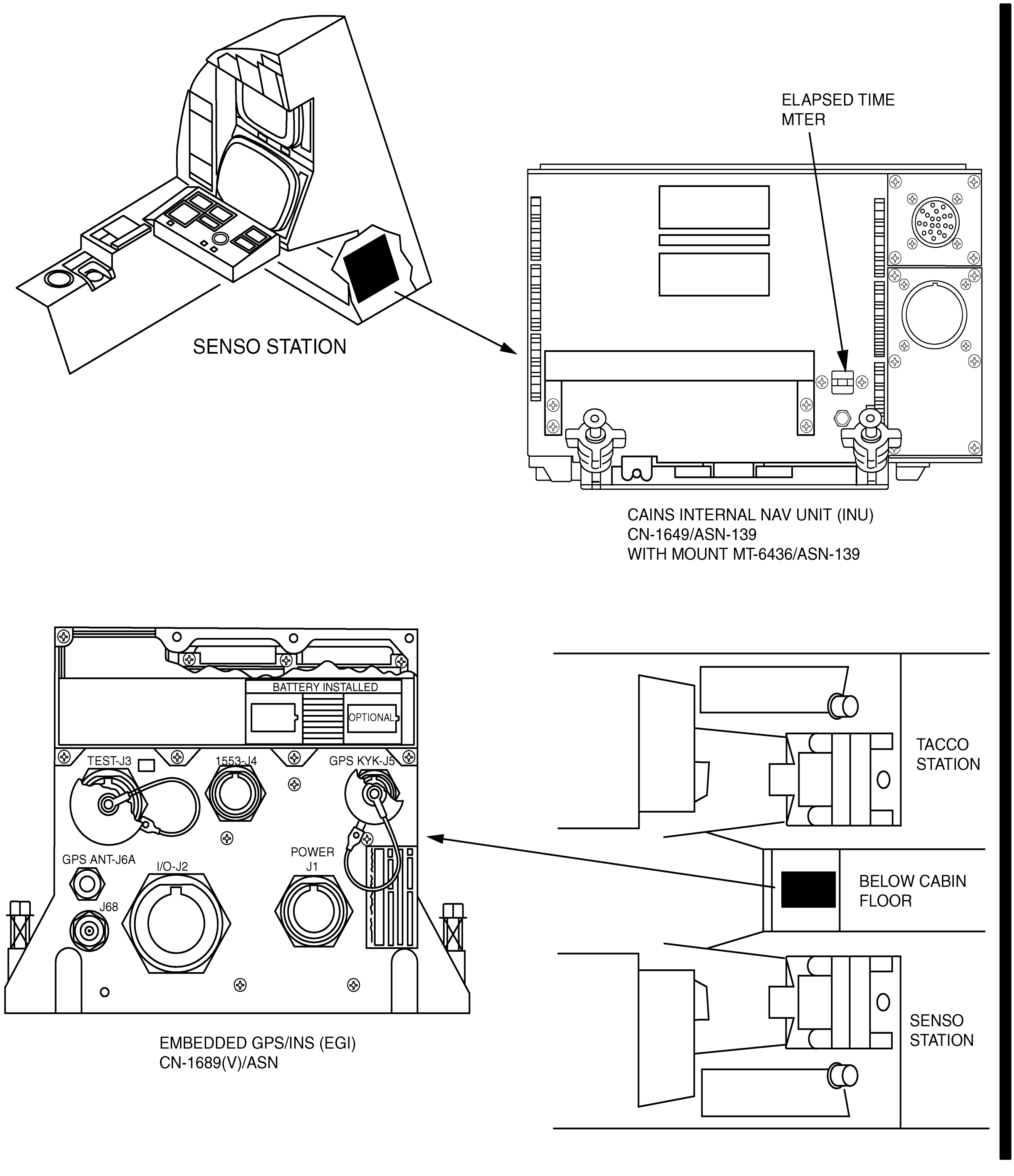


Figure 2-117. CAINS II Component Location (Aircraft Incorporating AFC-279) (Sheet 1 of 2)

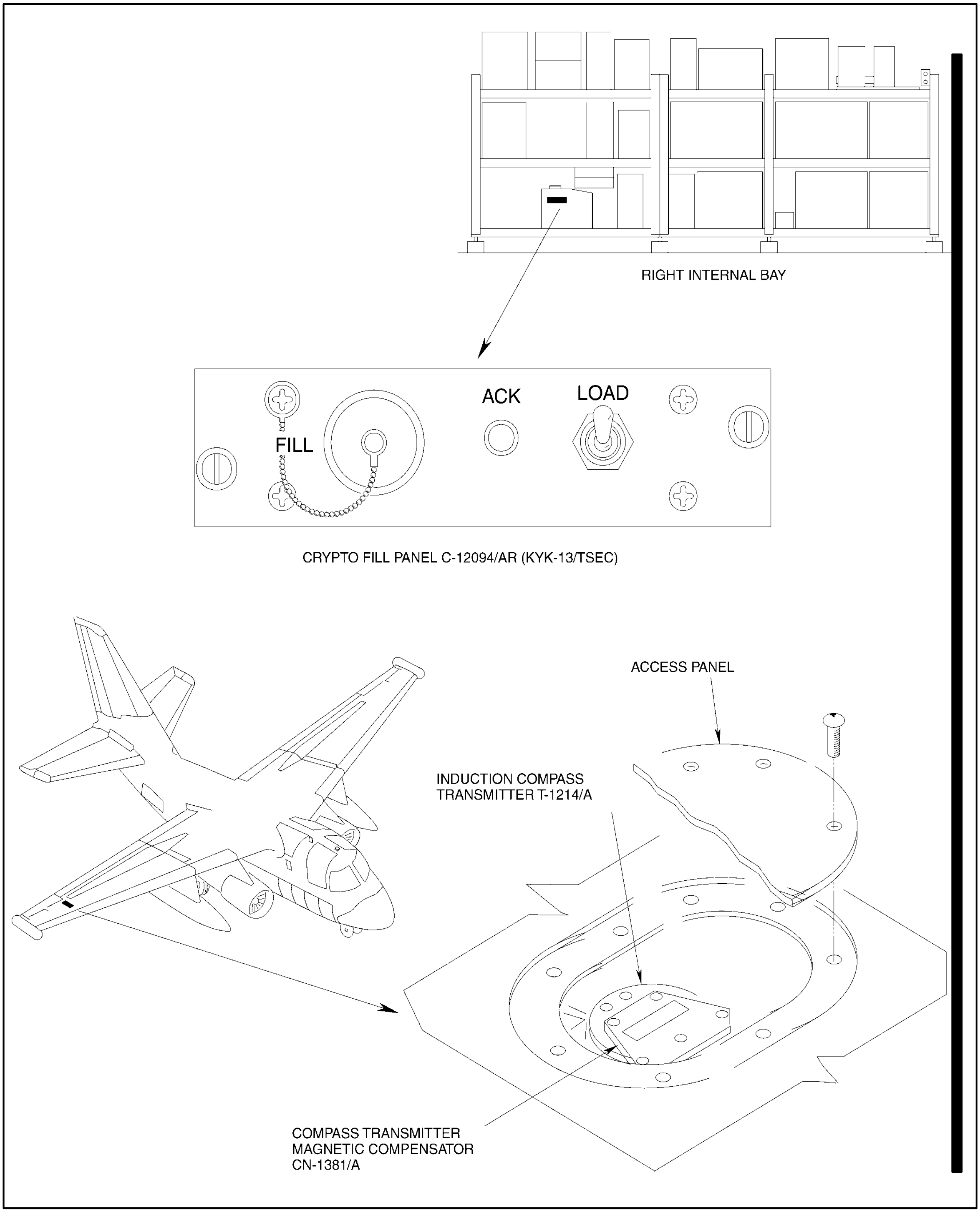


Figure 2-117. CAINS II Component Location (Aircraft Incorporating AFC-279) (Sheet 2)

2.22.7.5.2 Inertial Navigation Unit, CN-1649/ASN-139 (Aircraft Incorporating AFC-279). The CAINS, mounted under the SENSO console, is a self-contained, all altitude inertial navigation set that provides outputs of acceleration, velocity, position, heading, attitude, attitude rates, and time for pilot reference and aircraft navigation. The CAINS is capable of unaided (INS only) or aided (INS/GPS) navigation. Turn-on signals, mode commands, initialization data, and barometric altitude data for the CAINS are received from the CDNUs via the 1553B data bus. Logic from the NIWA that is used during the alignment mode to sense weight off wheels and airspeed greater than 50 KIAS indicates a transition from ground to in-flight operation. Alignment of the CAINS can be performed from a fixed base (ashore), moving base (at sea), or in the air.

The CAINS sensor assembly (SSA) contains three strap-down ring laser gyros and three single-degree-of-freedom accelerometers mounted on a sensor block. The RLGs are mounted with their input axes mutually perpendicular and collinear with the accelerometer axes on the sensor block.

The sensor data correction processor (SDCP) receives the raw gyro and accelerometer axis data from the sensor assembly and applies temperature compensation corrections. The SDCP then produces attitude and velocity quantities and outputs the data to the navigation processor (NAVP).

The CAINS power supply receivers 115 vac three phase 400 Hz from the Essential AC Bus. The power supply is divided into two separate units: the low-voltage power supply and the high-voltage power supply. The low-voltage power supply serves as a transformer-rectifier and generates dc voltages used by the CAINS electronics. The high-voltage power supply generates the dc voltages used by the RLGs.

2.22.7.5.3 KYK-13 Crypto Fill Panel, C-12094/AR (Aircraft Incorporating AFC-279). The Crypto Fill Panel (see Figure 2-118) is located on the Emergency Nav Battery Tray in the right internal bay. A connector for attaching the storage/fill device, a load switch, and acknowledge indicator are located on the front of the fill panel. The crypto fill panel facilitates Multiple Word of the Day (MWOD) encoding of the EGPS.

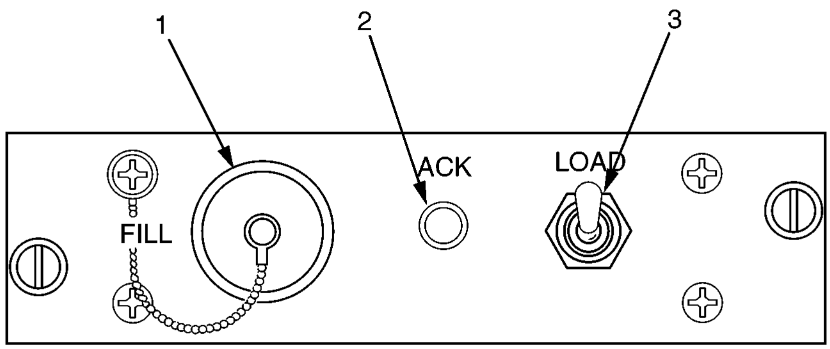
2.22.7.5.4 Remote Compass Transmitter, T-1214/A, and compass Transmitter Magnetic Compensator, CN-1381/A. The remote compass transmitter (RCT), located in the right wing (see Figure 2-117), furnishes the magnetic heading of the aircraft when the EGI and CAINS derived headings are not available. The magnetic compensator, mounted with the RCT, compensates the magnetic heading output for magnetic deviation unique to each particular aircraft. The EGI and CAINS do not use the magnetic heading derived from the RCT, but instead derive magnetic heading by applying local magnetic variation from a database to computed true heading.

2.22.7.6 CAINS II Operation (Aircraft Incorporating AFC-279). Operation of the CAINS II system is controlled by the CDNU. The CDNU controls turn-on/turn-off, mode commands, initialization data, and BIT for both the EGI and the CAINS units. The CDNU acts either as a bus controller (BC) or backup bus controller/remote terminal (BBC/RT). Each CDNU has identical bus control capability. The first CDNU operational and running the OFP controls the 1553 bus and functions as the active BC. The other CDNU assumes the BBC/RT mode. BC operation is transferred only if a failure occurs in the current bus controller CDNU power is secured. The transfer of data between the CDNUs and CAINS II system is via the MI-STD-1553B data bus.

Note

- To avoid bus controller handoff problems, CDNU No. 1 (forward) should be turned on first, to operate as the bus controller.
- If a power interrupt occurs with CDNU No. 2 acting as bus controller, loss of heading and attitude information on EFIs may result.
- For additional detail on CAINS II and its functions, see GPS/Inertial Navigation System (EGI) In-Flight Procedures Guide developed by Star Media Inc., and Sea Control Weapons School Atlantic, May 2000.

The EGI operational modes are: power-up initialization (INIT), alignment (ALN), and navigation (NAV). Initialization mode is entered upon application of power to the EGI. There are seven alignment sub-modes for the EGI. The EGI has only one navigation (NAV) mode with two possible navigation solutions: blended and free inertial.



CRYPTO FILL PANEL C-12094/AR
(KYR-13/TSEC)

INDEX	CONTROL/INDICATOR	FUNCTION
1	FILL connector	Provides for attachment of KYK-13 cable.
2	ACK light	Indicates successful data transfer when illuminated. (Not used for EGI.)
3	LOAD switch	Initiates data transfer. (Not required for loading MAGR or EGI.)

Figure 2-118. KYK-13/TSEC Crypto Fill Panel Controls and Indicators

The CAINS unit has three modes of operation: standby (STBY), alignment (ALN), and navigation (NAV). The standby mode is entered upon initial application of power to the CAINS. Standby can also be commanded, resulting in an orderly shutdown of the CAINS. This command may be used to save the data required for a stored heading alignment. For CAINS alignment, there are three primary alignment modes with corresponding sub-alignment modes and one backup alignment mode. The CAINS navigation modes available are: stand-alone navigation (SANAV) and aided navigation (AIDNAV).

Once airborne, the CDNU uses navigation data from an operator-selected source. The navigation sources available are: EGI, CAINS/GPS, CAINS, embedded INS (EINS), embedded GPS (EGPS), and GPS. If navigation data from the operator-selected source become invalid or unavailable, the CDNU then defaults to the next available source of valid navigation data lower in the hierarchy. The CDNU integrated navigation (INAV) solution hierarchy, from highest to lowest priority, is: EGI, CAINS/GPS, CAINS, EINS, EGPS, GPS, HDG/TAS, and FAIL. If the operator has not selected a navigation data source, the CDNU seeks the highest priority source available. The default INAV source is EGI. If heading is invalid for both the CAINS and EGI, the system uses magnetic heading from the remote compass transmitter in the right wing.

CAINS II system status is monitored through the CDNU Continuous Built-In-Test (CBIT) function. If CBIT detects a failure, a check status annunciation is displayed on the CDNU display, and the fault is identified on the CAINS or EGI status page. A more detailed and comprehensive evaluation of faults is available by performing the Initiated Built-In-Test (IBIT) off-line testing.

Note

The following IBITs are not available when airborne: CDNUs, NIU, EFIs, CAINS, EGI, and SCADC.

2.22.7.7 EGI Modes of Operation (Aircaft Incorporating AFC-279). The EGI has three primary modes of operation: power-up initialization (INIT), alignment (ALN), and navigation (NAV).

2.22.7.7.1 EGI Power-Up Initialization Mode (Aircraft Incorporating AFC-279). Power is applied to the EGI by selecting EGI to ON, on the CDNU Power Page, or indirectly by initiating RESTART ALIGN. This also automatically sets the EGPS to ON. Following power ON, the system automatically transitions to the power up initialization mode. While in INIT mode, all navigation outputs are set to zero, null or invalid as appropriate. All input messages are received and processed and the system responds to all MUX data requests.

2.22.7.7.2 EGI Alignment Modes (Aircraft Incorporating AFC-279). The EGI has seven alignment modes (see Figure 2-119) and two methods of alignment: gyrocompass (GC) alignment and stored heading (STHDG) alignment.

Gyrocompass alignment is the primary inertial alignment method. During GC alignment, present position data are entered via the 1553B data bus. Stored heading alignment implements a fast inertial alignment. The system initializes position and heading to the last values stored on the last shutdown, provided the EGI was transitioned to STBY prior to power off, and NAV, secondary align, or sub-align modes were not entered. If the EGI determines that the aircraft has been moved since the last shutdown, it transitions to the GC alignment method.

2.22.7.7.3 EGI Ground Alignment Mode (Aircraft Incorporating AFC-279). Restart alignment (RSTALN) is the alignment mode used when the aircraft is on a stationary base. EGI mode, position, alignment elapsed time, and alignment quality are displayed on the EGI Control Page. Ground alignment (GNDALN) is entered following a restart alignment while on the ground.

The operator can manually enter a latitude and longitude when the EGI is in GNDALN. If the operator enters a latitude and longitude while in GNDALN the CDNU will send the data to both the EGPS and EINS portions of the EGI. If the parking brake is released while the EGI is in GNDALN and EGPS is available, the EGI will transition to In-Flight Alignment utilizing EGPS reference data (IFA/GPS). If the parking brake is released while the EGI is in GNDALN and EGPS is not available, an EGI HOLD annunciation is displayed on all CDNU pages. Once the parking brake is reset, the EGI resumes alignment. Once alignment is complete, the CDNU displays EGI RDY on all CDNU pages. The EGI RDY message can be cleared only by the operator.

2.22.7.7.4 EGI Ground Alignment Stored Heading Mode (Aircraft Incorporating AFC-279). The EGI automatically transitions to the GNDALN/STHDG mode from the INIT mode if all of the following conditions are met:

1. A complete ground alignment was attained from previous operation.
2. The parking brake remained set during the alignment.
3. The NAV, secondary align, or sub-align modes were not entered.
4. The EGI was transitioned from GNDALN to STBY prior to power-off.
5. The aircraft has not been moved.

ALIGNMENT MODE	TYPE BASE
Ground Alignment (GNDALN)	Stationary Base
Ground Alignment/Stored Heading (GNDALN/STHDG)	Stationary Base
Carrier Alignment (CVALN)	Moving Base
Carrier Alignment/Stored Heading (CVALN/STHDG)	Moving Base
CV Manual (CVMAN)	Moving Base
In-Flight Alignment utilizing EGPS reference Data (IFA/GPS)	Moving Base or In-flight
In-Flight Alignment utilizing SCADC reference Data (IFA/SCADC)	In-flight

Figure 2-119. EGI Alignment Modes (Aircraft Incorporating AFC-279)

In GNDALN/STHDG mode, the EGI aligns using saved position data from the last complete alignment. Once the EGI has completed alignment, the CDNU displays EGI RDY on all CDNU pages. The EGI RDY message can be cleared only by the operator.

2.22.7.7.5 EGI Carrier Alignment Mode (Aircraft Incorporating AFC-279). Carrier alignment mode is the primary alignment mode used when the aircraft is on a moving base. When in CVALN mode, the EGI attempts to use Ships Inertial Navigation System (SINS) reference data via the Digital Data Communications Set, AN/ASW-25B, GPS reference data, or manually entered reference data. The CVALN mode is entered by selecting the CVALN line select key on the EGI control page. When the EGI is in the CVALN mode, the CDNU automatically commands the navigation interface unit to send SINS reference data to the EGI. If SINS data become unavailable or invalid after start of a SINS alignment, the EGI transitions to IFA/GPS alignment mode if EGPS data are available. If the SINS drop-out exceeds 30 seconds, and EGPS is unavailable or invalid, the EGI transitions to the CVMAN alignment mode using the last received carrier heading, speed, latitude, and longitude, and EGI HOLD is displayed on all CDNU pages. If SINS or EGPS reference data become valid again, the EGI uses the data and the EGI HOLD message is cleared, but the EGI remains in the CVMAN alignment mode.

It may be necessary to turn off the EGI and the reinitialize alignment for IFA.

The parking brake must be set for CVALN alignment mode to be initiated. If the parking brake is released while in CVALN alignment mode and EGPS reference data are available, the EGI automatically transitions to IFA/GPS alignment mode. If the parking brake is released and EGPS data are not available, EGI HOLD is displayed. Once the parking brake is reset, the EGI resumes alignment. When the alignment is complete the CDNU displays EGI RDY on all CDNU pages. The EGI RDY message can be cleared only by the operator.

A carrier alignment may be accomplished manually if SINS reference data are not available or if SINS data become unavailable or invalid during CVALN. If SINS data are unavailable for more than 5 seconds at the start of CVALN, the CDNU sends GPS reference data, if available, to the EGI. If GPS data are not available to the CDNU it displays dashes (- - - – -) in place of the latitude and longitude and alerts the operator to check data on the EGI manual page by displaying “ MANUAL DATA” in the scratchpad. The operator must then access the EGI manual page and manually enter any data required to start the alignment. If SINS data becomes available after starting a CVMAN alignment, the EGI uses the SINS data, but remains in the CVMAN mode.

Note

Once manual data have been entered, the data cannot be modified.

2.22.7.7.6 EGI Carrier Alignment Stored Heading Mode (Aircraft Incorporating AFC-279). The EGI automatically transitions to the CVALN/STHDG mode upon initation of CVALN mode if all of the following conditions are met:

1. A complete carrier alignment was attained from previous operation.
2. The parking brake remained set during the alignment.
3. The NAV, secondary align, or sub-align modes were not entered.
4. The EGI was transitioned from CVALN to STBY prior to power-off (automatically down when the EGI is powered down using the Power Page).
5. The aircraft has not been moved from its last deck spot.

The EGI aligns using saved position data from the last complete alignment. Once the EGI has completed alignment, the CDNU displays EGI RDY on all CDNU pages.

2.22.7.7.7 EGI In-flight Alignment Mode (Aircraft Incorporating AFC-279). The IFA mode is used to align the EGI when in flight. The IFA mode may also be used to align the EGI aboard ship. The IFA mode uses EGPS reference data, if valid, or SCADC reference data to perform the alignment. If the EGI is performing an alignment in GNDALN or GNDALN/STHDG and EGPS is valid and motion is detected (parking brake released), or if the EGI is performing an alignment in CVALN or CVALN/STHDG and EGPS is valid and SINS is not valid, the EGI automatically transtions to the IFA mode. If the reference data (EGPS or SCADC) become invalid for more than 65 seconds, the alignment is suspended. The CDNU displays EGI HOLD on all CDNU pages, and the alignment elapsed time stops incrementing on the EGI control page. When the reference data become valid again the alignment resumes. If the parking brake is released while in the IFA mode, the alignment is not affected. Once the EGI has completed the alignment, the CDNU displays EGI RDY on all CDNU pages. Upon completion of an in-flight alignment with weight off wheels, the EGI automatically transitions to the NAV mode, but the preferred method is the command the EGI into NAV mode on the ground after the EGI READY alert is displayed.

2.22.7.7.8 EGI Navigation Mode (Aircraft Incorporating AFC-279). The EGI transitions to the NAV mode when the EGI alignment is complete and the weight-off-wheels signal is valid, or when commanded using the EGI control page while in GNDALN, CVALN, or IFA and align quality is less than or equal to 5 nm/hr. When the EGI is selected as the navigation data source on the NAV Select Page, the CDNU uses the EGI blended solution. EGI NAV data source information is displayed on the CDNU Main RNAV Page. The EGI RNAV page may be selected from the Main RNAV page, and it displays the current EGI NAV solution. The figure of merit (FOM) for the solution is also displayed (see Figure 2-120).

2.22.7.8 CAINS Modes of Operation (Aircraft Incorporating AFC-279). The CAINS operational modes are Alignment (ALIGN), and Navigation (NAV). Power is applied to the CAINS by selecting CAINS to ON, on the CDNU power page, or indirectly by commanding the CAINS to GNDALN on the CAINS control page. Upon initial application of power, the CAINS enters the standby (STBY) mode.

2.22.7.8.1 CAINS Alignment Modes (Aircraft Incorporating AFC-279). The CAINS has three primary alignment modes, two corresponding sub-alignment modes, and one backup alignment mode (see Figure 2-121). The primary and corresponding sub-alignment modes are available only if the aircraft is not currently in or has not been in flight since power was applied. If the aircraft is in flight, the backup alignment mode (In-Flight Alignment) is used.

Note

The CAINS II requires pressure altitude to align and navigate. If SCADC is inoperable, enter the local pressure altitude via the CDNU RNAV GPS page entry field for baro aiding in order to align the CAINS.

2.22.7.8.2 CAINS Ground Alignment (Aircraft Incorporating AFC-279). CAINS Ground Alignment (GNDALN) mode is entered by selecting GNDALN on the CAINS control page. When GNDALN is selected and CAINS is OFF, the CDNU commands the CAINS to STBY, and then the CDNU sends the current position to the CAINS and displays it on the CAINS control page. If the current position is unavailable, the operator must enter the information manually. The parking brake must be set for ground alignment to be initiated. If the parking brake is not set, “ PARKING BRAKE” is displayed in the CDNU scratch pad. If the parking brake is released during ground alignment, CAINS HOLD is displayed on all CDNU pages. Once the

FOM VALUE	EXPECTED POSITION ERROR (METERS)
1	Less than or equal to 25
2	Greater than 25 and less than or equal to 50
3	Greater than 50 and less than or equal to 75
4	Greater than 75 and less than or equal to 100
5	Greater than 100 and less than or equal to 200
6	Greater than 200 and less than or equal to 500
7	Greater than 500 and less than or equal to 1000
8	Greater than 1000 and less than or equal to 5000
9	Greater than 5000

Figure 2-120. EGI NAV Solution Figure of Merit

PRIMARY ALIGNMENT MODE	CORRESPONDING SUB-ALIGNMENT MODE	TYPE BASE
Ground Alignment (GNDALN)	Stored Heading (STHDG)	Stationary
Carrier Alignment (CVALN)	Stored Heading (CVALN/STHDG), Carrier Manual (CVMAN)	Moving
In-flight Alignment (IFA)*	N/A	Moving
* The IFA mode is also used as the backup align mode.		

Figure 2-121. CAINS Alignment Modes

parking brake is reset, ground alignment resumes. After ground alignment is complete, CAINS RDY is displayed on all CDNU pages. The CAINS RDY message can be cleared only by the operator.

Note

The priority of the source of current position sent from the CDNU to the CAINS and EGI is:

1. GPS
2. Last CDNU INAV position
3. User-entered current position.

2.22.7.8.3 CAINS Ground Alignment With Stored Heading (Aircraft Incorporating AFC-279). CAINS can perform a ground alignment/stored heading alignment if the following conditions are met:

1. A complete ground alignment was attained from previous operation, and the parking brake remained set during the alignment.
2. The NAV, secondary align, or sub-align modes were not entered.
3. CAINS was commanded to STBY before power was removed.

If stored heading data are available when the operator selects GNDALN on the CAINS control page, the CDNU displays GNDALN/STHDG. Once alignment is complete CAINS RDY is displayed on all CDNU pages.

2.22.7.8.4 CAINS Carrier Alignment (Aircraft Incorporating AFC-279). CVLAN is the primary CAINS alignment mode used when the aircraft is on a moving base. The CVLAN mode is entered by selecting CVLAN on the CAINS control page. In the CVALN alignment mode, the CAINS attempts to use either a SINS input via the Digital Data Communications Set, AN/ASW-25B, or manually-input reference data. When CVALN alignment mode is selected, the CDNU commands the NIU to send SINS reference data to the CAINS. The CDNU displays the status of the SINS data on the CAINS control page. If SINS data become invalid or unavailable, the alignment is suspended and CAINS HOLD is displayed on all CDNU pages. If the SINS data are unavailable for more than 30 seconds, the CAINS transitions to the CVMAN alignment mode using the last carrier heading, speed, latitude, and longitude received from the data link.

2.22.7.8.5 CAINS Carrier Manual Alignment (Aircraft Incorporating AFC-279). CVMAN alignment mode is used when SINS data are invalid or unavailable, or to continue a CV alignment started with SINS data if SINS data drop out. If valid SINS data are not initially received, the CDNU displays CAINS HOLD on all CDNU pages. If SINS data are unavailable for more than 5 seconds, the CDNU sends GPS reference data. If GPS reference data are not available, dashes (- - - - -) are displayed in place of latitude and longitude on the CAINS control page and a " MANUAL DATA" message is displayed in the CDNU scratch pad. The operator must then select the CAINS manual page and manually enter the data required for alignment. Once manual data have been entered, the data cannot be modified. If the CAINS receives SINS data after starting a CVMAN alignment, the alignment restarts using the SINS data. Once alignment is complete, CAINS RDY is displayed on all CDNU pages. The CAINS RDY message must be cleared by the operator.

2.22.7.8.6 CAINS Carrier Alignment/Stored Heading (Aircraft Incorporating AFC-279). A CVALN/STHDG alignment can be performed provided:

1. A complete carrier alignment was attained from previous operation, and the parking brake remained set during alignment.

2. The NAV, secondary alignment, or sub-alignment modes were not entered.

3. The CAINS was set to STBY prior to power off.

If the CVALN/STHDG alignment mode is available, the CDNU displays CVALN/STHDG upon operator initiation of carrier alignment. The parking brake must be set for the CVALN/STHDG alignment mode to be initialized. Once alignment is complete, CAINS RDY is displayed on all CDNU pages.

2.22.7.8.7 CAINS In-Flight Alignment (Aircraft Incorporating AFC-279). IFA mode may be used for alignment on a carrier or as a backup mode while the aircraft is in flight. IFA mode is entered by selecting IFA on the CAINS control page. When IFA is selected, GPS reference data are sent to the CAINS. If GPS data are not available, CAINS HOLD is displayed on all CDNU pages and dashes (- - - - -) are displayed on the CDNU in place of latitude and longitude. If the GPS data drop out during the alignment for more than 65 seconds, the alignment is suspended, CAINS HOLD is displayed on all CDNU pages, and the alignment elapsed time stops incrementing. When GPS data become available again, the alignment resumes. If the parking brake is released while in the IFA mode, the alignment is not affected. Once alignment is complete, CAINS RDY is displayed on all CDNU pages, and CAINS automatically transitions to the aided navigation (AIDNAV) mode if GPS aiding is available.

Note

In IFA mode, the GPS provides inputs for alignment. If GPS is not available, the CAINS attempts to enter the IFA/SCADC alignment mode. Although the IFA/SCADC alignment mode is available, it is not valid in the S-3B (since the CAINS is rotated in the aircraft 90° from design). The IFA/SCADC alignment mode can provide attitude information, but the headings are erroneous.

2.22.7.8.8 CAINS Navigation Modes (Aircraft Incorporating AFC-279). CAINS is capable of two navigation modes: stand-alone (SANAV) and aided (AIDNAV). With CAINS selected on the CDNU NAV page, CAINS transitions to SANAV navigation mode from GNDALN, CVALN or IFA alignment mode if the alignment quality is less than or equal to 5 nm/hr and the operator selects SANAV on the CAINS control page, or from CVMAN alignment mode if alignment quality is less than equal to 5 nm/hr and parking brake is released. The navigation solution is calculated from CAINS data only. If GPS is available, CAINS automatically transitions to the AIDNAV navigation mode when an IFA alignment is complete, but the preferred method is to command the CAINS into SANAV mode on the ground after the CAINS RDY alert is displayed. If CAINS is in GNDALN or CVALN alignment mode with a valid weight-off-wheels signal and groundspeed is greater than 50 knots, the CAINS transitions to the IFA mode if alignment has not been completed (alignment quality is greater than 5.0).

Once alignment is complete, CAINS automatically transitions to AIDNAV navigation mode. When CAINS is in AIDNAV navigation mode, GPS and SCADC reference data are sent to the CAINS. If GPS data are not available, SCADC data are used. The CAINS navigation mode and current navigation solution are displayed on the CAINS RNAV page.

2.22.7.9 CAINS II Built-In-Test (Aircraft Incorporating AFC-279)

2.22.7.9.1 EGI BIT (Aircraft Incorporating AFC-279). CDNU Continuous Built-In-Test (CBIT) monitors the EGI continuously while power is applied. If CBIT detects a fault, a “ STATUS” message is displayed on the CDNU. EGI, EINS, and EGPS CBIT results are displayed on the EGI status page. Detailed CBIT results for the EINS, and EGPS are displayed on their respective status pages. A more comprehensive test can be performed by utilizing the initiated built-in-test (IBIT) function. IBIT is initiated on the EGI test sub-page from the system test 2/2 main page. EGI IBIT is available only when the aircraft is not in flight. Once the IBIT function is initiated, the EGI is not available for the duration of the test. Results of EGI, EINS, and EGPS IBIT are displayed on the EGI test page. Detailed results of EINS and EGPS IBIT are displayed on their respective test pages.

2.22.7.9.2 CAINS Built-In-Test (Aircraft Incorporating AFC-279). CDNU continuous built in test continuously monitors the CAINS while power is applied. If CBIT detects a fault, a " STATUS" message is displayed on the CDNU. CAINS CBIT results are displayed on the CAINS status page. A more comprehensive test of the CAINS system can be performed utilizing the IBIT function. The CAINS IBIT function is available only while the aircraft is not in flight. Once the IBIT function is initiated, the CAINS is not available for the duration of the test. Detailed results of CAINS IBIT are displayed on the CAINS test page.

2.22.8 ARN-153 Tacan. The ARN-153 tacan provides bearing and distance (up to 390 miles) from the aircraft to a selected surface station. It also provides tone information for station identity. In addition, the equipment will function in an air-to-air mode to indicate distance from a cooperating aircraft. The tacan displays range and bearing information to the pilot and copilot/COTAC on their respective HSIs. All ARN-153 tacan functions are controlled through the control display navigation unit.

The ARN-153 tacan transmits in the frequency range of 1025 to 1150 MHz and receives in the ranges of 962 to 1024 MHz and 1151 to 1213 MHz on any of 252 channels (X and Y).

Note

To ensure valid self-test of the ARN-153 tacan systems and to preclude local tacan stations overriding the BIT signal of the ARN-153, the test should not be made with a local tacan channel selected. The heading displayed during self-test is 270°.

2.22.8.1 ARN-153 Tacan Signal Flow (Aircraft Not Incorporating AFC-279). The ARN-153 tacan supplies bearing, distance and validity signals, in digital format, to the signal data converter. Using these data, the signal data converter supplies the flight instrument wired assembly with digital distance, analog bearing, and validity signals. The flight instrument wired assembly, in turn, provides the data to the NDCR for distribution to the GPDC (for the GEO correct function) and to the flight instruments. Also, the signal data converter directly supplies the NDCR with CDI, bearing, and To/From signals (in analog format) for flight instrument display. Refer to FO-13 for more detailed information on tacan signal flow.

2.22.8.2 ARN-153 Tacan Signal Flow (Aircraft Incorporating AFC-279). The ARN-153 bearing, distance and validity signals are supplied to the NIU via 1553B message for distribution to the EFIs and GPDC.

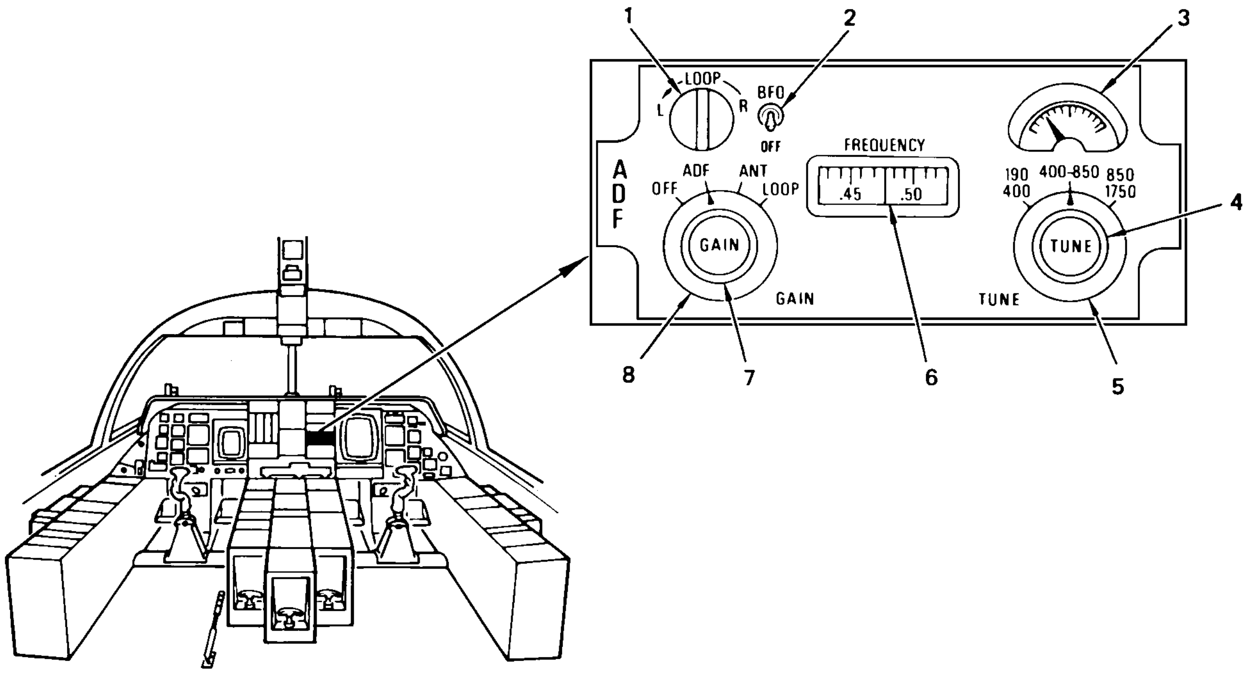
2.22.9 Low-Frequency Automatic Direction Finder (ARN-83). The low-frequency automatic direction finder is used for routine point-to-point radio navigation. The ADF receiver operates in the 190 to 1750 kHz frequency range. When in use, the system provides relative indications to ground radio beacons and commercial broadcasting stations; the bearing indications appear on bearing pointer No. 1 on the HSIs. The equipment can be manually operated also, enabling the pilots to navigate by locating the null direction of the loop antenna. In either mode, aural reception of the tuned-in station is available to the ICS. (See Figure 2-122.)

Note

When the S-3 is configured for tanker operations, the ADF control panel is removed and replaced by an ARS control panel.

2.22.10 UHF Direction Finder (ARA-50). The UHF direction finder is a radio direction finder set that works in conjunction with either UHF set. The direction finder determines the relative bearing of radio signals received by the selected UHF receiver. When read against the HSI compass card, relative bearing becomes compass bearing, either magnetic or true, depending on the compass card mode. DF operation and compass mode are determined by the settings of the UHF configuration and control page (see Figure 2-72) and the selection on the navigation display selector panel (see Figures 2-92 and 2-100 (AFC-279)). The bearing indication appears on bearing pointer No. 1 on the HSIs.

1. BRG NO 1 switch on navigation display selector panel — UHF-DF.



INDEX	CONTROL/INDICATOR	FUNCTION
1	LOOP switch	Center position — Removes manual control of antenna rotation. First position (R or L) — Allows slow speed rotation of antenna through 360° right or left. Second position (R or L) — Allows fast rotation through 90° right or left.
2	BFO switch	BFO — Turns the beat frequency oscillator on to provide an audio tone when receiving cw signals. OFF — Turns the beat frequency oscillator off.
3	Tuning meter	Indicates relative signal level of radio station when tuning receiver.
4	TUNE control	Tunes the receiver with the selected frequency range.
5	Range switch	Allows selection of three operating frequency ranges: 190 to 400 KHz, 400 to 850 KHz, or 850 to 1750 KHz.
6	Frequency indicator	Indicates frequency selected by TUNE control.

Figure 2-122. LF ADF Control Panel (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
7	GAIN control	Adjusts the audio output level.
8	Function switch	OFF — Removes electrical power from the set. ADF — Turns the set on and permits operation for homing or automatic direction finding. ANT — Permits radio station reception for radio range navigation, or for use as a commercial radio broadcast station receiver. LOOP — Used in conjunction with the LOOP switch for aural null homing and manual direction finding.

Figure 2-122. LF ADF Control Panel (Sheet 2)

2.22.11 Standard Central Air Data Computer. The SCADC senses airmass parameters of total pressure, static pressure, and total temperature, and uses that information to produce corrected barometric altitude, airspeed, and other information. Components of the set are two combination pitot/static probes to provide dynamic and static air pressure, two total-temperature probes, an air data computer, and two remotely located transducers (altimeters). The air data computer accepts the pressure and temperature data from the probes and computes pressure altitude, altitude rate, altitude error, indicated airspeed and error, true airspeed, and total temperature. This data are supplied to the barometric altimeter, other instruments, and associated equipment, as well as to the GPDC on aircraft incorporating AFC-272, the SCADC supplies these data to the CDNU via the 1553 data bus. The altimeter is a counterdrum type that normally displays altitude corresponding to electrical signals delivered by the air data computer. If electrical power fails, the altimeter automatically reverts to conventional barometric operation using pressure data from the pitot/static system.

The SCADC computer provides analog and digital electrical outputs associated with airspeed, altitude, and temperature to the following equipment:

1. Altimeters
2. General purpose digital computer
3. Automatic flight control system
4. Navigation data converter and repeater
5. IFF transponder
6. GPS.

2.22.11.1 SCADC System Operation. The pitot/static lines supply both ram air pressure and static air pressure to the pneumatic instruments and the SCADC. Normally, the port line supplies the pilot instruments and the No. 1 SCADC channel. The starboard line always supplies the copilot/COTAC instruments and the No. 2 SCADC channel. The port and starboard airmass temperature probes supply an electrical measurement of the free air temperature to No. 1 and No. 2 SCADC channels, respectively. The temperature is employed by each computer channel to produce true airspeed from the ram and static air pressure inputs. Each channel produces signals associated with airspeed, altitude, altitude rate, and temperature. This redundant design provides an almost complete backup in case of malfunctions in any one channel, pitot/static tube, or airmass temperature probe. (See Figure 2-123).

The pilot and copilot/COTAC altimeters can operate in either a mechanical (STBY) or electrical (RESET) mode selected at each altimeter. The mechanical mode displays altitude produced by the altimeter, mechanically, from the static air pressure input. The electrical mode displays altitude produced by the SCADC. The electrical mode eliminates lag and bounce inherent in the mechanical display and minimizes altitude error caused by the static pressure defect associated with aircraft Mach number. If the computer determines that its altitude output is unreliable, it causes the STBY warning flag to appear and switches the altimeter to mechanical operation. The SCADC barometric altitude sent to the GPDC, AFCS, and IFF transponder is always referenced to 29.92 inches Hg. The computed

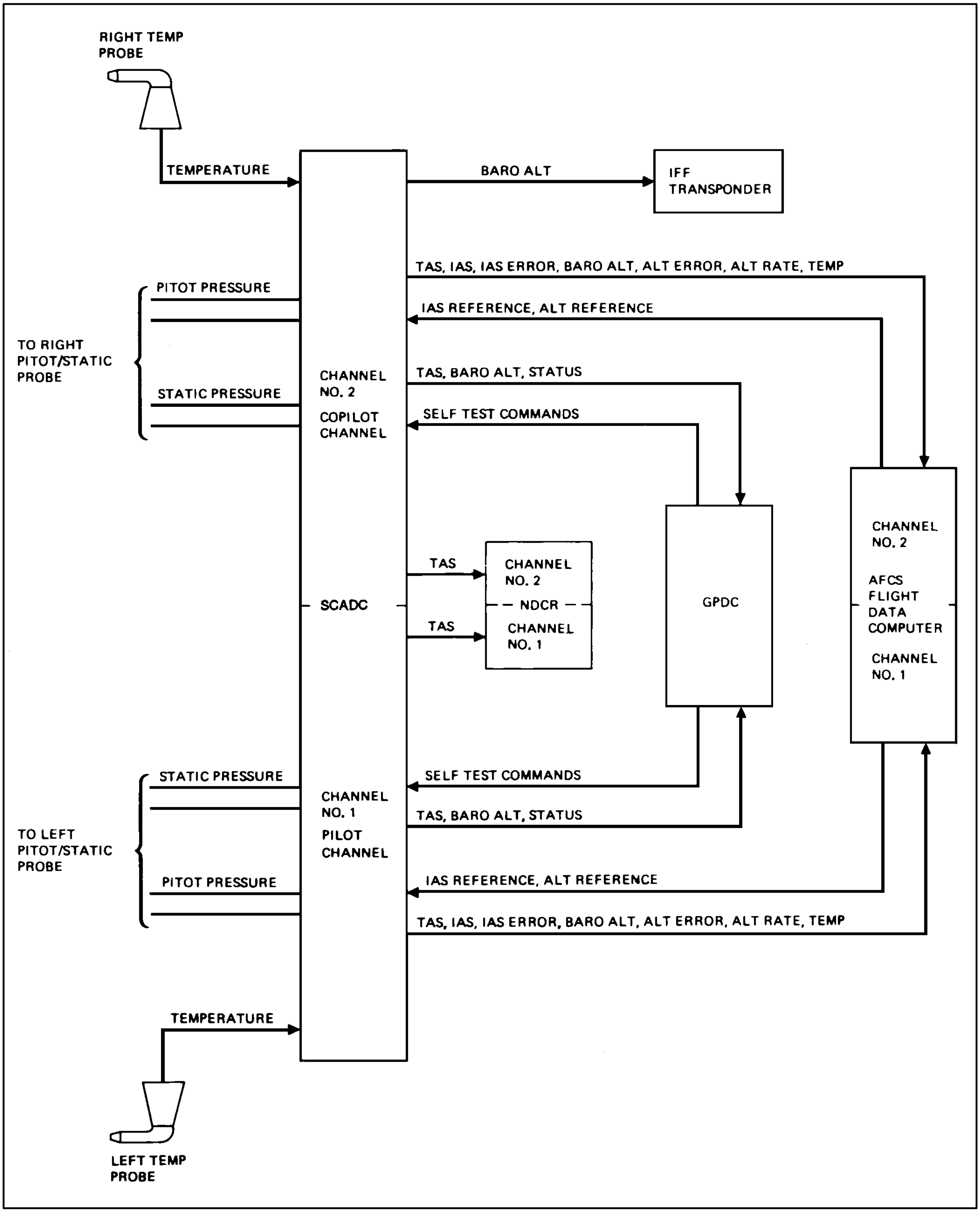


Figure 2-123. SCADC System

barometric altitude sent to the altimeters is also referenced by 29.92 but will display that altitude corrected by the difference between 29.92 and the barometric pressure set in the altimeter; therefore, the copilot/COTAC altimeter setting or operating mode does not affect the IFF altitude reporting. The copilot/COTAC altimeter and the IFF transponder, however are fed from the same SCADC channel No. 2; thus the copilot/COTAC can monitor the performance of the IFF altitude reporting by selecting RESET and 29.92 in the barometric setting on the altimeter. If a discrepancy between reported and observed altitude is observed or the altimeter has reverted to standby (STBY), the IFF altitude reporting has malfunctioned or ceased.

Note

When operating above FL180, the pilot should use the STBY mode to set to 29.92 inches Hg. The copilot/COTAC should use the RESET mode. This combination of altimeter settings will give the aircrew an immediate comparison between barometric and computed altitude from the SCADC and altitude reported to ATC via the IFF mode C.

The pilot and copilot/COTAC HSIs display the SCADC computer's true airspeed when TAS is selected on the navigation display selector. The pilot HSI is fed TAS by channel No. 1 and the copilot/COTAC HSI by channel No. 2.

The AFCS flight data computer has two redundant channels, each of which utilizes data from the corresponding SCADC channel. When the AFCS is operating in either the altitude or indicated airspeed hold mode, it has identified reference altitude or airspeed to the SCADC at the time of mode engagement. The SCADC then provides an error signal representing the difference between the desired altitude (or airspeed) and the current altitude (or airspeed). The pilot and copilot/COTAC can check the respective channel by selecting TAS on the navigation display selector panel.

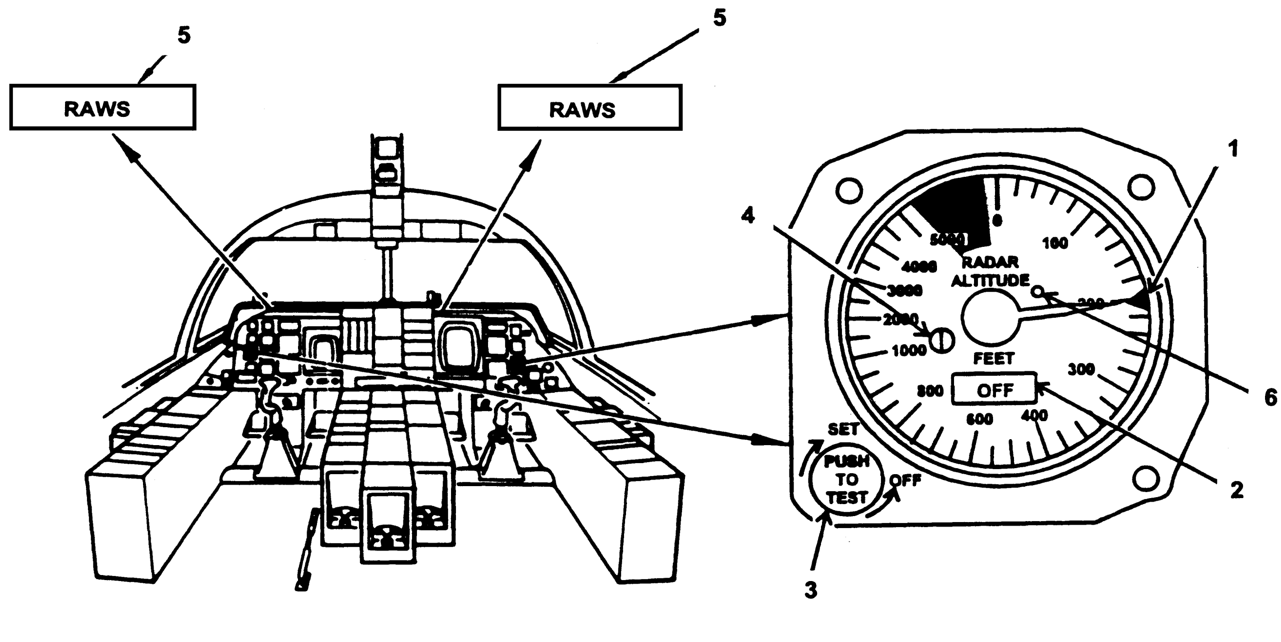
2.22.12 Radar Altimeter and Altitude Warning System (APN-194). The RAAWS performs two related functions: continuous measurement and display of aircraft height above land or water on two identical indicators (pilot and copilot/COTAC) and visual and aural low-altitude warnings at fixed and adjustable altitudes.

2.22.12.1 Radar Altimeter. The altitude measurement porition of the system consists of five components: a receiver-transmitter unit, two high-gain antennas, and two altitude indicators. The R/T unit transmits a radar signal through the transmit antenna, receives a portion of the reflected signal through the receive antenna, and produces an analog voltage of the aircraft altitude computed from the time delay between the transmitted and reflected signals. It has three modes of operation: search, track, and self-test. In the search mode, the receiver-transmitter searches the altitude range for a ground return. In the track mode, it locks on and tracks the ground return signal and procues altitude information that is transmitted continuously to the indicators (see Figure 2-124). In the self-test mode, the normal return is blanked and an artificial self-test pulse generated, injected into the receiver, and sent to the tracker as an artificial target at a range of 100 feet.

The two antennas are located on the underside of the fuselage, just forward of the tailhook, one left and one right of the aircraft centerline.

The altitude indicators are located on the pilot and copilot/COTAC instrument panels. The altitude indicator provides visual radar indications of absolute altitude by means of a single scale pointer against a fixed dial of altitude. The indicator scale is calibrated from 0 to slightly more than 5,000 feet in 20-foot increments up to 400 feet, 50-foot increments up to 1,000 feet, and in 500 foot increments above 1,000 feet. Provided that the aircraft altitude is not more than 45° from horizontal in pitch or 60° in roll, indications are within ±4 feet or ±4 percent, whichever is greater, of altitude as supplied by the R/T unit. The black mast near the top of the indicator face indicates the altitude region in which the system is inoperative.

Aircraft power is applied to the radar altimeter system by rotating the set knob a fraction of a turn clockwise from the off position. When power is applied the altimeter will immediately enter a track mode with the following indications: the off flag is out of view, the scale pointer indicates ±5 feet (on deck only), and the low warning lamp on the indicator face is lighted. The window and the off flag in the lower part of the indicator face indicate the operational status of the altimeter. When the system is operating normally, the off flag is out of view and the window is black. The off flag appears if 115-vac power is lost or if the reflected signal is lost or becomes unreliable.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Index triangle	Provides the pilot and copilot/COTAC with a reference mark along the altitude scale. When the altitude pointer reaches the index triangle setting, a visual and aural warning is actuated.
2	OFF flag	In view — Indicates that the radar altimeter is unreliable. **Note** When the pointer moves behind the mask below 5,000 feet, it indicates the radar altimeter is unreliable. Out of view — Radar altimeter is functioning normally.
3	PUSH TO TEST (set knob)	When initially rotated clockwise, it turns the radar altimeter on and causes the index triangle to move along the 0- to 5,000-foot scale. When rotated counterclockwise, it turns the radar altimeter off and moves the index triangle counterclockwise along the altitude scale. When pressed and held, it causes the radar altimeter to self-test with the following indications: warning lights flash on pilot and copilot/COTAC instrument panels, red warning light in the indicator, an aural 1000-Hz beeping tone is heard in the headphones, the indicator indicates 100±10 feet, and the green self-test light on the indicator illuminates.
4	Low-altitude warning light	Illuminates whenever the aircraft descends to the low-altitude index triangle or the two fixed altitudes (400 and 200 feet).
5	RAWS warning light	Illuminates whenever the low-altitude warning light is on providing an additional alert for the aircrew.
6	Self-test lamp	Illuminates green during push to test, indicating circuit test is in progress.

Figure 2-124. APN-194 Radar Altimeter

2.22.12.2 Radar Altitude Warning System. The radar altitude warning system provides visual and aural warnings to the pilot and copilot/COTAC whenever the aircraft descends through any of four altitudes: two fixed at 400 and 200 feet and two adjustable, one by each pilot and copilot/COTAC. In addition to the components mentioned for altitude measurement, the radar altitude warning system uses the following:

1. Adjustable altitude index triangles, one on the face or each altitude indicator

2. A low-altitude warning light on the face of each indicator and one each on the pilot and copilot/COTAC flight instrument panels

3. An audio frequency generator which produces a 1000-Hz tone

4. Control electronics.

Pilot and copilot/COTAC can independently set their adjustable altitudes to any heights on the indicator scale. Adjustable altitude is set by rotating the set knob on each radar altimeter indicator in either direction to move the index triangle along the 0- to 5,000-foot scale. If the control knob is rotated until the index triangle disappears behind the mask near the top of the instrument face, power is removed from the indicator and the system is shut off.

During descent, as an adjustable altitude is reached, the 1000-Hz tone is heard in the pilot headset and a low-altitude light on the indicator face flashes for 3 seconds. In addition, the two red warning lights on the glareshield flash for 3 seconds. When the first fixed altitude (400 feet) is reached, both the pilot and the copilot/COTAC warning lights flash and the tone is heard in both headphones for 3 seconds. When the second fixed altitude (200 feet) is reached, both sets of warning lights flash continuously and a pulsating 1000-Hz tone is heard in both headphones, if the flaps are less than 57 percent, until the aircraft climbs above that altitude. The low-altitude warnings are enabled only when the aircraft is descending. The warnings for the pilot or copilot/COTAC are enabled only when the aircraft is above his altitude or 200 feet, whichever is lower. The warnings are disabled when the aircraft ascends above 5,250 feet and are reenabled when it descends below 5,000 feet. The visual and aural warnings (at the two fixed altitudes but not the adjustable altitudes) are inhibited when the landing gear is down.

At any altitude up to 5,000 feet, when the reflected tracking signal is lost, the lights and the tone are enabled continuously, the off flag comes into view, and the altitude pointer disappears behind the mask until track is reacquired. With wheels down, the signal-lost warnings are inhibited, thus inhibiting alarms because of loss of track only.

When the indicator is first turned on, the altitude scale pointer appears from behind the mask and indicates ground track altitude (zero ±5 feet as a function of R/T calibration), the off flag disappears from view, a distinct 1000-Hz tone is present in the pilot or copilot/COTAC headphones for approximately 3 seconds, and a red LO ALT warning lamp on the indicator face is illuminated. If pilot or copilot/COTAC bug is set above the indicated altitude, the LO ALT warning light on that indicator face will be illuminated. The low warning light will remain illuminated until the bug is moved below the indicated altitude or the aircraft climbs above the bug set altitude. During takeoff, when the landing gear is raised and the aircraft is below the preset altitude of 200 feet, the warning lights will be enabled continuously until the aircraft climbs above 200 feet or the landing gear is lowered.

2.22.12.2.1 System Test. The radar altimeter and altitude warning system can be made to self-test at any time after a 1-minute warmup. Three steps are required to determine system operation: initial altitude indication, proper bit indications, and reacquisition of ground track upon completion of the bit.

When the indicator is first turned on (on deck), the altitude scale pointer appears from behind the mask and indicates ground track altitude (zero ±5 feet as a function of R/T calibration), the off flag disappears from view, a distinct 1000-Hz tone is present in the pilot or copilot/COTAC headphones for approximately 3 seconds, and a red LO ALT warning lamp on the indicator face is illuminated (if bug is set below indicated altitude).

The bit is performed by pressing and holding the set knob on either indicator for at least 10 seconds. A signal is generated internally that, if both indicators are on, causes:

1. Altitude scale pointer to rotate clockwise and indicate a test altitude of 100 ±10 feet

2. Off flag to remain shielded from view

3. A continuous 1000 Hz tone in the pilot or copilot/COTAC headphones

4. Red LO ALT lamp on the indicator face to extinguish

5. The two red RAAWS warning lights on the pilot and copilot/COTAC glareshield instrument panels and green self-test lamp on the indicator face to illuminate.

When the set knob is released, the system should reacquire ground track as indicated by the following:

1. Altitude scale pointer indicates ground track (zero ±5 feet).

2. The red LO ALT light on the indicator face illuminates.

3. All other warnings extinguish.

If one indicator is off, both indicators will display the test altitude and warnings during the self test. In aircraft not incorporating AFC-279, RAAWS system is not capable of communicating with the GPDC. Therefore, the GPDC will not be able to perform the on-line tests of the radar altimeter and altitude warning system.

2.22.12.3 RAAWS Operation. The RAAWS is an RF pulse modulated absolute altitude radar altimeter with very low power output and high receiver sensitivity.

2.22.12.3.1 Performance on the Deck and Lift-Off. When the system is turned on, it will acquire, track, and display altitude within 1 second. Personnel or equipment in motion around or near the antennas (sonobuoy chute area) can cause the RAAWS to see a Doppler shift and lock-on, track, and display an altitude above zero. When the movement ceases, the system will reacquire and indicate the proper ground track.

When the aircraft lifts off with the flaps less than 57 percent and the gear is raised, the RAAWS warnings will be enabled continuously until the aircraft ascends above the preset warning altitude of 200 feet.

2.23 AUTOMATIC FLIGHT CONTROL SYSTEM (AFCS)

The AFCS is designed to relieve the pilot of routine piloting tasks during periods of heavy workload. The AFCS also provides lateral-directional stability augmentation in the form of a yaw damper/turn coordinator. The AFCS is highly integrated with a number of the aircraft systems. Figure 2-125 shows the general relationships of the AFCS subsystems. FO-20 depicts the flow of signals among the system components. The aircrew interfaces with the AFCS through the Flight Mode Selector Panel (FMSP), Navigation Display Selector Panel (NDSP), and Flight Control Test Panel (FCTP). The AFCS also provides an extensive BIT capability including an aircrew-initiated BIT to identify malfunctioning components.

The cockpit AFCS controls are located on the FMSP, the FCTP, and the control sticks. AFCS system status and failure warning information are provided to the aircrew via the FMSP, the FCTP, the Failure Annunciator Panels (FAPs), and the Heads-Up Annunciator Panels. (See Figures 2-126 through 2-129.)

The AFCS is designed to prevent flight and engine control commands due to a single failure. This level of safety begins with redundancy management (RM) system monitoring and failure detection of the entire AFCS and related components. This RM monitoring and failure detection system, which is synonymous with dual-channel monitoring, operates automatically except when Power Up and Initiated BIT modes are running. Upon detection of a failure, RM will automatically disengage all axes and modes with no critical flight path deviations and will give visual warning to the pilot and copilot/COTAC. On aircraft incorporating AFC-273, RM will automatically disengage only the affected AFCS axes and related modes. Following disengagement, the aircrew may engage modes and continue to operate the AFCS single-channel; however, this is not a fail-safe, monitored condition.

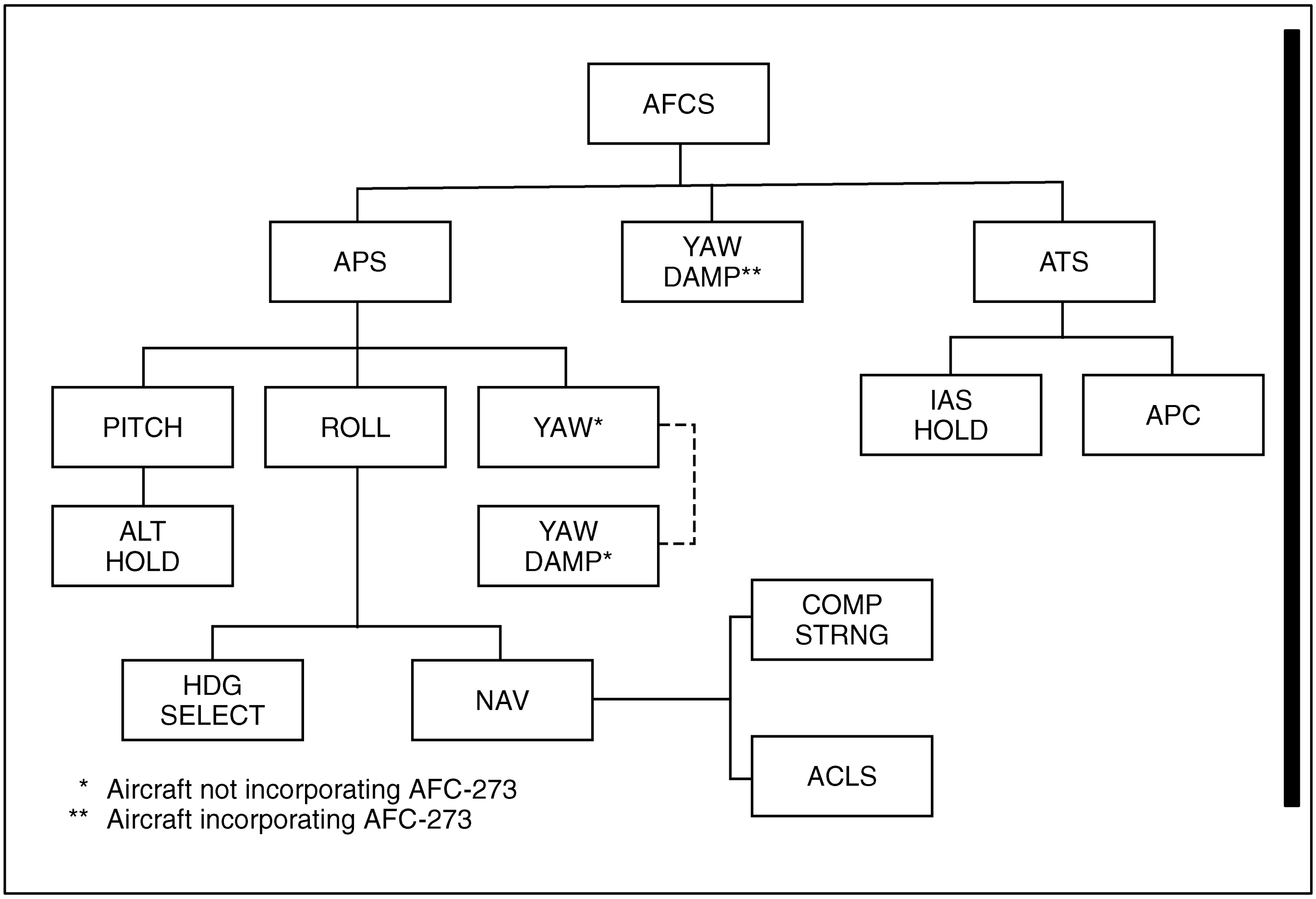


Figure 2-125. Automatic Flight Control System

CAUTION

On aircraft modified by AFC-273, the system may allow an AFCS mode to engage single-channel without illuminating the FAP caution lights. This can happen when the system detects a fault during attempted dual-channel mode engagement and disables the bad channel before allowing mode engagement. After mode engagement visually check the AFCS channe lights on the FCTP to confirm the AFCS is engaged dual-channel.

Note

Each attitude-heading source feeds one channel of the AFCS. The attitude and heading signals are compared against each other when engaged dual-channel by RM. Failure of a single signal or source will result in disengagement of the associated channel of the AFCS, but only after the signals disagree by a specific amount for a specific period of time.

An attitude reference selector switch is installed to allow dual-channel AFCS operation from a single attitude-heading reference source on the ground for maintenance purposes. This three-position rotary switch is mounted in the lower aft segment of the right internal avionics rack. The switch positions are INS, NORMAL, and AHRS (CAINS II, NORMAL, and EGI for aircraft with AFC-279). The switch shall be set to the NORMAL position for flight.

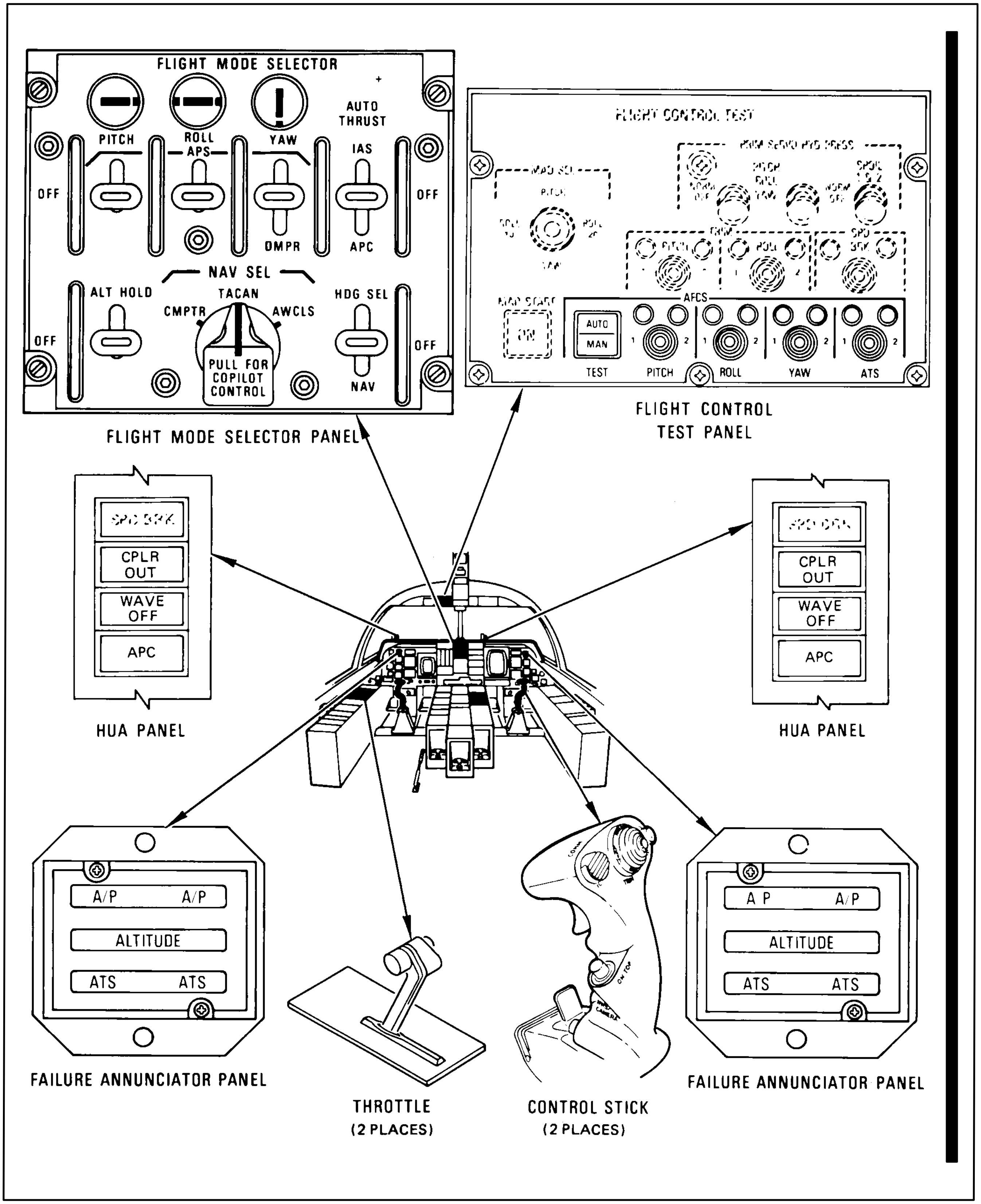
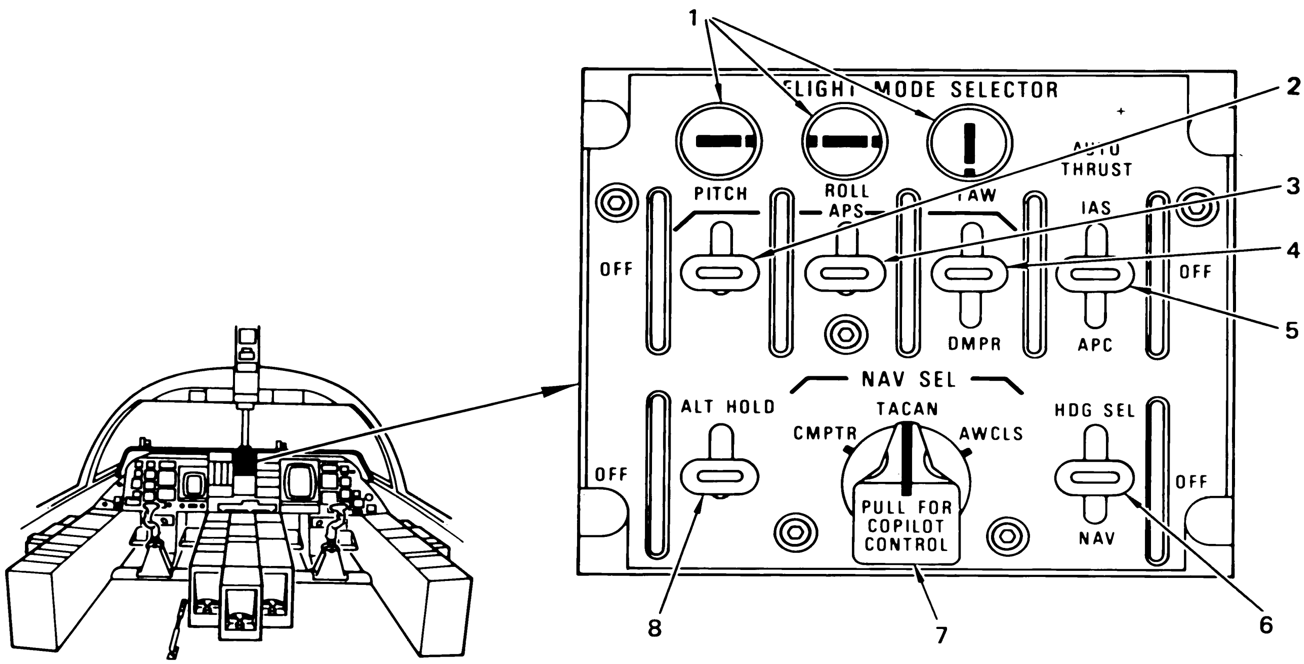


Figure 2-126. AFCS Control and Indicator Locations



INDEX	CONTROL/INDICATOR	FUNCTION
1	Trim and synchronization indicators	Prior to APS mode engagement — indicates general system status and trim position relative to neutral for their respective axis. **WARNING** Do not engage the APS in any mode if the pitch, roll, or yaw trim and synchronization indicators on the FMS panel are not centered. A hardover signal may be present in the AFCS. Do not engage the APS in any mode if indicator movement has occurred with the APS disengaged. In this case, indicator movement may be an indication of failure(s) effecting the AFCS. **Note** With the APS disengaged, the yaw indicator moves in response to pilot pedal and rudder trim knob inputs but does not remain offset if the pedal or trim knob is held or set away from neutral. The pitch and roll indicators should not move in response to pilot control stick or trim inputs with the APS disengaged. After APS mode engagement — indicates AFCS inputs to the elevator, aileron, and rudder servos or pilot control stick and pedal inputs to the servos.

Figure 2-127. Flight Mode Selector Panel (Sheet 1 of 4)

INDEX	CONTROL/INDICATOR	FUNCTION
2	PITCH switch	PITCH — Engages the pitch axis APS in the parallel mode. OFF — disengages the APS.
3	ROLL switch	ROLL — Engages the roll axis APS in the parallel mode. OFF — Disengages the APS. **Note** • The ROLL switch cannot be engaged unless the YAW APS (DMPR on aircraft incorporating AFC-273) is engaged first. • The ROLL switch cannot be engaged with AFC-244 incorporated. (AFC-244 not incorporated on aircraft incorporating AFC-273).
4	YAW switch	YAW — Engages the yaw axis APS in the parallel mode (inoperative on aircraft incorporating AFC-273). DMPR (damper) — Engages the yaw axis APS in the series mode. OFF — Disengages the APS. **Note** When the YAW switch is set to DMPR, the ROLL switch cannot be engaged. (Aircraft not incorporating AFC-273).
5	AUTO THRUST switch	IAS — References the ATS to the indicated airspeed at the time of switch engagement. APC — References the ATS to a constant AOA for landing approach upon switch engagement. OFF — Disengages the ATS.
6	HDG SEL/NAV switch	HDG SEL — Turns the aircraft to the prescribed heading selected on the controlling HSL. NAV — Couples the APS to the steering program generated by the GPDC or the steering commands from the ACLS system. OFF — Disengages either HDG SEL or NAV mode. **Note** • HDG SEL or NAV cannot be engaged unless the ROLL and YAW APS is engaged. • Both the pilot and copilot/COTAC NAV display VDI switches must be in the same position (either AHRS or INS) in order to use HDG SEL in the dual channel configuration.

Figure 2-127. Flight Mode Selector Panel (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
7	NAV SEL switch **Note** The NAV SEL switch is a three-position push-pull device used to select the source for display on the course deviation bar. It performs additional automatic functions when either TACAN or AWCLS is selected.	Pushed in — Pilot CRS SET and HDG SET knobs control the functions on both HSIs regardless of NAV/TACAN/AWCLS selection. Pulled out — Copilot/COTAC CRS SET and HDG SET knobs control the functions on both HSIs regardless of NAV/TACAN/AWCLS selection. CMPTR — Selects the GPDC as the source for FTP, DIST, and BRG only when: 1. DST/SPD switch is in NAV position 2. BRG NO 1 switch is in NAV position. Displays GPDC generated course and deviation from GPDC generated ground track to highest priority FTP. TACAN — Designates the selected tacan station as the source for FTP, DIST, and BRG only when: 1. DST/SPD switch is in TACAN position or NAV position 2. BRG NO 1 switch is in TACAN position or NAV position. Displays deviation from the pilot/copilot/COTAC selected tacan radial on-course deviation bar. AWCLS — Activates the automatic carrier landing system mode and: 1. Displays deviation from the selected tacan radial on-course deviation bar. 2. Enables needles on VDI to display ACLS (ASW-25) or ICLS (ARA-63) information. **Note** • If either the AWCLS or TACAN positions are selected, the following will occur automatically: • The compass card will indicate magnetic values regardless of the position of the AHRS/INS switch on the NDS panel. • If the NAV position is selected on the NDS panel with either the DIST/SPD or BRG NO 1 switch, tacan distance or bearing, respectively, will be displayed on the HSI in lieu of FTP distance or bearing.

Figure 2-127. Flight Mode Selector Panel (Sheet 3)

INDEX	CONTROL/INDICATOR	FUNCTION
7		**Note** • TAS, GS, UHF/DF (OTPI/DF switch after AFC-214) and LF DF display is not affected by the position of the NAV SEL switch. • The HSI annunciator lights will always correctly indicate what units/values are being displayed, regardless of whether they have been selected manually or automatically.
8	ALT HOLD switch	ALT HOLD — Maintains aircraft altitude to prescribed tolerances. OFF — Disengages the altitude hold mode. **Note** The altitude hold mode cannot be engaged unless the PITCH APS is engaged.

Figure 2-127. Flight Mode Selector Panel (Sheet 4)

WARNING

- Dual-channel operation of the AFCS with a single attitude-heading source selected is an unmonitored mode of operation that could result in exceeding structural design limits if the selected attitude-heading source has a failure.
- If IBIT is run with switch not in normal position, then IBIT will not perform a complete test of the system.

Note

When the attitude reference selector switch is not in the NORMAL position, the autopilot annunciation (A/P) caution light is constantly illuminated.

2.23.1 Automatic Pilot System (APS). The APS is a three-axis autopilot system that can control the aircraft in pitch, roll, and yaw. Each axis can be engaged singly or in combination. Logic is implemented to preclude the engagement of any subsystem or mode where an incompatible situation exists or until all conditions for safe operation are met. The AFCS mode compatibility is summarized in Figure 2-130.

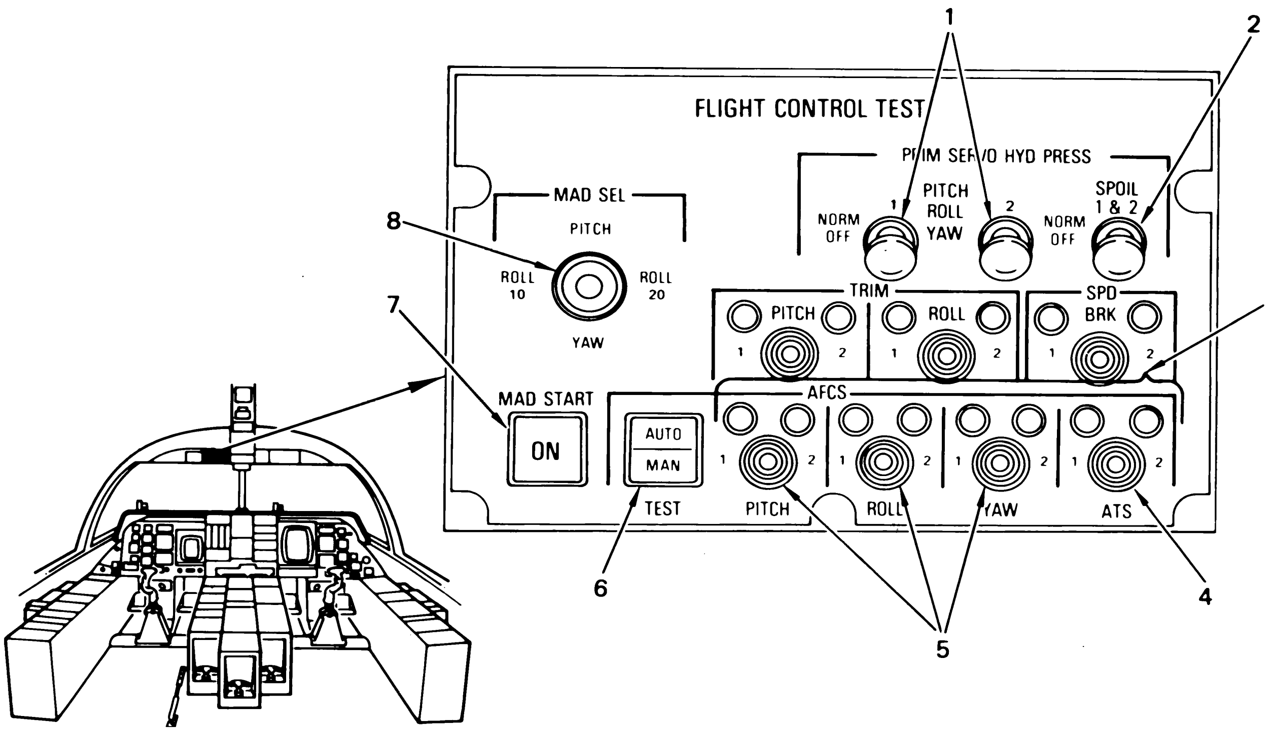
The APS provides the following eight modes of operation:

1. Yaw damper and turn coordination
2. Pitch attitude hold
3. Roll attitude hold/heading hold
4. Heading pre-select
5. Barometric altitude hold
6. Computer guidance
7. Automatic carrier landing
8. MAD compensation.

Note

Roll APS and related modes are not available on aircraft with Interim AFC-244 incorporated. AFC-244 is not incorporated on aircraft incorporating AFC-273.

2.23.1.1 Yaw Damper and Turn Coordination. Aircraft yaw damping and turn coordination are selected by setting the YAW switch on the FMSP to the DMPR (damper) position. These functions are provided in series; there is no rudder pedal movement associated with DMPR-commanded rudder movement. On aircraft with AFC-273 incorporated, the yaw damper mode can be engaged on deck prior to takeoff, and will remain engaged during touch-and-goes, bolters, etc.



INDEX	CONTROL/INDICATOR	FUNCTION
1	PRIM SERVO HYD PRESS — PITCH-ROLL-YAW (1 and 2) switches	NORM — Deenergizes solenoid valves to allow indicated hydraulic system pressure to power primary flight control servos. OFF — energizes solenoid valves to shut off indicated hydraulic system pressure to primary flight control servos.
2	SPOIL 1 & 2 switch	NORM — deenergizes solenoid valves open to allow No. 1 and No. 2 hydraulic system pressure to power spoiler servos. OFF — energizes solenoid valves closed to shut off No. 1 and No. 2 hydraulic system pressure to spoiler servos.

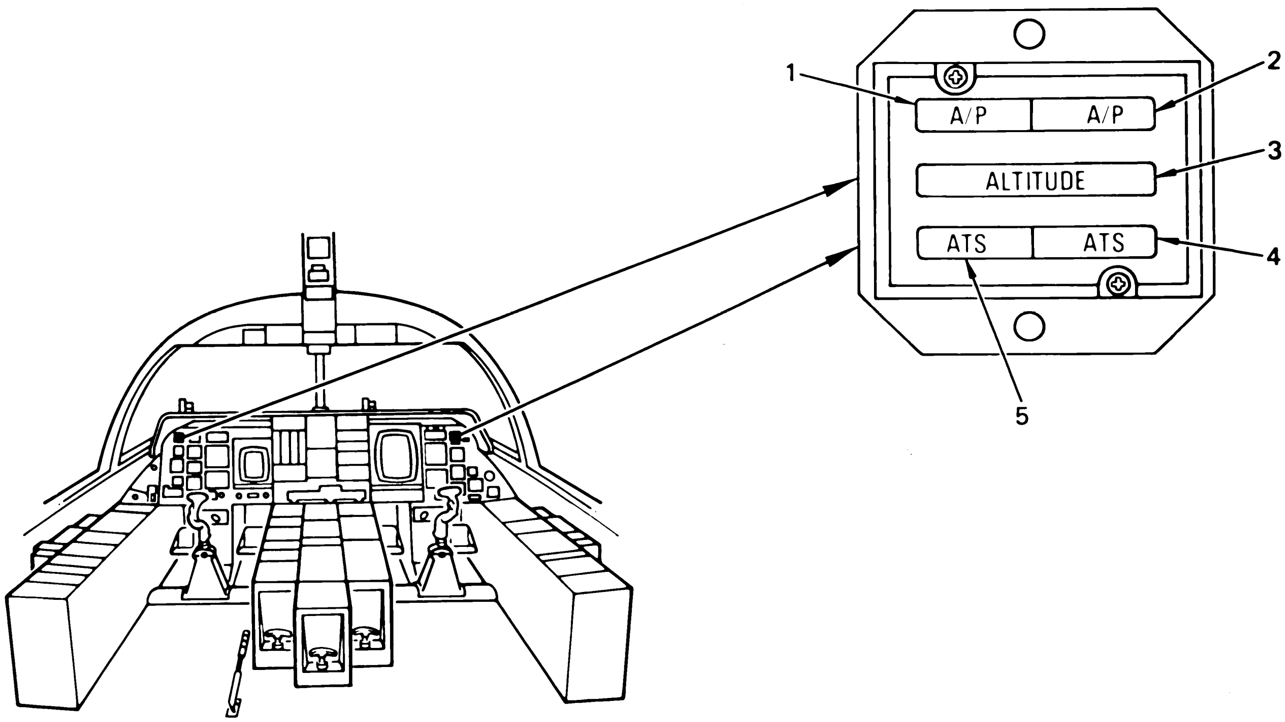
Figure 2-128. Flight Control Test Panel (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
3	AFCS PITCH, ROLL, YAW, and ATS channel lights (AFC-244 not incorporated on aircraft incorporating AFC-273)	Each, illuminated steady — cautions pilot that illuminated channel is disabled and not operating. Each, extinguished — indicates the following: ● Prior to APS or ATS engagement — channel is enabled for engagement. ● After APS or ATS engagement — channel is functioning. **Note** With interim AFC-244 incorporated, the aircraft shall not be flown if roll channel 1 and/or 2 lights are not illuminated.
4	ATS switch	Actuated to 1 or 2 — changes channel status from its previous condition of enabled (amber status light extinguished) or disabled (amber status light illuminated). **Note** If amber channel status light remains illuminated after successive actuations, there is a failure that prevents enabling the channel.
5	PITCH, ROLL, and YAW switches	Each, actuated to 1 or 2 — Changes channel status from its previous condition of enabled (amber status light extinguished) or disabled (amber status light illuminated). **Note** ● If amber channel status light remains illuminated after successive actuations, there is a failure that prevents enabling the channel. ● With the Attitude Reference Source Selector in the NORMAL position, channel 1 interfaces with the INS and the #1 hydraulic system and channel 2 interfaces with the AHRS and #2 hydraulic system.

Figure 2-128. Flight Control Test Panel (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
6	TEST switchlight	Initial depression — connects test programmer to system, initiates automatic test of AFCS, and illuminates steady green AUTO light. **Note** • At conclusion of automatic test, steady green MAN light is automatically illuminated to indicate that manual test functions are to be performed if desired. • At conclusion of manual test, AUTO/MAN lights flash until APS and ATS are disengaged, at which time AUTO/MAN lights illuminate steady. Second depression — disconnects test programmer from system and extinguishes AUTO/MAN light. **Note** • Actuating the test switch twice within a 5-second period will clear the results of AUTO/MAN BIT within the FDC memory, on aircraft incorporating AFC-273. • The switch is inoperative when airborne.
7	MAD START switchlight	Engages automatic MAD compensation maneuvers selected **Note** True airspeed must be less than 233 knots to engage any MAD mode.
8	MAD SEL switch	Selects automatic MAD compensation maneuvers: PITCH — aircraft will pitch ±3° minimum to ±5° maximum with a 6-second period. ROLL 10 — aircraft will roll ±10° with a 6-second period. ROLL 20 — aircraft will roll ±20° with a 6-second period. YAW — aircraft will yaw ±5° with a 6-second period. Center (off) — terminates the MAD compensation maneuver.

Figure 2-128. Flight Control Test Panel (Sheet 3)



INDEX	CONTROL/INDICATOR	FUNCTION
1	A/P (autopilot) warning light	Illuminated (red) flashing — warns the pilot that the autopilot system is disengaged. **Note** This light is latched and is extinguished by pressing the press-to-extinguish switch or by actuating the AFCS disconnect switch on either of the control sticks.
2	A/P (autopilot) caution light	Illuminated (amber) steady — cautions the pilot that an axis or mode of the APS is engaged in a nonfail-safe, single-channel configuration. **Note** This light cannot be extinguished except by APS disengagement, and it illuminates again on any APS subsystem reengagement in single-channel configuration.
3	ALTITUDE caution light	Illuminated steady — cautions the pilot that the PITCH APS is engaged and the altitude hold mode is not engaged, or the APS and APC are operating and ACLS is not engaged. **Note** This light is extinguished when either the altitude hold mode or ACLS is engaged or the APS is disengaged.

Figure 2-129. Failure Annunciator Panels (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
4	ATS (autothrust system) caution light	Illuminated (amber) steady — cautions the pilot that an ATS subsystem is engaged in a nonfail-safe, single-channel configuration. **Note** This light cannot be extinguished except by ATS disengagement, and it illuminates again on any ATS subsystem reengagement in single-channel configuration.
5	ATS warning light	Illuminated (red) flashing — warns the pilot that the autothrust system is disengaged by means other than pilot NWS button or normal landing touchdown. **Note** This light is latched and is extinguished by pressing the push-to-extinguish switch or by actuating the NWS switch on the pilot control stick (BUNO 159733 and subsequent and aircraft incorporating AFC-42).

Figure 2-129. Failure Annunciator Panels (Sheet 2)

INITIAL MODE SELECTED	SUBSEQUENT SELECTION					
	HEADING PRESELECT	BARO ALTITUDE HOLD	COMPUTER	ACLS	IAS HOLD	APC
APS Modes:						
Heading Preselect	—	3	2	2	3	3
Baro Altitude Hold	3	—	3	2	3	3
Computer	2	3	—	2	3	3
ACLS	2	1	2	—	1	3
ATS Modes:						
IAS Hold	3	3	3	2	—	2
APC	3	3	3	3	2	—

Code:

1. Initial mode selected holds, others will not hold.
2. Subsequent mode selected holds, others will not hold.
3. Both hold.

Figure 2-130. AFCS Mode Compatibility

WARNING

Taking off with yaw damper engaged single-channel on aircraft with AFC-273 incorporated will result in undesired flight path deviations if a yaw axis failure occurs. If flight is necessary with single-channel yaw damper, yaw damper should be engaged after takeoff, at a safe altitude.

Note

To stabilize the hose and drogue, the yaw damper should be engaged for all air refueling operations. Tanker operations without an operational yaw damper will cause the air refueling hose and drogue to oscillate vertically (up to 5 feet) due to the inherent adverse yaw and lightly damped Dutch roll of the S-3B.

2.23.1.2 Pitch Attitude and Roll Attitude Modes. Pitch and roll attitude modes are the basic modes of the APS. They must be engaged prior to engagement of more advanced modes, such as altitude hold and automatic guidance modes. Pitch and roll attitude modes are parallel; the actuator commands result in cockpit control stick movement that provides feedback to the pilot.

2.23.1.3 Pitch Attitude Hold Mode. When the PITCH switch is moved up to the APS position on the FMSP, the AFCS will capture and maintain the current aircraft pitch attitude. This mode functions only within ±30° pitch and above 75 knots airspeed. It cannot be engaged outside this range. Once engaged, the pilot may adjust the pitch attitude of the aircraft using control stick steering (CSS) up to the command maneuver limit. Approximately 3 pounds of longitudinal stick force is required to initiate an attitude change. Above 3 pounds, the pitch rate is proportional to the force applied to the stick. When the pilot releases the stick force, the APS will capture and maintain the pitch attitude at the time of release. In this mode, manual pitch trim is disabled and the autopilot commands the pitch trim system to ensure the aircraft will be in trimmed condition when pitch APS disengages. When CSS is used to change the pitch attitude, autotrim is disabled until the new pitch attitude is set.

2.23.1.4 Roll Attitude and Heading Hold Mode. When the ROLL switch is moved up to the APS position, the roll attitude/heading hold modes are engaged. With less than 3° angle of bank and no force on the control stick, the AFCS will capture and hold aircraft heading. While in heading hold mode, the AFCS may vary the AOB as required to maintain heading. With ROLL APS engaged, the pilot may adjust the angle of bank using CSS. In CSS, application of lateral stick force in excess of 2 pounds will cause the roll attitude to change at a rate proportional to the amount of force applied. When the stick is released from 3° to 45° angle of bank, the Roll APS will capture and maintain the bank angle present at the time of release. When released from 45° to 70° angle of bank, the aircraft will smoothly roll back down to and maintain approximately 45°. Above the roll maneuver limit of 70°, ROLL APS will disengage.

CAUTION

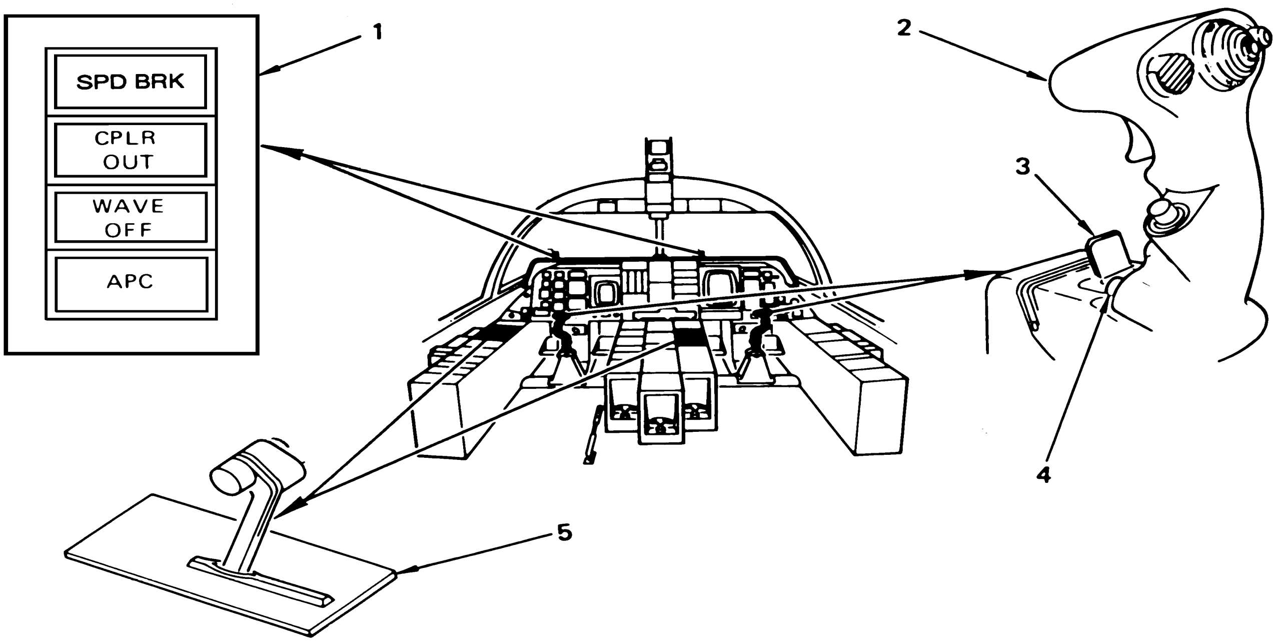
- Activation of the INS Fast Erect to correct an INS out-of-synch light when Roll APS is engaged will cause the aircraft to turn.

- Application of a steady pedal input with heading hold mode engaged will result in a roll-off when the pedal input is removed. Steady pedal inputs should be avoided with heading hold engaged.

Note

- For aircraft not incorporating AFC-273, the YAW switch must be in the APS position for Roll APS to be available. The YAW mode provides aircraft yaw damping and turn coordination and is a parallel mode; the rudder pedals move in response to YAW-commanded rudder movement.

- For aircraft incorporating AFC-273, the YAW switch must be in DMPR for Roll APS to be available. The YAW switch should not latch in the APS position.



INDEX	CONTROL/INDICATOR	FUNCTION
1	APC (approach power control) caution light	Illuminated flashing — cautions the pilot that an automatic disengagement of the APC mode has occurred. **Note** This light is controlled in conjunction with the FA panel ATS warning light whenever the APC mode is engaged. This light is extinguished by pushing the ATS warning light push-to-extinguish switch, or by actuating the NWS switch on the pilot control stick.*
2	Control sticks	CSS — either stick is used for pitch and roll control during APS operation. APS override — manually overrides the APS whenever a force of 25 pounds is applied to either control stick. After release of this force, the control sticks return to CSS operation.
3	AFCS disconnect switches (paddle switches)	Forward position — the normal spring-loaded position, maintains circuit integrity during APS operation. Aft position — opens normally closed momentary switches, positively and simultaneously disengages the APS subsystem and modes.
4	NWS switch (pilot only)	Disengages ATS and modes.*
5	Throttle levers	EMERGENCY ATS disengagement — automatically disengages the ATS whenever torque is applied for more than 1 second on any power lever. The pilot override force required for disengagement is a maximum of 11 pounds.

*BUNO 159733 and subsequent and aircraft incorporating AFC-42.

Figure 2-131. Miscellaneous AFCS Controls and Indicators

- For aircraft incorporating AFC-273, when turning with ROLL APS engaged, at approximately 45° AOB a slow, low-amplitude lateral stick oscillation (±0.15 inch) may occur. This results from ROLL APS switching between roll attitude hold and CSS modes. Changing either lateral stick force or AOB will eliminate the oscillation.

2.23.1.5 Heading Preselect Mode. The heading preselect mode permits the pilot to command the AFCS to turn the aircraft to a specific heading. The YAW (DMPR on aircraft incoporating AFC-273) and Roll APS modes must be engaged for this mode to be available. Either the pilot or copilot/COTAC then sets the HSI heading bug to the desired heading. When the HDG SEL/NAV switch on the FMS panel is moved to the HDG SEL position, the APS rolls the aircraft up to a maximum bank angle of 30° and turns to and captures the selected heading. When the AFCS captures the new heading, the HDG SEL/NAV switch moves back to the OFF position. Then, a new heading can be set on either HSI, if desired.

Note

- Under certain loading configurations, the aircraft may stabilize at bank angles greater than 30° during HDG SEL turns.
- At low airspeeds with an asymmetric stores loading, the aircraft may not capture the selected heading during turns away from the heavy store.

This mode is compatible with CSS operations. The pilot is able to use CSS to increase or decrease the bank angle, hence the turn rate, during the turn to the new heading. Application of lateral stick forces greater than 2 pounds causes an increase in bank angle. If the stick force is released when the aircraft is at greater than 7° angle of bank, the AFCS will return to the computed angle of bank and continue the turn to the selected heading. When force is released below 7° angle of bank, the heading select mode will disengage and the AFCS will return to the heading hold mode.

2.23.1.6 Barometric Altitude Hold Mode. The barometric altitude hold mode assists the pilot in capturing and maintaining a desired flight altitude. The stick must be free of pitch inputs and Pitch APS must be engaged for this mode to be available. When the ALT HOLD/OFF switch on the FMSP is moved to ALT HOLD, the AFCS will capture and maintain the aircraft's current barometric altitude. This mode may be engaged in level flight or up to 2,000 fpm rate of climb/descent. After engagement, the rate of climb or descent is gradually reduced to zero as the AFCS smoothly captures the altitude. The AFCS will maintain the captured altitude within the tolerances listed in Figure 2-132. The altitude hold mode has a performance monitor that will automatically disengage Pitch APS and altitude hold mode during single- and dual-channel operations when aircraft altitude deviates from the reference altitude by >150 feet above 800 feet MSL and by >50 feet below 800 feet MSL.

2.23.1.7 Computer Guidance Mode. The computer guidance mode is used to automatically guide the aircraft with steering commands from the general purpose digital computer (GPDC). For this mode to be available, the GPDC must be on line with a Fly To Point entered, the YAW (DMPR on aircraft incorporating AFC-273) and Roll APS modes must be engaged, and the NAV SEL switch must be set to the CMPTR position. The AFCS is coupled to the computer by moving the HDG SEL/NAV switch to the NAV position.

FLIGHT CONDITION	ALTITUDE	TOLERANCE
Straight and level	0 to 5000 feet Above 5000 feet	±5 feet ±0.1 percent of the altitude control reference
Constant airspeed turns with bank angles up to the command maneuver limit of 45°	0 to 6600 feet Above 6600 feet	±5 feet ±0.3 percent of the altitude control reference

Figure 2-132. Altitude Tolerance Limitations of Barometric Altitude Hold Mode

After coupling, GPDC navigation steering commands are sent to the AFCS. In this mode, the AFCS may use up to 45° AOB to steer to the FTP. The TACCO, copilot/COTAC, or SENSO can insert or remove up to 10 FTPs, while the pilot controls altitude and airspeed. With pitch attitude hold engaged, the pilot can change altitude on the way to an FTP using pitch CSS. The pilot can adjust the airspeed manually or use the IAS hold mode of the automatic throttle system to maintain airspeed. The GPDC steering program automatically corrects for speed and wind changes to maintain the desired track to the FTP. Once the aircraft captures the FTP, the computer guidance mode automatically uncouples and the APS returns to the roll attitude and heading hold mode. The HDG SEL/NAV switch returning to the OFF position indicates uncoupling. If more than one FTP has been entered in the GPDC, the APS will remained coupled upon capture of the first FTP and automatically steer the aircraft to the next FTP.

Note

Under high-wind conditions, the steering program may not enable capture of the FTP.

2.23.1.8 Automatic Carrier Landing System Mode. (Refer to paragraph 2.24.)

2.23.1.9 MAD Compensation Mode. The AFCS can be used to perform the pitch, roll, and yaw maneuvers required for compensation of the MAD system. These maneuvers are performed one axis at a time through the use of the five-position MAD SEL switch and the MAD START switch on the FCTP. The Pitch, Roll, and Yaw (DMPR on aircraft incorporating AFC-273) APS switches must be engaged. For MAD START to engage, the true airspeed must be less than 233 knots. To engage the Roll MAD or Yaw MAD, the Yaw (DMPR on aircraft incorporating AFC-273) and Roll APS must be in identical channel configurations. (e.g., if Roll APS is engaged single channel #2, Yaw APS (DMPR on aircraft incorporating AFC-273) must also be engaged single channel #2.)

Note

Yaw MAD should not be conducted with altitude hold engaged. Yaw sensitivity on the pitot/static probes can result in pitch inputs when altitude hold is engaged.

Yaw MAD requires engagement of both Yaw (DMPR on aircraft incorporating AFC-273) and Roll APS. Pitch MAD requires channel one, channel two, or both APS pitch channels be engaged, with altitude hold disengaged. YAW (DMPR on aircraft incorporating AFC-273) and Roll APS, and IAS hold modes may be engaged, but are not required (See Figure 2-133). Roll MAD requires that Pitch APS, altitude hold, and YAW (DMPR on aircraft incorporating AFC-273) and Roll APS be engaged.

2.23.2 Automatic Pilot System (APS) Operation

2.23.2.1 APS Engagement and Disengagement

2.23.2.1.1 APS Engagement. All of the following conditions must be met to permit engagement of APS modes:

1. Aircraft power to at least one channel of the AFCS.
2. At least one channel of each axis has satisfied the RM checks required to enable the channel.
3. Mode compatibility interlocks satisfied.
4. Angle of attack below 18 units for aircraft incorporating AFC-273 with the exception of the yaw damper (DMPR) mode.
5. Either or both PRIM SERVO HYD PRESS switches are turned OFF at the FCTP.
6. When altitude hold is engaged, Pitch APS and the altitude hold mode disengage when sensed altitude error exceeds 150 feet (above 800 feet MSL) or 50 feet (below 800 feet MSL).
7. Any failure detected by RM while engaged dual-channel.
8. Loss of any required validity signal (hydraulic pressure, rate sensor status, etc.) while engaged either single or dual channel.
9. Landing with the APS engaged and the touchdown switch on the landing gear is compressed.

USE → / FOR ↓	FLAP POSITION	AIRSPEED (KIAS)	ALTITUDE (FEET)	AFCS AXIS			ALTITUDE HOLD	AUTO THROTTLE
				PITCH	ROLL	YAW		
Pitch* MAD	MANUV	170	Max. 14,000	On	Optional	Optional	Off	Off
Roll MAD	MANUV	170	Max. 14,000	On	On	On	On	On
Yaw MAD	MANUV	170	Max. 14,000	On	On	On	Off	Off
*There is a 233 KTAS interlock on pitch MAD.								

Figure 2-133. MAD Compensation Maneuver Requirements

10. Pitch and roll attitude less than 30° and 70°, respectively.

11. Either or both of the PRIM SERVO HYD PRESS switches on the FCTP must be set to the NORM position.

12. SPOIL 1&2 switch on the FCTP must be in the NORM position for roll APS.

The aircrew must hold the FMSP toggle switches in the desired position for at least one-half second. This delay is intended to prevent inadvertent engagements.

Note

For aircraft incorporating AFC-273, the YAW switch should not latch in the APS position.

2.23.2.1.2 APS Automatic Disengagement. For aircraft not incorporating AFC-273, the APS completely disengages, including all axes and modes, under any of the following conditions:

For aircraft incorporating AFC-273, automatic disengagement occurs under the following conditions:

1. Pitch and Roll APS, engaged dual channel, disengage when RM detects a pitch or roll axis failure. Yaw axis remains engaged unless a yaw axis failure is detected. Yaw axis disengages if RM detects a yaw axis failure while the yaw axis is engaged dual-channel.

2. Loss of any required validity signal (e.g., hydraulic pressure, and rate sensor status) while engaged either single or dual-channel. Yaw axis remains engaged unless a yaw axis validity signal is lost.

3. Landing with the Pitch and/or Roll APS and associated modes engaged, except yaw damper (DMPR) remains engaged.

4. Either or both PRIM SERVO HYD PRESS switches are turned OFF at the FCTP.

5. All APS modes except yaw damper will automatically disengage when AOA exceeds 18 units for 3 seconds or 20 units for any amount of time.

6. Pitch attitude >30° or roll attitude >70° except yaw damper (DMPR) remains engaged.

7. When altitude hold is engaged, Pitch APS and the altitude hold mode disengage when altitude error >150 feet (above 800 feet MSL) or >50 feet (below 800 feet MSL).

The pitch APS will disengage whenever trailing edge flap position is changed by either the normal or emergency flap extension method. Roll APS will disengage when the SPOIL 1&2 switch is turned OFF at the FCTP.

2.23.2.1.3 APS Manual Disengagement. The APS completely disengages, including all axes and modes, under either of the following conditions:

1. Pulling the AFCS disconnect paddle switch on either control stick column. (This is the normal method of manually disengaging the APS.)

2. Setting APS toggle switches on the FMSP to the OFF position. Roll APS will disengage if Yaw

APS (DMPR on aircraft incorporating AFC-273) is disengaged.

Note

If an AFCS switch fails to disconnect, set the APS toggle switches to OFF to disengage the AFCS. This will result in illumination of the FAP warning lights.

2.23.2.2 Trim Operation. The Pitch APS mode has an automatic trim function to maintain a trimmed condition during changes in flight condition (e.g., airspeed) and aircraft configuration (e.g., thrust addition). This precludes transients when the AFCS disengages. Manual pitch trim is not available with Pitch APS engaged. Automatic roll and yaw trim is not provided. Rudder and roll trim should be set as desired prior to engaging the yaw and roll axes and should not be adjusted while the yaw and roll axes are engaged.

WARNING

- Do not make roll trim inputs with the Roll APS engaged. An aircraft transient may occur when the AFCS is disengaged. If changing flight conditions or aircraft configuration necessitate a roll trim change, disengage the AFCS before adjusting the roll trim.

- Because of the lack of automatic roll trim when ROLL APS is engaged, significant changes in airspeed or configuration (particularly with asymmetric loading) may result in roll transients when ROLL APS is disengaged. The AFCS does not use roll trim to maintain trimmed flight, but instead uses lateral stick inputs. When the AFCS is disengaged the lateral stick input is removed, which may result in a rolling input until the pilot manually adjusts the roll trim to the new flight conditions.

2.23.2.3 APS Override Capability. The pilot or copilot/COTAC can manually override the APS in all modes with normal control stick inputs, using reasonable force. This capability permits the pilot to quickly change the aircraft flight path without disengaging the APS first. APS will regain control as soon as the overriding force is removed.

2.23.2.4 Control Stick Steering. CSS permits the pilot or copilot/COTAC to maneuver the aircraft when the APS is engaged, with the following exceptions:

1. Pitch CSS is disabled when the ALT HOLD is engaged.

2. Pitch and roll CSS are disabled when the ACLS mode is engaged.

3. Roll CSS is disabled when the computer automatic guidance mode is engaged.

Note

CSS is disabled in these cases to preclude flight path deviations in response to unintentional control stick inputs.

The pilot or copilot/COTAC has full control capability to maneuver the aircraft within the AFCS maneuver limits of 30° pitch and 70° roll. Use of CSS to maneuver outside the limits will cause an automatic disengagement of the APS and its modes except the yaw damper (DMPR) will remain engaged on aircraft incorporating AFC-273.

Note

For aircraft incorporating AFC-273, when turning with ROLL APS engaged, at approximately 45° AOB a slow, low-amplitude lateral stick oscillation (±0.15 inch) may occur. This results from ROLL APS switching between roll attitude hold and CSS modes. Changing either lateral stick force or AOB will eliminate the oscillation.

2.23.2.5 Automatic Pilot Subsystem Operation. The APS is intended to relieve the pilot of routine flying tasks. Following takeoff and cleanup, the pilot can engage the Yaw (DMPR on aircraft incorporating AFC-273), Pitch, and Roll APS with the toggle switches on the FMSP. On aircraft incorporating AFC-273, yaw damper (DMPR) can be engaged prior to takeoff.

To fly a specific heading on departure, the pilot or copilot/COTAC can manually set the heading using the HDG SEL knob on the HSI and engage the HDG

SEL/NAV toggle switch to HDG SEL. When the toggle latches, the aircraft will automatically turn to, capture, and maintain the selected heading.

To establish the desired climb schedule, the pilot can set the desired engine power and then use Pitch CSS to set a pitch attitude that will maintain the desired speed. During the climb, the pilot can use Pitch CSS to modulate the pitch attitude as required to maintain the desired climb schedule. Upon arriving at the desired cruise altitude, the pilot can engage the ALT HOLD toggle switch. The aircraft will capture and maintain the altitude where the switch was engaged. The pilot can then adjust the throttles to set the desired cruise power setting.

The mission computer can be used to insert waypoints to define the desired aircraft route. The copilot/COTAC or TACCO can insert fly to points in the GPDC. The FTPs will be displayed on the pilot's tactical display with the message SELECT CPMTR. To have the APS fly the route, the pilot must turn the NAV SEL switch on the NCP to CMPTR and engage NAV with the HDG SEL/NAV toggle switch on the FMS panel. The SELECT CMPTR prompt will extinguish and the APS will automatically steer the aircraft along the FTPs, using commands from the GPDC steering subprogram.

Note

The APS system will steer only to GPDC FTPs. Steering is not provided to any other type of navigational waypoints.

Approaching the terminal area, the pilot can disengage ALT HOLD and use Pitch CSS to establish the desired descent schedule. During the descent, ALT HOLD can be used to capture desired let down altitudes.

Note

Single channel modes of the APS are unmonitored and system failures can cause flight path excursions.

2.23.3 Automatic Thrust System

2.23.3.1 IAS Hold Mode. This mode relieves the pilot of the task of maintaining an indicated airspeed. When the pilot or copilot/COTAC sets the AUTO THRUST toggle switch to the IAS position on the FMSP, the ATS sends commands to the ATS servos which operate the engine fuel controls as required to capture and maintain the airspeed indicated at the time of engagement. ATS-commanded engine fuel control bellcrank position changes are fed back to the throttle levers in the cockpit. During climbs, descents, and turns, the ATS will adjust the throttles to maintain the captured (reference) airspeed within 5 knots. ATS can command throttle positions from slightly above idle to intermediate power settings. A speed error pointer on the left side of each VDI (see Figures 2-93 and 2-99) indicates the difference between the current indicated airspeed and the reference indicated airspeed, providing the pilot and copilot/COTAC a visual indication of IAS HOLD mode performance. This mode can only be engaged with the landing gear retracted.

Note

With or without Pitch CSS, the pilot can easily command pitch attitudes that exceed the ATS command limits. The speed error pointer will show full deflection error and the airspeed will continue to deviate from the reference. For higher than intermediate power settings or to reach flight idle power settings, the IAS HOLD must be disengaged and the throttles set manually.

2.23.3.2 APC Mode. This mode is used in the landing configuration to relieve the pilot of the task of manipulating the throttles to maintain an on-speed condition (optimum AOA). When the pilot or copilot/COTAC sets the AUTO THRUST toggle switch to the APC position on the FMSP, the ATS sends commands to the ATS servos which operate the engine fuel controls as required to capture and maintain 15 units AOA within 1 unit. ATS-commanded engine fuel control bellcrank position changes are fed back to the throttle levers in the cockpit. This mode can be selected only when the landing gear is extended and the aircraft is airborne. This mode can be used alone or in conjunction with the pitch APS.

Note

To ensure optimum APC performance, the pilot should set minimum throttle friction and trim out pitch stick forces prior to APC engagement.

2.23.3.3 Automatic Thrust System Engagement and Disengagement

2.23.3.3.1 Engagement. The ATS is engaged by actuating the AUTO THRUST switch on the FMS panel. The following are required to engage subsystem:

1. Aircraft power to at least one channel of the ATS
2. At least one ATS channel has satisfied the RM checks required to enable the channel
3. Mode compatibility interlocks satisfied
4. For IAS HOLD mode, <18 units AOA for aircraft incorporating AFC-273
5. For APC mode, <20 units AOA for aircraft incorporating AFC-273
6. Both PRIM SERVO HYD PRESS switches on the FCTP must be set to NORM and both hydraulic systems must have nominal pressure.
7. Both throttle levers must be positioned between slightly above idle and intermediate thrust.
8. Left throttle lever must be within 10° of the right throttle lever.

The aircrew must hold the FMSP toggle switch in the desired position for at least one-half second. This engagement delay is intended to prevent inadvertent engagements.

Note

The throttle friction lever should be set at the minimum value before attempting to engage ATS. Any throttle friction setting will degrade ATS performance and may damage the ATS servos.

2.23.3.3.2 Automatic Disengagement. The ATS will automatically disengage under any of the following conditions:

1. ATS failure detected by RM provided the ATS is engaged dual-channel
2. Loss of any ATS validity signal provided the ATS is engaged dual- or single-channel.

The IAS will disengage under the following conditions:

1. Landing gear extended.
2. AOA exceeds 18 units for 3 seconds, or 20 units on aircraft incorporating AFC-273.

The APC will disengage under the following conditions:

1. Landing gear raised
2. Landing gear touchdown switch is compressed on either main gear
3. Either PRIM SERVO HYD PRESS PITCH-ROLL-YAW switch on the FCTP is turned OFF or a hydraulic system loses pressure
4. ACLS uncouples, except on aircraft incorporating AFC-273
5. AOA >20 units on aircraft incorporating AFC-273.

2.23.3.3.3 Manual Disengagement. Pressing the NWS/CAMERA switch on the pilot's control stick can manually disengage the ATS. This is the normal method of manual disengagement.

Note

In case of NWS/CAMERA switch failure, setting the AUTOTHRUST toggle switch to OFF should disengage the ATS. This will result in illumination of the FAP warning lights.

The Pilot or copilot/COTAC can also disengage the ATS by applying enough force to the throttle levers to override the ATS. The ATS system is designed to disengage with approximately 10 pounds of force on each throttle lever for more than 1 second.

Note

Applying approximately 40 pounds of force will release the ATS servo clutch to allow emergency override of the ATS system. Maintenance personnel must reset the clutch on the ground before the ATS can be re-engaged. Inadvertent release of the ATS servo clutch can be avoided by pressing the NWS/CAMERA switch prior to or simultaneously with application of force to the throttle levers.

2.23.3.4 APS-ATS Crossfeed Operation. Signals are crossfed between the APS and the ATS during the following terminal operations:

1. APC, Pitch APS, and Altitude Hold engaged
2. APC engaged.

2.23.3.4.1 APC, Pitch APS, and Altitude Hold Engaged. Operation of the AFCS with these modes engaged results in a constant crossfeed between the pitch control stick position signal and the ATS. In steady-state, wings-level flight, there will be relatively small movements of the ATS servos as they operate to maintain 15 units AOA. In a turn, the vertical component of lift is reduced, causing the APS to command trailing edge up elevator, which increases the AOA. The trailing edge up elevator command results in aft stick movement. Through a stick position-ATS interconnect, the ATS then smoothly increases thrust to maintain 15 units AOA.

Note

The pitch APS is operating in a parallel mode under these conditions, so there is a normal feedback movement of the control stick and a corresponding deflection of the pitch trim and synchronization indicator on the FMSP.

2.23.3.4.2 APC Engaged. During flight with the Pitch APS disengaged and APC engaged, crossfeed from the ATS to the elevator servo is used to minimize thrust-induced pitch changes. If the aircraft is in a stabilized flight condition on glide path and a gust is encountered, the normal reaction for the pilot is to move the control stick in pitch to hold glide path. The APC commands the ATS servos in response to changes in pitch control stick position, AOA, and normal acceleration. The thrust changes resulting from the APC commands to the ATS servos result in pitch changes, because the engines are located below the aircraft center of gravity.

Note

In this mode of flight, the crossfeed signal moves the elevator actuator in a series mode, so there is no feedback to the control stick and no deflection of the pitch trim and synchronization indicator on the FMSP.

2.23.4 AFCS Single-Channel Operations. The dual channels of the AFCS provide safety and redundancy. The AFCS will perform satisfactorily on only one channel, however the safety monitoring functions will be significantly degraded.

CAUTION

On aircraft incorporating AFC-273, the system may allow an AFCS mode to engage single-channel without illuminating the FAP caution lights. This can happen when the system detects a fault during attempted dual-channel mode engagement and disables the bad channel before allowing mode engagement. After mode engagement visually check the AFCS channe lights on the FCTP to confirm the AFCS is engaged dual-channel.

Note

- On aircraft incorporating AFC-273, AFCS mode performance may be degraded when the channels are not engaged similarly; for example, thrust engaged dual-channel and pitch engaged single-channel. It may be necessary to disengage and then engage all modes single-channel in the same channel.
- If electrical power to the FDC is lost while a mode is engaged single-channel, the FAP A/P warning light will illuminate when the mode(s) disengage. Under the same conditions on aircraft incorporating AFC-273, the A/P warning light will not illuminate.

2.23.4.1 APS Single-Channel Operations. If a single channel of the APS fails while engaged dual-channel, all axes of the APS will disengage. The PITCH, ROLL, and YAW channel status lights on the FCTP will indicate the failed channel. The pilot can then re-engage the APS single channel. Single-channel APS control authority is half of dual-channel APS control authority; however, this difference should not be apparent to the pilot. The amber A/P light on the FAP will remain illuminated to remind the pilot and copilot/COTAC that the AFCS is operating single channel.

WARNING

When operating single channel, automatic fault detection and mode disengagement is not provided. Some failures can cause hardovers. Unless dictated by mission requirements, do not operate single channel below 1,000 feet AGL. If the mission requires low-altitude, single-channel operation, engage the system above 1,000 feet AGL to ensure satisfactory performance prior to low-altitude use. Closely monitor the system during single-channel operations and be prepared to take control in the event of a hardover.

CAUTION

A pitch channel hardover while engaged single-channel at airspeeds above 250 KIAS will result in exceeding normal acceleration limits if not immediately countered. Single-channel pitch APS airspeed is limited to 250 KIAS.

Note

Single-channel pitch, roll, and heading hold mode of the APS wil not automatically disengage if the single attitude source fails.

2.23.4.2 ATS Single-Channel Operations. If a single channel of the ATS fails while engaged dual-channel, the ATS will disengage. The THRUST channel status lights on the FCTP will indicate the failed channel. The pilot can then re-engage the ATS single channel. Single-channel ATS control authority is the same as dual-channel ATS control authority. The amber ATS light on the FAP will remain illuminated to remind the pilot and copilot/COTAC that the AFCS is operating single channel.

Note

Single-channel ATS operations are unmonitored. It will be unable to detect failures and automatically disengage. ATS performance should be monitored closely during single-channel operations.

2.23.5 AFCS BIT. Following engine starts, the AFCS BIT can determine the status of AFCS and related equipment, and verify that the equipment is functioning properly. This test is initiated by pressing the TEST switch on the FCTP and is only available with aircraft weight on wheels. The AFCS BIT is a two-part test. When the pilot presses the TEST switch, the AUTO legend of the TEST switch illuminates and the first test, Automatic BIT, is run. The second part of the test, Manual BIT, commands the flight and engine control servos resulting in control surface movement and engine thrust changes. See paragraph 8.10 in Chapter 8, Shore-Based Procedures, and paragraph 11.4.1.7 in Chapter 11, Functional Check Flight, for actual test procedure.

Note

Any fault that is detected during either the Automatic BIT or Manual BIT will illuminate the appropriate failure legend on the FAP and the appropriate channel lights on the FCTP.

2.23.5.1 Flight Control Test Panel. The FCTP is the aircrew interface for AFCS BIT and for managing single-channel operations. When a failure that will disengage one or more axes of the AFCS is detected, the appropriate AFCS channel status light(s) will illuminate on the FCTP. The pilot can use the FCTP to selectively engage, disengage, or re-engage individual channels of the AFCS.

2.24 AUTOMATIC CARRIER LANDING SYSTEM

Note

Roll APS is not available with interim AFC-244 incorporated. AFC-244 is not incorporated on aircraft incorporating AFC-273.

The ACLS provides a reliable capability for final approach and landing of carrier-based aircraft. The system operates during daylight or darkness, with minimum conditions of severe weather and sea state and no limitation because of low ceilings and visibility. The system utilizes a precision tracking radar and computer aboard the carrier. The radar provides precise position data on the approaching aircraft with respect to the carrier. These data, along with data on pitch, roll, yaw, and deck motion of the carrier are supplied to the computer. The computer constantly calculates the desired position of the aircraft and generates a control signal that is transmitted to the aircraft by the data link system.

S-3B aircraft are cleared for day/night mode IA, II, and III approaches.

CAUTION

The brightness of the ACLS discrete panel lights may be distracting during night approaches.

The ACLS provides the following modes of operation:

1. Mode I — Approach is automatically controlled from the ACLS entry point to touchdown.

WARNING

Until further notice, S-3B aircraft are not authorized to conduct mode I approaches. The pilot should downgrade the approach from a mode IA to a mode II approach if AOA excursions repeatedly exceed ±2.5 units.

2. Mode IA — Approach is automatically controlled to a minimum of 200 feet and one-half mile, with manual control the remainder of the approach landing. Minimum acceptable ACLS configuration for coupled approaches is operational beacon, dual-channel pitch and roll APS, and single-channel yaw APS (DMPR on aircraft incorporating AFC-273) and APC.

3. Mode II — Approach is manually controlled using glideslope and azimuth information sent from the landing system and presented on the VDI.

4. Mode IIT — Approach is manually controlled as in mode II and supplemented by information supplied by the CCA controller.

5. Mode III — Approach is manually controlled following talkdown guidance from the CCA controller.

The ACLS is composed of two subsystems: shipboard subsystem and airborne subsystem.

The shipboard subsystem includes:

1. SPN-46 radar and ACLS computer
2. Naval tactical data system
3. SPN-41 precision approach transmitter.

The airborne subsystem includes:

1. ASW-33 AFCS
2. ASW-25 data link receiver
3. ARA-63 ICLS receiver decoder
4. APN-202 radar transponder.

2.24.1 Shipboard Subsystem

2.24.1.1 Carrier Air Traffic Control Center. The CATCC controls the aircraft from the marshaling area to the ACLS entry point and, when necessary, through the bolter/waveoff pattern back to the ACLS radar acquisition window. During the letdown from the marshaling point, the CATCC assigns an ACLS frequency to the aircraft. Data link is initiated and presented by discrete word displays on the telepanels in the cockpit (see Figure 2-134). At the ACLS entry point, the CATCC transfers control to landing control central.

2.24.1.2 Landing/Control Central (SPN-46). Landing control central acquires the aircraft on radar when the aircraft passes through the ACLS radar acquisition window that is usually located 4 to 6 miles astern of the carrier. At this time, the landing gear, flaps, and hook are down with APC engaged and the aircraft is flying at approach speed. The SPN-46 automatically sends discrete messages through the data-link system and begins transmitting vertical and lateral error signals to the aircraft cockpit display. Additional data-link signals in the form of discrete messages are trasmitted from the system and inform the pilot when to couple the aircraft AFCS to the SPN-46 shipboard computer. When the pilot couples the AFCS to the data-link, the SPN-46 takes control of the AFCS. The system controller sends a discrete message that the SPN-46 has command, and the aircraft flies down the approach path. At 12.5 seconds from touchdown, the SPN-46 sends a discrete message through the data link that deck motion compensation is added to the guidance commands. At 2.5 seconds from touchdown, the landing system freezes the pitch and bank commands and the AFCS holds the aircraft attitude to touchdown.

Incorporated in the landing control central and the tactical data system are control envelope limiters, signal monitors, and an LSO monitor. These system limiters and monitors are utilized to automatically disengage and decouple the AFCS whenever:

1. The aircraft exceeds the mode I flightpath control envelope.

2. The information stored in the data link is not updated within any 2.5-second period.

3. Any monitor sends a waveoff signal.

2.24.2 Airborne Subsystem. Approach guidance signals are transmitted from the carrier by the shipboard subsystems and the glideslope, and azimuth information is presented on the pilot and copilot/COTAC VDIs. Additional information is displayed to the flightcrew by the discrete indicator lights. The shipboard data-link transmitter transmits on a prescribed UHF frequency that must be set on the data-link receiver control panel. The shipboard SPN-41 transmits on a prescribed frequency corresponding to one of 20 channels selectable on the ARA-63 control panel.

2.24.2.1 Data Link Receiver (ASW-25). The data link receiver (Figure 2-134) is an airborne terminal that receives course and glidepath data signals transmitted from the carrier. These signals are received, decoded, and used as follows:

1. The pitch and bank commands are coupled to the AFCS for Mode I approach.

2. The vertical and lateral error signals are displayed on the VDI for the pilot to monitor in mode I. In mode II, these error signals display glidepath.

3. The signals are transformed also into discrete word messages and displayed on the discrete word display panel in the cockpit.

2.24.2.2 ICLS Receiver Decoder (ARA-63). The receiver decoder (Figure 2-136) receives approach guidance through vertical and lateral displacement signals transmitted from carrier or ground equipment.

2.24.3 Automatic Carrier Landing System Operation. Each aircraft is assigned an individual data-link address consisting of five digits that may be set from 00000 to 17777. The first digit on the left may only be 0 or 1. The remaining digits may be set from 0 to 7 (neither 8 nor 9 may be selected). Normally, the first two digits are assigned to an airwing and the last three digits are the aircraft modex. (If CAG-6 were assigned the numbers 06, then aircraft No. 702 address would be 06702). For an aircraft to receive any data-link information, the shipboard data-link transmitter must be transmitting that aircraft's address and the data-link receiver must be set on the proper frequency. Otherwise, the TILT discrete light will be illuminated.

The ACLS system is energized by placing the ASW-25 engage switch to ON with the mode switch in NORM, placing the ARA-63 POWER switch to ON, and placing the APN-202 MODE switch to STBY. After a 30-second time out, place the APN-202 MODE switch to ACLS. The proper frequency on the ASW-25 and the proper channel on the ARA-63 must be selected. The VDI toggle switch on the NAV DISPLAY SELECTOR determines which approach guidance information is displayed on its respective VDI. Movement of the VDI switch will not affect automatic control but simply changes which glideslope information is presented (SPN-41 or SPN-46).

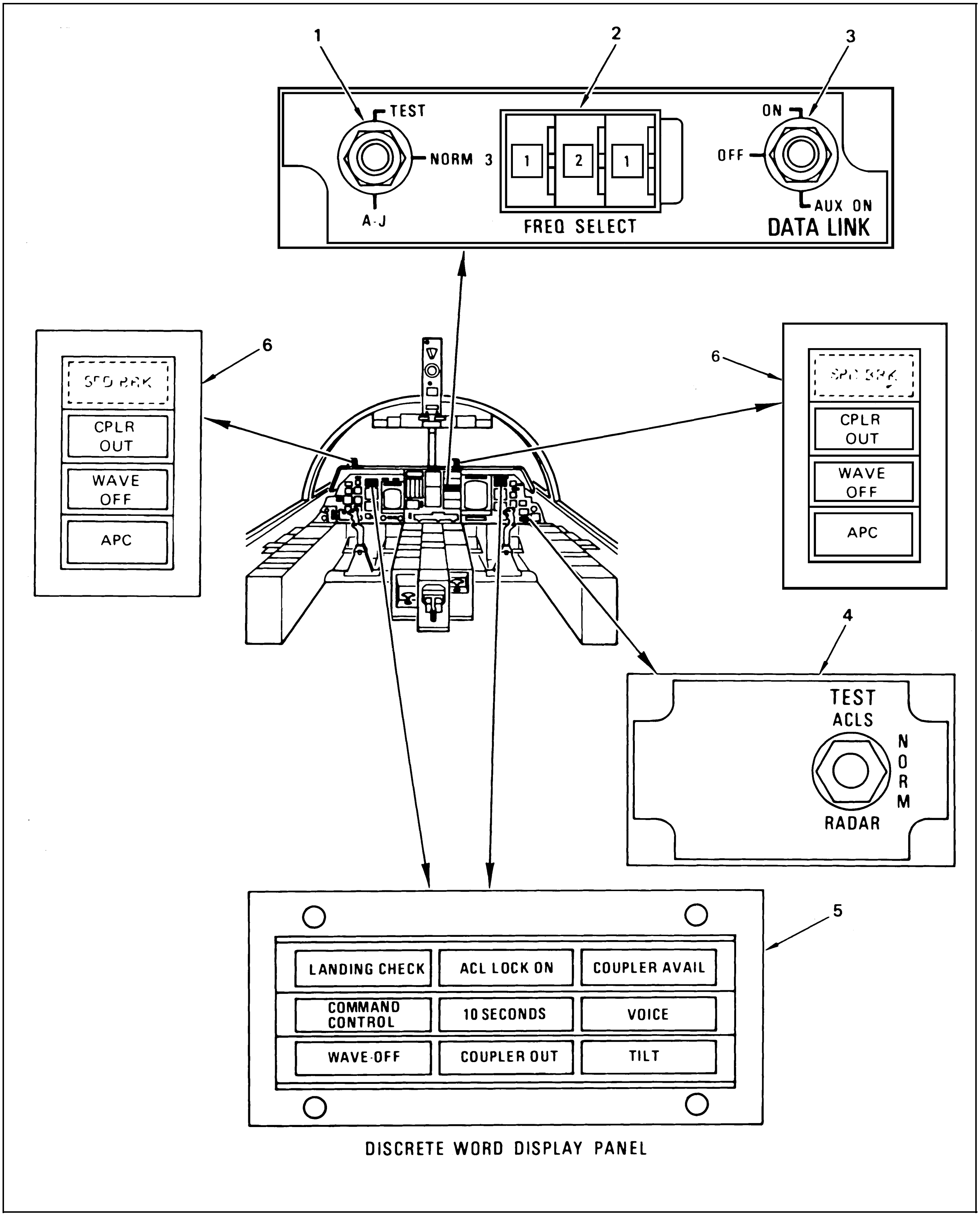


Figure 2-134. Automatic Carrier Landing System (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	TEST/A-J selector switch	TEST — reprograms the equipment to process a universal test message which provides a go/no-go check of the equipment. NORM — allows the data link to operate in a normal mode. A-J (anti-jam) — overrides the data link parity check circuitry.
2	FREQ SELECT	Thumbwheel operated selectors allow frequency selection from 300 to 324.9 MHz in 0.1 MHz increments.
3	DATA LINK power selector switch (3 position)	ON or OFF — applies or removes electrical power from the data link system. AUX ON (auxiliary on) — allows either UHF to be used as a data link receiver if the ASW-25B receiver fails.
4	ACLS/RADAR TEST switch	ACLS—allows the data link (ASW-25B) to be operated with weight-on-wheels. NORM — allows normal operation of the data link (ASW-25B) and APS-137(V) radar in flight. (Switch is spring-loaded to NORM position.) RADAR — allows operation of the APS-137(V) radar with weight-on-wheels.
5	Discrete Word Display Panel:	
	LANDING CHECK	Illuminates with green letters on a black background to advise that the landing check should be completed.
	ACL LOCK ON	Illuminates with green letters on a black background to advise that the shipboard radar and computer have locked on.
	COUPLER AVAIL	Illuminates with green letters on a black background to advise that the shipboard computer is ready to assume automatic landing control.
	COMMAND CONTROL	Illuminates with green letters on a black background to advise that the shipboard computer has assumed control of aircraft approach.
	10 SECONDS	Illuminates with green letters on a black background to advise that compensation for deck motion is being added to glide path commands.
	VOICE	Illuminates with green letters on a black background to advise that the landing officer wants voice communications for landing instructions.

Figure 2-134. Automatic Carrier Landing System (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
	WAVE-OFF	Illuminates with black letters on a red flashing background to indicate automatic disengagement of the landing system.
	COUPLER OUT	Illuminates with yellow letters on a black background to indicate that the autopilot is no longer coupled to the computer link.
	TILT	Illuminates with yellow letters on a black background to indicate that data link messages have not been received for 2.5 seconds.
6	Heads Up Annunciator (HUA) Panel:	
	CPLR OUT	Repeats the caution of the COUPLER OUT caution light on the discrete word display.
	WAVE-OFF	Repeats the WAVE-OFF warning of the discrete word display panel.
	APC	Illuminates to indicate that an automatic disengagement of the APC mode has occurred.

Figure 2-134. Automatic Carrier Landing System (Sheet 3)

2.24.3.1 Operation with SPN-46. (See Figure 2-135.)

Note

- Roll APS is not available with interim AFC-244 incorporated. AFC-244 is not incorporated on aircraft incorporating AFC-273.
- To avoid UHF radio interference and loss of the ACLS data signal, do not transmit UHF on the bottom antenna within 10 MHz of the ACLS frequency.

With the ASW-25 set on the proper UHF frequency and the correct address inserted by the CCA controller, the aircraft can be automatically controlled by the SPN-46 system up to 8 miles from the ship. The aircraft can receive UTM tests or ACLS discrete lights when within normal UHF range from the ship. Prior to SPN-46 lock-on, the VDI needles (VDI toggle switch in NAV) should be centered with the VERT and LAT alarm flags visible. If the ASW-25 power switch is placed from ON to OFF and back to ON in less than 20 seconds, any number of discrete lights may illuminate and the needles could be in any position. To remedy this situation, place the power switch to OFF for at least 20 seconds prior to returning it to ON. When the CCA controller inserts the aircraft address, the LANDING CHECK discrete light will illuminate and the TILT discrete light will extinguish if the aircraft is receiving the data-link signal. When the aircraft is within 8 miles, the CCA controller can initiate SPN-46 lock-on. When the SPN-46 radar locks on to the aircraft, the ACL LOCK ON discrete light will illuminate and the LANDING CHECK light will extinguish. Simultaneously, the VDI alarm flags will disappear and the elevation and azimuth needles will display the existing error. To receive automatic control, the PITCH, ROLL, and YAW (DMPR on aircraft incorporating AFC-273) axes of the APS must be engaged with the NAV SEL switch in the ACLS position. The AUTO THRUST switch must be in the APC position. The ACLS test light on the APN-202 will be illuminated indicating that the beacon is transponding to the SPN-46 radar signals. The COUPLER AVAIL discrete light will also illuminate indicating that the SPN-46 computer is ready to take automatic control of the aircraft. These vertical and lateral displacement signals are converted to elevation and azimuth displays on the VDI crosspointers. Thus, the pilot can control the aircraft manually during approach and landing by reference to the crosspointers (see Figures 2-93 and 2-99).

2.24.3.2 Radar Transponder (APN-202). The APN-202 is a radar transponder used in the ACLS position to operate with the SPN-46 radar. The R1623/APN beacon augmentor receiver receives

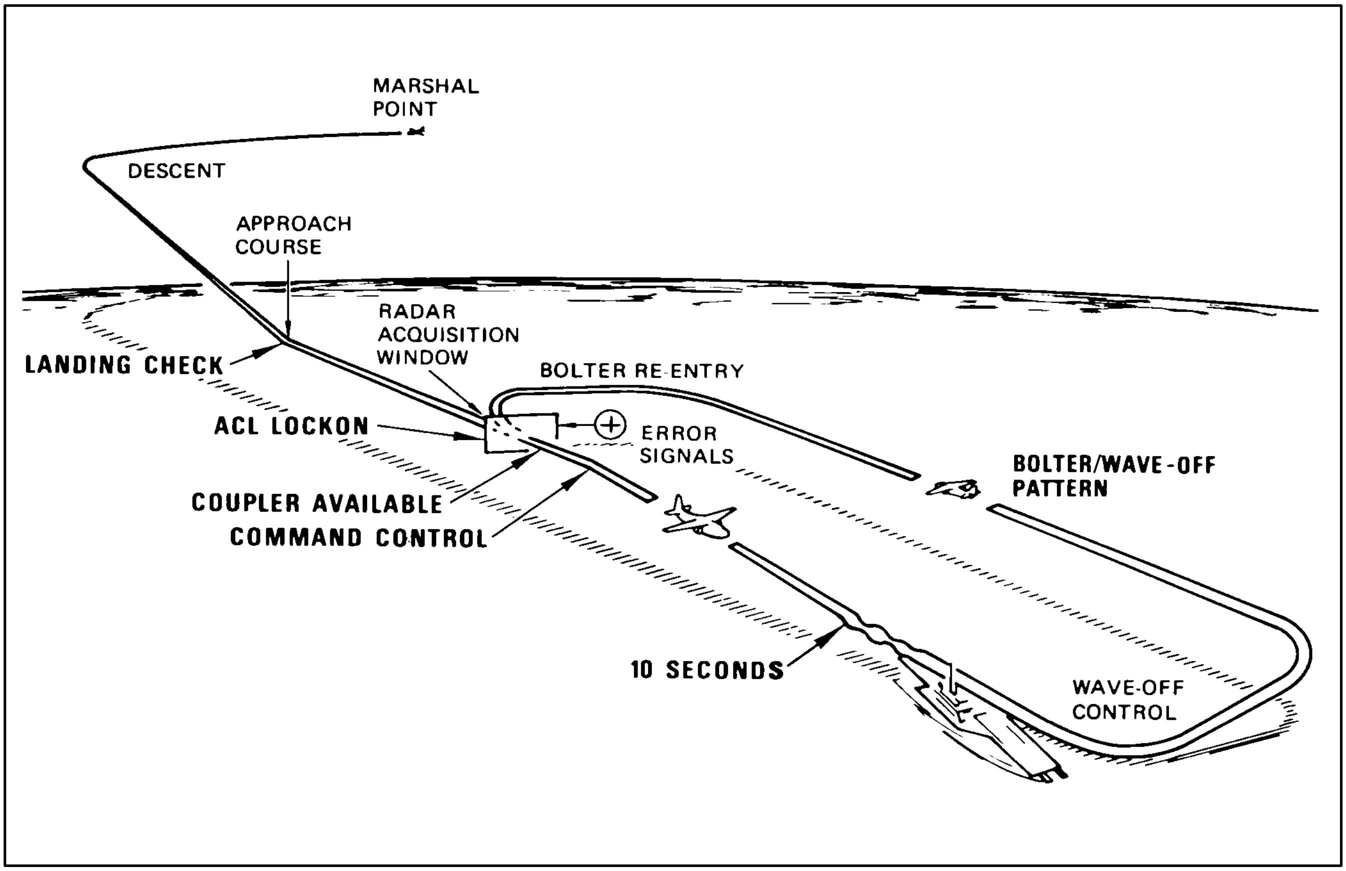
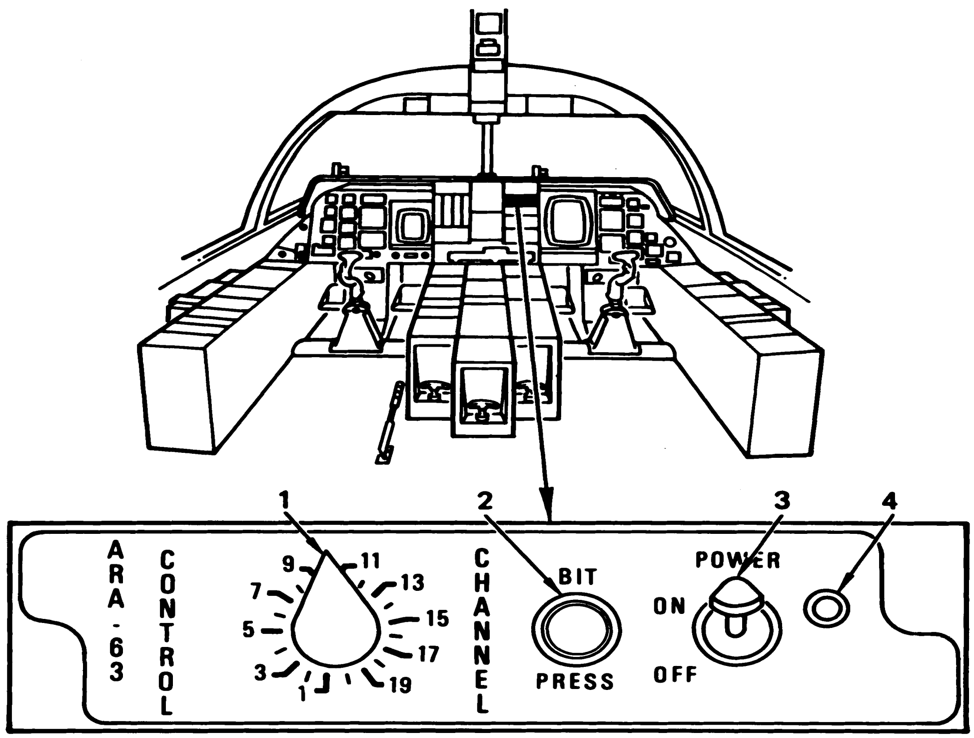


Figure 2-135. ACLS Approach Sequence

K_a-band signals from the SPN-46, and the APN-202 transmits back X-band signals. During operation, illumination of the ACLS TEST light indicates that the APN-202 is responding to SPN-46 signals. Prior to SPN-46 lock-on, this light may flash indicating that the SPN-46 is sweeping through the aircraft in a search mode (see Figure 2-137).

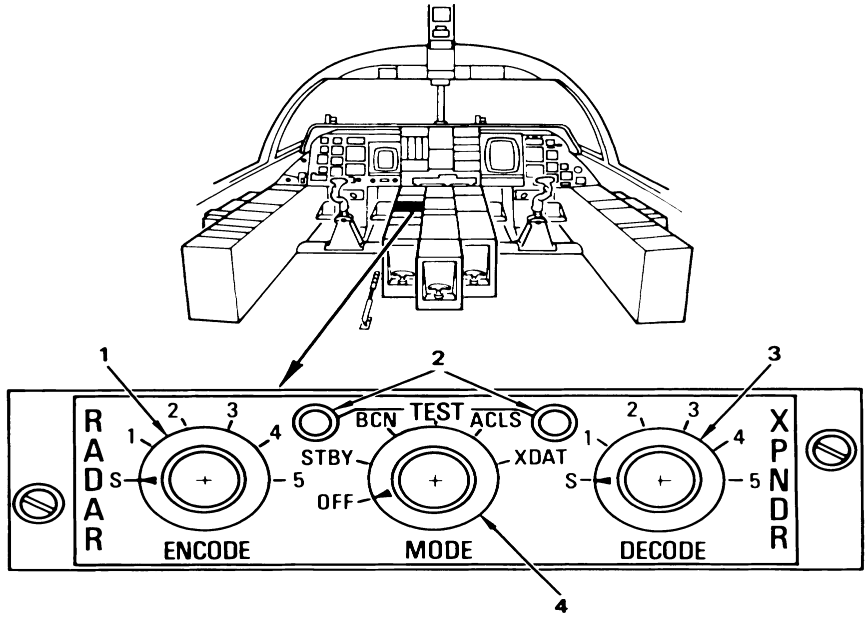
To couple the APS to the SPN-46, the HDG SEL/NAV switch must be placed in the NAV position. This should be done with the aircraft in straight-and- level flight with the APC holding the AOA on speed. After coupling, the pilot should report “Coupled” to the CCA controller who will then engage automatic control. When the SPN-46 has taken control, the COMMAND CONTROL discrete light will illuminate and the ACL LOCK ON discrete light will extinguish. The aircraft will then respond to ACLS control until touchdown or until an automatic, LSO, tower waveoff, or pilot takeover occurs. The pilot may regain manual control at any time by actuating the AFCS disconnect switch (see Figure 2-131).

An automatic waveoff will be sent at any time the aircraft exceeds the horizontal or vertical control limits during an approach. This could be caused by a system malfunction but is more likely caused by turbulence or ship turning. A waveoff will be indicated by the flashing WAVE-OFF discrete light. The COMMAND CONTROL and COUPLER AVAIL discrete lights will extinguish and the COUPLER OUT discrete light will illuminate indicating that the HDG SEL/NAV switch has returned to the neutral position and the APS is no longer responding to automatic control. A waveoff may also be sent by the LSO or the tower when the aircraft is within 1 mile (but no closer than 5 seconds) by use of the manual waveoff pickle switch. Receipt of this waveoff will be the same as an automatic system waveoff. A waveoff sent within 5 seconds will not uncouple the aircraft and will only be visible by the waveoff lights on the Fresnel lens. In this case, the pilot must uncouple the APS by use of the AFCS disconnect switch and initiate a waveoff.



INDEX	CONTROL/INDICATOR	FUNCTION
1	CHANNEL selector switch (20-position rotary)	This switch has 20 positions which allow selection of any one of 20 available channels for signal reception.
2	BIT switch	When momentarily pressed, this switch activates the BIT circuitry causing the vertical deviation indicator on each VDI to move to the center while the lateral deviation indicator oscillates half full right or left of center at about 2-second intervals and the VERT and LAT flags go out of view.
3	POWER switch	ON-OFF — applies or removes power to the carrier ILS equipment.
4	Power indicator light	Illuminates green when power is applied to the ICLS equipment.

Figure 2-136. ICLS Receiver Decoder



INDEX	CONTROL/INDICATOR	FUNCTION
1	ENCODE switch (6-position rotary)	S — utilizes the automatic carrier landing mode and encodes the signal being transmitted from the aircraft to the ship. 1 thru 5 — these positions are not used.
2	TEST lights BCN and ACLS	When both green lights are illuminated, they indicate a successful test when selected to the TEST mode. When the ACLS light illuminates (right light only) it indicates the system is being interrogated by the ACLS radar and it is responding. (Right TEST light intensity is controlled by console light dimmer switch).
3	DECODE switch (6-position rotary)	S — utilizes the automatic carrier landing mode and allows the incoming signal from the shipboard ACLS radar to be decoded. 1 thru 5 — these positions are not used.
4	MODE selector switch (6-position rotary)	OFF — removes power from the radar transponder and augmentor system. STDBY (standby) — applies power to the equipment for warmup and maintains a standby state ready for immediate use. Thirty seconds are required for warmup. BCN (beacon) — this mode is not used. TEST — applies BITE signals for system testing. ACLS — allows the radar beacon augmentor to be utilized with the automatic carrier landing system. XDAT (transmit data) — this mode is not used.

Figure 2-137. Radar Transponder

2.24.3.3 Operation with SPN-41. With the ARA-63 set on the proper channel, SPN-41 information can be received from over 50 miles from the ship if the aircraft is within the scan pattern of the SPN-41 antenna ($\pm 20°$ from centerline and from $10°$ above the horizon to the surface). With the aircraft outside of the SPN-41 scan, no information will be received and the VERT and LAT alarm flags will be present on the VDI. When the aircraft is within $\pm 1.4°$ of glideslope, the elevation needle moves proportionally to aircraft glideslope error and when within $\pm 6°$ of centerline, the azimuth needle moves proportionally to the lineup error. This area is called the proportional coverage zone. If the aircraft is outside of the proportional coverage zone in either azimuth or elevation but within the SPN-41 scan pattern, the respective needle will show a full deflection with its alarm flag out of sight.

The primary purpose of the precision approach system is to allow a redundancy in the ACL system. It allows the pilot to cross-check both SPN-41 and SPN-46 glideslope information throughout the approach. By allowing the SPN-46 system to automatically control the aircraft on glideslope while monitoring SPN-41 glideslope information, the pilot is able to ensure that glideslope control is accurate.

The precision approach system information can be used throughout an approach from marshal to the deck within the limitations of the SPN-41 antenna pattern. The azimuth information is especially useful since final bearings may often change during an approach. When the azimuth needle is centered, the aircraft is on final bearing. This is normally more accurate than the last supplied tacan final bearing, which is usually given only in $5°$ increments. The SPN-41 glideslope information is not of much value until tip-over. But at tip-over if the SPN-46 is not yet locked on, the approach can be continued in mode II without pilot distraction.

Note

The ILS utilizes a surface precision approach transmitter (SPN-41) and an airborne receiver decoder (ARA-63). This equipment is not compatible with FAA ILS.

2.24.3.4 ACLS Self-Tests. When in operation, the shipboard data-link continuously transmits a UTM that is used by the data-link receiver as a self-test feature. The data-link self-test is performed by selecting NAV on the VDI toggle switch, setting the ship data-link frequency on the ASW-25, and selecting ON on the ASW-25. When the TILT discrete appears, select and hold TEST on the ASW-25 mode switch. A good self-test will then be shown by the VDI needles cycling every 6 seconds from fly up and right to fly down and left. At fly down and left, the WAVE-OFF and VOICE discrete lights will illuminate and will extinguish at fly up and right. This cycle will continue as long as the mode switch is held in the TEST position. After releasing the mode switch, which is spring loaded to the NORM position, the VDI needles will center and VERT and LAT alarm flags will appear. To receive the VDI signals generated by data link, the VDI toggle switch must be in the NAV position.

The ARA-63 self-test is performed by selecting ON on the ARA-63 control box and pressing and holding the BIT pushbutton. The VDI toggle switch must be in the ILS position. A good test is indicated by the glideslope needle centering and the azimuth needle cycling to approximately one-half fly left, one-fourth fly left, one-fourth fly right, one-half fly right, and back in the opposite direction repeatedly as long as BIT is held. A malfunction in the system is indicated if this cycle does not occur or if the VERT or LAT alarm flags are present; the ARA-63 should not be relied upon as accurate.

The radar transponder test is performed by selecting STBY on the MODE selector switch and S on both the ENCODE and DECODE switches. After a 30-second warmup, select TEST on the MODE switch. A good self-test will be indicated by the illumination of both of the test lights within approximately 30 seconds.

Note

If the aircraft is parked on the flight deck aft of the island, the APN-202 should be left in OFF and the self-test delayed until airborne. Stray energy from the SPN-46 system can trigger the beacon and may degrade performance or preclude lock-ons of aircraft in the process of ACLS approaches.

An intermittent illumination of the ACLS test lights during the self-test indicates a fault in the system and will normally necessitate a skin-tracked mode II or mode III approach.

2.25 ESCAPE (EJECTION) SYSTEM

The aircraft is equipped with a four-man ejection system that provides safe ejection throughout the aircraft flight envelope (Figure 4-4). The system provides the pilot and copilot/COTAC with the capability of command ejection (entire crew) or individual crewmember ejection. Following command ejection initiation, the system ejects all four crewmembers within 1 second and is fully automatic through parachute deployment. The system consists of ejection seats, individual seat adjustment, command or individual ejection selection, and INCOS tray stowage.

The four ESCAPAC 1E-1 seats are similar at all stations (see Figures 2-138 and 2-139). Each seat has individual differences to provide protection and lateral separation during sequenced command ejection. The seats incorporate an ejection seat safety lever (headknocker) in the center of the headrest to prevent inadvertent firing of the seat by either the upper (face curtain) or lower (seat pan) ejection handle. A conventionally operated inertia reel lock lever is located on the left side of the seat bucket for locking and unlocking the shoulder harness. The inertia lock lever allows normal forward movement of the crewmember but automatically prevents forward movement during high-g deceleration. The inertia reel also incorporates a haulback feature to position the crewmember for ejection. A harness release handle, located on the right side of the seat bucket, provides emergency release of the parachute pack and survival kit from the seat and permits easy removal and installation of the survival kit for servicing. The seat adjustment system allows each seat to be lowered or raised. The system consists of a small electric motor that drives the seat up or down, parallel to the rails. The seat cannot be moved fore and aft. The system is controlled by individual crewmember switches located on their respective side consoles.

Command (crew/self) eject selector levers, located on the pilot and copilot/COTAC inboard seat rails, allow the pilot or copilot/COTAC the option to eject all crewmembers. The selector levers have two positions, self-eject (up) and crew eject (down). When the self-eject position is selected, only the respective seat will eject when an ejection handle is pulled. Selecting the crew eject position, with either lever, will eject all seats when a respective ejection handle is pulled. Also, selecting the crew eject position will illuminate the green advisory GROUP EJECT light at the TACCO and SENSO stations (see Figure 2-140). When at least one lever is in the self-eject position, the SEAT SELECT amber light on the master caution panel will extinguish prior to the aircraft ascent through the 17,000-foot altitude level. Descent through the 14,000-foot altitude level will illuminate the SEAT SELECT light advising the crewmembers that CREW EJECT has not been selected. The EJECT switch, located on the eyebrow panel above the windshield, illuminates the flashing red warning EJECT alert lights above the MPD on the TACCO and SENSO panels.

The INCOS tray stowage system automatically raises and locks the TACCO and SENSO trays before ejection. The system operates when the ejection handle is pulled, using gas generated by an initiator.

The ejection seat system consists of the following six major subsystems:

1. Propulsion system
2. Seat stabilization system
3. Lateral separation system
4. Man/seat separation system
5. Parachute, torso harness, and survival kit system
6. IFF ejection seat emergency actuation system.

2.25.1 Propulsion System. The propulsion system consists of two stages, the catapult stage and rocket stage. The catapult stage is fired first and provides the initial thrust to propel the seat up the guide rails and out of the aircraft. The rocket stage, ignited by gas from the catapult stage, provides sustaining thrust for ejection of the seat.

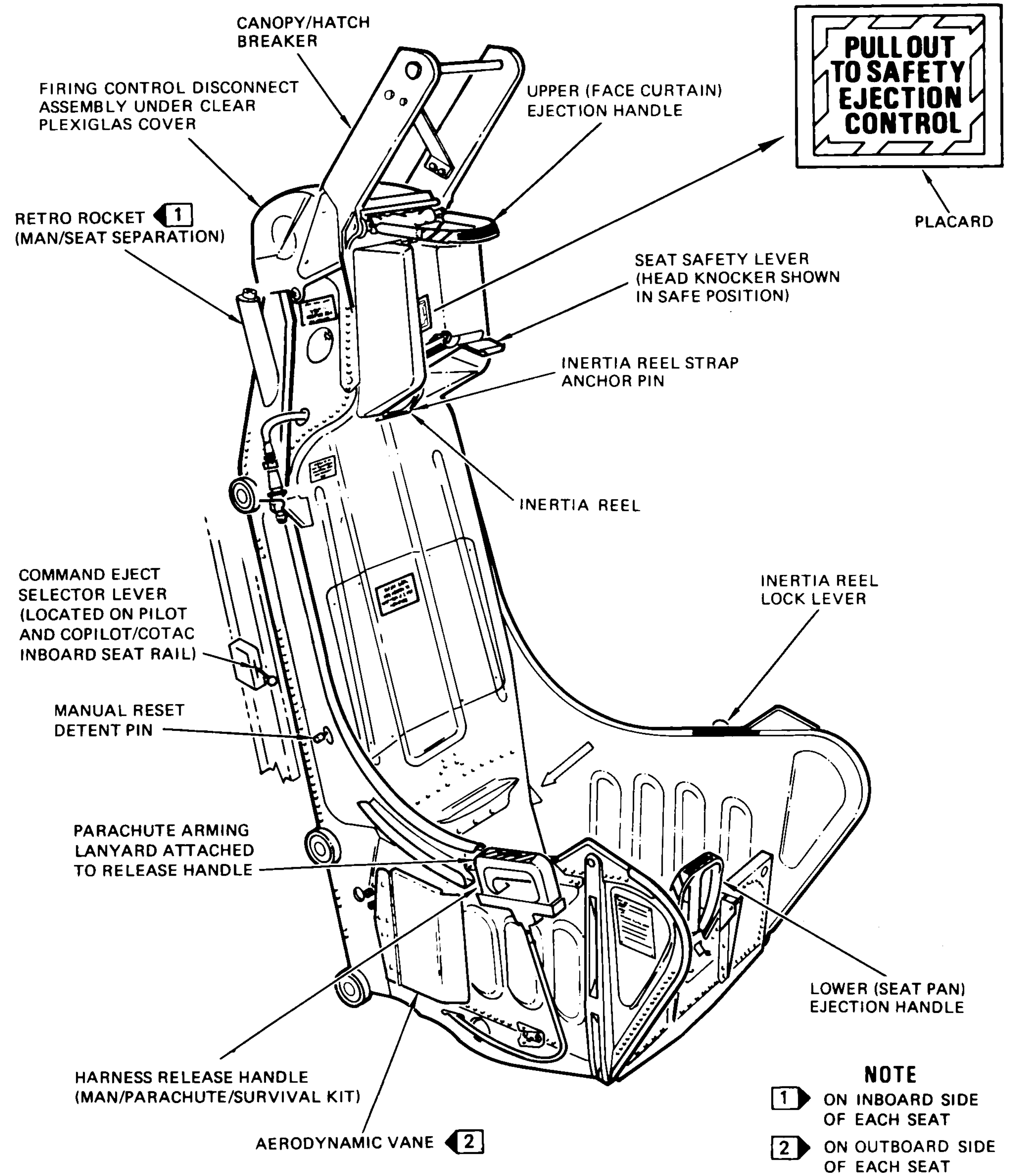


Figure 2-138. Ejection Seat

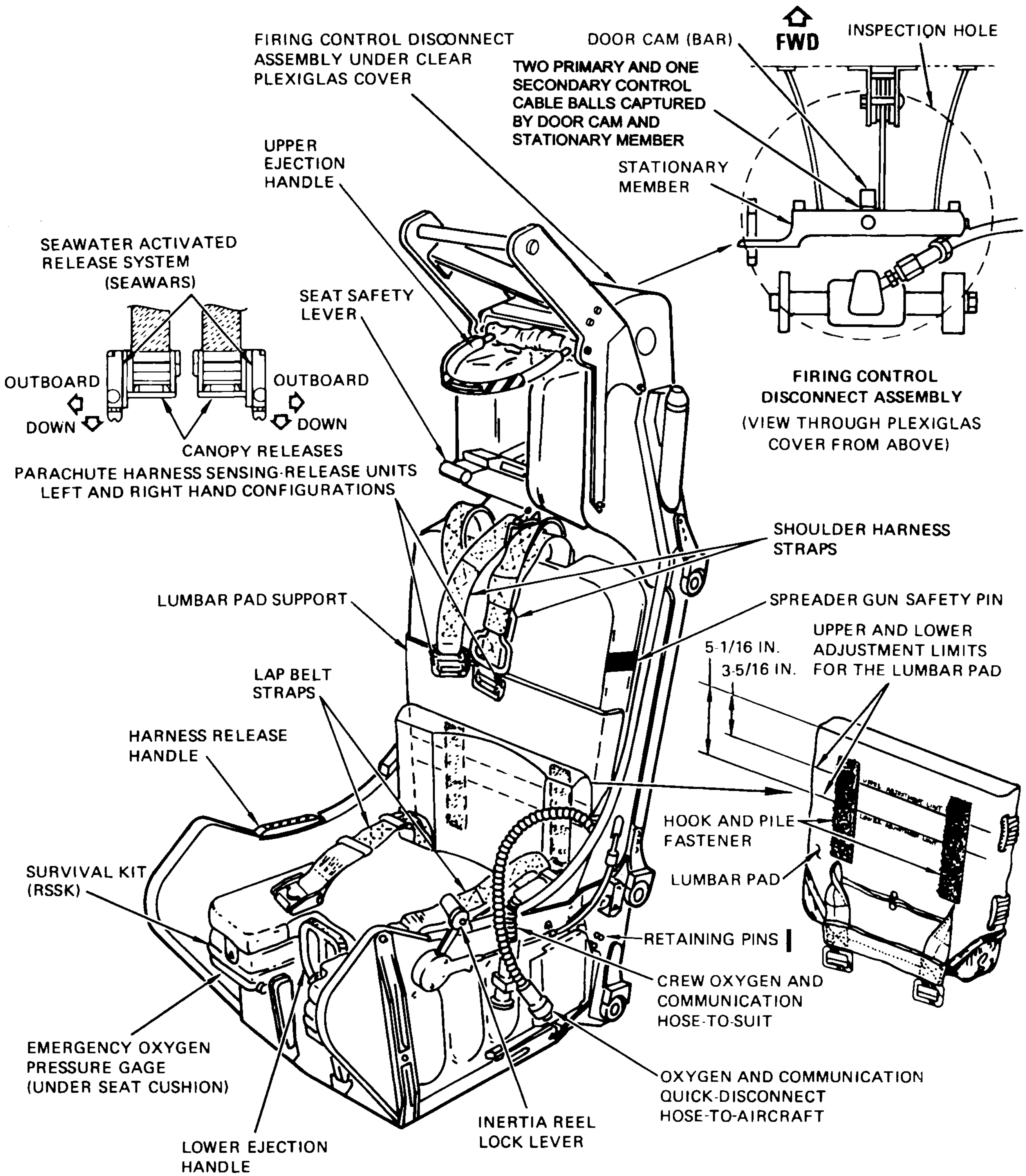


Figure 2-139. Ejection Seat — Survival Kit, SEA WARS, and Parachute Installed

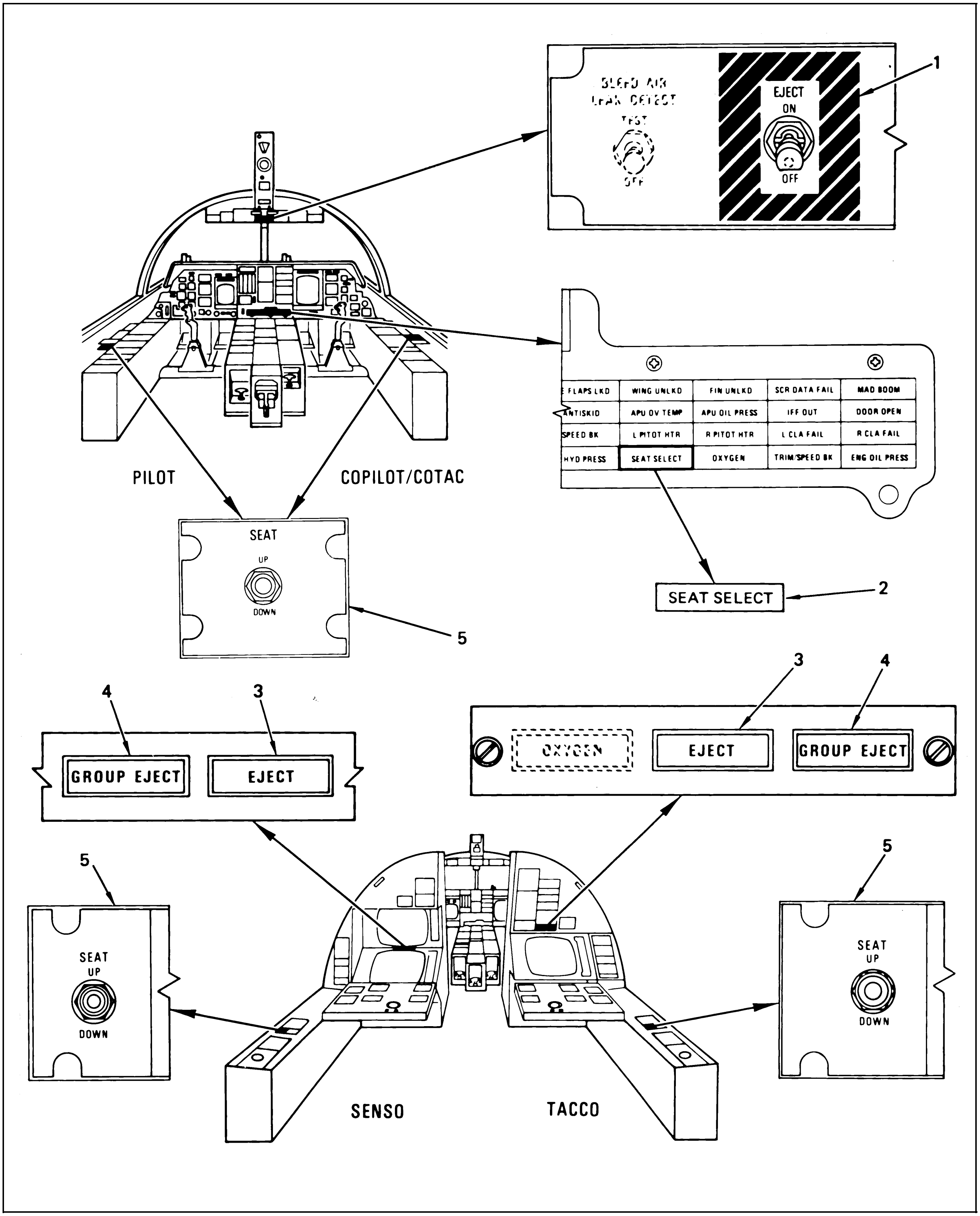


Figure 2-140. Ejection System Indicators and Auxiliary Controls (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	EJECT warning light switch	ON — illuminates TACCO and SENSO EJECT warning lights by pilot action. OFF — removes power to warning lights.
2	SEAT SELECT caution light	Illuminated amber—cautions pilot and copilot/ COTAC that at least one of the eject mode selector levers is in the SELF EJECT (up) individual ejection position and aircraft is below 15,000 feet. **Note** The SEAT SELECT caution light is controlled by a 15,000 foot nominal altitude barometric switch. The tolerance band is: 17,000 feet ascending, 14,000 feet descending.
3	EJECT alert warning light	Illuminated — prepare for immediate ejection. **WARNING** Do not initiate the ejection sequence.
4	GROUP EJECT advisory light	Illuminated green — advises TACCO and SENSO that either pilot or copilot/COTAC command eject selection lever is in the CREW EJECT (down) position. **WARNING** Crewmembers should not unstrap and depart from their seats if this light is illuminated. Extinguished — advises TACCO and SENSO that both pilot and copilot/COTAC command eject selection levers are in SELF EJECT (up) individual ejection position.
5	SEAT adjustment switch	UP — causes seat to move upward parallel to seat rails. Center — stops movement of seat (spring-loaded). DOWN — causes seat to move downward parallel to seat rails.

Figure 2-140. Ejection System Indicators and Auxiliary Controls (Sheet 2)

2.25.2 Seat Stabilization System. The STAPAC stabilizes the seat during ejections. The STAPAC is operative from the time the seat leaves the guide rails until after the rocket burnout. It contains a mechanically fired vernier rocket motor and a simple pitch-rate gyro located under the seat bucket. The gyro is brought up to operating speed by a gas-driven gear rack as the seat approaches the top of the guide rails. At this time, the gyro is uncaged and the vernier rocket is fired. If the seat starts to pitch from the attitude at which it left the aircraft, the gyro mechanically positions the vernier rocket in order to maintain the seat in the proper attitude until man/seat separation after rocket burnout. Additionally, the vernier rocket adds to the trajectory height of the seat and improves ejection capabilities from the aircraft during high sink-rate conditions.

2.25.3 Lateral Separation System. A system to maintain lateral separation during multicrew command ejection (crew eject) is provided by thrust from a small rocket thruster and the aerodynamic vane. As the seat separates from the aircraft, the aerodynamic vane is mechanically deployed into the airstream. The vane works in conjunction with the yaw thruster to rotate the seat into a trajectory that ensures lateral separation from the other seat trajectories. The lateral separation system provides approximately a 60-foot distance between the seats during command ejection.

2.25.4 Man/Seat Separation System. The man/seat separation system consists of a harness release actuator and a retrorocket. The harness release actuator, activated by gas pressure from the booster initiator, releases all restraining straps holding the crewmember in the seat. At the same time, it fires the retrorocket located adjacent to the headrest area of the seat. The retrorocket thrust retards the seat aft and out from under the crewmember resulting in man/seat separation. In addition, the retrorocket thrust decelerates the seat to provide separation, thus precluding man/seat/chute entanglement.

2.25.5 Parachute, Torso Harness, and Survival Kit. BuNo 159417 and subsequent and aircraft incorporating ACSC-294 require a NES-12E parachute; a NES-12C parachute can be used on unmodified aircraft. The personnel parachute is a back-type chute used with an integrated torso-harness. The parachute incorporates an arming lanyard that attaches to the emergency harness release handle on the right side of the aircraft ejection seat. On the modified seat, the emergency release handle assembly includes a locking plunger that will prevent locking of the handle in the receptacle if the arming cable is disconnected. An additional spring-loaded plunger within the receptacle rejects the handle if it is not oriented properly and the parachute arming cable is not installed correctly. During man/seat separation, the external pilot chute static line, which is attached to the seat, pulls the external pilot chute from its pocket to stabilize the man prior to automatic parachute deployment. The parachute also incorporates a conventional D-ring ripcord handle for manually deploying the parachute. The parachute has a 28-foot canopy incorporating a fail-safe ballistic gun to ensure rapid canopy spreading and inflation. The ballistic gun fires 14 slugs simultaneously to drag the attached suspension lines outward in a 360° spread. If a cartridge malfunction occurs, a fail-safe backup subsystem releases the slugs and allows the canopy to inflate aerodynamically.

2.25.5.1 Parachute Harness Sensing-Release Unit. This is a seawater activated system that automatically releases the parachute from the crewmember. When the sensing-release units are immersed in sea-water, cartridges are fired that allow the parachute risers to separate from the canopy releases.

The torso harness suit combines the parachute harness, lap restraint, and shoulder harness and is connected to the parachute risers by quick-release fittings. The harness is channeled through the torso suit to retain it in position and to facilitate suit donning. When in the aircraft, the canopy releases on the parachute risers are connected to the release fittings on the torso suit. The survival kit is also connected to the integral torso suit by means of lap-restraint, quick-release fittings.

2.25.6 Rigid Seat Survival Kit. Land/sea survival items are stowed in the RSSK (see Figure 2-141). The RSSK functions as a seat for each crewmember and as a container for an emergency oxygen system, URT-33 emergency radio-beacon, liferaft, and survival equipment. The RSSK contains an upper and lower container. It is opened by a single handle on the forward right side of the kit with ACC-377 incorporated.

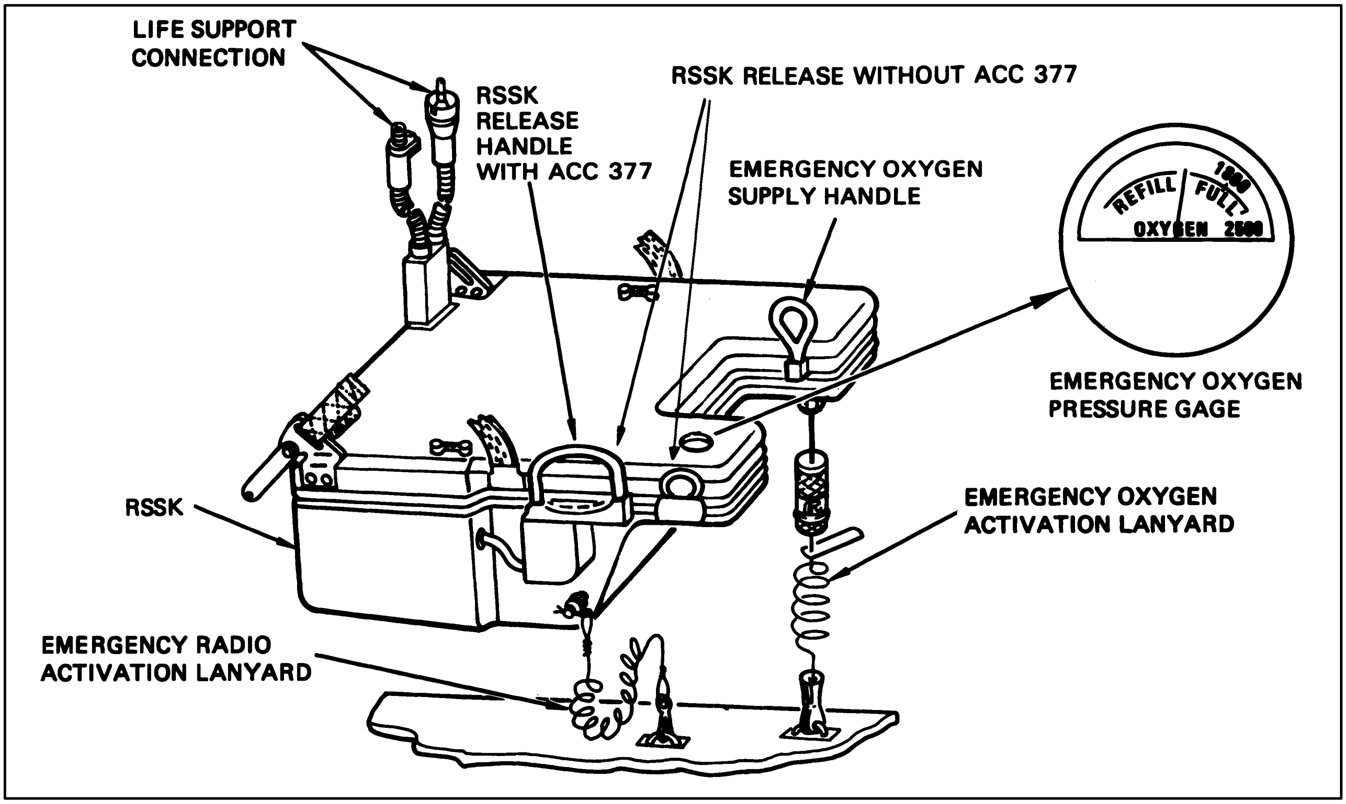


Figure 2-141. Rigid Seat Survival Kit

WARNING

RSSK without ACC-377 incorporated, the forward most handle needs to be pulled first if not simultaneously to prevent binding and failure of the raft to deploy.

The RSSK, attached to the crewmember torso harness by two adjustable retaining straps, is permanently mounted on the upper container that houses the emergency oxygen supply. The lower container houses the liferaft and survival equipment. To activate the RSSK deployment after ejection and main chute deployment, the crewmember pulls and discards the yellow release handle. After deployment, the lower container falls away but remains attached to the drop line. The life-raft attached to the drop line is automatically inflated.

2.25.6.1 RSSK Release Handle. The yellow RSSK release handle(s) on the forward right side of the kit is pulled free to release the lower container from the upper portion of the survival kit.

2.25.6.2 RSSK Equipment. A representative list of the RSSK lower container equipment follows:

1. Nylon cord, Type I
2. Radio beacon
3. Day/night distress signal Mk 13 Mod 0
4. Sea dye marker
5. Bailing sponge
6. SRU-31/P packet No. 1
7. SRU-31/P packet No. 2 (must be stowed on aviator if PLD is utilized)
8. Canned water (a second can optional)
9. Can opener
10. Ground/air emergency code card
11. Combat casualty blanket (optional equipment)
12. Personnel lowering device (optional equipment).

2.25.7 Ejection Seat System Operation

Note

For preflight and ejection procedures, refer to Part III and Part V.

The ejection sequence is initiated by pulling on either the upper ejection handle (face curtain) or the lower ejection handle between the knees (see Figure 2-142). This actuation stows the aft crew trays, activates the automatic haul-back feature of the inertia reel to position the crewmembers for ejection, and fires the catapult that accelerates each ejection seat up the rails. The seat rails and seat back act as an exhaust chute to guide the catapult/rocket thrust downward onto the cockpit floor to prevent burn hazards to the crew. Separation of the cable-attached RSSK from the deck activates the emergency oxygen system. When the seat is ejected, the IFF is actuated through a pressure switch to the emergency-on mode for transmission. Normal ejection is through the canopy; the seat is equipped with canopy/hatch breakers to protect crewmembers during ejection. (See Figure 2-143.)

2.25.7.1 Command Ejection. When the command ejection (all crew) option is exercised, the two aft crew seats will eject 0.52 second before the two forward crew seats. This time delay coupled with seat thrust trajectory assures separation between the four crewmembers (refer to Ejection Procedures, Part V). During a command ejection, the following sequence of events takes place (see Figure 2-144):

1. An initiator is fired by the actuating pilot and the crewmembers are forced back in their seats by their ballistic inertia reels; tray stowage takes place simultaneously at the SENSO and TACCO station. Time: 0 to 0.3 second.

2. At 0.3 second after command ejection actuation, the two aft seats start up the rails simultaneously; at 0.44 second, both aft seats clear the aircraft.

3. At 0.82 second, the forward seats start up the rails. At 0.96 second, the forward seats clear the aircraft.

After ejection:

1. At seat separation, the trimode external pilot chute is pulled from its pocket and opened by the static line attached to the ejection seat. At speeds from 0 to 90 knots, the EPC will inflate to full diameter; at speeds between 90 to 200 knots, the diameter reduces to 24 inches. Over 200 knots, the EPC inverts but effective drag is sufficient to extract the internal pilot chute and main canopy.

2. The automatic parachute actuator, which is armed during man/seat separation, fires in 0.4 second if at or below 14,000-foot altitude. The ripcord pins are removed from the locking cones allowing the spring bands to open the container. The external pilot chute release assembly releases the shear link cable when the container opens, thus allowing the external pilot chute and the internal pilot chute to pull the main recovery parachute from its container.

3. The crewmember, falling away from the external pilot chute and the internal pilot parachute, causes the main canopy to be pulled from the container. The main canopy is followed by its suspension lines. Immediately prior to full suspension line stretch, the ballistic spreading gun will fire, forcing the suspension lines out at the skirt hem, providing a more rapid opening of the canopy by allowing it to fill with air rapidly.

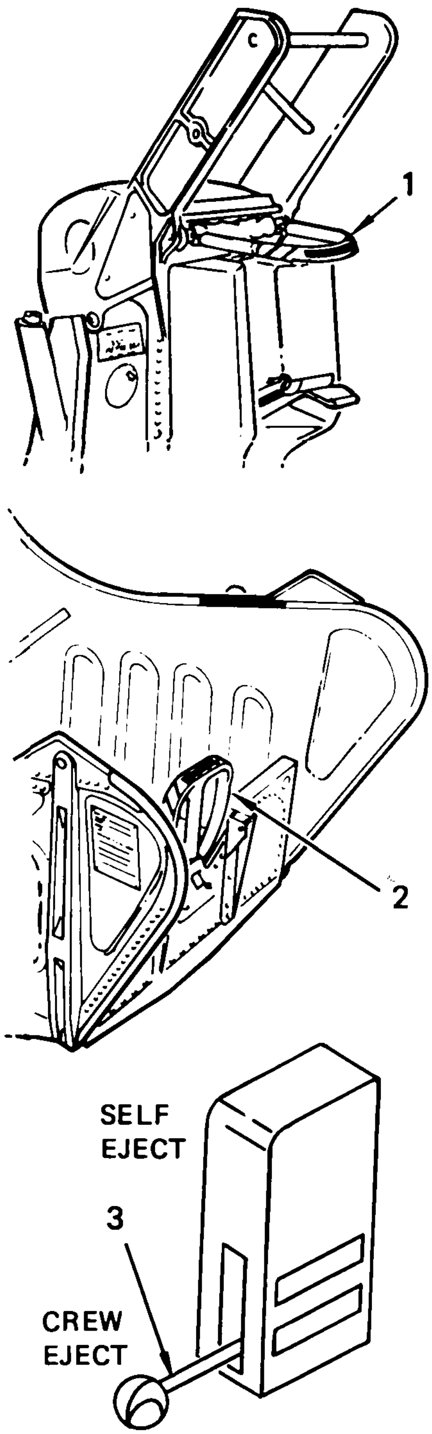
WARNING

If the ballistic spreader gun safety pin is not removed, the canopy will not open, either ballistically or aerodynamically.

Note

If the spreader gun fails to fire, the slugs separate from the gun assembly (at full suspension line stretch) allowing the canopy to open fully.

4. A piece of nylon tape used to momentarily shorten the canopy/suspension line effective length during the low-speed side of the escape envelope promotes more rapid opening characteristics.



INDEX	FUNCTION
1	Upper ejection handle — manually operated loop type handle attached to face curtain, located above crew-members head. Handle has following function when pulled to full extension: Pulled — initiates ejection sequence
2	Lower ejection handle — manually operated loop type handle located between crewmembers legs. Handle has following function when pulled to full extension. Pulled — initiates ejection sequence
3	Command (crew/self) eject selector levers - two two-position mechanical levers located inboard of pilot and copilot/COTAC seat only have following functions: SELF EJECT (up) - allows pilot or copilot/COTAC to be individually ejected when their eject handles pulled **WARNING** • When both pilot and copilot/COTAC have their command eject selection levers in up (individual ejection) position, all crew-members must individually eject. • When pilot lever is in down (CREW EJECT) position and copilot/COTAC lever is in up (SELF EJECT) position, only the pilot can eject all crew members by pulling an ejection handle. • When copilot/COTAC lever is down (CREW EJECT) position and pilot lever is in up (SELF EJECT) position only the copilot/ COTAC can eject all crewmembers by pulling ejection handle. CREW EJECT (down) — allows entire crew to be command ejected when either pilot or copilot/COTAC pulls on his ejection handle

Figure 2-142. Ejection Seat System Controls (Sheet 1 of 2)

FUNCTION	INDEX
Seat safety lever — manually operated two-position lever with following functions: Down (safe) — mechanically locks the initiator firing mechanism which is connected by cables to the upper and lower ejection handles. In this position, the seat is safe **WARNING** Seats with the lever (headknocker) down will be ejected if pilot or copilot/COTAC initiates ejection with his respective command eject lever in the command eject mode. Up (armed) — mechanically unlocks the initiator firing mechanism which is connected by cables to the upper and lower ejection handles. In this position, the seat is armed	4
Harness release handle — manually released handle with following function: Released — disconnects parachute and RSSK from the seat which allows crewmember to leave seat with parachute and RSSK attached to his person	5
Inertia-reel lock lever — two-position manually operated lever with following functions: Locked (forward) — mechanically locks inertia reel which prevents forward movement of shoulder harness Unlocked (aft) — mechanically unlocks inertia reel which allows forward movement of shoulder harness	6

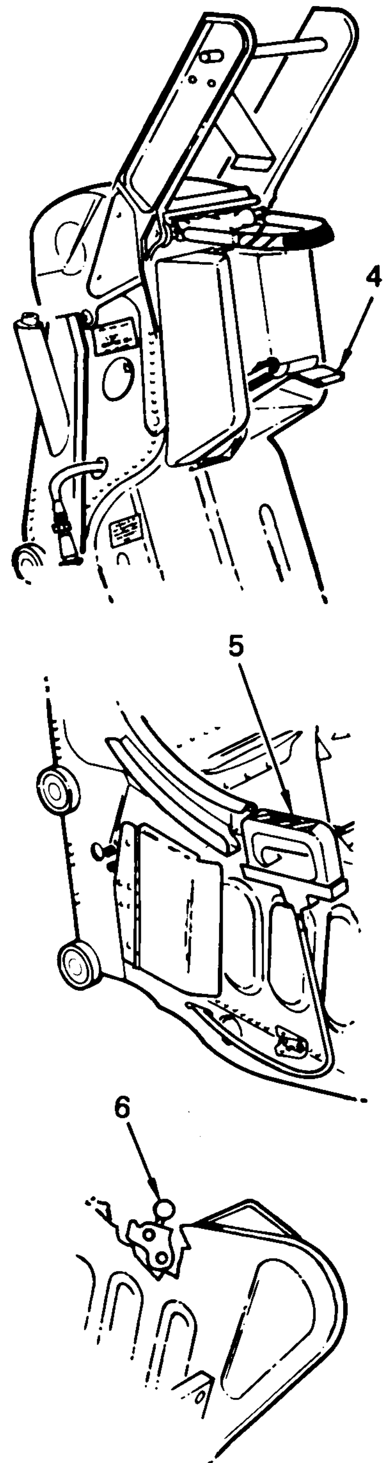


Figure 2-142. Ejection Seat System Controls (Sheet 2)

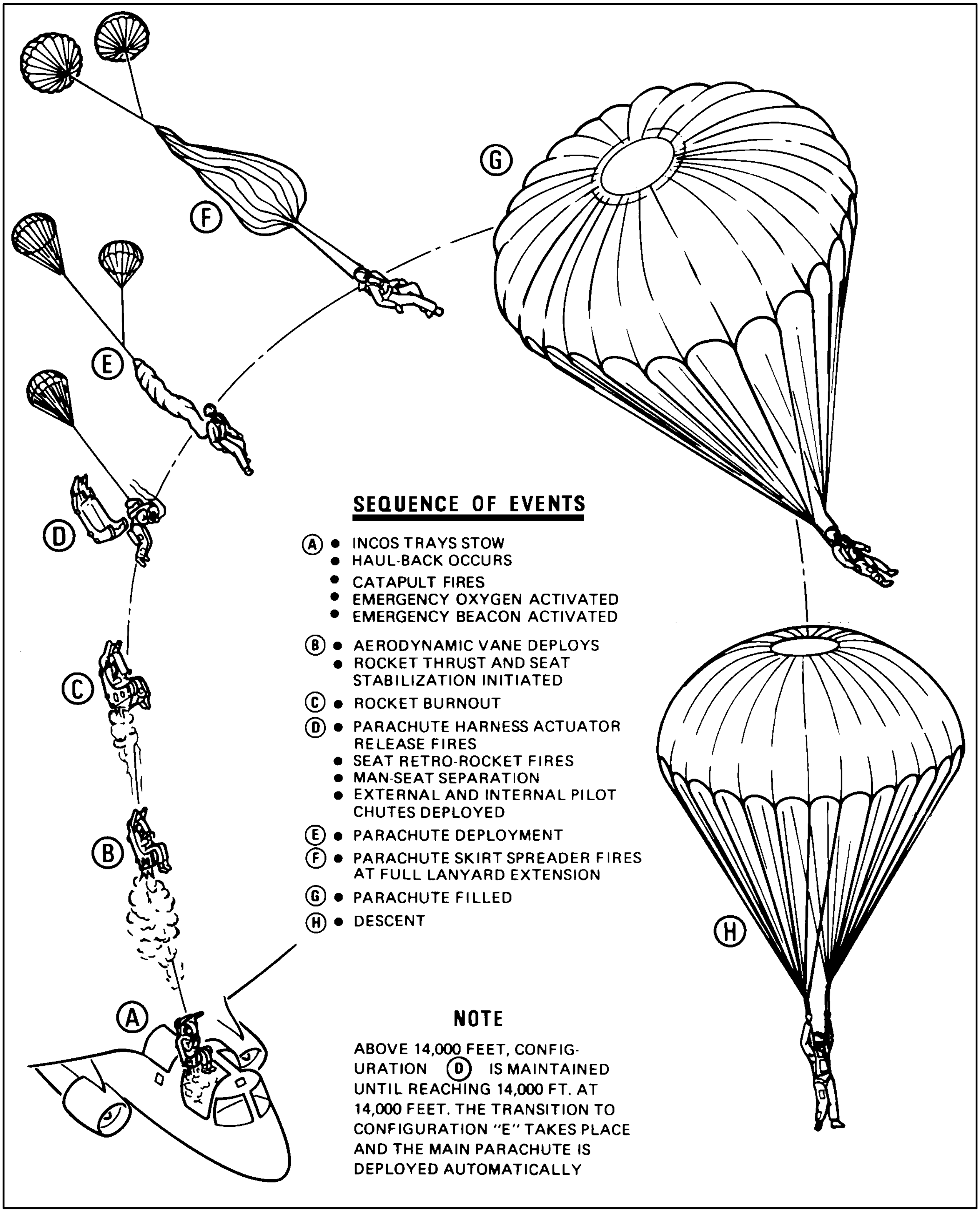


Figure 2-143. Individual Ejection Sequence

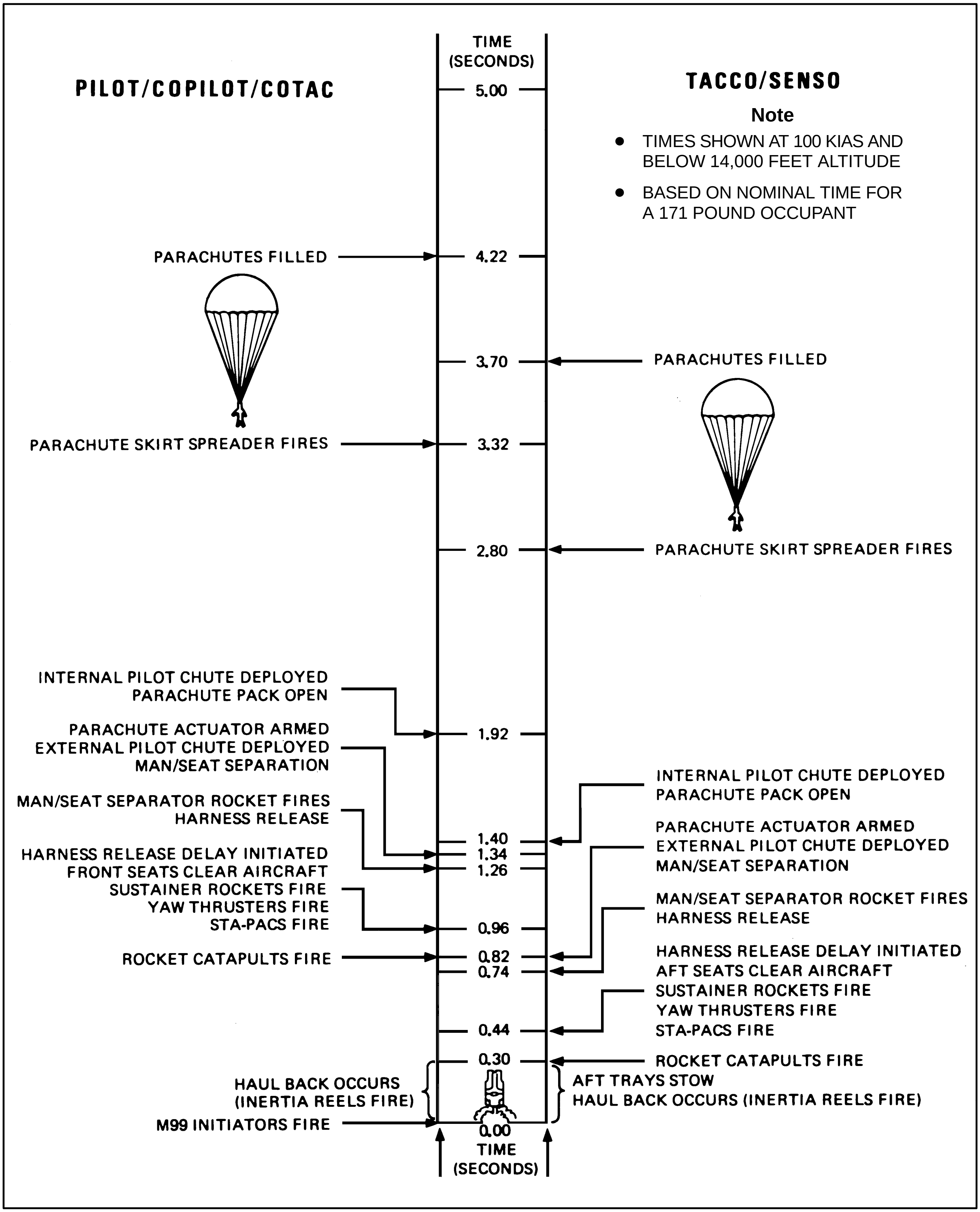


Figure 2-144. Crew Typical Ejection Sequence

5. The crewmember, suspended in his harness from the canopy releases during descent, must pull the survival kit release handle prior to landing, allowing the lower half of the survival kit to fall below him. During this time, the parachute container falls clear. Upon landing, the canopy and suspension lines can be disengaged from the integrated torso suit by using the quick-release shoulder fittings. The survival kit is disengaged from the integrated torso suit by using the lap quick-release fittings.

6. If you are downed in seawater, SEAWARS will release the parachute canopy within 2 seconds. However, if able, you should manually unlock each canopy release immediately on water entry. The SEAWARS does not operate in fresh water.

Note

If ground contact is anticipated among trees, rugged terrain, high tension wires, or similar conditions, deployment of the survival kit is not recommended.

7. If the crewmember should have to manually open the parachute by pulling the parachute ripcord (D-ring), only the internal pilot parachute deploys the main canopy. The external pilot chute bridle is disconnected by means of the external pilot chute override disconnect assembly.

2.25.8 Escape System Performance

1. 0 to 450 KIAS

2. 0 to 50,000 feet

3. 4,500 fpm sink rate (based on recovery at ejection initiation altitude)

4. 490 feet inverted (100 KIAS)

5. Parachute first-filled times (normal):

   a. 100 KIAS — 3.7 seconds

   b. 250 KIAS — 3.0 seconds

   c. 450 KIAS — 2.7 seconds.

2.26 CANOPY REMOVAL SYSTEM

The canopy removal system is an explosively operated system that utilizes a flexible, confined detonating cord and a linear shaped charge to cut an egressway through the canopy at each crew station. The system is initiated from any one of five T-handle locations; two are located externally and three are internal. Safety pins with red streamers are provided for the three internal T-handles; they must be removed prior to actuation for the system to operate. The two external T-handles are located below and forward of the windshield aft post on either side of the aircraft. One internal T-handle, for use by the pilot or copilot/COTAC, is located on the centerline overhead in the cockpit. The TACCO and SENSO each have a T-handle located above and outboard of their crew station panels. The external handles and the pilot internal handle will cut all crew station canopy panels when pulled. The TACCO and SENSO T-handles will cut only their respective canopy panels leaving the others undisturbed. (See Figure 2-145.)

Primarily, the system is designed for ground and ditching escape only. Normal seat ejection is through the canopy glass without benefit of canopy cutting. The seat is equipped with appropriate canopy/hatch breakers for personnel protection during ejection. When the T-handle is pulled, the canopy glass is vaporized by the heat of the flame that slices a very narrow and deep incision halfway through the glass. At this point, the shock wave is sufficient to fracture the remaining thickness and a fine spatter is thrown outward. At short range, this spatter could be dangerous to unprotected skin and eyes; however, at ranges of more than 10 feet, relative safety prevails, but caution should be exercised. The cut edges do not present a serious hazard to flight personnel in that ordinary flight gear is sufficient protection against scratches. The TACCO and SENSO station canopies are not blown clear of the aircraft and must be pushed out to permit crew egress on the ground or after ditching. The internal canopy removal T-handles are squeeze-to-pull type that incorporate a squeeze segment of operation that can incorporate a safety pin. The external handles do not incorporate safety pins, but rely upon a 10-foot lanyard to protect against inadvertent initiation.

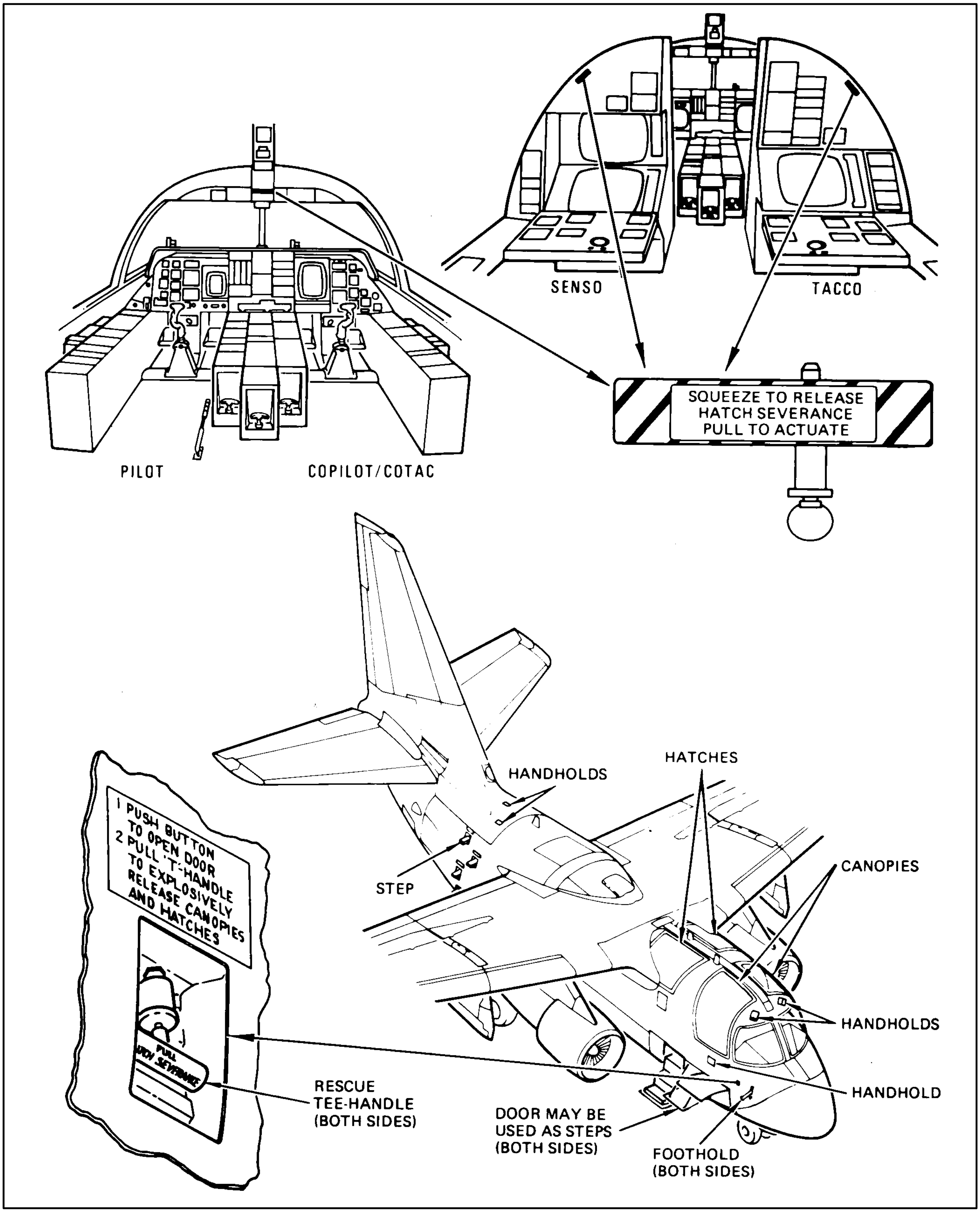


Figure 2-145. Canopies and Hatches Emergency Release

WARNING

- Inadvertent actuation of the canopy/hatch jettison system is possible if care is not exercised. DO NOT USE JETTISON HANDLES AS HANDHOLDS AT ANY TIME.
- Safety pins provided for the three internal T-handles are to be installed except during emergency landings.

2.27 OXYGEN SYSTEM

A liquid oxygen system (see Figure 2-146) is installed to provide breathing oxygen to all four crewmembers in case of cabin pressurization failure or contaminated air. The liquid oxygen is carried in a 10-liter, quick-change converter located in the compartment between the entry door and right bomb bay. Replenishment is accomplished by filling at the aircraft or by replacing the converter. A liquid oxygen quantity gauge, located on the pilot center instrument panel, indicates the amount of liquid oxygen in liters remaining in the converter. (See Figure 2-147 for oxygen duration in hours at altitude.) An OFF flag appears on the gauge when power to the gauge is removed. OXYGEN lights, located on the master caution panel in the cockpit and on the TACCO panel, illuminate whenever the pressure between the heat exchanger and shutoff valves drops or when the liquid oxygen quantity is 1 liter or less remaining. Pressing the momentary switch adjacent to the quantity gauge causes the pointer on the LOX quantity indicating gauge to rotate and, when 1 liter or less remains, the caution light to illuminate. (See Figure 2-148 for oxygen system controls and indicators.) When the system is utilized, the liquid oxygen boils off resulting in a buildup of gas pressure in the converter. The oxygen is directed to the ON/OFF valves (oxygen supply control switches) at each crew station side console, and is then routed through the quick disconnects located to the left of each crewmember.

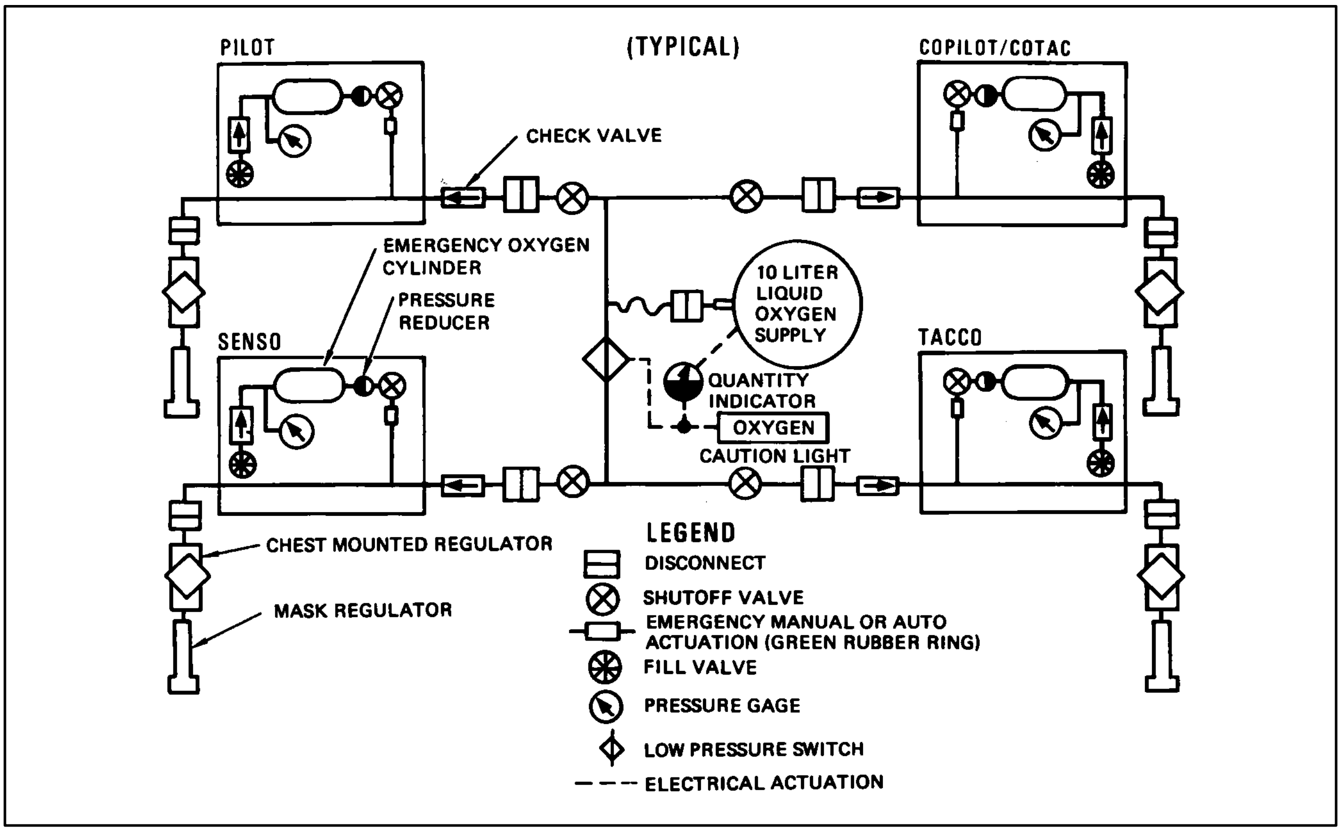


Figure 2-146. Oxygen System

Oxygen hoses from the survival kits attach to these disconnects, and the survival kits serve as connecting links between the aircraft oxygen system and the regulators. When an oxygen supply control switch is placed to ON, 100-percent oxygen is delivered to the mask at continuous positive pressure regardless of altitude. When the mask is removed for an extended period, the oxygen system should be switched OFF to conserve oxygen.

WARNING

When oxygen is not in use, the oxygen supply switch should be placed to OFF to preclude oxygen leakage.

2.27.1 Emergency Oxygen. Emergency oxygen is provided through a survival kit located under each crewmember seat cushion. It contains an emergency oxygen bottle that is activated automatically during the ejection process or manually at any time the emergency oxygen supply handle (green rubber ring) under the crewman left thigh is pulled. The emergency oxygen is stored in a cylinder with a capacity of 53 cubic inches at a pressure of 1,800 psi and is located in the survival kit. The cylinder is readily refillable and is equipped with a pressure gauge and pressure reducer to supply the required oxygen pressure. When fully filled, the cylinder contains oxygen for a safe descent from altitude. The emergency oxygen supply handle is a manually operated control used to operate the emergency oxygen supply system. It is located on the left side of the RSSK. The loop-type handle, when pulled, allows emergency oxygen to flow through the pressure reducer valve to the oxygen regulator. The emergency oxygen system is automatically actuated during seat ejection by a cable attached to the deck of the aircraft. An emergency oxygen gauge indicator for the emergency oxygen supply bottle is located on the RSSK seat below the seat cushion and indicates the oxygen pressure in the bottle. The dial indicates from 0 to 2,500psi. A needle moves along a red band calibrated from 0 to 1,800 psi into a black band calibrated from 1,800 (full) through 2,500 psi. (See Figure 2-141.) For minimum acceptable pressure, see Figure 3-4.

WARNING

When oxygen contamination is suspected, the normal system shall be turned off before actuating the emergency oxygen supply handle.

2.27.1.1 Oxygen System Operation. To operate the LOX system, the crewmember connects his oxygen mask to the RSSK hose. The oxygen supply switch is positioned to ON to begin the flow of 100-percent oxygen. The caution lights extinguish when sufficient pressure is being supplied by the converter independent of the individual switch positions. The LOX quantity gauge is observed to check the amount of oxygen available to the crew. (See Figure 2-147, for oxygen duration.) Should the LOX quantity drop below 1 liter or if the oxygen pressure supplied by the converter drops below a safe level, the OXYGEN caution lights illuminate. The system indicator can be tested at any time by pressing the TEST switch and observing the LOX quantity pointer and caution lights. A walkaround oxygen hose assembly is stowed in a container on the SENSO station bulkhead, outboard of the outer seat track. This walkaround hose assembly is provided for conditions requiring the SENSO to leave his seat when oxygen is required. ICS communication is selectable at the SENSO station at these times. (Refer to Figure 2-66 and FO-10.)

WARNING

An oxygen system check and oxygen mask ICS check shall be performed by all crewmembers to verify proper oxygen flow and oxygen mask ICS communication prior to flight.

2.27.1.1.1 Manual Activation. To manually activate the emergency oxygen supply system, pull the emergency oxygen supply handle on the RSSK.

2.27.1.1.2 Automatic Activation. The emergency oxygen supply system is automatically activated by a cable attached to the deck with initial movement of the ejection seat up the rails.

CREW OF TWO

CABIN PRESSURE ALTITUDE (FEET)	GAUGE QUANTITY — LITERS 100-PERCENT OXYGEN										
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**BELOW 1**
35,000 AND ABOVE	30.9	27.8	24.7	21.6	18.6	15.4	12.4	9.2	6.2	3.1	EMERGENCY
30,000	22.6	20.4	18.1	15.8	13.6	11.3	9.0	6.8	4.5	2.2	
25,000	17.5	15.7	14.0	12.2	10.5	8.7	7.0	5.5	3.5	1.7	
20,000	13.2	11.9	10.5	9.2	7.8	6.6	5.2	3.9	2.6	1.3	DESCENT TO ALTITUDE NOT REQUIRING OXYGEN
15,000	10.6	9.5	8.4	7.4	6.3	5.3	4.2	3.2	2.1	1.0	
10,000	8.5	7.7	6.8	6.0	5.1	4.2	3.4	2.5	1.7	0.8	
5,000	6.7	6.0	5.4	4.7	4.0	3.3	2.7	2.0	1.3	0.6	
SEA LEVEL	5.4	4.9	4.3	3.8	3.2	2.7	2.1	1.6	1.0	0.5	

CREW OF THREE

CABIN PRESSURE ALTITUDE (FEET)	GAUGE QUANTITY — LITERS 100-PERCENT OXYGEN										
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**BELOW 1**
35,000 AND ABOVE	20.6	18.5	16.5	14.4	12.4	10.3	8.2	6.1	4.1	2.1	EMERGENCY
30,000	15.1	13.6	12.1	10.5	9.0	7.5	6.0	4.5	3.0	1.5	
25,000	11.6	10.5	9.3	8.1	7.0	5.8	4.6	3.5	2.3	1.1	
20,000	8.8	7.9	7.0	6.1	5.2	4.4	3.5	2.6	1.7	0.8	DESCENT TO ALTITUDE NOT REQUIRING OXYGEN
15,000	7.0	6.3	5.6	4.9	4.2	3.5	2.8	2.1	1.4	0.7	
10,000	5.7	5.1	4.5	4.0	3.4	2.8	2.2	1.7	1.1	0.5	
5,000	4.5	4.0	3.6	3.1	2.7	2.2	1.8	1.3	0.9	0.4	
SEA LEVEL	3.6	3.2	2.9	2.5	2.1	1.8	1.4	1.1	0.7	0.3	

CREW OF FOUR

CABIN PRESSURE ALTITUDE (FEET)	GAUGE QUANTITY — LITERS 100-PERCENT OXYGEN										
	10	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**BELOW 1**
35,000 AND ABOVE	15.5	14.9	12.9	10.8	9.3	7.7	6.2	4.6	3.1	1.5	EMERGENCY
30,000	11.3	10.2	9.0	7.9	6.8	5.6	4.5	3.4	2.2	1.1	
25,000	8.7	7.8	7.0	6.3	5.2	4.4	3.5	2.6	1.7	0.8	
20,000	6.6	5.9	5.2	4.6	3.9	3.3	2.6	1.9	1.3	0.6	DESCENT TO ALTITUDE NOT REQUIRING OXYGEN
15,000	5.3	4.7	4.2	3.7	3.2	2.6	2.1	1.6	1.0	0.5	
10,000	4.3	3.8	3.4	3.0	2.5	2.1	1.7	1.2	0.8	0.4	
5,000	3.4	3.0	2.7	2.3	2.0	1.6	1.3	1.0	0.6	0.3	
SEA LEVEL	2.7	2.4	2.1	1.9	1.6	1.3	1.1	0.8	0.5	0.2	

Notes

Conversion of liquid O_2 to gaseous O_2 is 860 liters of gaseous to 1 liter of liquid O_2.

Based on conditions prevailing immediately after servicing — 8,600 liters of gaseous O_2 available; 24 hours after servicing — 6,740 liters of gaseous O_2 available.

Figure 2-147. Oxygen Duration in Hours

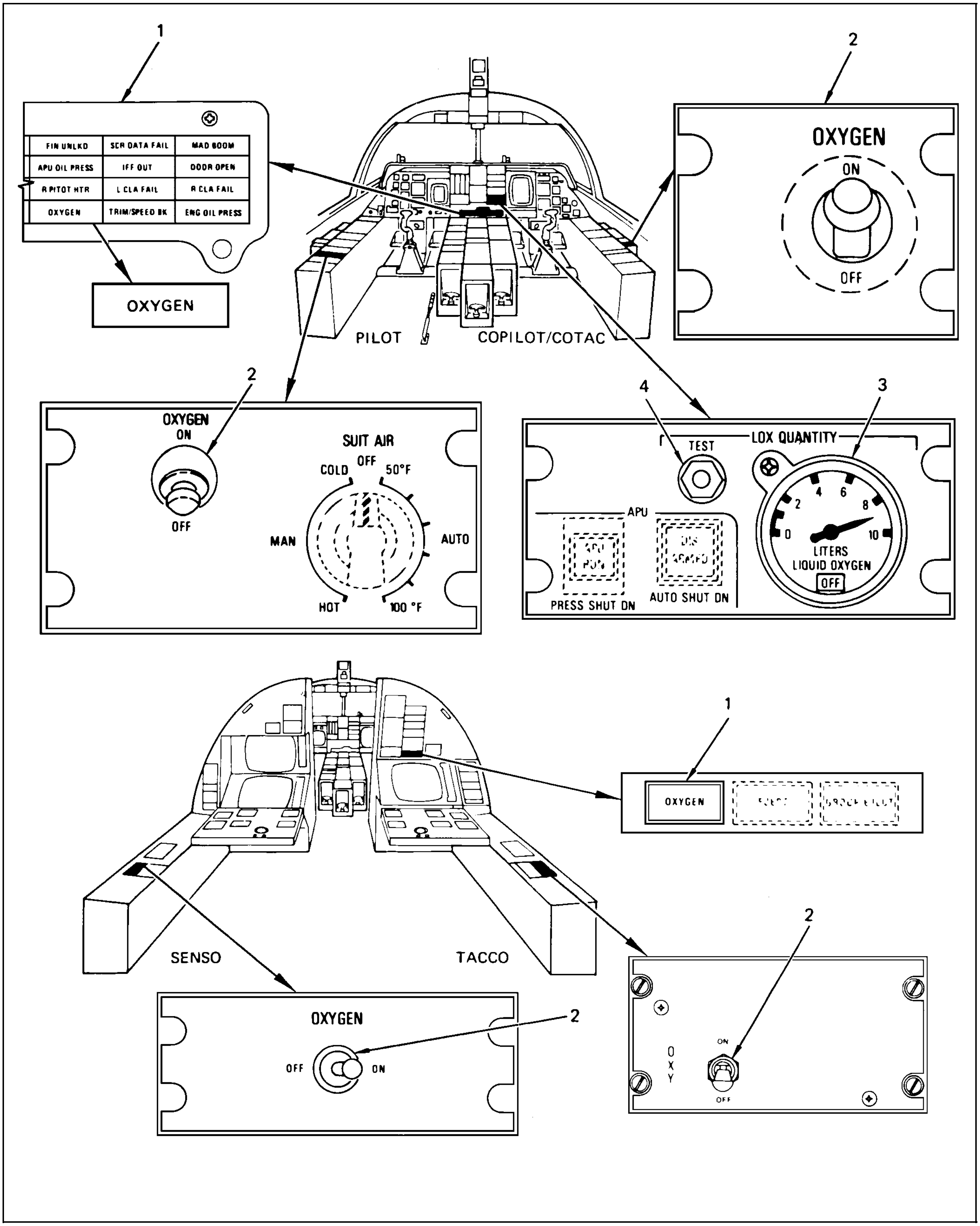


Figure 2-148. Crew Oxygen System Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	OXYGEN caution light	Illuminates when the liquid oxygen remaining is 1 liter or less or the oxygen pressure supplied by the converter drops below a safe level (42 psig).
2	Oxygen supply switch	Allows oxygen to flow to the respective crewmember oxygen mask.
3	Oxygen (LOX) quantity gauge	Indicates the amount of liquid oxygen contained in the converter tank in liters. The pointer rotates from 0 thru 10 liters (full). An OFF flag appears when power to the gauge is removed.
4	LOX QUANTITY TEST switch	When pressed, activates LOX quantity gauge pointer and OXYGEN caution light illuminates as pointer reaches 1 liter or less.

Figure 2-148. Crew Oxygen System Controls and Indicators (Sheet 2)

2.28 PITOT/STATIC SYSTEM

The pitot/static system (see Figure 2-149) senses dynamic and static air pressure to operate the following flight instruments (see Figure 2-150):

1. Airspeed/Mach indicator
2. Altimeter
3. Vertical speed indicator.

The pitot/static system also supplies inputs to the SCADC for data computations. Pitot/static heads, located one on each side of the forward fuselage below the cockpit windows, aft of the radome, sense dynamic and static pressure. Dynamic pressure is sensed through an opening in the front of the pitot/static heads, and static pressure is sensed through openings in the side of the heads. Alternate source selection is available for the pilot instruments by switches, placarded PITOT and STATIC, on the pitot/static source panel located outboard of the pilot side console (see Figure 2-151). When the PITOT and STATIC switches are positioned to NORM, the pilot instruments receive dynamic pressure from the left pitot/static head and static pressure from the No. 1 static system. The copilot/COTAC instruments receive dynamic pressure from the right head and static pressure from the No. 2 static system. If the pilot system malfunctions, the ALT position can be selected allowing dynamic pressure to be supplied from the right pitot/static head and static pressure from the No. 2 static system. The No. 2 static system is the only source that is available for the copilot/COTAC instruments under all conditions. An alternate source of pressure inputs is not provided for the copilot/COTAC. Both pitot/static heads are heated electrically. Control for electrical heat to the pitot/static heads is provided through the ANTI-ICING switch located on the ECS panel on the center console.

2.28.1 Airspeed/Mach Indicator. The airspeed/Mach indicators provide the pilots with indicated airspeed and indicated Mach. (See Figure 2-152). The instruments are calibrated from 0.4 to 2.0 Mach and from 0 to 650 knots. A pointer that rotates over a nonlinear scale indicates airspeed in knots. The pointer and a rotating card graduated with Mach numbers is used to indicate Mach. The pointer is driven by pitot dynamic pressure from the pitot/static system. The Mach card is driven by a pressure differential aneroid mechanism. Operation of the airspeed/Mach indicator is accomplished by air pressure differential derived from comparing pitot pressure with static pressure.

CAUTION

To set the Mach limit, turn the knob counterclockwise only.

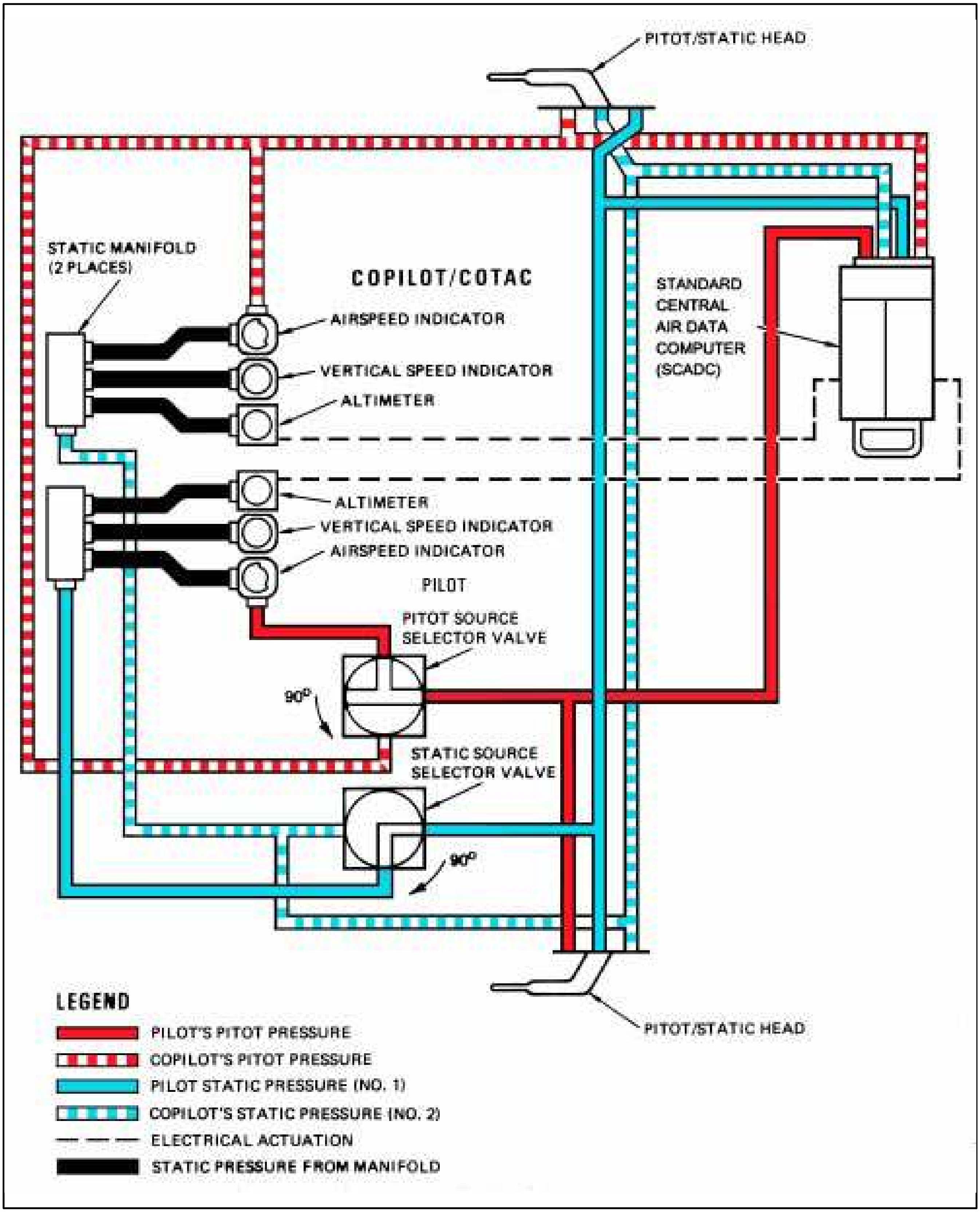


Figure 2-149. Pitot/Static System

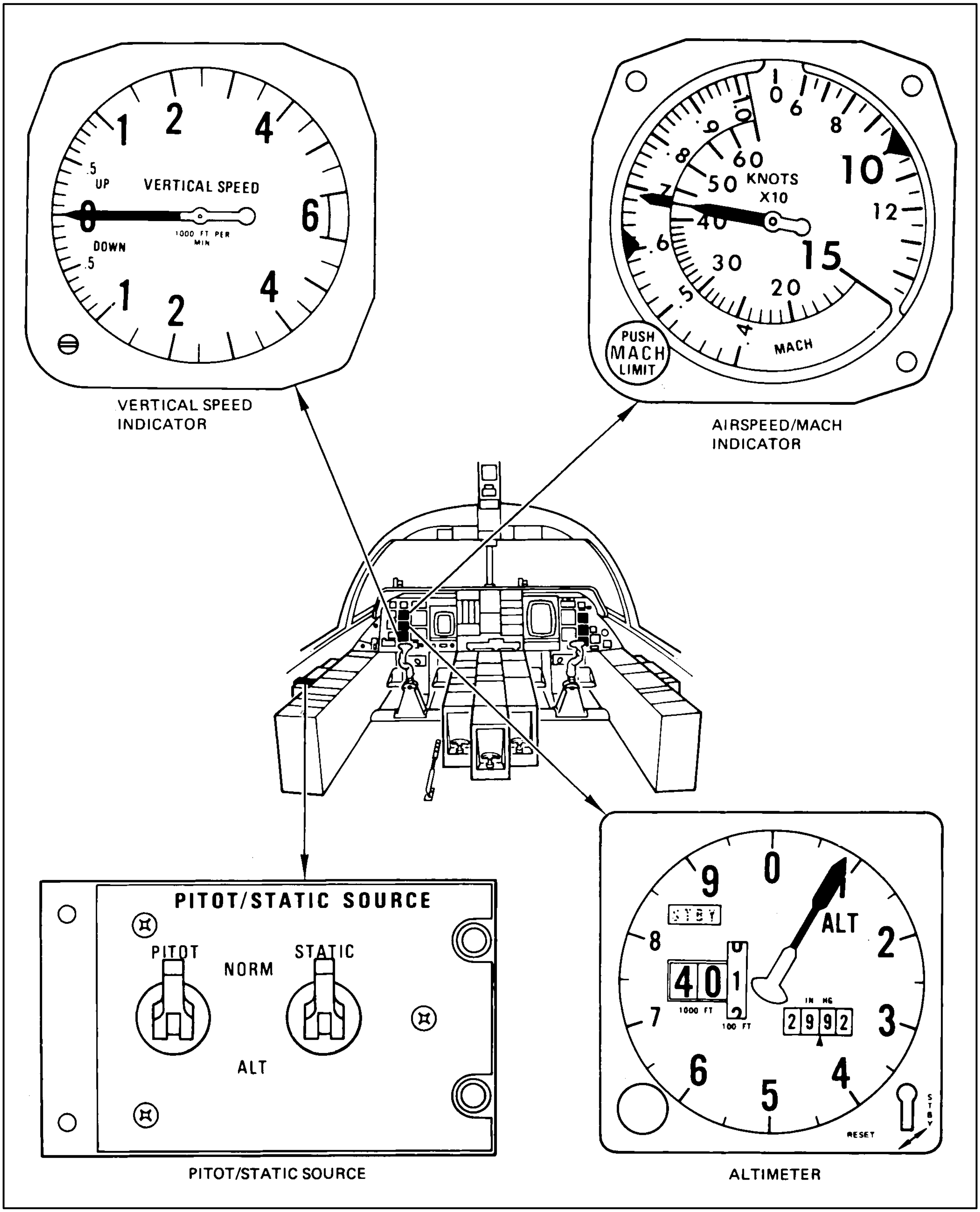
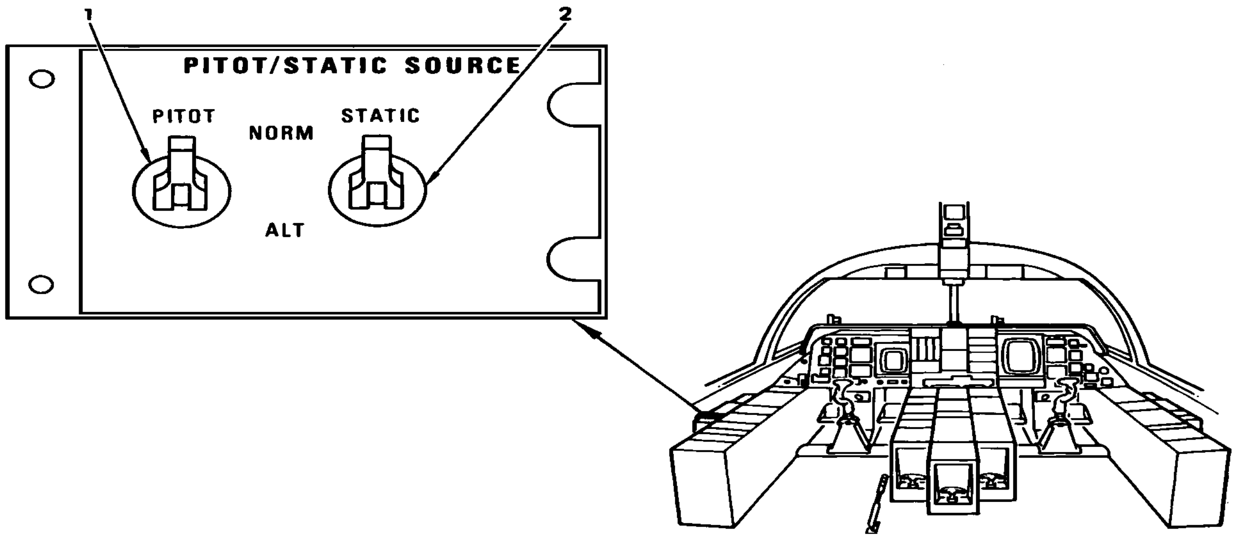


Figure 2-150. Pitot/Static Instruments



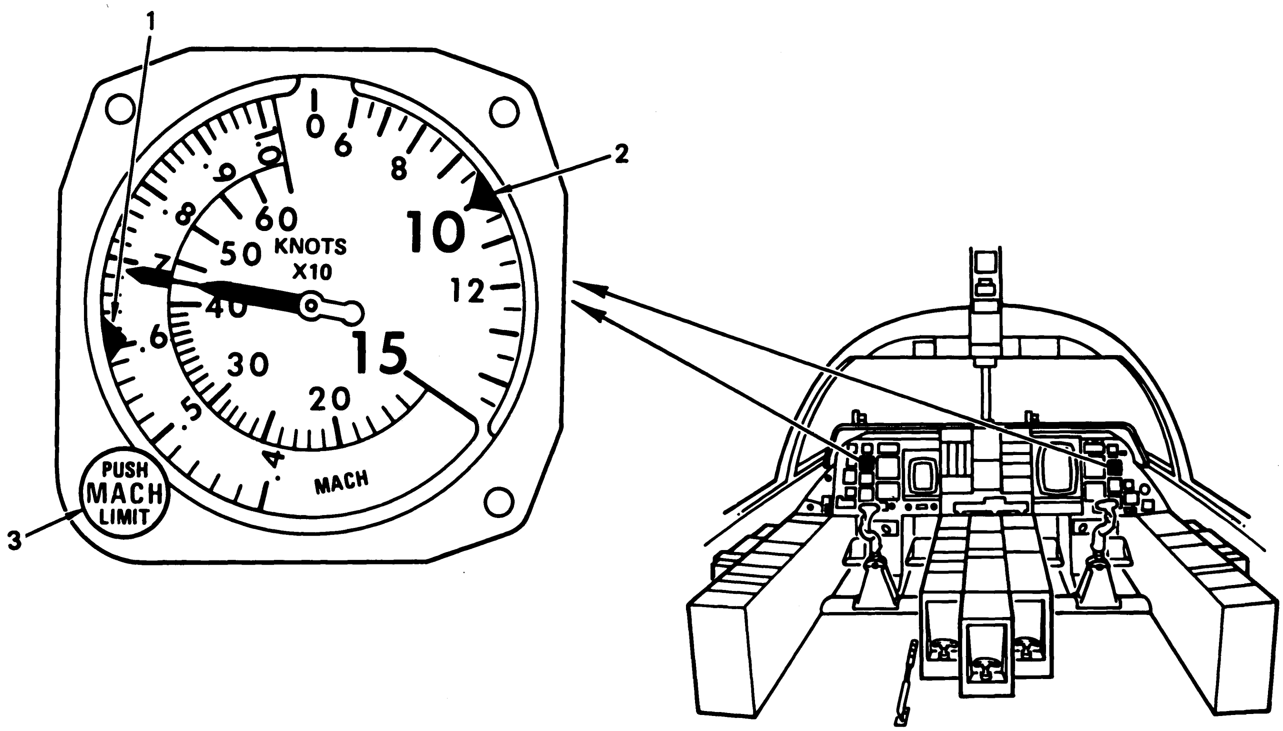
INDEX	CONTROL	FUNCTION
1	PITOT switch	Permits pilot to select NORM (left pitot) or ALT (right pitot) dynamic pressure source. Does not affect copilot/COTAC source.
2	STATIC switch	Permits pilot to select NORM (No. 1) or ALT (No. 2) static pressure source. Does not affect copilot/COTAC source.

Figure 2-151. Pitot/Static Source Panel

By reading the rotating card in conjunction with the pointer, the pilot can obtain indicated airspeed and Mach number simultaneously. The airspeed/Mach indicators incorporate a mechanical knob labeled MACH PUSH LIMIT that controls two indices on the face of the indicator. This knob is used to set the airspeed index located on the outer indicated airspeed scale. Rotation of the knob clockwise or counterclockwise causes the index triangle to move along the indicated airspeed scale from 0 to 150 knots, as desired. When the knob is pressed and rotated, it causes the Mach index to move along the Mach scale (0.4 to 2.0) to the Mach desired. The airspeed index may be set at a speed above stall that allows a margin of safety during landing approach or loiter maneuvers. The Mach index may be set for Mach cruise control.

2.28.2 Altimeter. The altimeter is a counterdrum pointer type operated by differential air pressure from the pitot/static system. (See Figure 2-153.) This differential pressure is processed in the SCADC where it is converted into electric signals that drive the indicator to display pressure altitude. The altimeter will automatically revert to conventional barometric operation if electric power failure occurs. The altimeter displays altitude readouts on a counterdrum and a pointer. The counter-drum consists of two bold-face digits that indicate thousands of feet and a smaller drum (to the right) that indicates hundreds of feet. The pointer rotates 360° about a scale calibrated from 0 to 1,000 feet in 50-foot increments, and indicates precise readouts of values less than 1,000 feet. A barometric scale located in the lower right half of the altimeter is a four-digit, veeder-type counter calibrated from 28.10 to 31.00 inches Hg in 0.01-inch increments. The scale is controlled by a knob located in the lower left corner of the instrument.

Operation of the barometric altimeter is controlled by the spring-loaded RESET/STBY selector located in the lower right corner of the instrument. When selected to the RESET position, the altimeter is operated electrically through the SCADC. When selected to the STBY position, the altimeter is operated barometrically. A barometric pressure set knob, located in the lower left corner of the instrument, is used to set the barometric pressure in inches Hg. A warning flag is located on the



INDEX	CONTROL/INDICATOR	FUNCTION
1	Mach index	Provides a reference mark along the Mach scale.
2	Airspeed index	Provides a reference mark along the airspeed scale.
3	MACH PUSH LIMIT knob	When pressed and rotated it causes the Mach index to move along the Mach scale from 0.4 to 2.0 Mach. When rotated (not pressed) it causes the airspeed index to move along the airspeed scale from 0 to 150 knots. **CAUTION** To set Mach limit, turn knob counterclockwise only.

Figure 2-152. Airspeed/Mach Indicator

face of the instrument. The flag is red with a black-lettered legend that reads STBY. When the STBY legend is visible, the altimeter is being operated barometrically from the pitot/static system. When the legend is not visible, the altimeter is being operated electrically through the SCADC. Standby barometric operation of the altimeter may be selected by placing the RESET/STBY selector to STBY. Also, the altimeter will revert to STBY operation automatically, if electrical power fails.

Note

When operating above FL180 or international transition altitude, the pilot should use the STBY mode set to 29.92 inches Hg. The copilot/COTAC should use the RESET mode. This combination of altimeter settings will give the aircrew an immediate comparison between barometric and computed altitude from the SCADC and altitude reported to ATC via the IFF mode C.

2.28.3 Vertical Speed Indicator. The vertical speed indicator operates by measuring the rate of change in static pressure supplied from the pitot/static system. The indicator displays vertical velocity in feet per minute. Range of the instrument is 0 to 6,000 fpm. The first 1,000 feet are marked in 100-foot increments and the remainder in 500-foot increments. The indicator uses a single pointer to indicate the rate of altitude change on a fixed circular scale. The needle is damped to minimize oscillation and is mechanically stopped at the extreme travel limits. (See Figure 2-154.)

2.29 MISCELLANEOUS FLIGHT INSTRUMENTS

See Figure 2-155.

2.29.1 Standby Attitude Indicator. The standby attitude indicator, located on the pilot instrument panel, consists of a miniature aircraft symbol, a bank angle dial, a bank index, and a two-colored drum background with a horizon line dividing the two. The color white is used to depict the top (or sky half) and grey is used to depict ground. The indicator roll index is graduated in 10° increments to 30°, with graduation marks at 60° and 90°. The indicator is capable of displaying 360° of roll, 92° of climb, and 78° of dive. The gyro is powered by the essential ac bus and operates whenever the bus is powered. Because of the high spin rate of the gyro, the indicator displays accurate pitch and roll data for approximately 9 minutes after electrical failure.

CAUTION

To prevent internal damage, ensure the standby attitude indicator remains locked for 2 minutes after applying power. The unit should be locked prior to securing power.

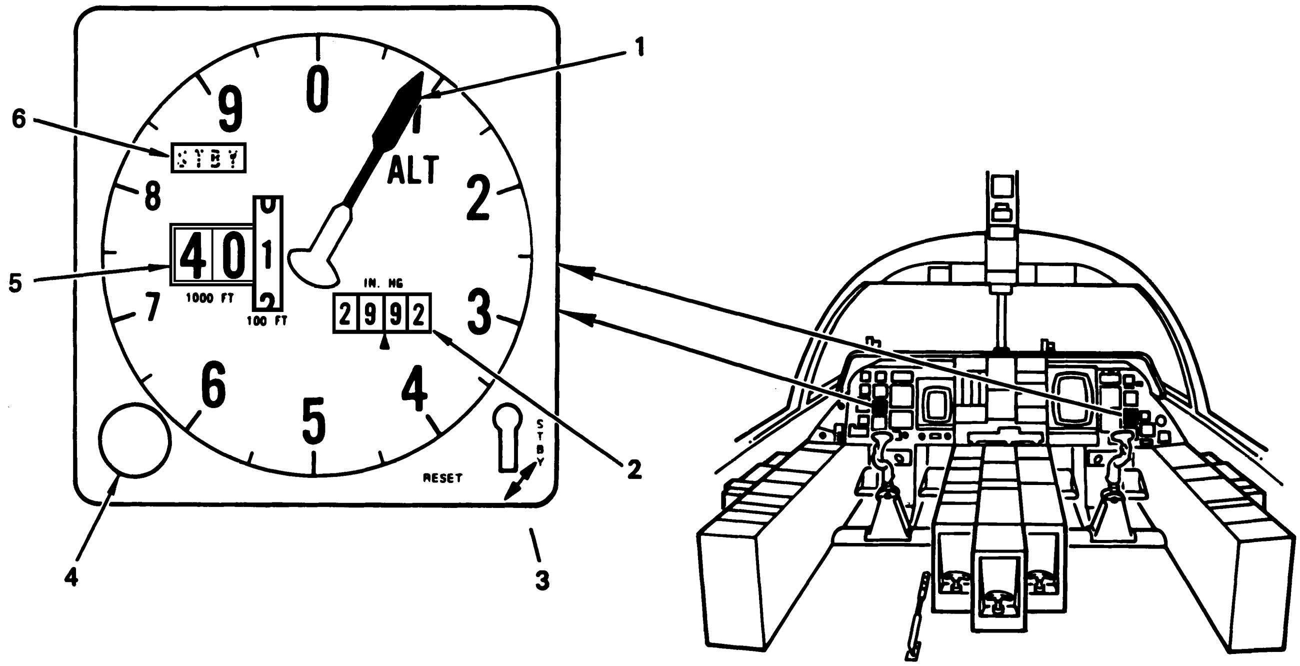
Note

In other than straight-and-level flight, the standby attitude indicator may begin precessing in less than 9 minutes.

The attitude indicator incorporates a pitch trim knob to position the miniature aircraft symbol above or below the horizon reference line. The pitch trim knob is also used to cage the gyro. When the pitch trim knob is pulled out, the gyro will cage. If the knob is rotated clockwise while extended, it will lock in the extended position. The attitude indicator also incorporates an OFF flag. The flag will appear if electrical power to the indicator is interrupted or if the gyro is caged with the pitch trim knob.

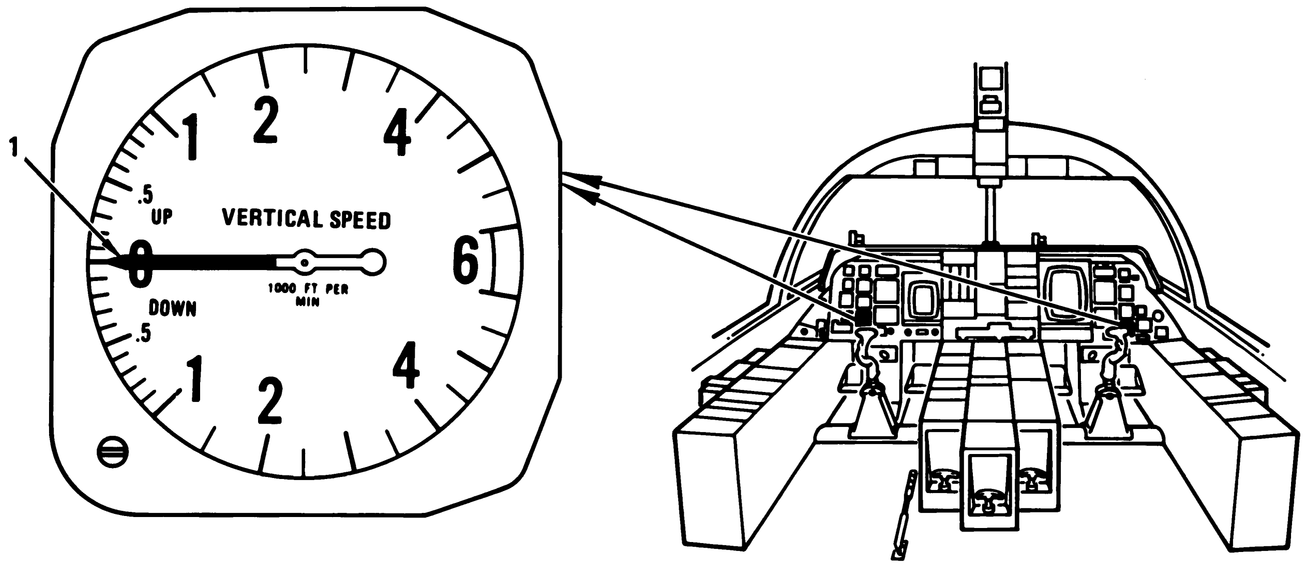
2.29.2 Outside Air Temperature Indicator. An indicator displaying uncorrected OAT is installed on the pilot instrument panel. A bulb, powered by the primary dc bus, consisting of a temperature sensitive resistor exposed to the slipstream measures the change in temperature of the air in the form of changing resistance. This change in resistance is displayed on the OAT indicator. The dial is graduated in degrees Centigrade from +50° to –50°.

2.29.3 Accelerometer. An accelerometer, located on the pilot instrument panel, displays to the pilot the vertical acceleration of the aircraft in g units. Three pointers on the instrument display g forces about a fixed dial. One pointer displays the actual g forces exerted on the aircraft in normal flight. The other two pointers record the limits of the g loading the aircraft has experienced. One pointer indicates positive g's, the other negative g's. Both pointers may be reset to one.



INDEX	CONTROL/INDICATOR	FUNCTION
1	Altimeter pointer	Indicates less than thousand-foot scale altitude in 50-foot increments.
2	Barometric scale	Displays altimeter setting in inches of mercury.
3	RESET/STBY selector	RESET — altimeter is operated electrically through SCADC. STBY — altimeter is operated barometrically through the pitot/static system.
4	Barometric pressure set knob	Sets barometric pressure in inches of mercury on barometric scale.
5	Altitude counter-drum	Indicates altitude in thousands of feet and hundreds of feet.
6	STBY warning flag	STBY flag denotes mode of altimeter operation: In/view (STBY) — operating barometrically. Out-of-view — operating electrically through SCADC.

Figure 2-153. Altimeter



INDEX	INDICATOR	FUNCTION
1	VSI pointer	Displays vertical velocity in feet per minute.

Figure 2-154. Vertical Speed Indicator

2.29.4 Magnetic Compass (Standby). The magnetic compass is mounted just below the eyebrow panel and is used as an emergency backup should the main compass fail. The compass consists of two magnetized needles mounted on a float with compass card attached. The float is housed in a chamber filled with kerosene to dampen excessive oscillation of the attached compass card. Two magnetized needles are in parallel and align themselves with magnetic north. The compass card has letters indicating cardinal headings and numbers every 30° with the last zero of the heading number omitted. The card is graduated in 5° increments and the heading is read behind the lubber line.

2.29.5 Clock. Two clocks are located in the cockpit, one on each pilots' respective flight instrument panel. The clocks are operated mechanically, and provide 8 days of continuous operation with one winding. The clocks incorporate an elapsed timer feature that allows measurement of 1 hour of elapsed time.

2.30 ANGLE-OF-ATTACK SYSTEM

The AOA system, in conjunction with the approach lights, provides the pilots and the LSO with visual indications of aircraft AOA. (See paragraph 37.3, AIRSPEED VERSUS UNITS ANGLE OF ATTACK, in Part XI.)

Indications (see Figure 2-156) are presented on the AOA indicator in the cockpit and may be used to establish various flight attitudes. For controlling airspeed during landing approaches, indicator readings are supplemented by lights on the AOA approach indexer mounted on the glareshield. (See Part XI for airspeed and AOA relationship.) Green, amber, and red approach lights mounted on the nosegear door provide the LSO with a similar indication of AOA. (Refer to paragraph 2.6.1.8, Exterior Lighting, for additional information concerning approach light operation.)

An AOA indicator, one located on the pilot and one located on the copilot/COTAC instrument panel, is

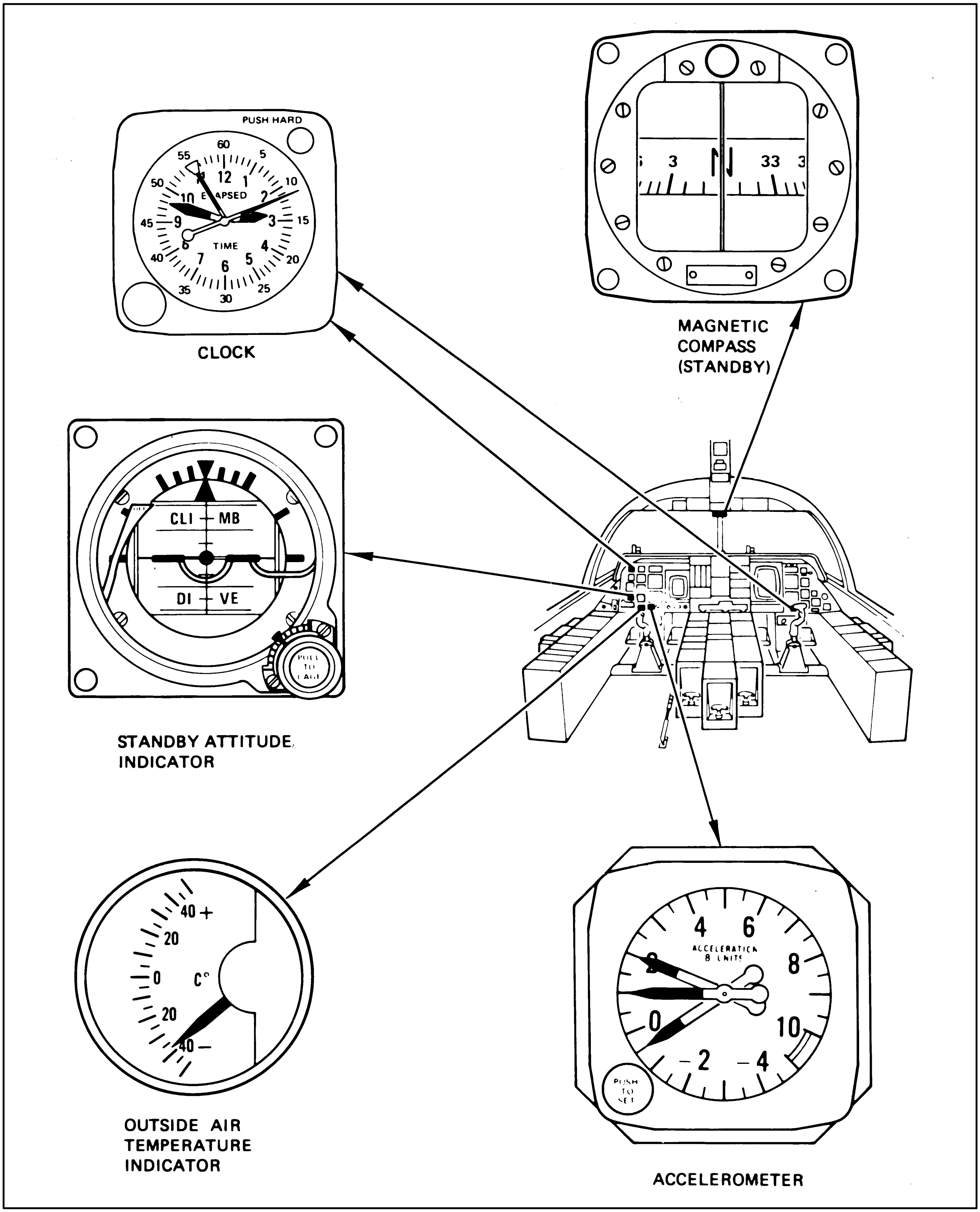


Figure 2-155. Miscellaneous Flight Instruments

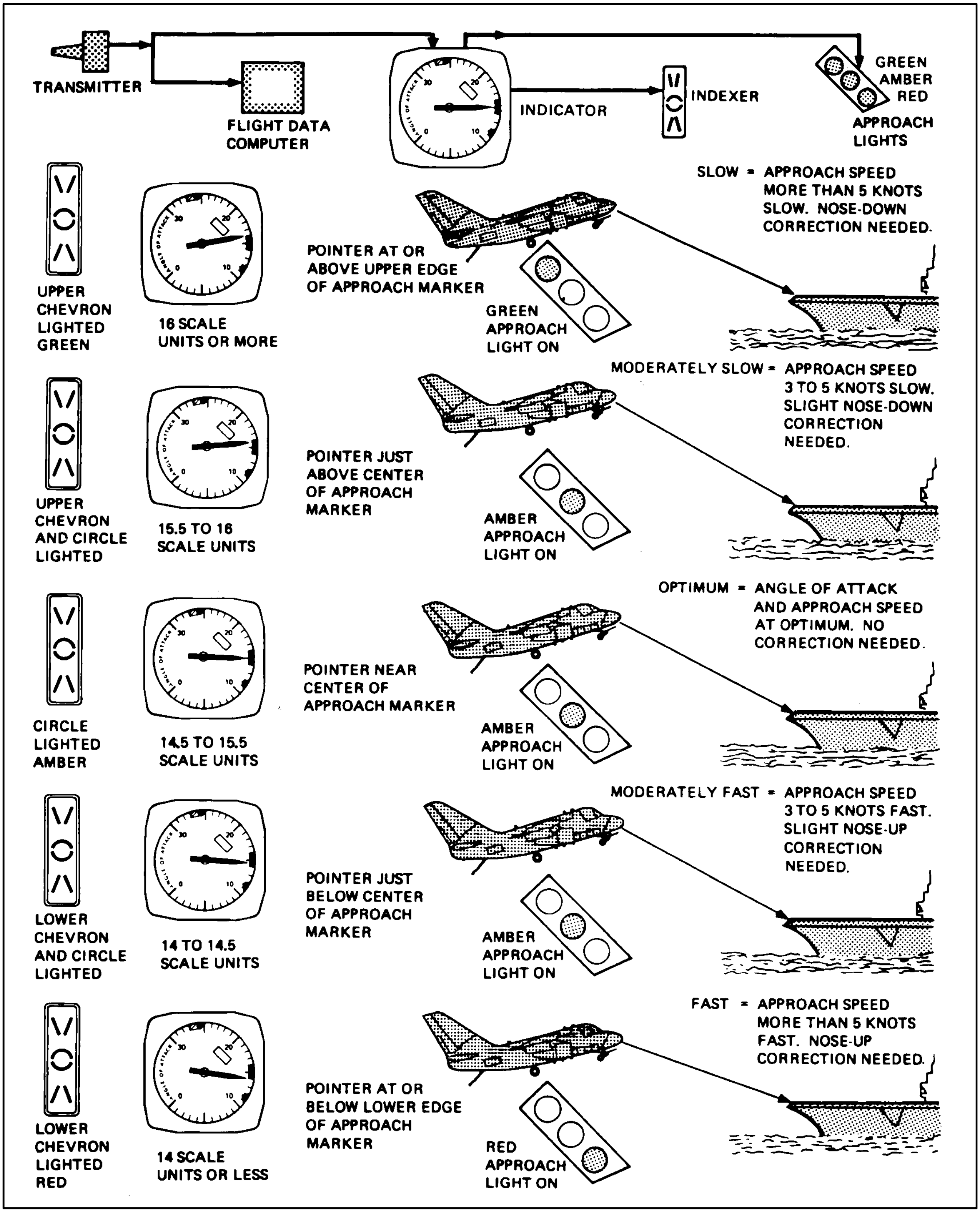


Figure 2-156. Angle-of-Attack Indications

graduated in 1-unit increments from 0 to 30 representing 1 unit AOA (see Figure 2-157). However, the AOA indicator is fully deflected at a minimum AOA of 5.5 units and a maximum AOA of 26.5 units. An OFF flag on the face of the indicator will appear in view if the system has failed or power has been removed. Failure of the system may also be indicated by the pointer fluctuating on the indicator or moving off scale. The AOA indicator receives signals from a probe (transducer) located on the right side of the aircraft just above and forward of the personnel door. The probe is a null-internal-vane instrument with a conical pressure sensor that is mechanically connected to potentiometers and synchros, converting position into electrical signals and driving an AOA pointer on the indicator. The AOA indicator controls operation of the approach indexer and approach lights and provides indications of high, optimum, and low AOAs during the landing condition. The indexer and approach lights are operated relative to pointer movement about the reference marker on the indicator.

When the aircraft is flown with the index pointer centered on the index marker, the optimum approach speed for any aircraft gross weight within the allowable limits will result. The indicator has preset nonadjustable index markers to indicate the desired AOA or basic 1g flight conditions.

Three reference markers are provided on the AOA indicator.

Maximum range marker — Indicates AOA (11.5 units) with gear and flaps up for maximum range cruise.

Landing approach/maximum endurance marker — Indicates AOA (15 units) for maximum endurance and optimum approach AOA with gear and flaps in landing position (landing approach). For maneuvering on station, use 14 units.

Stall warning marker — Indicates stall AOA units with gear and flaps down.

The approach indexer, one located on the pilot and one located on the copilot/COTAC glareshield, is a vertical display consisting of a green chevron (fly down), an amber donut (optimum AOA), and a red warning chevron (fly up) that are illuminated in sequence by signals received. The indexer provides a visual light presentation of aircraft AOA.

The approach indexer lights function only when all three landing gears are down and locked, the launch bar is up, and the aircraft weight is off the wheels. The APPROACH INDEXER switch is located on the center console in the cockpit. With the approach indexer control in the OFF position, the lights are extinguished. Indexer light brightness is controlled by rotating the indexer control clockwise from OFF to BRT for the desired intensity. Actuation of the approach indexer lights is controlled by signals from the pilot AOA indicator.

Light indications on the approach indexer depict the following information:

High (green) chevron — indicates high AOA and below required airspeed.

Donut (amber) — indicates optimum AOA and proper airspeed.

Low (red) chevron — indicates low AOA and excessive airspeed.

2.30.1 Angle-of-Attack System Operation. The approach, using the AOA system, can be flown by coordinating throttle and stick movements to establish the desired glidepath at optimum AOA. The stick is used to bring AOA to the optimum value, as indicated by illumination of the indexer circle (donut). As AOA goes high or low with resulting decrease or increase in airspeed, the indexer upper or lower chevron will be illuminated to point the direction in which the nose should be moved to return to the optimum AOA. The throttle position is changed to control the rate of descent so as to establish the desired glidepath.

The approach can also be flown with reference to AOA indicator readings. The attitude must be corrected to keep the indicator pointer as close as possible to the center of the 3-o'clock reference index.

Indications above and below the index indicate that the approach is being made slower or faster than optimum.

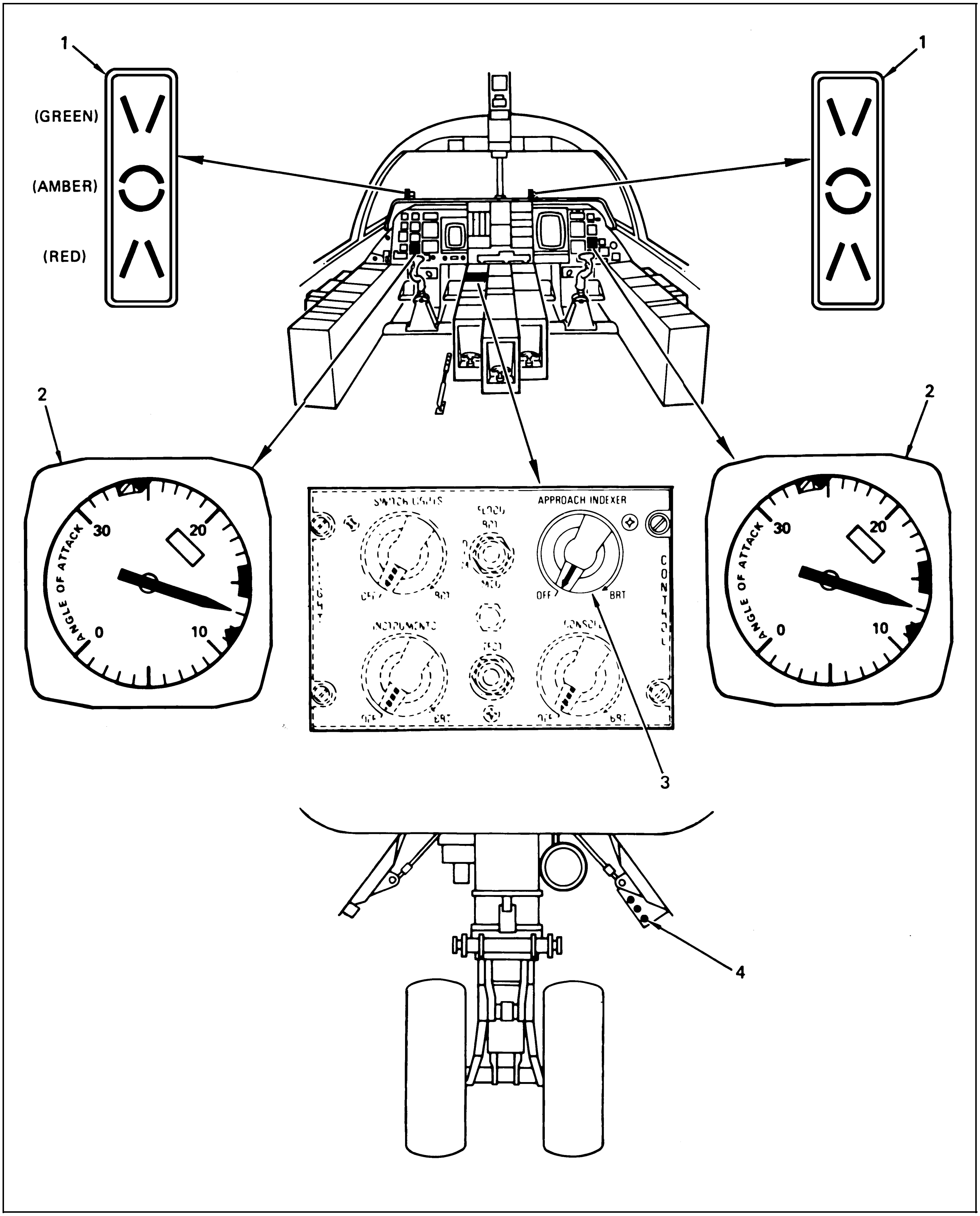


Figure 2-157. Angle-of-Attack Controls and Indicators (Sheet 1 of 2)

INDEX	CONTROL/INDICATOR	FUNCTION
1	AOA approach indexer	Provides a visual light presentation of aircraft angle-of-attack Green chevron — high angle-of-attack, low airspeed. Amber donut — optimum angle-of-attack, proper airspeed. Red chevron — low angle-of-attack, high airspeed.
2	AOA indicator	Controls operation of approach indexer and approach lights, provides visual indications of angle-of-attack Maximum range marker (gear and flaps up). Stall warning marker (gear and flaps down). Landing approach (gear DN, flaps LDG)/maximum endurance marker.
3	APPROACH INDEXER switch	Controls intensity of AOA indexer lights.
4	AOA approach lights	Indicates aircraft attitude to LSO (coincides with color lights on indexer).

Figure 2-157. Angle-of-Attack Controls and Indicators (Sheet 2)

CAUTION

Lights will not illuminate if the launch bar is down or if the landing gear is not locked down.

Note

- AOA is inaccurate during rapid pitch changes and in unbalanced flight.
- Approach lights are illuminated during approach, indicating aircraft AOA to the LSO. The lights will flash if the arresting hook is not down and the hook bypass switch is in the CARRIER position.

2.31 MISCELLANEOUS EQUIPMENT

Supplemental equipment items, located throughout the aircraft, are utilized for life support in various situations. This equipment is located in the cockpit area and the crew station area.

2.31.1 Thermos Bottles. Thermos bottles are stowed in the well located at the aft end of each crewmember side console.

2.31.2 Piddle Packs. Unused piddle packs are stowed in a compartment in the pilot side trim panel outboard of the map case or stowed in the first-aid kit locker located in the TACCO console at the top on the aisle side. After use, they can be stowed in a bag in the aft cabin until disposal after termination of the flight.

2.31.3 First-Aid Kit. A first-aid kit is stowed in the first-aid kit locker located in the TACCO console at the top on the aisle side.

2.31.4 Walkaround Oxygen Hose. A walkaround oxygen hose assembly is stowed in a container on the sensor station bulkhead, outboard of the outer seat track.

2.31.5 Map Storage. Map storage is provided adjacent to the seat under the pilot and copilot/COTAC outboard consoles.

2.32 CREW ENTRY DOOR

The crew entry door, located in the forward right fuselage of the aircraft aft of the copilot/COTAC station, is equipped with integral steps. In the closed-and-locked position, the door forms a pressure seal. The amber DOOR OPEN indicator caution light for the crew entry door is located on the master caution panel in the cockpit. All controls used to open and close the door are located on the crew entry door (see Figure 2-158). The door has the following components:

1. External door handle — Utilized for locking and unlocking the door from outside the aircraft.
2. Handle release trigger — Spring-loaded assembly used to hold the external door handle in stowed position.
3. Latch button — When pressed, the button permits rotation of external door handle.
4. Inside lift handle — Utilized to provide mechanical advantage for extending or retracting the door from inside the aircraft.
5. Locking pin lever — Utilized for locking or unlocking the door from inside the aircraft.
6. Locking pin lever door — Spring-loaded assembly applied to hold the locking pin lever in place after closing the door.
7. Support cable assembly — Inertial reel and cable assembly provided to assist in controlling the rate of door movement during opening and closing.

2.32.1 Crew Door Operation

WARNING

The crew door shall be closed and locked while the starboard engine is operating without the engine turn-screen installed.

Note

A positive acting cam-latching mechanism to catch the opening door under pressure is provided for the aircraft when the bayonets are retracted.

2.32.1.1 Opening Door From Outside. The door will open outward and downward utilizing the spring- balance linkage and the support cable. To open the door, the handle release trigger must be pressed to pop out the external door handle. The latch button, located immediately above the handle release trigger, must be pressed to permit the external door handle to be manually rotated in a counterclockwise direction. This rotation will retract the four locking pins, allowing the door to be lowered to the open position.

2.32.1.2 Closing Door From Outside. To secure the door, manually raise the door to the closed position. The external door handle, when rotated clockwise, will extend the locking pins. The external door handle is stowed by pushing inward until the handle release trigger is latched into position.

The following instructions are provided for opening and closing the door from outside the aircraft. See Figure 2-158, index 12, for location.

To open:

1. Press the trigger to release the handle.
2. Press the latch button while rotating the handle counterclockwise to approximately 15°; release the button.

WARNING

Failure to release the lock-release button at approximately 15° of door exterior handle rotation (2-o'clock position) may cause the personnel access door to blow down if the crew compartment has not depressurized.

3. Continue rotating the handle counterclockwise to the fully unlocked position.
4. Push in the handle and rotate clockwise to the horizontal position and stow.
5. Press the latch button and lower the door; use the hand grip in the middle step.

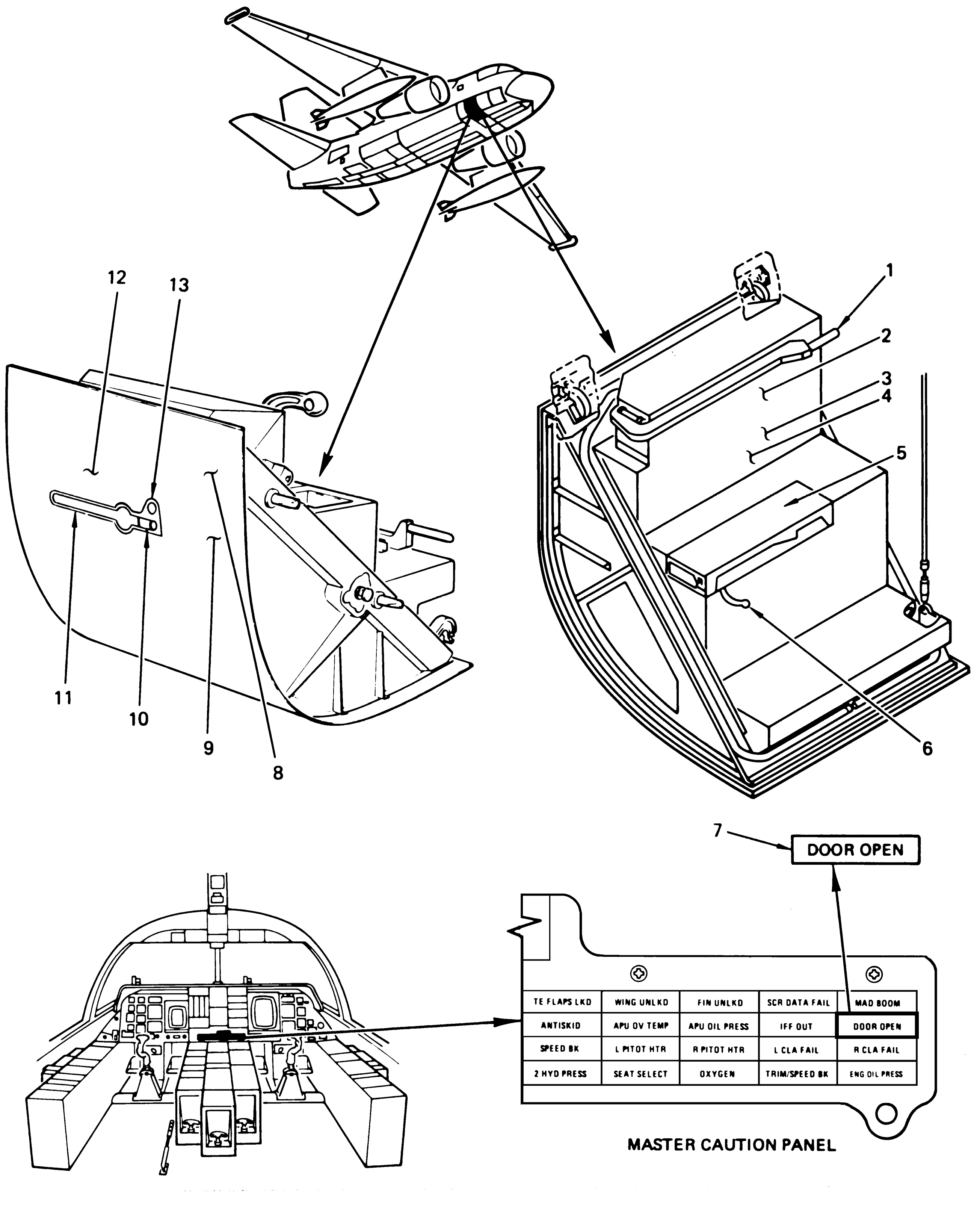


Figure 2-158. Crew Entry Door Controls and Indicator (Sheet 1 of 3)

INDEX	CONTROL/INDICATOR	FUNCTION
1	Inside lift handle	Two-position manually operated handle with the following functions: • Stowed — when not in use, handle is held out of the way by spring clip. • Extended — when unlatched and rotated to the upright position, it is used to open and close the door.
2	Decal	Instructions for opening and closing door from inside aircraft. Refer to Closing Door from Inside discussion, this section.
3	Decal	Instruction: WARNING — JET INTAKE AVOID EXITING AIRCRAFT WITH ENGINE RUNNING
4	Decal	Instruction: CAUTION BEFORE OPENING ELECTRIC POWER MUST BE ON WHEN GROUND AIR CONNECTED
5	Locking pin lever door	Spring-loaded, holds internal locking lever in place after door closed.
6	Locking pin lever	Manually operated lever with the following functions: • Close — when rotated counterclockwise, extends locking pins to lock door. • Open — when rotated clockwise, retracts locking pins to unlock door.
7	DOOR OPEN caution light	Illuminated — indicates the door is not closed and locked.
8	Decal	Instruction: CAUTION BEFORE OPENING ELECTRIC POWER MUST BE ON WHEN GROUND AIR CONNECTED
9	Decal	Instruction: PUSH TO UNLATCH
10	Handle release trigger (manual push button)	Pressed — releases the spring-loaded external door handle from the stowed position.
11	External door handle	Manually operated handle with the following functions: • Rotated counterclockwise — mechanically retracts four bayonet type locking pins located within the door, unlocking the door. • Rotated clockwise — mechanically extends the four bayonet type locking pins, locking the door.

Figure 2-158. Crew Entry Door Controls and Indicator (Sheet 2)

INDEX	CONTROL/INDICATOR	FUNCTION
12	Decal	Instructions for opening and closing door from outside aircraft. Refer to Closing Door from Outside discussion, this section.
13	Latch button (manual push button)	Pressed — unlocks the door handle allowing it to be manually rotated to open the door. **Note** A positive acting cam-latching mechanism to catch the opening door under pressure is provided for the aircraft when the bayonets are retracted.

Figure 2-158. Crew Entry Door Controls and Indicator (Sheet 3)

6. Raise the lift bar on the upper step and engage in the door stop.

To close:

1. Disengage the lift bar from the doorstep and stow.
2. Lift the door until the latch engages.
3. Press the trigger and release the handle.
4. Rotate the handle clockwise to the locked position.
5. Push the handle in to the flush-stowed position.

2.32.1.3 Opening Door From Inside. Two hands are required for opening the door from the inside. With one hand, the locking pin lever door can be positioned to allow free travel of the locking pin lever. With the other hand, the locking pin lever can be rotated clockwise to the open position. The unlocked door can be lowered to the open position assisted by the support cable and inertia reel assembly.

CAUTION

If door is opened without holding onto the inside lift handle, the door cable may break.

2.32.1.4 Closing Door From Inside. Both the inside lift handle and the locking pin lever are utilized to close the crew entry door. The lift handle is located on the top step and held flush to the step level by a spring clip. Rotated to the upright position, the handle provides a lever for raising the door to the closed position. When the door is in position, the locking pin lever located on the second step can be rotated counterclockwise to the closed position. This movement will extend the locking pins and secure the door.

Note

If the crew entry door is to be closed from the inside, the crew must ensure that the external door handle is in the stowed position and that it is properly latched. This handle can neither be stowed nor latched from inside the aircraft. It is not mandatory that the external handle be stowed to ensure crew safety.

The following instructions are provided for opening and closing the door from inside the aircraft. See Figure 2-158, index 2, for location.

To open:

1. Move the stowed lift handle to the extended position.
2. Pull the locking pin lever door and hold in the open position.
3. Rotate the locking pin lever through 15°.
4. Release the locking pin lever door.
5. Rotate the locking pin lever clockwise to the full-open position.
6. Pull the door inboard using the lift handle.

7. Pull the locking pin lever door and hold in the open position.

8. Lower the door approximately 6 inches and release the locking pin lever door.

9. Continue lowering the door using the lift handle and handhold in the door step.

To close:

1. Lift the door with the inside lift handle.

2. Use the handhold to pull until the catch engages.

3. Rotate the locking pin lever counterclockwise to the closed position.

Note

The flightcrew can verify the door is safely locked by observing if the locking pin lever is retained by the locking pin lever door.

2.33 EMERGENCY EQUIPMENT

2.33.1 Portable Fire Extinguisher. A portable fire extinguisher is stowed in mounting brackets on the left keelson (SENSO station) below and aft of the cockpit step.

2.33.2 Emergency Exit Light. An emergency exit light is installed in the overhead panel between the aft crewmember consoles. This light should be used only during an emergency.

CAUTION

Light may become a missile hazard during catapult launches and arrested landings. Consideration should be given to removing light during deployment aboard CVs.

2.34 EMERGENCY JETTISON SYSTEM

Emergency jettison is a means of reducing excess weight, drag, and hazard during emergencies. It should be considered in the following situations:

1. Weight and drag reductions

Note

Search stores cannot be emergency jettisoned with the search stores power and search stores control circuit breakers pulled.

The most rapid means of reducing weight and drag in order to maintain safe flight is by pressing the EXT JETT switch, adjacent to the gear handle. Actuation of the EXT JETT switch releases all wing station loads and 15 of the 16 sonobuoys (the sonobuoy in chute P2 remains in place) in less than 10 seconds.

2. Additional weight reduction is effected through the use of the selective jettison of the bomb bay

3. Fire in flight — An engine or nacelle fire requires that the engine be secured, that may also require consideration of weight and drag reduction. Fuselage and wing fires outboard of the nacelle require jettisoning only those explosive or pyrotechnic stores that may be affected by the fire. Wing store jettisoning is dependent upon electrical power; therefore, when in doubt, jettison wing stores.

4. Ignited stores — Flares and marine markers generate sufficient heat to initiate serious fires or explosions. Any indications of either of these being ignited while still in the dispenser or container warrants immediate jettisoning of the entire dispenser load or container.

WARNING

Flares contain magnesium.

5. Ditching or forced landing imminent — In addition to the reduction of weight and drag already considered, jettisoning of explosive or pyrotechnic stores and fuel must also be considered, time permitting, because of the additional hazard of store ignition after crash landing ashore or in the water.

6. Deferred landing emergency — Jettison must be considered when an existing malfunction will require emergency procedures to accomplish the landing at the termination of the flight. Intentional gear-up or partial gear-up landings and barricade arrestments are similar to ditchings and forced landings in that structural damage is always

incurred to some degree. Explosive or pyrotechnic stores and fuel that may be activated or spread during structural damage must be jettisoned prior to commencing the emergency landing. In most cases, sufficient time is available to thoroughly and systematically clear the aircraft of such stores and fuel, including possible missile hazards within the aircraft.

Note

Information concerning designated ordnance jettison areas should be obtained through local directives.

2.35 STRUCTURAL DATA RECORDING SET (SDRS)

The SDRS measures and records S-3B in-flight fatigue data, as well as various aircraft flight parameters such as airspeed, altitude, and roll rate. The SDRS comprises both airborne and ground support components to record and download the fatigue data. The SDRS operates automatically with the exception of the Data Entry Keypad, which requires aircrew preflight and post-flight inputs for aircraft loading flight profile information. (See Figures 2-159 through 2-161.)

The SDRS system components are:

1. Recorder Converter, RO-601/ASH-37
2. Memory Unit, MU-983/ASH-37
3. Motional Pickup Transducer, TR-354/ASH-37
4. Signal Data Converter, CV-4269/ASH-37
5. Independent Over-G Indicator
6. The Recorder Reproducer, RD-608/ASH-37
7. Data Entry Keypad, KY-941/ASH-37
8. Data Entry Keypad Power ON/OFF Button.

2.35.1 Recorder Converter (RC). A micro controller-based, 20-channel recorder converter (RC) is used to convert sensor signals to digital format and to transfer data to the memory unit. The RC is located adjacent to the video signal recorder compartment near the crew entrance hatch area.

2.35.2 Memory Unit (MU). A removable memory unit (MU) is used to store flight data for post-flight analysis. The MU is mounted to the RC by four captured screw fasteners and is removed and installed on the recorder/reproducer for data download by maintenance personnel. The two cat eye-type indicators located on the face of the MU indicate a Memory Full condition and a Built-In Test (BIT) failure condition.

Note

Maintenance personnel should be notified if either the Memory Full or Built-In Test cat-eyes display a solid white indication.

2.35.3 Motional Pickup Transducer (MPT). The multi-axis acceleration motional pick-up transducer (MPT) is used to provide signals proportional to the degree of motion (acceleration, strain gauge inputs, etc.) being experienced. The MPT is located near the aircraft CG in the bomb bay.

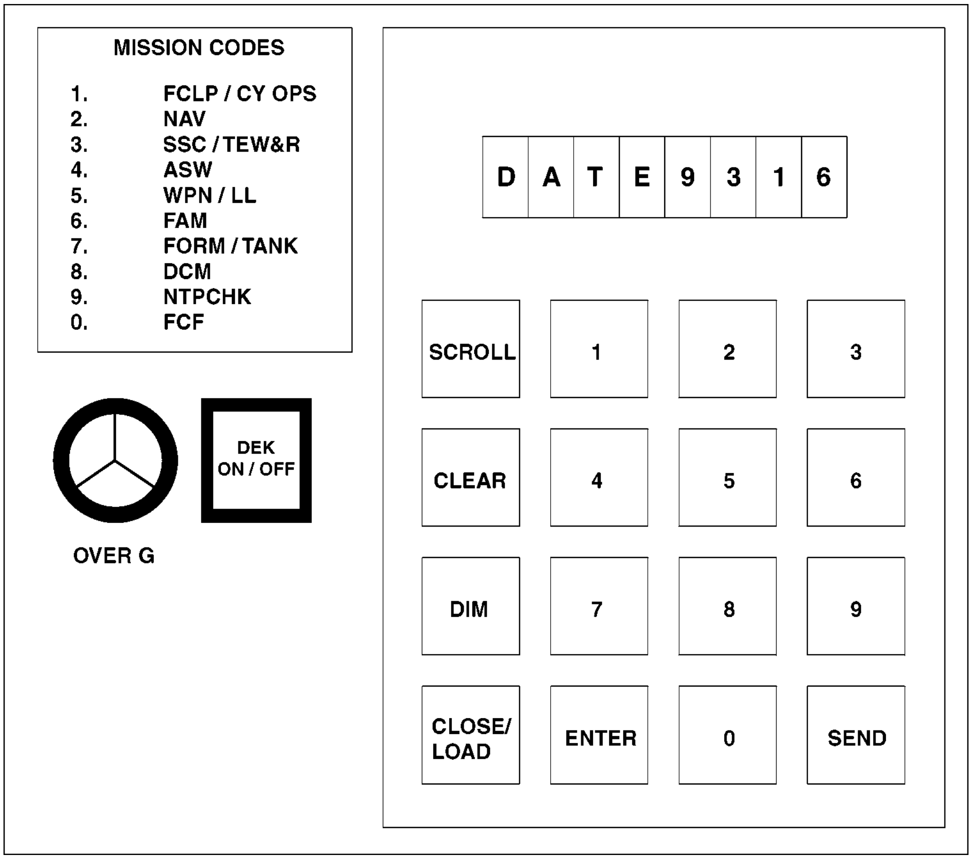
2.35.4 Signal Data Converter (SDC). The signal data converter (SDC) conditions signals from the standard central air data computer (SCADC), the fuel quantity data converter (FQDC), and the flight data computer (FDC) for input to the RC. The SDC is located under the crew entrance step aft of the RC.

2.35.5 Independent Over-G Indicator. The over-g indicator is a cat-eye-type display located just aft of the DEK. It changes from a clear indication to a solid white indication when a normal acceleration (N_Z) above 3.5 g is experienced. This indication is based on a preset calculation that does not include any variable aircraft loadings or any inputs placed in the DEK. When the over-g indication appears, the SDRS data should be downloaded and an over-g inspection performed. The accelerometer that triggers the over-g indicator is located near the aircraft center of gravity and may be slightly different from the accelerations recorded in the cockpit.

2.35.6 Recorder Reproducer. The Recorder Reproducer (R/R) is a ground support unit, which is used to download the SDRS flight data and upload software changes to the Recorder Converter, and can be used to troubleshoot or reconfigure the SDRS during improper operations. The RR is a portable computer not EMC-hardened and should not be used in a flight deck environment.

2.35.7 Data Entry Keypad (DEK). The data entry keypad (DEK) is used to input mission-specific information such as mission profile and aircraft gross weight to the RC. The DEK is located on the aisle side of the Senso station. The DEK has an independent ON/OFF button, which is used to initially apply power to the DEK for preflight data entry. The DEK power may then be secured in order to avoid distraction to the aircrew from the DEK display illumination. DEK operation is detailed in paragraph 2.35.8.

2.35.8 Data Entry Keypad On-Off Button. The DEK On-Off Button enables the DEK to be secured during night operations. In its ON mode, the DEK lighting may pose a distraction to the aircrew during night operations. In securing the DEK in flight, the SDRS will continue to monitor and record flight data. To input post-flight data after the DEK has been secured, press the On-Off button to energize the DEK and enter the flight data as required.



KEY	FUNCTION
1 — 9 AND 0	Numeric data entry.
SCROLL	Steps through the data entry fields for data entry or to determine if current data are correct. This should be done prior to pressing SEND.
CLEAR	Erases invalid data.
DIM	Press to exit NVIS compatible mode.
CLOSE/LOAD	No function related to the S-3B aircraft.
ENTER	Validates data and stores data in DEK memory buffer only.
SEND	Transmits data to memory buffer in the SDRS Recorder Converter (RC).
OVER G	Indicates normal acceleration (N_Z) exceeded 3.5 g's.
DEK ON/OFF	Secures DEK to prevent visual distraction during night operations.
MISSION CODES	Lists number of code for each S-3B mission type.

Figure 2-159. SDRS Data Entry Keypad Functions

Parameter	Input Range (1,000 lbs)
Julian Data	Automatic (Aircrew Verify)
Time	Automatic (Aircrew Verify)
Takeoff/landing Gross Weight (GW)	27.0 — 53.0
Port Wing Store Weight (W5)	0 — 3.0
Starboard Wing Store Weight	0 — 3.0
Bomb Bay Store Weight (BB)	0 — 3.5
Total Sonobuoy Weight (BUOY)	0 — 2.2
Mission Code (MC)	Codes Defined as 0 – 9 on placard mounted next to DEK.

Figure 2-160. SDRS Data Entry Keypad Functions

PROCEDURES	COMMENTS/RESULTS
1. Press DEK ON/OFF.	Button is illuminated. DEK keypad will illuminate. DEK will perform BIT test (approximately 7 to 10 seconds).
2. Enter data using keypad and press ENTER after each parameter.	To go forward to view parameters press SCROLL. Parameter list will repeat if SCROLL is continued.
3. After data entry is complete, press SEND.	
4. Prior to securing aircraft power after landing, input any changes to the aircraft configuration (gross weight, sonobuoy, bomb bay weight, etc.). After data entry is complete, press SEND.	

Note

- DEK may be secured after the data entry is complete.
- If an interrupt in aircraft power occurs or if power is purposely shut down, data must be re-entered.
- If DEK digital display is in "DIM" NVIS mode, display may appear to be blank. Press SIM button to illuminate display.

Figure 2-161. SDRS Startup Procedures

CHAPTER 3

Aircraft Servicing

3.1 SERVICING INSTRUCTIONS

Operations away from home base require preflight/postflight inspections not normally performed by flightcrew personnel. The following information is the minimum servicing information the crew may need for offbase operations (see Figure 3-1). For more detailed procedures, refer to Maintenance Instruction Manual (NAVAIR 01-S3AAB-2-1).

WARNING

Landing gear door bonding straps and external avionic door bonding straps contain beryllium. Aircrew should exercise caution during preflight. Inhalation of beryllium dust or contact with skin, lacerations, or mucous membranes present a hazard to human health.

Note

Aircraft with AFC-245 incorporated (carbon brakes) do not have main gear brake assemblies that contain beryllium.

When operating at a facility other than home base, flightcrews should perform the following minimum additional items:

1. Ensure sonobuoy safety door is open.
2. Attach grounding wires to aircraft (if available).
3. Install landing gear safety pins (three).
4. Install arresting hook safety pin.
5. Inspect engine oil quantity within 10 minutes after engine shutdown.
6. Inspect IDG oil quantity no sooner than 5 minutes after engine shutdown.
7. Inspect APU:
   a. APU for proper oil level
   b. APU ECU BIT indicators black (in left electrical load center)
   c. APU delta-P indicators (three) (not extended)
   d. Oil cooler inlet screen (free of obstructions)
   e. APU inlet (free of obstructions).
8. Inspect hydraulic reservoirs for proper quantity.
9. Inspect hydraulic filtration package delta-P indicators are not extended.
10. Check tires for obvious wear or damage.
11. Inspect brakes.
12. Check the following delta-P indicators on each engine (see Figure 3-1, Sheet 4).
    a. IDG oil filter
    b. Fuel filter
    c. Fuel control bleed sense
    d. Anti-icing valve, primary pressure regulator.
13. Check ECS compartment for the following (see Figure 3-1, Sheet 5):
    a. Hydraulic leaks/EHP delta-P indicator
    b. Turbine/fan overtemperature indicator
    c. ECS turbine oil level
    d. External fuel pressurization delta-P indicator.
14. Service fuel, oil, hydraulic, and liquid oxygen as necessary.

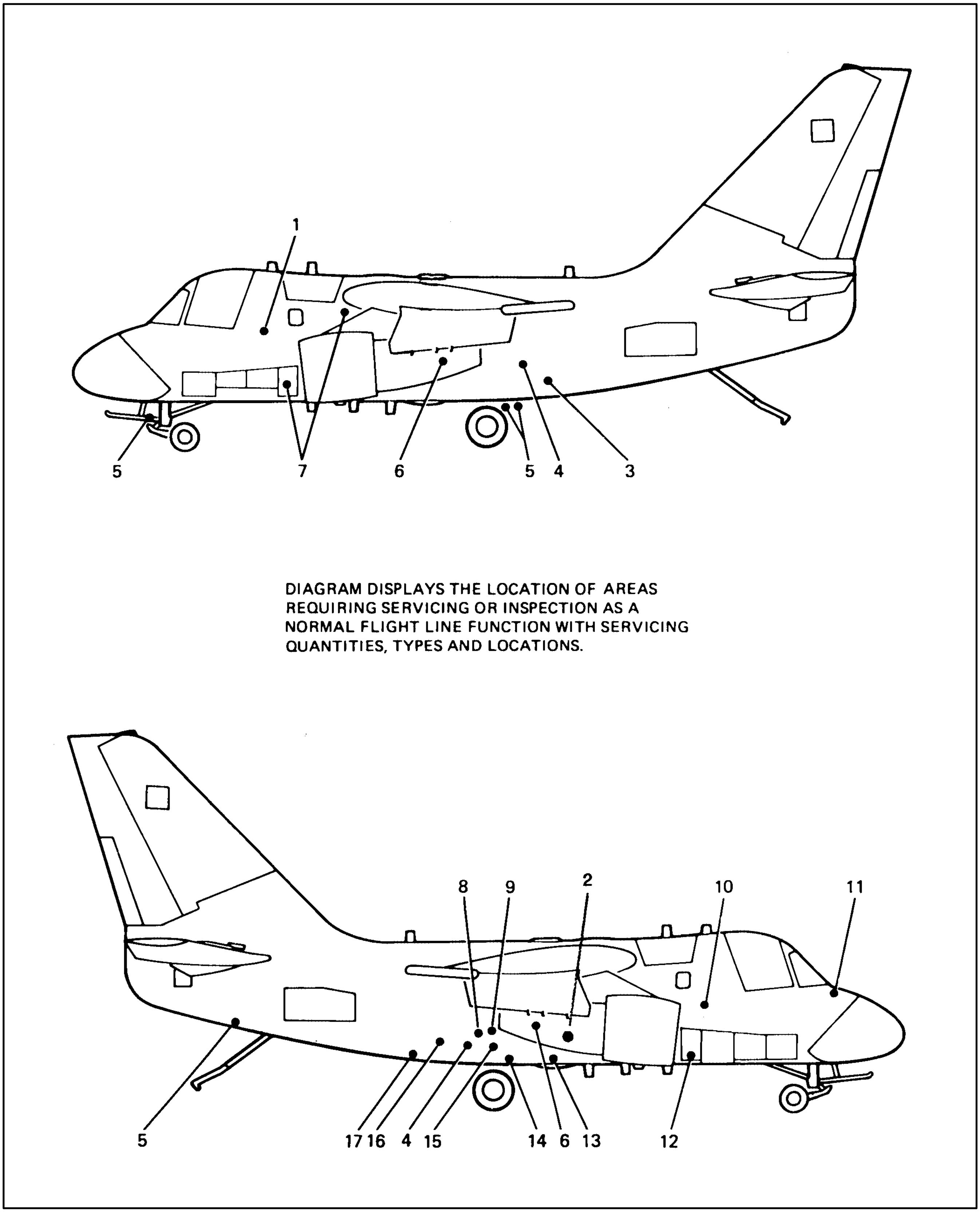


Figure 3-1. Aircraft Servicing (Sheet 1 of 8)

INDEX	UNIT	SPEC/TYPE	ITEM REQUIRED	SERVICE NECESSARY	ACCESS LOCATION
1	Rain repellent reservoir	MIL-R-81261 (WP)	Rain repellent	Replaceable container — 1 liter (75 psi dry nitrogen)	Internal — cockpit behind pilot
2	IDG (sight gauge)	MIL-L-23699 *MIL-L-7808 (alt)	Lubricating oil	Pressure fill service	Engine access door
3	ECS turbine (sight gauge)	MIL-L-23699 *MIL-L-7808 (alt)	Lubricating oil	Gravity filler	Left main landing gear wheelwell
4	Utility reservoir (System No. 1)	MIL-H-83282 ** MIL-H-5606A (alt)	Hydraulic fluid	3000 psi — Systems filled thru return lines or fill connection in wheelwell	Quick disconnects for individual system above each wheelwell
4	Flt cont reservoir (System No. 2)	MIL-H-83282 ** MIL-H-5606A (alt)	Hydraulic fluid		
5	Struts and tailhook	BB-N-411lb(1) Type 1 Class 1 Grade B	Nitrogen	Pressure (per attached graph on strut, tailhook gauge — 1000 psi dry nitrogen)	On units
6	Engines	MIL-L-23699 *MIL-L-7808 (alt) *** AEROSHELL 560	Lubricating oil	Pressure or gravity (emergency) — 6 quarts each (approximately)	Engine access door
7	APU	MIL-L-23699 *MIL-L-7808 (alt) *** AEROSHELL 560	Lubricating oil	Pressure filled BIT indicators checked	APU compartment Internal —left load center
8	DC electrical system	28 vdc	DC power	DC power (external)	Right main landing gear wheelwell
9	Inertial platform alignment receptacle	Umbilical connection			Right main landing gear wheelwell adjacent dc power receptacle
10	AC electrical system	115/200 V, 3 phase, 400 Hz	AC power	AC power (external)	Right forward fuselage — aft of crew door
11	Windshield washer reservoir	MIL-F-5566, with one-half ounce of CW100 per gallon	Windshield washer fluid	Gravity filler — 1 gallon	Forward upper fuselage
12	LOX converter	MIL-O-27210B	Liquid oxygen	Emergency LOX — 10 liter (replace or fill)	Right center fuselage

*MIL-L-23699 and MIL-L-7808 are mixable for one-time flights only. **MIL-H-83282 and MIL-H-5606A are mixable. Engine shall be completely drained and refilled with MIL-L-23699. ***AEROSHELL 560 is MIL-L-23699-compliant.

Figure 3-1. Aircraft Servicing (Sheet 2)

INDEX	UNIT	SPEC/TYPE	ITEM REQUIRED	SERVICE NECESSARY	ACCESS LOCATION
13	Start/APU accumulator	BB-N-411b(1) Type 1 Class 1 Grade B	Nitrogen	Serviced (1900 psi dry nitrogen)	Bomb bay right wheelwell (gauge)
14	Emergency brake accumulator	BB-N-411b(1) Type 1 Class 1 Grade B	Nitrogen	Serviced (1000 psi dry nitrogen)	Right wheelwell
15	Engine start, ECS ground operation	High pressure	External air	Air supply (50 ± 5 psi at 100 ppm)	Right wheelwell
16	Ground cooling, air conditioning	Low pressure	External air	Required if ground temp above 80 °F	Right fuselage aft of main landing gear
17	Internal and external fuel tanks	MIL-T-5624L or MIL-T-83133A	Fuel (JP-4, JP-5, or JP-8)	Single-point refuel/ defuel (340 gpm at 30 psi)	Right aft fuselage
	RSSK kit oxygen	MIL-O-27210D(1) Type 1 EPS 31.0950	Gaseous oxygen	Serviced with survival kit (1800 psi)	Each crew seat
	Main landing gear tires	BB-N-411b(1) Type 1 Class 1 Grade B	Nitrogen	Field — 245 psi, Carrier — 320 psi	Main landing gear wheelwell
	Nosewheel tires	BB-N-411b(1) Type 1 Grade 1 Grade B	Nitrogen	Field — 120 psi, Carrier — 320 psi	Nose wheelwell

Figure 3-1. Aircraft Servicing (Sheet 3)

3.1.1 Engine Oil System Servicing. To service the engine oil system it will be necessary to open the engine cowling. The 6-quart (approximately) engine oil tank and a quantity sight glass are located on the right side of each engine. The pressure fill adapter is located above the sight gauge (See Figure 3-1, Sheet 5).

CAUTION

- Do not overfill the system. If the ball in the sight gauge is at the bottom of the gauge, do not add more than 2 quarts of oil. Start engine, shut down, and recheck level.
- To eliminate the possibility of oil contamination, gravity fill of the system should be used only during an emergency.

Note

Engine oil quantity should be checked soon after shutdown to ensure an accurate indication. During extended periods of time (in excess of 10 minutes), oil will drain from the engine into the gearbox resulting in erroneous oil quantity indication. To obtain accurate oil level indication prior to the first flight of the day, it is recommended that the engine be motored with the starter for approximately 1 minute before checking the oil quantity level on the sight gauge. (An accurate indication can also be obtained if the oil quantity level is checked within approximately 10 minutes after engine shutdown.)

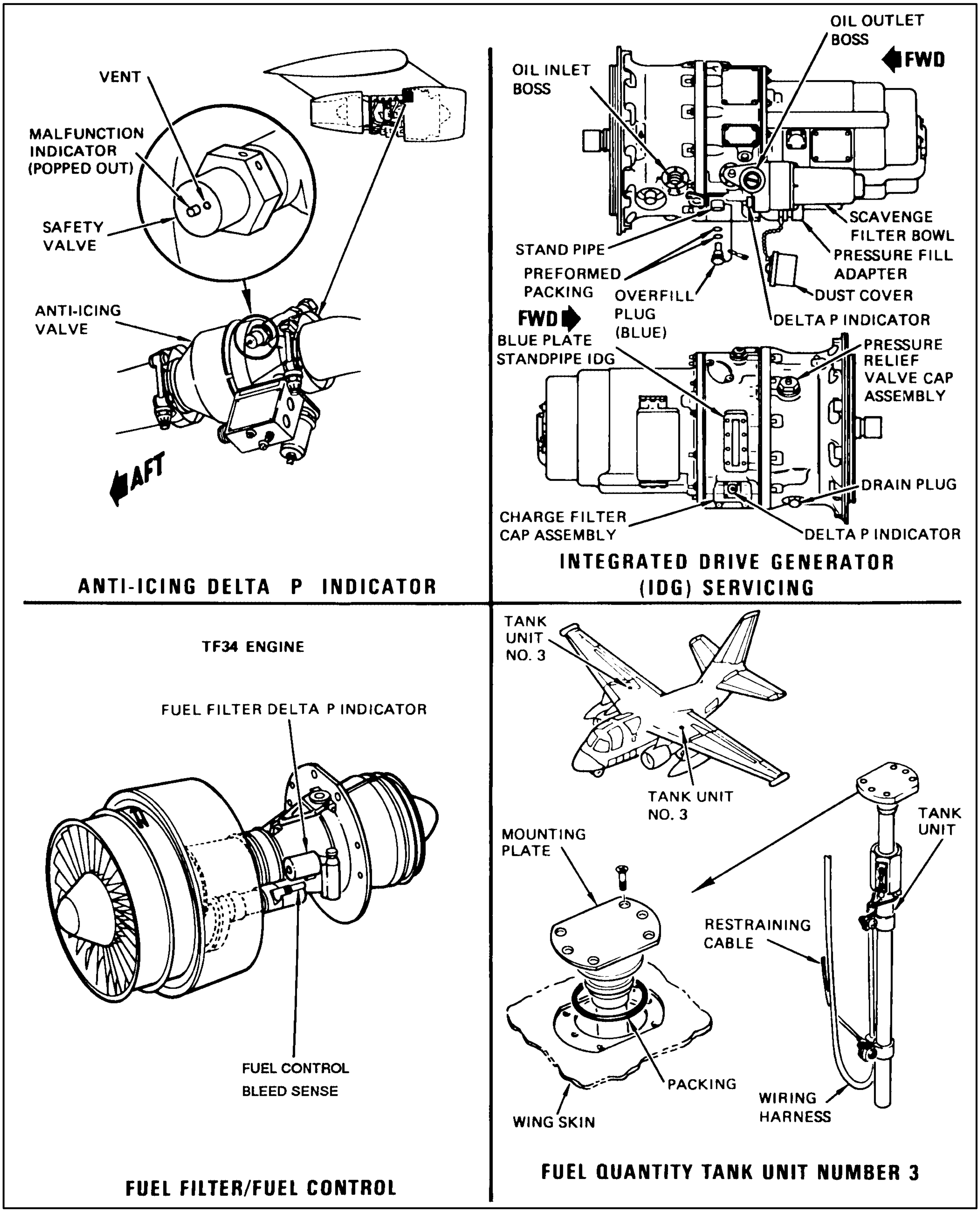


Figure 3-1. Aircraft Servicing (Sheet 4)

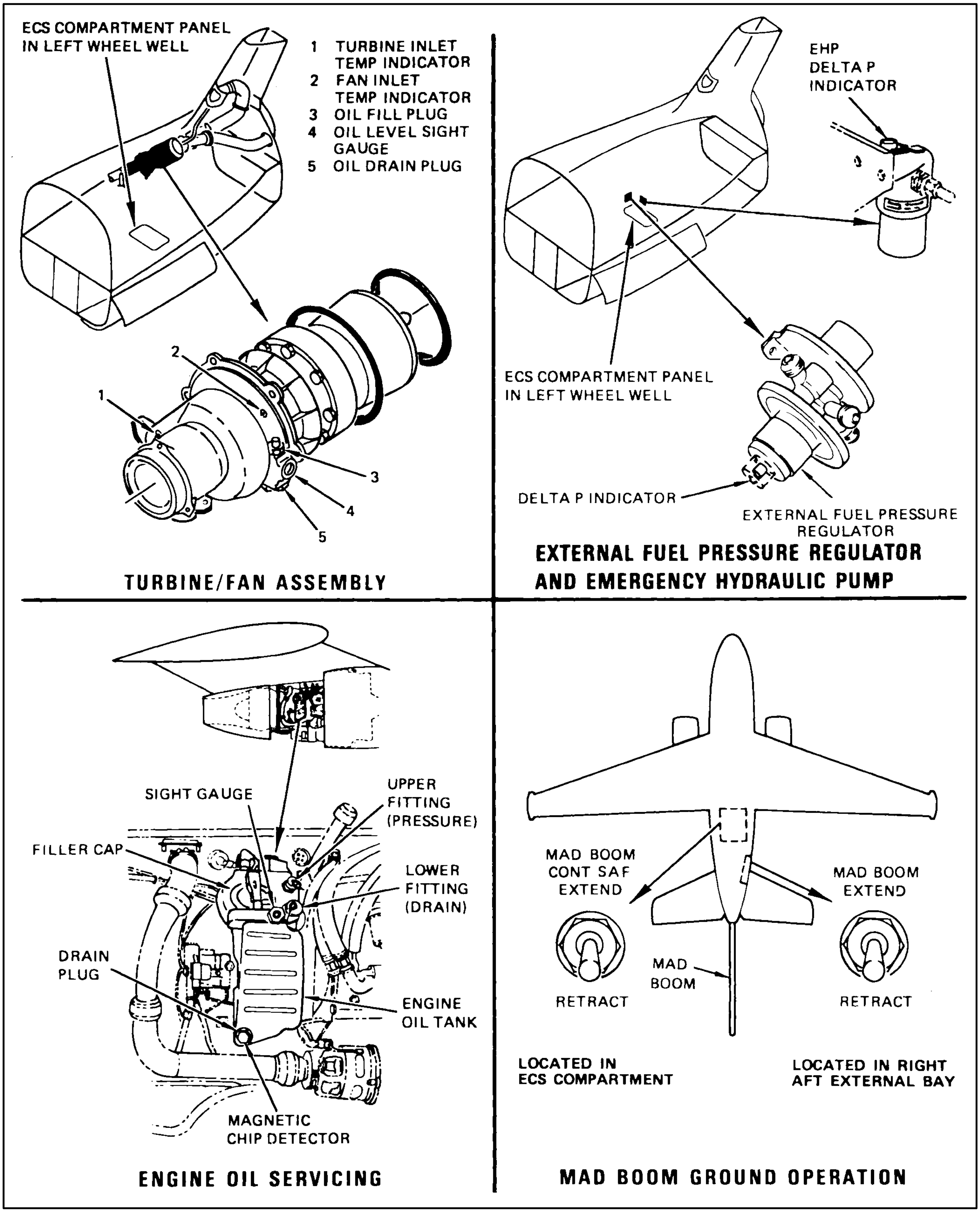


Figure 3-1. Aircraft Servicing (Sheet 5)

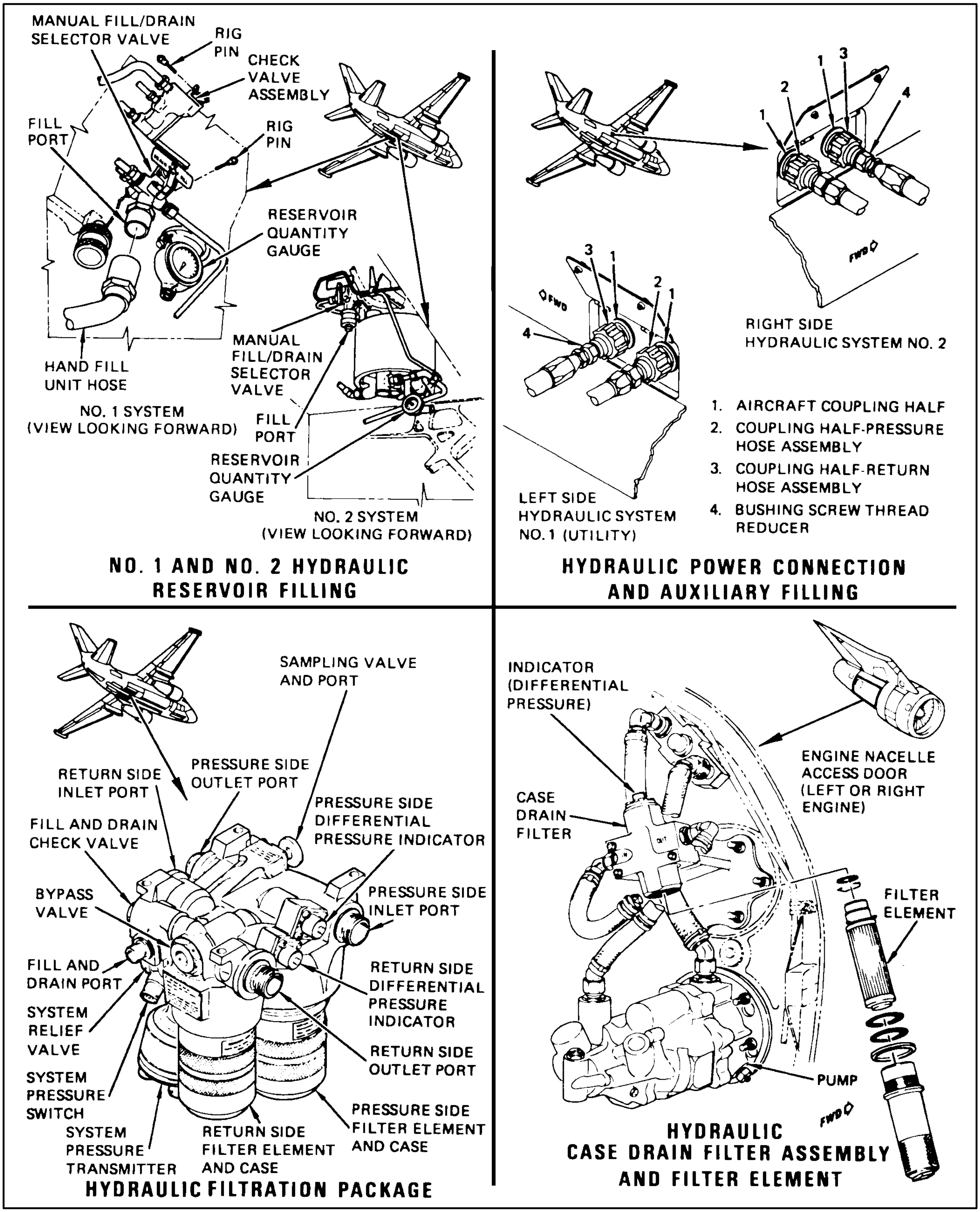
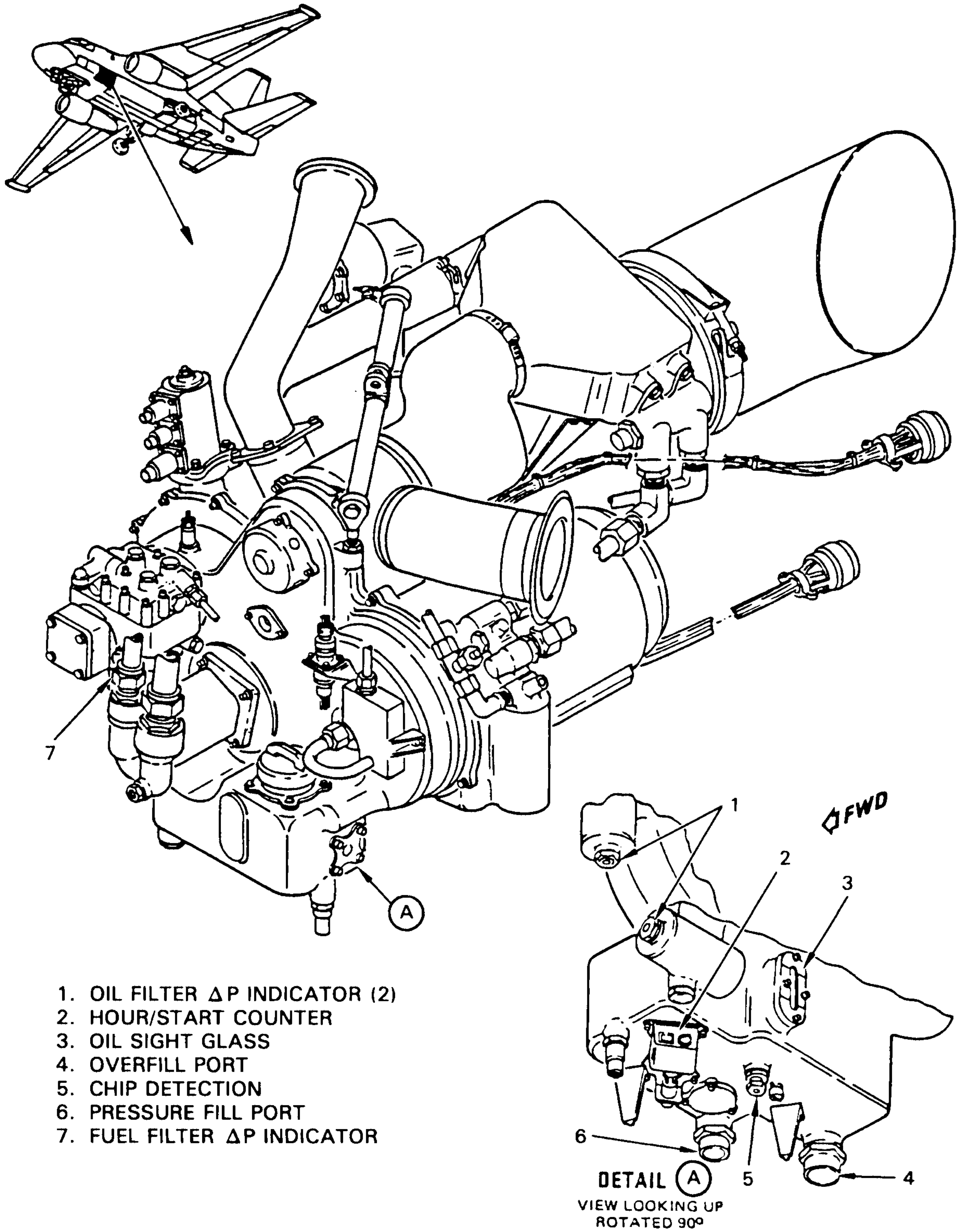


Figure 3-1. Aircraft Servicing (Sheet 6)



1. OIL FILTER ΔP INDICATOR (2)
2. HOUR/START COUNTER
3. OIL SIGHT GLASS
4. OVERFILL PORT
5. CHIP DETECTION
6. PRESSURE FILL PORT
7. FUEL FILTER ΔP INDICATOR

Figure 3-1. Aircraft Servicing (Sheet 7)

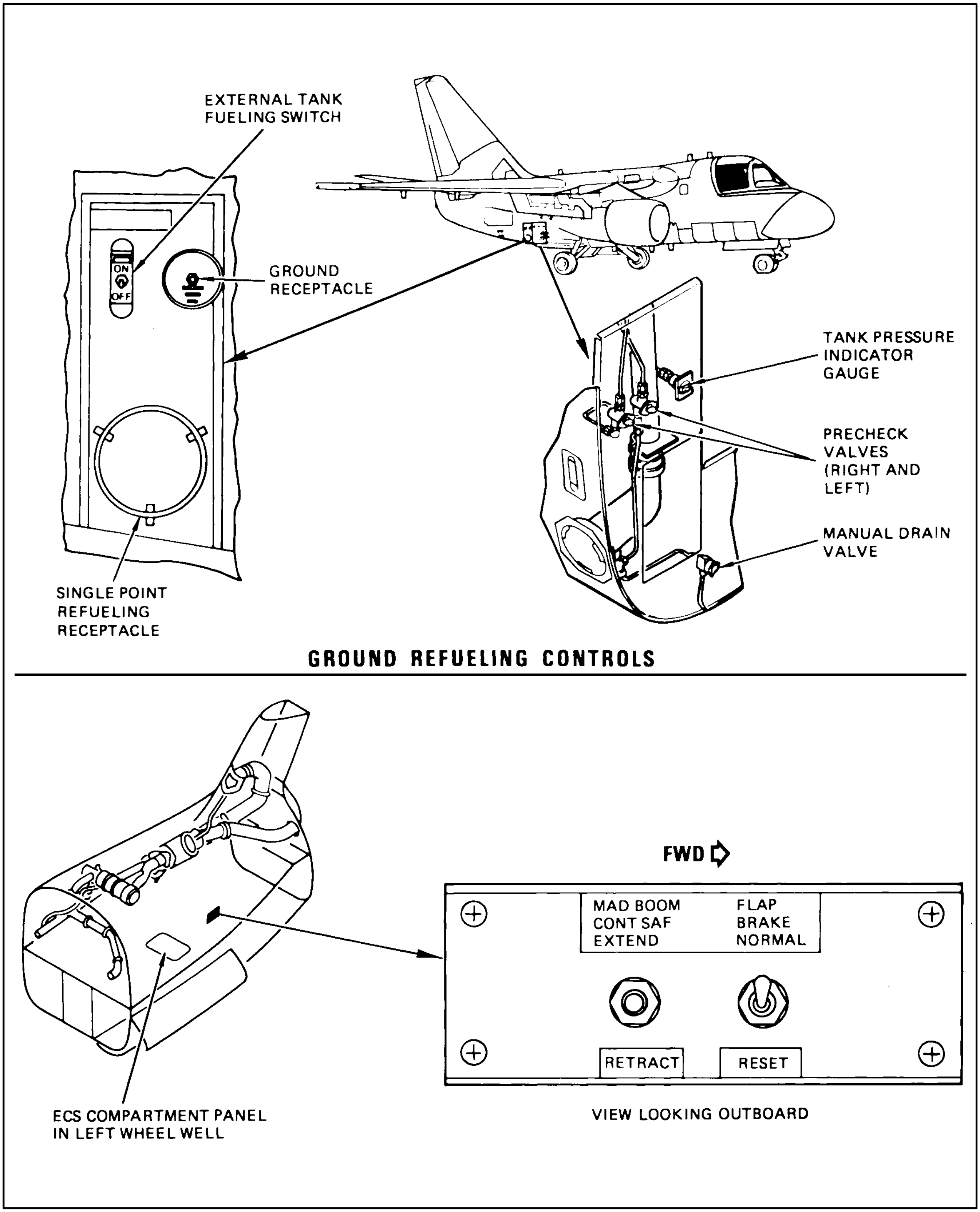


Figure 3-1. Aircraft Servicing (Sheet 8)

Note

- To add oil to the engine, a drain bottle with hose attached must be connected to the lower quick disconnect fitting adjacent to the sight gauge. After connection of the oil supply hose from the service cart is accomplished, pressure filling to the pressure fill adapter can be started. When oil is observed flowing into the drain bottle, the oil supply is properly filled. The quantity of oil used must be recorded and passed to maintenance personnel.

- Gravity servicing should not be accomplished until engine cools.

3.1.2 Integrated Drive Generator Servicing. The engine cowling must be opened to provide access for IDG servicing. Oil may be added when a service cart is connected to the pressure-fill adapter located on the left side of the IDG. It is extremely important to have the correct amount of oil in the IDG. Correct IDG oil level is a major factor in contributing to optimum cooling and performance. Avoid overfilling, which can result in a thermal disconnect. Avoid underfilling, which can result in IDG failure during catapult. The IDG can be serviced with the correct volume of oil irrespective of aircraft attitude within ±6° aircraft inclination. Correct oil quantity during filling procedures is established by the use of the overflow standpipe. A sight gauge with two indices is provided on the right side of the IDG for checking quantity; however, the sight gauge should not be used during filling procedures to verify oil level. Check the quantity as follows.

3.1.2.1 Hot or Warm Engine (Preferred Method)

1. Wait a minimum of 5 minutes after engine shutdown before checking oil level.

2. Optimum oil level will be at the middle of the silver band (anywhere in the band is acceptable).

3. If the level is below the lower index, service to the middle of the band.

4. If the level is above the upper index, drain until middle of the band is indicated.

3.1.2.1.1 Cold Engine

1. Oil level should be at or above the lower index.

2. If level is below the lower index, service to the middle of the band.

CAUTION

Servicing the IDG with oil when the aircraft has been exposed to ambient temperatures below –18 °C (0 °F) for an extended period will result in overfilling. Overfilling has resulted in rapid complete internal failure of the IDG.

3.1.3 APU Servicing. A sight gauge window is located at the left forward area of the APU compartment to indicate if oil level is satisfactory. Access for servicing is through the maintenance panel door located at the bottom of APU compartment and, forward of the inlet louvers. To service the system, a transparent hose with bottle attached should be connected to the drain fitting. With a servicing unit attached to the pressure fill connection, located on the forward end of the engine, oil should be added until overflow is observed in the drain line, indicating the tank is full. Disconnect pressure line and wait until overflow ceases. When properly serviced, oil level should be 0.3 inch below full mark if APU is cold. With APU hot, oil level should not be above full mark (see Figure 3-1, Sheet 7).

CAUTION

- Do not overfill the system.

- Servicing the APU oil system when the aircraft has been exposed to ambient temperatures below –18 °C (0 °F) for an extended period may result in overfilling. Overfilling under any circumstance can result in rapid failure of the APU.

3.1.3.1 APU Service Indicators. In addition to the oil level sight gauge, there are three APU BIT indicators and three delta-P indicators. The three BIT balls are located on the ECU in the left electrical load center to indicate overspeed, overtemperature, and low oil pressure. Clogged oil and fuel filters are indicated by delta-Ps on the APU. An hour/start counter is located below the oil sump on the APU along with the magnetic chip detector (see Figure 3-1, Sheet 7).

3.1.4 Hydraulic System Servicing. The No. 1 flight control/utility system and the No. 2 flight control system are serviced separately. Service connections and a reservoir quantity gauge for the No. 1 system are located in the left wheelwell. The reservoir quantity gauge has markings that indicate full (3.0 gallons) and refill (2.5 gallons). Fluid may be added to the reservoir from the servicing unit by connecting to the fill port. It is necessary to place the lever on the fill drain selector valve in the fill position for fluid to be accepted by the reservoir. Draining of the hydraulic system can be accomplished by placing the fill drain selector valve lever in the drain position after connecting the fill port to an appropriate container (see Figure 3-1, Sheet 6).

Note

Ensure the APU and EMER brake accumulator fully charge when servicing the No. 1 hydraulic system.

The No. 2 flight control system reservoir and service connections are located in the right wheelwell. A quantity gauge, located below the reservoir, has indicator markings at full (0.9 gallon) and refill (0.7 gallon). Servicing of the No. 2 hydraulic system can be accomplished in the same way as for the No. 1 hydraulic system. Separate hydraulic pressure and return fittings are located on the exterior of the aircraft above the left wheelwell for hydraulic system No. 1 and above the right wheelwell for hydraulic system No. 2. These separate fittings are provided for use when it is necessary to operate the hydraulic systems from a hydraulic teststand when the engines are not operating and to fill the hydraulic reservoirs by an auxiliary method (see Figure 3-1, Sheet 6).

CAUTION

To avoid overpressurization and resultant failure of the hydraulic oil cooler, do not connect/operate hydraulic teststand when cockpit fire pull handle is in the shutdown position.

There are a total of seven hydraulic delta-P indicators in the hydraulic system. There are two (total of four) delta-P indicators for each hydraulic filtration package located in each wheelwell: one (total of two) delta-P indicator is located on each case drain filter, which is mounted above the hydraulic pump on each engine; and a single delta-P indicator is located on the emergency hydraulic pump, which is located in the ECS compartment near the No. 1 system reservoir (see Figure 3-1, Sheets 5 and 6). A popped hydraulic delta-P indicates that the respective hydraulic oil filter is blocked and is being bypassed. When a hydraulic delta-P indicator is popped, the respective filter must be replaced and the hydraulic system must be inspected for the cause of the blockage.

3.1.5 Fuel System Servicing. The aircraft may be fueled with JP-4, JP-5 (MIL-T-5624L), or JP-8 (MIL-T-83133A) without engine fuel control adjustment being necessary (see Figure 3-2).

If fueling with approved fuels without fuel system icing inhibitor, the following procedures must be followed:

1. Fuel aircraft.

2. Obtain a fuel sample bottle and allow it to stand outside the aircraft for 15 minutes to stabilize its temperature.

3. Take a fuel sample and immediately record its temperature with a thermometer.

4. If the fuel temperature is above 59 °F, there are no flight restrictions; if the fuel temperature is between 40 and 59 °F, flight altitude is restricted to 22,000 feet. If the fuel temperature is below 40 °F, the aircraft/fuel combination must be warmed by suitable means to obtain a minimum fuel temperature of 40 °F prior to takeoff.

GRADE, NATO SYMBOL, AND NATIONAL SPECIFICATION OF APPLICABLE FUELS							
	PRIMARY FUELS			ALTERNATE FUELS			
				KEROSENE			WIDE CUT TYPE
NATION	JP-4	JP-5	JP-8	HIGH FLASH	LOW FLASH		
NATO SYMBOL	F-40	F-44	F-34	F-43		F-35	
UNITED STATES	MIL-T-5624L AM.1	MIL-T-5624L AM.1	MIL-T-83133A		ASTM D1655-78 (JET A)*	ASTM D1655-78 (JET A-1)**	ASTM D1655-78 (JET B)***
BELGIUM	BA-PF-2C		BA-PF-6				
CANADA	CAN2-3.22	3-GP-24H					
DENMARK	MIL-T-5624L AM.1	MIL-T-5624L AM.1	DERD 2453 ISS 4				
FRANCE	AIR-3407/B	AIR-3404/C	AIR-3405/C	AIR-3404/C		AIR-3405/C	
GERMAN FED. REP	VTL-9130/006 ISS 5		TL-9130-007 ISS 4				
GREECE	MIL-T-5624L AM.1	MIL-T-5624L AM.1					
ITALY	AER-M-C.142p	AA-M-C.143b	AER-M-C.141d	AA-M-C.143b		AER-M-C.141d	
NETHERLANDS	MIL-T-5624L AM.1		DERD 2453 ISS 4	DERD 2498 ISS 7		DERD 2494 ISS 8	
NORWAY	MIL-T-5624L AM.1		MIL-T-83133A				
PORTUGAL	MIL-T-5624L AM.1						
TURKEY	MIL-T-5624L AM.1						
UNITED KINGDOM	DERD 2454 ISS 4	DERD 2452 ISS 2	DERD 2453 ISS 4	DERD 2498 ISS 7		DERD 2494 ISS 8	

CAUTION

TF34 engines should be serviced with fuel containing fuel system icing inhibitor (FSII). Use of fuel without FSII is only permitted when the procedure and precautions in Fuel System Servicing are followed (this part).

Notes:

Refer to NAVAIR INSTRUCTION 10341.1 (Series) and NAVAIR 10300.1 (Series) for additional information on aviation fuels.

Same as F-44 except F-43 does not contain Fuel System Icing Inhibitor (FSII).

Same as F-34 except F-35 does not contain FSII.

* Same as JET A-1 except freezing point is –40 °C instead of –50 °C. Usually does not contain FSII. JET A is generally available at commercial airports in CONUS.

** Same as F-34 except inclusion of FSII is not mandatory and, therefore, JET A-1 does not usually contain FSII. JET A-1 is generally available at commercial airports in Europe.

*** JET B, available at commercial airports in CONUS and Canada, is similar to F-40 but FSII is not mandatory. JET B, therefore, does not usually contain FSII.

Figure 3-2. Fuel Availability

WARNING

The following should be observed closely during refueling operations:

1. Inspect vent to ensure it is not obstructed.
2. Ensure adequate grounding of the aircraft, fueling nozzle, and fueling equipment.
3. Ensure aircraft radar is not operating within 250 feet of the fueling area and that electrical equipment is not operating in the area.
4. Ensure that adequate firefighting equipment is available in the immediate area of the fueling operation.

CAUTION

- Temperatures are only valid if taken within 1 hour prior to takeoff.
- Fuel tanks must be adequately water drained prior to flight when operating without FSII.
- Prior to any fueling operation, ensure tank vent is clear. Never block vent as tank rupture may occur, especially during fueling operations.

3.1.5.1 External Tank Pressurization System Check Procedure

Note

It is recommended that this procedure be performed following initial installation of external fuel tanks, prior to No. 1 engine shutdown following flight with external tanks, or prior to hot pit refueling.

1. Pressurize the bleed air manifold (utilizing APU, ground start air, engine operating at IDLE; or supply air to the external tank pressurization system by connecting shop air to the ground air receptacle located in the starboard main landing gear wheelwell).
2. Provide aircraft with 115-vac power (utilizing generator, APU, or ground power).
3. Pressurize external fuel tanks by placing the EXT TRANS switch on the fuel control panel located in the flight station in OVERRIDE position. (Hold for a minimum of 1 minute; check no airflow from the external tank vent during this time.)
4. Station observer at an external fuel tank vent. Release EXT TRANS switch to OFF from OVERRIDE position. Monitor at external tank vent and verify that external fuel tank pressure vents.

Note

- If the external fuel tank pressurization system does not pass the above procedure, troubleshoot and repair prior to flight with external tanks. (Refer to NAVAIR 01-S3AAB-2-3.5 and 01-S3AAB-2-4.5.)

D704/31-300

- To check air refueling store pressurization, place the SHIP TANK switch on the ARS control panel to FROM STORE in addition to holding the EXT TRANS switch in OVERRIDE for 60 seconds.

31-301 (A/A42R-1)

- To check air refueling store pressurization, place the STORE switch on the ARS control panel to FROM in addition to holding the EXT TRANS switch in OVERRIDE.

3.1.5.2 Ground Fueling. The aircraft external and internal tanks are normally fueled by means of the single-point pressure fueling system. The external tanks may also be fueled by gravity as a normal procedure. Gravity fueling of the internal tanks is possible but should only be accomplished as an emergency procedure. A pressure fueling/defueling adapter is located on the exterior of the aircraft, just aft of the right wheelwell (see Figure 3-1, Sheet 8).

WARNING

If the fuel state of the Aero-1D drop tank/aerial refueling store is not known, do not remove the tank/stores filler cap because a fuel spill and/or spray may result.

3.1.5.2.1 Single-Point Fueling. To fuel the aircraft, a refueling unit capable of delivering fuel at 20 to 60 psi nozzle pressure is recommended. This refueling unit is connected at the single-point ground fueling/defueling adapter located on the side fuselage aft of the right wheelwell. Electrical power is not required to fuel the internal tanks.

When fuel pressure is applied to the system, manually open both precheck valves, located on the aft bulkhead of the right wheelwell, to check the operation of the pressure shutoff valves in each transfer tank. The pressure shutoff valves must close within 20 seconds from the time the precheck valves are held open. Fuel flow from the refueling unit will stop when both shutoff valves are closed. If either pressure shutoff valve fails to close within the required time period (within 20 seconds), indicating one or both of the shutoff valves have failed to close, the refueling operation should be terminated.

To continue the fueling operation after a satisfactory check of the pressure shutoff valve is made, the precheck valves are released and the internal tanks fueled while monitoring the fuel tank pressure gauge. A fuel tank pressure gauge, located on the aft bulkhead of the right wheelwell, consists of a drum marked with a red band labeled STOP REFUELING and a green band (continue fueling). A black indicator bar moves vertically along the drum to indicate internal fuel tank pressure.

In an emergency situation, fueling can be performed with faulty fuel shutoff valves. However, fueling must be terminated at some level less than full internal.

CAUTION

With initial flow of fuel into the tanks, the tank pressure indicator gauge should be observed for internal tank pressure. If excessive pressure is indicated at any time during fueling (black indicator bar moves into the red band), the fueling operation must be discontinued.

Fueling of the external tanks using the single-point pressure system requires 115-vac power to the essential ac bus, which supplies 115 vac to the transformer rectifier. From the transformer rectifier, 28 vdc is supplied to the essential dc bus, which supplies 28 vdc for the operation of the fueling/transfer valves in the wing pylons. Control of these valves is provided by the external tank fueling switch which is powered by the right primary dc bus and located on the side fuselage aft of the right wheelwell. When positioned to ON during fueling, the fueling/transfer valves are opened, allowing fuel to enter the external tanks. These valves will automatically close when the float switches in the external tanks sense full tanks.

Note

- The external tanks will accommodate a maximum of 265 gallons each.
- Ensure the fueling port cover is properly replaced and secured after fueling operations.
- Check pylon shutoff valve. (Refer to External Tank Pressurization System Check Procedure in paragraph 3.1.5.1.)

If primary bus power is not available, fully extend the in-flight refueling probe, position the refuel select switch on the instrument panel to INTERNAL/EXTERNAL, and then power the essential dc start bus with either the auxiliary power unit or an external 28-vdc source.

3.1.5.3 Ground Fueling Siphon Breaker Check Valve. On aircraft incorporating AFC-158, a siphon breaker check valve (see FO-12) is located in the line that provides siphon breaking for the pressure fueling manifold. The check valve closes when positive pressure is applied and deactivates the siphon breaker line during pressure fueling.

3.1.5.4 Gravity Fueling. Gravity fueling of internal fuel tanks should be accomplished only as an emergency procedure directed by operational necessity. Overwing fillercaps are not provided; however, in the event that pressure refueling equipment is not available (and in an emergency), gravity fueling of the internal tanks can be accomplished by removing the tank unit No. 3 (second capacitance probe from the outboard end of each transfer tank). These probes are provided with sufficient wire length to facilitate their removal. The external tanks can be gravity fueled through the external tank fillercap located on the upper forward section of each tank.

CAUTION

After gravity fueling the internal tanks, determine that probes are installed with the bolts wetted with MIL-C-16173 (grade 4) corrosion preventive compound. Calk voids between wing skin and mounting plate using MIL-S-8802 class B-1/2 sealing compound. The sealing compound requires 2 hours to dry before flying the aircraft.

Note

No aircraft fuel screens or deflectors are provided for gravity refueling.

3.1.5.5 Defueling. Defueling of the aircraft may be accomplished by connecting a suction hose and suction pump to the pressure refueling adapter and closing the defueling siphon breaker shutoff valve. Defueling of maximum internal and external fuel down to the 110-gallon level requires approximately 40 minutes.

CAUTION

Ensure manifold manual drain valve remains closed at all times.

3.1.5.6 Defueling Siphon Breaker Shutoff Valve. On aircraft with AFC-l58 incorporated, a defueling breaker shutoff valve (see FO-12), located in the line that provides siphon breaking for the pressure fueling manifold, is normally open. The shutoff valve is manually closed during defueling to deactivate the siphon breaker line. An open line would bypass the suction used to pull the fuel from the tanks.

3.1.5.7 Fuel Density Versus Temperature. Fuel quantity indication can vary even though the aircraft is serviced with the same number of gallons of fuel. The factors that cause the fuel weight to change with a constant quantity are temperature and fuel density tolerances. Figure 3-3 shows the variation of fuel density with temperature for nominal JP-4, JP-5, and JP-8 fuel. Production specifications for these fuels permit a density range of approximately ±0.2 pound per U.S. gallon. For example, although JP-4 has a normal fuel density of 6.5 pounds per U.S. gallon at 15 °C, it can vary from 6.3 to 6.7 pounds per U.S. gallon at this temperature. For accurate mission planning, the combined effect of initial fuel density and temperature must be considered for the fuel on board. Assuming the fuel being used has an initial fuel density of 6.3 pounds per

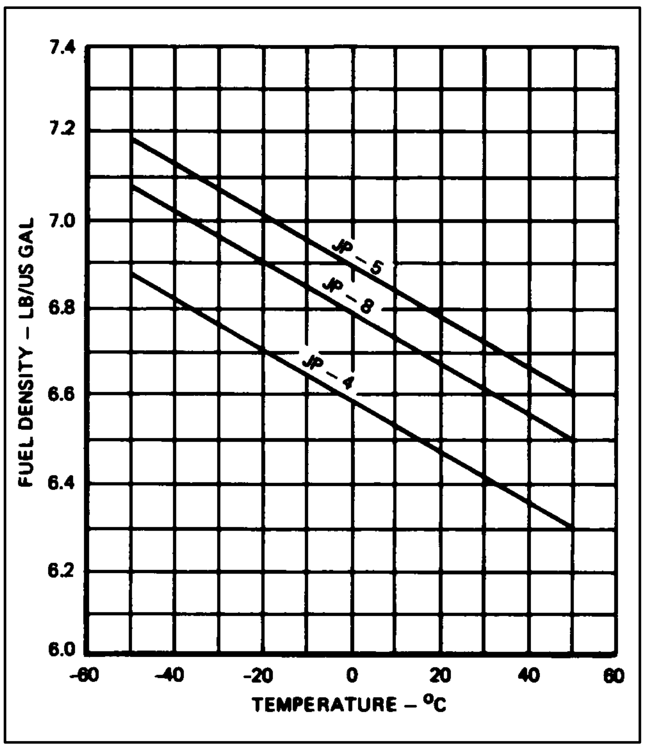


Figure 3-3. Fuel Density Versus Temperature

U.S. gallon at 15 °C, the same fuel at a temperature of 40 °C has a density of 6.15 pounds per U.S. gallon.

3.1.6 Engine Delta-P Indicators. The components that have delta-P indicators located on the engine are the anti-icing valve, bleed sense on the fuel control, fuel filter, integrated drive oil filters (see Figure 3-1, Sheet 4) and case drain oil filter (see Figure 3-1, Sheet 6). An extended anti-icing valve delta-P indicates that the primary of the regulator has failed and the regulator is in secondary mode. The maintenance action required is to check the piping for obstruction and replace the valve. The delta-P indicator on the anti-icing valve cannot be reset once it has extended. The valve must be replaced. A bleed sense delta-P, when extended, indicates a bleed leak at the fuel control or the bleed sense line between the engine and fuel control. Maintenance action required is to reset the delta-P, check for leaks in the bleed sense line, and change the fuel control, if applicable. An extended delta-P indicator on the fuel filter, integrated drive oil filter, or case drain oil filter indicates that the respective filter is in bypass. Maintenance action required is to reset the delta-P, change the respective filter, and check the system for contamination. Consult the appropriate maintenance instruction manual for the proper method of removing and installing the respective components.

3.1.7 ECS Compartment. The turbine fan assembly is located in the aft top center of the ECS compartment. Both turbine inlet overtemperature and fan inlet overtemperature indicators are on the turbine fan assembly. If either of these indicators is extended, the turbine fan assembly must be replaced. On the left side of the turbine fan assembly is the oil level sight gauge. Oil must be added if the level is below the center of the sight gauge. The external fuel pressurization delta-P indicator is located on the pressure regulator that is mounted on the forward left side of the ECS compartment. If the delta-P indicator is extended, replace the regulator (Figure 3-1, Sheet 5).

The locked flaps reset button in the ECS compartment is shown in Figure 3-1, Sheet 8.

3.1.8 Liquid Oxygen System Servicing

3.1.8.1 Normal System. A 10-liter oxygen converter is located on the right side of the aircraft, just aft of the entry door. Normal servicing of the system is accomplished by removal and replacement of the empty converter with a serviceable (full) unit. The oxygen converter may be refilled or topped off without removal from the aircraft by use of a suitable service cart.

WARNING

Only authorized personnel familiar with liquid oxygen characteristics should refill the oxygen converter.

CAUTION

Observe normal oxygen servicing safety practices (fill slowly, let temperature stabilize, use slow opening valves).

The filler hose should be connected from the service cart to the converter filler valve located on the lower aft side of the bottle to service the unit. A steady flow of oxygen from the drain, located at the bottom of the oxygen bay, will indicate the converter is full.

WARNING

All personnel working in the area should remain clear of the liquid oxygen overflow.

3.1.9 Emergency Oxygen System Servicing. An 1,800-psi emergency supply of oxygen is located in the RSSK. This container shall not be serviced in aircraft. To service the container, a source of gaseous oxygen is connected to the emergency bottle filler valve. The bottle can be charged to a correct pressure using the oxygen bottle charging pressure variation with temperature chart (see Figure 3-4).

3.1.10 APU Start Accumulator Servicing. The APU start accumulator and start valve package are located in the right bomb bay. The indicator and charging valve are located in the right wheelwell. Servicing of the APU accumulator requires dumping of system pressure to zero by pressing the No. 1 system hydraulic reservoir bleed button and then dumping the APU accumulator system by pressing the system dump button on the start valve package. This procedure is also required to determine the accurate precharge in the accumulator. A source of dry nitrogen can be connected to the charging valve and the accumulator should be charged to 1,900±100 psi (15 °C). Refer to Figure 3-5 for variations in APU accumulator precharge with ambient temperature change.

Note

Allow 1 minute after charging for nitrogen pressure to stabilize before checking charge.

AMBIENT AIR TEMPERATURE		CHARGING PRESSURE
°C	°F	PSIG (±25 PSIG)
–40	–40	1289
–30	–22	1374
–20	–4	1458
–10	14	1542
0	32	1625
10	50	1708
20	68	1791
30	86	1873
40	104	1956
50	122	2038
60	140	2120

Figure 3-4. Emergency Oxygen System Charging Pressure Per MIL-0-272 10D (ASG)

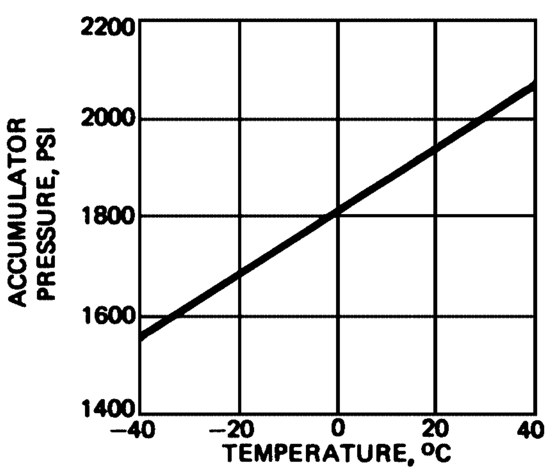


Figure 3-5. Nitrogen Precharge Pressure of APU Accumulator with Zero Hydraulic Pressure

3.1.11 Emergency Brake Accumulator Servicing. The emergency brake accumulator is located on the keelson in the right wheelwell. The accumulator has a pressure gauge and charging valve on the aft end of the accumulator. To service the accumulator, it is required that hydraulic system pressure be depleted to zero by pumping the brake pedals or that the accumulator be charged fully to 3,000 psi. A source of dry nitrogen can be connected to the charging valve of the accumulator and charged to the pressure indicated in Figure 3-6 or 3-7 as appropriate on the wheelwell accumulator gauge. When checking accumulator

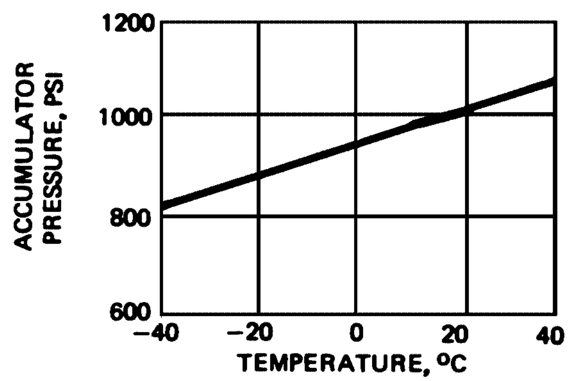


Figure 3-6. Emergency Brake Accumulator Precharge Pressure with Zero Hydraulic Pressure (Gradient 33.8 PSI/10 °C)

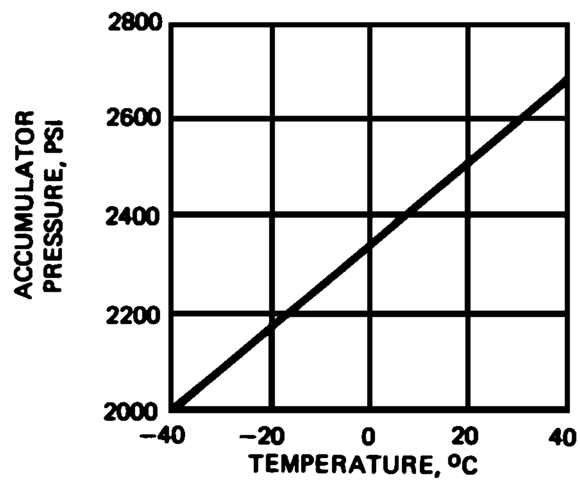


Figure 3-7. Emergency Brake Accumulator Precharge Pressure with 3,000 PSI Hydraulic Pressure (Gradient 85.7 PSI/10 °C

precharge pressures, it is mandatory to either deplete the hydraulic pressure or to have a full (3,000 psi) indication on the cockpit emergency brake indicator.

3.1.12 Electrical Power Receptacles

3.1.12.1 External AC Ground Power. A receptacle for connecting 115-vac, 400-Hz electrical power to the aircraft is located aft of the crew entry door above the oxygen compartment. Minimum requirement for an electrical ground power cart is 40 kVA. The following Navy units are approved: MG-1, MMG-1, and NC-8A. An NC-2A (30 kVA) may be used for most maintenance requirements aboard an aircraft carrier.

3.1.12.2 External DC Ground Power. A 28-vdc receptacle is located in the right wheelwell outboard and above the engine ground start air connection. If ac electrical power is not applied to the aircraft, dc power connected to this receptacle will permit single-point fueling of the external tanks and engine start.

CAUTION

Engine starts with external dc power will display no cockpit indications.

3.1.13 Inertial Platform Alignment Receptacle. A receptacle for connecting the umbilical used to align the platform of the inertial navigation system is located inboard of the dc receptacle.

3.1.14 Engine Ground Start Air. An engine ground start air connection is located in the right wheelwell. Required starting pressures from external air source are as follows:

Minimum (recommended)	45 psig (310 kPag)
Maximum (permissible)	75 psig (520 kPag) using a ground cart 100 psig (690 kPag) using ambient air temperature

The following units are compatible with the S-3B aircraft: GTC-85, MD-3A, MD-3B, NCPP-105, and RCPT-l05.

3.1.15 Ground Cooling Air. A connector for refrigerated ground cooling air is located on the overhead at the aft end of the right wheelwell. This connection provides for an appropriate source of cooling air to be connected to the aircraft during ground check or maintenance of avionic equipment when the aircraft air-conditioning system is not operating.

Precooling on the ground prior to flight is a requirement in hot weather. This can be achieved by operating with the APU running and the cabin door closed. Approximately 1 °F per minute cooldown rates can be achieved.

CAUTION

Above 31 °C (87 °F), avionic equipment should not be operated on the ground without a source of ground cooling air. At ambient temperatures between 8 and 31 °C (46 and 87 °F), the period of operation should not exceed 5 minutes without cooling air.

Ground cooling airflow rate must be a minimum of 100 pounds per minute at 10 °C (50 °F). The following ground cooling units are approved: NR-5B, NR-5C, NR-8, and NR-10.

CAUTION

After starting, with flow control valve in BYPASS, take all kinks out of the hose and push the flow control valve completely in for full flow. Failure to accomplish this can result in inadequate cooling of the avionic equipment with resultant overheat and failure.

An air outlet is installed in the overhead supply duct located between the TACCO and SENSO stations. A direct indication thermometer is installed on the aft inboard edge of the left internal avionics rack to monitor aft cabin temperature.

3.1.16 Rain Repellent System Servicing. The rain repellent bottle, located on the bulkhead behind the pilot, should be serviced when the level indication is below the green band on the gauge. After removal, the bottle can be serviced by removing the cap and check valve and pressing the plunger to relieve pressure. The bottle should be replaced with a 1-liter bottle of rain repellent fluid. The check valve should be replaced and the system charged to 75 psig with dry nitrogen. For further information, refer to U.S. Navy Service Bulletin No. 115.

Note

Occasionally, the rain repellent lines in the aircraft should be purged with dry nitrogen as residual fluid in the lines has a tendency to coagulate when exposed to moisture.

3.1.17 Windshield Washer Servicing

WARNING

Goggles or faceshield should be used when servicing the windshield washer system.

The windshield washer bottle can be serviced on the aircraft. The fillercap can be removed and checked by sight using the glass tube gauge attached. Fluid should be replaced with a mixture of 80-percent isopropyl alcohol and 20-percent distilled water and one-half ounce of CW100 per gallon of isopropyl alcohol and distilled water solution. An electric pump located in the bottom of the bottle does not require servicing.

3.1.18 Mad Boom Ground Operation. The MAD BOOM advisory indicator, located on the copilot/COTAC advisory light panel, lights green when the MAD BOOM is extended. The MAD boom group RETRACT/EXTEND safety switches (see Figure 3-1, Sheet 5), located in the right aft external avionics bay and the ECS compartment, are used to extend or retract the MAD boom when the aircraft is on the ground. The switches must be operated simultaneously by two operators, providing increased safety for personnel and aircraft.

3.1.19 Ground Handling. To ensure that there is no danger of collision with other aircraft or obstacles during ground handling, the following minimum safety precautions must be observed:

1. Landing gear pins should be installed
2. Adequate personnel shall accompany the aircraft during all towing operations.
3. A qualified individual should position himself near the towing vehicle and shall serve as aircraft director.
4. A qualified brake rider should be in the cockpit ensuring that the brake system is operative.

CAUTION

Check that emergency brake pressure indication is at least 50 percent into the green band. Pump up pressure with handpump as required.

5. When in confined areas, and as necessary for sharp maneuvers, towing speed should be limited to a normal walking speed. See Figure 3-8 for turning radius distances.

3.1.19.1 Raising Tailhook with No. 1 Hydraulic System Failed. If an arrested landing is performed with the No. 1 hydraulic system failed, the arresting hook should be raised as follows:

1. Bleed the nitrogen charge of the arresting hook shock absorber.

Note

Bleeding of the shock absorber is not mandatory but will reduce the amount of force required to raise the hook.

2. Place the hook handle in the UP position.
3. Raise the arresting hook.

Note

The arresting hook can be raised:

- Manually or with use of appropriate levers by lifting the hook until it engages the uplock.

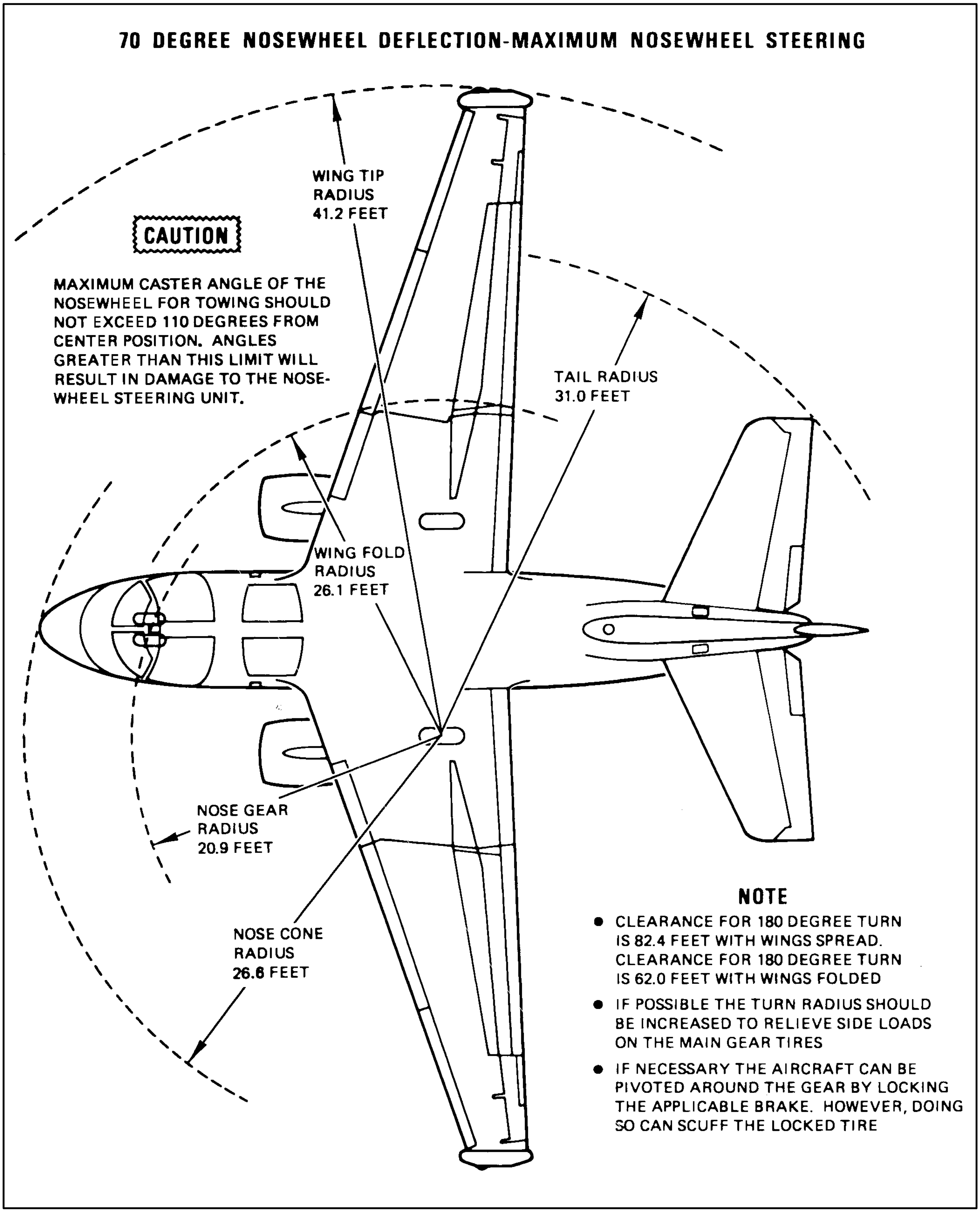


Figure 3-8. Aircraft Turning Radius

- By holding the manual override retract button in and pumping the hook up with the emergency hydraulic handpump.

3.1.19.2 Arresting Hook Failure to Retract. If the arresting hook fails to retract and No. 1 hydraulic pressure is normal, proceed as follows:

1. Place the hook handle in the UP position.
2. Push the manual override retract button.

WARNING

As soon as the manual override retract button is pushed, the hook will begin to retract.

Note

Hold the manual override retract button in until the arresting hook is up and locked.

3.1.20 Ground Secure Equipment

3.1.20.1 Covers, Safety Pins, and Wheel Chocks (See Figure 3-9.)

1. Pitot/static probe (right and left) covers
2. Temperature sensor (right and left) covers
3. Angle-of-attack vane (right) cover
4. Main landing gear (right and left) safety pins
5. Nose landing gear safety pin

Note

Insert nosegear pin from right side only.

6. Arresting gear safety pin
7. Bomb bay door safety pins
8. Engine shields (two right and two left — intake and exhaust)
9. Engine fan outlet plug (one left and one right)
10. ECS duct inlet plug (vertical fin)
11. Ejection seat safety levers (four)
12. Pilot canopy jettison handle safety pin
13. SENSO canopy jettison handle safety pin
14. TACCO canopy jettison handle safety pin
15. Wheel chocks
16. Sonobuoy safety door
17. Jury struts.

CAUTION

- Wing jury struts shall be used when the relative wind exceeds 60 knots.
- A tailfin jury strut is required whenever the tailfin is folded.

3.1.21 Transient Line Personnel Briefing. Transient line personnel not familiar with the S-3B aircraft should be briefed on the following prior to engine starting:

1. How and when to close main access door
2. Normal start indications
3. Abnormal start indications
4. Use of fire-extinguishing agents on APU and engine fires
5. Necessary hand signals
6. Any delays to be expected in taxi.

3.1.22 Danger Areas. Certain ground operations can result in damage to equipment and injury to personnel if adequate safety precautions are not observed. See Figure 3-10 for additional hazardous areas.

3.1.22.1 Engine Air Inlet and Fan. Keep this area free of all objects when air and electrical power are connected to the aircraft.

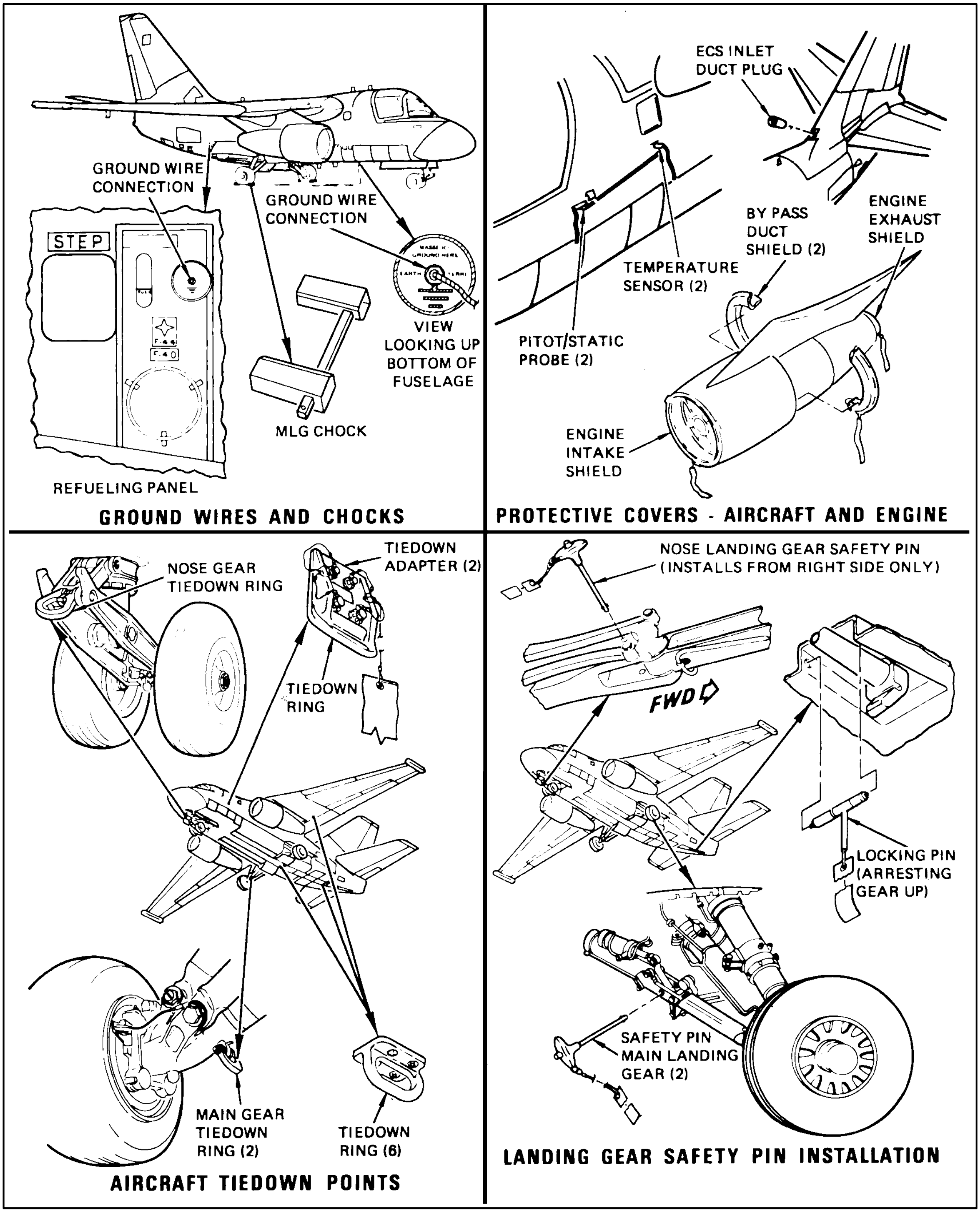


Figure 3-9. Ground Secure Equipment

3.1.22.2 HF Radio Antenna Area (Tailfin)

WARNING

Burns or electrical shock can occur if personnel physically contact the HF radio antenna area on the tailfin when the HF radio is operating. The 1,000-watt transmitter keys automatically during a system readiness test procedure.

3.1.22.3 Engine Blast Area. Structural damage to other aircraft and support equipment and personnel injuries can be incurred by blast-propelled objects and high exhaust temperatures.

3.1.22.4 Engine Compressor and Turbine Area. Engine failure could result in blades being thrown from the engine radially at high velocity. Keep personnel clear during engine runup.

3.1.22.5 Radar Radiation Area. Radar, when radiating at full power, is hazardous to personnel closer than 250 feet and fuel equipment/tanks closer than 250 feet. When radiating in dummy load, there is no radiation hazard. Radiating at full power with the BK 18-101 radar inhibitor plug installed is hazardous to personnel, fuel equipment, and fuel tanks closer than 50 feet (see Figure 3-10, Sheet 1).

3.1.22.6 Engine, Avionic Fan, and APU Noise Areas. High sound intensities (noise) often result in permanent damage to the ear. Noise is broadcast from the aircraft in patterns that vary in direction, distance, and intensity with changes in engine and APU speed and wind conditions. Damage to hearing occurs when the ear is exposed to high sound intensities for excessive periods of time. The higher the sound intensities, the shorter the period of exposure that will produce damage. Above approximately 140-decibel intensity, any exposure without ear protection can cause damage (see Figure 3-10, Sheet 3).

3.1.22.7 Search Store Launcher Chutes. Search stores are loaded with explosive cartridges. Opening the sonobuoy safety switch access door opens all cartridge primer leads, grounds the cartridge cases, and indicates launch circuit disablement by a light on the pilot armament panel.

WARNING

Sonobuoy safety switch access door shall be open when personnel are underneath the search store launching chutes. The lever arm position must be visually inspected to ensure proper positioning.

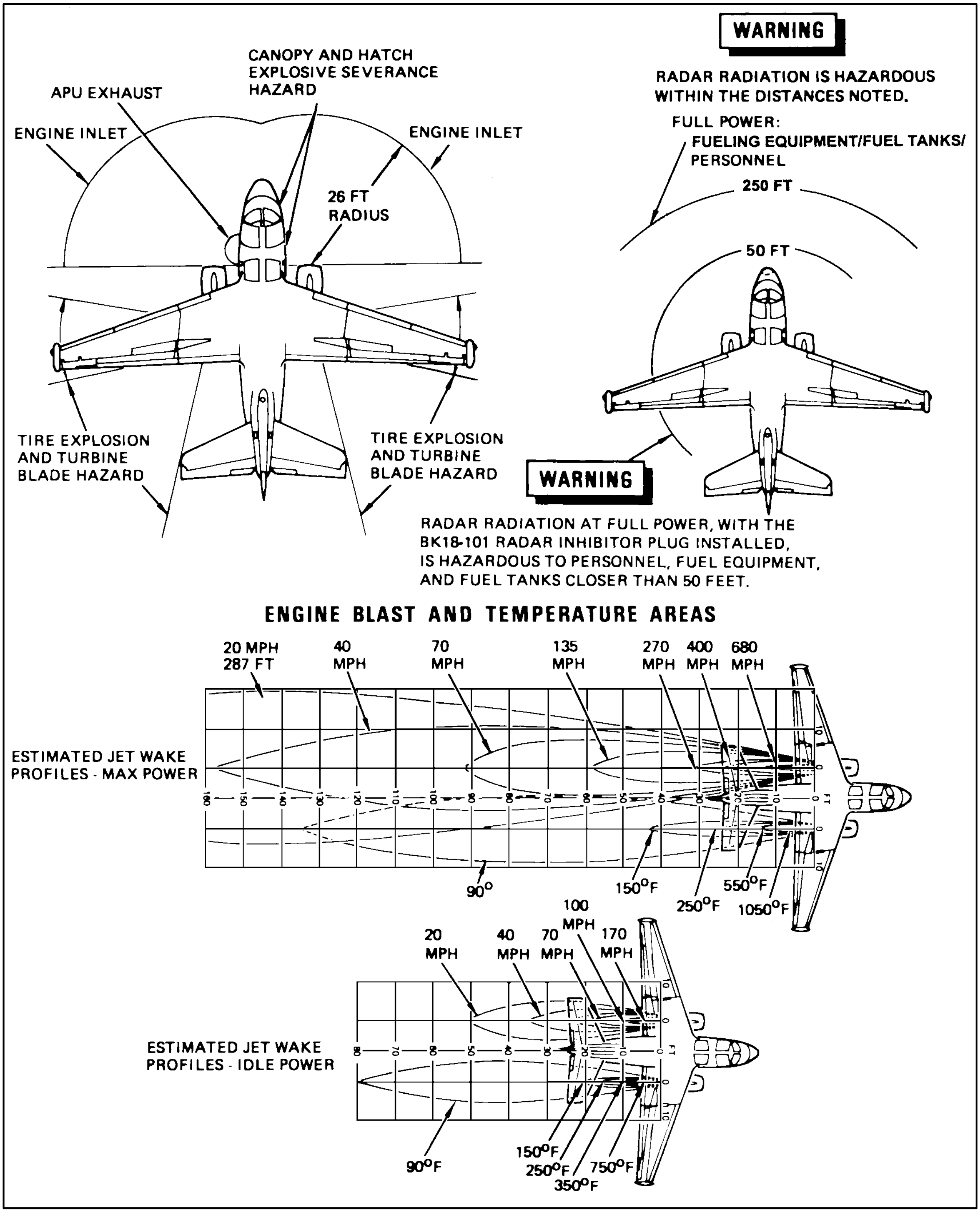
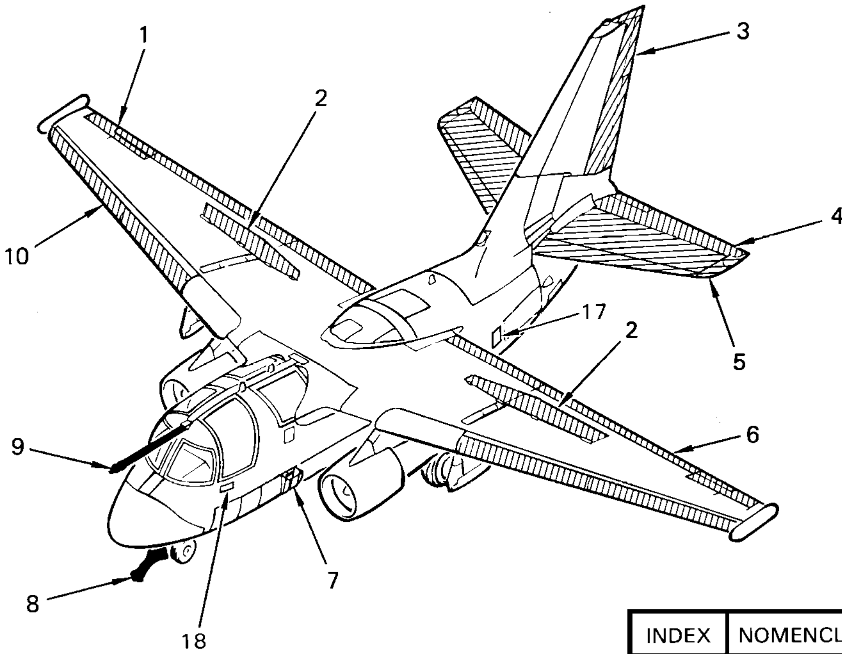
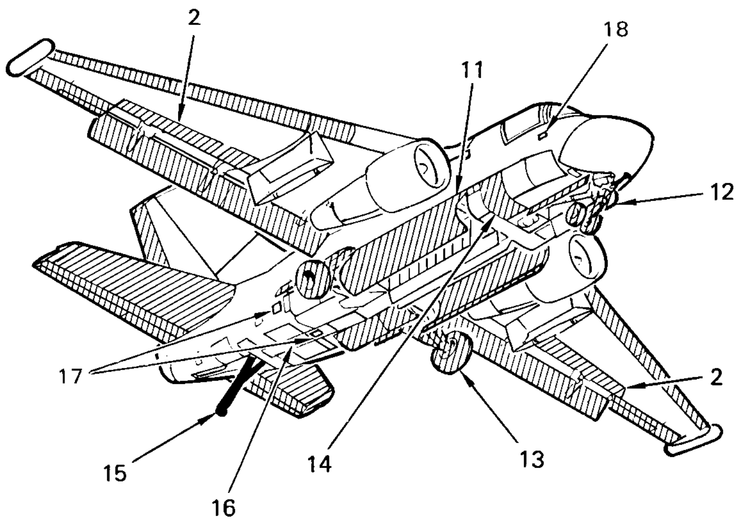


Figure 3-10. Danger Areas (Sheet 1 of 3)

HAZARDOUS SERVICING AREAS





INDEX	NOMENCLATURE
1	AILERON
2	SPOILER, UPPER AND LOWER
3	RUDDER
4	ELEVATOR
5	STABILIZER
6	WING TRAILING EDGE FLAPS
7	APU DOOR
8	LAUNCH BAR
9	REFUELING PROBE
10	LEADING EDGE FLAPS
11	BOMB BAY DOORS
12	NOSE LANDING GEAR AND DOORS
13	MAIN LANDING GEAR AND DOORS
14	PERSONNEL ACCESS DOOR
15	ARRESTING HOOK
16	SONOBUOY CHUTES
17	ECM DISPENSER MODULES
18	CANOPY/HATCH SEVERANCE

CAUTION

PERSONNEL SHOULD NOT WORK OR PLACE EQUIPMENT IN CLOSE VICINITY TO MOVABLE SURFACES

WARNING

MOVEMENT, EXTENSION, OR OPENING OF MOVABLE SURFACES MAY CREATE HAZARDS TO PERSONNEL

Figure 3-10. Danger Areas (Sheet 2)

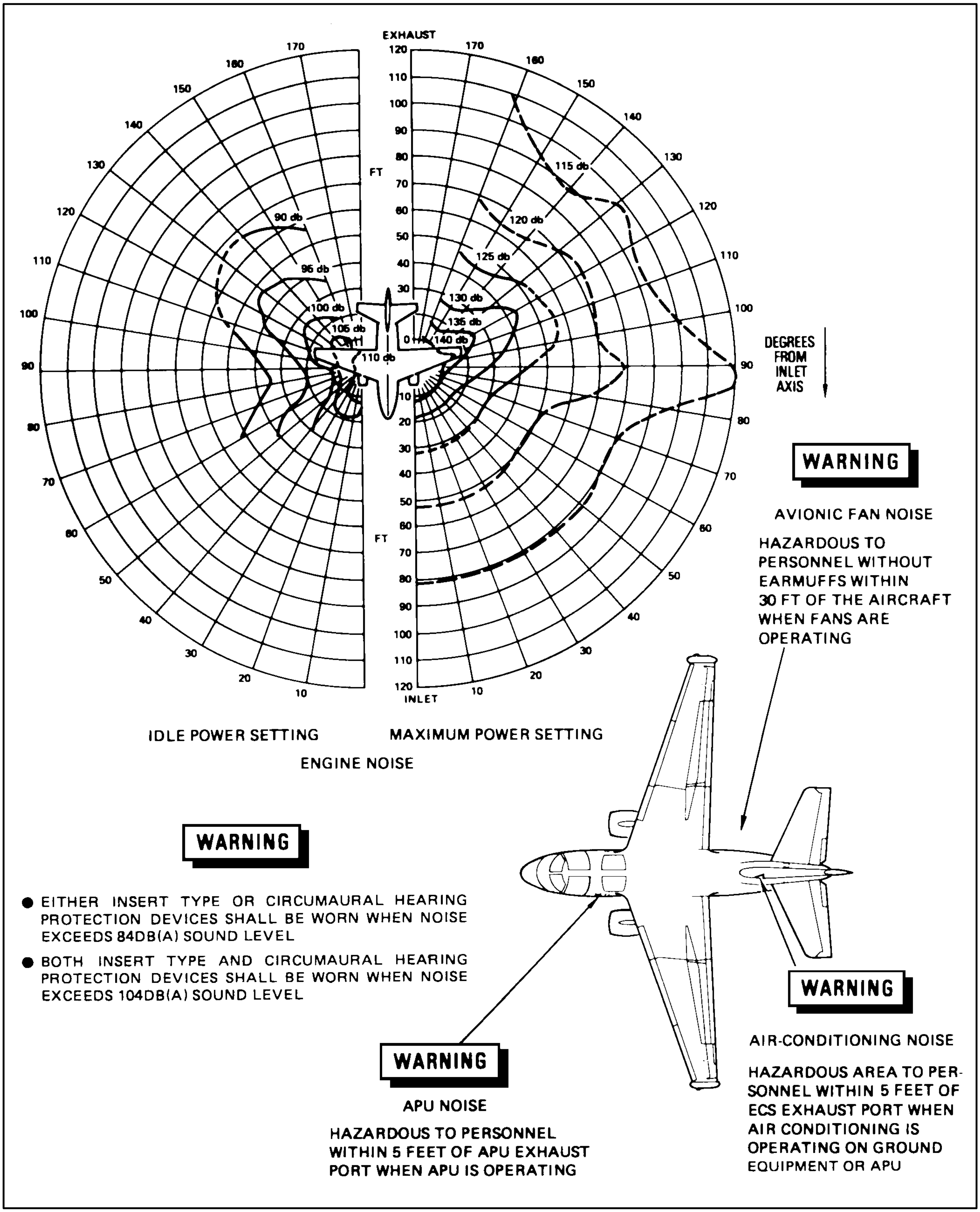


Figure 3-10. Danger Areas (Sheet 3)

CHAPTER 4

Aircraft Operating Limitations

4.1 INTRODUCTION

All limitations imposed on the aircraft shall be observed during normal operations. Cognizance must be taken of Figure 4-1, since it illustrates operating limitations not necessarily repeated in the text.

4.2 AIRCRAFT LIMITATIONS

4.2.1 Ejection Seat. Flight is permitted only with the pilot and copilot/COTAC seats occupied. Flight is prohibited with an unoccupied seat of an adjacent pair (pilot-copilot/COTAC or SENSO-TACCO).

4.2.2 Maximum Airspeed Limits. Maximum air-speed limits for various external configurations are shown in Figure 4-2.

4.2.2.1 Tire Limitations. The maximum recommended speed on touchdown is 174 knots at 245 psig.

4.2.3 Turbulent Air Penetration. The recommended procedure on encountering severe turbulence such as associated with frontal or cumulus activity is to adjust airspeed to between 250 and 260 KIAS (not to exceed 0.7 Mach). Flaps should be retracted and yaw damper engaged. These airspeeds will provide adequate stall margin without encountering excessive loads.

4.2.4 Crosswind Landing Limits. The maximum recommended 90° crosswind components for landing are as follows:

1. Primary or alternate flight control system — 25 knots.
2. Emergency flight control system — 5 knots.

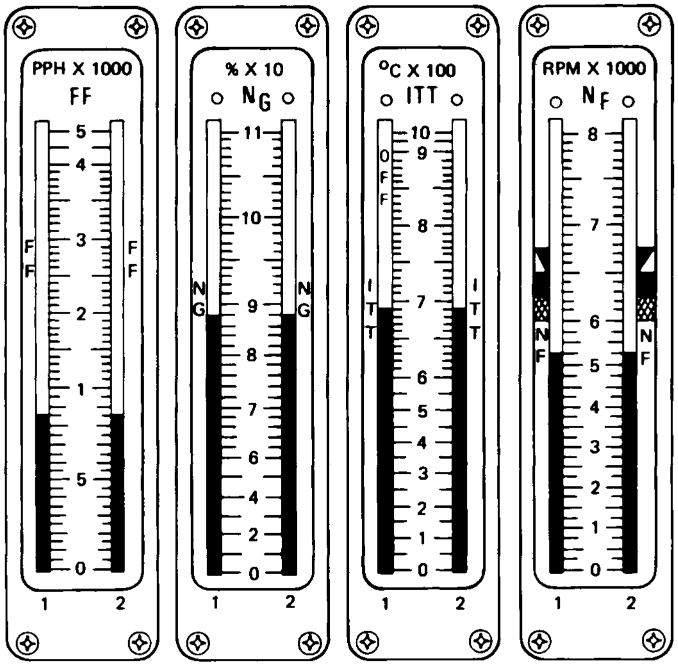
4.2.5 Maneuvering Limits. Symmetrical acceleration and rolling limits are shown in Figure 4-3. Rapid rolls from high-g entries are to be avoided because of load factor increase accompanying spoiler deployment. Figure 4-4 shows the operating flight envelope (airspeed versus load factor) up to 8,000 feet at a gross weight of 36,600 pounds or less. Above 8,000 feet, the airspeed limit is 0.79 Mach number. For gross weights above 36,600 pounds, limit load factor is reduced as shown in the lower portion (weight versus load factor) of Figure 4-4 and corresponds to a N_ZW product of 128,000 pounds. To determine positive g-limits in flight, the N_ZW product should be divided by the gross weight (for example: with an aircraft gross weight of 43,000 pounds, the approximate positive limit is 3.0g).

When flying in conditions of moderate turbulence, do not deliberately exceed 2.0g in maneuvers. This precaution minimizes the possibility of overstressing the aircraft as a result of the combined effects of gusts and maneuver loads.

CAUTION

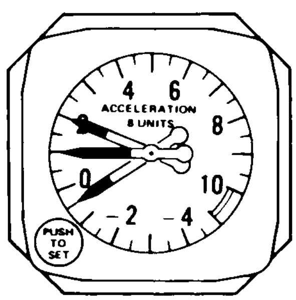
Holding steep attitudes in pitch or roll causes a reduction in the feed tank fuel level caused by overflow into the transfer tank. When this occurs, attitudes should be limited as necessary to prevent the feed tank fuel level from going below 600 pounds; avoid high-g and zero-g maneuvers. If fuel low pressure light(s) illuminate at low level, abort the maneuver and assume a normal noseup attitude. This will provide gravity fuel flow to the feed pump surge box.

4.2.6 Catapult/Takeoff Limits. Stabilizer trim setting during takeoff is critical and varies with aircraft center-of-gravity position, outside air temperature, and weight. Takeoff trim settings should be determined by the procedures in Chapter 7.



NOTE

REFER TO FIGURE 2-2 FOR LIGHTS ILLUMINATION VALUES. OPERATING LIMITATIONS ARE LISTED IN FIGURE 4-6.



ACCELEROMETER

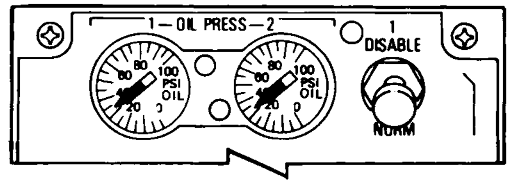
+3.5 MAXIMUM – 1.0 MINIMUM
(CLEAN AND LOITER (LOTR) CONFIGURATION)

+3.5 MAXIMUM – 1.0 MINIMUM
(WITH FLAPS IN MANEUVER (MANUV)

+2.0 MAXIMUM – 0.0 MINIMUM
(WITH TAKEOFF OR LAND (LDG) FLAPS)

NOTE

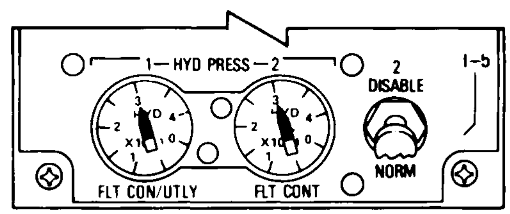
SEE FIGURE 4-4 FOR VARIATION OF LIMIT LOAD FACTOR WITH WEIGHT



OIL PRESSURE

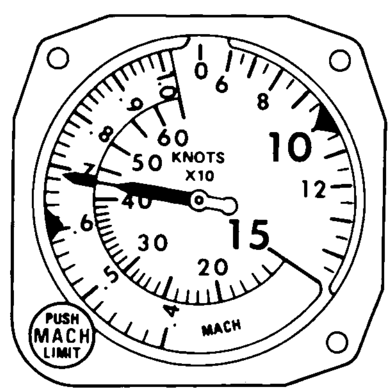
NOTE

SEE FIGURE 4-9 FOR APPLICABLE LIMITS.



HYDRAULIC PRESSURE

2850 PSI (MINIMUM)
3000 PSI (NORMAL)
3250 PSI (MAXIMUM)



AIRSPEED

450 KIAS OR 0.79 MACH MAXIMUM
(CLEAN CONFIGURATION)

NOTE

SEE FIGURE 4-2 FOR OTHER CONFIGURATION LIMITS

Figure 4-1. Instrument Markings

CONFIGURATION	MAXIMUM AIRSPEED
No external stores	450 KIAS/0.79M
Bomb bay doors	450 KIAS/0.79M
Pylon stores	450 KIAS/0.79M
Cargo pods (CNU-264/A)	See Figure 4-13
Cargo pods (CNU-188/A)	450 KIAS/0.79M
FLIR	450 KIAS/0.79M
Loiter flaps	250 KIAS/0.50M
Maneuver flaps	250 KIAS/0.50M
Takeoff flaps	186 KIAS
EFCS training	250 KIAS/0.62M
EFCS operations	300 KIAS/0.65M
Landing flaps: Extension	156 KIAS
Landing flaps: Extended or retraction	156 KIAS
Landing gear extended	186 KIAS
Emergency gear extension	140 KIAS
Speedbrakes	450 KIAS/0.79M
Speedbrakes (Extend or retract with SPOIL I & 2 switch)	250 KIAS
Aerial refueling probe extended	300 KIAS/0.62M
ARQ-49 SATCAT pod	370 KIAS
APU door — opening and closing	250 KIAS

CAUTION

A pitch channel hardover while engaged single-channel at airspeeds above 250 KIAS will result in exceeding normal acceleration limits if not immediately countered. Single-channel pitch airspeed should be limited to 250 KIAS.

Note

- Raising the landing gear causes the cg to move aft 1.5-percent MAC.
- For a takeoff cg aft of 24.5-percent MAC (gear down) or 26 percent (gear up), at airpseeds greater than 330 KIAS, caution must be exercised because of increased longitudinal sensitivity.
- Refer to Figure 4-13 for cg and airspeed limits with CNU-264/A cargo pods.

Figure 4-2. Maximum Airspeed Limits

SYMMETRICAL	
No external stores	+3.5 to –1.0g
Bomb bay door	+3.5 to –1.0g
Pylon stores	See NAVAIR 01-S3AAA-IT
Speedbrakes	+3.5 to –1.0g
Loiter flaps	+3.5 to –1.0g
Maneuver flaps	+3.5 to –1.0g
Takeoff flaps	+2.0 to 0g
Land flaps	+2.0 to 0g
Cargo pods (CNU-264/A)	+3.0 to –1.0g
Cargo pods (CNU-188/A)	+3.5 to –1.0g
ARQ-49 SATCAT pod	+3.5 to –1.0g
Air refueling stores	+3.5 to –1.0g

Note

- See Figure 4-4 for maximum load factor variation with weight.
- Rolling pullout load factor limits are 1.0g to 80 percent of the symmetrical positive limit.

ROLLING

Rolling with or without external stores:

With 1.5g entry 300 KIAS

CAUTION

When rolling 360° with a 1g entry above 320 KIAS (either with or without external stores) abrupt lateral inputs should be avoided on entry and recovery because of the probability of overstress caused by inadvertent longitudinal stick inputs.

Figure 4-3. Maneuvering Limits

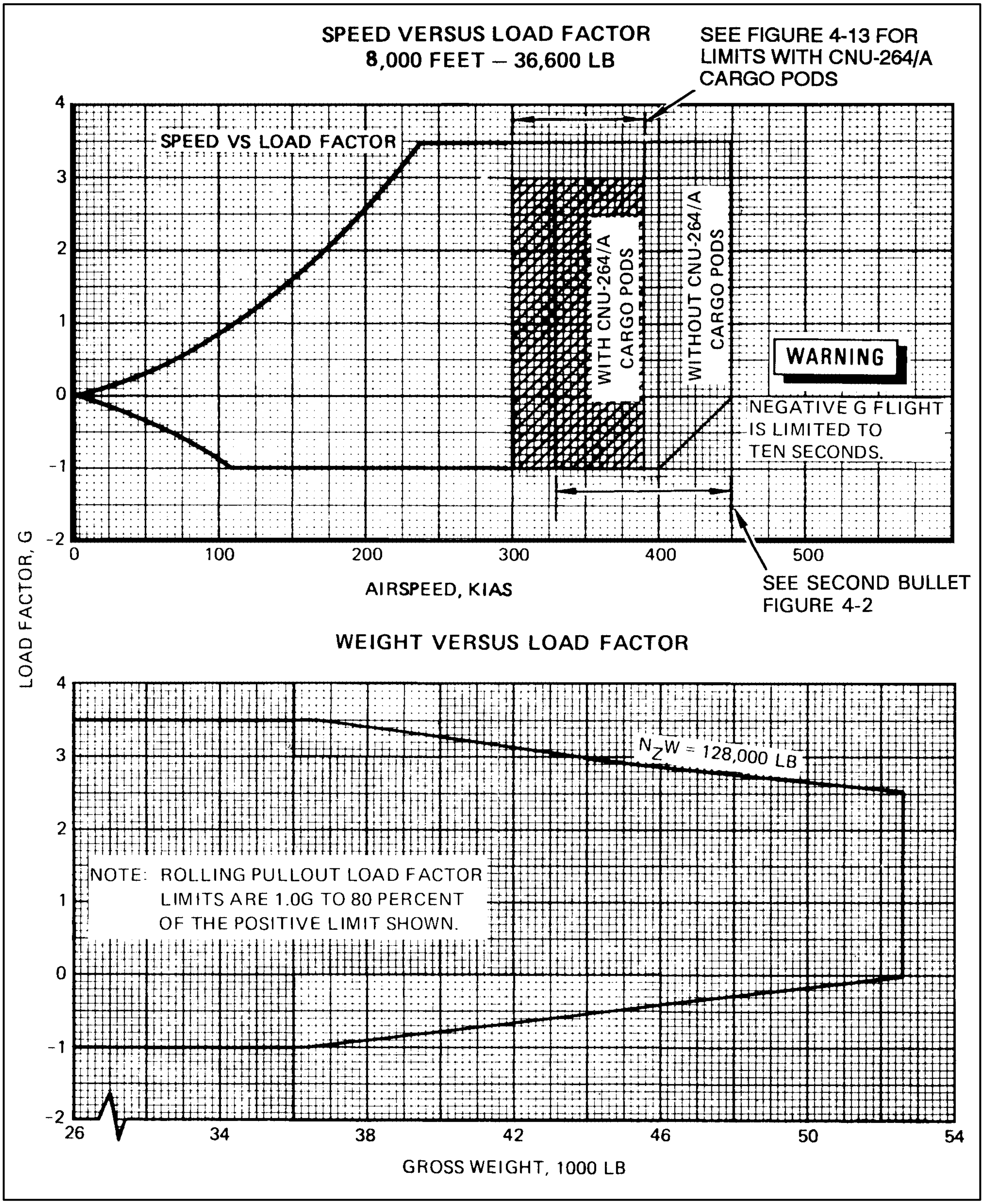


Figure 4-4. Operating Flight Envelope

Takeoff should not be attempted when calculated single-engine rate of climb, gear down, is less than zero or is too low to provide adequate clearance over known obstacles after takeoff. Catapult launches are authorized as provided in the following table:

Catapult Launch Crosswind Limitations Maximum Allowable Crosswind (Knots) Catapult (Excess Endspeed — Knots)				
Asymmetric Load	Bow (15)	Bow (10)	Waist (15)	Waist (10)
0 – 200 pounds	20	13	10	6
201 – 949 pounds	10	0	5	0
950 – 1600 pounds	5	0	2	0
1601 + pounds	2	0	2	0

Note

Launches from catapult 4 in any load configuration are not authorized with port crosswind in excess of 5 knots.

4.2.7 Speedbrake Operation Limits. Use of speedbrakes (excluding operation utilizing DLC) with takeoff (TAKEOFF) or land (LDG) flaps extended is prohibited below 10,000 feet AGL.

CAUTION

Care should be exercised in extending speedbrakes in accelerated flight or during rolling pullouts. Otherwise, limit load factor may be exceeded.

4.2.8 In-Flight Refueling Limits. Aerial refueling is authorized from all U.S. Navy, U.S. Marine Corps, and U.S. Air Force aircraft equipped with internally or externally mounted tanker systems. Maximum in-flight refueling airspeed is 275 KIAS. Aft cg limit for in-flight refueling operations is 30-percent MAC without CNU-264/A cargo pods and 24.8-percent MAC (gear down) with CNU-264/A cargo pods.

4.2.9 Center-of-Gravity Envelope. The allowable cg envelope for the aircraft is shown in Figure 4-5. The forward limit is determined by configurations with the landing gear down whereas the aft limit is determined by configurations with the gear up. The variation of aircraft cg and the effect of various loadings should be noted in the Weight and Balance Handbook (NAVAIR 01-1B-40), Form F. For a production-configured aircraft, only the bomb bay stores, sonobuoys, and crew appreciably affect cg, as shown in Figure 7-1.

The pilot should be cognizant of the cg position at all times accounting for in-flight changes caused by weapon or search store deployments. This is because flight characteristics, particularly during takeoff and landing operations, are affected by cg position as discussed in Part IV.

WARNING

Aft cg limit for takeoff with CNU-264/A cargo pods is 24.8-percent MAC, gear down.

4.2.10 Flap System Limits. The following limitations are placed on the operation of the leading and trailing edge flap system.

4.2.10.1 Flap Asymmetry. Do not operate flaps if asymmetry exceeds 25 percent.

CAUTION

Do not under any circumstances reset the asymmetrical lockout system in flight.

4.2.10.2 Operations with Leading Edge Flaps Retracted. Catapult takeoffs with leading edge flaps retracted can be conducted with current NATOPS pitch trim settings if 20 knots excess endspeed is provided and no turns are initiated until the trailing edge flaps have been retracted.

Field takeoffs can be conducted with normal takeoff speeds provided no turns are initiated until the trailing edge flaps have been retracted.

NOTE

FOR FLIGHT PLANNING, OBTAIN WEIGHT/CENTER-OF-GRAVITY FROM NAVAIR 01-1B-40 FORM F

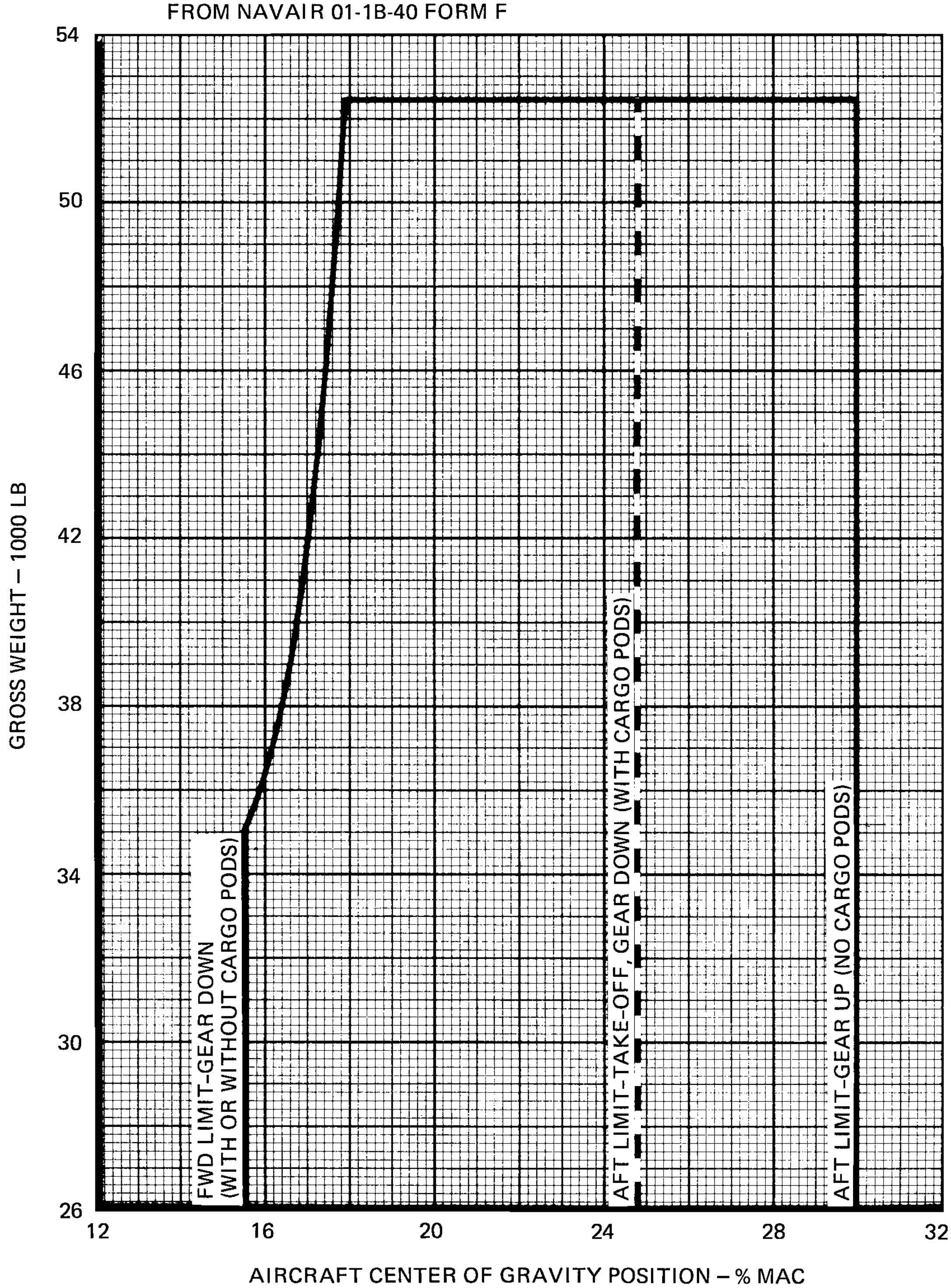


Figure 4-5. Center-of-Gravity Envelope

WARNING

Minimal or complete absence of stall warning with leading edge flaps retracted in the takeoff or land configurations will inhibit application of stall recovery procedures, resulting in a rapidly progressive stall condition and possible departure from controlled flight. Flight tests indicate altitude loss during recovery is in excess of 3,000 feet.

4.2.11 Operating Gross Weights. Maximum operating gross weights for the aircraft are as follows:

1. Takeoff weight . . . . 52,500 lb
2. Field landing weight . . . . 45,900 lb
3. Field carrier landing practice weight . . . . 40,500 lb
4. Carrier landing weights (flaps maneuver or greater):
   a. Asymmetrical loads less than 800 lb . . . . 40,500 lb
   b. Asymmetrical loads exceeding 800 lb . . . . 37,700 lb
5. Landing weights (flaps less than maneuver):
   a. Field landing (FCLP) . . . . 36,000 lb
   b. Field landing (minimum rate of descent) . . . . 38,000 lb
   c. Carrier landing . . . . 38,000 lb
6. Barricade engagements:
   a. Full flaps . . . . 37,700 lb
   b. Partial or no flaps . . . . 36,000 lb

4.2.12 Prohibited Maneuvers. The following maneuvers are prohibited:

1. Intentional spins
2. Continuous rolling beyond 360°
3. Sustained zero-g maneuvers for greater than 4 seconds
4. Sustained negative-g flight for greater than 10 seconds
5. Simulated dual-engine flameout approaches
6. Actual dual-engine flameout approaches unless it is impossible and/or impractical to abandon aircraft
7. Loops
8. Mode I approaches.
9. Practice EFCS flight.

Note

EFCS flight is permitted when required on post-maintenance functional checkflights.

4.2.13 Simulated Emergencies. Exercise caution when performing simulated emergencies. Compound simulated emergencies in the aircraft are prohibited because of safety considerations. The minimum altitude to initiate a simulated single-engine failure is 200 feet AGL.

4.3 ENGINE LIMITATIONS

4.3.1 Engine Operating Limits. (See Figure 4-6.)

POWER SETTING	ITT	TIME (MIN)
MAXIMUM	825	5
INTERMEDIATE	785	30
MAXIMUM CONTINUOUS	755 OR BELOW	NONE
MAXIMUM N_G (%RPM)		99.7
MAXIMUM FLIGHT NF (RPM)		7700
MAXIMUM STATIC NF (RPM)		7400

Figure 4-6. Engine Operating Limits

4.3.1.1 Engine Starting Limits

CAUTION

An external dc power only start is not recommended because of the inability to monitor the start sequence.

The time between ground starts is limited to 30 seconds minimum after the gas generator rotor has stopped rotating. There is no limit on time between airstarts. When using the APU, engine crossbleed air source, or external air, the air turbine starter duty cycle limits are as follows:

1. Time on — 5 MINUTES MAXIMUM.
2. Time off — 30 MINUTES MINIMUM.
3. Starting frequency — 5 CONSECUTIVE STARTS FOLLOWED BY 15-MINUTE COOLING PERIOD.

The time from advancing throttle to IDLE until engine light-off (ITT increases) is limited to 20 seconds maximum.

The TF34 airstart envelope is shown in Figure 4-7.

4.3.1.2 Interturbine Temperature Limits. The limits for ITT during transients of the TF34 engine are shown on Figure 4-8.

4.3.1.3 Engine Steady-State Operating Limits. The steady-state operating limits of the TF34 engine are defined in Figure 4-6. These limits are listed for cockpit indications.

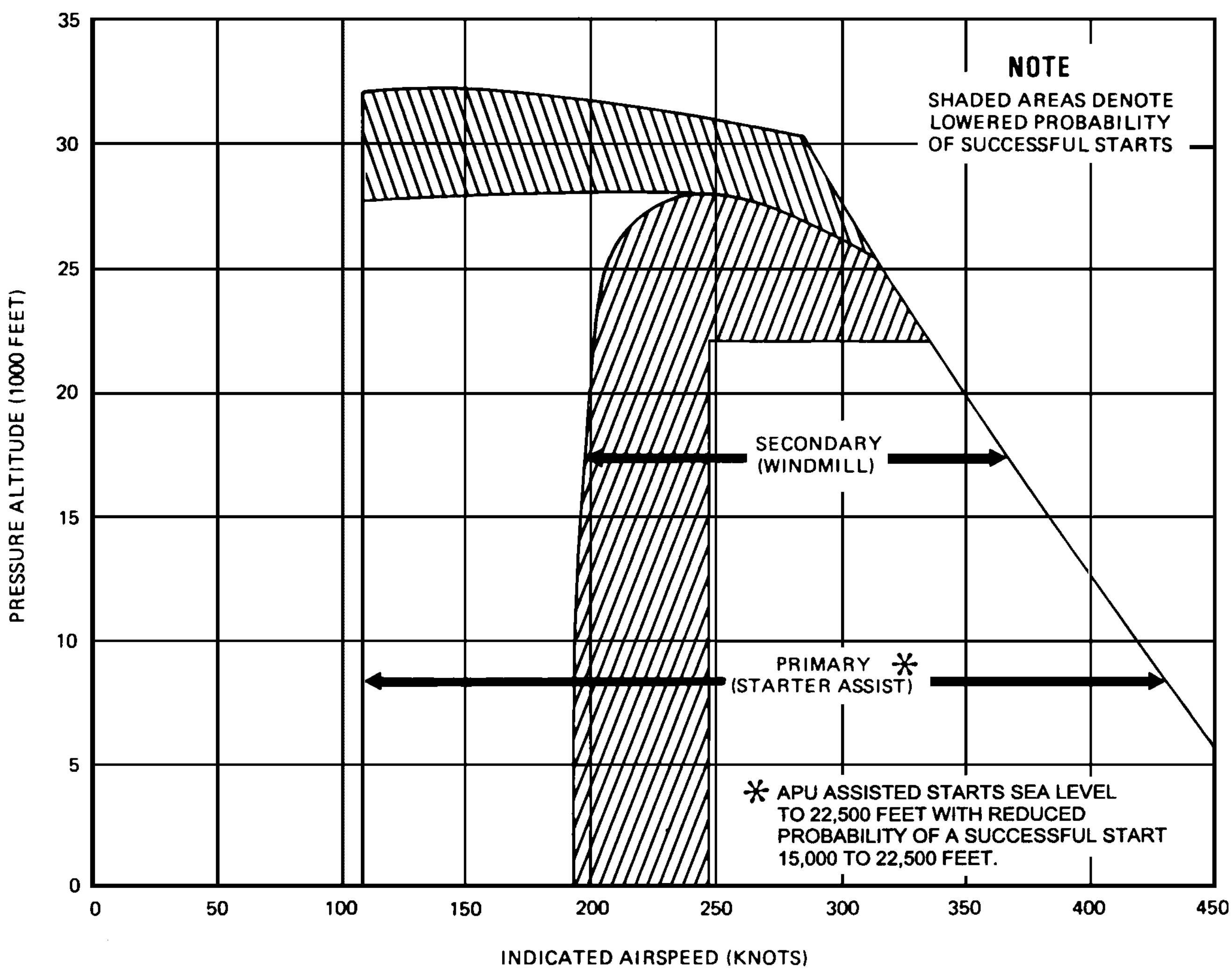


Figure 4-7. Engine Airstart Envelope

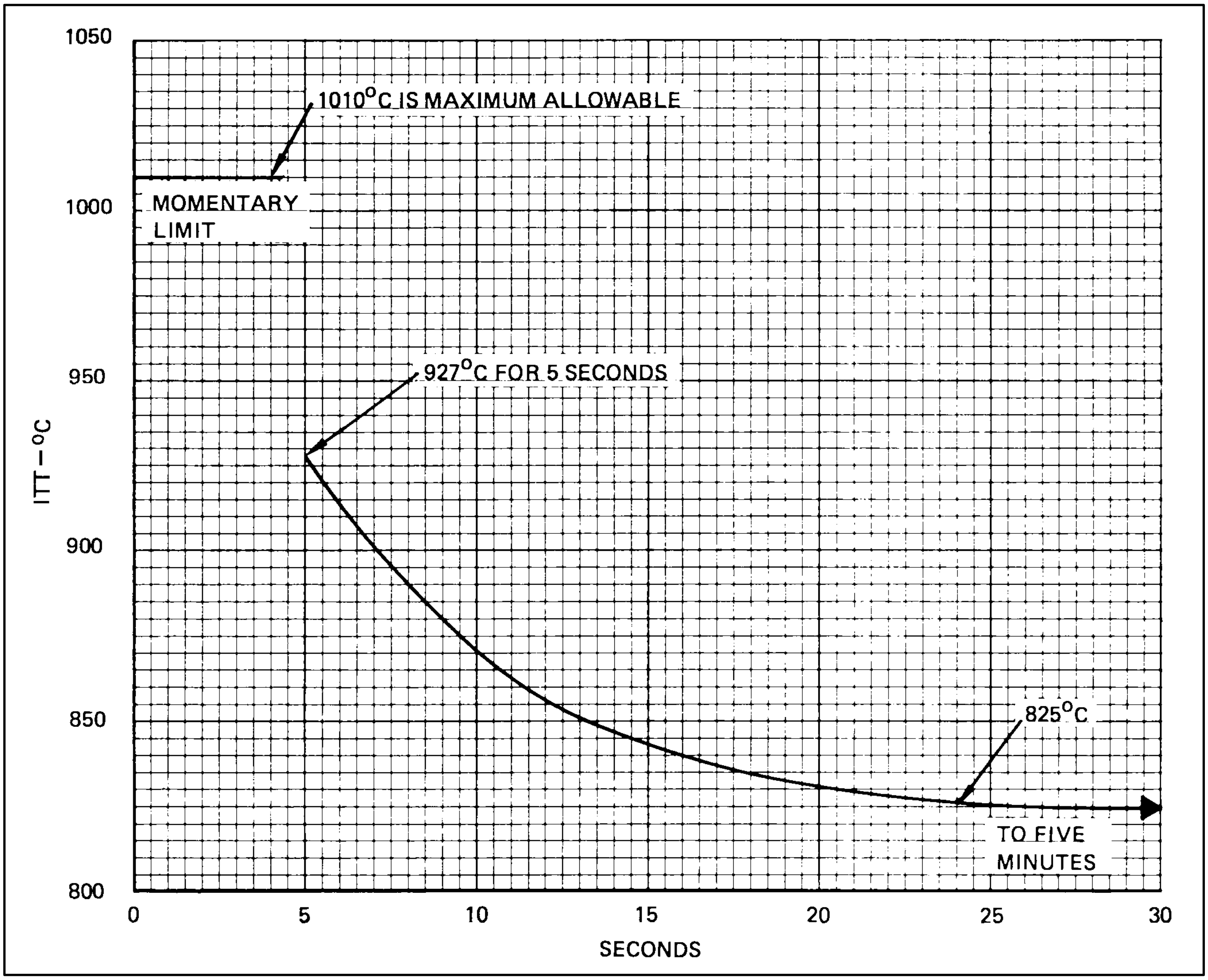


Figure 4-8. Interturbine Temperature Limits During Engine Transients

Note

To extend the life of the TF34 engine turbine components and minimize engine maintenance requirements, the following guidelines should be followed:

1. ITT should be reduced to the lowest possible level required to safely perform operational/training requirements.

2. Engine thermal cycles (low-high-low power transients) should be minimized whenever possible.

3. Engine airstarts should be made only when required by safety, training, and maintenance requirements.

4.3.1.4 Fuel Limits. Use of fuel without anti-icing additive is prohibited except as stated in paragraph 3.1.5, Fuel System Servicing. Refer to Figure 3-2.

4.3.1.5 Oil System Limits. Figure 4-9 shows the operating pressure limits at any gas generator speed using MIL-L-23699 or MIL-L-7808 oil.

4.3.1.6 Crosswind Operation. The limits for crosswind operation of the engine are shown on Figure 4-10.

4.3.1.7 APU Operating Limits. The APU can supply air for assisted main engine starts from sea level up to 22,500 with reduced probability of a successful start from 15,000 to 22,500 feet. For APU starting and operating envelope, see Figure 4-11.

CAUTION

SHOULD ANY OF THE FOLLOWING OCCUR, UNLESS SAFETY OF FLIGHT CONDITIONS DICTATE OTHERWISE, THE ENGINE SHOULD BE IMMEDIATELY SECURED:

- OIL PRESSURE IS NOT WITHIN LIMITS SHOWN, EXCEPT AS IN NOTE BELOW.
- A CHANGE OF MORE THAN 10 PSI FROM STEADY STATE OPERATING CONDITIONS, EVEN IF PRESSURE REMAINS WITHIN LIMITS.
- ACRID ENGINE FUMES MAY INDICATE SERIOUS FUEL OR LUBE SYSTEMS FAILURE.

NOTE

- OIL PRESSURE DURING INITIAL START (COLD OIL) SHOULD RETURN TO WITHIN LIMITS AFTER 15 MINUTES AT IDLE SPEED. HIGHER POWER SETTINGS THAN IDLE ARE REQUIRED FOR MORE RAPID WARMUP.
- IF OIL PRESSURE IS WITHIN LIMITS AT IDLE POWER, PRESSURES ABOVE 95 PSI FOLLOWING INITIAL ENGINE TRANSIENTS ARE ACCEPTABLE PROVIDED OIL PRESSURE RETURNS WITHIN LIMITS IN 5 MINUTES.
- MIL-L-23699/AEROSHELL 560 AND MIL-L-7808 ARE MIXABLE FOR ONE-TIME FLIGHTS ONLY. IF ANY MIL-L-7808 OIL IS USED, OIL PRESSURE LIMITS ARE 5 PSI LOWER THAN SHOWN. ENGINE SHALL BE COMPLETELY DRAINED AND REFILLED WITH MIL-L-23699/ AEROSHELL 560.

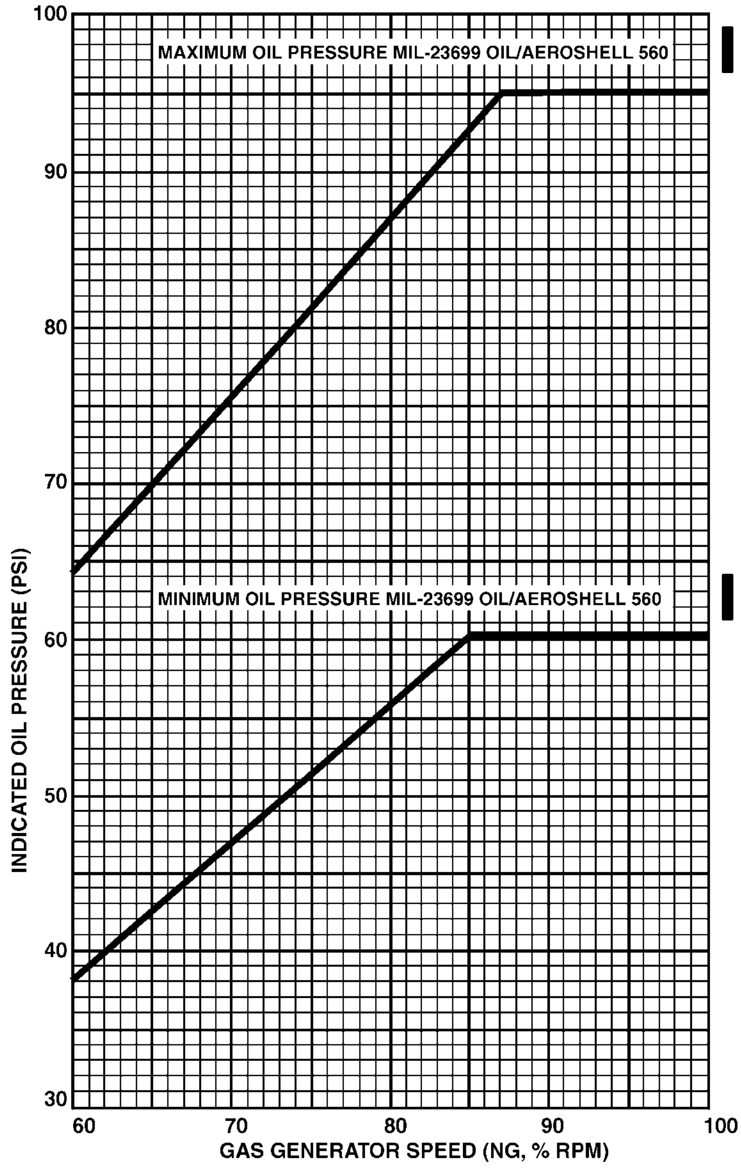
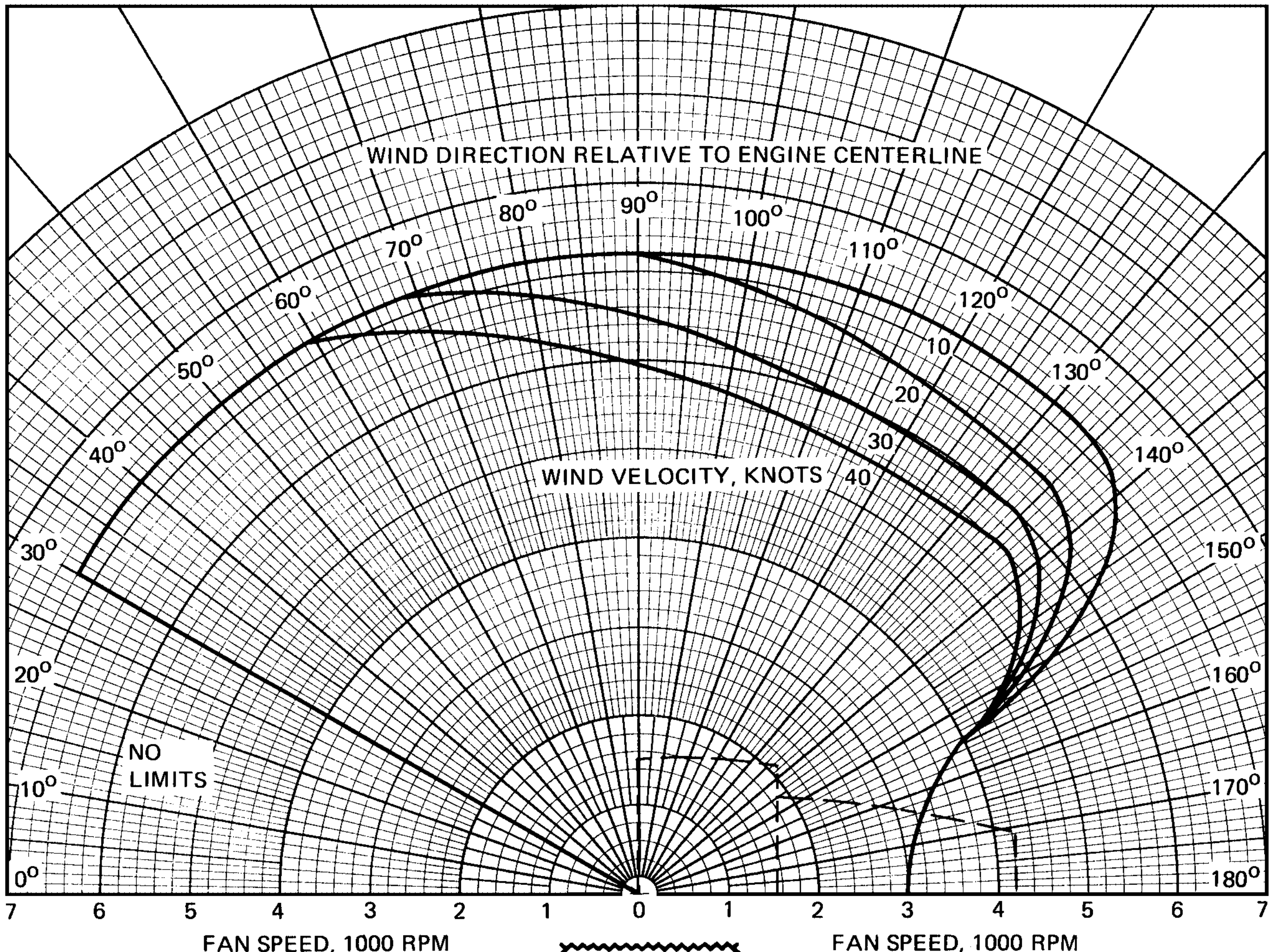


Figure 4-9. Engine Oil Pressure Limits



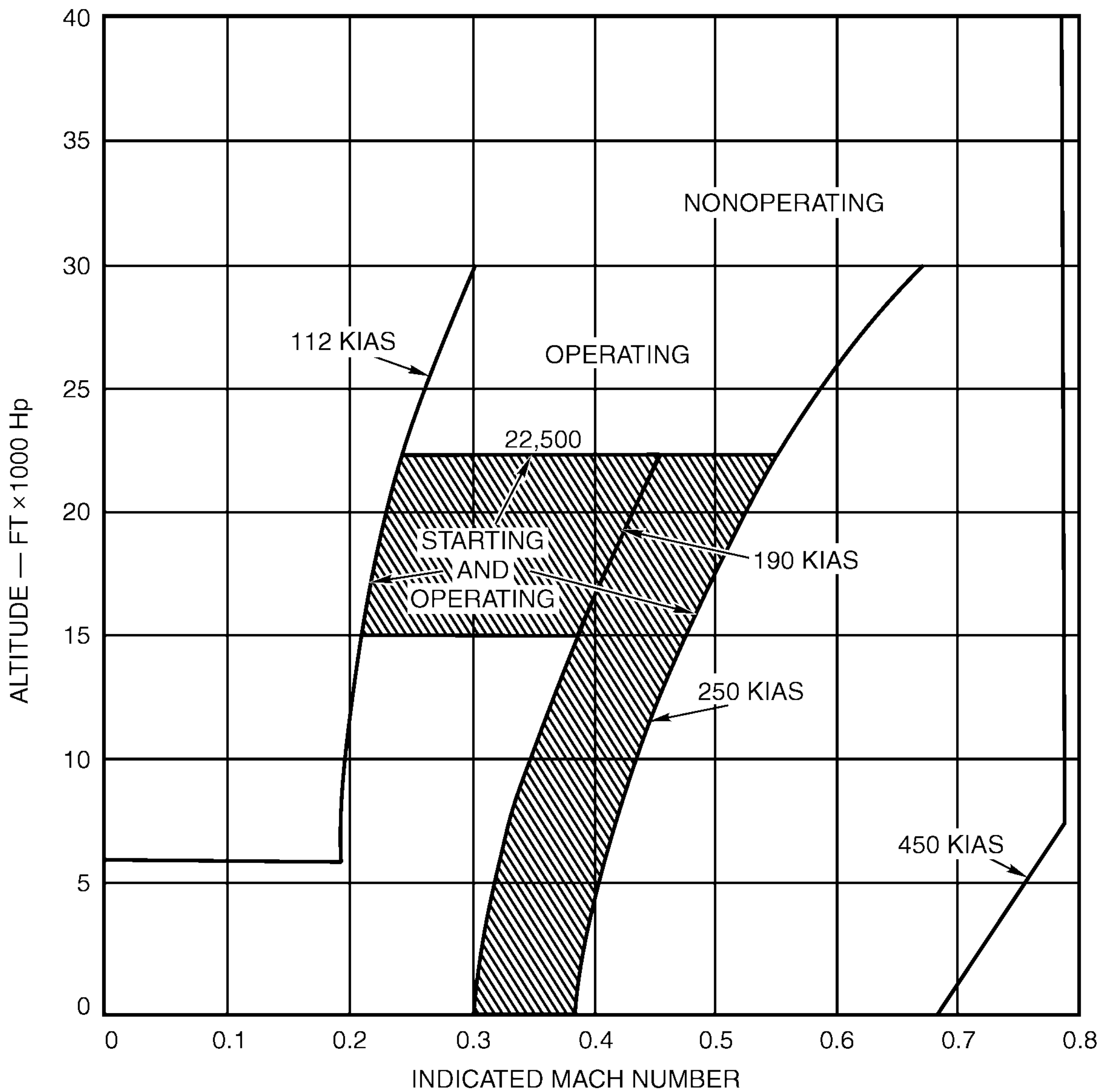
CAUTION

THE TF34 CAN START IN UP TO 40 KNOT TAILWINDS WITHOUT ANY SIGNIFICANT EFFECT ON TURBINE TEMPERATURES OR ENGINE START TIMES. IF THE ENGINE IS STARTED DURING TAILWINDS IN EXCESS OF 40 KNOTS, STALL OR OVER-TEMPERATURE MAY RESULT.

NOTE: NO FAN SPEED LIMIT IF WIND LESS THAN 10 KNOTS

EXAMPLE:
WIND VELOCITY IS 40 KTS BLOWING AT 90° ANGLE RELATIVE TO ENGINE CENTERLINE. FAN SPEED LIMIT IS 5960 RPM.

Figure 4-10. TF34 Crosswind Limits



- Reference MIL-P-85486(AS), S-3A APU Equipment Specification.
- This envelope applicable with ECU P/N 2117960-2 installed.
- Shaded area denotes reduced probability of successful starts. Use following procedure to increase start probability.

> If APU exhaust door is open — close door, wait 20 seconds.

> Open APU exhaust door.

> Start APU within 5 seconds of opening exhaust door.

> Push DISARM switch after pulling APU handle to start position.

Figure 4-11. APU Starting and Operating Envelope

4.4 AERO-1D FUEL TANK LIMITS

Design limits of the Aero-1D fuel tanks impose the following limitations:

1. Catapult launch — Do not catapult with partially full Aero-1D tanks or refueling stores. A catapult launch is permissible if the Aero-1D tanks or refueling store are full or empty (full tanks is that quantity at which automatic shutoff occurs).

2. Arrested landings — Do not routinely perform arrested landings with any fuel in the Aero-1D tanks or air refueling store. If operational necessity dictates, arrestments with up to 500 pounds of fuel remaining in the Aero-1D or refueling store are permissible.

3. Nonflared landings — Do not routinely perform nonflared landings with any fuel in the Aero-1D tanks or air refueling store. If operational necessity dictates, nonflared landings with up to 500 pounds of fuel remaining in the Aero-1D or refueling store are permissible.

4. If more than 500 pounds of fuel are trapped in the store, then a flared minimum rate-of-descent landing should be made. Nonarrested flared landings are permissible with any amount of fuel in the Aero-1D tanks or refueling store.

WARNING

Nonflared landings and/or arrested landings with more than 500 pounds of fuel in the Aero-1D tanks or air refueling stores can result in serious damage to the tank/store and should not be attempted except in an emergency.

5. Barricade engagement — Do not perform barricade engagement with any fuel in the Aero-1D tanks or air refueling store.

6. Jettison speeds — Up to 350 KIAS/0.79 Mach, whichever is less, for all tank/store fuel levels.

4.5 CNU-264/A CARGO POD

Each pod comes equipped with two cargo nets, two cargo restraint panels, and four cargo restraint stanchions. The empty weight includes this equipment. See Figure 4-12.

4.5.1 Operating Limitations. The pods may be carried either singly or in pairs. One pod and one Aero-1D external tank may also be carried. When pods are installed, aircraft aft cg is limited to 24.8-percent MAC (gear down). Forward limit remains at 15.5-percent MAC. Maneuvering limits are +3.0g to –1.0g.

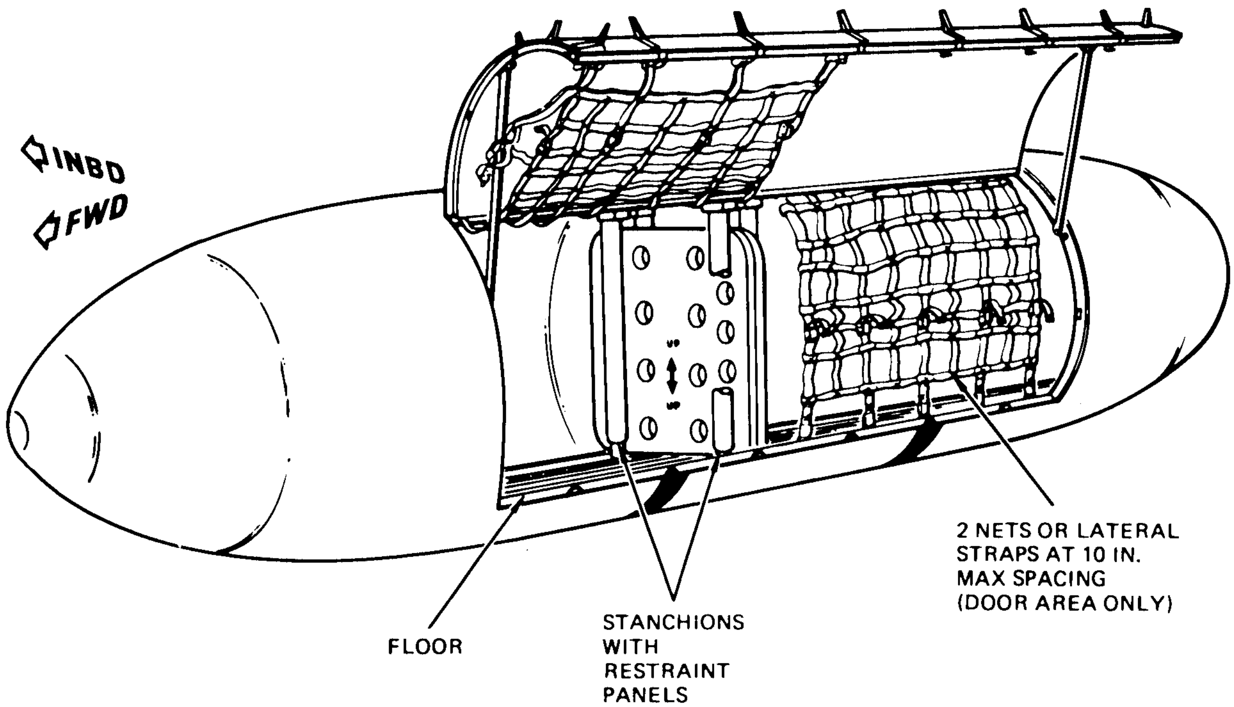
4.5.2 Cargo Loading, Securing, Unloading. The loaded cargo pod has a cg limitation of ±12 inches from the longitudinal center of the pod. In the event of a partial load, stanchions and restraint panels are required both forward and aft of the cargo to accommodate launch and arrestment acceleration. The only situation in which stanchions and restraint panels are not required is when a combination of package sizes may occasion a net stowage condition from bulkhead to bulkhead without the possibility of forward or aft cargo shift. In this instance, the restraint panels and stanchions will be installed fully fore and aft. Partial loads will be loaded from the center fore and aft. Full loads will be loaded from fore and aft towards the center.

4.5.2.1 Cargo Pod Securing Procedures. In all cargo pod loading conditions, longitudinal restraint shall be accomplished through the use of stanchions and restraint panels. Lateral restraint must be accomplished by two nets and/or straps that utilize fittings in both deck and overhead tracks. Maintain a maximum strap spacing of 10 inches in the door area.

4.5.2.2 Cargo Pod Limits. Jettison of cargo pods is not recommended unless an emergency exists. Refer to Figure 4-13 for cargo pod jettison limits.

4.6 CNU-188/A CARGO POD

The CNU-188/A external baggage container (Figure 4-14) is a modified Aero-1D fuel tank that incorporates two baggage compartments. Each compartment contains an access door, shelf, and baggage tiedown harness. The tiedown harness is composed of six seatbelts in a crossover pattern for securing baggage to the compartment shelves.



LENGTH OVERALL	– 200 INCHES
OUTSIDE DIAMETER	– 42 INCHES
INSIDE LENGTH	– 152 INCHES
INSIDE DIAMETER	– 36 INCHES
FLOOR WIDTH	– 26 INCHES
DOOR OPENING	– 30 INCHES HIGH, 87 INCHES WIDE
EMPTY WEIGHT	– 460 POUNDS
FLOOR LOADING	– 50 POUNDS PER SQUARE FOOT
MAX CARGO	
ITEM SIZE*	– 25″ x 28″ x 86″
MAX CAPACITY	– 1000 POUNDS OR 90 CUBIC FEET

*SMALLER CROSS SECTIONS AND LONGER LENGTHS CAN BE ACCOMMODATED UP TO 118 INCHES IN LENGTH.

Figure 4-12. CNU-264/A Cargo Pod

CNU-264/A

SPEEDBRAKES – NO EXTEND OR RETRACT WHEN ABOVE 2.5G

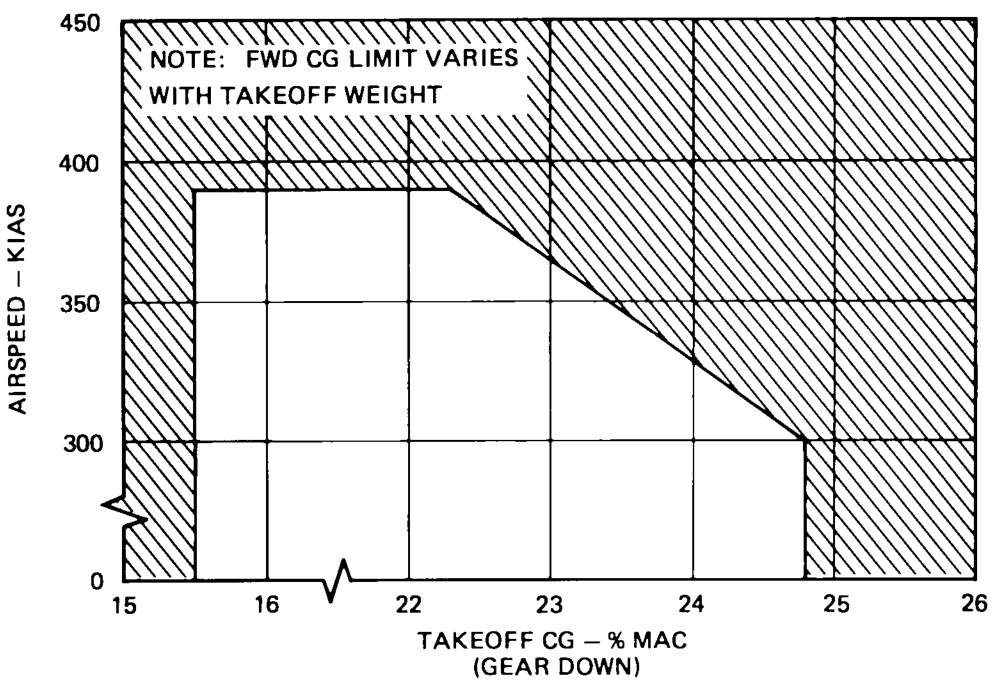
MAXIMUM MACH – 0.65

AIRSPEED AND CG – SEE FIGURE BELOW

POD JETTISON

CAUTION

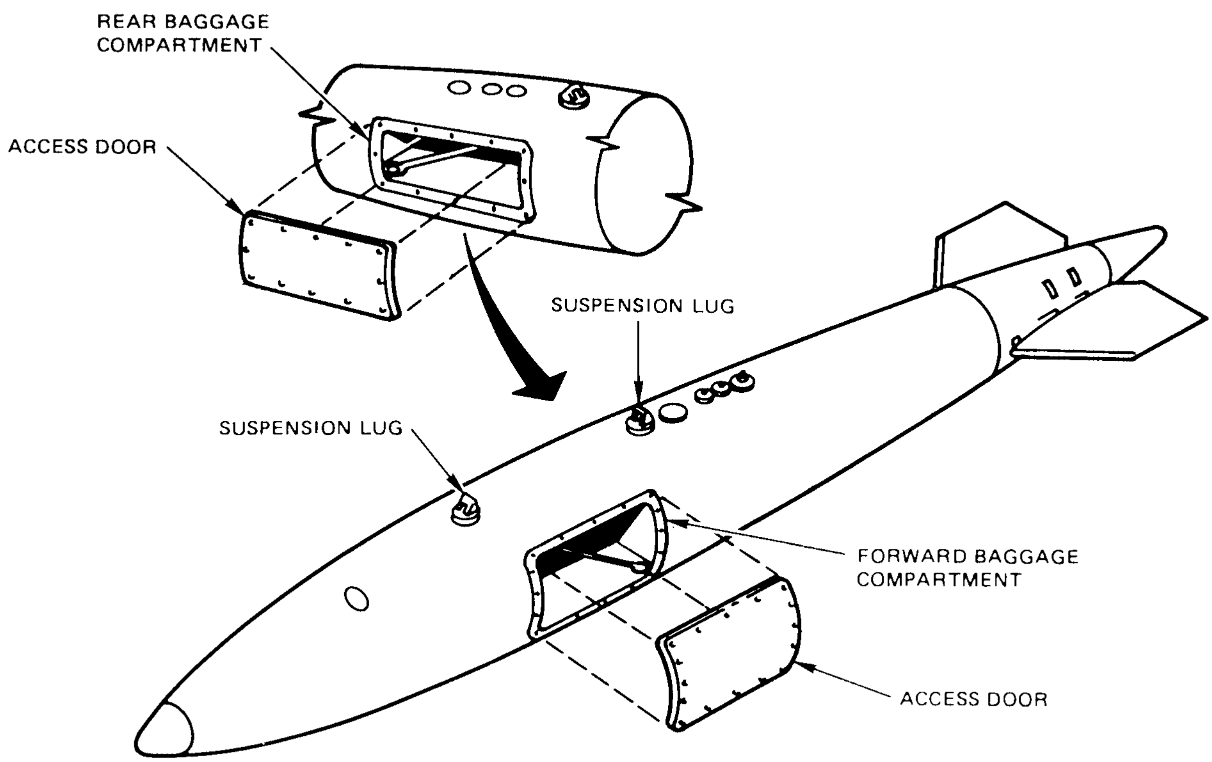
JETTISON OF CARGO PODS IS RESTRICTED TO LESS THAN 200 KIAS AND LESS THAN 16.5 UNITS AOA. REDUCE SIDESLIP (NEAR ZERO) AND ESTABLISH LEVEL FLIGHT (NEAR 1.0G) PRIOR TO JETTISON.



CAUTION

SIDEWAYS POD MOTION CAUSED BY POD BUFFET (FOR LIGHTLY LOADED/EMPTY PODS) MAY BECOME APPARENT AT THE PILOT STATION AT ABOUT 0.64 M. IF THIS PHENOMENON IS ENCOUNTERED REDUCE CRUISE SPEED TO OR BELOW 0.60 M IN ORDER TO AVOID POD BUFFET.

Figure 4-13. Flight Limitations with Cargo Pods



WEIGHT:	218 LB.
DIMENSIONS:	
LENGTH:	227 IN.
DIAMETER:	26.5 IN.
CAPACITY:	350 LB.
SUSPENSION:	30 IN.

Figure 4-14. CNU-188/A External Baggage Container

4.6.1 Operating Limitations. The CNU-188/A pod may be carried either singly or in pairs. One pod may be carried with either an Aero-1D fuel tank or a CNU-264/A cargo pod. Maneuvering limits are +3.5g to –1.0g.

4.6.2 Cargo Pod Limits. Jettison of cargo pods is not recommended unless an emergency exists. Jettison speeds up to 350 KIAS/0.79 Mach, whichever is less, are permitted in an emergency for all pod loads.

4.7 STORES LIMITS

4.7.1 External Store Limitations. Only the external stores listed in the S-3B Tactical Manual, NAVAIR 01-S3AAB-1T (NWP 55-2-S3B), may be carried and released singly or in combination to the limits shown. Operating limitations for flight, catapulting, and arrested landings with external stores are the same as the basic aircraft unless otherwise noted.

Bomb bay stores should not be released with the FLIR turret extended.

4.7.2 Air Refueling Store Tanker

Operating limitations:

ARS (hose retracted/RAT feathered) — 450 KIAS/.79M.

ARS refueling speeds (31-301 (A/A42R-1)) — 175 TO 275 KIAS.

Hose extension/RAT unfeather speeds (31-301 (A/A42R-1)) — 175 TO 325 KIAS.

Hose retraction speeds (31-301 (A/A42R-1)) — 175 TO 300 KIAS.

Refueling altitudes:

All stores and receivers — 500 ft AGL to 25,000 ft MSL

Maximum refueling tanker attitudes:

Pitch — ±5°
Roll — 30°
Yaw — Balanced flight

Qualified receiver aircraft, day and night:

ES-3A, S-3, A-7/TA-7, A-6, EA-6, F-14, F/A-18, AV-8, JAGUAR

Authorized to provide up to a maximum fuel load (top offs authorized) to the following aircrafts — Tornado ECR/F-3/GR-1/IDS/PA-200, Mirage 2000, Jaguar A/E/B/S, Mirage F-1, Skyhawk A-4, Harrier (include Sea Harrier).

Authorized to provide up to 700 pounds less than maximum fuel load (top offs prohibited) to the following — F-8, Super Entendard, Entendard, Hawk.

Receiver air refueling maximum airspeeds:

ES-3A, S-3, A-7/TA-7, A-6, EA-6, F-14, F/A-18, AV-8, JAGUAR — 275 KIAS.

Optimum emergency dirty tanking:

Tanker configuration — Clean (gear and flaps up)

Note

For high gross weight conditions, maneuver flaps may be used to reduce AOA of the tanker without degrading hose/drogue stability.

Tanker minimum airspeed (all receivers) (A/A42R-1) — 175 KIAS

Tanker minimum airspeed (all receivers) (A/A42R-1) with D704 RAT — 200 KIAS

ARS store jettison — 350 KIAS maximum, 1g level flight.

ARS hose jettison — 250 KIAS maximum, 1g level flight.

Catapult launch with ARS — Full or empty ARS; do not catapult with a partially full ARS.

Arrested landing with ARS — Less than 500 pounds of fuel.

PART II

Indoctrination

CHAPTER 5

Indoctrination

5.1 GROUND TRAINING SYLLABUS

5.1.1 Minimum Ground Training. The NATOPS ground training syllabus establishes minimum requirements that must be satisfactorily completed prior to operating S-3B aircraft. The ground training syllabus for each activity will vary according to local conditions, field facilities, requirements of higher authority, and the immediate unit commander estimate of squadron readiness.

5.1.1.1 Minimum Ground Training Requirements. The minimum ground training requirements for the S-3B pilot, copilot/COTAC, and TACCO shall be successfully completed prior to flight as follows:

1. Fleet Aviation Specialized Operation Training S-3B Flightcrew Familiarization Course (or equivalent)
2. Preflight check of the aircraft
3. Cockpit check and familiarization
4. Emergency egress, safety and survival equipment checkout
5. S-3B Flight/Weapons System Simulator Training Syllabus (if available)
6. Locally prepared written examination covering appropriate emergency procedures
7. Flight physiology training required by OPNAVINST 3710.7.

The minimum ground training requirements an S-3B flight observer/selected passenger shall successfully complete prior to flight are as follows:

1. Emergency egress, safety and survival equipment checkout
2. Lookout responsibilities and procedures
3. Emergencies evaluation and use of emergency procedures checklist
4. Hand signals (ground and flight)
5. Flight physiology training required by OPNAVINST 3710.7.

5.2 FLIGHT TRAINING SYLLABUS

The NATOPS Flight Training Syllabus is designed to effect the orderly and expeditious qualification of pilots, copilots/COTACs, and TACCOs to fly the S-3B aircraft and to operate the weapon systems from aircraft carriers and/or field installations.

5.3 CEILING VISIBILITY REQUIREMENTS

The following ceiling and/or visibility minimums apply for the pilot in command.

FIRST PILOT TIME IN MODEL (Hours)	CEILING (Feet)/ VISIBILITY (Miles)
10 to 20	800/2, 900/1-1/2, 1000/1
20 to 45	500/3, 600/2, 700/1
45 and greater	OPNAV minimums

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

1. Have a minimum of 10 hours in model
2. Complete two simulated instrument sorties
3. Complete two actual or simulated tacan penetrations to field minimums.

5.4 INITIAL QUALIFICATION AND CURRENCY REQUIREMENTS

Successful completion of a formal course of instruction conducted by a fleet readiness squadron or completion of the minimum ground and flight training requirement is required for initial qualification in the S-3B aircraft. Requirements to maintain currency shall be established by the unit commanding officer, but shall require 10 hours of first-pilot/6 hours of COTAC time and two takeoffs and landings every 90 days as a minimum. (Additionally, all crewmen will complete an annual NATOPS evaluation and receive at least a grade of Conditionally Qualified.) Requalification of those crewmembers whose currency has lapsed shall include appropriate ground training followed by a familiarization flight.

5.5 REQUIREMENTS FOR VARIOUS FLIGHT PHASES

5.5.1 Solo Flight. Solo flight is prohibited.

5.5.2 Night Flight. For night flight, a minimum of not less than 10 hours in S-3B aircraft is required.

5.5.3 Cross-Country Flight. For cross-country flight, a pilot must meet the following criteria:

1. Have a valid instrument rating.
2. Have completed at least one night familiarization flight in S-3B aircraft.
3. Have completed a locally prescribed S-3B aircraft servicing checkout.
4. Must be currently qualified in S-3B aircraft.

5.5.4 Ferry Flight. Ferry requirements are contained in the current OPNAVINST 3710.7. Training requirements, checkout procedures, evaluation procedures, and weather minimums for members of ferry squadrons shall be governed by the provisions contained in the current OPNAVINST 3710.7.

5.5.5 Functional Checkflights. Functional checkflight requirements are contained in OPNAV 4790.2. They shall be conducted with the minimum crew of two, flown by a NATOPS and instrument qualified pilot and copilot/COTAC.

5.5.6 Instrument Evaluation Flights. Instrument evaluations shall be conducted by a naval aviator or naval flight officer (designated in writing by the commanding officer as an instrument evaluator) in an aircraft or approved simulator.

5.6 REQUIREMENTS FOR NIGHT/ INSTRUMENT FLIGHT

Aircraft instrumentation requirements for instrument flight are specified in OPNAVINST 3710.7 instructions. Both an AHRS and operating inertial platform are required for overwater night and for instrument flight. A radar altimeter is required for all night and instrument flights originating or terminating aboard ship and for all overwater night and instrument flights in which the mission (except for landing and takeoff) requires descent below 1,000 feet.

5.7 OXYGEN REQUIREMENTS

Oxygen is required (mask to be worn) whenever cabin altitude exceeds 10,000 feet. Oxygen requirement for tactical jets set forth in OPNAVINST 3710.7 cannot always be met by a full S-3 crew on extended missions because of the limited amount of oxygen on board. Therefore, S-3 aircrew shall comply with the requirements in paragraph 8.2.4 and Figure 8-3 of OPNAVINST 3710.7 for multipiloted pressurized aircraft. Oxygen is not required for field takeoffs or landings. Oxygen should be worn for all CV approaches, landings, and on-deck taxiing and launches. The oxygen mask offers desirable protection in the event of an ejection or canopy damage caused by a birdstrike.

5.8 SMOKING

Smoking in the aircraft is prohibited.

5.9 CARRIER LANDING QUALIFICATIONS

Carrier landing qualifications will be in accordance with the LSO NATOPS Manual (NAVAIR 00-80T-104).

5.10 MINIMUM CREW REQUIREMENTS

The S-3B aircraft can be safely flown by one pilot with a qualified selected passenger in the right seat.

5.11 DESIGNATION AND FUNCTION OF FLIGHT CREWMEMBERS

5.11.1 Command Function. An S-3B aircraft or formation of S-3B aircraft shall be flown under the command of a pilot in command, formation leader, or mission commander (as appropriate), so designated by the reporting custodian or authorized representative. When a flight schedule is published, the pilot in command, formation leader, or mission commander (as appropriate) shall be specifically designated thereon for each aircraft and flight respectively. Specific responsibility and authority is delineated in the current OPNAVINST 3710.7, modified as follows:

5.11.1.1 Pilot in Command. The pilot in command is a naval aviator who is responsible for the safe and orderly conduct of the flight. Successful completion of contractor training or familiarization requirements satisfies the necessary training requirements to be eligible for pilot in command.

5.11.1.2 Formation Leader. A formation leader is a naval aviator who directs a flight of two or more S-3B aircraft and is responsible for the safe and orderly conduct of the flight.

5.11.1.3 Mission Commander. A mission commander is a naval aviator or naval flight officer, designated in writing by appropriate authority, who is responsible for all phases of the assigned mission except those aspects of safety of flight that are related to the physical control of the aircraft that are beyond the qualification of the mission commander designator. Implicit in the designation of a naval aviator or naval flight officer as mission commander is the fulfillment of OPNAVINST requirements. A naval aviator shall have a minimum of 700 hours total pilot time of which 100 will be in model. A naval flight officer shall have a minimum of 350 hours of flight time of which 75 will be in model. It is not the intent of this manual to require a mission commander for every flight in an S-3B aircraft. Additionally, to be eligible for mission commander designation, the individual must have the following qualifications:

1. Be a designated naval aviator or naval flight officer who is NATOPS qualified in S-3B aircraft
2. Be instrument qualified in S-3B aircraft, as appropriate to designator
3. Demonstrate sustained excellence in crew leadership, weapon system knowledge, aircraft systems knowledge, and assigned mission proficiency
4. Demonstrate positive leadership ability and maturity of judgment to command and train assigned flight crewmembers in all phases of assigned missions.

5.11.1.4 Aircraft Commander. An aircraft commander is a naval aviator, designated in writing by appropriate authority, who meets the minimum OPNAVINST requirements. It is not the intent of this manual to require an aircraft commander for every flight in an S-3B aircraft.

5.11.2 Crew Function. To effectively execute the S-3B mission, crews shall be composed of the following personnel.

5.11.2.1 Pilot. The pilot shall be a qualified naval aviator assigned to exercise physical control of the aircraft during all missions.

5.11.2.2 Copilot/COTAC. The copilot/COTAC shall be designated naval aviator/naval flight officer who is qualified to perform the assist functions of the right front seat.

5.11.2.3 Tactical Coordinator. The TACCO shall be a qualified naval flight officer assigned to direct and coordinate the flightcrew during assigned tactical missions utilizing the integrated weapons system.

5.12 VIP/ORIENTATION FLIGHTS

VIP/orientation flight requirements are contained in OPNAVINST 3710.7.

5.13 PERSONAL FLYING EQUIPMENT

The equipment indicated below shall be worn or carried on all flights in S-3B aircraft.

1. Flame-retardant flight suit
2. Identification tags
3. Flight gloves

4. Flight safety boots
5. Protective helmet
6. Life preserver
7. Knife
8. Oxygen mask
9. Antiexposure suit (when required by OPNAVINST 3710.7)
10. Signal devices
11. Flashlight (when darkness or night flight is expected)
12. Navigation packet
13. Pocket checklist
14. Torso harness.

The latest available flight safety and survival equipment as authorized (Aviation Crew Systems, Volume 7, Aircrew Personal Protective Equipment, NAVAIR 13-1-6.7) shall be used by crewmembers for flight in S-3B aircraft.

5.14 SPECIAL AIRCRAFT EQUIPMENT

A NATOPS flight manual should be required equipment in all S-3B aircraft; however, or as a minimum, complete aircraft servicing information (Chapter 3) shall be carried.

PART III

Normal Procedures

CHAPTER 6

Briefing/Debriefing

6.1 BRIEFING

The degree of success enjoyed on all flights is a direct measure of the adequacy of the preparation, planning, and conduct of the preflight briefing. This applies to individual crewmembers as well as personnel specifically charged with formal briefing responsibilities.

6.1.1 Nonoperational Briefing. Functional checkflights will be briefed by the officer in the maintenance department most qualified to instruct flight personnel as to the proper execution of the required checks.

6.1.2 Operational Briefing. Mission complexity demands that pilots and air crewmen be given complete, comprehensive briefings on all operations. The briefing officer shall work in conjunction with the operations officer, air intelligence officer, and any other officers concerned in preparing the necessary information. He shall make optimum use of all graphic presentation devices, maps, and charts that are available.

6.1.2.1 Preoperational Briefing. Immediately prior to all operations of appreciable complexity and duration, a general information brief shall be given to familiarize personnel with the overall nature of the operation. The following topics shall be included:

1. The mission and objectives of the operation.
2. A breakdown of the operation and how it will be conducted.
3. The geographical area in which the operation will be conducted.
4. The forces involved, both friendly and enemy, and how they will be deployed.
5. The rules of engagement set down by the governing operation order that controls the conduct of the operation.
6. Search and rescue, EMCON, and other special communication procedures that will be used, including authenticators.
7. A discussion by the briefing officer of the tactics to be employed.

6.1.3 Preflight Briefing. These briefs are presented immediately before the launching of scheduled flights and therefore must be carried out in the most expeditious manner. It is imperative that all pilots and air crewmen be in flight gear and otherwise ready for the brief at the designated time. Required equipment shall be checked out by the appropriate aircrew before brief time. The brief should include, but not be limited to, the items in Figure 6-1.

6.2 DEBRIEFING

A major contributor to the preflight briefing and success of future missions is the knowledge gained from the postflight debriefing. In the debriefing, operational techniques and aircraft operation are reviewed while the circumstances and details of the flight are still vivid to the crew.

Each flight shall be followed by a thorough debriefing and shall include:

1. A general discussion of the flight with particular attention given to aircraft difficulties and the effectiveness of weapons and tactics employed
2. Operational and tactical information to be used for subsequent flights
3. Air intelligence officer interrogation, if applicable.

1. GENERAL
   a. Aircraft assignments, call sign, event number
   b. Fuel load, stores, aircraft gross weight, cg
   c. Engine start, taxi, launch, recovery times
   d. Takeoff performance
   e. External/internal preflight responsibilities.
2. MISSION
   a. Primary
   b. Secondary
   c. Operating area
   d. On-station time.
3. WEATHER (base, en route, operating area, destination, altitude)
   a. Wind
   b. Cloud coverage
   c. Severe weather/avoidance plan
   d. Visibility
   e. Sea state
   f. SST and OAT
   g. Ocean conditions
   h. Divert weather.
4. COMMUNICATIONS
   a. ICS description/utilization (hot/cold microphone, CONF one-two usage)
   b. Channels and frequencies
   c. Controlling agencies
   d. Navigational aids
   e. Radio procedures and discipline
   f. Required reports
   g. Authenticators, IFF/SIF procedures
   h. ADIZ procedures
   i. EMCON conditions/procedures
   j. Data link procedures.
5. NAVIGATION/MISSION PLANNING
   a. Type of clearance
   b. Duty runway
   c. Departure and climbout
   d. Route of flight
   e. NOTAMs
   f. Restricted or danger areas
   g. Fuel management/tanker procedures
   h. Marshal
   i. Penetration procedures
   j. GCA/CCA procedures
   k. Recovery time and order.
6. SSC
   a. Contact intelligence
   b. Search plan
   c. Contact investigation tactics
   d. Participating units
      (1) Voice calls and side numbers
      (2) Disposition
      (3) Utilization.
   e. Coordinated operations
   f. Attack criteria
   g. Rules of engagement.
7. FORMATION
   a. Taxi/marshal
   b. Takeoff
      (1) Interval
      (2) Communication
      (3) Abort procedures.
   c. Joinup/climb
      (1) Rendezvous
      (2) Power settings
      (3) Speeds.
   d. Formation procedures
      (1) Parade/cruise
      (2) Crossunders

Figure 6-1. Preflight Briefing (Sheet 1 of 4)

(3) Turns (VFR/IFR)

(4) Lead changes.

e. Night procedures

(1) Communications

(2) Lighting.

f. Approach

(1) Penetration

(2) Level-off

(3) Dirty up

(4) Wingman dropoff

(5) Waveoff/bolter

(6) Communications.

g. VFR break/landing

(1) Formation configurations

(2) Breakup order

(3) Type of break.

h. Emergencies

(1) Lost sight

(2) Lost communications

(3) Midair

(4) Landing

(5) HEFOE.

8. LOW-LEVEL NAVIGATION

a. Route description

b. Altitude restrictions

c. En route terrain/avoidance

d. En route hazards/obstacles

e. Chart currency

f. Bird strike

g. En route diverts.

9. ORDNANCE

a. Type/quantity/fuzing

b. Preflight

c. Delivery envelope

d. Switchology

e. Minimum release/pullout altitudes

f. Arming/dearming/hung ordnance/jettison procedures

g. Firebreak procedures.

10. WEAPONS

a. Target description

(1) Target time

(2) Location

(3) Run-in heading

(4) Elevation

(5) Target ring ranges.

b. Pattern description

(1) Type delivery

(2) Turn direction

(3) Break altitude/interval

(4) Abeam position

(5) Downwind/pattern altitude

(6) Turn-in procedures

(7) Run-in altitude/airspeed

(8) MIL setting/downrange travel.

c. Voice calls

d. Off target rendezvous

(1) Altitude/direction

(2) Hung ordnance inspection.

e. Lost communications

f. Pattern emergency

g. Lost sight

h. Hung ordnance approach.

11. FCLP

a. Charlie time

b. Field/pattern description

(1) Course rules

(2) Type pattern

(3) Break altitude/field elevation

(4) Paddles frequency

Figure 6-1. Preflight Briefing (Sheet 2)

(5) Runway description

(6) Delta procedures (clean/dirty).

c. Voice procedures

d. Hot seat procedures

e. Emergencies

(1) Lost communications

(2) Pattern emergency.

12. CARRIER OPERATIONS

a. Launch/overhead time

b. BRC/final bearing

c. Type recovery/pattern

d. Communication plan

(1) Tacan

(2) ACLS/ICLS

(3) UHF homer

(4) SINS

(5) Strike

(6) Marshal

(7) Final A/B

(8) Land/launch

(9) Departure.

e. On-deck procedures

(1) Flight deck safety

(2) Ejection seat safety

(3) Taxiing/director signals

(4) Use of parking brake

(5) Wing spread/fold

(6) Launch procedures

(7) Clearing landing area

(8) Hot switch.

f. Emergencies

(1) Lost brakes

(2) Lost communications

(3) NWS failure

(4) Catapult emergencies

(5) Suspend procedures.

g. Divert field

(1) Field/runway description

(2) Frequencies

(3) Operating hours

(4) Weather

(5) Alternate (if required).

13. IN-FLIGHT REFUELING

a. Tanker call sign

b. Rendezvous

(1) Radial/DME

(2) Altitude.

c. Package description

d. Visual signals

e. Emergencies

(1) Reel response failure

(2) Emergency breakaway

(3) Package fluid leaks/fail light

(4) Basket slap/canopy crack.

f. Tanker departure.

14. TANKER OPERATIONS

a. ARS limitations

b. Receiver limitations

c. Receiver/air wing bingo and approach requirements

d. Scheduled and maximum gives

e. Fuel management

f. Tanker stations

g. Tanker procedures

h. ARS failures

i. Exterior lighting.

Figure 6-1. Preflight Briefing (Sheet 3)

15. SAFETY OF FLIGHT
    a. Lookout doctrine
    b. Low-altitude maneuvering
        (1) Altitude/airspeed/AOA/AOB limits
        (2) Configuration
        (3) Crew coordination/communications.
    c. Out of seat procedures
    d. Ejection procedures
        (1) Seat description/preflight
        (2) Ejection criteria
        (3) Survival equipment
        (4) Postejection procedures.
    e. Emergency egress
        (1) Canopy jettison
        (2) Door operation.

16. EMERGENCIES
    a. Takeoff
    b. In flight
    c. Radio failure
    d. Loss of NAVAIDs/system navigation
    e. Landing
    f. Hydroplaning
    g. SAR procedures
    h. Weapon system degradation (go/no-go criteria)
    i. Bingo/bingo field characteristics
    j. Emergency/NATOPS question of the day.

17. RISK ASSESSMENT/RISK MANAGEMENT
    a. Expected hazards
    b. Crew proficiency/experience
    c. Environmental factors
    d. Risk controls/decisions.

18. AIRCREW COORDINATION/ COMMUNICATION
    a. Takeoff
    b. Mission
    c. Approach/landing
    d. Emergencies
    e. Out of control flight.

Figure 6-1. Preflight Briefing (Sheet 4)

CHAPTER 7

Mission Planning

7.1 OPERATIONAL PLANNING

Sea Control missions involve changing tactical situations and require rapid shifts in tactical application within the contact area. Therefore, mission planning is necessarily limited to thorough briefings on currently available intelligence and the application of the proper tactics to meet the needs of the rapidly changing situation. Although training missions, navigation plans, search plans, and cross-country flights may be preplanned, the tactical portion of a mission requires aircrews to employ their knowledge, experience, originality, and imagination in prosecuting active contacts. Those portions of missions and those complete missions that do allow planning shall be planned as thoroughly and completely as possible to realize maximum safety and mission accomplishment.

7.2 TAKEOFF PLANNING

7.2.1 Takeoff Trim Determination. Optimum stabilizer trim for takeoff is dependent on the knowledge of several factors prior to boarding the aircraft, including takeoff cg, outside air temperature, and takeoff weight. The following steps should be followed prior to every takeoff:

1. Determine the no internal stores cg for the aircraft using the Weight and Balance Handbook (NAVAIR 01-1B-40), Form F — Tactical (read line 13 in percent MAC directly).

2. Determine the incremental cg travel caused by the addition of internal stores (sonobuoys and bomb bay stores) using Figure 7-1.

CAUTION

- Addition of sonobuoys shifts the cg more aft.

- Addition of bomb bay stores shifts the cg forward.

3. Add the total increment determined in step 2 to the no internal stores cg determined in step 1.

4. Determine the stabilizer trim position for the cg from step 3 using Figure 7-2 (interpolate for outside air temperature).

Note

This setting assumes a takeoff weight of 33,000 to 47,000 pounds. If the takeoff weight is greater than 47,000 pounds, increase the aircraft noseup trim by 1/2° as noted in Figure 7-2. If the takeoff weight is less than 33,000 pounds, reduce the aircraft noseup trim by 1/2°.

The above optimum trim determination assumes that the excess end-speed is approximately 20 knots. This setting is satisfactory for excess end-speeds between 5 and 40 knots.

7.2.1.1 Example. Assume takeoff conditions to be:

Takeoff gross weight — 43,000 pounds

No bomb bay stores

Sonobuoys — 1,650 pounds

Outside air temperature — 25 °C

20 knots excess end-speed.

1. Using the Weight and Balance Handbook, Form F, line 13, determine that the no internal stores cg is 22.0-percent MAC.

2. Using Figure 7-1, the incremental cg for 1,650 pounds of sonobuoys is +4.6-percent MAC.

3. Actual takeoff cg, by adding steps 1 and 2 (22.0 +4.6), is 26.6-percent MAC.

4. Using Figure 7-2, the stabilizer trim position at 26.6-percent MAC and +25 °C OAT is 0.5° aircraft noseup.

INTERNAL STORE WEIGHTS		
THE INDICATED STORE WEIGHTS LISTED BELOW ARE APPROXIMATE AND FOR MISSION PLANNING ONLY. SEE WEIGHT AND BALANCE HANDBOOK, NAVAIR 01-1B-40, CHART E, FOR SPECIFICATION WEIGHTS. MAXIMUM ALLOWABLE SONOBUOY WEIGHT INCLUDING NONEXPENDABLES IS 2,154 POUNDS (BUOY, CAD, SLC). USE THE FOLLOWING APPROXIMATE WEIGHTS WHEN COMPUTING CG TRAVEL DUE TO INTERNAL STORES:		
SEARCH STORE		**AVERAGE EXPENDABLE UNIT WEIGHT —POUNDS—**
AN/SSQ-36	BT BUOY	17
AN/SSQ-41A	LOFAR BUOY	16
AN/SSQ-41B	LOFAR BUOY	17
AN/SSQ-47B	RANGE ONLY	23
AN/SSQ-53	DIFAR BUOY	19
AN/SSQ-53A	DIFAR BUOY	23
AN/SSQ-53B	DIFAR BUOY	29
AN/SSQ-57A	CALIBRATED LOFAR BUOY	17
AN/SSQ-57B	SAR	18
AN/SSQ-62	DICASS BUOY	39
AN/SSQ-62A	DICASS BUOY	39
AN/SSQ-62B	DICASS BUOY	39
AN/SSQ-71	ATAC	30
AN/SSQ-77A	VLAD	29
AN/SSQ-86	DLC	25
MK-25	MARINE MARKER	4
MK-58	MARINE MARKER	12
MK-84	SUS	6

Figure 7-1. Takeoff Center of Gravity (Sheet 1 of 3)

Note

Since takeoff gross weight is 43,000 pounds, no weight correction is required.

5. Final takeoff trim is 0.5° aircraft noseup.

7.2.2 Lateral Trim for Takeoff. The lateral trim setting for takeoff is normally zero. However, if there is a known crosswind component or wing heavy condition, such as asymmetric stores on the wing pylons or asymmetric fuel in the wing, it is recommended that the lateral trim be set for more optimum stick forces following catapult or field takeoff. The recommended lateral trim in this section will give zero lateral force at approximately 1.2 times the stall speed, which is equivalent to an excess end-speed of approximately 20 knots and is near field takeoff lift-off speed.

TAKEOFF CG COMPUTATION:

REFERENCE: WEIGHT AND BALANCE HANDBOOK, NAVAIR 01-1B-40, FORM F.

EFFECT OF FUEL AND EXTERNAL STORES ON CG IS NEGLIGIBLE.

1. FROM REFERENCE, DETERMINE NO INTERNAL STORES CG.
2. FROM CHART BELOW, DETERMINE CG INCREMENT DUE TO INTERNAL STORES
3. ADD CG FROM STEP 1 TO INCREMENT OF STEP 2.
4. ENTER TAKEOFF TRIM SETTING WITH THIS CG
5. MAXIMUM SONOBUOY WEIGHT LIMIT (SONOBUOYS INCLUDING CADs AND SLCs IS 2154 POUNDS).

S-3 ΔCG TRAVEL DUE TO INTERNAL STORES

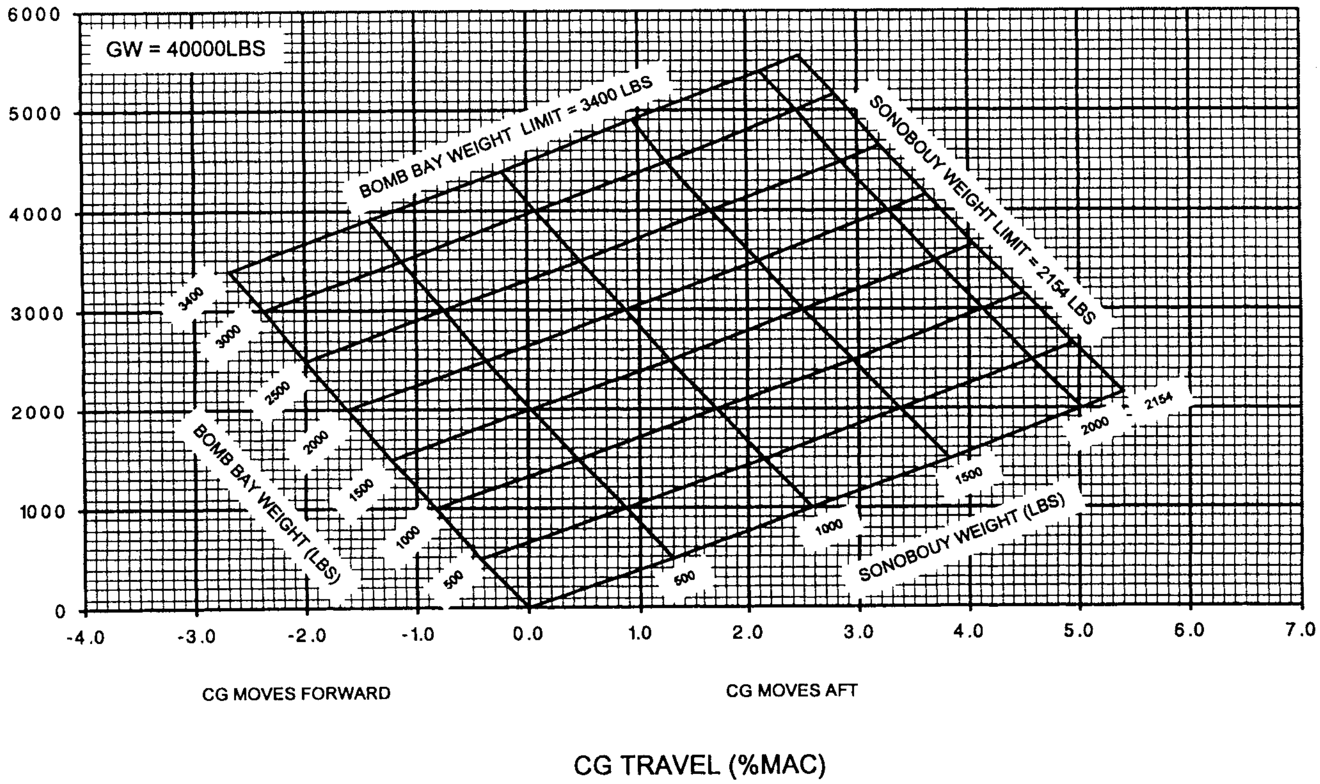


Figure 7-1. Takeoff Center of Gravity (Sheet 2)

DELTA % MAC AT 40,000 GROSS WEIGHT						
TORPEDOES	SONOBUOYS					
	0	500	1,000	1,500	2,000	2,154
0	0.0	1.3	2.6	3.8	5.0	5.4
500	–0.4	0.9	2.1	3.4	4.6	4.9
1,000	–0.8	0.5	1.7	2.9	4.1	4.5
1,500	–1.2	0.0	1.3	2.5	3.7	4.0
2,000	–1.6	–0.4	0.9	2.1	3.3	3.6
2,500	–2.0	–0.7	0.5	1.7	2.8	3.2
3,000	–2.4	–1.1	0.1	1.3	2.4	2.8
3,400	–2.7	–1.4	–0.2	1.0	2.1	2.5

DELTA % MAC AT 45,000 GROSS WEIGHT						
TORPEDOES	SONOBUOYS					
	0	500	1,000	1,500	2,000	2,154
0	0.0	1.2	2.3	3.4	4.5	4.8
500	–0.4	0.8	1.9	3.0	4.1	4.4
1,000	–0.7	0.4	1.5	2.6	3.7	4.0
1,500	–1.1	0.1	1.2	2.3	3.3	3.7
2,000	–1.4	–0.3	0.8	1.9	3.0	3.3
2,500	–1.8	–0.6	0.5	1.5	2.6	2.9
3,000	–2.1	–1.0	0.1	1.2	2.2	2.5
3,400	–2.4	–1.2	–0.2	0.9	1.9	2.3

DELTA % MAC AT 50,000 GROSS WEIGHT						
TORPEDOES	SONOBUOYS					
	0	500	1,000	1,500	2,000	2,154
0	0.0	1.0	2.1	3.1	4.1	4.4
500	–0.3	0.7	1.7	2.7	3.7	4.0
1,000	–0.7	0.4	1.4	2.4	3.3	3.6
1,500	–1.0	0.0	1.0	2.0	3.0	3.3
2,000	–1.3	–0.3	0.7	1.7	2.7	2.9
2,500	–1.6	–0.6	0.4	1.4	2.3	2.6
3,000	–1.9	–0.9	0.1	1.0	2.0	2.3
3,400	–2.2	–1.2	–0.2	0.8	1.7	2.0

Figure 7-1. Takeoff Center of Gravity (Sheet 3)

DETERMINATION OF STABILIZER TRIM SETTING:

- USE CG FROM TAKEOFF CENTER-OF-GRAVITY CHART AND READ STABILIZER TRIM POSITION FROM CHART BELOW BY INTERPOLATING FOR TEMPERATURE.
- THE CHART BELOW IS BASED ON TAKEOFF WEIGHTS BETWEEN 33,000 AND 47,000 POUNDS.

NOTE

IF TAKEOFF WEIGHT IS GREATER THAN 47,000 POUNDS: INCREASE THE AIRCRAFT NOSE-UP TRIM BY ONE-HALF DEGREE.

IF TAKEOFF WEIGHT IS LESS THAN 33,000 POUNDS: DECREASE THE AIRCRAFT NOSE-UP TRIM BY ONE-HALF DEGREE.

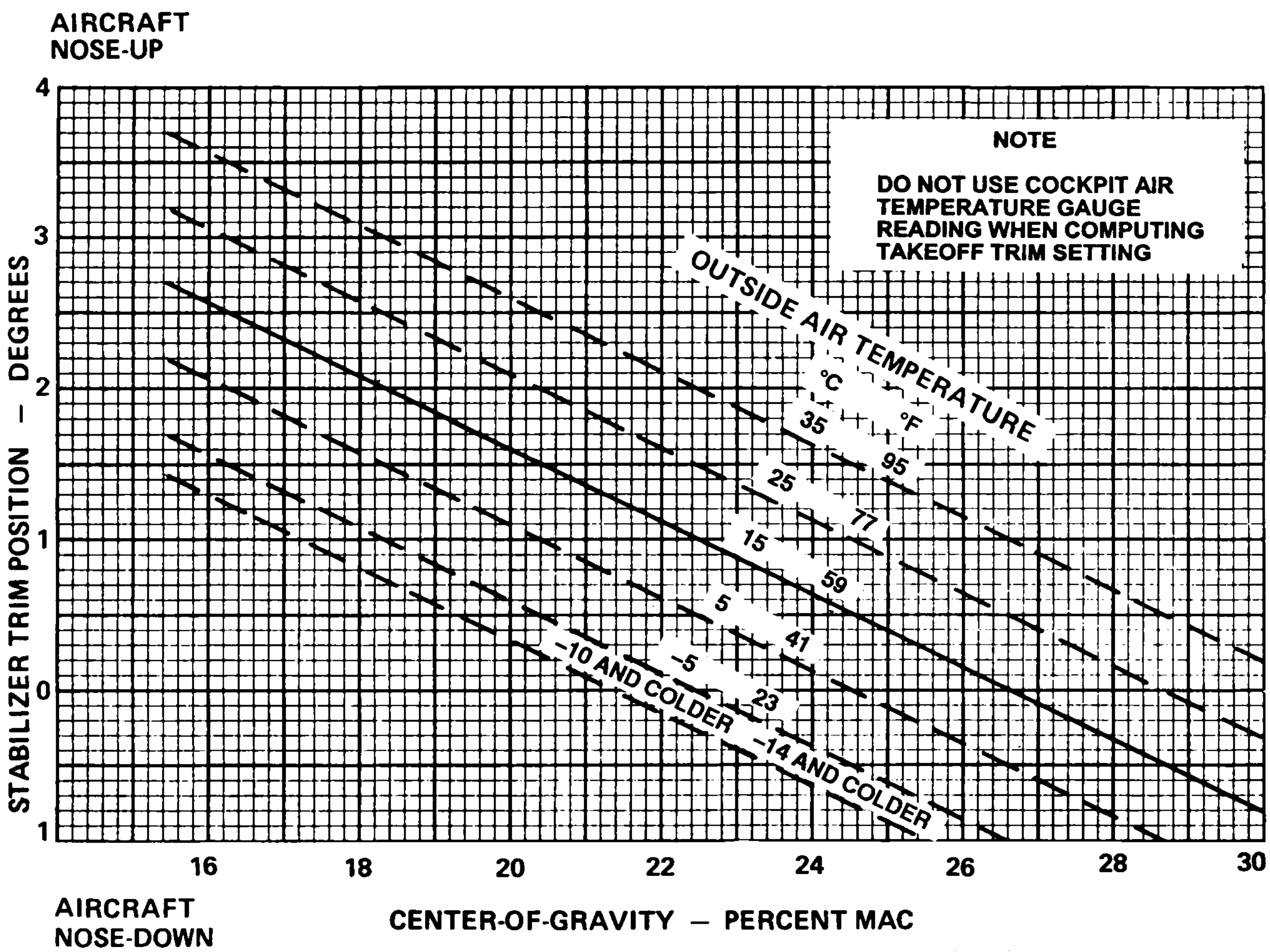


Figure 7-2. Takeoff Trim Setting

1. Asymmetric wing pylon stores

   a. Figure 31-1 shows that the weight of two Mk 84 bombs, conical, is 3,978 pounds; therefore, one Mk 84 bomb weighs 1,989 pounds.

   b. Determine the recommended lateral trim setting from Figure 7-3 (enter with the approximate wing store weight and read the recommended asymmetric-store-weight trim setting).

CAUTION

If wing store is carried on one side only, set in opposite wing-down trim.

2. Asymmetric internal wing fuel:

An asymmetrical fuel condition may exist prior to takeoff as a result of different left or right transfer tank fuel with full feed tank fuel. Safe takeoffs can be made with large amounts of differential fuel if lateral trim is set properly.

   a. Determine asymmetric fuel weight by subtracting the lightest transfer tank fuel load from the heaviest.

   b. Determine the recommended lateral trim setting from Figure 7-3 (enter with the incremental pounds of fuel from the previous step and read the recommended asymmetric-fuel trim setting).

CAUTION

If transfer tank fuel is heavy on one side, set in opposite wing-down trim.

3. Asymmetric wing pylon stores and asymmetric internal wing fuel

If both conditions exist, proper trim can be obtained by adding the two increments.

4. Crosswind component

If the crosswind component is up to 5 knots, make no additional lateral trim correction. If the crosswind component is between 6 and 20 knots, add approximately 2° upwind wing-down lateral trim.

7.2.2.1 Example. Assume there is one Mk 84 bomb, conical, on the right wing (pylon only on the left wing) and 5,000 pounds of fuel in the left transfer tank and 3,500 pounds in the right transfer tank. Also assume a 10-knot crosswind component from the right side of the aircraft.

1. Figure 31-1 shows that the weight of two Mk 84 bombs, conical, is 3,978 pounds; therefore, one Mk 84 bomb weighs 1,989 pounds.

   a. Enter the chart shown in the upper half of Figure 7-3 with the asymmetric store weight of 1,989 pounds and determine a lateral trim increment required of 6.0°.

Note

Since the right wing is heavy, the lateral trim for stores is 6.0° left wing-down.

2. From the fuel quantity gauges that indicate 5,000 pounds of fuel in the left transfer tank and 3,500 pounds in the right transfer tank, there is a 1,500-pound left wing-heavy condition.

   a. Enter the chart shown in the lower half of Figure 7-3 with the asymmetric wing fuel of 1,500 pounds and determine the lateral trim increment required to be 2.2°.

Note

Since the left wing is heavy, the lateral trim for fuel is 2.2° right wing-down.

3. Adding the two increments:

   Asymmetric stores . . . . . . 6.0° left wing-down

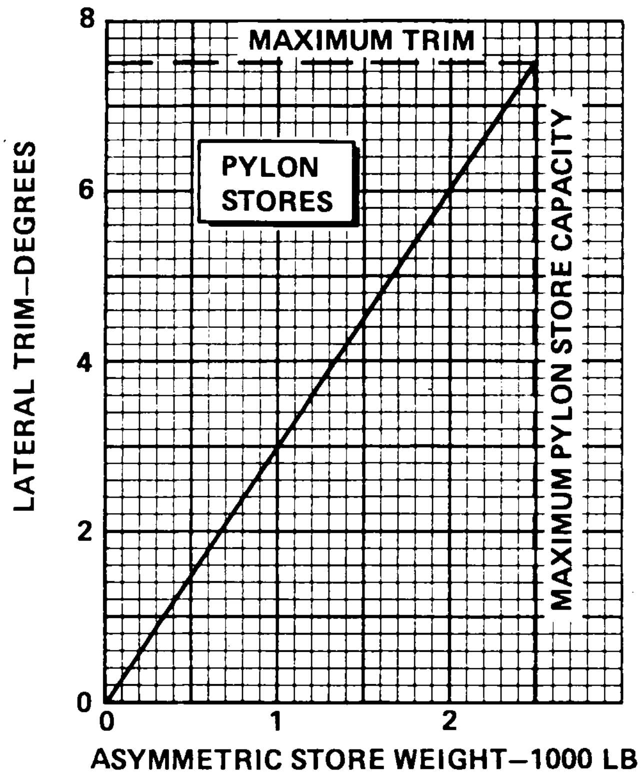
   Asymmetric fuel . . . . . . 2.2° right wing-down

   Asymmetric load
   lateral trim . . . . 3.8° left wing-down.

4. For the 10-knot crosswind component, add an additional 2° right wing-down.

   Total lateral trim . . . . 1.8° left wing-down.

7.2.3 Yaw Trim for Takeoff. Except for known asymmetric yaw conditions at takeoff, the yaw trim should be set to zero.



DETERMINATION OF LATERAL TRIM SETTINGS:

- TAKEOFF FLAPS
- CATAPULT WITH APPROXIMATELY 15 TO 20 KNOTS EXCESS ENDSPEED (OR) AFTER FIELD LIFT-OFF.
- IF ONE WING IS HEAVY, USE OPPOSITE WING-DOWN TRIM.
- CROSSWIND CATAPULT LAUNCHES ARE AUTHORIZED WITHIN 10 KNOTS CROSSWIND COMPONENT ON THE BOW CATAPULTS AND WITHIN 5 KNOTS CROSSWIND COMPONENT ON THE WAIST CATAPULTS FOR 950 POUNDS OR LESS ASYMMETRIC LOADS. FOR ASYMMETRIC LOADS BETWEEN 951 AND 1,600 POUNDS, CROSSWIND CATAPULT LAUNCHES ARE AUTHORIZED WITHIN 5 KNOTS CROSSWIND COMPONENT ON THE BOW CATAPULTS ONLY. ZERO CROSSWIND COMPONENT IS RE- QUIRED FOR ASYMMETRIC LOADS OF 951 POUNDS OR GREATER ON THE WAIST CATAPULTS AND 1,601 POUNDS OR GREATER ON THE BOW CATA PULTS UP TO THE LIMITATIONS OF THE AIRCRAFT.

1. DETERMINE LEFT OR RIGHT WING-DOWN TRIM INCREMENT DUE TO PYLON STORES.
2. DETERMINE LEFT OR RIGHT WING-DOWN TRIM INCREMENT DUE TO FUEL LOAD.
3. ADD INCREMENTS FOR ASYMMETRIC PYLON STORES AND FUEL FROM STEPS 1 AND 2.

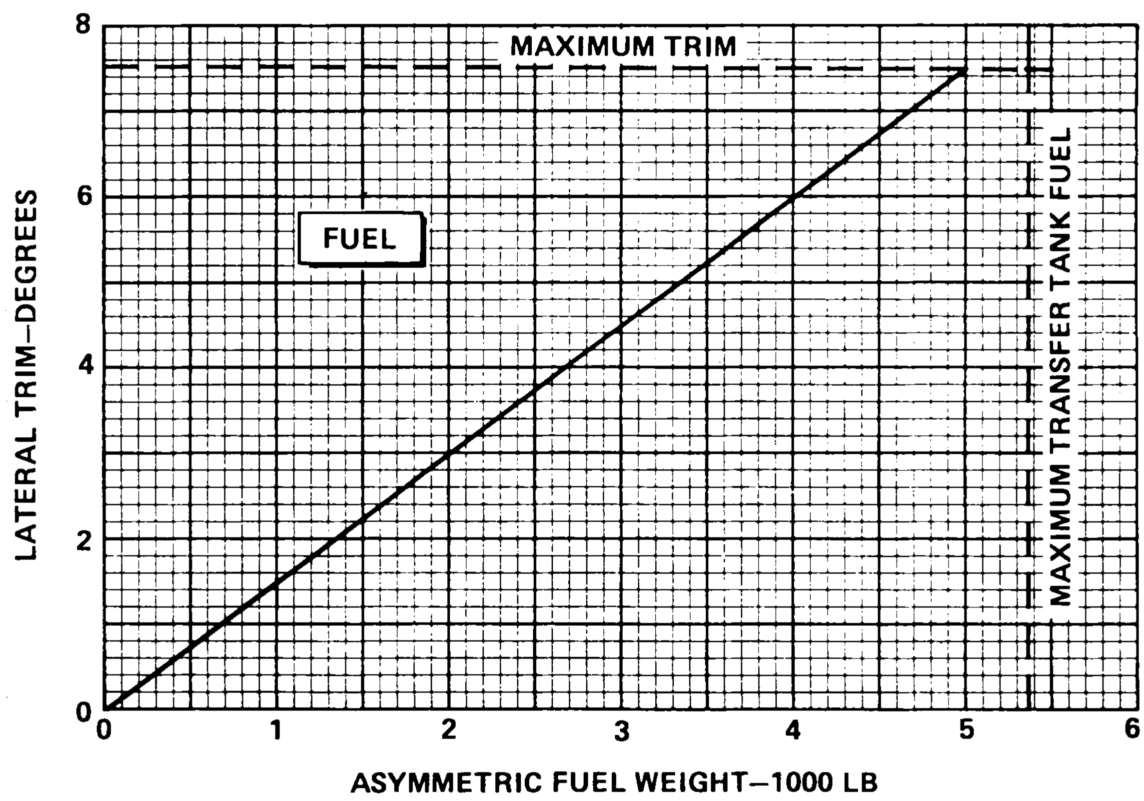


Figure 7-3. Lateral Trim for Takeoff with Asymmetric Loads

7.2.4 Takeoff Performance. Normally the runway length available for takeoff should equal or exceed the distance required to accelerate and stop the aircraft from the recommended takeoff speed. Takeoff data for the aircraft is depicted in Chapter 32 and shall be computed for all takeoffs.

WARNING

On aircraft prior to BuNo 159396, a weight-off-wheels signal is required from both weight-on-wheels proximity switches before stores jettison can occur. An undetected failure in one of the circuits could prevent stores jettison; therefore, on those aircraft, do not take off with aircraft weights greater than that allowable to assure safe flight with single-engine operation if stores jettison cannot be accomplished. (See single-engine climb gradient discussion in Chapter 32.)

Prior to taking the runway, the following must be accomplished:

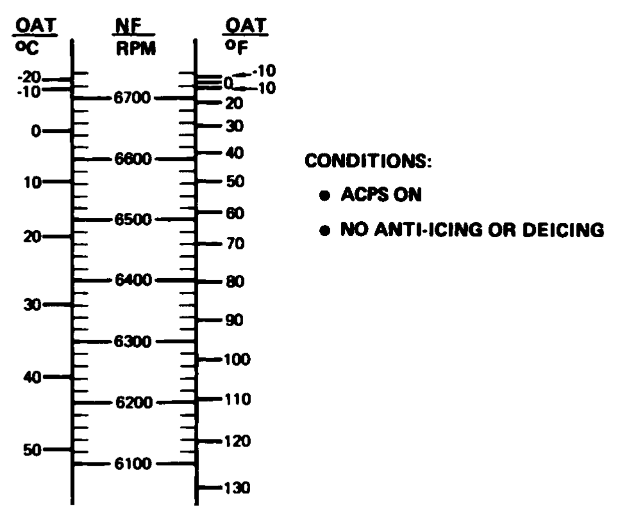
1. Check maximum allowable gross weight (based on temperature and altitude (see Chapter 32)).
2. Determine takeoff speed (based on gross weight in Chapter 32).
3. Determine refusal speed (see Chapter 32).
4. Determine decision speed (see Chapter 32).
5. Determine single-engine climb speed in takeoff configuration (see Chapter 32).
6. Determine minimum takeoff fan speed (see Figure 7-4).
7. Takeoff checklist completed.

7.3 NAVIGATION

The importance of maintaining an accurate and current plot of aircraft position cannot be overemphasized. Accurate navigation is required to enable the pilot to return to his carrier or shore base upon completion of his mission and to enable him to make prompt and accurate reports of contacts.

7.3.1 Equipment Available for Navigation. The following equipment is normally available to assist in the navigation required for most missions.

1. FDIS
2. LF/DF
3. AHRS
4. CAINS/CAINS II
5. GPS
6. Tacan
7. Doppler
8. ICLS
9. Radar
10. ASW DECONFIG
11. UHF/DF
12. AACS
13. RAAWS
14. AFCS
15. AWCLS.



NOTE

- THE FAN SPEEDS SHOWN REPRESENT THE PEAK VALUE IMMEDIATELY FOLLOWING POWER APPLICATION FROM IDLE.
- BELOW -15 °C (+5 °F) THE ENGINE COMPRESSOR DISCHARGE PRESSURE LIMIT MAY RESTRICT FAN SPEED BELOW THE VALUE SHOWN.

Figure 7-4. Minimum Takeoff Fan Speed

WARNING

- For aircraft not incorporating AFC-279, whenever a power interrupt to the INS and/or AHRS occurs, such as during power source transfer, generator failure, or a momentary IFPM failure, the INS and/or AHRS will as a result of a hardware anomaly initiate automatic fast sync to the flux valve (magnetic heading). If this occurs during a turn, the flux valve output exhibits large errors; consequently, the automatic sync will cause the heading displayed on the HSI to be in error. Simultaneously, CAINS magnetic variation will also drive to an erroneous value.

- In flight: The pilot should closely monitor and compare the INS and AHRS magnetic heading display with the magnetic compass for an erroneous heading. Whenever a power transfer or momentary IFPM failure occurs, the aircraft should be flown wings level and a manual fast sync initiated to correct the INS and AHRS heading displayed in the HSI and magnetic variation displayed on the navigation control panel.

- On the ground: During preflight this condition will cause a momentary heading jump and momentary display of the attitude and heading flags. The heading will, however, be valid immediately thereafter and will require no pilot action.

7.4 CRUISE CONTROL

The aircraft normally has more than adequate fuel aboard for its mission; however, pilots should cultivate the habit of fuel conservation on every flight. Although they are not frequent, occasions of being diverted to airfields ashore, holding for long periods prior to landing, or lost ship procedures happen often enough to require that such occurrences be prepared for in the planning of every mission, both at sea and ashore.

7.4.1 Flight Performance Data. Power tables and charts in Chapter 38 should be utilized to obtain the maximum effective control of fuel consumption. Long-range power and maximum endurance power will be used as appropriate.

7.5 LANDING PERFORMANCE

Landing performance is dependent on a multitude of variables ranging from those that can be controlled (such as gross weight and configuration) to those that cannot be controlled (such as decreased braking effectiveness caused by ice or water on the runway, crosswind or tailwind components, obstacles in the landing approach path, and runway length). Landing data for the aircraft is depicted in Chapter 37 and should be determined prior to landing.

1. Compute gross weight to ensure it is within allowable limits (refer to Chapter 4).

2. Determine crosswind component and ensure it is within limits (refer to Chapter 4).

3. Determine landing distance (refer to Chapter 37).

4. Compare landing distance with field length and arresting gear location and availability.

5. Complete landing checklist.

7.6 RUNWAY BEARING STRENGTH

The runway bearing strengths for field operations is determined from the applicable DOD FLIPs and is reported in two manners:

1. FAA/DOD system based on aircraft gross weight and landing gear configuration.

2. ICAO ACN/PCN system based on a published PCN number, type of pavement, pavement subgrade category, aircraft tire pressure, and pavement evaluation method.

The ACN for field operations is determined from Figure 7-5. This requires only that the published pavement type, rigid or flexible (from the first letter in the coded format), be used to determine the ACN.

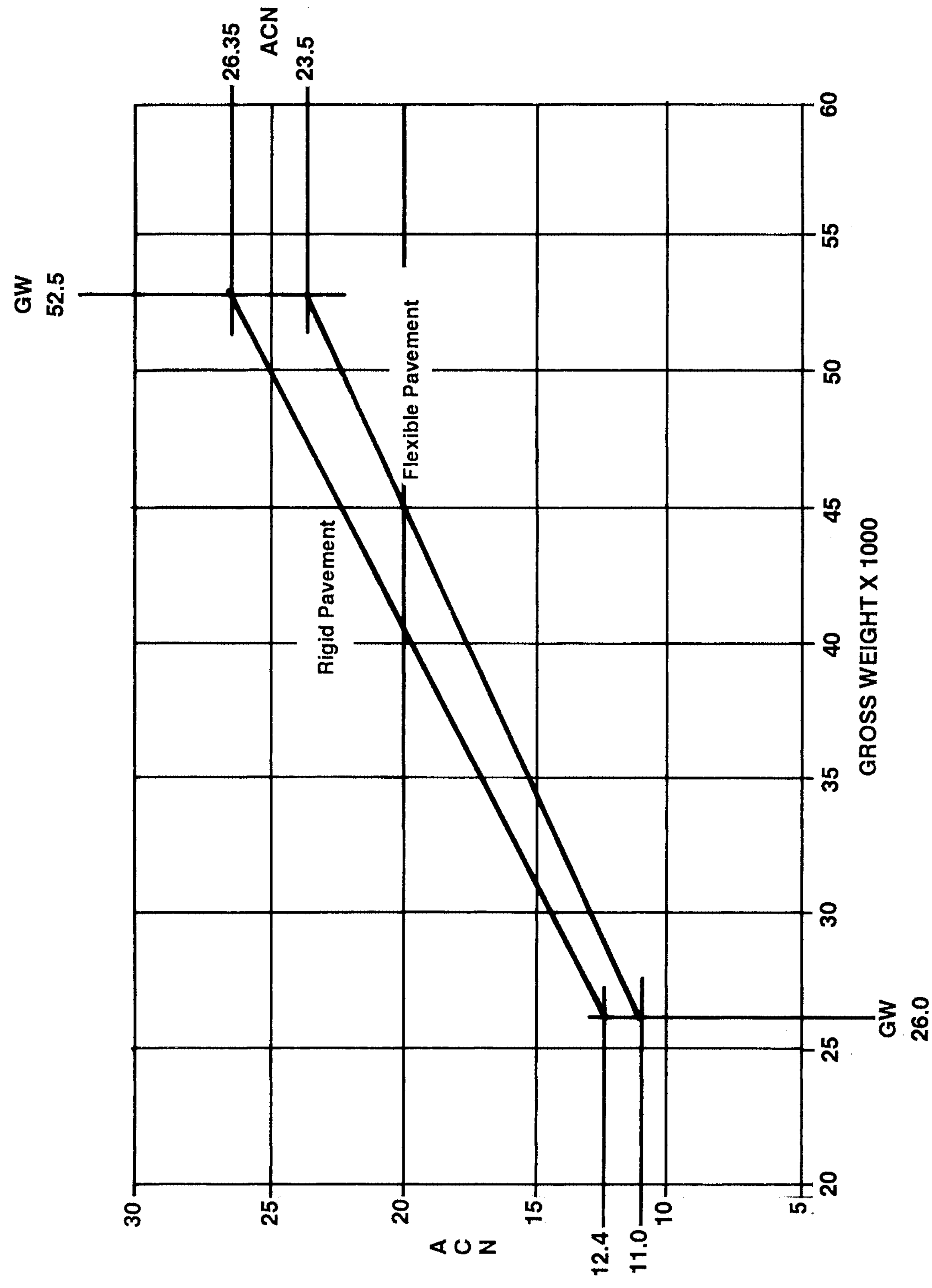


Figure 7-5. Aircraft Classification Number for Field Operations

CHAPTER 8

Shore-Based Procedures

8.1 SHORE-BASED OPERATIONS

Shore-based operations in the S-3B aircraft may vary from familiarization of new pilots to full-scale around-the-clock SUW operations. Many of the procedures required in shore-based operations are identical to those used in shipboard operations, while others vary in major aspects. In this chapter, shore-based procedures discussed will cover as many operational situations as possible.

While operating from a shore base, squadrons will normally conduct operational and training flights to increase and maintain operational mission readiness. Commanding officers shall ensure that all flight operations are conducted in conformance with the rules and regulations promulgated by the various commands and agencies controlling the fields, facilities, and areas to be used.

8.2 SCHEDULING

Normally, all flights will be scheduled on a daily flight schedule.

8.3 LINE OPERATIONS

8.3.1 Aircraft Acceptance. The pilot should not accept the aircraft for flight until he is assured that the aircraft is satisfactory for safe flight and can accomplish the assigned mission. Two major steps prior to acceptance of the aircraft are a careful examination of the aircraft's recent discrepancies and a thorough preflight inspection.

8.3.1.1 Aircraft Discrepancies. The discrepancy reports from the previous 10 flights should be available to the pilot for his examination.

1. The pilot will ensure that the plane captain has conducted a preflight inspection and has entered the appropriate information and signed the aircraft acceptance form.
2. The pilot in command, when satisfied with the acceptance form information, will sign the aircraft acceptance form.

8.3.1.2 Preflight Inspection. The pilot in command will see that a proper preflight inspection is accomplished by his crew.

8.3.1.3 Standard Checklists. Checklists are provided to ensure that all basic safety precautions are observed in the previous phases of aircraft operation. The pilot in command will assure that all required checklists are completed. Takeoff, landing, and emergency checklists will be challenge and reply. Checklist action may be initiated prior to a challenge.

8.4 EXTERIOR INSPECTION

The walkaround inspection should be conducted along the path shown in Figure 8-1. The numbers on the diagram correspond with those in the list below. Access doors, covers, position of bomb bay doors, and control surfaces as well as the general condition of the aircraft will be noted. Any indication of oil, fuel, or hydraulic leaks should be investigated.

WARNING

Landing gear door bonding straps, external avionic door bonding straps, and main gear brake assemblies contain beryllium. Aircrew should exercise caution during preflight. Inhalation of beryllium dust or contact with skin, lacerations, or mucous membranes presents a hazard to human health.

Note

Aircraft with AFC-245 incorporated (carbon brakes) do not have main gear brake assemblies that contain beryllium.

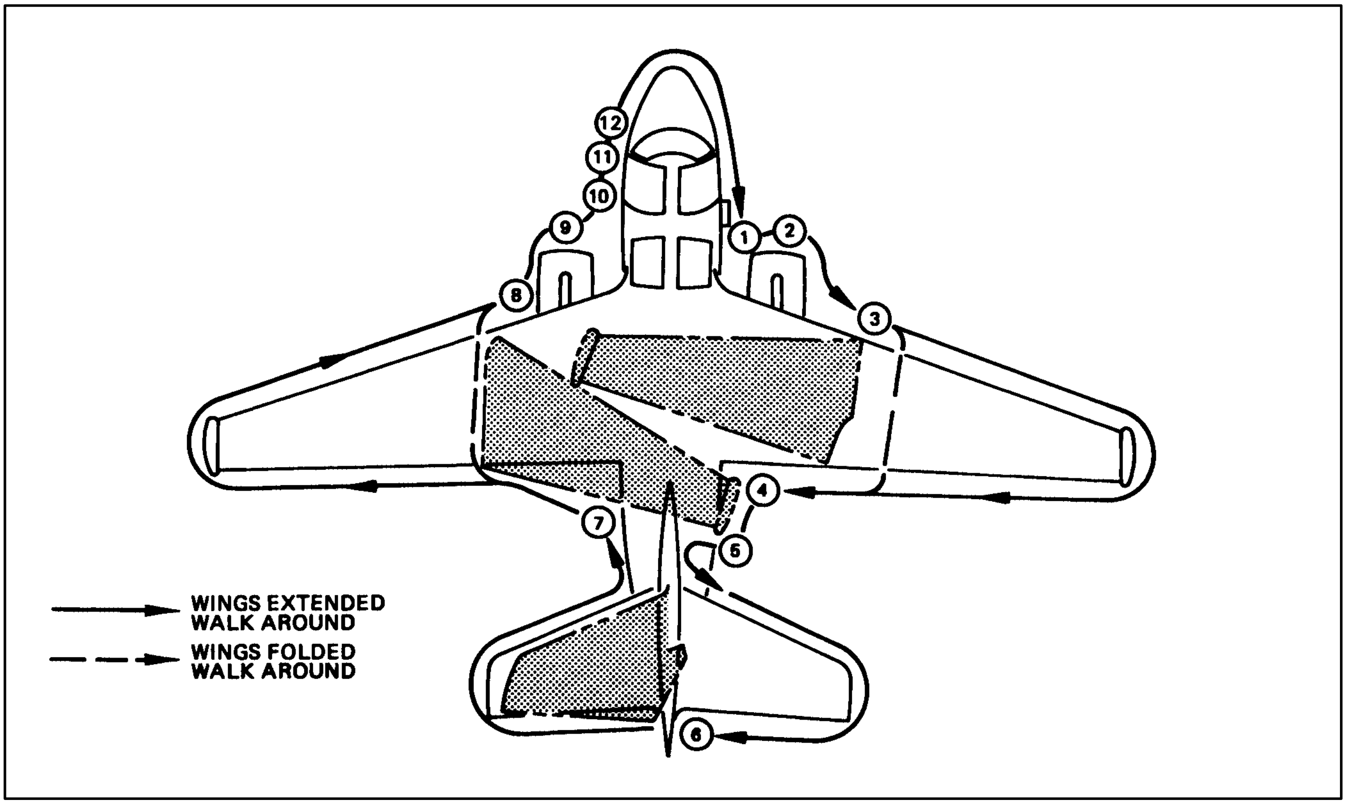


Figure 8-1. Exterior Inspection Diagram

Proceed as follows:

1. LOX converter

   a. Compartment integrity

   b. Door — SECURE.

2. No. 2 engine

   a. Fan and honeycomb — CONDITION, EVIDENCE OF FOD CHECK.

   b. Fan duct and piano hinges — CONDITION.

   c. Fan exhaust area — CONDITION AND INTEGRITY OF IDG OIL AND HYDRAULIC OIL COOLERS.

   d. Cowling and oil tank door — SECURE.

   e. Tailpipe area — CONDITION AND EVIDENCE OF FOD.

   f. Turbine blades — CONDITION.

3. Right wing

   a. Wing flaps, spoilers, ailerons, and antennas — CONDITION, NOTE FLAP POSITION.

   b. Wing fold hinge area — LEAKS, CHAFING, AND LOCK INDICATORS.

4. Right landing gear

   a. Landing gear safety pin — IN AND FREE UNTIL THE NO. 1 HYDRAULIC SYSTEM IS POWERED.

   b. Landing gear shock strut — PROPER EXTENSION/TORQUESTRIPE UNBROKEN.

   c. Tiedown D-ring — CONDITION AND SPRING RETRACTION.

   d. Tire — CONDITION AND INFLATION.

   e. Brake — CHECK.

   f. Doors and linkages — SECURE.

   g. No. 2 hydraulic system (integrity, capacity, indicators) — NORMAL.

h. Sonobuoy safety door — CHECK OPEN.

i. Refueling cap — SECURE.

5. Mid and aft fuselage

a. Jury struts (wing and fin) — REMOVE.

b. ECS inlet — FREE OF OBSTRUCTIONS.

c. Fuselage steps — STOW.

6. Empennage area

a. Aft fuselage area — NO HYDRAULIC FLUID LEAKS.

b. Hook safety pin — AS DESIRED.

WARNING

Do not remove arresting hook safety pin until after start of No. 1 engine if hook is resting on pin.

c. Hook, hook point, accumulator gauge — NORMAL, CONDITION AND SECURITY.

d. Fuel tank vent and dump outlet — CLEAR.

e. Stabilizer, rudder, rudder trim — NOTE POSITION.

f. Sonobuoy safety door — CHECK OPEN.

g. Fin fold hinge area — CONDITION.

7. Left landing gear

a. Landing gear safety pin — IN AND FREE UNTIL THE NO. 1 HYDRAULIC SYSTEM IS POWERED.

b. Landing gear shock strut — PROPER EXTENSION/TORQUESTRIPE UNBROKEN.

c. Tiedown D-ring — CONDITION AND SPRING RETRACTION.

d. Tire — CONDITION AND INFLATION.

e. Brake — CHECK.

f. Doors and linkages — SECURE.

g. No. 1 hydraulic system (integrity, capacity, indicators) — NORMAL.

h. ECS compartment — CHECK AND LATCH DOOR.

8. LEFT wing

a. Wing flaps, spoilers, ailerons, and antennas — CONDITION, NOTE FLAP POSITION.

b. Wing fold area — LEAKS, CHAFING, AND LOCK INDICATORS.

9. No. 1 engine

a. Fan and honeycomb — CONDITION, EVIDENCE OF FOD CHECK.

b. Fan duct piano hinges — CONDITION.

c. Fan exhaust area — CONDITION AND INTEGRITY OF IDG OIL AND HYDRAULIC OIL COOLERS.

d. Cowling and oil tank door — SECURE.

e. Tailpipe area — CONDITION AND EVIDENCE OF FOD.

f. Turbine blades — CONDITION.

10. APU compartment

a. APU oil cooler inlet — CHECK FREE OF OBSTRUCTIONS.

b. Fuel, oil, and hydraulics — CHECK FOR LEAKS

c. APU inlet — CHECK FREE OF OBSTRUCTIONS.

d. APU exhaust door — NOTE POSITION.

e. APU oil level — CHECK WITHIN THE FULL AND ADD LINES.

f. APU oil indicators (ΔP_S) — CHECK.

g. Bomb bay door safety pin — INSTALLED IF BOMB BAY DOORS OPEN.

h. Bomb bay door ground operation controls access door — CLOSE AND LATCH AS REQUIRED.

11. Nose landing gear

a. Nosegear safety pin — IN AND FREE UNTIL THE NO. 1 HYDRAULIC SYSTEM IS POWERED.

b. FLIR/FLIR ground maintenance switch/FLIR access door (external door) — POSITION/FLT STATION CONTROL/SECURE.

Note

The FLIR ground maintenance switch must be in FLT STATION CONTROL position for in-flight actuation of the FLIR. If it is desired to positively retain the FLIR in the retracted position, the ground maintenance switch should be placed in the STOP position.

c. Landing gear shock strut — PROPER EXTENSION.

d. Tiedown D-ring — CONDITION AND SPRING RETRACTION.

e. Tires — CONDITION AND INFLATION.

f. Doors and linkages — SECURE.

g. Landing, taxi, and approach lights — SECURE.

h. Launch bar/launch bar manual-extend control — NOTE POSITION/NORMAL POSITION.

i. Hydraulic fluid leaks — CHECK.

j. Hold back assembly — SECURITY, SPRING TENSION, LEFT/RIGHT DOG-EARS FOR FREE PLAY (maximum 1/16 inch).

12. Forward fuselage (left and right side)

a. Pitot tubes — UNCOVER AND CONDITION.

b. Total temperature probes — UNCOVER AND CONDITION.

c. AOA probe — UNCOVER AND CONDITION.

d. Radome — LATCH AND SECURE.

e. OAT sensor — UNOBSTRUCTED.

8.5 NORMAL ENTRY (THROUGH PERSONNEL DOOR ON RIGHT SIDE OF AIRCRAFT)

WARNING

The crew door shall be closed and locked while the starboard engine is operating without engine turn screen installed.

1. Press trigger to release handle.

2. Press latch button while rotating handle counterclockwise to approximately 15°; release button.

WARNING

Failure to release lock-release button at approximately 15° of door exterior handle rotation (2-o'clock position) may cause personnel access door to blow down if crew compartment has not depressurized.

3. Continue rotating handle counterclockwise to fully unlocked position.

4. Push in handle and rotate clockwise to horizontal position and stow.

5. Press latch button and lower door — use hand grip in middle step.

6. Raise lift bar on upper step and engage in door stop.

8.6 INTERIOR INSPECTION

WARNING

- Flight is permitted only with the pilot and copilot/COTAC seats or all seats occupied. Flight is prohibited with an unoccupied seat of an adjacent pair (pilot and copilot/COTAC or SENSO and TACCO).

- Prior to occupying any crew seat, check the following items:

    1. To assure proper ballast for ejection seat trajectory, it is mandatory that the survival kit and parachute remain in each unoccupied seat. Survival kit/ parachute retention straps must be used for securing this equipment.

    2. The firing control disconnect shall be inspected on all seats prior to strap-in. It will appear as a 2-1/2-inch bright silver bar with three cables attached and seated flush against a gray metal housing as seen through the clear plexiglass window. If this condition does not exist, the seat cannot be fired by the occupant.

- Stowing of any object under the seat is prohibited as it may cause seat damage and subsequent ejection sequence failure.

- Weights may be used to ballast either of the rear seats to meet the requirements of occupancy.

8.6.1 Forward Interior Inspection Procedures

WARNING

Prior to commencing interior inspection, ensure the 4-3-2-1 safety items are checked:

- Four ejection seat safety levers (head-knockers) — DOWN.
- Three canopy/hatch severance pins — INSTALLED.
- Two ejection mode selector levers — UP (SELF).
- One parking brake — SET.

Interior inspection procedures are as follows:

1. APU FIRE EXT switch — GUARD DOWN.
2. Oxygen — OFF.
3. Lights (switch, console, flood, utility, and compartment lights) — OFF.
4. Canopy/hatch severance actuator lines — ATTACHED AND INTACT.

WARNING

Loose, damaged tubing, or broken safety wire/torque seal on canopy/hatch severance fittings could indicate and/or cause a failure of the canopy removal system.

5. Walkaround oxygen hose — PRESENT, INTACT, AND SECURE.
6. Ejection seat preflight

WARNING

Do not use jettison handles as handholds at any time.

a. Upper and lower ejection handles — VISIBLE AND CONNECTED.

b. Outboard seat and lapbelt retaining pin visible — CHECK.

c. AERODYNAMIC vane — CHECK FLUSH.

d. Outboard seat rail clear of obstructions — CHECK.

e. Firing control disconnect — CONNECTED.

f. Inboard seat rail clear of obstructions — CHECK.

g. Inboard seat and lapbelt retaining pin visible — CHECK.

h. Harness release handle installed — CHECK.

i. Parachute arming lanyard installed and connected to emergency restraint release — CHECK.

j. External pilot chute static line routed correctly — CHECK.

k. External pilot chute attachment cable connected to container — CHECK.

l. Spreader gun safety pin visible and stowed — CHECK.

WARNING

If the ballistic spreader gun safety pin is not removed, the canopy will not open either ballistically or aerodynamically.

m. Ballistic inertia reel (one yellow pin visible under headknocker and between headrests) — CONNECTED.

n. Shoulder harness straps (when locked) secure and no slack — CHECK.

o. SEAWARS properly installed — CHECK.

p. Seat and lapbelt secure — CHECK.

q. Lumbar pad (if desired) — INSTALLED WITHIN LIMITS.

r. Oxygen hoses connected to RSSK and console with protective cover installed — CHECK.

s. Emergency oxygen pressure — CHECK.

t. Emergency oxygen actuation handle installed — CHECK.

u. Emergency oxygen actuation lanyard connected — CHECK.

v. Emergency radio beacon actuation lanyard connected (if radio is not installed, lanyard will not be installed) — CHECK.

7. Hydraulic handpump handle — STOW.

a. Check emergency brake and APU accumulator pressures. If not in green area (2,800 psi minimum for APU accumulator), pump up with handpump, assisted by EHP.

CAUTION

To prevent internal damage, do not lock the standby attitude indicator prior to applying power. The unit should be locked prior to securing power only.

8. Standby gyro — UNLOCK.

8.6.2 Aft Internal Preflight Procedures

WARNING

Do not use jettison handles as handholds at any time.

1. If rear seats are unoccupied, check for:

a. Rear seat retention straps — SECURE.

b. Ballast weight — SECURE.

c. Oxygen — OFF.

d. Trays — UP.

e. Lights (switch, console, flood, utility, and compartment lights) — OFF.

2. Avionics/displays/UDG — OFF.

3. Fire extinguisher, first-aid kit, emergency light — CHECK.

4. USH-42 access door — SECURE.

5. Ejection seat preflight — CHECK.

6. Internal avionics compartment — Check the following:

   a. Loose gear and avionics boxes — SECURE.

   b. KG-40 (if applicable) — INSTALLED.

   c. FDC GROUND TEST switch — FLIGHT.

   d. INS toggle switches — UP.

   e. MAD toggle switches — UP.

   f. AHRS source selection — NORMAL.

   g. GPDC bites — RESET.

   h. FLIR control circuit breakers — IN.

   i. FLIR power supply toggle switches — UP.

   j. Circuit breakers — CHECK.

      (1) Search stores control (if stores loaded and flying over land) — OUT.

      (2) Search stores power (if stores loaded and flying over land) — OUT.

      (3) DMTU — OUT (until TC installed).

   k. TORP Preset switch — ON.

   l. Harpoon LOAD/READY switch — READY.

   m. Red-guarded switches.

      (1) Safety disable SAR/JTSN — DOWN.

      (2) Search and kill safety disable — DOWN.

   n. After TC loaded.

      (1) DMTU circuit breaker — IN.

8.7 APU PROCEDURES

If the APU is to be used during start without external electrical hookup, the ELECTRICAL PWR APU GEN switch should be turned on. The APU is designed to start is the APU hydraulic accumulator temperature is above –32 °C (–25 °F) and fuel and air temperatures are higher the –29 °C (–20 °F) with JP-5 and JP-8 or –32 °C (–25 °F) with JP-4.

WARNING

Operation of the APU handle can result in starting the APU even though no electrical or hydraulic ground power is supplied.

CAUTION

If the APU RUN light fails to illuminate within 30 seconds after start initiation, immediately shut down APU using T-handle. Emergency brake accumulator cannot be recharged by the handpump or No. 1 hydraulic system unless the APU start handle is in the OFF position or the APU RUN indicator is illuminated.

Note

The APU FIRE Warning switchlight should be pushed while initiating APU start. The warning light illuminates as APU rpm is obtained during the start, indicating fire warning detection is available. Release the switchlight as soon as the warning detection has been checked.

8.7.1 APU Starting Procedures

1. Check APU accumulator pressure gauge. If accumulator is less than 2,800 psi, bring pressure up with the hydraulic handpump or use EHP.

WARNING

Ensure that personnel are clear of APU inlet and exhaust door before starting APU.

CAUTION

Ensure that the bomb bay ground safety pin has been removed prior to starting the APU. Starting the APU with the ground safety in installed may ingest the pin and FOD the APU.

2. Pull APU handle up to first detent and pause momentarily.

Note

Ignition and fuel valve opening are initiated only when the doors are fully opened. On the deck, with warm oil, doors will open within 5 seconds. At altitude, up to 15 seconds may be required for the APU door to open because of cold soaking.

3. Rotate APU handle clockwise 45° and pull to second detent. APU is ready to accept load when APU RUN indicator illuminates.

8.7.2 APU Shutdown Procedures

8.7.2.1 Primary Method. Shut down the APU by pushing the handle to the stowed position. Note that the APU RUN light extinguishers.

8.7.2.2 Secondary Method. Shut down the APU by pressing the APU RUN SHUT DN switchlight. Note that the light extinguishes. This shuts down the APU and checks the overspeed circuit by sending a false overspeed signal to the ECU, closing the fuel valve.

8.7.2.3 Emergency Method. Shut down the APU by pressing the EMER APU SHUT DOWN switch. This shuts down the APU by sending a false overspeed signal to the ECU, closing the fuel valve.

Note

If APU is secured by auto-shutdown, secondary method, or emergency method, push APU T-handle to stored position as soon as possible.

8.7.2.4 Closing APU Door. After stopping the APU, wait a minimum of 30 seconds, than rotate the handle clockwise and hold down against spring for approximately 15 seconds or until signaled by outside observer (if available).

Note

The APU accumulator must have at least 2,200 psi indicated on cockpit gauge or No. 1 hydraulic system pressure available to close the door.

8.8 PRESTART

WARNING

When extreme forward-left body movements are made, the automatic parachute actuator is susceptible to inadvertent actuation when the shoulder harness is unlocked.

CAUTION

Do not close the gustlock cover without electrical power and No. 1 hydraulic pressure in the aircraft.

8.8.1 Pre-APU Start (Pilot)

1. EMER INSTR light switch — TEST, THEN AUTO.

CAUTION

Without emergency dc battery power or power to the essential dc bus, the APU fire extinguisher will not be operable.

Note

- Ensure emergency dc battery power is available prior to an APU start without external power applied. Checking the emergency dc battery can be accomplished by pressing either the SENSO or TACCO interior light press to test switch, which will illuminate the red EJECT light. Also, checks can be accomplished by selecting TEST on the pilot's EMER INSTR LIGHTS switch, which will illuminate pilot instrument floodlights, eject panel lights, and APU pressure gauge light.

- To minimize battery discharge, do not hold the switch in the TEST position longer than necessary to check the appropriate floodlights. Out of the off position, a fully charged battery has a maximum lifetime of 30 minutes.

2. Flap handle — CORRESPONDING.
3. External light switch — AS REQUIRED.
4. Landing gear handle — DOWN.
5. Standby gyro — UNCAGED.

CAUTION

To prevent internal damage, do not lock the standby attitude indicator prior to applying power. The unit should be locked prior to securing power only.

6. RAAWS — OFF.
7. MPD — OFF.
8. Parking brake — SET.
9. Hook handle — CORRESPONDING.
10. Electrical power panel — CHECK, SET.
    a. Generator switches — OFF.
    b. APU generator switch — OFF.
    c. Bus switches — OFF.
11. APN-202 — OFF.
12. Fuel dump handle — DOWN (latched).
13. Armament control panel — CORRESPONDING.
    a. Bomb bay EMER DOOR switch — OFF.
14. INS/Doppler (Aircraft not incorporating AFC-279) — OFF.
15. CDNUs (2) (Aircraft incorporating AFC-279) — OFF.
16. IFR probe switch — CORRESPONDING.
17. ARA-63 — OFF.
18. ASW-25 — OFF.
19. ADF (if configured) — OFF.
20. ARS control panel (if configured) — CHECK, SET.
    a. Power switch — OFF.
    b. Extend retract switch — RETRACT.
    c. HOSE CUT switch — SAFE/GUARDED.
21. IFF — OFF.
22. External power/air — AS REQUIRED.
    a. External power switch — RESET, ON.
    b. Bus switches — NORM.
    c. External air — CONNECT.

8.8.2 Pre-APU Start (COTAC)

1. KY-58 — OFF.
2. KG-40 — OFF.
3. MAD control panel — OFF.
4. RAAWS — OFF.
5. MPD — OFF.
6. ARA-63 — OFF.
7. ASW-25 — OFF.

8. ADF (if configured) — OFF.

9. ARS control panel (if configured) — CHECK, SET.

   a. Power switch — OFF.

   b. Extend retract switch — RETRACT.

   c. Hose cut switch — SAFE/GUARDED.

10. IFF — OFF.

11. Armament control panel — SET CORRESPONDING.

    a. Bomb bay EMER DOOR switch — OFF.

12. INS/Doppler (Aircraft not incorporating AFC-279) — OFF.

13. CDNUs (2) (Aircraft incorporating AFC-279) — OFF.

14. IFR PROBE switch — CORRESPONDING.

15. Hook handle — CORRESPONDING.

16. Parking brake — SET.

17. Electrical power panel — CHECK/SET.

    a. Generator switches — OFF.

    b. APU generator switch — OFF.

    c. Bus switches — OFF.

18. APN-202 — OFF.

19. Fuel dump handle — DOWN (latched).

8.8.3 APU Start (Combine Pilot and COTAC)

1. APU — AS REQUIRED.

   a. APU accumulator pressure — CHECK 2,800 PSI MINIMUM.

   b. APU — START.

CAUTION

If the APU RUN light fails to illuminate within 30 seconds after start initiation, immediately shut down the APU utilizing the APU T-handle.

Note

- If no external power is available, the APU fire warning switchlight should be pushed while initiating an APU start. The warning light illuminates as APU rpm is obtained during the start indicating fire warning detection is available. Release the switchlight as soon as the warning detection has been checked.

- If the APU RUN light fails to illuminate, check to see that the pilot instrument light is off.

   c. APU FIRE/CAUTION lights (when PMG energized) — CHECK.

2. APU GEN switch — ON.

3. Bus switches — NORM.

4. EHP switch — ON.

Note

Recharge the APU accumulator as soon as possible after an APU start. In the event of an APU fire, 2,200 psi is required to close the APU door.

5. AIR COND switch — NORM.

6. APU AIR switch — AS DESIRED.

7. Environmental panel — CHECK, SET.

   a. AUX VENT switch — OFF.

CAUTION

If the AUX VENT switch is turned out of the OFF position, the recirculating air shutoff valve will be open, which can lead to rapid overheating of operating internal bay avionics. This condition will exist with APU AIR as a source of air and right primary ac bus powered or external source of air with right primary bus powered.

b. ANTI-ICING switch — OFF.

c. DE-ICING switch — OFF.

d. CABIN PRESS switch — DUMP.

e. TEMP SEL switch — AS DESIRED (out of off detent).

CAUTION

- Positioning the TEMP SELECT switch to full hot in the MAN (manual) mode can overheat and possibly damage the cabin air distribution ducting.
- Selection of OFF stops routing of air through the water separator and can lead to a buildup of water, which can freeze causing damage to ECS ducting.

Note

Operation of the air-conditioning system with the BLEED AIR ENG 1 switch off (APU only operating) or the BLEED AIR ENG 2 switch off (ground engine start air only available) will not allow proper temperature control of the cabin (system will operate full cold).

8.8.4 Post-APU Start (Pilot)

1. INS (Aircraft not incorporating AFC-279) — ALIGN.
2. CDNUs (2) (Aircraft incorporating AFC-279) — ON.

Note

To ensure cockpit control of the 1553 bus, turn on the pilot CDNU first; then turn on the TACCO CDNU.

3. EGI/CAINS (Aircraft incorporating AFC-279) — ALIGN.
4. O_2 mask — CHECK, CONNECTED.
5. UHF control panel — OFF.
6. Seat — ADJUST.
7. PITOT/STATIC SOURCE switches — NORM.
8. Lighting control panel — AS REQUIRED.
9. Boom/mask switch — AS DESIRED.

WARNING

An oxygen system check and oxygen mask ICS check shall be performed by all crewmembers to verify proper oxygen flow and oxygen mask ICS communication prior to flight.

10. ICS/CI control panel — CHECK, SET.

Note

Override functions must be selected if using essential power. Reset UHF/ICS selections after primary power is selected.

11. Brake selector switch — NORMAL.
12. Throttles/throttle friction — OFF/AS REQUIRED.
13. Wing flap lever — UP.

CAUTION

If trailing edge flaps are extended, they may be damaged if a tailpipe fire occurs on deck.

Note

Ensure trailing edge flaps are up prior to engine start. Flaps may be retracted with electrical power applied utilizing the EHP and flap handle or the emergency flap extend/retract switch.

14. Launch bar switch — RET.

15. MASTER ARM, SRCH PWR, and ECM ARM switches — OFF.

16. Standby gyro — SET.

17. Altimeter/RAAWS — TEST, SET.

WARNING

Because of the possible internal electrical failure of the altimeter (AAU-19A), the pilot and COTAC should never simultaneously operate in the reset mode.

18. AOA gauge — CHECK.

19. Clock — CHECK, SET.

20. Airspeed indicator — CHECK.

21. VSI — CHECK.

22. EFI (Aircraft incorporating AFC-279) — CHECK, SET.

Note

Backup battery supplies power to the pilot upper EFI only.

23. MPD — OFF.

24. EMER BRAKE PRESS indicator — IN THE GREEN.

25. Parking brake — SET.

    a. PK BRAKE ON and EMER BRAKE ON advisory lights — ON.

CAUTION

- Do not set the parking brake without pressing the brake pedals.
- The light will continue to illuminate when hydraulic pressure is depleted, but the EMER BK ON light will be off.

26. Pilot NAV display selector panel — AS DESIRED. (EGI selected as attitude source on aircraft incorporating AFC-279.)

27. T-5 disable switches — NORM.

28. Interior light panel — AS REQUIRED.

29. APN 202 — AS REQUIRED.

30. APX 76 — AS REQUIRED.

31. Gustlock — AS REQUIRED.

32. Emergency landing gear T-handle — STOWED (latched).

33. Armament control panel — CHECK CORRESPONDING.

    a. SONO safety door switchlight — ON.

34. Tacan — AS REQUIRED.

35. Doppler switch (Aircraft not incorporating AFC-279) — AS REQUIRED.

36. Master caution panel lights — CHECK.

    a. Check the dimming feature with the pilot FLT INSTR light switch.

Note

- The dimming circuit is disabled with the white dome light on.
- Test light illuminates the following lights:

    (1) Master caution panel (all)

    (2) Advisory panel (all)

    (3) Electrical control panel (all)

    (4) Pilot and COTAC approach indexers (all)

    (5) AFCS failure annunciator lights (all)

    (6) SRCH PWR light

(7) MSTR ARM light

(8) NWS light

(9) EHP light

(10) Hook handle light

(11) Landing gear handle light

(12) WHEELS warning light

(13) Pilot and COTAC RAAWS warning light

(14) ATR unlocked light

(15) ECM ready light

(16) MSL FIRE STA W5 light

(17) MSL FIRE STA W6 light

(18) Pilot and COTAC radar altimeter light

(19) Engine limit lights (over N_g, ITT, N_f gauges)

(20) Pilot and COTAC master caution switchlights

(21) APU RUN light

(22) APU DISARMED light

(23) APU AIR ON light

(24) DLC warning light

37. Fuel panel — CHECK, SET.

a. GAUGE TEST switch quantity needles/totalizer gauge — PRESS/1,000 POUNDS

(1) 1 and 2 FUEL LOW and master caution lights — ON.

b. Fuel EXT TRANS switch — AS DESIRED.

c. EXT FUEL quantity — CHECK.

38. COTAC NAV display selector panel — AS DESIRED.

39. ARA-63 — AS REQUIRED.

40. ASW-25 — AS REQUIRED.

41. ADF (if configured) — AS REQUIRED.

42. ARS control panel (if installed) — BIT CHECK (if appropriate).

43. LOX quantity — TEST.

Note

Check OXYGEN caution light illumination at 1 liter or less quantity indication.

44. IFF — STBY.

45. Fuel idle control switch — NORM.

46. Emergency flap switch — NORM.

47. COMM EQUIP COOLING switch — NORM.

48. FLIR retract — NORM.

49. Radios — AS DESIRED.

WARNING

Burns or electrical shock can occur if personnel physically contact the HF radio antenna area on the tailfin when the HF radio is operating. The 1,000-watt transmitter keys automatically during a SRT procedure.

50. FEED TANK INTCN handle — CYCLE, CLOSE.

51. Dome light — AS REQUIRED.

52. Windshield panel

a. Windshield heat — OFF.

b. Windshield washer switch — OFF.

c. Windshield wiper switch — OFF.

CAUTION

Do not operate wiper on a dry windshield.

53. Both bleed air switches — ON.

Note

The BLEED AIR ENG 1 switch must be on to provide temperature control capability.

54. Form lights — AS REQUIRED.
55. FLIR — AS REQUIRED.
56. Exterior lights — AS REQUIRED.
57. FIRE pull handles — CYCLE, FORWARD.
58. Engine fire warning system — TEST.
59. EJECT light — CHECK.
    a. EJECT warning light switch — ON.
    b. TACCO and SENSO EJECT warning lights — CHECK.
    c. EJECT warning light switch — OFF.
60. BLEED AIR LEAK DETECT switch — TEST.
    a. Check 1, 2 CAB, and APU (BL LEAK) master caution lights — ON.
61. Flight control test panel — CHECK.
    a. Servo switches (three) — OFF.
    b. Speedbrake and trim lights — OUT.
62. Ignition switches — ON.
63. Taxi light — OFF.

8.8.5 Post-APU Start (COTAC)

1. INS (Aircraft not incorporating AFC-279) — ALIGN.
2. EGI/CAINS (Aircraft incorporating AFC-279) — ALIGN.
3. IFR probe handle — CHECK, CRANK.
4. KY-58 — AS REQUIRED.
5. KG-40 — AS REQUIRED.
6. O_2 mask — CHECK CONNECTED.
7. Seat — ADJUST.
8. Lighting control panel — AS REQUIRED.
9. MASK/BOOM switch — AS REQUIRED.

WARNING

An oxygen system check and oxygen mask ICS check shall be performed by all crewmembers to verify proper oxygen flow and oxygen mask ICS communication prior to flight.

10. ICS/CI control panel — CHECK, SET.

Note

Override functions must be selected if using essential power. Reset UHF/ICS selections after primary power is selected.

11. Radar offline control panel — STBY, 0 TILT.
12. Altimeter/RAAWS — SET, TEST.

WARNING

Because of the possible internal electrical failure of the altimeter (AAU-19A), the pilot and COTAC should never simultaneously operate in the reset mode.

13. AOA gauge — CHECK.
14. Airspeed indicator — CHECK.
15. VSI — CHECK.
16. EFI (Aircraft incorporating AFC-279) — CHECK, SET.
17. Clock — CHECK, SET.

18. MPD — OFF.

19. COTAC NAV display selector panel — AS DESIRED.

20. ARA-63 — AS REQUIRED.

21. ASW-25 — AS REQUIRED.

22. ADF (if configured) — AS REQUIRED.

23. LOX quantity — TEST.

Note

Check the OXYGEN caution light illumination at 1 liter or less quantity indication.

24. IFF — STBY.

25. Fuel idle control switch — NORM.

26. Emergency flap control panel — NORM.

27. COMM EQUIP COOLING switch — NORM.

28. FLIR retract — NORM.

29. Radios — AS DESIRED.

WARNING

Burns or electrical shock can occur if personnel physically contact the HF radio antenna area on the tailfin when the HF radio is operating. The 1,000-watt transmitter keys automatically during a SRT procedure.

30. Emergency landing gear T-handle — STOWED (latched).

31. Armament control panel — CHECK CORRESPONDING.

    a. SONO safety door switchlight — ON.

32. Tacan — AS REQUIRED.

33. Doppler (Aircraft not incorporating AFC-279) — AS REQUIRED.

34. Master caution panel lights — CHECK.

Note

- The dimming circuit is disabled with the white dome light on.
- Test light illuminates the following lights:

Master caution panel (all)

Advisory panel (all)

Electrical control panel (all)

Pilot and COTAC approach indexers (all)

AFCS failure annunciator lights

SRCH PWR light

MASTER ARM light

NWS light

EHP light

Hook handle light

Landing gear handle light

WHEELS warning light

Pilot and COTAC RAAWS warning light

ATR unlock light

ECM ready light

MSL FIRE STA W5 light

MSL FIRE STA W6 light

Pilot and COTAC radar altimeter light

Engine limit lights (over N_g, ITT, N_f gauges)

Pilot and COTAC master caution switchlights

APU RUN light

APU DISARMED light

APU AIR ON light

DLC warning light

35. Fuel panel — CHECK SET.

    a. Check gauge test switch quantity needles/totalizer gauge — PRESS/1,000 POUNDS.

        (1) 1 and 2 FUEL LOW and master caution lights — ON.

    b. Fuel EXT TRANS switch — AS DESIRED.

    c. EXT FUEL quantity — CHECK.

36. Pilot NAV display selector panel — AS DESIRED.

37. T-5 disable switches — NORM.

38. Interior light panel — AS REQUIRED.

39. APN-202 — AS REQUIRED.

40. APX-76 — AS REQUIRED.

41. Gustlock — AS REQUIRED.

42. Dome light — AS REQUIRED.

43. Windshield panel

    a. Windshield heat — OFF.

    b. Windshield washer switch — OFF.

    c. Windshield wiper switch — OFF.

CAUTION

Do not operate wiper on a dry windshield.

44. Both bleed air switches — ON.

Note

The BLEED AIR ENG 1 switch must be on to provide temperature control capability.

45. Formation lights — AS REQUIRED.

46. Exterior lights — AS REQUIRED.

47. FIRE pull handles — FORWARD.

48. Engine fire warning system — TEST.

49. EJECT light — CHECK.

    a. EJECT warning light switch — ON.

    b. TACCO and SENSO EJECT warning lights — CHECK.

    c. EJECT warning light switch — OFF.

50. Bleed air leak detect switch — TEST.

    a. Check 1, 2, CAB, and APU (BL LEAK) master caution lights.

51. Flight control test panel — CHECK.

    a. Servo switches (three) — OFF.

    b. Speedbrake and trim lights — OUT.

52. Ignition switches — ON.

8.9 ENGINE START

1. Bomb Bay Ground Safety Pin/Access Door — REMOVE/CLOSE.

WARNING

Visually confirm all personnel are clear of both bomb bays prior to removing bomb bay safety pin. Inadvertent bomb bay closure may occur immediately upon closing bomb bay door ground control panel.

2. Bomb Bay Doors — CLOSE.

3. No. 1 engine — START.

    a. Start switch — START.

Start clock simultaneously; start oil pressure indication within 10 seconds.

Note

The starter caution light will illuminate during the start sequence when positioning the START switch to START. The caution light should extinguish after starter cutout speed, indicating that the starter valve has closed.

b. Bleed air pressure — CHECK.

(1) APU air — 30 TO 35 PSI.

(2) External air — 45 TO 75 PSI.

Air-conditioning will cease and bleed air pressure should decrease momentarily when start switch is activated. Also, the APU AIR ON switchlight will extinguish for approximately 5 seconds while the ECS system shifts from air-conditioning mode to engine start mode.

Check N_g greater than 15 percent and ITT less than 100 °C.

c. Throttle — IDLE.

Note

Minimum N_g for ignition is 9 percent; however, for improved start reliability, 15 percent or greater should be used.

d. Engine instruments — MONITOR.

(1) Light-off within 20 seconds after advancing throttle to IDLE. ITT indication should be monitored throughout the start. Refer to Chapter 4 for engine limits.

(2) Hydraulic pressure

(a) 400 to 500 psi at less than 47- to 54-percent N_g.

(b) 2,850 to 3,250 psi above 47- to 54-percent N_g.

Note

When No. 2 engine is started first on APU power, normal hydraulic pressure gauge indications will not be available unless the left primary bus is powered.

(3) Starter cutout (start switch returns to STOP/START position) at 54- to 57-percent N_g.

Note

- At starter cutout, the APU AIR ON switchlight will extinguish for approximately 5 seconds while the ECS system shifts from engine start mode back to the air-conditioning mode.
- Because of peculiarities of some engines, the FUEL PRESS light may extinguish momentarily, then reilluminate during the start cycle upon initiation of fuel. This, in turn, may trigger the master CAUTION light flasher circuit. This condition is considered normal and has no adverse affect on engine operation.

(4) Engine-idle power conditions (bleed/generator off, –18 to +32 °C (0 to 90 °F) ambient temperature. Use the following values for reference only:

(a) FF — 290 TO 550 PPH.

(b) N_g — 59.2 TO 66.0 PERCENT.

(c) ITT — 360 TO 646 °C.

(d) N_f — 1,500 TO 2,400 RPM.

(e) Oil pressure — 38 TO 100 PSI (cold); 38 TO 70 PSI (warm).

(f) Hydraulic pressure — 2,850 TO 3,250 PSI.

e. Engine warning/caution lights — CHECK.

Check FIRE warning, starter, oil pressure, fuel pressure, engine limit, fuel idle and fuel filter caution lights. For abnormal indications, refer to Part V.

Note

If the START switch does not return to the STOP/START position automatically by 57-percent N_g, manually return the switch to STOP/START position and report this on debrief.

4. LH GEN switch — NORM.

5. No. 1 PRIM SERVO HYD PRESS switch — NORM.

6. EXT PWR switch/air — OFF/DISCONNECT.

WARNING

The EXT PWR switch shall be placed to the OFF position prior to signaling the plane captain to disconnect the external power source.

7. Landing gear/hook pins — REMOVE

8. Crew entry door — CLOSE.

9. No. 2 engine — START.

Same as No. 1 engine. Repeat step 4.

WARNING

The crew door shall be closed and locked while the starboard engine is operating without engine turn screen installed.

CAUTION

- Rapid throttle movements on No. 1 engine above flight idle under certain wind conditions may cause No. 1 engine compressor stall because of APU exhaust gas ingestion.

- If only No. 2 engine start is to be accomplished with the wings folded, ensure that the stick is centered during start.

Note

- Starting No. 2 engine with No. 1 at idle and APU not running could cause an abnormal start. If No. 2 engine cannot be started within normal limits, advance No. 1 engine to 80-percent N_g and reattempt. If a normal start occurs, no malfunction exists.

- If No. 1 engine is to be used to crossbleed start No. 2 engine and the APU is running, the APU AIR ON switchlight should be set to OFF (extinguished) prior to advancing No. 1 throttle.

- The starter caution light will illuminate during the start sequence when positioning the START switch to START. The caution light should extinguish after starter cutout speed, indicating that the starter valve has closed.

10. RH GEN switch — NORM.

11. No. 2 PRIM SERVO HYD PRESS switch — NORM.

12. SPOIL 1 & 2 switch — NORM.

8.10 AFTER START

1. BLEED AIR switches, one at a time — OFF, THEN ON.

   a. Check for illumination of appropriate BL CLSD light on master caution panel.

2. APU AIR — OFF.

CAUTION

The APU should be turned off or APU AIR switchlight set to OFF (extinguished) during ground operations whenever the aircraft engines are to be operated above flight idle and the bleed air valves are open to preclude No. 1 engine compressor stalls and roll back.

3. APU — AS DESIRED.

4. Engine idle undershoot — COMPLETE.

Note

The APU should be secured or the APU AIR switchlight should be set to OFF (extinguished) prior to performing this check to preclude pressure surges in the APU bleed air system when engine bleed air pressure is higher than APU bleed air pressure.

Perform on each engine as follows:

a. Stabilize No. 1 engine at IDLE and note N_g.

b. Jam-accelerate the No. 1 throttle to MAX PWR position.

c. When N_g reaches 73 to 75 percent, immediately snap-decelerate the No. 1 throttle to IDLE position.

d. For an acceptable engine, idle N_g must be no lower than idle N_g noted in step a and in accordance with Figure 8-2.

e. Repeat steps a through d for No. 2 engine.

5. Fuel idle control test — CHECK.

a. FUEL IDLE CONT switch — NORM.

(1) Both engines should be at ground idle (approximately 64-percent N_g).

b. FUEL IDLE CONT switch — FLT IDLE.

(1) Both engines should go from ground idle (approximately 64-percent N_g) to flight idle (approximately 69-percent N_g).

c. ANTI-ICING switch — ENG & PITOT.

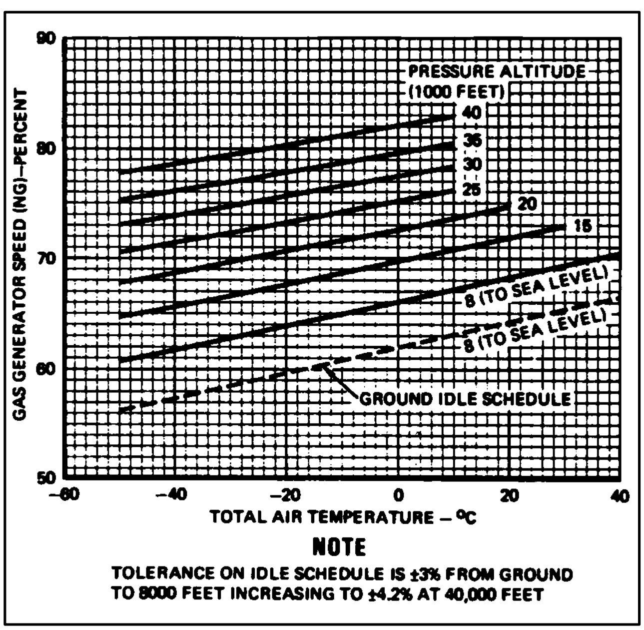


Figure 8-2. TF34-400 Idle Schedule

Note

The APU should be secured or APU AIR switchlight set to OFF (extinguished) while performing anti-ice and deice system checks using engine bleed air to preclude pressure surges in the APU bleed air system associated with high-low flow shift in the ECS system.

(1) No. 1 A-ICE ON and No. 2 A-ICE ON lights illuminate. Note ITT rise.

d. DE-ICING switch — SINGLE CYCLE.

(1) ECS shifts to low flow.

e. ANTI-ICING and DE-ICING switches — OFF.

f. FUEL IDLE CONT switch — NORM.

(1) Both engines from flight idle to ground idle.

g. FUEL IDLE CONT switch — IND LT TEST (momentarily).

(1) No change in engine speed.

(2) FUEL IDLE light illuminates.

6. APU AIR — AS REQUIRED.

7. Cockpit control checks — PERFORM.

a. Flight controls/EFCS/trim — CHECK.

(1) FLAPS — LOITER (enables fast trim rate).

(2) No. 1 PRIM SERVO HYD PRESS switch — OFF (check for normal control forces).

(3) No. 2 PRIM SERVO HYD PRESS switch — OFF (check for EFCS latch up).

Note

Reversion to EFCS while pushing forward on stick may result in failure of elevator control to engage.

(4) AUTO BOLTER GROUND TEST (ABT) switch — PRESS, WITH CONTROL STICK FORWARD (check for no nose-down trim change).

(5) No. 2 PRIM SERVO HYD PRESS switch — NORM (check for normal control forces).

(6) No. 1 PRIM SERVO HYD PRESS switch — NORM.

(7) Pitch and roll trim (for control) — CHECK (CP).

(8) TRIM DISC switch — PRESS (CP) (visually check for six lights on FCT panel). CHECK THAT PITCH AND ROLL CONTROL IS LOST. REENABLE ALL CHANNELS.

(9) TRIM DISC switch — PRESS (P) (visually check for six lights on FCT panel). CHECK THAT PITCH AND ROLL CONTROL IS LOST. REENABLE ALL CHANNELS.

(10) Roll/rudder trim — CHECK FOR CONTROL (P).

b. AFCS BIT check — PERFORM.

(1) On the FCTP, ensure that the MAD SEL switch is in the center (neutral) position and the channel indicator lights are extinguished.

(2) On the FMSP, ensure all switches are set to OFF.

Note

If the wings are folded, the VDI switches on the pilot and copilot/COTAC NAV DISPLAY SELECTOR panel must be set to the same position to prevent nuisance faults.

(3) On both FAPs, check that no legends are illuminated. (Depress to extinguish, if required.)

WARNING

Check all control surfaces for clearance. Warn ground personnel of impending surface motion and engine thrust change.

(4) Aileron and rudder trim — set at zero.

(5) Flaps — UP. (Aircraft not incorporating AFC-273.)

Note

For aircraft incorporating AFC-273, flaps may be in any position.

(6) NWS — OFF.

(7) APU AIR — OFF.

(8) On the FCTP, momentarily depress the TEST AUTO/MAN switch. Keep hands and feet clear of the control stick and pedals.

(9) Check for the following BIT results:

(a) The AUTO light should illuminate.

(b) On the FCTP, AFCS channel lights and both halves of the MAD START ON indicator light should illuminate and then extinguish.

(c) On the FAP, A/P and ATS red lamps should flash and the A/P, ATS, and ALTITUDE yellow lamps should illuminate and then extinguish.

(d) On the HUAP, the APC red lamp should flash and then extinguish.

(e) The SPD flag and needle should momentarily come into view.

(f) The MAN light should illuminate in about 2 minutes for aircraft not incorporating AFC-273 and about 25 seconds for aircraft incorporating AFC-273.

Note

BIT run times depend on the number of faults detected. The BIT run times given may be exceeded.

(10) Channel status lights now indicate AUTO BIT failures.

(11) Ensure throttle friction is off.

For aircraft not incorporating AFC-273:

(a) Move the throttles to 75 percent N_g, minimum.

(b) On FMSP, engage PITCH, ROLL, YAW, and APC switches, and keep hands and feet clear of the control stick and pedals.

For aircraft incorporating AFC-273:

(a) Ensure throttles are at idle.

(b) On FMSP, engage in sequence APC, DMPR, ROLL, and PITCH switches. Keep hands and feet clear of the control stick and pedals.

(12) AUTO BIT failures indicated on the FCTP panel are extinguished.

(13) Control stick makes small movements fore and aft, left and right.

(14) Throttles make small fore and aft movements.

For aircraft not incorporating AFC-273, after approximately 10 seconds, AUTO and MAN lights will both come on and flash on the FCTP.

For aircraft incorporating AFC-273, after approximately 70 seconds, the AUTO and MAN lights on the FCTP will flash.

(15) Momentarily activate the AFCS disconnect (paddle) switch on the control stick — PITCH, ROLL, and YAW FMSP switches return to OFF.

(16) After approximately 3 seconds, activate the pilot's NWS switch 2 times — APC FMSP switch returns to OFF.

Note

Activating the NWS switch prior to activating the AFCS disconnect switch will abort IBIT processing and prevent proper display of fault indications.

(17) Return the throttles to IDLE.

(18) Press the TEST AUTO/MAN switch.

Check that AUTO and MAN lights are extinguished. The AFCS channel status lights on the FCTP and FAP lights will now reflect all cumulative failures detected by the Automatic and Manual BIT.

Note

On aircraft incorporating AFC-273, actuating the test switch twice within a 5-second period will clear the results of AUTO/MAN BIT within the FDC memory.

8. Plane captain assisted checks — PERFORM.

a. Flight controls/trim/DLC — CHECK.

(1) Control check (using both systems) — COMPLETE.

(a) Stick full forward and full right rudder — CHECK (plane captain check for direction and authority).

(b) Stick full aft and full left rudder — CHECK (plane captain check for direction and authority).

(c) Release controls — CHECK FOR POSITIVE CENTERING IN ALL AXES.

(2) Autobolter trim — CHECK (P).

(a) Control stick — FULL FORWARD (P) (observe no nosedown trim change).

(b) AUTO BOLTER GROUND TEST (ABT) switch — PRESS (P) (observe nosedown trim change. Continue trimming until full nosedown).

(3) Pitch trim/stick position monitor — CHECK (P).

(a) Trim — NOSEUP.

While holding control stick against forward stop and pressing AUTO BOLTER

Plane captain visual signal.

GROUND TEST switch (P), observe noseup trim change for approximately 2 seconds followed by dual pitch channel disconnect.

(b) Pitch trim (channels 1 and 2) — RESET (P).

(c) Continue trimming until full noseup (P).

(d) Trim — NOSEDOWN.

While holding control stick against aft stop and pressing AUTO BOLTER GROUND TEST switch (P), observe nosedown trim change for approximately 2 seconds followed by dual pitch channel disconnect.

(e) Pitch trim (channels 1 and 2) — RESET (P).

(f) Trim nosedown until takeoff trim is set to the value determined in Chapter 7.

WARNING

If the takeoff trim is set more than 1°different from the recommended setting, uncomfortable attitudes may occur after takeoff. Excessive nosedown trim may result in inability to rotate the aircraft. Excessive noseup trim may result in premature rotation to a stalled condition. Compliance to the required trim setting is mandatory for safe operation of the craft.

(4) Direct lift control — CHECK.

(a) DLC switch — ATTEMPT TO ENGAGE, RELEASE TO OFF, RESET.

Ensure DLC will not engage.

(b) AUTO BOLTER GROUND TEST switch — PRESS AND HOLD.

(c) DLC switch — ENGAGE.

(d) ON TOP switch — PRESS AND HOLD.

Speedbrake indicator should indicate 12°, pilot AOA indicator should indicate approximately a 2-unit decrease. Extension beyond approximately 12° indicates system malfunction.

(e) ON TOP switch — RELEASE.

Speedbrake indicator should indicate 0°, pilot AOA indicator should indicate increase.

(f) AUTO BOLTER GROUND TEST switch — RELEASE.

DLC switch should return to OFF.

b. IFR (in-flight refueling) probe — CHECK, RETRACT.

c. External lights — CHECK.

d. Arresting hook — CHECK, RETRACT.

Note

Ensure NWS is not engaged when arresting hook is lowered to enable the plane captain to visually ensure that the nosewheel does not move to a position other than centered.

e. Launch bar — CHECK, RETRACT.

CAUTION

Failure of the LNCH BAR EXT advisory light to illuminate when the launch bar is extended may indicate a failure of the launch bar control circuitry. This may result in landing gear retraction with the launch bar extended.

f. Nosewheel steering — CHECK, ON.

CAUTION

Do not check the arresting hook, launch bar, or nosewheel steering prior to removing the tiedowns from the nosewheel.

Plane captain visual signal.

Note

Nosewheel steering will not engage if the emergency landing gear extension handle has been actuated and the valve has not been reset. The NWS ON advisory light will operate normally, but the EMER BRAKE ON light will remain on after releasing the parking brake.

g. Wing/fin — SPREAD/ERECT, CHECK.

Note

Wing spread or fold sequence can be terminated at any time by lifting the gustlock cover out of the detent momentarily.

To spread wings/erect the fin:

(1) WING/FIN FOLD gustlock cover in up detent.

(2) WING SPREAD/FOLD switch — SPREAD (momentarily).

(3) FIN FOLD/ERECT switch — ERECT (momentarily).

CAUTION

When fin folding is initiated, the rudder pedals are disengaged automatically from the rudder servo. Therefore, the aircraft should be stationary, and nosewheel steering should not be used while folding or erecting the vertical fin.

(4) After both wings have completely extended and the locking pins have extended, as evidenced by a No. 1 hydraulic system pressure fluctuation, lower WING/FIN FOLD gustlock cover upon signal from ground crewman.

WARNING

Visually check wings spread prior to stowing gustlock cover.

Note

Some differential in wing spreading is normal.

(5) Warning flags, lights — RETRACT, OUT.

h. The following After Start Checklist items shall be checked only after the gustlock is stowed:

(1) Speedbrakes — EXTEND.

(2) Flaps — TAKEOFF (check lower spoiler dwell).

CAUTION

During high-power ground operation, the trailing edge flaps should be in the UP position to prevent damage by heat from the engine exhaust.

(3) SPOIL 1 & 2 switch — OFF.

(4) Speedbrakes — RETRACT.

(5) SPOIL 1 & 2 switch — NORMAL.

(6) FLAPS/ELEV INPUT gauge — WITHIN LIMITS.

i. External fuel tank pressurization system (if tanks are installed) — CHECK.

(1) EXT TRANS switch — OVERRIDE (60 seconds minimum, then set OFF).

CAUTION

Failure of one or both external tanks to depressurize may result in overpressurizing internal tanks and possible uncontrolled venting of internal fuel to a minimum of 4,400 pounds.

9. SONO safety door — CLOSE.

8.11 TAKEOFF

1. Pitot heat — ON.

2. CABIN PRESS switch — NORMAL.

3. Windshield heat — ON.

4. CDNUs (Aircraft incorporating AFC-279) — ON.

Note

To ensure a stable navigation and flight information display system, both CDNUs must be on with the pilot CDNU operating as the bus controller (flight station CDNU).

5. Radios/NAVAIDs/IFF — SET.

   a. Turn indicators and compasses — CHECK.

   b. Course deviation indicator — SET.

   c. NAV display selector panel — SET.

   d. NAV SEL switch — TACAN.

   e. Tacan — T/R.

6. FLIR/radar — RETRACT/STANDBY (0 tilt)

CAUTION

- Catapult launch with the FLIR viewer in any position other than fully retracted is prohibited.

- Field takeoff or landing with FLIR viewer extended is not recommended because of possible damage to the lens.

Note

The FLIR RETRACT switch is inoperative with weight on wheels. If FLIR cannot be retracted using software procedures, retraction may be attempted by pulling the FLIR (1-F-14), FLIR SYSTEM (1-B-9), and FLIR SYSTEM COOLER (1-E-9) circuit breakers on the left-hinged circuit breaker panel or by pulling the LOGIC PWR circuit breaker on the FLIR converter. If unsuccessful, have ground personnel check turret alignment and attempt retraction using the ground maintenance switch.

7. Pilot emergency instrument lights (Aircraft incorporating AFC-279) — AUTO.

Note

Switch in AUTO will ensure a basic navigation and flight display system in the event of a dual generator failure.

8. Shoulder harnesses — LOCK.

9. Ejection seats — ARM/CREW EJECT.

   a. Ejection seat safety lever (headknocker) — UP AND STOW.

   b. Crew/self-eject selector levers — CREW EJECT (down).

WARNING

Crewmembers should remain strapped in their seats and keep headknockers up whenever the CREW EJECT advisory light is illuminated.

10. O_2 mask — AS DESIRED

11. INCOS trays — STOW.

12. Brake selector switch OFF to ANTI SKID ON — ANTI SKID MOMENTARY FLICKER.

    a. Emergency brakes/EMER BK ON advisory light — CHECK/ON.

    b. Normal brakes/EMER BK ON advisory light — CHECK/OFF.

    c. Antiskid brakes

       (1) Field — ON.

       (2) Carrier — OFF.

Note

Recycling the ANTI SKID switch below 20 knots will give a proper indication of the caution light.

13. Wings/fin — SPREAD/ERECT, LOCK.
14. Flaps/bias — TAKEOFF/IN THE WHITE.

WARNING

Minimal or complete absence of stall warning with leading edge flaps retracted in the takeoff or land configuration will inhibit application of stall recovery procedures, resulting in a rapidly progressive stall condition and possible departure from controlled flight. Flight test indicate altitude loss during recovery is in excess of 3,000 feet.

15. Speedbrakes — IN.
16. Trim — SET.
17. EHP switch — ON.
18. APU — OFF.

WARNING

Tests have shown APU exhaust going down the No. 1 engine intake can cause compressor stalls.

19. Flight control test panel — CHECK.

Check three servo switches on, speedbrake and trim lights out, and roll AFCS channels illuminated.

20. DMPR (Aircraft incorporating AFC-273) — CHECK.

WARNING

If dual channel DMPR is not available, DMPR shall not be engaged until safely airborne.

21. Flight controls — CHECK.

To be completed for multiple trap/catapult operations.

Note

Static torque braking characteristics of carbon brakes at elevated brake temperatures may not prevent the wheels from rolling. Elevated brake temperatures may be attained following extended taxi evolutions at high ambient temperatures or following landings or aborted takeoffs.

8.12 AFTER TAKEOFF

1. EHP switch — AS DESIRED.
2. Fuel transfer — CHECK.
3. APU door — CLOSED.
4. APU generator switch — ON.
5. Cabin pressure (above 5,000 feet) — CHECK.

8.13 APPROACH

1. MASTER ARM/SRCH PWR/ECM ARM SW — OFF.
2. Brakes — AS REQUIRED.
   a. Brake selector switch:
      (1) Field — ANTI SKID ON.
      (2) Carrier — ANTI SKID OFF.
   b. Brake pressure gauge — GREEN.

WARNING

If the brake pressure gauge is in the red (danger) area and the accumulator cannot be charged with the handpump or EHP, do not taxi after arrestment during carrier landings. Perform field arrestment during field landing.

3. Lights — AS REQUIRED.
4. Flight control test panel — CHECK.
   a. Servo switches (three) — ON.
   b. Speedbrake and trim lights out — CHECK.

5. Altimeter/RAAWS — SET.

6. NAVAIDs/NAV display selections — SET.

7. External fuel transfer — AS REQUIRED.

8. ARS — STOW.

CAUTION

The stow indicator can illuminate with up to 4 feet of the refueling hose and drogue extended. To ensure the drogue is fully stowed, leave the STORE POWER switch ON and the HOSE switch in RET for 5 seconds after the stow indicator illuminates.

9. APU/APU generator — AS DESIRED.

CAUTION

If APU is operating prior to landing and the APU AIR ON switchlight illuminates at touchdown, it should be selected to OFF (extinguished) to avoid pressure surges in the APU bleed air system when throttles are advanced past flight idle.

Note

During shore-based operations, the APU start may be deferred to the After Landing Checklist.

10. FLIR — RETRACT.

11. Radar —STBY (0 tilt).

12. SRCH PWR/CONT circuit breakers — AS DESIRED.

13. Ejection seats/eject selector levers — ARM/ CREW EJECT.

WARNING

All headknockers must be up before either pilot selects CREW EJECT.

14. O_2 mask — AS DESIRED.

15. INCOS trays — STOW.

8.14 LANDING CHECKLIST

1. EHP switch — ON.

2. Shoulder harness — LOCK.

3. Speedbrakes — RETRACT.

*4. Fuel — CHECK.

*5. Hook — AS REQUIRED.

*6. Landing gear — DOWN.

   a. Landing gear handle — DOWN.

   b. Landing gear indicators — ALL DOWN.

   c. Landing gear handle light — OUT.

*7. Flaps — AS REQUIRED.

   a. Flap lever and indicators — CORRESPONDING.

*8. DLC — AS REQUIRED.

Note

DLC should be checked for operation prior to final approach.

8.15 AFTER LANDING

After clearing the runway:

1. Speedbrakes — RETRACT.

2. Wing flaps — UP.

*Abbreviated Landing Checklist.

3. Brake selector switch — OFF.

CAUTION

Remove pressure from brake pedals when deselecting antiskid brakes. Movement of the selector switch may result in a surge of pressure that could result in momentary locking of the wheels.

4. No. 2 hydraulic servo — OFF.

5. SPOIL 1 & 2 switch — OFF.

6. Gustlock cover — SET.

7. APU/APU generator — START/ON.

8. APU AIR — AS REQUIRED.

CAUTION

The APU should be turned off or APU AIR switchlight set to OFF (extinguished) during ground operations whenever the aircraft engines are to be operated above flight idle and the bleed air valves are open to preclude No. 1 engine compressor stalls and roll back.

9. Avionics/displays — OFF.

   a. NAVAIDs/RAAWS — OFF.

   b. IFF — OFF.

   c. Computer and displays — OFF.

   d. Radar — OFF.

10. Pilot emergency instrument lights — OFF.

11. Ignition switches — OFF.

12. No. 2 generator — OFF.

13. No. 2 engine — SECURE (as desired).

On shutdown, the throttle should be retarded to the OFF position and the FIRE pull handle pulled.

CAUTION

Monitor ITT after shutdown. If ITT exceeds 540 °C, motor engine with starter. Refer to ENGINE FIRE ON DECK.

Note

The No. 2 engine may be secured while taxiing to the line to reduce residual thrust and facilitate securing the aircraft in the chocks.

14. Ejection seats/eject select levers — AS DESIRED.

15. Oxygen — OFF.

16. Pitot heat/windshield heat switches — OFF.

17. CABIN PRESS switch — DUMP.

18. Wings fold — AS REQUIRED.

CAUTION

- Do not attempt to fold the wings unless all spoiler surfaces are fully retracted.
- To reduce fatigue on the wingfold hinges, wings should be folded/spread while the aircraft is stopped, if practicable.

CAUTION

- The wings should not be folded or spread from the cockpit with the EHP on if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wing.
- Cockpit control of the wing fold system is lost when emergency wing fold is initiated from the left wheelwell. Raising the gustlock cover out of the up detent will not stop an emergency wing fold.

To fold the wings:

a. WING/FIN FOLD gustlock — RAISE.

Note

Ensure that cover is perpendicular to console and firmly pressed into detent to arm system.

b. WING SPREAD/FOLD switch — FOLD (momentarily).

19. Trim

a. Aileron — SET 0.

b. Rudder — SET 0.

c. Elevator — SET 1 NOSEDOWN.

8.16 HOT REFUELING

1. No. 2 engine — SECURE.
2. Radar/HF — STBY/OFF.
3. SONO safety door — OPEN.
4. ECM stores pin (if applicable) — INSTALL.

8.17 HOT SWITCH

1. Crew/self-eject selector levers — SELF EJECT.
2. Ejection seat safety lever (headknockers) — DOWN.
3. Parking brake — SET.
4. NWS — OFF.

After crew switch:

5. APU Start and Post-APU Start Checklist — REVIEW.
6. No. 2 bleed air switch — CYCLE.
7. No. 2 engine — START.
8. Takeoff Checklist — COMPLETED.

Note

No. 2 bleed air switch must be cycled to close the 14th-stage bleed air augmentation valve, preventing a hung or hot start on restart attempt.

8.18 SECURE

WARNING

When operating at field elevations above 5,000 feet, the cabin pressurization system will pressurize the cabin. Before opening the cabin door depressurize the cabin by positioning the CABIN PRESS switch to the DUMP position.

1. Crew/self-eject selector levers — SELF EJECT.

WARNING

Both eject levers shall be placed in the SELF EJECT position prior to any crewmember lowering his headknocker.

2. Ejection seat safety lever (headknockers) — DOWN.
3. Parking brake — SET.
4. Canopy/hatch severance pins — INSTALL.

WARNING

Do not use jettison handles as handholds at any time.

5. Fin fold — AS REQUIRED.

To fold the fin:

a. WING/FIN FOLD gustlock cover — RAISE.

Note

Ensure that cover is perpendicular to console and firmly pressed into detent to arm system.

b. FINFOLD/ERECT switch — FOLD (momentarily).

6. No. 2 engine — CHECK SECURE.

7. Avionics (CDNUs on aircraft incorporating AFC-279) — OFF.

Note

Power down the CAINS/EGI first, then turn off the two CDNUs.

8. SONO safety door — OPEN.

9. ECM stores pin (if applicable) — INSTALL.

10. Chocks/chains — INSTALL.

11. Ground air/electric power — AS REQUIRED.

12. No. 1 hydraulic servo — OFF.

13. No. 1 GENERATOR — OFF.

14. No. 1 engine — SECURE.

15. FIRE pull handles — PULL.

16. Landing gear/hook pins — INSTALL.

17. Emergency floodlight — OFF.

18. Exterior/interior lights — OFF.

19. EHP switch — OFF.

20. Standby gyro — CAGE AND LOCK.

Wait 1 minute after engine shutdown before proceeding.

21. Bus switches — OFF.

22. APU GEN switch — OFF.

23. APU — OFF.

8.19 POSTFLIGHT INSPECTION

The pilot will ensure that a proper postflight inspection has been accomplished before leaving the aircraft area and ensure that the landing gearpins are installed.

CHAPTER 9

Carrier-Based Procedures

9.1 CARRIER-BASED OPERATIONS

The CV NATOPS and LSO NATOPS Manuals are the governing references for carrier-based operations.

9.2 CARRIER-BASED NORMAL PROCEDURES

9.2.1 Preflight

9.2.1.1 Day. A normal preflight inspection should be accomplished with particular attention given to the landing gear, tires, hook, hook damper gauge pressure, and underside of the fuselage for possible damage.

Occasionally, the aircraft assigned will be manned on the hangar deck. Unless the aircraft is already spotted on the elevator, it will be towed to the elevator for access to the flight deck. The signal to stop a plane that is being moved by other than its own power is a whistle blast. Leave the helmet off to hear whistle signals. Any whistle blast signifies an immediate stop. The aircraft will be raised to the flight deck level and either respotted or started on the elevator.

Note

Emergency brake pressure should be kept in the green area on the gauge by use of the auxiliary handpump.

9.2.1.2 Night. External preflight should be made utilizing a blue-lensed flashlight. In addition to normal cockpit preflight, ensure that external light switches are positioned to bright and steady with the bottom anticollision light off. The master exterior lights switch and taxi light switch should always be in the OFF position prior to start. Set the cockpit and approach indexer lights as desired.

9.2.2 Checklists. Standard shore-based checklists will be utilized. Where a choice of action exists (i.e., brake selector), the action appropriate to the carrier will be utilized. Because of deck multiple and individual carrier peculiarities, some poststart actions must be deferred until the wings are spread or the aircraft is broken down.

9.2.3 Poststart

9.2.3.1 Day. Engines will normally be started 30 minutes prior to launch, and functional checks will be performed. Do not let the plane directors hurry these checks. When ready, signal the plane director with a thumbs-up signal. Chocks and tiedowns will be removed upon signal by the plane director.

9.2.3.2 Night. After normal system checks are completed, perform exterior lights check by momentarily turning the exterior master switch on, then off. When ready, signal the plane director with a vertical motion of the flashlight; this means checks are completed and the aircraft is up. If the aircraft is down, make a horizontal motion with the flashlight.

9.2.4 Taxi

WARNING

If aircraft rolls into the catwalk or over the side, do not attempt ejection after aircraft has passed the horizontal. Pull canopy/hatch severance handle after aircraft settles.

CAUTION

When taxiing/turning on deck, if increased ITT is encountered because of ingested jet exhaust, secure bleed air, select flight idle, or carefully increase power as necessary to prevent an overtemperature condition. Monitor ITT and shutdown if overtemperature occurs.

CAUTION

Wing spread/fold during flight deck taxi in high wind speed can result in the aircraft breaking traction and sliding when the deck is wet/slippery. Flightcrews must be attuned to wind and deck conditions whenever the wings are spread/folded. The aircraft longitudinal axis should be pointed into the relative wind to the maximum extent possible during the wing spread/fold sequence.

9.2.4.1 Day. Any signal from the plane director given from above the waist is intended for the pilot. Any signal given from below the waist is intended for deck handling personnel. While taxiing, careful attention must be given to the director and his signals shall be followed explicitly. Nosewheel steering permits the use of minimum power while taxiing. During turns, maintain sufficient momentum on the aircraft to preclude the use of high-power settings while in the turn. Hard turns should be accomplished using full rudder deflection, avoiding brake pedal inputs. Taxi speed shall be slow at all times, especially on wet decks and approaching the catapult area. Be prepared to use emergency braking should normal braking fail.

9.2.4.2 Night. During night operations, slow and careful handling of aircraft by both plane directors and pilots is mandatory. If there is any doubt as to the plane director signals, stop.

9.2.5 Launch Procedures

WARNING

Placing the cockpit launch bar control switch to RET position prematurely (prior to full tension) may result in improper hookup and early separation from the shuttle.

CAUTION

- Failure of the LNCH BAR EXT advisory light to illuminate when the launch bar is extended may indicate a failure of the launch bar control circuitry. This may result in landing gear retraction with the launch bar extended.

- As the launch bar enters the lead-in track, nosewheel steering should be disengaged to prevent possible damage to the nosewheel steering mechanism.

Note

- Placing the cockpit launch bar control switch in RET position after full tension allows hydraulic pressure to immediately raise the launch bar as the shuttle moves aft if the launch has been suspended.

- If the cockpit launch bar control switch is placed in the RET position prior to advancing the throttles to maximum position, the LNCH BAR FAIL caution light will illuminate; however, upon advancing the throttles, this caution light will go out.

9.2.5.1 Day. Proper positioning on the catapult is easily accomplished by following the plane director signals explicitly. All functional checks will be performed prior to taxiing onto the catapult as practicable. After the launch bar is dropped to the deck and the holdback fitting has been attached to the aircraft and checked by squadron maintenance personnel, the aircraft will taxi to the mouth of the lead-in track. Disengage nosewheel steering. As the aircraft rolls forward, the launch bar will drop into the shuttle and the aircraft will stop in position for shuttle tension-up.

9.2.5.2 Night. Maneuvering the aircraft for catapult hookup at night is identical to that used in day operation. The pilot must rely upon and follow closely the plane director signals.

9.2.6 Catapult Launch

9.2.6.1 Day. Ensure that the Takeoff Checklist is completed before entering the nose-tow approach ramp. Aircraft trim should be set to the recommended settings as determined in paragraph 7.2, TAKEOFF PLANNING.

WARNING

- During catapult launches with leading edge flaps retracted, do not perform a clearing turn until the trailing edge flaps have been retracted in accordance with the recommended flaps-up airspeed schedule.

- If the takeoff trim is set more than 1° different from the recommended setting, hazardous attitudes may occur after takeoff. During a catapult launch, excessive nosedown trim may cause considerable altitude loss and contact with the water. Excessive noseup trim may result in extreme overrotation and stall may result. Compliance to the required trim settings is mandatory for safe operation of the aircraft.

Upon receipt of the tension-up-and-release-brakes signal, advance the throttles to full military power and rotate the catapult grip to the proper position. Place the launch bar switch to RETRACT. Check all engine and flight instruments for normal indications and operation. Ensure the crew is ready, place the head against the headrest, and salute the catapult officer. Grasp the stick lightly and allow the stick to move aft because of acceleration forces during the power stroke. As the aircraft leaves the deck, the stick will return to the trim position. The pilot should be prepared to provide smooth control inputs to maintain an optimum 10° to 12° noseup attitude over that on deck prior to tension. Avoid clearing turns until an airspeed well above minimum has been established.

WARNING

Catapult takeoffs with leading edge flaps retracted can be conducted with current NATOPS pitch trim settings if 20 knots excess endspeed is provided and no turns are initiated until the trailing edge flaps have been retracted.

After launch, crosscheck AOA and attitude and monitor the airspeed and altimeter for increasing values. Retract the landing gear after becoming airborne. Retract the flaps in accordance with the recommended flap-up airspeed schedule.

Instrument scan after launch should include all flight instruments. Initial pitch attitude is immediately indicated on the VDI. Wing position is displayed on the VDI and by the HSI (if turning). Airspeed information is available and can be monitored during the catapult stroke. Vertical speed may be used after leaving the catapult. It must be emphasized that the most important requirement after catapult launch is establishing a comfortable climb rate.

Note

Immediately after launch, the AOA may momentarily indicate a higher than normal indication (19.5 to 20.5 units). This is a result of an updraft created by the ship's bow.

9.2.6.2 Night. The procedures for catapult launch at night are basically the same as for day launches. When ready to launch, signal the catapult officer by placing the external light master switch to ON. The launch technique discussed under the day procedures is applicable. The copilot/COTAC should monitor the flight instruments until climbing through 2,500 feet.

WARNING

Generator failures during catapult launch generally result in a bright flash of light followed by scope failure if the MPD is on. Pilot and copilot/COTAC scopes should be OFF prior to night catapult launches to prevent disorientation and possible loss of night vision.

9.2.7 Aircraft or Catapult Malfunction. If it is determined that the aircraft is down after establishing military power, signal the catapult officer by shaking the head from side-to-side. Transmit to PriFly, "Suspend (catapult number)." Never raise a hand into the catapult officer's view to give thumbs-down signal (it may be misinterpreted as a salute and the catapult will be fired). At night, do not turn master light switch on. The catapult officer will relay a NO-GO situation to the deck-edge catapult operator by crossing his forearms in front of his face. The catapult officer will then give the release-tension signal and walk in front of the wing to give the throttle-back signal. The launch bar will retract as the shuttle moves aft. Then, and only then, reduce the throttles from military to IDLE and remove head from headrest. The same signals will be used to signify a catapult malfunction.

WARNING

Leave the throttles at military until the catapult officer walks in front of the wing and signals for power to be reduced to IDLE.

9.2.8 Recovery. Procedures for arrival, marshal, and approach shall be in accordance with the CV NATOPS Manual. The recommended approach angle of attack is 15 units with corresponding approach airspeeds varying linearly between 118 KIAS with land flaps at 40,500 pounds to 98 KIAS at 28,000 pounds and 125 KIAS with takeoff flaps at 40,500 pounds to 104 KIAS at 28,000 pounds. A hook-to-eye value of 14.5 feet has been utilized and provides satisfactory hook-to-ramp clearance.

WARNING

With one or both main wheel tires blown, one or both main gear may collapse on touchdown because of induced resonance from unbalanced rotation of the blown tire(s). Consideration should be given to diverting to shore for a short-field arrestment. Landing weight should be minimized.

The direct lift control system shall be engaged for all normal carrier approaches including no-flap approaches.

9.2.9 Pattern (VFR). Pattern entry (see Figure 9-1) shall be in accordance with the CV NATOPS Manual. At the break, the leader shall break smartly to 45° to 90° of bank, reduce power to IDLE, extend speedbrakes, slow to 186 KIAS, extend the landing gear, retract speedbrakes, and place the flaps to TAKEOFF (at 156 KIAS place flaps to LDG), and maintain 800 feet until established downwind. On downwind, descend to 600 feet and slow to optimum AOA. Subsequent aircraft should break at 17-second intervals for arrested landings and 12 seconds for touch-and-go landings.

Approaching the abeam position, cross-check airspeed and angle-of-attack indicators for proper indications. If an APC approach is desired, engage the system at this time. At the abeam position, the aircraft should be 600 feet, optimum AOA, 0.9 to 1.1 miles abeam, with the Landing Checklist completed.

9.2.10 Approach

9.2.10.1 Approach (Manual). Commence turn-in abeam the LSO platform to have approximately a 15-second groove. Establish a 20° to 22° turn towards final approach and begin a slight rate of descent, maintaining optimum AOA. Passing the 90° position, the aircraft should be at 450 feet, optimum AOA. Establish a 500-fpm rate of descent at this time. Meatball acquisition will occur near the 45° position. Adjust power and trim as necessary to maintain a centered ball and optimum angle of attack.

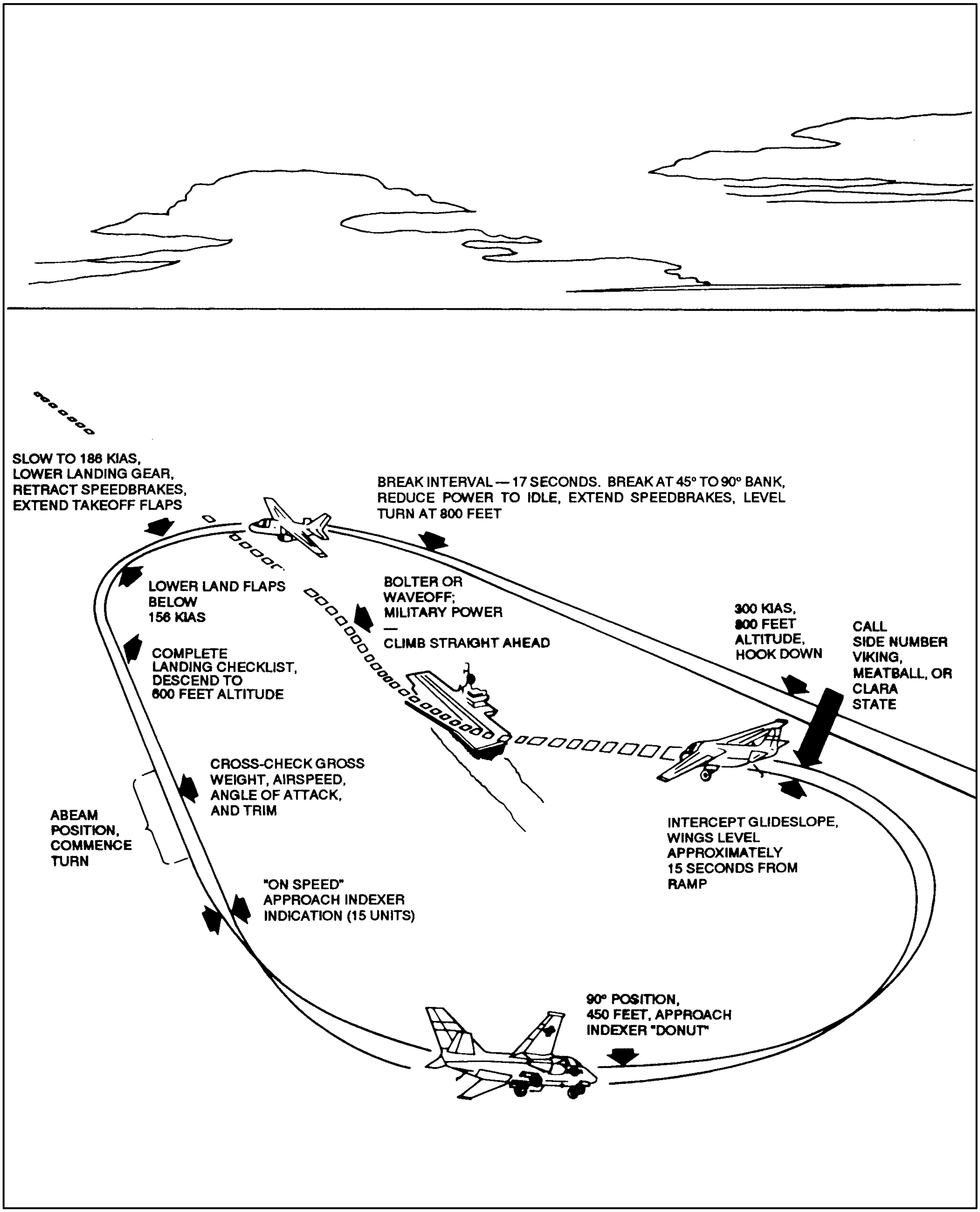


Figure 9-1. Carrier Landing Pattern

When rolling out, start reducing power and adjust nose attitude to maintain optimum AOA and the desired rate of descent. Scan lineup and correct any errors expeditiously. Glideslope corrections should be timely in fashion and require coordinated power and attitude adjustments to optimize aircraft response and performance. During the approach, continuously scan meatball, lineup, and angle of attack. As the aircraft approaches the ramp, corrections should become smaller and more precise. DLC should primarily be utilized inside the in close position to stop a rising meatball condition. Substantial power reductions in this area of the approach should be avoided. Poor engine response and subsequent poor glideslope control will result if the power is reduced to a near idle setting during the latter part of the approach.

WARNING

- Reducing stick forces by trimming noseup during a decelerating, low-power approach to a slow touchdown will result in an excessive amount of noseup trim for a touch and go/bolter. Application of full power will result in an immediate nose pitchup. Under these conditions, nosedown trim may be necessary to control the aircraft. Loss of pitch trim may require immediate reduction of power as well as full forward stick to control the noseup trim change. If unable to control pitch attitude, reduce power prior to exceeding 15° noseup attitude. Use extreme caution when pitch trim has been disconnected.

- When conducting an approach with leading edge flaps retracted, maneuvering should be minimized and extreme caution exercised so the aircraft does not decelerate above optimum AOA. A straight-in approach is recommended.

Note

In both carrier and land environment, when winds are above 30 knots and/or gusty conditions exist, consideration may be given to landing with the flaps in TAKEOFF position.

9.2.10.2 Approach (APC). Engage APC prior to the 180° position when at approximately optimum AOA. Maintain hand contact with the throttles throughout the approach; this technique will allow for timely waveoffs if necessary as well as provide a throttle referenced attitude position. During the approach, utilize smooth nose inputs to adjust altitude; abrupt attitude changes will cause large power transients resulting in poor altitude and AOA control.

Note

To ensure optimum APC performance, the pilot should set minimum throttle friction and trim out pitch stick forces prior to APC engagement.

Passing the 90° position, adjust attitude to commence a 500-fpm rate of descent. Following meatball acquisition, continue to scan AOA as well as the ball; observing AOA changes will allow for more astute attitude corrections.

Reduce attitude slightly when rolling out on start to maintain optimum rate of descent. Corrections to glideslope in the groove must be smoothly applied using attitude control. Lead recorrections and continue to observe AOA throughout the approach. Approaching the ramp avoid dropping the nose to correct for high glidescope situations; higher than anticipated descent rates will develop as a result of the combination attitude and power reduction. Maintain attitude and use DLC to correct for high situations approaching the ramp. Add full power immediately upon touchdown in anticipation of a bolter.

Waveoffs and power calls initiated by the LSO will require disengagement of APC. This procedure should be accomplished by pressing the NWS switch and simultaneously adding power.

WARNING

Automatic disengagement of the APC in the groove requires timely action by the pilot to avoid a dangerously low/slow situation from developing. Upon illumination of the APC automatic disengagement light located on the HUA panel, immediately add power.

9.2.11 Waveoff/Bolter Pattern

9.2.11.1 Day. A waveoff during the approach will be signaled by the LSO primarily by flashing red lights on the OLS and backup UHF radio transmission. Upon receiving a waveoff signal the pilot should immediately disengage APC and add full maximum power. The landing attitude (approx. 4° to 6° noseup) must be maintained to reduce the possibility of in-flight engagement during waveoff. Positive forward control stick pressure is required to counter the noseup pitching moment generated by the large power addition. Under no circumstances should optimum angle of attack be exceeded during the waveoff as this will necessitate a nose-high attitude and decrease the aircraft hook to ramp clearance. Climb straight ahead on a waveoff or a bolter, then make a slight right turn to parallel the ship's base recovery course. Do not cross the bow while flying upwind. Be alert for other aircraft launching or entering the pattern from the break. The aircraft ahead will have priority for the turn downwind.

9.2.11.2 Night. On a waveoff at night, utilize the same pilot technique as in the day pattern. Climbing on the waveoff or bolter, climb straight ahead on the final bearing. The downwind turn will be made at an altitude of 1,200 feet. The night pattern should be flown entirely on instruments until in a position to acquire the meatball visually. However, it is prudent to maintain alert to the transmission of other aircraft and to make a brief visual check when it becomes apparent another aircraft is in close proximity.

9.2.12 Arrested Landing and Exit from Landing Area

9.2.12.1 Day. Upon touchdown, advance the throttles to full military power. As soon as arrested, place the throttles to IDLE. Allow the aircraft to roll back to disengage the arresting gear, then raise the hook on the director's signal. Initiate taxi on the director's signal. Engage NWS and taxi clear of the landing area. Keep the engines running until the director signals chocks-are-in-place and cut-engine.

CAUTION

- Abrupt NWS inputs without sufficient forward momentum may result in failure of the NWS.
- Monitor engine instruments following rollout. Secure engine if indications of N_g rollback together with high and increasing ITT are observed.

Clear the landing area in an expeditious but controlled manner. Fold wings when directed. Do not secure No. 2 engine until tied down.

WARNING

Do not fold the fin prior to aircraft tiedown because of loss of artificial feel in the NWS that will cause degraded deck handling qualities.

9.2.12.2 Night. The same procedures for day operations should be utilized at night except that immediately following arrestment, place the master exterior light switch to OFF. Taxi out of the landing area slowly. Do not stare fixedly at the plane director wands, but use them as the center of the scan pattern.

9.2.13 Carrier-Controlled Approach. Carrier-controlled approaches shall be conducted in accordance with the CV NATOPS Manual. A typical pattern is shown in Figure 9-2.

9.2.13.1 Marshal. Aircraft will normally marshal individually at maximum endurance with the arresting hook down.

9.2.13.2 Penetration. The aircraft will depart marshal allowing approximately 500 pounds of fuel for the penetration and approach.

Penetration will be accomplished in accordance with published approach procedures.

9.3 FIELD CARRIER LANDING PRACTICE PROCEDURES

9.3.1 Preflight Inspection. A normal preflight inspection (see Figure 8-1) will be conducted with specific attention being given to the strut condition and extension.

9.3.2 Pattern Entry. Call "Paddles" prior to pattern entry to confirm Charlie time. Enter the break at 800 feet above the terrain. When cleared to break and

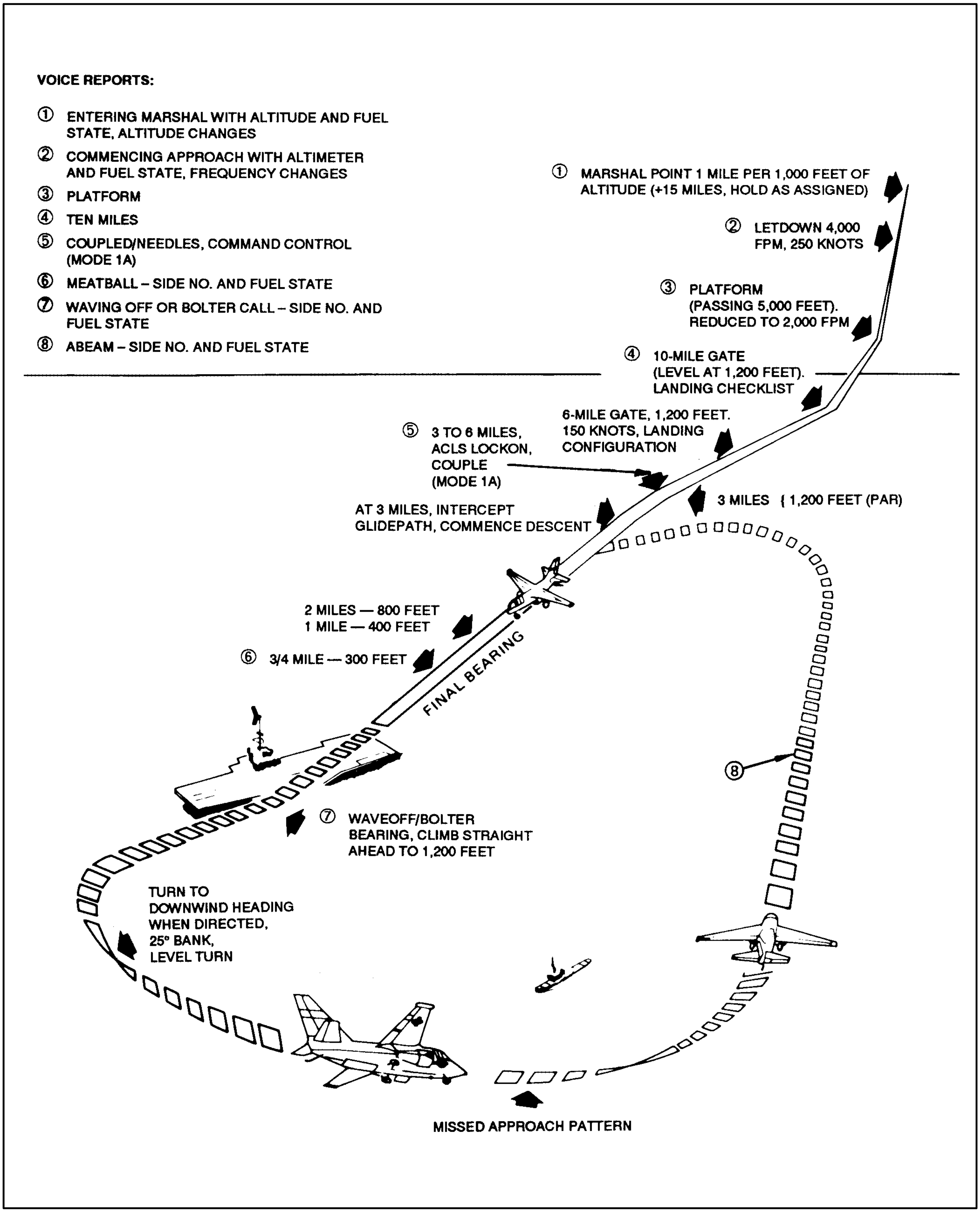


Figure 9-2. Carrier-Controlled Approach

the proper interval of the aircraft ahead is assured, roll into a 45° to 90° banked turn, reduce power to IDLE, extend speedbrakes, slow to 186 KIAS, extend gear, retract speedbrakes, and place flaps to TAKE OFF. At l56 KIAS, place flaps to LDG and maintain 800 feet until intercepting the downwind leg. On the downwind leg, descend to 600 feet above the terrain. Slow to on-speed angle of attack and check airspeed against the angle-of-attack indicator to ensure proper calibration for aircraft gross weight. Aircraft in formation will take a 10-second break interval. Complete the Landing Checklist prior to reaching the 180° position. Check that the hook bypass switch is in the FIELD position.

9.3.3 Normal Pattern

9.3.3.1 Approach. Begin the approach by turning 13 to 18 seconds past the abeam position to have an approximately 15-second, wings-level groove. Passing the 90° position, the aircraft should be at 450 feet, optimum AOA. Commence a 500-fpm rate of descent at this time. Meatball acquisition will occur near the 45° position, adjust power and trim as necessary to maintain a centered ball and optimum angle of attack.

9.3.4 Bingo Fuel. Recovery at divert field should be with no less than 1,000 pounds of fuel remaining.

Note

FCLP landings are permissible only with empty Aero-1D tanks, if installed.

9.3.5 Night Pattern. The night pattern and approach technique are generally the same as the day pattern with the following exceptions:

1. The pattern will be flown on instruments until visual acquisition of the meatball is made.

2. A straight-in CCA-type approach at 600 feet above the terrain will be made by extending the downwind leg 30 seconds past the 180° position.

9.3.5.1 Ninety-Degree Position. Maintain optimum angle of attack at 600 feet.

9.3.5.2 Final. At approximately the 45° position, the meatball will appear. Change power and attitude as necessary to keep the meatball centered. Glideslope corrections should be made quickly by smooth changes in power, stick position, and trim as required to maintain a centered meatball and optimum angle of attack.

9.3.6 Landing. Keep the aircraft on the glideslope and centerline throughout the approach. Do not flare. When touchdown is made, add full power immediately and use the bolter technique described in this chapter. Climb straight ahead. Turn downwind for the next pass when the aircraft ahead is approximately in the 10-o'clock position on the downwind leg.

9.3.7 Waveoff. The pilot must initiate a waveoff whenever he believes his aircraft to be in an unsafe position. Anytime a waveoff is received, either by the waveoff lights or by radio, it is mandatory and will be answered with FULL MILITARY POWER. Maintain approach attitude until assured touchdown will not occur.

9.4 ACLS FLIGHT PROCEDURES

9.4.1 In Marshal

1. Radar transponder (APN-202) MODE selector switch — STBY.

2. ACLS (ASW-25) power switch — ON.

3. ACLS FREQ SELECT — PROPER FREQUENCY SET.

4. ACLS selector switch — NORM.

5. ARA-63 POWER switch — ON.

6. ARA-63 CHANNEL selector — PROPER CHANNEL SET.

7. VDI toggle switch — NAV (ACLS on aircraft incorporating AFC-279).

8. NAV SEL switch — AWCLS.

9. ACLS data-link self-test.

10. VDI toggle switch — ILS (CILS/VOR on aircraft incorporating AFC-279).

11. Perform ARA-63 self-test.

12. Radar transponder — PERFORM BEACON SELF-TEST.
13. Radar transponder MODE selector switch — ACLS.

9.4.2 After Descent

1. Perform landing checks at 8 miles, 1,200 feet or as assigned.
2. AUTO THRUST switch — APC.
3. APS switches YAW (DMPR on aircraft incorporating AFC-273), ROLL, and PITCH. — ENGAGED.
4. Monitor SPN-41 needles and tacan for proper lineup information.

9.4.3 ACLS Approach

1. Observe LANDING CHECK discrete light on, TILT discrete light extinguished. Ensure landing checks are completed.
2. At lock-on, observe ACL LOCK ON and COUPLER AVAIL discrete lights illuminated. Observe right radar transponder ACLS TEST light illuminated.
3. Ensure straight and level, on-speed, steady-state flight.
4. HDG SEL/NAV switch — NAV.
5. Report “Coupled.”
6. Observe illumination of COMMAND CONTROL discrete light.
7. Monitor discrete lights and needles during approach.
8. At one-half mile (or three-fourths mile, depending on ship procedures), the CCA controller will ask for a ball-call. Report “(call sign), coupled ball (state).” LSO will acknowledge, “Roger, coupled ball.”
9. After the ball-call, control calls by the LSO (lineup, power, attitude, etc.) will necessitate an uncouple. Press the AFCS disconnect switch and continue the approach in APC or manual throttle at pilot discretion. By pressing the AFCS disconnect switch, pitch, roll, and yaw axes will also disengage. An additional method to disengage is to set the HDG SEL/NAV switch to OFF. This will enable the YAW APS (DMPR on aircraft not incorporating AFC-273) to remaining engaged. The pitch and roll axes will disengage, causing the A/P warning light to flash.
10. If the approach is Mode IA, the CCA controller should revert to Mode II at one-half mile, causing the APS to disengage. This will illuminate the COUPLER OUT and ACL LOCK discrete lights and cause the red A/P warning light to flash. It will extinguish the COMMAND CONTROL and COUPLER AVAIL discrete lights. To preclude YAW APS disengagement in aircraft not incorporating AFC-273, set the HDG SEL/NAV switch to OFF prior to the CCA controller action.

CHAPTER 10

In-Flight Procedures

10.1 AIRCRAFT OPERATIONS

10.1.1 Taxi. The aircraft is taxied by use of nosewheel steering and brakes. Control aircraft direction by use of nosewheel steering, and control aircraft velocity with braking action. The most effective method to make a hard turn is to use maximum nosewheel steering deflection while controlling velocity by outboard wheelbraking.

Note

To prevent possible damage to wing fold systems, it is recommended that towing or taxiing beyond the immediate vicinity of the line area be accomplished with either the wings spread or the wings folded with jury struts installed.

10.1.2 Takeoff. To take off, the aircraft is taxied onto the runway and aligned as desired using nosewheel steering. The brakes should be applied, both engines simultaneously jam accelerated, and the fan speed should be checked (see Figure 7-4). If the aircraft starts moving, release the brakes and check engine instruments on the initial portion of the takeoff roll. If the aircraft remains stationary, release the brakes after the engine instruments are checked and the pilot should drop his heels to the floor, maintaining directional control with nosewheel steering. The rudders will become effective at about 60 KIAS, at which time nosewheel steering can be disconnected. Throughout the takeoff roll, the wings should be kept level with lateral stick. At rotate speed, the stick should be programmed back to rotate to 8° to 10° noseup. Maintain this attitude, retract the gear and flaps, and accelerate to the climb schedule. Above 45,000-pound gross weight, the flaps should not be retracted until 180 KIAS, while below 45,000-pound gross weight, 160 KIAS flap retraction speed will not result in uncomfortable settle or higher than desired AOAs. After intercepting the climb schedule, set climb power and check pressurization above 5,000 feet.

CAUTION

During catapult or field takeoffs with leading edge flaps retracted, do not initiate turns until the trailing edge flaps have been retracted.

Note

- Static torque braking characteristics of carbon brakes at elevated brake temperatures may not prevent the wheels from rolling. Elevated brake temperatures may be attained following extended taxi evolutions at high ambient temperatures or following landings or aborted takeoffs. During formation takeoffs, power should be initially advanced to 80-percent N_g and engine instruments rechecked following brake release.
- Following an aborted takeoff, a visual inspection of the brake assemblies should be performed by qualified personnel prior to continued operations.
- Elevated wheel temperatures following an aborted takeoff may cause the fuse plugs to release tire pressure, resulting in fully deflated mainmount tires.

At flight altitudes above 25,000 feet above sea level, cabin altitude should be monitored to assure a normal pressurization rate. The inability of the cabin pressure controller and the safety valve to function satisfactorily could result in cabin overpressurization.

10.1.3 Cruise. Optimum cruise performance can be attained by flying at maximum-range airspeeds and flying at optimum cruise altitudes contained in Part XI. Performance may also be improved if deice is selected with the ANTI-ICING switch in PITOT position. This configuration reduces bleed air demand on the engines, but cabin temperature and pressure must be closely monitored. Aircrew must ensure sufficient cooling is provided to the GPDC and if cabin altitude exceeds 10,000 feet, oxygen masks are required.

10.1.4 Pattern (VFR). Pattern entry should be in accordance with local course rules. At the break, roll the aircraft smartly 45° to 90° angle of bank, reduce power to idle, extend speedbrakes, slow to 186 knots, extend landing gear, retract speedbrakes, and place flaps to TAKEOFF (at 156 knots place flaps to LANDING). Maintain break altitude until established downwind. On downwind, descend to pattern altitude.

Note

Recommended break airspeed is 300 knots.

Approaching the abeam position, cross-check airspeed and AOA for proper indications. If an APC approach is desired, engage the system at this time. At the abeam position, the aircraft should be at pattern altitude, optimum AOA, 0.9 to 1.1 miles abeam with the Landing Checklist completed.

10.1.5 Normal Landing. The aircraft should be stabilized at optimum AOA at the 180° position. It then should be flown at optimum AOA to touchdown. With DLC engaged, thrust-pitch compensation minimizes pitch changes with power; however, if DLC cannot be engaged, then power changes will require coordinated stick to maintain pitch attitude. Because of the slow engine response from IDLE, care should be exercised when operating the engines near IDLE. At touchdown, retard the throttles to IDLE, extend the speedbrakes, continue to fly the aircraft laterally and directionally with stick and rudder, and apply the brakes as desired. The nosewheel steering can be engaged at any speed if directional control problems are encountered; however, if no problems are encountered, it probably will not be required except to turn off the runway.

Note

In both carrier and land environment, when winds are above 30 knots and/or gusty conditions exist, consideration may be given to landing with the flaps in TAKEOFF position.

10.1.6 Touch-and-Go Landing. At touchdown, full power should be applied and the aircraft allowed to rotate at a controlled rate to 8° to 10° pitch attitude. With approach trim setting, forward stick will be required to control the pitch rate at lift-off.

WARNING

Reducing stick forces by trimming noseup during a decelerating, low-power approach to a slow touchdown will result in an excessive amount of noseup trim for a touch and go/bolter. Application of full power will result in an immediate nose pitchup. Under these conditions, nosedown trim may be necessary to control the aircraft. Loss of pitch trim may require immediate reduction of power as well as full forward stick to control the noseup trim change.

10.1.7 Crosswind Landing. Use of the wing-down-top-rudder, crab technique, or combination thereof can be used during a landing approach in crosswind conditions. However, if a crab is utilized, it must be removed with a rudder correction prior to touchdown. If the wing-down-top-rudder technique is used, a slight increase in power will be required because of the increased drag caused by sideslip. As sideslip is increased or decreased during the approach, rate of descent will vary accordingly. Crosswind correction using sideslip is effective in crosswind components up to approximately 15 knots. For higher crosswind components, use crab and sideslip as necessary. Use of TAKEOFF flaps may make the approach easier by reducing sideslip requirements. However, the crosswind effects after landing are not diminished by higher landing speeds. After touchdown, it is paramount that crosswind corrections be applied during rollout to maintain lateral and directional control. Disengaging of yaw damper during the approach will increase the rudder available during a sideslip approach, but significantly increase pilot workload because of Dutch-roll.

Crosswinds tend to pick up the up-wind wing and weathercock the aircraft during rollout. Use lateral control into the wind to keep the wing down. Considerable downwind rudder may be required to oppose weathercocking and lateral control input. Engagement of nosewheel steering should be made as slow as possible, and the rudder pedals should be centered prior to engagement to prevent an abrupt swerve.

Crosswind landings on wet or icy runways will require judicious use of power and all available controls (rudder, aileron, brakes, and nosewheel steering) during rollout to accomplish a safe landing. The decreased braking action available could lead to tire hydroplaning and aircraft skidding if the crosswind component is excessive. Landing approaches in the S-3B should always be made to the runway having the smallest crosswind component, particularly when reduced braking action is expected. Should a crosswind landing on a wet or icy runway be unavoidable, serious consideration should be given to executing a short-field arrestment. If the aircraft enters a skid during landing rollout and judicious use of power and controls proves insufficient to correct the situation, the pilot should be prepared to execute a go-around if sufficient runway remains or to drop the hook and take a field arrestment if abort gear is available.

Note

- If the nosewheel steering is not already engaged when the tailhook is lowered, the nosewheel will be powered to the center position.
- On deck, if the nosewheel steering is engaged prior to hook extension, normal nosewheel steering authority will be available.

10.1.8 No-Flap Landing. The no-flap landing is flown the same as the normal landing. The pattern will be automatically adjusted to a wider abeam and deeper extension off the 180, because of the higher approach speeds. The DLC system should be engaged and APC may be utilized during the approach; however, DLC operation should be avoided in close.

The extension of upper and lower speedbrakes during DLC operation will significantly increase rate of descent and the potential to exceed landing gear vertical load limits. The stall margin will also be reduced proportionally greater with DLC operation in the no-flap configuration. Rotation of the aircraft to arrest sink rate caused by DLC operation coupled with lower power levels than in a full flap approach decrease the stall margin even more. It must be emphasized that although the angle of attack displayed to the pilot remains at 15 units with DLC operation, the wing is at 17 units.

Landing distances are increased and landing performance data should be computed prior to landing. The horizontal stabilizer trim rate will be variable as a function of stabilizer position and lateral stick stops will reduce lateral control authority.

10.1.9 Maneuver Flap Landing. Maneuver flap landings are flown the same as normal landings. The DLC system should be engaged and will function normally. APC may be utilized and is recommended for the approach. Landing distances are increased and landing performance data should be computed prior to landing.

10.1.10 No Leading Edge Flap Landings. Minimal or complete absence of stall warning with leading edge flaps retracted in the takeoff or land configurations will inhibit application of stall recovery procedures, resulting in a rapidly progressive stall condition and possible departure from controlled flight. Flight tests indicate altitude loss during recovery is in excess of 3,000 feet. When conducting an approach with leading edge flaps retracted, maneuvering should be minimized and extreme caution exercised so the aircraft does not decelerate above optimum AOA. A straight-in approach is recommended.

10.2 INSTRUMENT FLIGHT PROCEDURES

The S-3B aircraft is a multipiloted aircraft for instrument flight if both the pilot and copilot/COTAC seats are occupied by S-3B NATOPS qualified pilot and copilot/COTAC, possessing a current instrument rating.

10.2.1 Flight Planning. Clearance delays, prolonged operation at low altitudes, and holding demand a critical approach to flight planning. Prior to instrument flight, reference should be made to S-3B performance data, FLIP, and weather to ensure successful completion of a flight.

10.2.2 Instrument Takeoff and Climb. After completing the Takeoff Checklist, taxi into position and align the aircraft with the runway heading. Note the HSI heading and adjust the VDI pitch attitude to zero. Add full power, verify engine operation, and release the brakes. Maintain runway heading using the HSI. Use lateral and rudder controls to maintain wing position and correct heading deviations. Passing 60 KIAS, disengage nosewheel steering. At rotation speed, rotate the aircraft to 8° to 10° pitch attitude on the VDI. After comfortably airborne with a positive rate of climb, raise the landing gear. Raise the flaps to UP, predicated on gross weight.

When the aircraft accelerates to climb speed (220 KIAS), adjust VDI pitch attitude to 10° to 12° or as necessary to maintain 220 KIAS until intercepting 0.6 IMN. Upon intercepting 0.6 IMN, maintain this Mach until the desired level-off altitude is reached. Intermediate power should be utilized in the climb after reaching initial climb speed. Accurate climb schedules can be computed for various gross weights and drag counts utilizing data in Part XI.

Note

When operating above FL 180, the pilot should use the STBY mode set to 29.92 inches of mercury. The copilot/COTAC should use the RESET mode. This combination of altimeter settings will give the aircrew an immediate comparison between barometric and computed altitude from the SCADC and altitude reported to ATC via the IFF mode C.

10.2.3 Instrument Cruise Flight. After level-off, establish desired cruise airspeed or Mach number. Adjust VDI pitch index as desired to aid in maintaining level flight.

10.2.4 Instrument Turns. Turns should be standard rate except on final approach when they should be half-standard rate. Normally they should not exceed 30° angle of bank. However, if steeper turns are necessary, maintain VDI index position for level flight and adjust power as required to maintain trim airspeed. Do not exceed optimum AOA. In holding, turns should be standard rate, and the airspeed should be that for maximum endurance plus 15 knots for ease of maneuvering (approximately 180 KIAS). Precise endurance airspeeds can be computed from data in Part XI.

10.2.5 Instrument Penetration/Descent. Prior to commencing a penetration or descent in IMC, the pilot should prepare the aircraft for adverse weather conditions. Windshield heat may be required to prevent fogging or icing. Engine anti-ice should be utilized to prevent engine icing. Wing and empennage deicing may be required to prevent structural icing. If the penetration or descent will terminate in an approach, the approach checklist should be completed. A maximum endurance or maximum range descent may be desirable. If so, reduce power to IDLE and maintain appropriate airspeed computed from data in Part XI.

If a more rapid descent is required, it is recommended that the pilot adjust pitch attitude to maintain 250 KIAS. Upon reaching 250 KIAS, extend 25° to 30° of speedbrakes and reduce power to IDLE. Adjust pitch attitude to maintain 250 KIAS. When within 2,000 feet of the desired level-off altitude, adjust pitch attitude to maintain a rate of descent approximately equal to the altitude remaining prior to level-off. Speedbrakes should be retracted and power adjusted upon reaching desired level-off altitude and speed.

10.2.6 Instrument Approaches. Adjust final approach speed and configuration as necessary for a safe approach. Airspeed and configuration should be set prior to descent on final. In the event of a missed approach, apply maximum power and retract gear/flaps in accordance with airspeed limitation per gross weight. Continue missed approach as directed or published.

10.3 STALL AND AEROBATICS CHECKLIST

1. Harness — LOCKED.
2. Loose gear — STOWED.
3. Trays — UP.
4. Radar — STBY (0 tilt).
5. Pin box — SECURE.

10.4 EXTERNAL TANK FUEL TRANSFER

1. EXT TRANS switch — AUTO.
2. External tank fuel quantity — MONITOR.

When either external tank quantity indicates 500 to 300 pounds of fuel remaining:

3. EXT TRANS switch — OFF.

Note

Failure to discontinue transfer when either external tank quantity indicates 500 to 300 pounds of fuel remaining may result in venting fuel down to approximately 4,400 pounds remaining.

If practical, when both transfer tanks indicate 1,000 pounds or less fuel remaining:

4. EXT TRANS switch — AUTO.

Note

When each transfer tank contains less than 1,000 pounds, the fuel level is below the dive vent line inlet and the remaining fuel in the external tanks can be transferred without venting fuel. Following this procedure will prevent in-flight venting unless the bleed air selector valve should stick open before the fuel level has dropped below the dive vent line inlet.

When external tanks are empty:

5. EXT TRANS switch — OFF.

10.5 FUEL DUMP

The fuel dump system is mechanically actuated and requires no electrical power. The T-handle located on the left side aft of the center console initiates dumping when pulled up. Fuel will dump at a rate of 1,400 pounds per minute maximum, down to full feed tanks and 300 pounds in each transfer tank, depending upon aircraft attitude and initial transfer tank level.

CAUTION

The MAD boom must be fully retracted before dumping fuel, otherwise fuel may be introduced into the ECS compartment.

1. Fuel dump T-handle — PULL.

On completion of fuel dump operation:

2. Fuel dump T-handle — PUSH DOWN.

Note

Following in-flight fuel dump, maintain a landing configuration attitude (approximately 5° noseup) for a minimum of 1 minute to ensure all fuel has drained from the dump system plumbing. This will prevent fuel spillage on deck following landing or arrestment.

10.6 IN-FLIGHT REFUELING

Note

Refer to Chapter 4 for in-flight refueling limits.

In-flight refueling technique is very similar to formation flight technique. There are several factors involved that require close pilot consideration. Because the formation position is essentially in trail, the receiver aircraft is subjected to the wake and engine exhaust stream of the tanker. Depending upon the tanker type and receiver position, either crosstrim and/or increased sensitivity in pitch control will be encountered. Flight into and out of a wingtip vortex or engine exhaust stream requires care since uncommanded pitch or roll inputs can occur during transition.

Airspeed, altitude, and gross weight considerations also affect in-flight refueling. Low airspeed, low altitude, and low gross weight reduce the maximum safe closure rate with the tanker because under these conditions the S-3B cannot reduce airspeed rapidly without speedbrakes. Use of speedbrakes for this function should be avoided, since large pitch excursions can occur with resultant receiver/tanker damage in the probe or hose/reel system.

Flying qualities of the S-3B are affected mainly by tanking airspeed and flap position. At 220 KIAS, longitudinal control is somewhat sensitive. With maneuver flaps extended, longitudinal control becomes less sensitive. However, except at aft cg, lateral/longitudinal control harmony is degraded with the effect that lateral control is more difficult. At 250 KIAS, longitudinal control is significantly more sensitive, requiring more precise control. In general, the increase in airspeed also raises the receiver position in relation to the tanker, which aggravates controllability in the tanker wake and engine exhaust stream turbulence. Minimum tanking airspeed is generally dependent on tanker and in-flight refueling package limitations.

At 250 KIAS for KA-6D and a tanker-configured S-3B, and at 270 KIAS for tankers carrying the D-704/31-300 aerial refueling stores, the S-3B bow-wave begins to have noticeable effect on the drogue during final closure and a significant increase in minimum closure rate begins to occur. At all airspeeds, tanking can be satisfactorily conducted with or without the yaw damper; however, use of yaw damper is recommended. When making final corrections prior to engagement, rudder should be used for directional corrections instead of aileron. Use of the yaw position (up) should be avoided because it tends to adversely affect control of the aircraft.

WARNING

If windshield or canopy is hit by the drogue, consideration should be given to executing windshield/canopy crack procedures in Chapter 19.

Pilots should be familiar with respective tanker characteristics, configuration, and capabilities prior to conducting IFR operations.

Maximum in-flight refueling airspeed for the S-3B is 275 KIAS. Optimum configuration for the S-3B is 230 KIAS (250 KIAS with the A-4), and flaps up with yaw damper engaged.

10.6.1 Rendezvous and Engagement Procedures. Receiver aircraft will rendezvous in left echelon abeam the tanker, ensuring that the aft area of the tanker is clear. Receiver aircraft should remain well clear of the tanker during all drogue actuations. If a reel malfunctions, the drogue and hose assembly may be carried away. When signaled by the flight leader, either by UHF or visual communications, the tanker will deploy the drogue. After drogue extension, the receiver should move to a position aft of the drogue. Ensure the drogue is fully extended by noting an amber light on the drogue fairing of the tanker aircraft.

10.6.2 Pilot Technique. The tanker pilot, as leader of the refueling formation, has the primary responsibility for maintaining an effective lookout for other aircraft, although other members of the flight are responsible for assisting to the maximum extent possible. Receiver pilots shall place any electromagnetic radiating device to standby operation, lower helmet visor, don oxygen mask, and position necessary cockpit switches for receiving fuel.

If the amber light is on and the lower anticollision lights on the tanker are extinguished, receiver aircraft may be cleared to engage the drogue.

CAUTION

If the amber light is not on, the tanker shall be notified and receiver aircraft shall not engage the drogue until proper cockpit indications are obtained by the tanker.

The receiver aircraft will assume the ready position, approximately 10 to 15 feet behind and slightly below the drogue. The receiver aircraft should be positioned relative to the tanker and trimmed at this position prior to closing the drogue. The relative position of the drogue to the tanker aircraft should be noted so that the receiver aircraft may assume the proper disengagement position following refueling.

WARNING

- Flying higher than the normal receiver position places the S-3B wing and horizontal stabilizer in the high energy jet exhaust of the tanker and can result in an uncommanded rise of the S-3B receiver to a position above and behind the tanker.

- Attempting to counter the uncommanded rise can result in violent pitch oscillations.

- If less than 30 feet of hose is extended outside of the tanker refueling package, a midair collision could occur if the uncommanded rise were encountered.

It is important to use the wing position of the tanker aircraft to reference the receiver aircraft attitude for approach and tanking operations. Successful engagement will necessitate flying precise formation on the tanker aircraft and keeping the drogue in the receiver aircraft pilot's peripheral vision. Keep the drogue superimposed over the hose so that very little if any hose is visible to ensure proper alignment.

A small amount of power should be added by the receiver pilot to commence a 3- to 5-knot closure with the drogue. The vertical displacement of the probe to the drogue should be decreased smoothly so that the last few feet of travel may be level. A positive rate of closure must be maintained until the drogue and probe are engaged and locked or until the decision is made to abort the attempt. If the drogue is overshot, lineup corrections are out of phase or the receiver pilot is overcontrolling; it is best to abort the attempt and reopen to about 15 feet aft of the drogue.

CAUTION

If the probe hangs up on the lip of the drogue basket causing the drogue to tilt on the probe, an immediate abort is necessary to preclude damage to the drogue assembly.

After engaging the drogue, continue the hose insertion until the amber light is out (about 5 to 8 feet). The green light on the tanker should illuminate, indicating fuel transfer. The receiver aircraft should be flown in a trail position on the tanker with the hose maintained in the natural trail position. The receiver aircraft should maintain a position so that if some opening between the tanker and the receiver occurs, transfer will not be interrupted.

To disengage from the drogue, the receiver pilot should return the drogue to the position at which the drogue was first engaged, then establish a slow opening rate by reduction in power. Backing out should be done slowly and directly aft of the above described position with no vertical or lateral motion.

CAUTION

Possible damage that may occur to either the tanker and/or receiver aircraft because of improper disconnect procedures include a damaged fueling package, a broken hose or probe, and possible external airframe damage to either aircraft from a whipping hose and drogue.

The receiver aircraft should not move away from the drogue until all other members of the flight are sighted. Following final drogue disengagement, the receiver aircraft should take up loose right echelon position. The last aircraft to receive fuel will move to the right of the drogue and observe the drogue retracted and stowed prior to departing the tanker or joining the rest of his flight. Separation of the receiver flight and the tanker may be accomplished by either element commencing a turn away from the refueling course and either or both changing altitude. Both the flight leader and the tanker pilot must understand the procedures to be used, and a course and altitude differential should be obtained by each. During departure, a careful lookout should be maintained to avoid other tankers or flights in the area.

Refer to the CV NATOPS Manual and the Aircraft Refueling NATOPS Manual for a complete description of specific and general in-flight refueling procedures.

10.6.3 Night Refueling. Night refueling is performed in the same manner as during the day. The tanker should have all exterior lights DIM and the anticollision lights OFF.

Take up an initial position on the tanker and use the same procedures described in this chapter for day refueling. The receiver aircraft lights should be on BRIGHT and the anticollision light ON. The tendency in night air refueling is to start the approach too far aft; this makes it very difficult to judge relative motion and usually results in a high closure rate.

10.6.4 In-Flight Refueling While in a Descent. In-flight refueling while in a descent (tobogganing) may be required in an emergency situation where the S-3B is thrust limited (high altitude, emergency configurations with landing gear extended, etc.). By requesting the tanker aircraft to accept a slight rate of descent (500 to 1,000 fpm), the thrust required to perform in-flight refueling will be significantly reduced. This will also increase the tendency to underrun the tanker with the pilot being unable to rapidly arrest closure rates with power alone. Therefore, when performing in-flight refueling in a descent, the pilot should limit his closure rate to no higher than 3 knots.

10.6.5 Emergency Disengagement Procedures. Emergency breakaway action by the receiver aircraft may become necessary if difficulties occur in either the tanker or the receiver aircraft. Emergency breakaway signals are by radio transmission and/or turning on the lower anticollision lights. The action taken will be prompted by the nature of the emergency; however, if at all possible, the receiver aircraft should make an expeditious return to the normal disconnect position and disengage without delay, using the normal disconnect procedures. If normal disconnect procedures are followed, disconnecting slowly, the possibilities of damage to the tanker and/or receiver aircraft are reduced.

10.6.6 Aerial Refueling Hazards

1. Tanker or drogue streaming fuel or hydraulic fluid — An engagement should not be attempted and the tanker shall be informed by the receiver aircraft.
2. No tanker (amber) ready light — Possibility exists that the hose is not fully extended or that the reel is jammed so that it will not take up the hose slack upon engagement.
3. Oscillating drogue — Caused by ripped canopy on basket rim, unsteady tanker altitude, or air turbulence. Tanker can possibly change altitude/ airspeed or cycle drogue to minimize effects.
4. Misaligned initial approach position — Requires radical corrections to effect engagement. Receiver aircraft may strike the drogue or hook the hose with refueling probe.
5. Excessive engagement speed — Last minute corrections have to be more abrupt, and the possibility exists that excessive hose whip upon engagement will break probe-drogue coupling connection.
6. Misaligned at high closure speeds — The drogue may contact radome, nose section canopy, or other areas and cause damage. If the drogue is missed, remain clear of the drogue and back straight out until the drogue is in sight. Avoid looking up and/or back for the drogue, since this may cause inadvertent back pressure on the stick and result in a climb into the drogue or tanker aircraft. Use the tanker as a reference until safely aft of the drogue.
7. Too slow an engagement speed — Induced drogue oscillations with immediate danger to receiver aircraft windscreen and canopy. Difficulty may be experienced in properly seating the probe in the drogue.
8. Excessive disengagement speed — Possible separation of hose and drogue assembly from the tanker.
9. Misalignment on disengagement — Will result in drogue whip and possible equipment damage.

10.6.7 Receiver Aircraft Checklist

CAUTION

With the IFR probe extended and deicing selected below 3,000 ± 600 feet, the air-conditioning system will operate in low flow without ram air augmentation or recirculation air. This condition can result in overheat of the internal avionics. In this circumstance, turning the AUX VENT switch out of the off detent will energize the recirculation air system.

10.6.7.1 In-Flight Refueling (Normal)

1. PROBE switch — EXTEND.
2. PROBE OUT light (illuminated) — CHECK.
3. REFUEL SEL switch — INT OR INT/EXT.

Note

- If only the internal tanks are to be refueled, position the switch to INT.
- If the internal and external tanks are to be refueled, position the switch to INT/EXT.
- To prevent fuel vapors from entering the cabin during in-flight refueling, the auxiliary vent/ram air valve is closed automatically when the refueling probe is extended.

4. Radar — STBY.

WARNING

- The radar shall not be operated (STBY) during in-flight refueling.
- Radar radiation is hazardous within the following distances:

	Full Power (feet)	BK18-101 Inhibitor (shorting plug) (feet)	Dummy Load (feet)
Fueling equipment	250	50	0
Fuel tanks	250	50	0
Personnel	250	50	0

5. HF — OFF.

6. O_2 mask — AS REQUIRED.

Note

O_2 masks shall be worn for all tanking above 10,000 feet MSL and during operations with KC-135/KC-10 aircraft.

7. Visor — DOWN.

On completion of the refueling operation:

8. PROBE switch — RETRACT.

CAUTION

If probe is damaged, do not retract probe because of lack of probe position sensing, which may cause actuator motor damage.

10.6.7.2 In-Flight Refueling (Manual)

1. IFR PROBE ACTUATOR circuit breaker — PULL.

WARNING

Failure to pull the IFR probe actuator circuit breaker prior to manual handcrank operation may result in injury if probe motor actuates with handcrank in manual operation receptacle.

CAUTION

When using the manual crank system for IFR probe extension/retraction, cranking should be stopped when the PROBE OUT advisory light illuminates/extinguishes as appropriate. Additional cranking is not required and may cause damage to the probe drive system.

2. Refueling probe handcrank — INSERT IN MANUAL OPERATION RECEPTACLE.

3. Refueling probe handcrank — TURN COUNTERCLOCKWISE FOR EXTENSION OF PROBE.

On completion of refueling operation:

4. Refueling probe handcrank — TURN CLOCKWISE FOR RETRACTION OF PROBE.

5. Refueling probe handcrank — REMOVE FROM RECEPTACLE AND STORE.

Note

If the probe cannot be retracted electrically, landing with the probe extended is permissible. However, all ram air system functions will be inoperable.

10.6.8 KC-135 Refueling Operations. Aerial refueling from the KC-135 aircraft incorporating a boom with a hose-drogue adapter is fundamentally different than from the standard Navy and Marine hose-drogue systems. The KC-135 hose has a fixed length of 9 feet and has no reel retraction capability. In order to accomplish refueling, the drogue must be pushed in approximately 4 feet and held in that position within ± 2 feet fore and aft. The hose will form a “C” shape when in the correct position. After engagement, radial displacement from the boom and coupling must be within 3 feet or less. If the S-3B is positioned too far aft with the hose near the trail position, slight aft or radial movement will result in disconnect. The potentially more hazardous situation occurs when the drogue is pushed forward too far, such that the hose could be looped around the drogue on the probe.

The receiver aircraft will assume the ready position approximately 5 feet directly aft of the drogue. From a stabilized ready position, a slower closure rate of 0.5 to 1 knot is maintained until engagement occurs. The Air Force drogue is heavier and more stable than the Navy drogue and will not be affected by the S-3B bow wave during the relatively slow closure. It is mandatory that the pilot maintain a slow closure rate (1 knot or less) to preclude overrunning the boomtip, since there is no takeup capability in the system and only 9 feet of total hose length.

WARNING

Excessive closure rate (greater than 1 knot) to the engagement position can result in damage by overrunning the drogue and boom.

Disengagement should occur from a position directly aft of the boom tip with no radial displacement because of the high sideloads generated on the probe by the Air Force boom-drogue assembly.

WARNING

- Off-center disconnects can result in damage to the refueling probe or nozzle because of the excessive sideloads generated by the Air Force boom-drogue adapter.

- When refueling from a KC-135 equipped with an MA-2 coupling on the drogue, the maximum total fuel aboard the receiver shall not exceed 11,050 pounds of JP-4, 11,650 pounds of JP-5, or 11,390 pounds of JP-8 fuel. Failure to observe these limitations may result in overpressurization and rupture of the fuel tanks because of inadequate pressure regulation of KC-135 aircraft tanker systems. If the KC-135 is equipped with an MA-3 coupling on the drogue, full receiver topoff is permitted.

WARNING

Refueling from the KC-135 is more demanding than from Navy tankers. The S-3B should have a relatively forward to midcenter of gravity to decrease aircraft sensitivity to longitudinal control inputs and reduce the potential for pilot- induced oscillations. Twin-engine refueling envelope is 220 to 270 KIAS and from 12,000 to 26,000 feet. The single-engine envelope is 190 to 220 KIAS from 5,000 to 8,000 feet.

10.6.9 KC-10 Refueling Operations. The KC-10 tanker is equipped with a hose and drogue reel system similar in design to the Navy KA series aircraft. Maximum in-flight refueling airspeed and altitude for the S-3 when refueling from the KC-10 is 275 KIAS and 25,000 feet. Optimum configuration for the S-3 is 220 KIAS with a closure rate of 3 to 5 knots. At airspeeds above 250 KIAS, tanker-induced light turbulence causes random drogue movement of 2 to 3 feet. At airspeeds less than 250 KIAS, 1 foot of movement will be encountered. When engaging the drogue, recommend only the first 20 feet of hose travel be used to preclude nose and tail overlap.

WARNING

When joining a flight of receiver aircraft, do not close astern of the KC-10 within 1 to 3 miles from coaltitude to 500 feet below. Loss of aircraft control can occur if wake turbulence is encountered.

10.6.10 Refueling Emergency Configurations. Refueling emergency configurations are defined as single-engine and/or gear down conditions.

Single- engine gear down refueling is not recommended using the KC-135.

10.6.10.1 Single-Engine, Gear-Down Refueling. During single-engine gear-down refueling, the flaps must remain in the UP position to reduce drag. The pilot should consider reduction of drag through jettison of external stores should sufficient closure rate not be attainable. The aircraft will be at an AOA between 15 and 16.5 units dependent upon gross weight and maneuvers. Aircraft response to control input will be sluggish, and large control input displacements will be required to achieve engagement. The pilot should accommodate thrust asymmetry by trimming rudder and aileron forces to zero at the precontact position, followed by a smooth application of power in order to avoid large yaw excursions. The greater precision requirements for drogue latch are aggravated even further at the lower airspeeds, and increased pilot performance is required in maintaining horizontal/vertical lineup as well as controlled closure rates.

10.6.10.2 Single-Engine Refueling (KC-135). Asymmetric thrust should be accommodated by trimming rudder and aileron forces to zero at the precontact position. Closure rate should be controlled to 1 knot or less. The previous warnings under KC-135 refueling operations apply in the emergency configurations.

10.6.11 Air Refueling Tanker Procedures

10.6.11.1 Tanker Operation

10.6.12 31-301(A/A42R-1) Operations. For tanker missions, the ARS is controlled directly through the ARS control panel. No ACP, master arm, or search power control inputs are required. The ACP should be configured in the same manner as when carrying an Aero-1D. Placing the ARS control panel power switch to ON provides electrical power to the ARS and unfeathers the RAT.

WARNING

Ensure that personnel are clear of the RAT prior to placing the PWR switch to the ON position.

WARNING

- Do not unfeather the RAT or extend or retract the drogue when overpopulated areas or when other aircraft are close abeam or in trail.
- Do not extend the drogue when a store hydraulic leak has been observed or the RED PRESS or LOW RESV light is on.
- Do not actuate the speedbrakes during any part of the refueling operation.

CAUTION

Keeping POWER switch ON for more than 30 seconds after PRESS (red) indicator light illuminates may cause severe damage to store hydraulic pump and/or ram air turbine.

Placing the HOSE RETR/EXT/RESET switch to EXT removes hydraulic retract pressure and allows the ejection spring to eject the drogue and hose into the airstream. The remainder of the hose extension is aerodynamic. Once extended, the amber ready light on the aft of the store and the amber RDY light on the ARS control panel will illuminate.

The amber ready light on the ARS tailcone and cockpit drogue position indicators are indications to the receiver and tanker pilots that the drogue is ready for engagement. Cycling of the POWER switch from ON to OFF now has no effect on the store because the power bypass relay is energized. After the drogue is engaged, the receiver aircraft must move the drogue forward until the amber ready light goes off. Reel-in causes the RDY light to go out. If the TRANS switch is in AUTO, fuel will be transferred to the receiver. Fuel flow will illuminate a green transfer light on the aft end of the store indicating to the receiver pilot that he is receiving fuel. A green transfer light (XFR) on the ARS control panel will illuminate when the receiver is in the refueling range and the tanker is offloading fuel. The tanker pilot monitors the fuel off-load on the refuel display.

WARNING

On the 31-301 (A/A42R-1), placing the HOSE switch in RESET while a receiver aircraft is engaged in the drogue can result in a slack hose with subsequent damage to the receiver aircraft.

CAUTION

Changing airspeed after extending the drogue can adversely affect hose reel-in response. If airspeed is increased subsequent to drogue extension, hose response may be sluggish. If airspeed is reduced, drogue may tend to retract upon engagement. If a change in airspeed in excess of 10 KIAS is necessary, proper hose response can be restored by holding the HOSE RETR/EXT/RESET switch in RESET for 5 seconds or by retracting and extending the hose.

Note

If the refueling hose is pushed in more than halfway, fuel flow will stop, the green transfer indicator on the cockpit control panel and the green transfer light on the ARS will go off, and the amber ready light on the cockpit control panel and on the ARS will flash. Fuel will start flowing again and the ready light will stop flashing when the hose is pulled out slightly more than halfway.

When the desired amount of fuel has been off-loaded, the TRANS switch is placed in OFF and disengagement may be initiated by the receiver pilot. Fuel transfer may be stopped at any time by placing the TRANS switch to OFF. Refueling will stop if the receiver aircraft backs off enough for the amber drogue ready light to come on or if the probe disengages. The 31-301 (A/A42R-1) allows for scheduling the amount of fuel to be transferred. At the completion of the scheduled fuel offload, the transfer of fuel is terminated and the green lights on the store and control panel extinguish. The amber ready light will illuminate just prior to the receiver aircraft reaching the full trail position. Separation will occur at a pull force of approximately 250 to 300 pounds.

Placing the HOSE RETR/EXT/RESET switch to RETR permits hydraulic pressure to reel in the hose. When the hose is fully retracted, STOW LIGHT will illuminate.

CAUTION

The stow indicator can illuminate with up to 4 feet of the refueling hose and drogue extended. To ensure the drogue is fully stowed, leave the STORE POWER switch ON and the HOSE switch in RET for 5 seconds after the stow indicator illuminates.

Placing the PWR switch to OFF (when the hose is retracted) removes electrical power from the store. The RAT feathers, causing hydraulic pump operations to stop.

CAUTION

- Lack of hydraulic pressure will cause whiplash to occur in the refueling hose. If either the PRESS (red) or LOW RESV light illuminates, the hookup should be discontinued and the hose retracted.
- Keeping POWER switch ON for more than 30 seconds after PRESS (red) indicator light illuminates may cause severe damage to store hydraulic pump and/or ram air turbine.

Note

Loss of all electrical power to the store will automatically cause the RAT to feather, preventing hose and drogue retraction regardless of cockpit switch position.

If the hose fails to retract after refueling, the hose and drogue may be jettisoned by placing the HOSE CUT/SAFE switch to CUT. This deenergizes the store's electrical system and causes the RAT to feather. When store hydraulic pressure drops below 1,300 psi, the circuit actuates a cartridge-powered hose cutter that severs the hose and crimps shut the severed end of the hose that is remaining with the tank. Crimping the severed hose end prevents fuel spillage into the store tailcone.

Note

For the 31-301 (A/A42R-1), the HOSE CUT/SAFE switch is spring loaded and must be held in the CUT position for at least 5 seconds to complete hose jettison sequencing. Once the 31-301 jettison circuit has been activated, power for unfeathering the RAT cannot be reapplied to the ARS until the postguillotine shutdown relay has been manually reset on the ground.

Fuel transfer from the aircraft transfer tanks to the ARS is accomplished by placing the STORE switch to TO, with the ARS PWR switch in the ON position.

Fuel transfer from an Aero-1D fuel tank on wing station W6 into the aircraft feed tanks is accomplished by positioning the EXT TRANS switch to AUTO.

During refueling operations, the tanker aircrew must carefully manage fuel location. Consideration must be given to the amount of fuel remaining in the store and remaining flight time. When sufficient fuel is in the ARS, the STORE switch is placed in OFF to shut off the transfer pumps. If no further offloading is required, the EXT TRANS switch is placed in AUTO and the STORE switch is placed in FROM to transfer any fuel remaining in the external tanks into the feed tanks.

10.6.12.1 ARS Fuel Dump. Dumping fuel from the ARS is accomplished after the hose/drogue is retracted and the RAT is feathered by positioning the POWER switch to DUMP. Fuel dumping of a full ARS takes up to 7 minutes to complete.

WARNING

Do not jettison the hose or operate the ARS after fuel dump unless it is critical for safety of flight. Fuel dumping may trap fuel in the tailcone of the ARS and create a fire hazard.

10.6.12.2 31-301 (A/A42R-1) Checklist

WARNING

Do not hand turn the RAT in a clockwise direction (as viewed from the front). To do so will damage the internal mechanism of the RAT.

10.6.12.2.1 Preflight

1. Cockpit switches — CHECK.
   a. MASTER ARM switch — OFF.
   b. ACP station W5 — FTK.
   c. ARS PWR switch — OFF (dump guard down).
   d. STORE switch — OFF.
   e. HOSE switch — RETR.
   f. TRANS switch — OFF.
   g. HOSE CUT/SAFE switch — SAFE, COVER DOWN, SHEAR WIRED.
2. General condition of store/all hoses and connections intact.
3. Check for hydraulic/fuel leaks.
4. Drogue — FULLY STOWED/FEATHER STRAPS SECURE.
5. Ready/transfer lights — GOOD CONDITION.
6. Hydraulic servicing — CHECK.
   a. Open the nosecone right-hand inspection door.
   b. Observing the hydraulic fluid level indicator, turn the RAT counterclockwise as observed from the front three to four turns or until resistance is felt. Observe the hydraulic gauge needle. The indicator should be in the green arc (full) area. If the needle is anywhere outside of the green arc, the hydraulics are either overserviced or under-serviced. Reservice prior to launch.
   c. Release the RAT.

d. Open the nosecone left-hand inspection door.

e. Check the delta-P indicator on the hydraulic system filter.

7. Check the hydraulic fluid heat exchange inlet is free of obstructions.

10.6.12.2.2 Prestart

1. ARS PWR switch — OFF (dump guard down).
2. HOSE switch — RET.
3. TRANS switch — OFF.
4. STORE switch — OFF.
5. LIGHT switch — AS REQUIRED.
6. HOSE CUT/SAFE switch — SAFE, COVER DOWN, SHEAR WIRED.

10.6.12.2.3 Poststart

SYSTEM CHECK

1. ARS PWR switch — OFF.
2. PC turns propeller four turns counterclockwise (as viewed from the front, then holds with hands clear of propeller blades).
3. Propeller — CLEAR.

WARNING

Personal injury will result if hands are not clear of RAT blades when the ON-OFF-DUMP switch is selected to the ON position.

4. ARS PWR switch — ON (white stow light and HYD LOW PRESS lights illuminate).

Note

If no lights are present on the ARS control box with the ARS power switch on, the ARS postguillotine shutdown relay may need to be reset. This circuit breaker is located internally in the store and must be reset by maintenance personnel. Additionally, the tailcone should be observed during system check and the flightcrew informed if the tailcone lights fail to illuminate.

5. PC/pilot checks that propeller unfeathers.
6. PC inspect ARS nosecone panels for integrity/security.
7. REFUEL switch — BIT CODE (note stored codes).
8. BITE test button — PRESS (self-test of electrical systems).

Note

If BITE is actuated with less than 300 pounds of fuel in the store, invalid fault indications may result.

9. Light test for 12 seconds

   a. LOW RESV — ON.

   b. DUMP light — ON.

   c. Advisory lights — ALL ON.

   (1) LBS LED — ALL 8s, THEN UP TO 500.

   (2) STOW/PRESS lights — ON.

   (3) Other alert/advisory lights — OFF.

   (4) LBS LED — 00 OR 0E, IF A FAULT IS DETECTED RECORD BIT CODES.

   (5) ARS PWR switch — OFF.

10. Abort codes:

    a. 115 — CONTROL PANELS.

    b. 116 — HOSE REEL TRANSDUCER.

    c. 153 — LOW HYDRAULIC RESERVOIR.

Note

- In flight, the BIT check will stop on 500 pounds while the system completes a hydraulic self-test. The hydraulic pressure light should not be illuminated.
- The BIT function performs a system check of the ARS hydraulic, electric, and

fuel systems. It also monitors ARS status during ARS operation.

- On the ground, the hydraulic BIT will not run because of the absence of hydraulic pressure. In flight, a full BIT check will be run. The ARS should contain at least 30 gallons of fuel prior to running the BIT in flight. Otherwise, invalid fault indications may result.

10.6.12.2.4 Pressure Check

1. STORE switch — FROM.
2. EXTERNAL TRANS switch — OVERRIDE.

After 60 seconds:

3. STORE switch — OFF.

PC checks for venting.

WARNING

Because of a possible fire hazard, ARS pressure checks should not be conducted over catapults during CV operations.

10.6.12.3 In-Flight

10.6.12.3.1 Before Tanking

1. Exterior lights — SET (as required).
2. Receivers — CLEAR.
3. Radar — SECURED.
4. HF — RECEIVE ONLY.

WARNING

HF transmissions will couple through the ARS hose and drogue creating an explosive hazard.

5. APS — OFF.

WARNING

During tanker operations, automatic disengagement of the APS may cause large and abrupt oscillations of the air refueling hose and drogue when extended. The APS shall not be engaged in any mode other than YAW DMPR while conducting air refueling.

6. ARS PWR switch — ON.
7. RAT — UNFEATHERS/TURNS UP.

WARNING

Do not unfeather the RAT or extend/retract the drogue when over populated areas or when other aircraft are close abeam or behind.

8. Pressure light — OFF.
9. LOW RESV light — OFF.
10. DUMP light — OFF.
11. DATA DISPLAY switch — SCH.
12. DATA DISPLAY switch — DEL.
13. HOSE switch — EXT.

CAUTION

- Do not extend the drogue after it has been retracted, when a hydraulic leak has been observed, or when the RED PRESS or LOW RESV lights are on.
- Do not extend the drogue if there is any evidence of a possible electrical failure.

Ten seconds after extension:

14. RDY light — ON.
15. TRANS switch — AUTO or OFF.

WARNING

Do not manually reset the hose response with a receiver engaged or in close proximity to the hose.

CAUTION

- The transfer switch should always be in the AUTO position for normal fuel transfer. The OVRD position is an emergency condition that overrides normal system operation and provides fuel flow regardless of hose position.
- Keeping POWER switch ON for more than 30 seconds after PRESS (red) indicator light illuminates may cause severe damage to store hydraulic pump and/or ram air turbine.

Note

The 31-301 (A/A42R-1) ARS control panel has a three-position HOSE switch. With the hose out and the receiver clear, the switch should be held in the reset position for 5 seconds each time indicated airspeed changes more than 10 knots. To retract and reextend the hose will accomplish the same.

16. Clear in receiver.

After engaged and in fuel transfer range:

17. RDY ADV light — OFF.
18. XFR light — ON.
19. Receiver checks for green light on tailcone and leaks.
20. Monitor transfer.

10.6.12.3.2 Tanking Complete

1. TRANS switch — OFF.
2. XFR ADV light — OFF.
3. Receiver — CLEAR.
4. HOSE switch — RETR.
5. STOW ADV light — ON/DROGUE STOWED.

CAUTION

The stow indicator can illuminate with up to 4 feet of the refueling hose and drogue extended. To ensure the drogue is fully stowed, leave the STORE POWER switch ON and the HOSE switch in RET for 5 seconds after the stow indicator illuminates.

Note

If the drogue cannot be fully retracted at 250 KIAS, decreasing airspeed to 200 KIAS should assist retraction.

6. ARS PWR switch — OFF.
7. RAT — FEATHERED.

10.6.12.3.3 Fuel Transfer from Transfer Tank to Store

1. ARS PWR switch — ON.
2. STORE switch — TO.

10.6.12.3.4 Fuel Transfer from Store to Feed Tanks

1. STORE switch — FROM.
2. EXT FUEL XFR switch — AUTO.

10.6.12.3.5 Prelanding Checks

1. HOSE switch — RETR (check hose in).
2. STOW ADV light — ON.
3. STORE switch — OFF.
4. TRANS switch — OFF.
5. ARS PWR switch — OFF.
6. RAT — FEATHERED.
7. EXT TRANS switch — OFF.
8. Exterior lights — AS REQUIRED.

10.6.12.4 Emergency Fuel Transfer. If problems are encountered in transferring fuel from an ARS to a receiver aircraft, a system in the 31-301 (A/A42R-1) ARS can bypass some normal switch functions to provide emergency fuel transfer. After the receiver aircraft has successfully engaged the drogue, hold the TRANS switch in the OVRD position. This function will bypass the fuel quantity low-level switch and the fuel flow range switches.

CAUTION

- A receiver aircraft should not attempt an engagement when the switch is in the OVRD position, since there will be fuel under pressure in the coupling. This may cause fuel spray on the receiver aircraft and a hose whip may result.
- The TRANS switch should be turned OFF prior to the receiver making a disconnect.

Note

Do not continue to hold the TRANS SWITCH in the OVRD position if the green XFR light on the ARS control panel extinguishes.

10.6.12.5 Tanker Configuration. The S-3 is equipped to carry and operate an ARS on wing station W5 only. An ARS may be carried on wing station W6 for ferry purposes. An ARS installed on wing station W6 will function as an Aero-1D drop tank but will not be operable for air refueling purposes. During normal operations, air refueling is conducted with the YAW DMPR engaged and all other modes of the AFCS off.

WARNING

Tanker operations with APS modes engaged, other than YAW DMPR, can cause oscillations in the hose and drogue. APS disengagements will cause rapid and divergent movements in the hose and drogue creating a hazard for a receiver in the precontact position. APS modes, other than YAW DMPR, should not be engaged while conducting air refueling.

CAUTION

ARS operations without an operational YAW DMPR will cause vertical drogue oscillations making air refueling difficult. Air refueling operations without an operational YAW DMPR should not be conducted.

10.6.12.6 Night Tanker Lighting. During night air refueling, proper exterior lighting is critical to safe and expedient operations. Wing position lights should be on BRIGHT, the taillight on DIM, formation strips on BRIGHT, and Floods/Tanker Light switch to TANKER. After receiver rendezvous, select UPPER on the ANTI COLLISION LIGHT switch. Tankers should be configured with green lenses on the upper and lower anticollision lights.

Note

Rendezvousing receivers will not see the lower anticollision light unless stepped down at least 1,000 feet from the tanker altitude.

10.6.12.7 Emergency Operations. Refer to Emergency Procedures, Part V.

10.6.12.8 Store Limitations and Restrictions. Refer to Chapter 3.

10.7 FORMATION FLIGHT

10.7.1 Rendezvous

10.7.1.1 Circling Rendezvous. A circling rendezvous is used when aircraft are separated by extended or indefinite distances or time intervals. The pattern is normally a port orbit around a geographical fix maintaining a 30° bank angle. Altitude must be specified and airspeed will be 250 KIAS unless otherwise briefed. Upon arrival, each wingman should fly over the fix slightly below the rendezvous altitude to provide altitude separation upon entry into the pattern. The first aircraft to arrive at the fix should establish the orbit. Subsequent aircrews should be able to sight other aircraft in the circle from directly over the fix. When other aircraft are sighted, a hard turn in the direction of the orbit turn should be made to establish a 40° bearing line relative to the joining aircraft. Rough-bearing lineup can be established by masking the leader outboard wingtip with his vertical fin. Vary bank angle as necessary to maintain the bearing until joined. Do not use an airspeed advantage in excess of 15 knots. As the rendezvous reaches the terminal phase, check closure rate and fuselage crosstracking angle so as to stop on the inside of the turn, then cross under to a normal wing position on the outside of the turn. Pilots must not carry excessive airspeed in the rendezvous. Whenever it is necessary for a pilot to go to the outside of the rendezvous, he will report this to the flight leader.

10.7.1.2 Tacan Circling Rendezvous. A tacan circling rendezvous is used when aircraft are separated by extended or indefinite distances or time intervals and it is not possible to use a geographic fix (at sea or above an overcast). The pattern will normally be a port orbit, tangent to the designated tacan radial at a specified distance and altitude. Normally, each pilot should fly outbound on the assigned radial, maintaining the briefed climb schedule or rendezvous speed. Upon reaching the join-up circle, wingman should commence a port orbit, using 30° of bank or greater until visual contact is made with the flight leader. If necessary, request the leader's position. The leader will state his position around the orbit as 1, 2, 3, or 4, corresponding respectively to 0°, 90°, 180°, or 270° of turn from the designated radial as shown in Figure 10-1. Each pilot then plans his turn to cut across the orbit for rendezvous. The UHF/DF may be used to assist in picking up the leader.

10.7.1.3 Running Rendezvous. A running rendezvous is simply a balanced parade join-up of two or more aircraft from the rear hemisphere. The rendezvous is effected by closing from the rear on a prebriefed heading or radial. It should be accomplished with the lead aircraft at 220 KIAS while climbing or 250 KIAS while level at a designated altitude.

Note

When operating the tacan in the A/A mode, distance to the origin of the strongest signal received will be transmitted to as many as five aircraft. This signal is not necessarily the distance to the nearest aircraft.

Air-to-air ranging requires cooperating aircraft to be within line-of-sight distance. This mode enables the tacan installation to provide range indications between one aircraft and up to five others. Tacan displays range information only in the A/A mode.

If A/A operation is desired between two aircraft, the channels selected must be separated by exactly 63 channels (lead aircraft on channel 64 and wingman on channel 1). Both aircraft must be operating in A/A mode. The range between aircraft will be displayed on the DME indicator. The maximum lock-on range is 300 miles; however, because of antenna masking, operating ranges will usually be less.

If A/A operation is desired between 1 lead aircraft and 5 others, the leader must be tuned to a channel that is 63 channels higher than the other aircraft. Thus the leader could select channel 64 and the 5 others should select channel 1.

10.7.1.4 Low-Visibility Rendezvous/Rendezvous on Different Model Aircraft. This type of rendezvous should be performed in emergencies only when directed by higher authority or when the urgency of the mission dictates. The rendezvous aircraft should be flown at a safe maneuvering airspeed. The initial procedures will be as previously described for standard rendezvous. However, the latter stages should be modified as follows:

1. Establish radio contact, if possible, and determine indicated airspeed and intended flightpath of the aircraft to be joined.

2. Place all lights on BRIGHT and FLASH.

3. Rendezvous approximately 1,000 feet out, slightly aft of abeam (4- or 8-o'clock) of the lead aircraft.

4. Close cautiously while assuring constant nose-to-tail clearance. Maintain a constant relative bearing. Changes in relative bearings will cause apparent foreshortening or lengthening of the lead aircraft fuselage and will make determination of closure rate difficult.

Note

Rendezvous on different model aircraft and/or in low-visibility conditions are

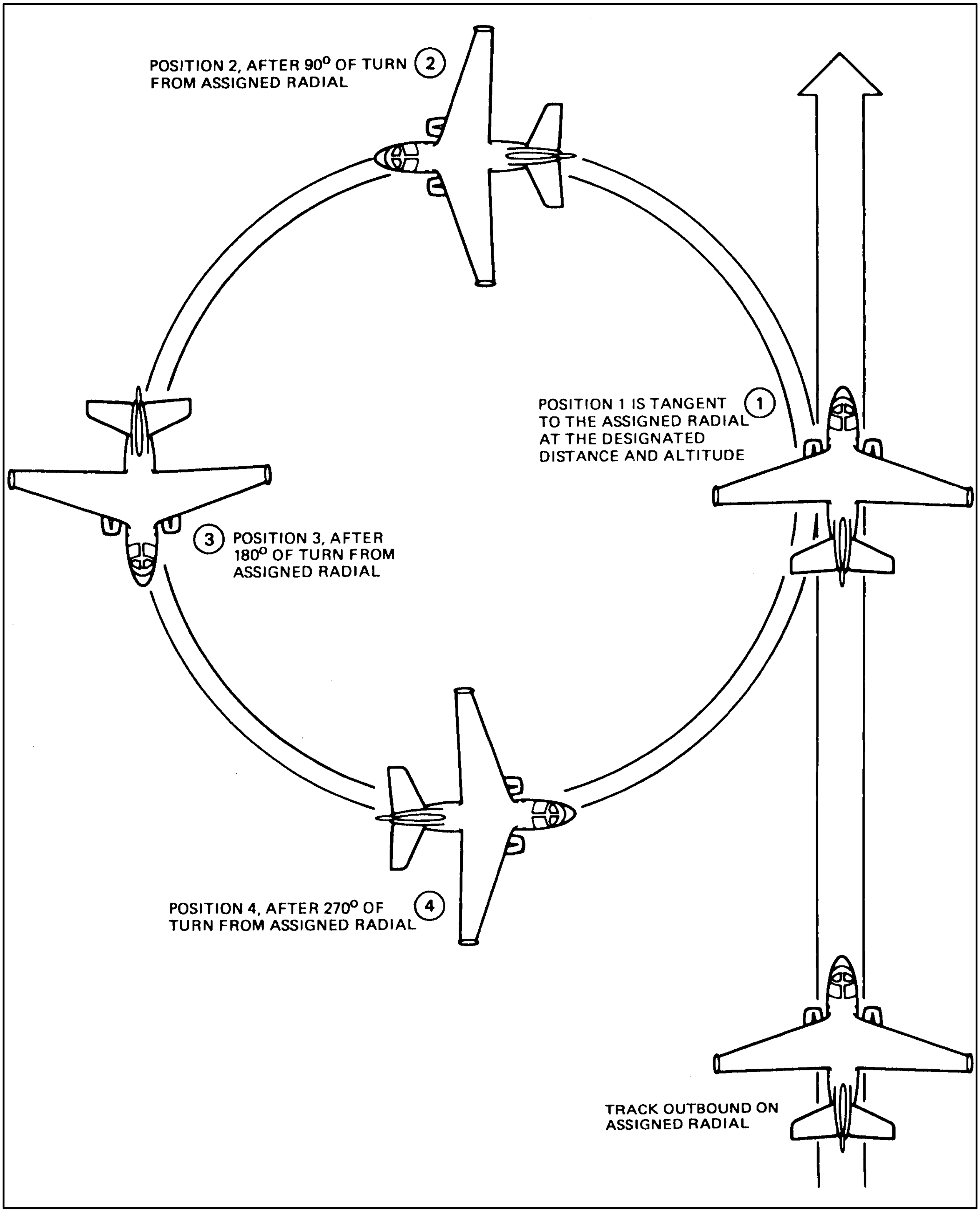


Figure 10-1. Tacan Circling Rendezvous

conducive to vertigo. Extreme caution and good judgment must be exercised and at no time should a rapid closing rate be allowed to develop.

10.7.1.5 Night Rendezvous Flying Procedures. Night flying procedures are identical to day procedures with the exceptions given below.

10.7.1.5.1 Night Rendezvous. Rendezvous at night is similar to daytime rendezvous except that in the final portion the pilot should try to close to a position slightly astern rather than directly toward the aircraft ahead. Pilots joining from astern will move out to the side to enhance their judgment of closure rates as well as to ensure safe clearance.

10.7.1.5.2 Night Formation. Because of the lack of adequate formation lighting, it is imperative that the wingman maintain a position so that his anticollision lights illuminate the lead aircraft. Wingtip clearance shall be maintained at all times. The wingman should avoid staring at the lead aircraft to avoid light fixation.

10.7.1.6 Safety Rules for Rendezvous

1. During all rendezvous, safety shall be the prime consideration.

2. Keep all aircraft ahead constantly in view and join in order.

3. During rendezvous, use only enough stepdown to ensure vertical clearance on the aircraft ahead.

4. When necessary, a wingman should abort the rendezvous by leveling his wings, sighting all aircraft ahead, and flying below them to the outside of the formation. He should then remain on the outside until all other aircraft have joined.

5. To avoid overshooting, all relative motions should be stopped when joining on an inside wing position. A crossunder to the outside may then be made.

6. During a running rendezvous, use caution in the final stage of join-up, since relative motion is difficult to discern when approaching from astern.

10.7.2 Parade Formation. A parade formation is flown whenever the formation is likely to be critically observed from the ground or when under instrument conditions. The flight leader is restricted to smooth, coordinated maneuvers. All configuration changes including speedbrake deployments will be executed on signal.

Echelon bearing (approximately 30°) is determined by covering one-half of the fuselage star insignia with the engine cowl to form an ice-cream-cone picture. Stepdown of 5 feet is achieved by centering the engine cowl on the fuselage star horizontally. Wingtip clearance is maintained by fitting the engine cowl to the star diameter and gauging overall aircraft size (see Figure 10-2).

Parade turns are normally executed with the wingman rolling about his own longitudinal axis. However, when instrument conditions exist, the wingman will roll about the leader's axis to reduce the possibility of vertigo (see Figures 10-2 and 10-3).

If the wingman loses sight of the leader, he shall take a 30° heading cut away from the flight, level off, and advise the leader of his intentions. The heading away from the leader shall be 1 minute in duration; at that time, resume original heading.

10.7.3 Free Cruise Formation. Cruise is used in nearly all situations where parade formations are not practicable. It allows the flight leader more flexibility in a tactical maneuvering environment. This formation allows for a better lookout doctrine and reduces wingman fatigue and fuel consumption on extended flights.

The wingman shall slide out and back until a nose-to-tail clearance of 20 feet has been established. Cruise bearing can be defined by covering the fuselage star with the engine nacelle. This relative position will provide about 50 feet between aircraft and a relative bearing of approximately 45° (see Figure 10-4).

10.7.4 Formation Approaches. Because of aircraft malfunctions or operational circumstances, formation approaches may be required. During formation approaches, the standard parade position will be maintained by the wing aircraft. If transition to the landing configuration cannot be made safely and in a timely manner in VMC after a penetration, the transition should be made prior to penetration or prior to entering IMC.

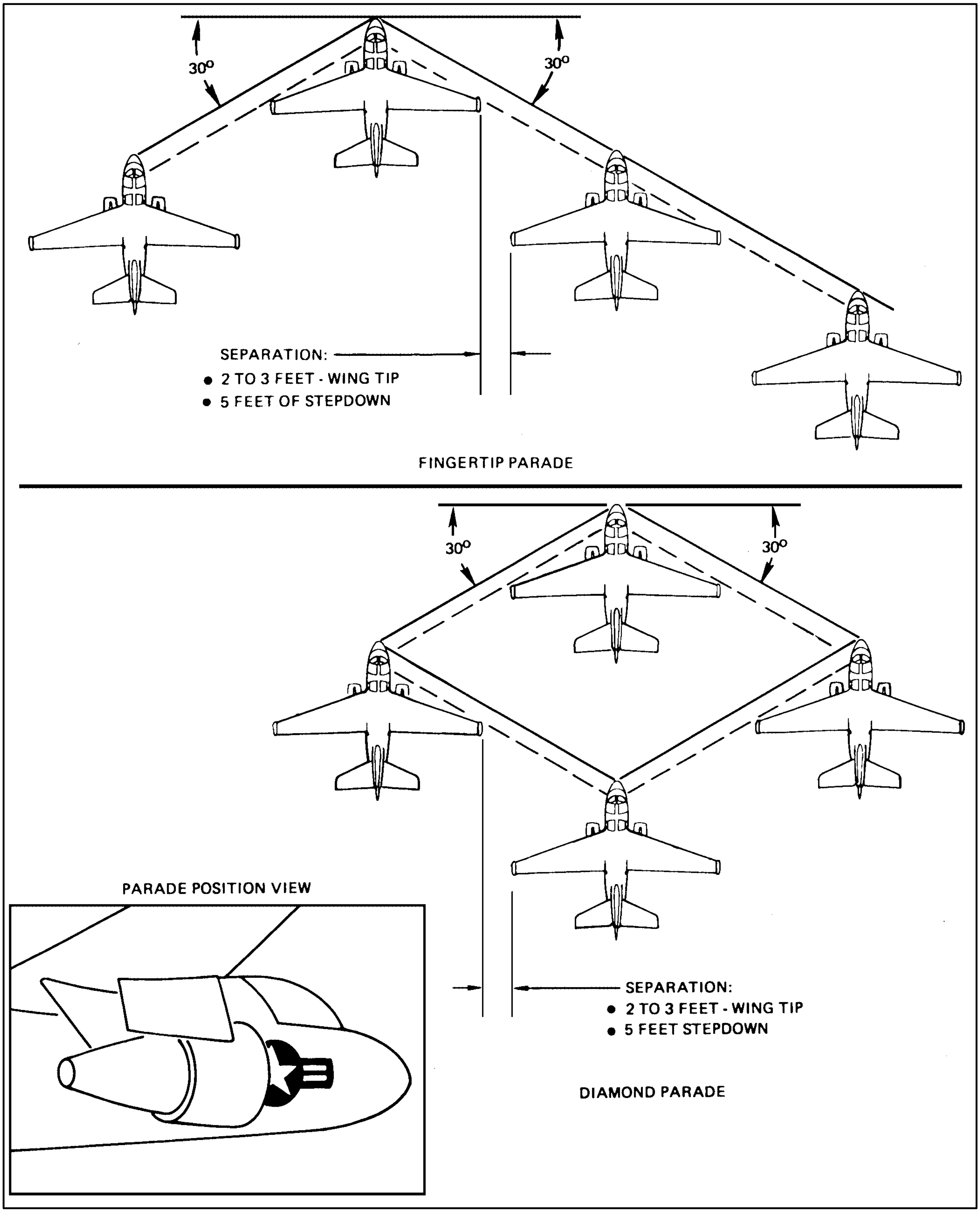


Figure 10-2. Parade Formations

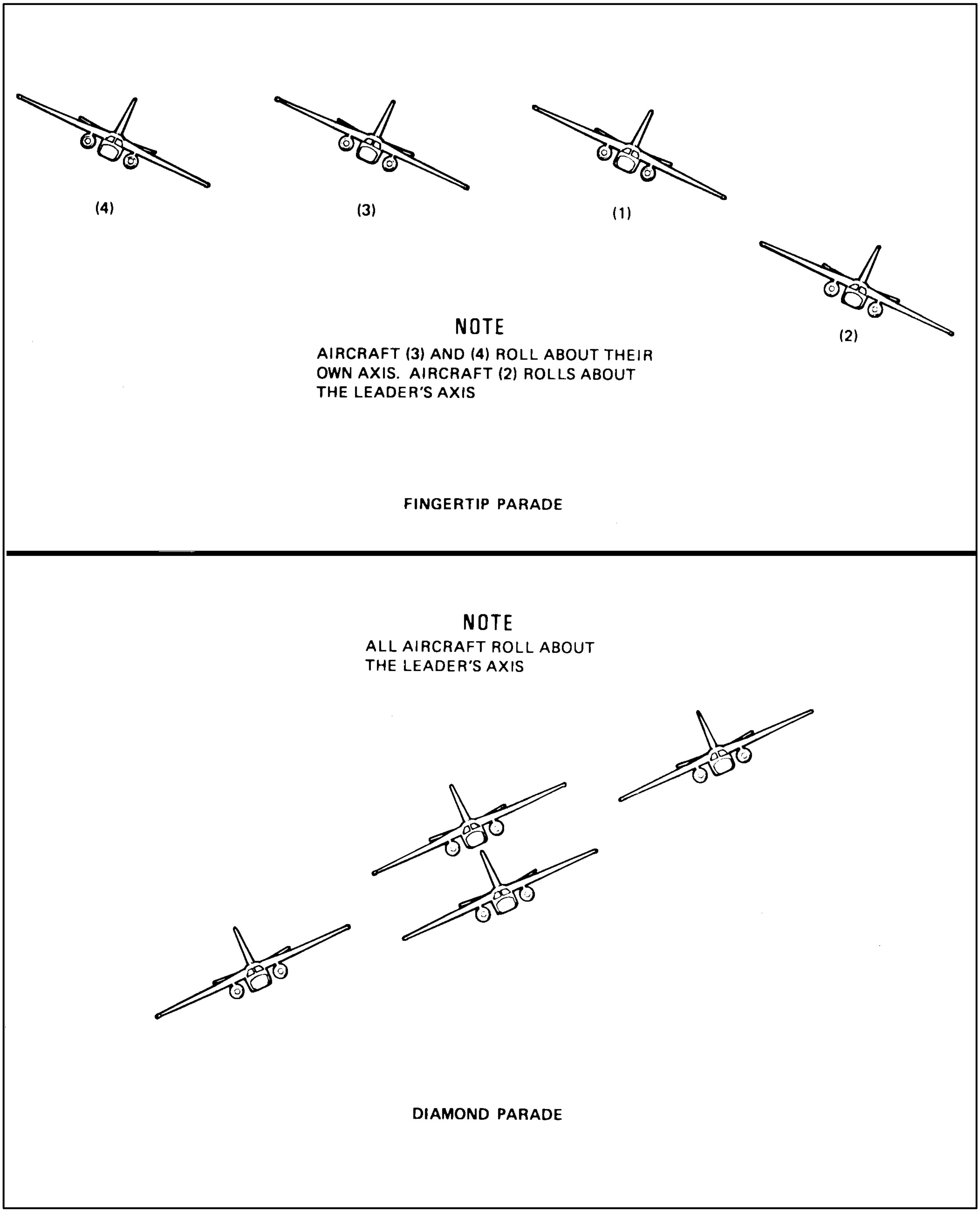


Figure 10-3. Parade Formation Turns

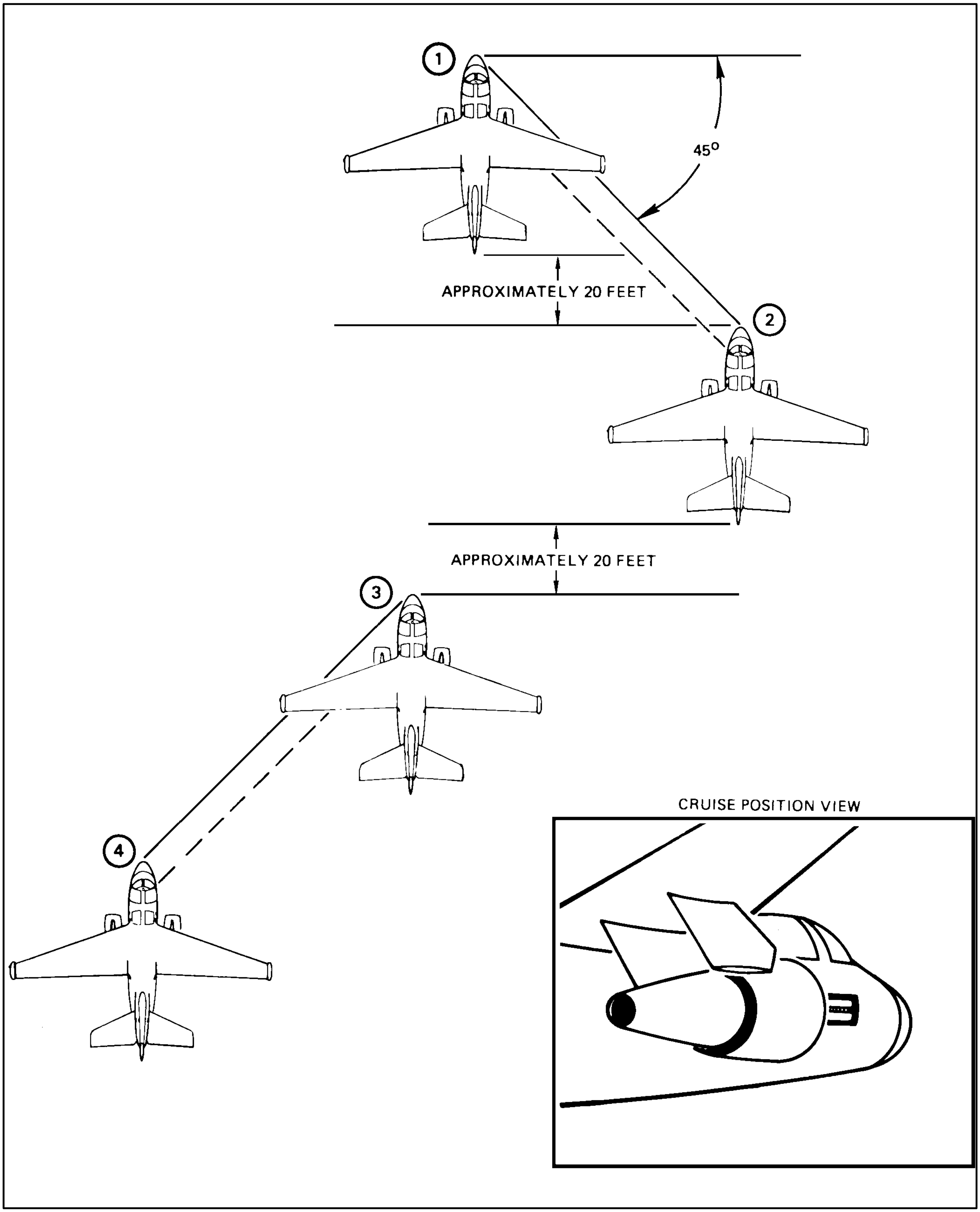


Figure 10-4. Free Cruise Formation

The leader will commence a penetration by pushing over, extending speedbrakes when approaching 250 knots, and then reducing power to a minimum of 700 lb/hr fuel flow per engine. Approaching the level-off altitude, the leader will smoothly raise the aircraft nose to maintain the level-off altitude while allowing the aircraft to decelerate. Passing 186 KIAS, the leader will signal the wingman to lower landing gear using standard hand signals. At this time, the leader and the wingman will simultaneously lower landing gear, retract speedbrakes, and select TAKEOFF flaps. As the aircraft continue to decelerate and when passing 156 KIAS, the leader will signal the wingman to lower flaps using a standard hand signal. Both the leader and the wingman will simultaneously lower LAND flaps. As the lead aircraft approaches 13 units AOA, power will be adjusted to maintain 13 units AOA. However, in no case should the leader copilot/COTAC see the wingman approach lights showing a steady on-speed (amber light) or slower condition. If the leader copilot/ COTAC observes the wing aircraft on-speed or slow, he should advise the leader to increase speed. A normal approach should be flown to meatball interception. At this time, the leader will signal the wingman using standard signals that the landing area is in sight, and the wingman should take over visually and land. The leader should break away so as to not interfere with the wingman approach.

Should the wingman desire to rejoin after a touch-and-go or bolter, he will execute a normal touch-and-go or bolter and accelerate to 130 KIAS. After he is safely airborne he should look for the leader who should have adjusted his breakaway to parallel the runway or final bearing while accelerating to 130 knots and climbing to 300 feet. A properly executed break-away will cause the leader to appear in the wingman's 10- to 11-o'clock position. A rendezvous can now be effected and either a departure executed or another approach commenced.

If it is desirable to execute a departure after a rejoin or because of a missed approach, the leader will add power to approximately 750 °C (ITT) and establish a climb while accelerating. When in VMC, he will signal the wingman to raise the landing gear using standard signals. At this time, both the leader and the wingman will raise the landing gear and select TAKEOFF flaps. As the aircraft accelerates past 160 KIAS or 180 KIAS (as appropriate), the leader will signal the wingman to raise flaps using standard signals. At this time, both the leader and the wingman will raise their flaps completely and execute the rest of their climbout.

CHAPTER 11

Functional Checkflight Procedures

11.1 FUNCTIONAL CHECKFLIGHTS

Checkflights shall be performed when directed by the current OPNAVINST 4790.2, type commanders, or other appropriate authority. Checkflights shall be conducted in accordance with the requirements of the current OPNAVINST 3710.7 utilizing the NATOPS functional checkflight checklist (NAVAIR 01-S3AAB-1F).

11.2 CONDITIONS REQUIRING FUNCTIONAL CHECKFLIGHTS (SEE FIGURE 11-1.)

1. At the completion of aircraft rework and acceptance inspection. All checklist items required are prefixed A.

2. After installation of an engine, fuel control, or major engine components that cannot be checked on the ground. Minimum items are prefixed B.

3. When fixed flight surfaces have been installed or reinstalled, or when movable flight surfaces or flight controls have been installed, reinstalled, adjusted, or rerigged and improper adjustment or replacement of such components could cause an unsafe operating condition. Minimum items required are prefixed C.

4. After installation, reinstallation, or adjustment of landing gear components that could affect emergency landing gear extension. Minimum items required are prefixed D.

11.3 FUNCTIONAL CHECKFLIGHT PROCEDURES

Checkflights will be conducted utilizing existing NATOPS procedures contained within this manual. Except for profile A, checkflights may be conducted in conjunction with an assigned operational or training mission, provided the requirements of the current OPNAVINST 3710.7 series are satisfied and the checkflight requirements are completed prior to performing the ancillary mission. If a system or component does not meet the performance requirements of the functional checkflight checklist and precludes completion of the secondary mission with an adequate degree of safety under all conditions, the flight will be terminated.

Systems or components that do not meet the performance criteria contained within the functional checkflight checklist will require additional checkflights as necessary. However, only the portion of the checklist relating to that system or component need be performed. It is not the intent of this manual to cover every conceivable circumstance requiring a checkflight, but to provide minimum guidance with sufficient latitude to allow users to meet operational commitments while maintaining adequate margins of safety during the conduct of functional checkflights. The exercise of prudent judgment and sound reasoning in the assignment of checkflights and during the conduct of the flights is mandatory.

11.4 CHECKFLIGHT

The functional checks should be performed in the sequence presented in the following procedures and in the functional checkflight checklist (NAVAIR 01-S3AAB-1F), to ensure an adequate margin of safety in consonance with an efficient use of time. Except where specified in particular tests, the flight profiles contain a range of altitudes that allow a pilot to maneuver as necessary to avoid adverse environmental conditions. Each checkflight profile is assigned a letter A to D as per paragraph 11.2. The applicable letter prefixes each test that is required by a particular profile. It is incumbent for checkflight crews to familiarize themselves with the checkflight requirements prior to every checkflight.

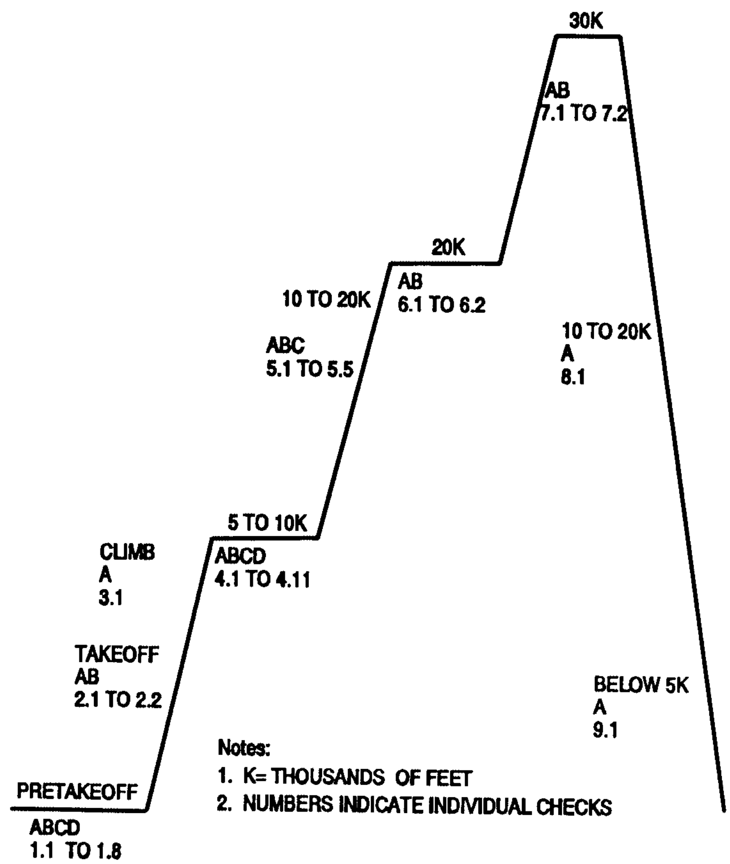


Figure 11-1. Flight Profile

PROFILE

A **11.4.1 Pretakeoff.** Perform turnaround and daily inspections in accordance with NAVAIR 01-S3AAB-6-1 and NAVAIR 01-S3AAB-6-3.

A **11.4.1.1 APU Start Check**

1. Ground air and electric power — OFF.
2. Check accumulator pressure.

   LIMIT:

   a. 2,800 to 3,300 psi
3. Start APU.

   LIMITS:

   a. APU light off within 3 seconds.

   b. APU RUN light within 30 seconds.

   c. No APU OV TEMP, APU OIL PRESS, APU BL LEAK, or APU FIRE lights.

Note

If necessary to shut down and restart, allow 40 seconds between shutdown and restart.

4. Turn on APU generator.
5. AIR COND switch/APU AIR switchlight — ON.

   LIMITS:

   a. 30 to 35 psi on bleed air manifold pressure gauge.

   b. Press APU AIR switchlight ON; light should extinguish and air-conditioning flow should cease. Press again; ON should illuminate and air-conditioning flow returns.

A **11.4.1.2 Single-Engine Waveoff Logic Check.** Check Prior to Starting No. 1 Engine:

1. AIR COND switch ON.
2. APU AIR switchlight — ON.
3. Move No. 1 engine throttle quickly to maximum power and then to IDLE.

   LIMIT:

   a. Air-conditioning should shut off.
4. Reset AIR COND switch.

PROFILE

5. No. 1 engine throttle — OFF.

6. Perform steps 1 through 5 with No. 2 engine throttle.

A

11.4.1.3 EHP Check

1. RH and LH primary buses powered.

2. EHP and No. 1 hydraulic servo turned on (No. 2 hydraulic servo off).

   LIMITS:

   a. EMER PUMP light illuminates.

   b. 2,850 psi indication on No. 1 hydraulic system.

3. NWS turned on. Check for normal operation. NWS off.

4. Cycle flight control. Check for normal operation.

5. Secure EHP.

   LIMITS:

   a. EMER PUMP light extinguishes.

   b. No. 1 hydraulic system pressure drops to zero.

A D

11.4.1.4 Emergency Landing Gear Reset Check. Perform the following check after the No. 1 hydraulic system is pressurized.

1. Engage NWS.

2. Actuate emergency landing gear extension T-handle.

3. Verify NWS lost.

4. Stow the emergency landing gear extension T-handle.

WARNING

Because of the close proximity of the EMERGENCY LANDING GEAR RESET switch to the EXTERNAL JETTISON switch, proceed cautiously to avoid unintentional release of external stores.

5. Reset emergency landing gear system.

6. Verify NWS regained.

PROFILE

A B

11.4.1.5 Engine Ground Start

1. Start engines using normal procedures.

   LIMITS: After selecting engine start switch:

   a. Air-conditioning will cease and bleed air pressure will drop momentarily. APU AIR switchlight will extinguish then illuminate ON during start cycle.

   b. Starter caution light will illuminate.

   c. Bleed air manifold gauge will read 30 to 35 psi.

2. Note and record the following:

   a. Hydraulic pump cut-in speed.

   b. Starter cutout speed.

   c. Maximum ITT during start.

   d. Start time from placing throttle to IDLE to engine reaching IDLE.

A

11.4.1.6 Parking Brake Check

1. Release parking brake.

   LIMIT:

   a. PK BRAKE ON and EMER BK ON advisory lights should go off.

2. Reset parking brake.

   LIMIT:

   a. PK BRAKE ON and EMER BK ON advisory lights should come on.

A B C

11.4.1.7 AFCS BITE Check

1. Ensure CAINS, AHRS, and SCADC (aircraft not incorporating AFC-279), CAINS II, EGI, and SCADC (aircraft incorporating AFC-279), are operational, both engines running.

2. On the Flight Control Test Panel, ensure that the MAD SEL switch is in the center (neutral) position and the channel indicator lights are extinguished.

3. On the Flight Mode Selector Panel ensure all switches are set to OFF.

WARNING

On both Failure Annunciator Panels, check that no legends are illuminated. (Depress to extinguish, if required.)

PROFILE

WARNING

Check all control surfaces for clearance. Warn ground personnel of impending surface motion and engine thrust change.

Note

If the wings are folded, the VDI switches on the pilot and copilot/COTAC NAV DISPLAY SELECTOR panel must be set to the same position to prevent nuisance faults.

4. Aileron and rudder trim — set at zero.
5. Flaps — UP. (Aircraft not incorporating AFC-273. For aircraft incorporating AFC-273, flaps may be in any position.)
6. NWS — OFF.
7. APU AIR — OFF.
8. On the FCTP, momentarily depress the TEST AUTO/MAN switch. Keep hands and feet clear of the control stick and pedals.

Note

BIT run times depend on the number of faults detected. The BIT run times given below may be exceeded.

LIMITS:

a. AUTO light illuminates.

b. On the FTCP, AFCS channel lights and both halves of the MAD START ON indicator light illuminate and then extinguish.

c. On the FAP, A/P AND ATS red lamps flash and the A/P, ATS, and ALTITUDE yellow lamps illuminate and then extinguish.

d. On the HUAP, the APC red lamp flashes and then extinguishes.

e. SPD flag and needle momentarily come into view.

f. MAN light illuminates in approximately 2 minutes. (Aircraft not incorporating AFC-273.)

g. MAN light illuminates in approximately 25 seconds. (Aircraft incorporating AFC-273.)

9. Channel status lights now indicate AUTO BIT failures.
10. Ensure throttle friction is off.
11. For aircraft not incorporating AFC-273:

a. Move the throttles to 75 percent N_g, minimum.

PROFILE

b. On FMSP, engage PITCH, ROLL, YAW, and APC switches, and keep hands and feet clear of the control stick and pedals.

LIMITS:

(1) AUTO BIT failures indicated on the FCTP panel are extinguished.

(2) Control stick makes small movements fore and aft, left and right.

(3) Throttles make fore and aft movements.

(4) After approximately 10 seconds, AUTO and MAN lights will both come on and flash on the FCTP.

12. For aircraft incorporating AFC-273:

a. Ensure throttles are at idle.

b. On FMSP, engage in sequence APC, DMPR, ROLL, and PITCH switches. Keep hands and feet clear of the control stick and pedals.

LIMITS:

(1) AUTO BIT failures indicated on the FCTP are extinguished.

(2) Control stick makes small movements fore and aft, left and right.

(3) Throttles make small fore and aft movements.

(4) After approximately 70 seconds, the AUTO and MAN lights on the FCTP will flash.

13. Momentarily activate the AFCS disconnect (paddle) switch on the control stick.

LIMIT:

a. PITCH, ROLL, and YAW FMSP switches return to OFF.

14. After approximately 3 seconds, activate the pilot's NWS switch 2 times.

LIMIT:

a. The APC FMSP switch returns to OFF.

Note

Activating the NWS switch prior to activating the AFCS disconnect switch will abort IBIT processing and prevent proper display of fault indications.

15. Return the throttles to IDLE.

16. Press the TEST AUTO/MAN switch.

LIMIT:

a. Check that AUTO and MAN lights are extinguished.

PROFILE

17. The AFCS channel status lights on the FCTP and FAP lights will now reflect all cumulative failures detected by the Automatic and Manual BIT.

Note

On aircraft incorporating AFC-273, actuating the test switch twice within a 5-second period will clear the results of AUTO/MAN BIT within the FDC memory.

18. Complete TAKEOFF checklist.

A B C

11.4.1.8 DMPR Prior to Taxi (Aircraft Incorporating AFC-273)

1. Engage DMPR prior to taxi.
2. Taxi with DMPR engaged.

   LIMIT:

   a. No rudder pedal feedback detected during taxi.

A

11.4.1.9 APU Shutdown Check

1. Check APU accumulator recharged.
2. Push APU DISARMED light.

   LIMIT:

   a. Light should not illuminate.

3. Press APU control T-handle to stowed position.

   LIMIT:

   a. APU RUN light off.

4. After cooling APU, close door.

   LIMIT:

   a. Door closed.

11.4.2 Takeoff Checks

A B

11.4.2.1 Takeoff Data Check. Record the following data prior to takeoff:

Note

Record OAT, altitude, and hydraulic pressure prior to adding power. Record fuel flow, N_g, and ITT, as soon as full power is reached. Record oil pressure and N_f after 15 seconds.

PROFILE

1. OAT __________ °C.

2. Pressure altitude __________ inches Hg.

	No. 1 Eng		No. 2 Eng	
3. Hydraulic pressure	______________	psi	______________	psi
4. Fuel flow	______________	lb/hr	______________	lb/hr
5. N_g	______________	% rpm	______________	% rpm
6. ITT	______________	°C	______________	°C
7. N_f	______________	rpm	______________	rpm
8. Oil pressure	______________	psi	______________	psi

A B C

11.4.2.2 DMPR Takeoff (Aircraft Incorporating AFC-273)

1. Perform normal takeoff with DMPR engaged.

   LIMIT:

   a. Verify normal NWS and rudder response during takeoff run.

A B

11.4.2.3 Internal Fuel Transfer Check (Both Engines Running)

1. Observe proper fuel transfer from transfer to feed tanks.

   LIMIT:

   a. Feed tanks remain full until transfer tanks are empty.

WARNING

If dual channel DMPR is not available, DMPR shall not be engaged until safely airborne.

A

11.4.3 Climb Checks

11.4.3.1 Cabin Pressurization Check

1. Determine pressure schedule below is being maintained above 5,000 feet.

   LIMIT:

Flight Altitude (feet)	Cabin Altitude (feet)
5,000 to 24,300	3,500 to 5,850
30,000	6,500 to 8,800
40,000	10,500 to 13,000

PROFILE

11.4.4 Level Flight

A

11.4.4.1 APX-72 IFF Check (5,000 to 10,000 Feet)

Preliminary conditions:

1. Contact an approach control on any radar facility (at 50 miles or more distance).

Mode/code checks:

1. Request a mode 3/A check using code specified by the ground station.

   LIMIT:

   a. Ground station acknowledges receiving the correct code.

Identification check:

1. Upon completion of the mode/code check, request an identification check (any mode).
2. IDENT/OUT/MIC switch to IDENT position for 5 seconds, then release.

   LIMIT:

   a. Ground station acknowledges receipt of the proper identification return.

Mode C check:

1. Request approach control for a mode C check.
2. M-C TEST switch to ON.

   LIMIT:

   a. Ground station acknowledges approximate aircraft barometric altitude, with 29.92 inches Hg set in altimeter.

Note

- IFF altitude is referenced to 29.92 inches Hg (inches of mercury) at all times.
- Military mode 3 is equivalent to civil mode A (mode 3-A).

A C

11.4.4.2 Normal/Emergency Flaps Check (156 KIAS Maximum) (5,000 to 10,000 Feet)

1. Move flap lever from UP to LAND.

   LIMIT:

   a. Leading edge flaps indicate DOWN and trailing edge flaps indicate DOWN (100 percent) in 9 to 20 seconds.

PROFILE

2. Move flap lever from LDG to UP.

   LIMIT:

   a. Leading edge flaps indicate UP and trailing edge flaps indicate UP (zero percent) in 9 to 20 seconds.

3. Place EMER FLAP switch to EMER position. Extend the trailing edge flaps to DOWN (100 percent) using the EMER FLAP switch.

   LIMITS:

   a. Trailing edge flaps go from UP (zero) to DOWN (100 percent) in 30 to 60 seconds.

   b. Leading edge flaps do not move.

4. Move flap lever from UP to MANUV position.

   LIMIT:

   a. Leading edge flaps indicate DN.

5. Move flap lever from MANUV to UP position.

   LIMIT:

   a. Leading edge and trailing edge flaps do not move.

6. Using the EMER FLAP switch, retract the flaps.

   LIMITS:

   a. Trailing edge flaps go from DOWN (100 percent) to UP (zero) in 30 to 60 seconds.

   b. When trailing edge flaps pass through 25 percent (on way up), leading edge flaps retract from DN to UP.

7. Place EMER FLAP switch to NORMAL position.

A D

11.4.4.3 Normal Landing Gear Check (186 KIAS) and External Fuel Transfer Check (If External Tanks Installed) (5,000 to 10,000 feet)[1]

1. Landing gear up.[1]

2. EXT TRANS switch to OFF.[1]

3. Transfer tanks less than full.[1]

4. EXT TRANS switch to AUTO.[1]

5. QTY SEL switch to EXT.[1]

[1]Only on A profile with drop tanks installed.

PROFILE

6. Observe decrease in external fuel remaining.[1]

   LIMITS:

   a. Transfer starts within 5 minutes.

   b. Transfer rate is greater than engine consumption.

7. Extend flaps to TAKEOFF.

8. Extend gear.

   LIMITS:

   a. Nose gear and main gear extend and lock in 9±3 seconds or less.

   b. Light in gear handle goes out.

   c. Gear position indicators function properly.

   LIMIT:

   (1) External fuel transfer stops.[1]

9. EXT TRANS switch override (hold).[1]

   LIMIT:

   a. Fuel transfer starts again.[1]

10. EXT TRANS switch to AUTO.[1]

11. Retract gear.

    LIMITS:

    a. Nose gear and main gear retract in 11±3 seconds or less.

    b. Light in gear handle goes out.

    c. Gear position indicators function properly.

    d. Fuel transfer begins again.[1]

    e. Transfer tanks should fill up and with the feed tanks remain full throughout transfer until external tanks are empty.[1]

12. Check gear warning system (wing flaps to TAKEOFF, gear UP).

    LIMIT:

    a. Flashing WHEELS light on instrument panel flashes when AOA is between 14 and 16 units.

13. Leave flaps in TAKEOFF.

[1]Only on A profile with drop tanks installed.

PROFILE

A D

11.4.4.4 Emergency Landing Gear Check (140 KIAS Maximum) (5,000 to 10,000 Feet)

1. Pull landing gear emergency extension T-handle.

   LIMITS:

   a. Nose gear and main gear will indicate down and locked in 90 seconds maximum.

   b. Gear position indicator functions properly.

2. Place landing gear handle to DN position.

   LIMIT:

   a. Red light in gear handle goes off when handle is put down.

   b. EMER BK ON light on advisory panel comes on.

3. Restore emergency landing gear emergency extension T-handle to normal position.

WARNING

Because of the close proximity of the EMERGENCY LANDING GEAR RESET switch to the EXTERNAL JETTISON switch, proceed cautiously to avoid unintentional release of external stores.

4. Press emergency landing gear extension (EMER LG RESET) switch.

   LIMIT:

   a. EMER BK ON light on advisory panel goes off.

5. Retract landing gear handle to UP.

   LIMIT:

   a. Gear retracts within prescribed time limit.

A

11.4.4.5 Angle of Attack, Approach Airspeed, Windshield Wiper, Speedbrake Warning Check (5,000 to 10,000 Feet)

Note

- The altitude hold mode of the AFCS and CAINS must be operational.
- The altitude hold mode of the AFCS, and the EGI or CAINS must be operational. (Aircraft incorporating AFC-279.)

PROFILE

1. Landing gear down.
2. Flaps down.
3. Pitch AFCS/altitude hold on.
4. APC off.
5. Adjust power to maintain precisely 15 units AOA.
6. Place windshield wiper switch to LOW.

   LIMIT:

   a. Windshield wipers operate at low speed.
7. Place windshield wiper switch to HIGH.

   LIMIT:

   a. Windshield wipers operate at twice low-speed rate.
8. Place windshield wiper switch to OFF.

   LIMIT:

   a. Wipers stop and park in the outboard position.
9. Record the following data:

   a. Weight of fuel and ordnance.

   b. Empty weight plus crew.

   c. Gross weight.

   d. Chart airspeed (Figure 11-2).

   e. Pilot airspeed.

   f. Copilot/COTAC airspeed.

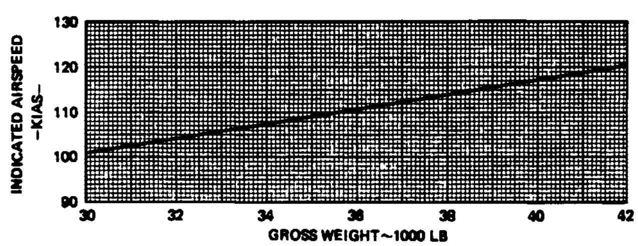


Figure 11-2. 15 Units AOA Airspeed Chart

PROFILE

LIMITS:

(1) Pilot and copilot/COTAC airspeed within ±3 knots of chart.

(2) Maximum spread between indicators 4 knots.

If difference between indicators is greater than 4 knots or if either airspeed indicator is greater than ±3 knots from chart airspeed, proceed with steps 10 through 14, for aircraft not incorporating AFC-279. For aircraft incorporating AFC-279, proceed to step 15.

10. Select AUX 0 on navigation control panel.

11. Read and record vertical velocity as displayed on the upper display to one decimal place.

    LIMIT:

    a. ±0.5 fps.

12. Select AUX 6 and enter:

    Upper — 5130

    Lower — 1800.

13. Select AUX 8, then read and record IMU pitch attitude as displayed on the lower display to one decimal place.

14. Record the following data:

    a. Vertical velocity (in fps).

    b. IMU pitch attitude (in degrees).

For aircraft incorporating AFC-279 proceed as follows:

15. Select progress 2/3 page on CDNU.

16. Read and record vertical velocity as displayed next to LSK6

    LIMIT:

    a. 30 fpm.

17. Record the following data as displayed on the EFI (VDI):

    a. Vertical velocity (in fpm).

    b. Pitch attitude (in degrees).

PROFILE
A C

11.4.4.6 DLC System Check (5,000 to 10,000 Feet)[2]

1. Extend gear and flaps.

2. Set 78-percent N_g; trim aircraft at donut AOA airspeed for a constant attitude, hands off.

3. Move DLC switch to ENGAGE.

   LIMIT:

   a. DLC switch latches.

   Note

   A slight pitch transient result if throttles are not positioned for the null that is at approximately 78-percent N_g. Retrim if necessary.

4. To check thrust compensation, increase engine speed (N_g) to 82-percent N_g and immediately return to initial speed (78-percent N_g).

   LIMIT:

   a. Aircraft maintains attitude within ±2-1/2° without pilot input.

5. To check DLC pitch compensation, press ON TOP switch for 2 seconds and release.

   LIMIT:

   a. Aircraft maintains attitude within ±2° without pilot input.

6. To check DLC/AOA compensation, press and hold the ON TOP switch and maintain a constant attitude and airspeed.

   LIMITS:

   a. Speedbrakes extend to approximately 12°±2°.

   b. The pilot AOA indexer remains on donut.

   c. The copilot/COTAC AOA indicator increases approximately 2 units.

   d. The rate of sink increases by approximately 400±100 fpm.

7. Increase AOA to above 17 units.

8. Actuate DLC by pressing the ON TOP button.

   LIMIT:

   a. SPD BRK warning light illuminates when AOA is above 17 units and speedbrakes are not retracted.

[2]Not required for rudder system component changes.

PROFILE

9. Release the ON TOP switch.

10. Move throttles full forward.

    LIMIT:

    a. DLC disconnects and DLC warning light on glareshield does not illuminate.

11. Reduce power and reengage DLC.

12. To check the DLC gear-up interlock, retract gear.

    LIMIT:

    a. DLC warning light comes on.

13. Place DLC switch to reset position.

    LIMIT:

    a. DLC warning light OFF.

14. Place DLC switch to ENGAGE.

    LIMIT:

    a. DLC switch will not stay engaged.

A B

11.4.4.7 Fuel Dump Check (186 KIAS Maximum) (5,000 to 10,000 Feet)

1. TAKEOFF flaps, climb attitude.

2. Greater than 50-percent fuel remaining in transfer tank (minimum 1,000 pounds per transfer tank).

3. MAD boom retracted.

4. Radar off.

5. No radio transmissions.

6. Pull FUEL DUMP handle. Hold until evidence of dumping (observe on gauge or by observing with the FLIR).

    LIMITS:

    a. Transfer tank fuel level decreases at a greater rate than normal.

    b. Feed tank fuel level does not drop.

PROFILE

7. Close fuel dump valve (FUEL DUMP handle pushed down).

   LIMIT:

   a. Transfer tank fuel level drops at normal rate.

A

11.4.4.8 Cabin Pressurization Check (10,000 Feet)

1. Determine pressure schedule below is being maintained above 5,000 feet.

   LIMIT:

Flight Altitude (feet)	Cabin Altitude (feet)
5,000 to 24,300	3,500 to 5,850
30,000	6,500 to 8,800
40,000	10,500 to 13,000

A B

11.4.4.9 Engine Flight Idle Check (10,000 Feet)

1. Set power for approximately 180 KIAS.
2. Retard No. 1 engine throttle control to IDLE position.
3. After allowing 1 minute for idle N_g to stabilize, record the following data:

   a. Idle N_g (percent rpm)

   b. OAT (°C)

   LIMIT:

   (1) See Figure 2-10.

4. Repeat steps 1 through 3 for No. 2 engine.

   a. Idle N_g (percent rpm)

A B

11.4.4.10 Cabin Pressure Dump/Auxiliary Ventilation Check (Approximately 10,000 Feet)

1. O_2 mask — ON.
2. Select DUMP position on CABIN PRESS switch.

   LIMIT:

   a. Cabin pressure must dump.

PROFILE

3. Climb aircraft until CAB PRESS caution light comes on.

   LIMIT:

   a. CAB PRESS caution light comes on at 13,000±1,600 feet. Record light-on altitude.

4. Descend until CAB PRESS caution light goes off.

   LIMIT:

   a. Light goes off at 11,000±1,600 feet. Record light-off altitude.

5. AIR COND switch to OFF/RESET.

   LIMIT:

   a. Airflow ceases.

6. Rotate AUX VENT switch toward ON.

   LIMIT:

   a. Airflow is felt from ducts in cockpit and from defroster ring at base of windshield. Airflow increases as rotary switch is moved toward ON.

7. AUX VENT switch to OFF.

8. AIR COND switch to ON.

9. CABIN PRESS switch to NORM.

   LIMIT:

   a. Cabin pressurizes in 45 to 120 seconds.

A C

11.4.4.11 MAD Maneuver Check (160 to 180 KIAS with MANUV Flaps) (10,000 to 20,000 Feet)

Note

- MAD maneuvers cannot be successfully accomplished if roll and yaw channels are engaged cross-channel. These must be engaged channel 1 and channel 1, channel 2 and channel 2, or dual and dual.
- Maximum TAS for MAD maneuvers is 233 knots.
- Inability to satisfactorily perform pitch maneuver can result from single-channel SCADC operation.

1. Engage YAW (DMPR on aircraft incorporating AFC-273), ROLL, and PITCH APS on FMS panel; ALT HOLD switch to OFF.

PROFILE

2. On the FCT panel, select MAD SEL switch to PITCH and press MAD START switchlight.

   LIMITS:

   a. Aircraft pitches ±3° within 6-second period.

   b. Altitude variations do not exceed 50 feet.

3. Return MAD SEL switch to OFF.

4. Select MAD SEL switch to ROLL 10° engage ALT HOLD mode, and press MAD START switchlight.

   LIMITS:

   a. Aircraft rolls ±10° within 6-second period.

   b. Heading is maintained to within ±1.5°.

5. Return MAD SEL switch to OFF.

6. Disengage ALT HOLD mode. Move MAD SEL switch to YAW and press MAD START switchlight.

   LIMIT:

   a. Aircraft yaws through heading changes of ±5° within a 6-second period. Bank angle should not exceed ±1°.

A B C

11.4.4.12 Computer Automatic Guidance (160 to 180 KIAS with MANUV Flaps) (10,000 to 20,000 Feet) (Aircraft Incorporating AFC-273)

Note

Prior to using the mode, this check should be completed while above 5,000 feet AGL.

1. GPDC operational.

2. Insert one normal FTP at a range of 5 miles, 60° left or right of aircraft heading.

3. DMPR, ROLL, PITCH, ALT HOLD, and IAS HOLD engaged and NAV SEL switch in CMPTR.

4. Engage HDG SEL/NAV switch in NAV.

   LIMITS:

   a. Aircraft rolls into 40° to 50° bank turn toward the FTP.

   b. Aircraft captures FTP within 0.2 miles.

PROFILE

A C

11.4.4.13 Emergency Flight Control System Check (10,000 to 20,000 Feet)

1. Trim aircraft precisely in straight-and-level flight at 200 KIAS, flaps up.

WARNING

- Reversion to EFCS while pushing forward on stick may result in failure of elevator control to engage during flight.
- Transfers to EFCS with trailing edge flaps extended will result in a moderate nosedown pitching movement requiring high pull forces (80 pounds or more) and immediate retrimming of the stabilizer to maintain adequate pitch control.

2. Place SPOIL 1 & 2 switch to OFF.
3. Place PITCH, ROLL, and YAW 1 and 2 switches to OFF. Do not retrim aircraft.

Note

If stick forces are acceptable, proceed to step 8.

4. Estimate push or pull force required to hold nose attitude constant in level flight and record.
5. Trim out pitch force if necessary and record balance-ball offset (deflection) while holding wings level.
6. While holding wings level, record rudder trim change necessary to zero balance ball.
7. With pitch trimmed and balance ball centered, estimate stick force in roll required to level wings.

CAUTION

Relax control forces on stick prior to next step.

8. Return all flight control servo switches to NORM position.

A B C

11.4.4.14 Automatic Flight Control System Check (200 KIAS) (10,000 to 20,000 Feet)

1. CAINS, AHRS, and SCADC operational. (Aircraft not incorporating AFC-279.)

   CAINS, EGI, and SCADC oprational. (Aircraft incorporating AFC-279.)

2. ALT HOLD and HDG SEL switch to OFF.

PROFILE

3. Engage YAW (DMPR on aircraft incorporating AFC-273), ROLL, and PITCH APS and set AUTO THRUST switch to IAS on FMS panel.

   LIMITS:

   a. No abrupt divergent movements of aircraft.

   b. Fault lights remain off.

11.4.4.14.1 Heading Hold

1. Note heading.

2. Roll aircraft to bank angle of less than 2° and release.

   LIMIT:

   a. Aircraft rolls out wings level and holds heading at time of release ±1°.

11.4.4.14.2 Roll Control

1. Roll aircraft to 25° left or right and release.

   LIMIT:

   a. Aircraft maintains 25°±1°.

2. Roll aircraft to 60° left or right and release.

   LIMIT:

   a. Aircraft rolls to bank angle of 40° to 50°.

11.4.4.14.3 Heading Preselect (Aircraft incorporating AFC-273)

1. Set HSI heading select marker to ±90° of current heading.

2. Engage HDG SEL.

   LIMIT:

   a. Aircraft rolls smoothly to bank angle of 30°±5°.

   b. Aircraft smoothly captures new heading ±2°.

11.4.4.14.4 Roll APS Disengage (Aircraft incorporating AFC-273)

1. DMPR and ROLL APS engaged.

CAUTION

When ROLL APS disengages, an abrupt increase in roll rate will occur. To avoid possible overstress of aircraft, be prepared to quickly reduce lateral stick force.

PROFILE

Note

The lateral stick forces will increase considerably passing 60°, as the ROLL APS tries to roll the aircraft back to a bank angle of 45°.

2. Roll aircraft bank angle to 80°.

   LIMIT:

   a. Roll APS disengages at bank angle of 70°±5°.

11.4.4.14.5 Pitch Control

1. Pull up 5° pitch angle and release.

   LIMIT:

   a. Aircraft holds 5° noseup attitude.

2. Push down 5° pitch angle and release.

   LIMIT:

   a. Aircraft holds 5° nosedown attitude.

11.4.4.14.6 Pitch APS Disengage (Aircraft Incorporating AFC-273)

1. Ensure VDI pitch attitude scale is set to zero.

2. Set 35° nose-down pitch attitude.

WARNING

Aircraft will accelerate rapidly and lose significant altitude during this maneuver. Oil pressure will drop as g limits are approached.

   LIMIT:

   a. Pitch APS disengages at nose-down pitch attitude of 30±2°.

11.4.4.14.7 Altitude Hold/IAS Hold (Level Flight)[3]

1. Engage IAS and ALT HOLD on FMS panel while in level flight.

   LIMITS:

   a. ALTITUDE status light off (on capture of altitude).

   b. Aircraft holds altitude to 5,000±5 feet and 0.1 percent of engaged altitude above 5,000 feet.

[3]These are the only items to be checked on “B” profile.

PROFILE

2. Bank aircraft 30° left and right and release.

   LIMITS:

   a. Aircraft maintains engaged altitude up to 6,600±20 feet and within 0.3 percent above 6,600 feet.

   b. IAS is held within ±5 KIAS throughout maneuver.

11.4.4.14.8 Autopitch Trim and High AOA Disengagement (Aircraft Incorporating AFC-273)

Initial conditions:

Donut speed.

Flaps — LDG

Gear — DN

External stores — empty.

GW — less than 40,500 pounds.

1. CAINS, AHRS and SCADC operational.

2. ALT HOLD and HDG SEL — OFF.

3. Engage DMPR and ROLL and trim aircraft in a 1500 ft/min climb.

4. Engage PITCH and ALT HOLD at desired altitude.

   LIMITS:

   a. No abrupt divergent movement of aircraft.

   b. Fault lights remain off.

   c. Nose-down Pitch Trim should operate within approximately 5 seconds of engagement as indicated by Pilot's Pitch Trim indicator; all modes should remain engaged and AOA should not exceed 17 units.

5. Disengage PITCH, ROLL, and DMPR.

6. Stabilize at 17 units AOA.

7. Engage DMPR and PITCH APS.

8. Slowly increase AOA to exactly 19 units.

   LIMIT:

   a. Pitch APS disengages 3 seconds after passing 18 units AOA.

PROFILE

9. Stabilize at 17 units AOA.

10. Re-engage pitch APS.

11. Within 2 seconds, smoothly increase AOA above 20 units.

    LIMIT:

    a. Pitch APS disengages when passing 20±1 units AOA.

Note

Cockpit AOA gauge lags actual aircraft AOA. The indicated AOA at Pitch APS disengagement may be slightly less than 20 units.

11.4.4.14.9 APC[3]

Initial conditions:

Donut Speed.

Flaps — LDG.

Gear — DN.

Pitch and roll axes disengaged; DMPR engaged.

1. Engage APC.

   LIMIT:

   a. Throttles move smoothly to maintain 15 units AOA.

2. Bank aircraft 30° either way.

   LIMIT:

   a. Throttles advance to maintain 15±3 units while in turn.

3. Repeat in opposite direction.

   LIMIT:

   a. Throttles advance to maintain 15±3 units while in turn.

4. Stabilize aircraft in a 600-fpm descent and engage DLC.

5. Actuate DLC for 3 seconds and release.

   LIMITS:

   a. The aircraft maintains attitude within ±2°.

[3]These are the only items to be checked on “B” profile.

PROFILE

b. AOA indexer remains on donut.

c. Power fluctuations will be small.

6. Disconnect APC using NWS switch.

LIMITS:

a. AUTO THRUST switch goes to OFF position.

b. APC light on glareshield does not come on.

c. ATS red light does not flash.

11.4.4.14.10 APC and Altitude Hold (Aircraft Incorporating AFC-273)

1. Engage APC, PITCH APS, and ALT HOLD.

2. Bank aircraft 30° left and right.

LIMITS:

a. APC smoothly adds power to maintain 15±3 units AOA.

b. Aircraft maintains altitude within 0.1 percent of altitude.

A

11.4.4.15 APU Start and Operate Check (15,000 Feet 0.5 M)

1. Start APU.

LIMIT:

a. APU RUN light on (within 30 seconds maximum).

2. Push DISARMED switchlight.

LIMIT:

a. DISARMED switchlight should illuminate.

3. Press APU RUN light.

LIMIT:

a. APU RUN light should extinguish.

4. When light goes out, press APU control handle to stowed position.

5. After approximately 30 seconds of cooling, rotate handle 30° clockwise and press against spring. Hold approximately 15 seconds for doors to close.

PROFILE

A B C

11.4.4.16 Wing and Empennage De-ice/Engine Anti-Ice Check (10,000 to 20,000 Feet)[4]

1. Outside air temperature 5 °C or below.
2. ANTI-ICING switch to ENG & PITOT.

   LIMITS:

   a. Anti-Ice advisory (NO.1 A-ICE ON and NO. 2 A-ICE ON) lights come on.

   b. ITT rises.

   c. L and R PITOT HTR lights remain off.
3. DE-ICING switch to SINGLE CYCLE.

   LIMITS:

   a. DE-ICE FAIL or DE-ICE HOT caution light remains off.

   b. Note change in ITT reading when DE-ICING switch turned on and at beginning of each cycle valve operation.

   c. Cyclic valve remains open 30±2 seconds.

   d. Air-conditioning goes to low flow.
4. Repeat test with DE-ICING switch in WING & EMP position.

   LIMIT:

   a. Limits are the same as for SINGLE CYCLE operation.
5. ANTI-ICING switch to PITOT.

   LIMITS:

   a. Anti-ice advisory (NO. 1 A-ICE ON and NO. 2 A-ICE ON) lights off.

   b. ITT returns to original reading.

A

11.4.4.17 Cabin Pressurization Check (20,000 Feet)

1. Determine pressure schedule below is being maintained above 5,000 feet.

   LIMIT:

Flight Altitude (feet)	Cabin Altitude (feet)
5,000 to 24,300	3,500 to 5,850
30,000	6,500 to 8,800
40,000	10,500 to 13,000

[4]This check is only required for “C” profile when leading edge flaps or horizontal stabilizer has been changed.

PROFILE

A B

11.4.4.18 Engine Flight Idle Check (20,000 Feet)

1. Set power for approximately 180 KIAS.
2. Retard No. 1 engine throttle control to IDLE position.
3. After allowing 1 minute for idle N_g to stabilize, record the following data:
   a. Idle N_g (percent rpm).
   b. OAT (°C).

   LIMIT:

   (1) See Figure 2-10.
4. Repeat steps 1 through 3 for No. 2 engine.
   a. Idle N_g (percent rpm).

A

11.4.4.19 Cabin Pressurization Check (30,000 Feet)

1. Determine pressure schedule below is being maintained above 5,000 feet.

   LIMIT:

Flight Altitude (feet)	Cabin Altitude (feet)
5,000 to 24,300	3,500 to 5,850
30,000	6,500 to 8,800
40,000	10,500 to 13,000

A B

11.4.4.20 Engine Flight Idle Check (30,000 Feet)

1. Set power for approximately 180 KIAS.
2. Retard No. 1 engine throttle control to IDLE position.
3. After allowing 1 minute for idle N_g to stabilize, record the following data:
   a. Idle N_g (percent rpm).
   b. OAT (°C).

   LIMIT:

   (1) See Figure 2-10.
4. Repeat steps 1 through 3 for No. 2 engine.
   a. Idle N_g (percent rpm).

PROFILE

A C

11.4.4.21 Speedbrake Operation (10,000 to 20,000 Feet 300 KIAS)

1. Roll trim zero.
2. Deploy speedbrakes to full extension.

   LIMIT:

   a. No significant rolloff.

   b. Speedbrake caution light remains off.
3. Retract speedbrakes.

A

11.4.4.22 RAAWS Acquisition and Tracking Check (Below 5,000 Feet AGL)

1. Bank aircraft to greater than 45° left and right.

   LIMIT:

   a. Verify tracking up to 45°.
2. Verify tracking while climbing and descending at greater than 2,000 fpm.
3. Verify that aural and visual warnings occur for 3 seconds when descending through pilot and copilot/COTAC bug setting but not while climbing through bugs.
4. Descend to 300 feet AGL with gear and flaps up.

   LIMIT:

   a. At 400 feet AGL, 3-second aural and visual alarms.
5. Climb to 6,000 feet AGL. Verify tracking to 5,600 feet AGL.

During landing:

6. Verify no alarms at 400 feet and 200 feet AGL during landing. Bug alarms at bug settings are normal.

A B C

11.4.4.23 Mode IA ACLS (Aircraft Incorporating AFC-273)

Note

Check should be completed prior to conducting carrier-based ACLS operations.

1. APN-202, ASW-25, CILS operational.

Note

UHF backup may be used if ASW-25 is inoperative.

PROFILE

2. Perform Mode 1A approach.

LIMITS:

a. Aircraft couples smoothly.

b. Aircraft remains coupled until DH.

c. Aircraft flies approach to approach minimums (200 feet and 1/2 mile).

d. Aircraft automatically uncouples at DH.

A B C

11.4.4.24 DMPR Landing (Aircraft Incorporating AFC-273)

1. Perform normal landing with DMPR engaged.

LIMIT:

a. No transients or feed back during landing roll-out.

PART IV

Flight Characteristics

CHAPTER 12

Flight Characteristics

12.1 PRIMARY CONTROL SYSTEM

The aircraft is controlled by a conventional elevator/stabilizer, rudder, and aileron/spoiler control system. Lateral stick movement, hence roll authority, is limited mechanically as a function of flap position to avoid excessively high roll rates. When the trailing edge flaps are less than 26 percent, the control stick becomes limited in roll to 55 percent of full travel.

Use of lateral trim activates the appropriate spoilers as well as the ailerons. Therefore, if large amounts of lateral trim are used, a very slight change in flight characteristics (buffet, lateral-directional stability, and directional trim) may be noticeable and lateral control response will be noticeably faster in the direction of trim input.

The rudder is hydraulically powered and operates at 3,000 psi with flaps at takeoff or landing position. With flap settings less than 57 percent, regulators reduce the operating pressure to 750 psi to limit the loads imposed on the vertical fin at high speed. Actuation of the rudder trim moves the rudder tab and also moves the zero force point in the artificial feel system. This prevents large rudder transients in the event of complete hydraulic failure. Maximum rudder travel because of pedal deflection is ±27° at low speed and approximately ±3° at a limit speed of 450 KIAS (±6° at a limit speed of 340 KIAS). As airspeed increases, the rudder pedal deflection required to attain maximum available rudder deflection decreases from 3.5 inches at optimum approach airspeed to 1.0 inch at 450 KIAS.

WARNING

Do not make abrupt, uncoordinated rudder pedal inputs or alternating left and right pedal inputs above 250 KIAS. Although the rudder servo operating pressure is reduced from 3,000 to 750 psi with flap settings less than 57 percent, the rudder can generate enough sideslip to overstress and fail the vertical fin.

WARNING

Maximum attainable sideslip caused by rudder trim is significantly greater than can be attained through the rudder pedals. Rudder trim can generate enough sideslip to overstress and fail the vertical fin. To avoid high vertical fin loads, trim induced sideslip should not exceed 1-1/2 ball widths above 200 KIAS.

12.1.1 Single-System or Emergency Hydraulic Pump Operation. In the event of failure of either No. 1 or No. 2 hydraulic pump, the hydraulically powered flight controls will function on the remaining pump, or in the case of a dual hydraulic pump failure on the emergency hydraulic pump, but at a reduced rate and load carrying capability. There is no perceptible change in flying quality or handling characteristics during single-pump operation.

If the integrity of hydraulic system No. 1 remains intact and the emergency hydraulic pump is activated, the full capabilities of the utility hydraulic system will be available to the aircrew.

If single-system operation is the result of failure of the No. 1 (utility) system integrity, trailing edge flaps can only be extended (or retracted) electrically. Also, the landing gear cannot be extended hydraulically but is designed to freefall to the extended position at airspeeds less than 140 knots.

12.2 EMERGENCY FLIGHT CONTROL SYSTEM

Whenever hydraulic pressure on both systems falls below 800 psi, an automatic transfer to EFCS occurs, causing the powered system control force feel mechanism and AFCS to disengage. The EFCS control forces are composed of forces required to move the control system components and forces caused by aerodynamic loads on the control surfaces. Maximum control surface deflections are about 60 percent of the powered values and roll control power is significantly reduced because the spoilers are inoperative. Electric pitch trim and mechanical rudder trim are available on EFCS; however, roll trim is not.

The pilot control stick may be extended to increase mechanical advantage and reduce control forces.

With flaps up and aircraft in trim, transfer to EFCS results in little lateral or directional trim change; however, there will be a noseup or nosedown trim change. The force required to hold pitch attitude may be from 90 pounds push to 50 pounds pull depending on elevator tab rigging, cg, and airspeed. With trailing edge flaps extended, transfer to EFCS will result in immediate removal of elevator bias. A nosedown pitching moment will develop, requiring immediate noseup pitch trim. The pull force required to hold pitch attitude will vary with elevator tab rigging, cg, airspeed, and trailing edge flap position. Transition to EFCS with takeoff flaps will require pull force in excess of 80 pounds to hold pitch attitude.

WARNING

Reversion to EFCS with takeoff flaps will result in a moderate nosedown pitching movement requiring in excess of 80 pounds of pull force and immediate noseup pitch trim to maintain pitch attitude. Intentional transfer to EFCS should be made only with trailing edge flaps retracted.

CAUTION

When conducting EFCS flight, ensure all axes are trimmed prior to transfer to EFCS to minimize magnitude of transition trim change. When returning to powered flight, relax control forces prior to reverting to powered system to avoid inadvertent overstress or accelerated stall.

Note

If rudder trim is not set at zero, the rudder pedals will shift upon transfer to EFCS. Corrective action should not be taken. The aircraft is still in trim as the rudder did not move.

In general, EFCS longitudinal control forces are high and aircraft response slow. Pitch trim is more effective than stick force in generating pitch attitude changes and should be used to reduce maneuvering control force requirements. Highest roll rates are achieved through use of a combination of lateral stick and rudder. Rudder trim can be used to roll into or maintain bank angles, thereby reducing rudder forces that are high. The dutch roll is lightly damped. Once Dutch-roll oscillation is excited, additional rudder or aileron inputs will tend to aggravate the situation. Dutch-roll damping improves at lower altitudes and higher airspeeds. Lateral asymmetry caused by fuel loading or external stores may be compensated for with rudder trim, and the roll trim can be used to center the control stick.

For approaches, it is desirable that a long straight-in final with a stabilized rate of descent be established to reduce pilot workload. Approaches should be made with trailing edge flaps in the takeoff position and minimum approach speed should be the higher of 125 KIAS or optimum AOA. Any power changes will require immediate retrimming of the stabilizer. The landing touchdown point may be as much as 3,000 feet longer than intended.

WARNING

The control stick moves forward when noseup trim is actuated on EFCS. Forward stick travel is limited during EFCS approaches because of noseup trim requirements. The control stick is at or near the forward stop at forward cg positions. Waveoff from an EFCS approach will require immediate nosedown trim. Rapid and large power changes should be avoided on EFCS, particularly during waveoff.

WARNING

- Reversion to EFCS while pushing forward on stick may result in failure of elevator control to engage during flight and subsequent loss of longitudinal control authority at all pitch trim and trailing edge flap settings.
- Timely glideslope corrections on EFCS are not possible because of a combination of high pitch and rudder control forces and slow aircraft response, lightly damped Dutch-roll, adverse yaw because of aileron deflection, limited forward stick travel, and lack of autopilot yaw damper or turn coordination. Therefore a CV landing on EFCS shall not be attempted.
- During field landings, directional control with rudder may be inadequate because of the high control forces and slow aircraft response. Lack of nosewheel steering and antiskid brakes compound the directional control problem. A combination of rudder and differential braking should be used to maintain directional control. All EFCS approaches should be planned for a short-field arrestment.
- During EFCS flight in aircraft utilizing MIL-H-83282 hydraulic fluid in elevator and rudder viscous dampers, higher than normal stick forces may be encountered when dampers are exposed to a cold environment. EFCS landing should be attempted only after successful controllability check.

12.3 LATERAL CONTROL

The upper and lower wing spoilers in conjunction with the ailerons provide a very high roll rate capability. A slight noseup trim change with large lateral control inputs is noticeable and is because of the spoilers. Because of this, full abrupt lateral control inputs result in a small incremental load factor, the amount varying with speed. Above 300 KIAS, abrupt roll inputs above 1.5g result in load factor excursions that could lead to overstress of the aircraft. Simultaneous aft stick movement when making abrupt roll inputs is to be avoided, particularly when rolling with an aft cg. Rudder is not required to coordinate high rate rolls and at high speed can tend to increase load factor excursions. Some rudder application may be beneficial to coordinate gentle bank/turning maneuvers at slow speed without yaw damper engaged. Lateral trim activates appropriate spoilers as well as ailerons. Large amounts of lateral trim will result in noticeably faster lateral control response in the direction of trim input.

12.4 LATERAL DIRECTIONAL CHARACTERISTICS

Without the yaw damper engaged, the aircraft exhibits a lightly damped dutch roll. This mode of motion is easily excited by turbulence, rudder inputs, and to a lesser extent, by the adverse yaw created by aileron inputs. After being excited, the dutch roll continues in the form of lightly damped oscillations that make precise heading control in the approach configuration difficult. The yaw damper provides good dutch roll damping as well as turn coordination.

WARNING

Do not make abrupt rudder pedal inputs or alternating left and right pedal inputs in sequence at airspeeds above 250 KIAS. The period or duration of one complete Dutch-roll mode oscillation is approximately 3 to 5 seconds. Rudder pedal inputs applied during the same period will result in sideslip angles that are much greater than can be achieved with steady rudder inputs. Abrupt rudder pedal inputs or alternating left and right pedal inputs in sequence can generate enough sideslip to overstress and fail the vertical fin.

Note

The yaw damper adds excessive input into a 360° roll resulting in unbalanced flight at the completion of the maneuver.

12.5 WING FLAPS

Extension of the wing flaps results initially in a mild nosedown trim change requiring aft stick to maintain altitude. As the trailing edge flaps extend, the trailing edge up elevator bias provided by the ratio changer will reduce both the trim change and aft stick required. The net trim change from flaps up to flaps down is very small and can easily be adjusted while the flaps are moving. A light airframe buffet is noticeable with landing flaps at all speeds. With maneuver flaps, a noticeable buffet commences at about 220 KIAS, increasing in intensity up to limit speed. Full flap extension requires 14 seconds on the normal system and about 50 seconds using the emergency system.

12.6 ASYMMETRIC FLAP OPERATIONS

If a large differential load exists between the right and left ends of the flap actuator, the flap asymmetry detector system will lock the flaps and illuminate the TE FLAPS LKD light in the master caution panel. This can be caused by a mechanical jam or linkage failure or airloads caused by asymmetric spoiler extension during flap actuation if the flaps are improperly rigged. If this occurs in flight, a rolling moment is generated that can normally be controlled with lateral stick or roll trim.

There are some failure conditions in which a flap asymmetry may exist without a flap lockup, and these are potentially hazardous. During flight with flaps extended, a linkage failure in one of the outboard flap panels could cause the flap panel to fully retract, resulting in a rapid rolloff and pitchup. This situation requires immediate application of lateral stick to stop the roll and full forward stick to avoid stall. Stall speed will increase by as much as 30 knots because of lift loss from flap retraction and spoiler deflection. Power must be added immediately to avoid stall and minimize altitude loss during recovery. AOA should be maintained at 13.5 to 16.5 units to facilitate the recovery. Lateral control is adequate to return the aircraft to controlled flight with one flap fully extended and the other fully retracted; however, selecting MANUV flaps will reduce the stick deflections required for control if no flap lockup has occurred. Selecting MANUV flaps rather than UP precludes a reduction in lateral control authority that occurs as the flap actuator retracts through 26 percent.

12.7 PITCH CHANGE WITH POWER

The engines are mounted below the vertical cg of the aircraft. This offset plus the influence of the fan discharge airflow across the stabilizer results in a noseup pitching moment when increasing thrust and a nosedown pitching moment when decreasing thrust. These pitch trim changes are apparent over the entire flight regime of the aircraft, but are most evident and require the most pilot compensation when in the approach configuration. During manual carrier approaches, the thrust changes required for precise ball control produces noticeable pitch trim changes that the pilot is required to compensate with stick inputs.

Engaging the direct lift control enables DLC and activates thrust pitch compensation and pitch damping. The pitch trim changes caused by small power corrections on glideslope are compensated for with DLC engaged by a series elevator input. Pitch rate damping is also provided through the STCU. The combined effect of TPC and pitch damping is a significant reduction in pilot workload on the glideslope.

12.8 PITCH TRIM SYSTEM OPERATION

Pitch trim monitor features are designed to disconnect the system in the event of certain malfunctions (see Figure 2-46). Continuous trim may cause disconnects of a normally operating system. To avoid nuisance disconnects, intermittent trim should be utilized.

12.9 SPEEDBRAKE OPERATION

Spoilers on the top and bottom portion of the wing serve as speedbrakes and, when actuated, result in a slight noseup trim change requiring forward stick application to hold altitude. With the spoilers deflected, wing lift is significantly decreased and drag is increased. This feature allows for rapid descent from altitude; however, some aspects of speedbrake operation are potentially dangerous. The speedbrakes decrease lift that results in an increase in stall speed. Speedbrake buffet masks stall warning and increases the sink rate significantly at stall as well. The speedbrakes should not be fully extended with flaps at takeoff or land position because of the heavy airframe buffet. Takeoffs with speedbrakes extended are extremely hazardous and may not be possible. Attempting to level off at low altitude with the speedbrakes extended results in rapid deceleration and increases the risk of stall.

CAUTION

Care should be exercised in extending speedbrakes in accelerated flight or during rolling pullouts. Otherwise, limit load factor may be exceeded.

12.10 TAKEOFF, WAVEOFF, AND BOLTER

Control surfaces utilized for longitudinal control of the aircraft are the trimmable horizontal stabilizer and elevator. Pitch trim controls the horizontal stabilizer; therefore, it becomes a very powerful device for generating pitching moments in the aircraft, particularly in the low-speed regime, during takeoffs, waveoffs, and bolters. In this regime, pitch changes with power are the greatest, and the trim position for takeoff as well as the ability to retrim during the waveoff and bolter becomes very critical.

Takeoff stabilizer trim setting is primarily a function of cg and temperature, and (to a lesser degree) weight. The effects of external stores (other than weight effects), internal fuel, and excess end-speed for catapult takeoff are essentially negligible.

Since the biggest effect on longitudinal trim setting is the cg, it is important to account for the cg variation with sonobuoy load and bomb bay stores. Fuel load, wing stores, and crew weight have negligible effect on cg. Recommended stabilizer trim settings for takeoff should be determined by the procedure in paragraph 7.2.1, Takeoff Trim Determination. If the internal store loading changes during a mission, the cg variation should be accounted for by using the data of Figure 7-1. The takeoff trim setting should be recomputed for each takeoff if any of the related variables change from the preceding takeoff.

The pitch trim indicator that is marked in degrees of stabilizer angle should be correlated with the aft fuselage markings near the horizontal tail. The full range of trim travel should be checked prior to each flight.

The lateral trim for takeoff is usually zero; however, if there is asymmetric internal wing fuel or asymmetric stores, the lateral trim should be set according to the procedure in paragraph 7.2.2, Lateral Trim for Takeoff. If there is a heavy right wing because of transfer tank fuel or a store on only the right wing, set in left wing-down lateral trim.

Directional trim should be set to zero except for some expected known asymmetric condition.

WARNING

Excessive nosedown trim may result in lack of ability to rotate the aircraft during a field takeoff. During a catapult launch, excessive nosedown trim may cause considerable altitude loss and contact with the water. During a field takeoff, excessive noseup trim may result in premature rotation to a stalled condition; extreme overrotation and stall may result during a catapult launch. Compliance to the required trim setting is mandatory for safe operation of the aircraft.

During field takeoffs with aft cg (full sonobuoy load and no bomb bay stores) and partial fuel loads, the nosewheel may lift off the runway initially if full power is applied prior to brake release; however, directional control can be maintained with differential braking under these conditions. The effects of aft cg nosewheel liftoff can be minimized by using a rolling takeoff technique and not applying maximum power until the brakes have been released. Executing a waveoff or bolter by applying full power requires a simultaneous application of forward stick to counter the noseup trim change because of power. Failure to counteract the noseup trim change with forward stick action can result in an extremely nose-high attitude. If more than approximately 75 percent of forward travel is used, the autobolter trim system automatically trims the aircraft nosedown until the stick is moved back through the approximately 75-percent position.

12.11 STALL CHARACTERISTICS

The aircraft exhibits varying stall characteristics depending on configuration, power, g-onset rate of entry, loading, and center of gravity. Significant changes in stall and stall warning characteristics exist when operating in the takeoff and land configuration with leading edge flaps retracted. In general, stall warning consists of light to moderate buffet occurring at a nominal 5 to 10 knots before the stall, increasing in amplitude as speed is reduced. The stall is characterized by a moderate nosedown pitch attitude change that can be accompanied by a slight rolloff as the stall progresses. Deeper stall penetration will result in a greater rolloff tendency and much higher roll rates. A normal recovery from the stall is effected by reducing AOA to 18.5 units or below, retracting speedbrakes (if extended), and applying power. Roll wings level when AOA is less than 18.5. During recovery, the elevator, ailerons, and rudder effectiveness are good. There is a tendency to enter a progressive or secondary stall if forward stick inputs are not coordinated to counter the noseup pitching moment associated with rapid application of power.

12.11.1 Clean Stalls (No Flap)

12.11.1.1 Normal Stall (Wings Level 1g). The aircraft exhibits conventional stall characteristics with no flaps. Stalls in the S-3B aircraft are generally characterized by a light buffet onset at around 19.5 to 20.5 units AOA, increasing to moderate intensities as AOA increases about 2 to 3 units. This increase in AOA (2 to 3 units) corresponds to about 10 knots. The stall occurs as a g-break or porpoising oscillation at 21.5 to 22.5 units AOA with load excursion of +0.25g in a period of about 2 seconds. If further back stick is applied, the pitch oscillations will diverge in magnitude until deep stall penetration occurs normally as a rolloff at an excessive pitch attitude and angle of attack; however, forward stick provides timely recovery. During the normal pitch oscillation stalls, roll attitude changes are mild and easily accomplished by moving the stick forward to reduce AOA and then simultaneously adding power and leveling the wings.

12.11.1.2 Accelerated Stall (Turn Greater Than 1g). Stall buffet occurs as described above for 1g stall approaches. The buffet intensity increases with increasing g level; however, the AOA difference between warning and stall decreases to 1 unit at 2.5g. Minor pitch oscillations can occur up to the stall that is characterized by the same g-break/pitch oscillations as the 1g stalls and can be accompanied by a rolloff into or out of the turn if aggravated. Stall recovery is easily accomplished by relaxing backstick pressure to lower AOA and then simultaneously adding power and leveling the wings.

12.11.2 Stalls in the Takeoff and Land Configurations

12.11.2.1 Leading Edge Flap Extended

12.11.2.1.1 Normal Stall (Wings Level 1g). The aircraft exhibits similar characteristics to the no-flap configuration. Stall warning begins with the onset of light buffet and a nose-high pitch attitude, at around 20.5 to 21.5 units AOA in the takeoff configuration and 21.5 to 22.5 units in the land configuration. The buffet increases to moderate intensities as AOA increases about 2 to 3 units. This increase in AOA (2 to 3 units) corresponds to about 5 knots. Controls are effective in all three control axes up to stall; however, small uncommanded roll excursions of about $\pm 2^\circ$ can develop that are easily countered with lateral stick. Stall is indicated by an easily perceptible g break above 25 units AOA with a minor tendency to rolloff. During recovery, the elevator, ailerons, and rudder effectiveness are good.

12.11.2.1.2 Accelerated Stall (Turn Greater Than 1g). Accelerated stall characteristics will vary depending on the g-onset rate; however, stall warning is generally characterized by moderate to heavy buffet at slightly higher AOA (1 to 2 units) with buffet intensity increasing with increasing g. Controls are effective in all control axes up to stall. Stall is indicated by a g break above 25 units AOA with an increased tendency to rolloff.

12.11.2.2 Effects of Leading Edge Flaps Retracted. With leading edge flaps retracted, significant changes to the flight characteristics must be understood and extreme caution exercised. With leading edge flaps extended, airflow separation begins at the trailing edge of the wing root and gradually progresses forward and outward as a greater portion of the wing becomes involved. This progression provides the pilot with a predictable stall warning and control effectiveness throughout the stall progression. With leading edge flaps retracted, airflow separation is less predictable, often beginning at the wing leading edge, and is invariably abrupt, thus precipitating a dangerous loss of lift with little or no warning. Loss of lift can occur abruptly near stall even with small increases in AOA and may result in unusual attitudes if flow separates unevenly from both wings. Flight tests have shown with leading edge flaps retracted, stall warning and margin are reduced or even eliminated, stall speed is increased, and rolloff tendency at or near the stall is increased with an increased tendency to enter into a poststall condition.

12.11.2.2.1 Normal Stall (Wings Level 1g). With the leading edge flaps retracted, the stall characteristics are notably degraded. Stall warning is characterized by a barely perceptible and easily masked airframe buffet occurring at about 20 to 21 units AOA in both the takeoff and land configuration. The airframe buffet is accompanied with small roll tendencies. During flight tests, the light stall warning buffet and relatively small roll tendency were not considered sufficient indicators of stall to enable the pilot to routinely effect stall recovery prior to entering the stall. The stall is characterized by a rolloff at approximately 21 units AOA. Flight tests have also shown that failure to initiate stall recovery at the first indication of stall will result in deep stall penetration susceptible to large, uncontrollable rolloffs, reducing the probability of making a recovery if encountered at low altitude.

12.11.2.2.2 Accelerated Stall (Turn Greater Than 1g). Accelerated stall characteristics pose a significant hazard to flight safety. The accelerated stall does not provide stall warning, resulting in stall entry without notice. Flight tests have shown that the stall is characterized by an abrupt rolloff with roll rates exceeding 30° per second at approximately 21 units AOA. Lateral control is ineffective and will aggravate the stalled condition if applied to counter the rolloff. Increased g-onset rate entries resulted in flight departures and excessive altitude loss (greater than 3,000 feet) during recovery. Recovery at low altitude is unlikely because of the significant amount of altitude required to recover from the stalled condition.

WARNING

- Minimal or complete absence of stall warning with leading edge flaps retracted in the takeoff configuration requires extreme caution when considering flight in this configuration. Catapult takeoffs with leading edge flaps retracted can be conducted with current NATOPS pitch trim settings if 20 knots excess endspeed is provided and no turns are initiated until the trailing edge flaps have been retracted.

- Leading edge flaps up has a negligible effect on approach and landing characteristics if flown at the optimum on-speed AOA. However, because of the minimal or complete absence of stall warning with the leading edge flaps retracted in the land configuration, maneuvering should be minimized and extreme caution exercised so the aircraft does not decelerate above optimum AOA. A straight-in approach is recommended.

Note

The equations used for angle-of-bank commands on computer steering are based on 2.1g being available at 159 knots in the maneuver configuration. This performance criterion is not applicable with leading edge flaps up. Because of the reduced stall warning, computer steering should not be used for flight operation with leading edge flaps retracted.

12.11.3 Effect of Power. Full power-on stalls with the flaps in takeoff or land requires continual programming of forward stick as the stall is approached. The amount of forward stick required is dependent on cg position, altitude, and longitudinal trim setting. The amount of forward stick required may activate autobolter trim, which would preclude stalling the aircraft; however, dynamically entering or trimming into the stall may not activate autobolter trim. The approach to stall is marked by unusually high pitch attitude (approximately 30°) that, in itself, provides warning of impending stall.

WARNING

During full power-on stalls, there is little or no aerodynamic buffet warning as the stall is approached.

Single-engine operation at high power setting can aggravate the stall and produce a poststall gyration of incipient spin caused by the yawing moment generated by the asymmetric thrust condition. The stall in the high-power configuration is generally marked by an abrupt rolloff to bank angles in excess of 60°.

12.11.4 Approach Rate. As speed bleed rate increases during stall approaches, there is less time available for recognition of impending stall and recovery action between the onset of buffet and stall. Stall warning buffet is manifested in the same manner as for slow approaches, but there is a tendency for the pitching oscillation to subside. Because of this, the stall may be marked by aft stick, a stabilized AOA up to 26.5 units, and a high rate of descent as opposed to the normal pitch oscillation stall. Speed for stall warning buffet and stall may be as much as 5 knots lower than for slow entries. Rapid aft stick application should be avoided, particularly at aft cg's because the aircraft abruptly rotates to high angles of attack well above stall with no buffet warning.

12.11.5 Effect of Center of Gravity. At an aft cg, high AOAs (in excess of 20° true AOA) are readily attainable with less than half elevator travel, and as would be expected, attitude changes are very responsive to small elevator inputs. Large, rapid elevator inputs can result in the aircraft abruptly rotating to AOAs of 30° to 40° true AOA with no stall warning whatsoever, and, therefore, should be avoided. When high AOAs are realized and recovery is initiated, the nose may continue to rise another 4° to 5° before dropping even though the backstick has been released.

Maximum AOAs are reduced somewhat at intermediate and forward cg, and it is possible to obtain full aft stick with the aircraft stabilized in a moderate high rate of descent at 21 to 22 units AOA. Forward cg stall speeds are about 5 knots higher than at the aft cg.

12.11.6 Stall Speeds. Stall speeds are shown in Figure 12-1 for sea-level conditions up to 15,000 feet for mid-to-aft cg positions. The values are applicable to power for level-flight or power-off conditions. Above approximately 15,000 feet, Mach effects become noticeable, resulting in an increase in stall speeds of 10 to 15 knots at 35,000 feet.

12.11.7 Out-of-Control Flight. A spin flight test program has not been conducted on the S-3B aircraft. Out-of-control flight characteristics are based on analytical spin studies and stall maneuver flight test. Spins have not been experienced during stall maneuver flight test, even with full back stick stalls; however, holding the aircraft in a stalled attitude can result in moderate uncontrolled rolloffs in excess of 40° angle of bank. During the gyrations that follow the rolloff, experience has shown that the AOA and turn-and-slip indicators may be pegged, but the airspeed will increase. To recover, use full forward stick, neutral ailerons and rudder, and reduce power.

WARNING

Out-of-control flight may be aggravated if spin recovery controls are applied prior to a fully developed spin. The most effective way of avoiding a spin is full forward stick and neutral rudders/ailerons.

12.12 SPINS

Wind tunnel data show that if the S-3B aircraft should enter a spin, the rate is 2 to 3 seconds per turn. Descent rate is about 300 feet per second with a 45° nosedown attitude. The likelihood of a poststall spin increases if high power settings and aft stick are maintained or abnormal control inputs are made at the stall. This is particularly true for single-engine, high-power stalls. A fully developed spin is indicated by fully deflected AOA and turn indicators with steady rate of descent and constant airspeed. Recovery from a conventional fully developed spin is effected by simultaneously applying full forward stick, rudder against the spin, and aileron with the spin. Recovery may take several turns to effect after the application of recovery controls and will be accompanied by an increased roll rate and lowering of nose attitude prior to recovery. Refer to Part V for spin recovery procedures. Indications are that the aircraft will not spin inverted with controls neutral.

12.13 SENSITIVITY AT HIGH AIRSPEEDS

Because of sensitivity at high airspeeds with a takeoff cg aft of 24-percent MAC, the following characteristics could lead to an inadvertent overstress when above 300 KIAS:

1. Low stick force and control stick position per g.

2. High frequency g excursions that the g meter is unable to accurately measure.

Pilot-induced oscillations in this region may result in undesired g excursions because of control stick oscillations. Release of the stick remains the best recovery from PIO maneuvers.

When the takeoff cg is at or forward of 24-percent MAC, the aircraft is sensitive at airspeeds in excess of 300 KIAS; however, the danger of inadvertent overstress is diminished. Therefore, the stick force and stick position per g is higher, the g meter more accurately reflects the actual g level, there is no PIO tendency, and the control stick does not exhibit a tendency to oscillate and drive the aircraft through undesired g excursions.

FLAPS	UP			MANEUVER			TAKEOFF			LAND		
BANK ANGLE (degrees) LOAD FACTOR (g)	0 1.0	45 1.4	60 2.0	0 1.0	45 1.4	60 2.0	0 1.0	45 1.4	60 2.0	0 1.0	45 1.4	60 2.0
30,000 pounds	104	123	147	91	108	130	85	101	120	81	95	114
35,000 pounds	112	133	158	99	117	140	92	109	130	87	103	123
40,000 pounds	120	142	169	106	125	150	98	116	139	93	110	131
45,000 pounds	127	150	180	112	133	160	104	123	147	98	116	139
50,000 pounds	134	158	189	118	140	168	110	130	155	104	123	146
52,500 pounds	137	162	194	121	144	172	112	133	159	106	126	150

Figure 12-1. Stall Speeds — KIAS

CAUTION

- When the high-speed dash capability of the aircraft is utilized, slow, deliberate, longitudinal control inputs are required to prevent g excursions that could overstress the aircraft.
- Extreme care must be exercised to not overcontrol nose attitude when extending speedbrakes above 300 KIAS and at cg aft of 24-percent MAC.

12.14 DIVE CHARACTERISTICS AT 0.79 MACH[1]

The aircraft handles normally in a limit Mach dive. As 0.76 Mach is approached, Mach buffet will begin providing a cue to the approach of limit Mach. However, the transonic drag rise does not present a sufficient barrier to prevent overspeeding of the aircraft. If the aircraft exceeds 0.79 Mach, it will begin to pitch and roll. Maximum Mach dives with the speed-brakes extended will result in extremely nose-low attitudes and corresponding extreme rates of descent. Figure 12-2 should be consulted anytime high speed dives are taken below 10,000 feet AGL.

12.15 LOW-ALTITUDE FLIGHT

The S-3B aircraft offers essentially no sensory cues to increasing airspeed or loss of altitude. When performing tactical maneuvers frequent reference to flight instruments is required as altitude can be easily lost. When flight visibility decreases or the horizon becomes less prominent, pilot workload becomes progressively higher and the minimum altitude should be increased proportionately. Although low-altitude flight can be safely accomplished regardless of AFCS status, flight below 1,000 feet AGL under night or instrument conditions without a functioning AFCS should be approached cautiously.

The unique character of sea control missions and in order to obtain optimum results from sensors, flight below OPNAVINST minimums may be required. However, flight below 200 feet is prohibited under any conditions except for takeoff or landing. Under night or instrument conditions, 400 feet is the minimum safe operating altitude. The latter limit assumes an operating radar altimeter.

Flight at the slower airspeeds typical of maximum endurance increases pilot workload significantly and is not recommended for low-altitude maneuvering. Airspeeds and configurations used to improve maneuvering characteristics increase fuel consumption.

12.16 AEROBATIC MANEUVERS

12.16.1 Aileron Roll. Entry speed is 300 KIAS with yaw damper off. Execute a wings-level, 1.5g pullup to a 10° nose-high pitch attitude. Upon reaching 10° nose high, release the back pressure on the stick, pause momentarily, and then commence a 360° roll either to the left or right. The roll should be commenced with a smooth input of either full left or right stick

[1] See Chapter 4 for current Mach limits.

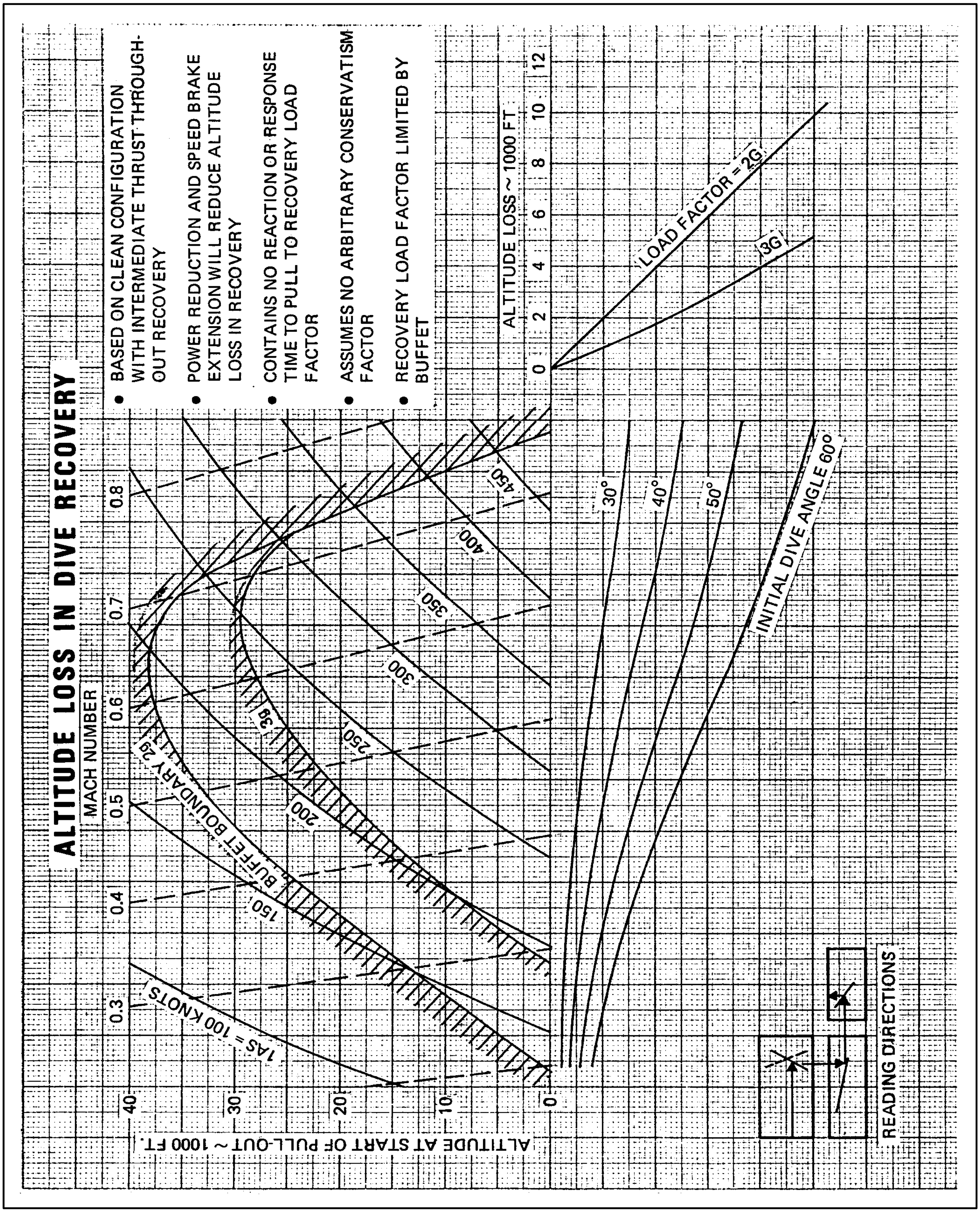


Figure 12-2. Altitude Loss in Dive Recovery

(aileron). Adjust the roll rate during the maneuver to complete it with a pitch attitude not below 5° nose low on the aircraft's entry heading.

Note

Entry speed for both the wingover and barrel roll is 350 KIAS with power set at the greater of 755 °C or 2,000 lb/hr fuel flow.

12.16.2 Wingover. Execute a level, 1.5g pullup to a 15° nose-high pitch attitude. Upon reaching 15° nose high, begin to smoothly roll the aircraft to either the left or right while maintaining the 1.5g pullup. At 30° angle of bank, the aircraft's pitch attitude should be 40° nose high. Upon reaching 40° nose high, relax the g on the aircraft and continue smoothly rolling until the angle of bank is 90°. Maintain 90° angle of bank until the aircraft's nose falls through the horizon and reaches 10° nose low. As the nose passes through the horizon, aircraft heading should be 90° off of the aircraft's entry heading. Upon reaching a pitch attitude of 10° nose low, commence a smooth rollout. At 20° nose low, the angle of bank should be 60°; at 30° nose low, the angle of bank should be 30°. Upon reaching a pitch attitude of 30° nose low, begin programming backstick pressure so as to commence a 1.5 to 2.0g pullup to complete the maneuver at entry altitude, on airspeed with the wings level, and 180° off of the aircraft's entry heading.

12.16.3 Barrel Roll. Execute a level, 1.5g pullup to a 15° nose-high pitch attitude. Upon reaching 15° nose high, begin a left or right roll while maintaining the entry g loading. Upon reaching a pitch attitude of 30° nose high, the angle of bank should be 30°. At a pitch attitude of 45° nose high, the angle of bank should be 70°. After reaching a pitch attitude of 45° nose high, relax the g loading and increase the roll rate to arrive inverted, 90° off of the aircraft's entry heading with the aircraft's nose passing through the horizon. Maintain the increased rate of roll as the aircraft's nose falls through the horizon so as to arrive at a pitch attitude of 30° nose low with an angle of bank of 90°. Continue smoothly rolling to wings level while programming backstick pressure to commence a 1.5 to 2.0g pullup so as to arrive wings level on the aircraft's entry heading, altitude, and airspeed.

Note

Entry speed for the half-Cuban eight and Immelman is 380 KIAS with power set to maintain that airspeed; for the split "S," it is 180 KIAS. The maximum aircraft gross weight to attain 3.5g is 36,600 pounds.

12.16.4 One-Half Cuban Eight. In a wings-level attitude, begin a steady 3g pullup. Maintain a constant 3g pull until AOA reaches 16.5 units, then adjust backstick pressure as required to maintain 16.5 units AOA through the inverted position with the wings level with the opposite horizon. When the pitch attitude reaches 35° nose low with the wings level and aircraft inverted, begin a 180° roll either to the left or right to arrive 45° nose low, wings level in an upright attitude. Upon reaching the point 45° nose low, upright, and on the reciprocal of the entry heading, adjust backstick pressure as required (not to exceed limit g load) to pull out of the maneuver wings level at 380 KIAS in level flight on the reciprocal of the aircraft's entry heading and on entry altitude.

12.16.5 Immelman. In a wings-level attitude, begin a steady 3g pullup. Maintain a constant 3g pull until AOA reaches 16.5 units, then adjust backstick pressure as required to maintain 16.5 units AOA. Maintain a wings-level attitude until the nose is 10° above the opposite horizon with the aircraft inverted. Upon reaching a pitch attitude of 10° above the opposite horizon, inverted, begin a 180° roll either to the left or the right so as to arrive in a wings-level and upright attitude. At completion of the maneuver, aircraft heading should be 180° off of the aircraft's entry heading.

12.16.6 Split 'S.'' Entry speed is 180 KIAS. Pull the aircraft to a pitch attitude of 15° nose high while simultaneously retarding the throttles to idle. Upon reaching the pitch attitude of 15° nose high, release the backstick pressure and allow the airspeed to bleed off the 160 KIAS. Upon reaching 160 KIAS, smoothly roll the aircraft either left or right for 180°. Immediately upon reaching the inverted position, adjust backstick pressure as required to achieve 16.5 units AOA. Maintain 16.5 units AOA until 3.0g's become available, then adjust backstick pressure as required to maintain 3.0g's. After rolling inverted, the wings are held in a level attitude for the remainder of the maneuver. Maintain the 3.0g pullup until the aircraft is in level flight on the reciprocal of the aircraft's entry heading. At the completion of the maneuver, the airspeed should be approximately 370 KIAS. Altitude loss in the split "S" will normally be between 6,500 to 7,000 feet. Recommended entry altitude is between 17,000 and 19,000 feet AGL.

12.17 SINGLE-ENGINE CHARACTERISTICS

The aircraft has excellent single-engine handling characteristics. At high airspeeds, the loss of one engine results in a very slow roll into the dead engine. At slower airspeeds, the yaw and roll is more pronounced; however, the rudder is effective for countering the yaw. The static minimum control airspeed in the takeoff configuration with one engine at maximum thrust and the other at low idle is generally in the airspeed band of stall warning buffet. In all configurations, control of the aircraft can be maintained when below the minimum control speed if bank angle is increased into the operating engine. This technique should be used for single-engine waveoffs. To optimize single-engine waveoff performance, the landing gear should be raised expeditiously to reduce drag. External jettison and fuel dump should be considered if adverse waveoff performance is expected or encountered. Flying technique to optimize single-engine waveoff performance is to maintain 15 units AOA, bank aircraft into the good engine 3° to 5°, and maintain aircraft track through moderate rudder input into the good engine. This rudder input normally results in approximately a three-fourths to one ball deflection from center. Full rudder trim in the direction to counter yaw increases the minimum control airspeed by about 10 percent; therefore, keep rudder trim at zero for all single-engine operations in the takeoff or landing pattern.

12.17.1 Engine Failure after Decision Speed. Upon engine failure, maintain runway centerline and directional control using proper rudder deflection and stick control inputs. At rotation speed, rotate to approximately 5° nose up and maintain lift-off speed until clear of ground obstacles. Bank 3° to 5° into the operating engine, maintain 3/4 ball out from center, and fly a straight ground track. When safely airborne, raise the landing gear to maximize single-engine rate of climb. If climb performance is insufficient to clear obstacles or conditions warrant, jettison external stores as required, and then, if necessary, dump fuel to achieve the required rate of climb. Do not delay external jettison if the rate of climb appears insufficient. Once all obstacles are cleared, accelerate to 15 unties AOA and continue to climb to a safe altitude above 1,000 feet AGL. Upon reaching a safe altitude, refer to the appropriate Emergency Procedures Checklist.

12.18 EXTERNAL STORES/ PROTUBERANCES

12.18.1 Symmetrical Configuration. Generally speaking, carriage of external stores does not cause any significant change in aircraft handling characteristics. A light airframe roughness is noticeable at high speeds with high drag configurations; in addition, there may be slight yaw disturbances. There also is a tendency with blunt stores for small amplitude, lateral-directional oscillations to develop at low speed near stall AOAs. There may be a greater tendency to roll off at the stall than with no stores. There is a slight tendency to pitch up as the stall is approached at aft cg with mines installed.

12.18.2 Asymmetric Configurations. Flight with asymmetric external configurations requiring lateral trim causes small but noticeable changes in flight characteristics because of the spoiler panels being extended to effect lateral trim. Some effects may be noted in buffet and lateral directional stability, but the most noticeable characteristic is a faster roll response in the direction away from the store. Small amplitude pitching oscillations may also be noticeable at high angle of attack.

Stall characteristics with asymmetric store loadings are predominately marked by a rolloff or pitch oscillation. Rolloff direction varies depending on stall entry conditions. Single-engine control is not significantly degraded with an asymmetric store condition; however, jettison of asymmetric stores should be considered after an engine failure to prepare for the possibility of transfer to EFCS.

12.18.3 Protuberances. The only significant effect of protuberances such as the bomb bay doors or FLIR is manifested as buffet that increases in intensity with speed. Bomb bay door buffet is moderate to heavy, whereas FLIR buffet is very light.

12.19 HIGH PITCH ATTITUDE RECOVERIES

12.19.1 Cruise and Maneuver Recoveries. The aircraft has sufficient energy and maneuverability so that high pitch attitude maneuvers are sometimes useful. If high pitch attitudes (40° or higher) and low airspeeds (160 KIAS and below) are encountered, flight tests have shown that a pushover recovery will provide the greatest stall margin and minimum altitude loss during return to normal flight attitudes and airspeeds. When a high pitch attitude recovery is necessary, a constant AOA reading of 10 to 15 units should be established and maintained with power remaining constant. As the nose approaches the horizon, full power should be added and the same AOA maintained until the aircraft is climbing. If full forward stick is attained without a corresponding decrease in pitch attitude and pitch trim is inoperative or disconnected, the aircraft should be rolled with a moderate stick input to between 60° and 90° angle of bank in order to reduce the pitch attitude; however, stall warning buffet will probably be encountered, yaw excursions may develop, and the altitude loss will be excessive.

12.19.2 Bolter, Waveoff, and Takeoff Configurations. Because of the pitchup from power addition in the takeoff, bolter, and waveoff configurations, pitch attitudes in excess of those normally required for takeoffs and waveoffs can result. Because these conditions occur in close proximity to the ground, timely and correct action is required. If high pitch rates are detected, immediate forward stick should be applied to arrest the rates and control the pitch attitude. If a high, decelerating approach is allowed to develop or if the DLC malfunctions, the trim can be as much as 2° noseup above optimum for approach. When full power is applied in this instance, sufficient elevator may not be available to recover the aircraft and another method to produce a nosedown pitch rate is required.

The normal method of providing sufficient nosedown authority, if enough elevator control does not exist, is with the autobolter trim system. This system will provide sufficient nosedown controllability to assure recovery from the situations cited above or in the event of excessive noseup mistrim for takeoff. In the event this system malfunctions or the pitch trim disconnects and the aircraft has excessive noseup trim, timely action is required to maintain control of the aircraft.

Under these conditions, 30° noseup attitude can be attained in less than 2 seconds; therefore, it is necessary for the pilot to recognize this deteriorated situation and take immediate corrective action. In this instance, time permits only two actions that can salvage the situation: stick and throttle application. Put the stick full forward with nosedown trim and reduce power far enough to produce a nosedown pitch rate satisfactory for reducing the AOA but not so far that the aircraft decelerates. The power reduction that corresponds with this criterion is approximately 2,000 N_f per engine. These actions should be as instinctive as possible because there is little room for error. If the stick is on the stops with nosedown pitch actuation and the aircraft attitude passes 25°, EJECT even if the power has not been reduced because by then power reduction will only produce deceleration into the stall. If the aircraft is recovered but longitudinal control is still marginal, ensure that the flaps are in the landing position for maximum nosedown control. A rolloff recovery should not be attempted because of insufficient altitude and excursion out of the ejection envelope.

12.20 WEAPONS RELEASE/ROCKET FIRINGS

Release or forced ejection of external stores from the wing pylon or bomb bay is detectable but has no significant effect on flying qualities or handling characteristics. Only when heavy stores (1,500 to 2,000 pounds) are released is there any perceptible aircraft response. For single pylon releases, a small, easily corrected rolloff occurs accompanied by the reaction force that is felt in the cockpit. For left and right pylon (simultaneous) releases, the reaction force is more noticeable in the cockpit and may result in a g jump on the accelerometer. This is only a dynamic response characteristic of the accelerometer and does not reflect the actual aircraft load, which is considerably less. A momentary noseup attitude change can also be expected because of the sudden weight decrease. The aircraft is an extremely stable weapons platform and rocket firings pose no unusual characteristics.

Release of search stores is detectable because of the reaction force of the CAD firing and is most noticeable for releases from the forward tubes. Only if a large number of sonobuoys is jettisoned would a trim change be noted. This is because of a shift in cg. Maximum cg shift would be about 6 percent if 59 sonobuoys were released simultaneously.

12.21 ANTISKID BRAKING SYSTEM

The antiskid braking system is an electrical augmentation of the normal brake system (refer to Part I). Its purpose is to sense wheelskid and command brake release to prevent tire failure as the result of a skidding wheel. This results in the maximum possible braking effectiveness for the runway condition. When the system is functioning as designed under poor braking conditions (wet runway, icy patches) or under maximum energy stops, the pilot senses system operation as changes in aircraft deceleration. For maximum deceleration on a dry or wet runway, a smooth moderate to heavy pedal input should be made upon speedbrake extension and maintained until slowed to fast taxi speed.

When force is applied to the brake pedal, the resultant resistance is not feedback from the actual brake cylinders, but is rather an artificial force proportional to the amount of pedal deflection. This force will be felt whether the brakes have failed or are operable. There will be normal pedal feel, but no deceleration when the antiskid system senses a failure. Normal pedal feel and no deceleration can also occur upon initial brake application if the speedbrakes are not extended or upon initial brake application if the aircraft rebounds after touchdown. In these situations, the antiskid dumps the brake pressure because there is insufficient normal force on the wheels to prevent brake lock. The system has not failed, but is operating normally.

12.22 ARRESTING HOOK

Directional control of the S-3B on the ground requires a combination of flight controls, differential braking, and nosewheel steering. At low speeds, nosewheel steering and differential braking are most effective because there is insufficient wind over control surfaces to make large directional changes. As speed increases, nosewheel steering and braking cause more dramatic changes, and utilization of ailerons and rudders with a free castering nosewheel allows more precise control of the aircraft. Control becomes more difficult as the hook is extended because the nosewheel is centered and locked. This requires flight controls and differential braking to move the aircraft against a point that is not free to pivot. The end results are the necessity to use nosewheel steering for directional control with the hook extended. Certain dangers are inherent in this situation. At high speed, nosewheel steering is sensitive to rudder pedal inputs and is easily overcontrolled. At low speed, large rudder deflections may be necessary to hold the aircraft straight down the runway and engaging nosewheel steering at this point would cause drastic directional changes. In order to minimize control problems, consideration should be given to delay extending the hook until 1,000 feet from the arresting gear.

12.23 CARBON BRAKES

Optimum braking technique with carbon brakes is achieved with one smooth brake application of moderate intensity. Carbon brakes are sensitive to pedal inputs when applied at higher groundspeeds (greater than 80 knots) and differential braking action may result in mild pilot-induced directional oscillations. Recommend only light braking above groundspeed of 80 knots.

PART V

Emergency Procedures

CHAPTER 13 — EMERGENCY PROCEDURES — GENERAL

CHAPTER 14 — IMMEDIATE ACTION

CHAPTER 15 — FOLLOW-ON PROCEDURES

CHAPTER 16 — ENGINE/APU ABNORMAL PROCEDURES

CHAPTER 17 — FUEL ABNORMAL PROCEDURES

CHAPTER 18 — ELECTRICAL ABNORMAL PROCEDURES

CHAPTER 19 — HYDRAULIC SYSTEM FAILURE ABNORMAL PROCEDURES

CHAPTER 20 — ENVIRONMENTAL CONTROL SYSTEM ABNORMAL PROCEDURES

CHAPTER 21 — FLIGHT CONTROLS ABNORMAL PROCEDURES

CHAPTER 22 — UNUSUAL ATTITUDE, STALL/SPIN RECOVERY ABNORMAL PROCEDURES

CHAPTER 23 — LANDING ABNORMAL PROCEDURES

CHAPTER 24 — AIR REFUELING STORES ABNORMAL PROCEDURES

CHAPTER 25 — JETTISON/EJECT, RESCUE OPERATION ABNORMAL PROCEDURES

CHAPTER 13

Emergency Procedures — General

13.1 INTRODUCTION

This chapter describes procedures to be used in coping with various simple emergencies and some limited compound emergencies that can reasonably be expected during aircraft operation. They take into consideration a limited number of environmental conditions but by no means represent a complete list of conditions a pilot can experience during operations.

Crewmembers should be completely familiar with all emergency procedures contained herein. Special emphasis should be placed on those emergency procedures or steps that require immediate action or where reference to the pocket checklist would be impractical. Those items preceded by an asterisk shall be accomplished without reference to the checklist. Knowledge of these procedures and systems as a result of understanding developed through study of Part I will be required if compound emergencies not covered in this part are encountered. In that case, the pilot must exercise initiative and judgment based on this knowledge and any environmental conditions that may affect the decision.

Each emergency presents a different problem that can be solved only through specific remedial action. Judgment, precision, and teamwork essential to handle emergencies quickly can only be developed through frequent simulated emergencies and emergency drills. The pilot in command is responsible for the progress and completion of the flight and, in this regard, must determine that emergency procedures are properly completed. He may delegate accomplishment of certain phases of the emergency procedures to other crewmembers, but the main execution of emergency procedures is the responsibility of the pilot in command.

A pilot experiencing any emergency during flight, as soon as possible after completion of the emergency checklists, shall notify the surface craft or ground station in as much detail as is possible of the following:

1. Nature of the emergency
2. Assistance desired
3. Intentions
4. Any other information that might be related to the incident or any other incidents encountered that might affect the safety of the flight.

If any control or trim difficulties are encountered at any time during the conduct of a flight, the aircraft should be climbed to a safe altitude (normally 10,000 feet AGL or above) and tested for controllability in the landing configuration to determine the best flap setting for a landing and to determine ability to wave off.

Certain emergencies when encountered will lead to single-engine flight. Flightcrews shall complete single-engine procedures when appropriate.

Note

The S-3B is an extremely stable and reliable platform during single-engine flight. More danger may exist in not securing a malfunctioning engine and then suffering catastrophic failure at an inopportune time (for example, on final approach) than securing the engine and continuing with single-engine flight following the appropriate NATOPS procedures.

It must be kept in mind that the emergency procedures herein are guides to action and are not a substitute for the exercise of good judgment.

13.2 FORMATTING OF EMERGENCY AND ABNORMAL PROCEDURES

13.2.1 Definitions

1. Memory Items — Those items contained in Immediate action checklists that are proceeded by an asterisk (*) and must be accomplished from memory sequentially without reference to the checklist.

2. Immediate Action Items — Those checklist items that are of a time critical nature. They are grouped

together in Chapter 14 of this manual and in front of the PCL for easy and rapid reference.

3. Follow-On Procedures — Those checklist items that are not time critical. In all cases they "Follow On" from Immediate Action checklists. They are grouped in Chapter 15 of this manual and are contained in the PCL.

4. Abnormal Procedures — Those checklists that contain no immediate action items or procedures. They are grouped in Chapters 16 through 25 of this manual and are contained in the PCL.

13.2.2 Formatting and Administration of Emergency and Abnormal Procedures

1. Discussion — Immediate action checklists are grouped by system. A bold title bar identifies the name of the checklist. Checklist steps preceded by asterisk (*) are accomplished from memory. Steps are numbered, but numbers are not read aloud, they are there to help you stay in sequence until the checklist is complete. All checklists contained in this section (Part V — Emergency Procedures) are challenge and response. Accomplishment of all checklists contained in this section will be conducted in the following order:

   a. The pilot-in-command (PIC) will concentrate on maintaining control of aircraft.

   b. The first crewmember to recognize an emergency/abnormal situation will clearly announce it to all crewmembers, such as "engine fire" or "hydraulic system loss." If it is not immediately obvious what the problem is the PIC must take the time to analyze the situation and coordinate crew discussion. Through this process, the PIC will determine and announce to the crew which checklist procedure applies.

   c. Complete any memory items associated with the abnormal situation. Accomplishment of all checklist items contained in this section should involve both the PIC and COTAC using the challenge/response technique.

   d. When the aircraft is not in a critical phase of flight, the PIC will command the COTAC/TACCO to reference the PCL. Read any memory items to insure they were completed then read and accomplish the remaining Immediate Action, Follow-On, or Abnormal checklist steps.

CAUTION

When the master caution switchlight is pressed (reset to a ready condition), the fault lights on the master caution panel remain on except for the FAN OUT, TRIM/SPEED BRK, and ENG LIMIT lights, which will go out.

Note

Aircrew may cancel the master caution light once assured that all crewmembers are aware that an abnormal operating situation exists.

13.2.3 Formatting of Abnormal Checklists

1. "If" statements — Conditional statements contained in checklists that are accomplished only if the statement is true.

2. "Or" arrows — Indicate one or more options, however, only one option is completed.

3. "Goto" statement — Checklist items are accomplished in sequence unless directed to do otherwise by a "Goto" statement.

13.3 SIMULATED EMERGENCY TRAINING

Simulated emergency training is necessary to develop fully qualified flightcrews. Weapon system trainers should be utilized to the fullest extent possible for the conduct of such training. In-flight simulated emergency training should be conducted only in VFR conditions in those cases where meaningful training cannot be achieved on the ground but can be accomplished in flight without creating a condition hazardous to flight safety. The following rules shall apply when practicing in-flight emergencies:

1. Emergencies shall be practiced in such a manner as to allow sufficient altitude for safe recovery. In particular, situations will not be created that will place the aircraft or crew in a hazardous situation in the event of an unexpected single-engine failure.

2. Compound emergencies (multiple failures) will not be practiced in flight. Simulated loss of systems normally lost with an engine failure is not considered a compound emergency. Examples of compound emergencies include: no flap, single-engine landings; and complete electrical failure.

3. An instructor pilot shall demonstrate, as necessary, all emergency training maneuvers to a pilot under instruction and ensure his knowledge of these maneuvers prior to his performing the particular maneuver.

4. Engine failures will be simulated by retarding the throttle to IDLE. The FIRE pull handle will not be used to simulate an emergency. Spoilers will not be used to offset idle thrust of the failed engine. Simulated engine failures on takeoff will not be conducted on short runways or at speeds greater than 80 KIAS until the aircraft is airborne.

5. Actual single-engine flight, for training purposes, will be conducted at a minimum altitude of 4,000 feet AGL. Engine shutdown will be accomplished by utilizing the PRECAUTIONARY ENGINE SHUTDOWN checklist, paragraph 16.1. Intentional shutdowns of either engine will not be made with an inoperable APU/APU generator. The No. 1 engine will not be shut down for training without an operating EHP.

6. Stalls and unusual attitude practice will be conducted so as to complete recovery at a minimum altitude of 10,000 feet AGL. Unusual attitude practice will be with gear and flaps up. Leading edge flap retracted stall shall be initiated at no less than 15,000 feet AGL.

7. No-flap practice field landing shall be conducted with the leading edge flaps extended because of inherent danger from reduced stall warning and increased stall airspeed. Flap extension shall be conducted in accordance with the procedures in paragraph 23.1, Landing With Flap Settings Other Than Takeoff or Land.

8. During poststall gyrations, application of neutral flight controls will normally result in recovery within one to two turns and may be used during training demonstrations to avoid the negative g associated with full forward stick recoveries.

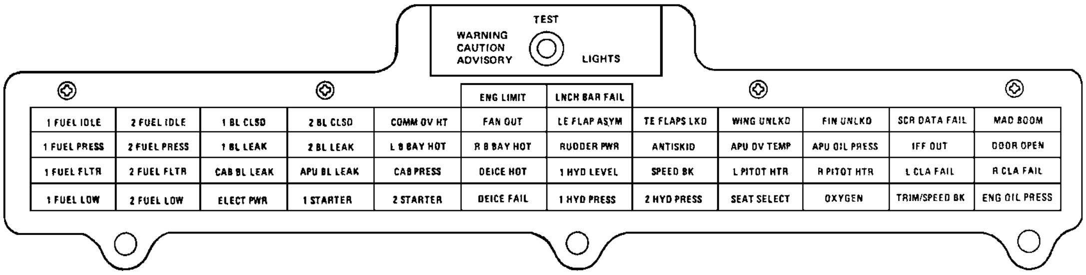
9. Prior to simulation of electrical system failures, equipment that may be damaged by power interruption will be secured. Generators and bus switches will not be secured in flight to simulate electrical malfunctions.

13.4 MASTER CAUTION PANEL LIGHTS/ ACTION PROCEDURES

Caution information is provided usually to the pilots by amber caution lights on the master caution panel located on the center instrument panel (see FO-2). See Figure 13-1 for action procedures when caution lights illuminate. Refer to Chapter 2 for additional information.

CAUTION

When the master CAUTION switchlight is pressed (reset to a ready condition), the fault lights on the master caution panel remain on except for the FAN OUT, TRIM/ SPEED BK, and ENG LIMIT lights, which will go out.



LIGHT	INDICATES	CORRECTIVE ACTION
ANTISKID	One of the following: 1. Antiskid is selected and is not operating properly. 2. Parking brake is set (emergency brakes are activated) with antiskid selected. 3. Antiskid is selected at greater than 20 knots. 4. During takeoff/landing, contact is made on one wheel then the other, causing one wheel to turn at 20 knots or greater and the other to turn below 10 knots.	1. Deselect antiskid. 2. Ensure light goes off after parking brakes are released. 3. Attempt braking. If antiskid is functioning properly, continue with antiskid selected; otherwise, deselect antiskid and select at lower speed. 4. Attempt braking. If normal antiskid braking is available, continue rollout with antiskid selected. If antiskid braking is unavailable, refer to Antiskid Failure, paragraph 14.6.1, for appropriate action.
APU BL LEAK	Temperature along APU bleed air supply duct has exceeded 127 °C (260 °F).	Secure APU.
APU OIL PRESS	APU oil pressure is below prescribed value for 30 seconds.	Secure APU with T-handle unless APU automatic shutdown has been overridden.
APU OV TEMP	Excessive exhaust gas temperature of APU.	Secure APU with T-handle unless APU automatic shutdown has been overridden.
L B BAY HOT (or) R B BAY HOT	Respective bomb bay temperature is 66 °C (150 °F) or greater.	Open bomb bay door. Jettison weapons as required. Secure APU if opening bomb bay doors does not extinguish the light.
1 BL CLSD (or) 2 BL CLSD	Respective bleed air valve is closed.	Check respective bleed air switch position. Attempt reset. If unable, refer to Bleed Air Shutoff Valve Failure, paragraph 20.1, for appropriate action.
1 BL LEAK (or) 2 BL LEAK	Temperature along respective bleed air duct is over 127 °C (260 °F).	Turn off corresponding bleed air switch. Refer to Bleed Air Leak, paragraph 14.1.4, for additional action.
CAB BL LEAK	Temperature along bleed air manifold between bleed air flow control valve and air cycle refrigeration package has exceeded 127 °C (260 °F).	Turn off air-conditioning switch. Refer to Bleed Air Leak, paragraph 14.1.4, for additional action.
CAB PRESS	Cabin altitude greater than 13,000 feet.	Check CABIN PRESS switch is in the NORM position. Reset air-conditioning switch. If pressurization cannot be regained, descend or use oxygen as required.
L CLA FAIL (or) R CLA FAIL	Both power supplies for the respective CLA have failed.	Consult Control Logic Assembly Failures, paragraph 18.3, for functions lost and appropriate action.

Figure 13-1. Master Caution Panel Lights/Action (Sheet 1 of 4)

INDEX	INDICATES	CORRECTIVE ACTION
COMM OVHT	Right aft avionics compartment is hot.	In flight, select COMM EQUIP COOLING switch to EMER. On ground, secure radio equipment and investigate.
DEICE FAIL	One of the following: 1. Deice is selected without anti-ice. 2. Failure of deice pressure regulating and shutoff valve or cyclic valve to operate. 3. Deice is selected with the wings folded. 4. Insufficient bleed air pressure. 5. (Single-bleed operation) indicates deice timer has cycled to zone deiced by the engine with the bleed air valve off.	1. Select anti-ice. 2. Continue to operate (failed zones will not deice). 3. Spread wings. 4. Advance power so that minimum of 30 psi exists in duct.
DEICE HOT	One or more deicing zone temperatures exceed safe limits.	Deselect deice.
DOOR OPEN	Cabin door is not closed and locked.	Close and lock cabin door.
ELECT PWR	Illumination of caution light on electrical control panel.	Check electrical control panel. Refer to Electrical System Malfunctions in Chapter 18 for appropriate action.
ENG LIMIT	N_g, N_f, or ITT limit is exceeded.	Check engine instruments. Refer to Engine Malfunctions, paragraph 14.2, for appropriate action.
ENG OIL PRESS	Low oil pressure in either engine.	Monitor oil pressure gauges.
FAN OUT	Failure of cooling fan.	Check fan fault panel for appropriate ground action. In flight, refer to Avionics Fan Failure procedure, paragraph 20.3.
FIN UNLKD	One or both fin locking pins are not engaged.	Lock fin. Do not take off with light illuminated.
1 FUEL FLTR (or) 2 FUEL FLTR	High differential pressure (ΔP) across fuel filter because of possible contamination.	Avoid abrupt throttle changes. Monitor engine operation. Land at suitable field.
1 FUEL IDLE (or) 2 FUEL IDLE	Minimum fuel flow reset solenoid malfunction. Failure to go high or to flight idle when scheduled.	Monitor fuel flow. Do not reduce below 550 pph during conditions where high or flight idle would normally be scheduled to prevent possible engine rollback. **CAUTION** Illumination of a FUEL IDLE caution light in flight indicates that the engine idle speed control is in ground-idle. The fuel idle control switch should be placed in the FLT IDLE position until touchdown for a final landing. With FLT IDLE selected, the caution light should extinguish. If the caution light remains on, the pilot must maintain 550 pph minimum fuel flow manually to prevent possible engine rollback.

Figure 13-1. Master Caution Panel Lights/Action (Sheet 2)

INDEX	INDICATES	CORRECTIVE ACTION
1 FUEL LOW (or) 2 FUEL LOW	Approximately 400 pounds of fuel remaining in respective feed tank.	Refer to Fuel Low-level Caution Light, paragraph 17.1, for appropriate action. Refer to Figure 13-2 for appropriate fuel levels when gravity transferring to feed tank.
1 FUEL PRESS (or) 2 FUEL PRESS	Fuel pressure low to engine. **Note** Illumination of fuel pressure light with simultaneous decrease in feed tank quantity and fuel remaining in transfer tank indicates a probable engine-driven boost pump failure.	Avoid abrupt throttle changes and high power settings. Reduce altitude to maintain engine operation on gravity feed. Refer to Figure 13-2 for appropriate fuel levels when gravity transferring to feed tank. Land as soon as practical.
IFF OUT	Transponder failed to transmit response to mode 4 interrogation.	Check mode 4 IFF.
1 HYD LEVEL	Less than 2 gallons of fluid remaining. Emergency brakes and APU accumulator will not recharge and the EHP will not operate.	Observe No. 1 hydraulic system for potential failure. Land as soon as practical with No. 1 hydraulic system. Handpump may be used to recharge accumulators. If practical, secure No. 1 servo to isolate utility from flight control system. Consideration should be given to taking an arrested landing. Brakes may be lost.
1 HYD PRESS (or) 2 HYD PRESS	1,900 psi or less in hydraulic system.	Monitor hydraulic pressure gauge for potential failure. If No. 1 hydraulic system pressure is required, activate EHP. Land as soon as practical.
LE FLAP ASYM	All leading edge flaps are not corresponding to commanded position.	Visually check flaps. Attempt recycle. Do not exceed airspeed limits.
LNCH BAR FAIL	One of the following: 1. Insufficient hydraulic pressure for retraction if LAUNCH BAR control switch is in the RET position, launch bar in shuttle, and full power is applied. 2. Full power is not applied when launch bar is in shuttle, LAUNCH BAR switch is in RET or EMER RET position, and sufficient hydraulic pressure is available. 3. Launch bar is not up and locked 3 seconds after weight off wheels and LAUNCH BAR switch is in RET or EMER RET position.	1. Suspend launch and have maintenance check manual extend control knob in normal position. If light remains on upon reapplication of power, abort launch, use EMER RET to retract the launch bar to clear the catapult. 2. Add full power and check. If light does not go off, do not launch. 3. Do not raise gear. Do not make arrested landing with launch bar not retracted. Refer to Launch Bar Fails To Retract In Flight, paragraph 19.8.
MAD BOOM	MAD boom is not fully retracted with landing gear down.	Retract MAD boom prior to carrier landing. If unable, divert should be considered.

Figure 13-1. Master Caution Panel Lights/Action (Sheet 3)

INDEX	INDICATES	CORRECTIVE ACTION
OXYGEN	One of the following: 1. Less than 1 liter remaining. 2. Converter pressure low.	Check oxygen supply switches to OFF. Conserve oxygen and descend as necessary.
L PITOT HTR	Pitot heater is inoperative.	Pilot select alternate pitot/static source.
R PITOT HTR	Pitot heater is inoperative.	Copilot/COTAC airspeed and altitude may be erroneous.
RUDDER PWR	One of the following: 1. Failure of either hydraulic system pressure and trailing edge flaps beyond 57 percent. 2. Failure of rudder servo to decrease operating pressure on one or both systems to 750 psi at flap positions less than 57 percent. 3. Failure of rudder servo to increase operating pressure on one or both systems to 3,000 psi at flap positions greater than 57 percent.	1. Observe flap limit airspeeds. 2. Limit rudder deflection at high speeds with 3,000 psi. Do not use AFCS yaw damper above 200 KIAS. 3. Reduced rudder pressure increases minimum control speed slightly (approximately 5 KIAS).
SCR DATA FAIL	Failure in the secure data unit (KG-40).	Transmit only unclassified information.
SEAT SELECT	At least one command ejection lever is in SELF EJECT position and aircraft is below 15,000 feet.	Place all command ejection levers in CREW EJECT position or climb above 15,000 feet.
SPEED BK	One of the following: 1. Trailing edge flaps up and one or both lower spoilers dwelled. 2. Trailing edge flaps not up and one or both lower spoilers not dwelled.	1. Use speedbrakes with caution. 2. Do not use DLC. Roll response may not be symmetrical.
1 STARTER (or) 2 STARTER	Respective starter valve is not closed regardless of START switch position.	Refer to Starter Caution Light, paragraphs 14.2.2 and 14.2.3, for appropriate action.
TE FLAPS LKD	Trailing edge flaps are locked in position.	Observe flap limits. Do not reset flap control circuit breakers or recycle flaps.
TRIM/SPEED BK	Disconnect in pitch or roll trim or speedbrake control.	Reset trim or speedbrake at flight control test panel.
WING UNLKD	One or more wing locking pins not engaged.	Lock wing. Do not take off with light illuminated. In flight, with no associated hydraulic fluctuations, the light may indicate a proximity switch malfunction. The presence of associated No. 1 hydraulic fluctuations may be the result of CLA generated wing unlock commands. In that case, the wing fold system can be isolated by raising the landing gear or lowering the emergency landing gear extension handle. Make arrested landing.

Figure 13-1. Master Caution Panel Lights/Action (Sheet 4)

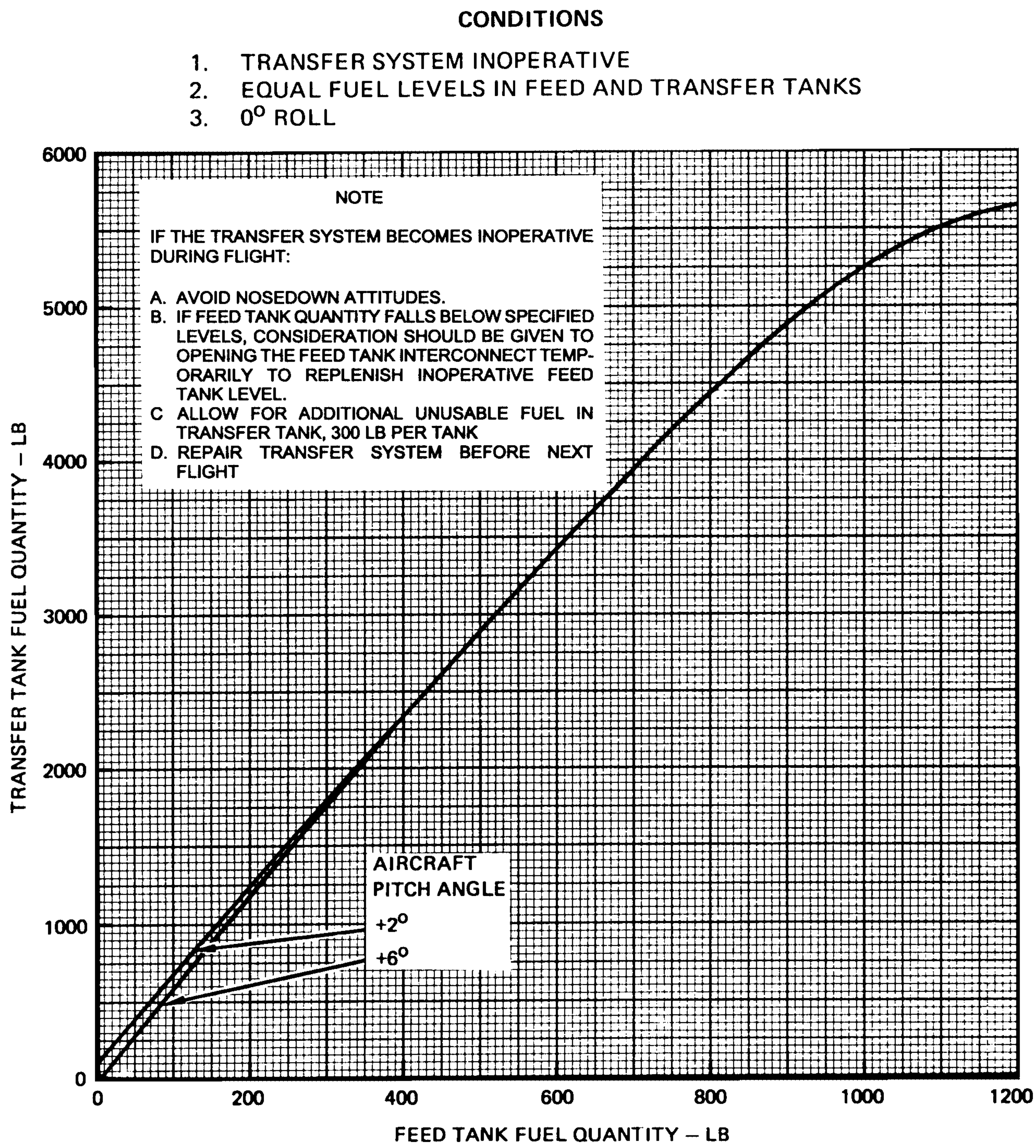


Figure 13-2. Feed Tank Level (Minimum) During Gravity Feed Operation

CHAPTER 14

Immediate Action

14.1 FIRE

With all fires on deck, stop the aircraft and notify ground/tower of emergency.

14.1.1 Auxiliary Power Unit Fire

*1. APU T-handle — DOWN.

*2. APU door — CLOSE.

*3. APU FIRE EXT switch — ON.

If on deck:

4. Engines — SHUT DOWN.

If fire persists following rundown of the APU (approximately 1 minute after shutdown):

5. Exit aircraft.

WARNING

Extinguishing agent applied directly to the APU turbine area before it has stopped or directly into the APU exhaust may cause the turbine disk to shatter.

CAUTION

When using portable fire extinguishers, the nozzle should be directed into the APU blow-in door in such a manner as to fill the area around the APU with the extinguishing agent.

Note

Brief torching (5 to 10 seconds) at the APU exhaust door during start is normal and does not require APU shutdown. Torching is more apparent following a previous abort for no light-off or during night operations.

14.1.2 Engine Fire On Deck. An engine fire during ground operations normally may take one of two forms. One will be indicated by simultaneous illumination of the appropriate emergency shutdown (FIRE) handle indicator warning light for the affected engine and the pilot and copilot/COTAC ENG 1 FIRE or ENG 2 FIRE warning lights. In addition, the pilot should be aware of potential fire reported by ground or tower personnel or by personal observation (tailpipe smoking, high residual ITT after shutdown, torching from the tailpipe, or fuel/oil/hydraulic leaks) without a FIRE warning light indication.

*1. Throttle — OFF.

*2. FIRE pull handle — PULL.

*3. Ignition switch — OFF.

→ If fire light not illuminated (signaled by outside observer only).

*4. MOTOR ENGINE AND PROCEED TO STEP 5.

Note

- If in START position, leave in START position. If in STOP position, allow engine Ng to decay to 57-percent rpm (or less) before selecting START position.
- Essential bus electrical power and starting air are required to motor the engine.
- The starter caution light will illuminate when positioning the start switch to START.

OR

→ If fire light illuminated:

5. BLEED AIR SWITCH — OFF.

6. GENERATOR SWITCH — OFF.

7. FLAPS — UP.

If fire persists:

8. OPPOSITE ENGINE/APU — SHUT DOWN.

9. EXIT AIRCRAFT.

Note

In the event the throttle fails to shut down the engine, actuation of the FIRE handle to the closed position will result in engine shutdown; however, a short period of continued engine operation (5 to 10 seconds) will occur before engine shutdown is indicated. Subsequent engine rundown may be accompanied by a slow N_g decay, fluctuating ITT, high residual ITT following rundown, and tailpipe smoking.

14.1.3 Engine Fire/Explosion In Flight. An engine fire in flight is indicated by illumination simultaneously of the ENG 1 FIRE or ENG 2 FIRE lights on the instrument panels and/or the red light in the FIRE pull handle of the appropriate engine.

Characteristics of pod-mounted engines are such that fires can generally be contained within the engine.

*1. Throttle — OFF.

*2. FIRE pull handle — PULL.

*3. Ignition switch — OFF.

→ If fire persists and is uncontrollable:

4. Eject.

OR

→ If fire goes out:

5. Proceed to nearest suitable field for landing.

6. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

14.1.4 Bleed Air Leak. Bleed air duct leaks may be indicated by illumination of indicator lights on the master caution panel that have been activated by temperature sensors. Failure of an engine bleed air duct, upstream of the bleed air shutoff valve, may be detected by the engine fire warning system but cannot be isolated except by securing the engine.

Illumination of the bleed leak lights may also indicate overtemperature or fire in the respective areas caused by other than a bleed leak. Illumination of these lights requires the following procedures.

14.1.4.1 BLEED LEAK Light(s)

*1. BLEED AIR switch — OFF.

CAUTION

Operation of APU may cause reillumination of the 1 BL LEAK caution light.

If respective light does not extinguish in 1 minute or if both bleed leak lights illuminated:

CAUTION

Simultaneous illumination of 1 BL LEAK and 2 BL LEAK lights may indicate an ECS compartment fire. In this event, the crew should be alert for secondary indications that would confirm a fire, such as smoke or fumes in the cockpit.

2. O_2 MASK — AS REQUIRED.

3. BOTH BLEED AIR SWITCHES — OFF.

CAUTION

If both BLEED AIR switches are secured, no fuel can be transferred from external stores. If recovering aboard ship, consider dumping fuel from the ARS and jettisoning the drop tank.

4. APU — OFF.

5. AIR COND switch — OFF.

6. AUX VENT control — ON.

If light(s) does not extinguish within 4 minutes:

7. BUS switches — OFF.

Note

Refer to Equipment Available on Essential Bus, Figure 14-1.

8. ICS — SELECT OVERRIDE/PTT.

9. Arrestment briefing — COMPLETE (if gear available).

   a. Determine most appropriate gear available.

   b. Notify control tower of intentions.

   c. Adjust gross weight as necessary.

   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

10. Make an arrested landing (if gear available).

If ECS compartment/fuselage fire is indicated:

11. Go to Fuselage Fire Procedure, paragraph 14.1.11.

12. Normal Landing Checklist — COMPLETE.

WARNING

If executing the above procedures, do not extinguish the bleed leak light(s). Secondary indications of a fuselage fire should be investigated. If secondary indications (hydraulic fluctuations, smoke in cockpit, control binding, etc.) are present, the crew should be ready for immediate ejection.

Note

Continued air-conditioning pressurization system operation with air from the opposite engine is possible. Airfoil de-icing shall not be operated.

14.1.4.2 APU BLEED LEAK Light

*1. APU T-handle — DOWN.

2. APU door — CLOSE.

If light does not extinguish in 1 minute:

3. No. 1 BLEED AIR switch — OFF.

WARNING

Continuous illumination of the APU BL LEAK light may indicate a bleed leak in the port bomb bay. Detonation of stores may occur without illumination of the L B BAY HOT light.

14.1.4.3 CAB BL LEAK Light

*1. O_2 mask — AS REQUIRED.

*2. AIR COND switch — OFF.

3. AUX VENT control — ON.

14.1.5 Electrical Fire. Initial isolation should be accomplished by securing both left and right primary bus switches. If the fire does not extinguish, the electrical fire is on the essential bus, which can only be secured by turning off both generators.

*1. O_2 mask — ON.

2. BUS switches — OFF.

3. ICS — SELECT OVERRIDE/PTT.

4. Proceed to nearest suitable field for landing.

If fire persists:

5. AIR COND switch — OFF.
6. AUX vent control — ON.
7. Cabin press switch — DUMP.
8. Generator switches (both) — OFF.

If essential bus power required or fire goes out:

9. APU check airspeed/altitude — START.
10. APU generator switch — CHECK ON.

WARNING

Restoring electrical power will result in wing rack unlock (wing stores will not jettison) and, if the sonobuoy safety door is closed, sonobuoy safety jettison circuit will jettison. Wing rack unlock and sonobuoy jettison may be prevented by pulling their respective circuit breakers (WING JETTISON circuit breaker (4-B-1) and SEARCH STORE CONTROL circuit breaker (3-D-13) — PULL (as required).

OR

11. APU automatic shutdown — DISARM.
12. Go to step 18.

If fire persists:

13. APU GEN switch — OFF.
14. ALL nonessential equipment — SECURE.
15. APU GEN switch — ON.
16. Go to step 18.

If fire persists:

17. EJECT.

If fire goes out, do not reenergize buses and land as soon as practical:

18. ARRESTMENT BRIEFING — COMPLETE (if gear available).

    a. Determine most appropriate gear available.

    b. Notify control tower of intentions.

    c. Adjust gross weight as necessary.

    d. Review hook skip contingencies.

Note

- Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.
- The emergency battery is the only source of electrical power with both engine generators and the APU generator secured. The battery powers the TACCO and SENSO EJECT lights, the APU accumulator gauge, and a floodlight below the pilot glareshield that illuminates the basic flight instruments. The compass, altimeter, airspeed indicator, and VSI will remain operative; consequently, altitude and weather conditions should be considered before turning off all generators.

19. Make an arrested landing (if gear available).
20. Normal Landing Checklist — COMPLETE.

14.1.6 Fume Isolation in Cabin. Acrid fumes in the ACPS that burn the eyes and respiratory tissues and that persist during steady-state engine operation at power settings below 80-percent N_g may be indicative of fuel in the 14th stage compressor and compressor diffuser. If such a condition exists, an engine explosion may result and serious consideration should be given to securing the engine.

Fumes in the cabin can generally be isolated to one engine or the air-conditioning turbine. To determine which engine is introducing the fumes, engine bleed air shutoff valves should be selectively closed. If fumes are isolated to the No. 1 system and the APU is running, the APU should be secured. Fumes that result from operation of the ACPS from either engine should be considered to emanate from the air-conditioning turbine.

14.1.7 Smoke or Fume Removal. Smoke or fume removal can be accomplished without electrical power as long as the DUMP position of the CABIN PRESS switch is selected prior to securing electrical power. The safety valve and the outflow valve will remain in their open, or dump, positions until power is restored. The bleed air shutoff valves will close and the ram air valve will go fully open during the period of power off to facilitate smoke removal.

Note

Both hydraulic systems operating.

AHRS[1]
AOA
BLEED AIR
— LEAK DETECTOR
— PRESSURE INDICATOR
— LEFT AND RIGHT SHUTOFF VALVES
BRAKES
— EMERGENCY ONLY
CABIN TEMPERATURE CONTROL
CAINS II[2]
CDNU
— FLT STA
— TACCO
CLA L/R
COMMUNICATIONS
— PILOT UHF-1 RADIO
— COTAC HF CC BACKUP FREQ
CRYPTO/ZEROIZE
— ZEROIZE THE CODE
DEICE CONTROL
DIGITAL DATA SET
EGI[2]
EMER COM COOLING[2]
ENGINE ANTI-ICE
ENGINE INDICATORS
ENGINE START
FANS
— INTERNAL AVIONICS
— SENSO CONSOLE
FIRE DETECTION
FLIR CONTROL
— OFF-LINE RETRACT ONLY
FUEL FLOW/QUANTITY
— EXCEPT NO EXTERNAL TANK REFUELING
GPS
— FIWA
— GPS RECEIVER
— SDC
HYDRAULIC PRESSURE INDICATOR
— NO. 1 ONLY
ICLS
ICS
— PTT/OVERRIDE ONLY
IFF
INS
LANDING GEAR
— PRESS DOWN LOCK SOLENOID TO RAISE
GEAR HANDLE
LAUNCH BAR
— RETRACT ONLY
LIGHTING (EXTERIOR)
— APPROACH LIGHTS
— FORMATION LIGHTS
— WING AND TAIL POSITION LIGHTS
LIGHTING (INTERNAL)
— ADVISORY PANEL LIGHTS
— APU ACCUMULATOR GAUGE
FLOODLIGHT
— CENTER CONSOLE FLOODLIGHT
— CENTER CONSOLE LIGHTING
— CENTER INSTRUMENT FLOODLIGHT
— COPILOT/COTAC CONSOLE FLOOD LIGHT AND INSTRUMENT FLOODLIGHT
— CREW UTILITY LIGHTS
— EMERGENCY INSTRUMENT LIGHTS
— MASTER CAUTION PANEL LIGHTS
— PILOT ICS LIGHT
— PILOT INSTRUMENT FLOODLIGHT
— TACCO AND SENSO EJECT WARNING LIGHTS
LOX SYSTEM
MAD BOOM
NAVIGATION INSTRUMENTS
— EFIS[2]
— NDCR (CH. 1)[1]
— NIC (CH. 1)[2]
— PILOT VDI, HSI (LESS TRUE HEADING AND NO.2 NEEDLE)[1]
PITOT HEATER
— LEFT ONLY
PRESSURIZATION/AIR-CONDITIONING
PRIMARY SERVOS
RADAR ALTIMETER
SAR SONOBUOY
— RELEASE LIGHT INOPERATIVE
SPEEDBRAKE
— ONE-HALF NORMAL RATE
STANDBY ATTITUDE INDICATOR
STORES JETTISON (WING)
TACAN
TRAILING-EDGE FLAPS
TRIM
— PITCH AND ROLL RATE DECREASED (CHANNEL 1 ONLY)
TURN NEEDLE
WINDSHIELD WIPER
— PILOT ONLY

Notes

1. Aircraft not incorporating AFC-279.
2. Aircraft incorporating AFC-279.

Figure 14-1. Equipment Available on the Essential Bus

With electrical power:

*1. O_2 mask — ON.

*2. AIR COND switch — OFF.

*3. AUX VENT control — ON.

*4. CABIN PRESS switch — DUMP.

14.1.8 Wing Fire

1. DE-ICING switch — OFF.
2. Bleed air switch — OFF.
3. Wing store(s) (if installed) — JETTISON (as required).
4. Proceed to nearest suitable field for landing.
5. Wing lights switch — OFF.
6. Throttle — OFF (as required).
7. Fire pull handle — PULL (as required).

If fire is outboard of engines and weather conditions are favorable:

8. BUS SWITCHES — OFF.

Note

Refer to Equipment Available on Essential Bus (Figure 14-1).

9. ICS — SELECT OVERRIDE/PTT.

If fire persists:

OR 10. EJECT.

If fire goes out:

11. Go to Engine Failure/Fire/Explosion Engine Shutdown Checklist, paragraph 15.1.1 (if required).

14.1.9 Hot Brakes. If heavy braking is used during landing or taxiing, overheated brakes may result. Avoid prolonged brake applications while taxiing to prevent brake disk fusing. If hot brakes are suspected, notify appropriate ground personnel, have the aircraft chocked, and do not reapply brakes or parking brake until the brake disks have cooled.

14.1.10 Brake Fire

1. Aircraft — STOP.
2. Tower — NOTIFY.
3. Engines — SHUT DOWN.
4. Seat — SAFE.
5. Exit aircraft.

WARNING

Proceed forward of the aircraft and stay clear of the fire; the tires may explode.

CAUTION

Do not set parking brake.

14.1.11 Fuselage Fire. Fuselage fires inside the aircraft fuselage are usually of electrical origin and can probably be isolated by securing electrical power. Other fires may be caused by a bleed air leak, which can be isolated by closing the pylon bleed air shutoff valves. Fires fed by hydraulic fluid or fuel are possible, especially in the ECS unpressurized compartment. Firefighting provisions are not provided, and failure to isolate and immediately extinguish a fire of this type should prompt the pilot to consider immediate ejection. Illumination of the 1 BL LEAK, 2 BL LEAK, or CAB BL LEAK light may be an indication of an ECS compartment fire. If executing the BLEED AIR LEAK procedures, paragraph 14.1.4, does not extinguish the bleed leak lights, secondary indications of a fuselage fire should be investigated.

If ECS compartment/fuselage fire is confirmed:

1. Eject.

14.2 ENGINE MALFUNCTIONS

14.2.1 Abnormal Start. The following categories are considered as abnormal start characteristics:

Compressor stall — a rapid rise in ITT and usually an rpm hangup or a rapid drop of rpm.

Oil pressure — if oil pressure is over limits or if there is no oil pressure.

Vibrations — unusual vibrations during start or steady state.

Cold hangup — engine fails to accelerate to the proper idle speed accompanied by low ITT. A restart can be attempted immediately; however, engine still may hang up (engine operating instructions should be followed for troubleshooting).

CAUTION

- Hot starts may be encountered with high residual ITT, possibly accompanied by low bleed pressure. A restart may be attempted after motoring engine to reduce residual ITT to less than 100 °C. Observe starter duty cycle.
- Wet start — no light-off within 20 seconds after throttle is placed to IDLE.

Note

- An investigation or inspection should be made prior to any attempt for a restart after a compressor stall, a hot start, fire warning, oil pressure out of limits, or vibration.
- Hot start — an abnormal increase in ITT to above limits during start (see Figure 4-8).
- After securing engine, affected bleed air switch must be cycled to close 14-stage bleed air augmentation valve, preventing a hung or hot start on restart attempt.

*1. Throttle — OFF.

OR

→ If start prerequisites not met (no oil pressure, low oil pressure, N_g <15 percent, ITT >100°) or a hung start, compressor stall, or engine vibrations are evident:

*2. Start switch — STOP.

3. Go to step 7.

→ If a hot start or a wet start is suspected:

*4. Motor engine

Note

- The starter caution light will illuminate when positioning the START switch to START.
- If in START position, leave in START position. If in STOP position, allow engine N_g to decay to 57-percent rpm (or less) before selecting START position.

5. Check for absence of fuel in tailpipe.

6. If fuel is present, motor engine again and recheck for fuel in tailpipe.

7. Bleed air switch — CYCLE.

Note

After securing engine, affected bleed air switch must be cycled to close 14th-stage bleed air augmentation valve, preventing a hung or hot start on restart attempt.

14.2.2 Starter Caution Light After Starter Cutout (During Start Sequence). The respective starter caution light will illuminate (normal indication) when positioning the START switch to START, indicating that the starter valve is open. However, if the starter caution light remains on after engine starter cutout speed during the start sequence execute the following:

*1. Bleed air switch — CYCLE.

If the starter light stays illuminated:

*2. Throttle — OFF.

3. Bleed air switch — CYCLE.

Note

After securing the engine, the affected bleed air switch must be cycled to close the 14th stage bleed air augmentation valve of the affected engine to prevent a hung start or hot start on restart attempt.

14.2.3 Starter Caution Light Other Than During Start Sequence

WARNING

The starter light will indicate an open starter control valve. Normal engine operation with this light illuminated may lead to starter disintegration and aircraft damage. The affected engine should be secured as soon as possible, and restart should not be attempted unless use of the engine is absolutely necessary.

*1. Throttle — OFF.

If airborne:

2. Proceed to nearest suitable field for landing.

3. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

14.2.4 Dual Starter Caution Lights In Flight

→ If flight conditions permit securing electrical power:

*1. O_2 mask — AS REQUIRED.

*2. Generator switches — OFF.

*3. APU GEN switch — OFF.

4. Proceed to nearest suitable field for landing.

OR

5. START CONT circuit breakers (4-C-13 and 4-D-13, right fixed circuit breaker panel) (4-C-14 and 4-D-14 on aircraft incorporating AFC-279) — PULL.

6. WING JETTISON circuit breaker (4-B-1) (on right fixed circuit breaker panel) and SEARCH STORE CONTROL circuit breaker (3-D-13) (on right hinged circuit breaker panel) — PULL (as required).

WARNING

Restoring electrical power will result in wing rack unlock (wing stores will not jettison) and, if the sonobuoy safety door is closed, sonobuoys on the jettison circuit will jettison. Wing rack unlock and sonobuoy jettison will be prevented by pulling their respective circuit breakers.

7. Generator switches — NORM.

8. Land as soon as possible.

→ If flight conditions make securing of electrical power impractical:

*1. Throttles — MINIMIZE POWER SETTINGS.

2. START CONT circuit breakers (4-C-13 and 4-D-13, right fixed circuit breaker panel) (4-C-14 and 4-D-14 on aircraft incorporating AFC-279) — PULL.

3. Land as soon as possible.

WARNING

- Simultaneous illumination of both starter caution lights may be the result of a failure within the right CLA that commands both start control valves open during flight.
- Higher power settings (greater than idle) with the start control valves open (starter caution lights illuminated) will increase the possibility of starter disintegration and may result in engine failure. If flight conditions make securing electrical power impractical, the throttles must be kept at the lowest possible power setting during the out-of-seat operation involved in pulling the start control circuit breakers.

WARNING

Pulling the start control circuit breakers will isolate the start control valves, allowing them to close. Assisted airstarts will not be possible.

14.2.5 Engine Failure After Decision Speed

*1. At Lift-off Speed — FLY SINGLE-ENGINE PROFILE. (Refer to Engine Failure after Decision Speed, paragraph 12.17.1.)

WARNING

Maintain directional control with rudder and lateral controls. Use of nosewheel steering or differential braking will adversely affect takeoff performance.

*2. Landing Gear — UP.

*3. External jettison — AS REQUIRED.

4. Fuel dump— AS REQUIRED.

5. Throttle — OFF.

6. Proceed to nearest suitable field for landing.

7. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

WARNING

Immediate jettison of bomb bay stores shall be delayed because of increased drag caused by bomb bay doors actuation.

Note

- The flying technique to optimize single-engine climb performance is to maintain 15 units AOA, bank aircraft into the good engine 3° to 5° and maintain aircraft track through moderate rudder input into the good engine. This rudder input normally results in approximately a three-fourths to one ball deflection from center.
- The landing gear will not retract if No. 1 hydraulic system pressure is not available from either the engine driven or emergency hydraulic pump.
- Jettison of a full sonobuoy load will result in a significant forward cg shift and an attendant nosedown trim change; be prepared to use back stick and noseup trim.

14.2.6 Single-Engine Failure/Flameout. Engine flameout is indicated by a rapid decay in ITT and N_g without moving the throttle, followed by illumination of the HYD PRESS, OIL PRESS, FUEL PRESS, and ELEC PWR caution lights. Check for abnormal indications and allow time for the residual fuel to clear the engine before attempting to relight.

*1. Throttle — OFF.

2. Proceed to nearest suitable field for landing.

3. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

14.2.7 Dual-Engine Failure/Flameout

Note

Altitude permitting, establishing the aircraft in the windmill airstart envelope will enable a windmill start in the event the APU does not start or does not provide sufficient bleed air for an assisted airstart. Steps 1 through 10 should not be delayed while establishing the aircraft in the windmill airstart envelope.

*1. O_2 mask — AS REQUIRED.

*2. APU — CHECK ALTITUDE, AIRSPEED/START.

*3. APU GEN switch — ON.

*4. APU automatic shutdown — DISARM.

Note

Essential bus power is required for the APU automatic shutdown feature to operate.

*5. EHP — ON.

*6. FIRE pull handles — FWD.

*7. Ignition switches — ON.

*8. START switch (1 or 2) — START.

Note

The starter caution light will illuminate during the start sequence when positioning the START switch to START. The caution light should extinguish after starter cutout speed, indicating that the starter valve has closed.

*9. Corresponding throttle — IDLE.

→ If no start and altitude permitting:

*10. Opposite engine — ATTEMPT START.

OR If no start:

11. Eject.

→ If engine starts:

12. Generator switch — CHECK NORM.

13. BUS Switches — CHECK NORM.

14. Bleed air switch — CHECK ON.

15. Hydraulic Servo — CHECK ON.

16. Proceed to nearest suitable field for landing.

17. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

WARNING

Only one APU start attempt will be available. Ensure the aircraft is below 22,500 feet and below 250 KIAS before attempting an APU start. Failure to start the APU airborne within 5 seconds of pulling the handle to the first detent may result in an unsuccessful APU start.

Note

- If dual flameout occurs above 22,500 feet, consideration should be given to attempting a windmill airstart during descent.
- If impossible or impractical to eject, execute Flameout Approach and Landing procedures, paragraph 23.7.

14.2.8 Oil System Malfunctions

Failure of the engine oil system may be indicated by any of the following:

1. An increase/decrease in oil pressure above/below the limits given in Figure 4-9 except as noted therein.
2. A change of more than 10 psi from steady-state operating conditions, even if pressure remains within limits.
3. Acrid engine fumes may be an indication of serious fuel system or lube system failure. Isolate fumes by selectively securing bleed air shutoff valves.

Should any of the above occur, unless safety of flight conditions dictate otherwise, the engine should be immediately secured. If safety of flight necessitates continued engine operation, a low constant throttle setting should be maintained. Throttle changes, speedbrake usage, or maneuvering should be avoided.

*1. Throttle — IDLE.

2. Engine instruments — MONITOR.

WARNING

If oil pressure drops to zero, the engine shall be shut down to preclude a catastrophic failure, unless safety of flight dictates otherwise.

Note

- The engine oil pressure caution light will not illuminate until oil pressure is below 30 psi.
- No indication of high oil pressure will be given on the cockpit annunciator panel.
- The use of takeoff flaps is highly recommended even if the engine is not secured. This will allow for both better throttle response on the good engine and an increased waveoff capability in the case of engine seizure.

If abnormal indications persist:

3. Throttle — OFF.
4. Proceed to nearest suitable field for landing.
5. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

14.2.9 Engine Vibrations. Vibrations may be an indication of internal engine failure. Low frequency vibrations may result from asymmetric shedding of ice accumulations from the fan blades and the engine need not be secured.

If severe vibrations are encountered or minor vibrations are accompanied by secondary indications, secure the engine and do not attempt a restart. If engine vibrations are encountered, the bleed air switch should be cycled to attempt to eliminate the vibration.

*1. Throttle — REDUCE.

2. Bleed air switch — CYCLE.

If engine vibrations still exist:

3. Throttle — OFF.
4. Proceed to nearest suitable field for landing.
5. Go to Engine Failure/Fire/Explosion Shutdown checklist, paragraph 15.1.1.

14.3 FLIGHT CONTROLS

14.3.1 Runaway Pitch/Roll Trim

*1. Trim disconnect button — PRESS.

When aircraft control is regained and trim is required:

2. Trim — REENGAGE SINGLE CHANNEL. (If runaway continues, attempt to reengage the opposite channel.)
3. Trim/Speedbrakes — REENGAGE PREVIOUSLY OPERATIONAL SYSTEMS.

Note

- Excessive amounts of noseup trim may not be controllable with full forward stick. Reducing power, reducing airspeed, extending flaps, and banking will assist in retaining control.
- Excessive amounts of nosedown trim may not be controllable with full aft stick. Adding power, increasing airspeed, and raising flaps will assist in retaining control.
- Pitch trim cannot be reconnected when the control stick is beyond 75 percent forward or if pitch trim is being commanded. Single channel operation is half the normal rate.

4. If required, go to Operating With Disconnected Pitch Trim, paragraph 14.3.1.1.

14.3.1.1 Operating With Disconnected Pitch Trim. If the pitch trim disconnects and cannot be reconnected, the flaps may be adjusted to reduce the stick force.

1. Establish straight and level flight.
2. Flaps (select emergency) — EMER.
3. Emergency flaps — TOGGLE TO REDUCE STICK FORCES.

4. Flap lever — MANUV.

5. Fly a straight-in approach, attempting to minimize large power changes.

Note

Lowering the flaps increases the pull force on the control stick. If a pull force is required to maintain level flight with the flaps up, the flaps should be left in the UP position.

14.3.2 Speedbrake Warning Light. Speedbrakes must be retracted prior to takeoff.

Illumination of the flashing red speedbrake warning light may occur during takeoff, catapult launch or in flight. It will illuminate if the speedbrakes are not fully retracted and the AOA reaches 17 units or the throttles are advanced to full power.

14.3.2.1 Speedbrakes Fail to Normally Retract

*1. SPOIL 1 & 2 Switch — OFF.

Note

Do not use the SPOIL 1 & 2 switch to retract or extend the speedbrakes at airspeeds in excess of 250 KIAS.

14.3.3 Split Trailing Edge Flaps. Split trailing edge flaps (not to be confused with trailing edge flap lockup) is a linkage failure condition where one flap trails aerodynamically and the other flap extends to the commanded position. Below 1,000 feet AGL in landing configuration, single trailing edge flap extension will result in abrupt rolloff or entry into stall warning buffet that will require immediate control and power inputs. If necessary to increase roll authority:

CAUTION

Do not attempt to operate flaps by either the normal or emergency system if flap asymmetry exceeds 25 percent or if the TE FLAPS LKD caution light is on.

*1. Flaps — MANEUVER.

If control cannot be regained:

OR *2. Eject

If control is regained:

3. Proceed to nearest suitable field for landing.

4. Climb — 10,000 FEET AGL MINIMUM.

5. Controllability — ASCERTAIN.

6. LAND AS SOON AS PRACTICAL.

7. Make a short-field arrested landing.

8. Arrestment briefing — COMPLETE.

   a. Determine most appropriate gear available.

   b. Notify control tower of intentions.

   c. Adjust gross weight as necessary.

   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

14.3.4 Flight Control Failures. A mechanical failure in the flight control system requires immediate analysis and action. If stick and rudder inputs fail to control the aircraft, consider the ejection envelope before attempting a recovery. If airspeed is rapidly increasing, reduce power. Trim provides a secondary means for controlling the aircraft; use of pitch, roll, and rudder trim may be necessary for a successful recovery. If hydraulic pressure is available and the flight controls are not in a fully powered mode, cycling the primary hydraulic servo switches or manually reverting to EFCS may also aid in controlling the aircraft.

In the event of an uncommanded motion caused by a mechanical failure in the flight control system, immediate application of flight controls and/or trim will be required in an attempt to arrest the motion.

If a mechanical hardover condition exists such that full aileron/spoiler deflection is commanded, full opposite stick may be ineffective in arresting or significantly reducing the roll. In such a case, spoilers must be turned off using the SPOIL 1 and 2 switch before opposite rudder will be effective in arresting or significantly reducing the roll. Once spoilers revert to the trail position, if a fully deflected aileron is being countered with full opposite rudder, a slow roll in the direction of the deflected aileron may still result. Aileron trim should then be used because it provides an alternate method to reduce the amount of deflected aileron. When the spoilers are off, if opposite aileron trim and rudder have been applied and the roll rate cannot be arrested, reverting to EFCS may restore sufficient lateral control.

If a mechanical failure of the elevator occurs, changing the position of the leading and trailing edge flaps may help to arrest the resulting aircraft pitch change.

If a mechanical failure in the rudder pedal linkage occurs, selection of yaw damper may actually improve the flying qualities since the yaw damper applies direct input to the rudder servo without the use of the cables used in the primary flight control system. Additionally, rudder trim will still be available and may prove useful.

WARNING

Reversion to the EFCS with any displacement of the stick and/or rudder pedals may result in failure of the corresponding flight control surface to engage during flight.

Note

Certain AFCS failures can result in uncommanded maneuvers, even if the AFCS is not engaged. Holding either AFCS paddle switch in the disconnect position may eliminate the uncommanded input. If the unwanted command is from an electrical source, securing both bus switches should remove the electrical power source.

14.3.5 Failure of Aircraft to Respond to Control Inputs. Flight control system failure modes exist in which normal flight control responses in either the powered or EFCS condition are not available. These failure modes may manifest themselves as either large reductions in or total loss of control movement accompanied by one or more of the following symptoms:

1. Failure of the flight control system to automatically revert to/from EFCS in one or more axes.
2. Loss of flight control cable/linkage integrity.
3. Severing of normal servo input/output and control feel in one or more axes.
4. Uncommanded cycling of the flight control system between the powered and EFCS modes.
5. Jammed flight controls in one or more axes.

Under these circumstances the following may provide the necessary means for maintaining or regaining control of the aircraft:

1. Utilization of all available trim systems.
2. Changing positions of leading and trailing edge flaps.
3. Forcing the flight controls into the powered mode by rapidly cycling the flight control servo switches when hydraulic pressure is available.
4. Manually reverting to EFCS by securing the servo switches.

If the aircraft fails to respond to control inputs, proceed as follows:

*1. AFCS paddle switch — PULL AND HOLD.

*2. Trim — AS REQUIRED.

If control is not regained and altitude/airspeed permit:

*3. Hydraulic servos — SEPARATELY CYCLE OFF/ON.

OR

CAUTION

In the event of an EFCS latch-up while cycling servos, relax the control forces prior to recycling the servo on.

If control is not regained and altitude/airspeed permit:

OR

WARNING

- Reversion to the EFCS with any displacement of the stick and/or rudder pedals may result in failure of the corresponding flight control surface to engage during flight.
- Transition to EFCS at speeds in excess of 250 KIAS will produce pitch forces that may preclude pitch control without trimming.
- Transfer to EFCS with trailing edge flaps extended will result in a moderate nose-down pitching moment requiring high pull forces (80 pounds or more) and immediate retrimming of the stabilizer.

*4. Hydraulic Servo switches (both) — OFF.

If control is not regained passing 10,000 feet AGL:

*5. Eject.

If control regained:

6. Go to Failure of Aircraft to Respond to Control Inputs Follow-On Procedure, paragraph 15.2.1.

14.3.6 Uncommanded Pitch, Roll, Yaw. It is possible that an electrical malfunction in the AFCS system could cause uncommanded pitch, roll, or yaw inputs. Interrupting power to the AFCS system with the AFCS paddle switch should correct the problem, however, some failure modes will allow power to continue to flow to the flight control servos after the switch is released. In this event holding the AFCS paddle switch until power is secured with the bus switches or circuit breakers will prove successful.

In the event of an uncommanded pitch, roll, or yaw due to electrical malfunction in the AFCS system, power must be secured with the following procedures:

*1. AFCS paddle switch — PULL AND HOLD.

*2. DLC switch (if engaged) — OFF.

OR

If control cannot be regained:

*3. EJECT.

If control is regained:

4. Go to Uncommanded Pitch, Roll, Yaw Follow-On Procedures, paragraph 15.2.2.

14.4 ELECTRICAL

14.4.1 Dual-Generator Failure

*1. O_2 mask — AS REQUIRED.

*2. BUS switches — OFF.

WARNING

Restoring electrical power will result in wing rack unlock (wing stores will not jettison) and, if the sonobuoy safety door is closed, sonobuoys on the jettison circuit will jettison. Wing rack unlock and sonobuoy jettison may be prevented by pulling their respective circuit breakers (WING JETTISON circuit breaker (4-B-1) and SEARCH STORE CONTROL circuit breaker (3-D-13) — PULL (as required)).

Note

Consider not delaying the start of the APU.

*3. Generator switches — ATTEMPT RESET.

*4. APU — CHECK ALTITUDE, AIRSPEED/START.

*5. APU GEN switch — ON.

*6. AUTO SHUTDOWN — DISARM.

Note

Essential bus power is required for the APU AUTO SHUT DN feature to operate.

If unable to reset generators:

7. Nonessential equipment — OFF.

8. BUS switches — NORM.

9. Land as soon as practical.

Note

With APU AUTO SHUT DN in the DISARM mode, an APU overload would be indicated by an APU OV TEMP warning on the master caution panel. If allowed to persist, APU RPM will drop until the APU generator is disconnected from all buses.

14.5 OUT-OF-CONTROL RECOVERY

14.5.1 Out-of-Control Recovery. This procedure is appropriate for poststall gyration, erect spin, and inverted spin recoveries.

If the aircraft departs from controlled flight at low airspeed/high AOA, recovery to controlled flight is optimized by neutralizing flight controls and establishing proper aircraft configuration.

*1. Controls, pitch trim — NEUTRALIZE, LESS THAN 1° NOSE UP.

*2. Throttles, speedbrakes, flaps — IDLE, RETRACT.

*3. Harness — LOCKED.

If erect spin confirmed:

*4. Apply positive recovery controls:

a. Stick — FULL FWD AND WITH TURN NEEDLE.

b. Rudder — FULL OPPOSITE TURN NEEDLE.

c. Controls — NEUTRALIZE WHEN AOA REACHES 16.5 UNITS.

If no indication of recovery below 10,000 feet AGL:

*5. EJECT.

WARNING

- Application of spin recovery controls before the aircraft is in a fully developed spin may result in initiating a spin or prolonging recovery.
- In an inverted spin, dual-engine flameout is possible because of fuel starvation and a transfer to EFCS will occur.
- Failure to neutralize controls promptly following spin recovery may result in the aircraft entering an inverted spin. This would be characterized by the turn needle changing directions, AOA going from 26.5 to 5.5 units, and the accelerometer indicating less than zero.
- Do not exceed 18.5 units AOA during recovery to prevent a secondary departure.
- Rapid addition of power at low speed or high AOA should be avoided. Longitudinal control may be insufficient to compensate for the rapid noseup pitch associated with abrupt power increases an a deeper stall penetration may result.

Note

- Application of forward stick following a departure provides the most timely reduction in AOA and return to controlled flight.
- In an erect spin, AOA will be pegged at 26.5 units, airspeed constant, turn needle pegged in direction of spin, and aircraft under positive g. Rotation will be steady at 3 seconds per turn and nose attitude approximately 45° down.
- The balance ball is not a valid indicator of spin direction and must not be used.
- The only positive indication of spin recovery is AOA.
- Roll rate will increase during recovery.

- Recovery will require 1 to 3 turns (3 to 9 seconds).
- Aircraft attitude may be very nosedown during recovery.

14.6 BRAKES

14.6.1 Antiskid Brake System Failure on Deck

*1. Brakes — RELEASE.

*2. Brake selector switch — ANTISKID OFF.

*3. Brakes — REAPPLY.

CAUTION

Failure to release the brakes prior to repositioning the brake selector switch may result in blown tires.

14.6.2 Normal Brake System Failure on Deck

*1. Brakes — RELEASE.

*2. Brake selector switch — EMER BRAKE.

*3. Brakes — REAPPLY.

CAUTION

- Failure to release the brakes prior to repositioning the brake selector switch may result in blown tires.
- Use of the Emergency brake above 60 KIAS increases the possibility of blown tires. Consider executing a go-around and short-field arrestment if problem occurs on landing rollout.

14.6.3 Emergency Brake System Failure on Deck

➤ If adequate runway remains:

*1. Execute go-around.

OR

2. Execute a short-field arrestment at a suitable field (refer to Field Emergency Arresting Gear procedures, paragraph 23.5).

➤ If adequate runway does not remain and arresting gear is available:

*1. NWS — AS REQUIRED.

*2. Hook — EXTEND.

WARNING

Ejection should be considered if the overrun area is not suitable.

CAUTION

- Center rudder pedals prior to engaging NWS to preclude overcontrol/hardover.
- Extension of the hook while in a skid could aggravate directional control problems because of power centering of the nosewheel.

Note

- Do not disengage NWS once engaged unless a known failure occurs. Multiple selection and deselection of the NWS may mask normal operation and contribute to directional control problems.
- If adequate runway does not remain and arresting gear is not available, consider potential benefits/risks associated with securing engines.

14.7 ENVIRONMENTAL CONTROL SYSTEM

14.7.1 Cabin Pressurization Failure

*1. O_2 mask — AS REQUIRED.

2. AIR COND switch — CYCLE.

Note

Prior to cycling the air-conditioning, ensure crewmembers have been informed of intended action to prepare themselves for accompanying rapid change in cabin altitude.

If the malfunction persists:

Note

- Operating at altitudes of 30,000 feet (approximately) or above without cabin pressurization will result in pressure breathing (positive exhalation pressure required).
- Allow cabin pressure to equalize after securing the AIR COND switch, before dumping cabin pressure by means of the CABIN PRESS switch.

3. AIR COND switch — OFF.

4. CABIN PRESS switch — DUMP.

5. AIR COND switch — ON.

6. Descend — BELOW 25,000 FEET.

7. LAND AS SOON AS PRACTICAL.

14.7.2 Windshield/Canopy Crack

*1. Visor — DOWN.

*2. O_2 mask — ON.

*3. CABIN PRESS switch — DUMP.

*4. Airspeed — 200 KIAS OR 0.5 MACH (maximum).

CAUTION

- Changing the heat condition of the windshield may cause increased cracking.
- Windshield delamination is a related condition that does not result in a significant degradation of windshield strength; however, separation of the outer layer of the windshield may create a potential FOD hazard.

Note

In the event of explosive depressurization, push to talk is recommended for all ICS communications.

14.8 TAKEOFF/LANDING

14.8.1 Aborted Takeoff

*1. Throttles — IDLE.

*2. Speedbrakes — EXTEND.

*3. Brakes — AS REQUIRED.

*4. NWS — AS REQUIRED.

*5. Hook — AS REQUIRED.

WARNING

Under no circumstances should a pilot's decision to abort a takeoff be delayed because of knowledge that an emergency arresting gear is available at the end of the runway.

Note

- If the hook is extended without NWS engaged, the nosewheel will center. When NWS is engaged, the nosewheel centering feature is overridden.
- Do not disengage NWS once engaged unless a known failure occurs. Multiple selection and deselection of NWS may mask normal operation and contribute to directional control problems.

- If No. 1 hydraulic system pressure fails, normal brakes, antiskid brakes, and NWS will be lost.
- If antiskid is not operable, care should be used in brake application to avoid blown tires.
- Until speedbrakes are fully extended, braking with antiskid selected may appear ineffective. Selection of emergency brakes at this time will cause blown tires.
- Following an aborted takeoff, a visual inspection of the brake assemblies should be performed by qualified personnel prior to continued operations.
- Elevated wheel temperatures following an aborted takeoff may cause the fuse plugs to release tire pressure, resulting in fully deflated mainmount tires.

14.8.2 Tire Failure

CAUTION

- Failure to release brakes prior to repositioning the brake selector switch may result in blown tires.
- Do not use brakes on the wheel with a failed tire.

Note

- Do not disengage nosewheel steering once engaged unless a known failure occurs. Multiple selection and deselection of NWS masks normal operation and contributes to directional control problems.
- Maintain directional control by use of rudder and NWS. NWS and light single-wheel braking will decelerate the aircraft effectively.

If below decision speed or on landing rollout:

*1. Throttles — IDLE.

*2. Speedbrakes — EXTEND.

*3. Brake selector switch — ANTISKID OFF.

*4. Brakes — AS REQUIRED.

*5. NWS — AS REQUIRED.

*6. Hook — AS REQUIRED.

WARNING

Tire failure will cause a complete dump of the antiskid brake system. Failure to move the brake selector switch out of the antiskid position will result in complete loss of brakes.

OR

If above decision speed:

*1. Leave gear down.

2. Go to LANDING WITH BLOWN TIRE Follow-On procedure, paragraph 15.3.1.

14.8.3 Speedbrakes Failure to Extend on Landing

If adequate runway is not available to safely stop or antiskid brakes are inoperable:

*1. Execute a go-around.

2. Climb to a safe altitude.

3. Troubleshoot the system.

Note

If the problem was caused by failure of the DLC to disengage on touchdown, make subsequent landing with the DLC off.

If normal speedbrake control is regained:

OR

4. Execute a normal landing.

If normal speedbrake control is not regained:

5. Land without speedbrakes on a runway of suitable length.

If a runway of suitable length is not available, runway conditions warrant, or anti-skid brakes are not available:

6. Make an arrested landing.

7. Arrestment briefing — COMPLETE.

   a. Determine most appropriate gear available.

   b. Notify control tower of intentions.

   c. Adjust gross weight as necessary.

   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

CAUTION

Failure of the speedbrakes to extend on landing will increase stopping distance because of decreased braking effectiveness associated with reduced weight on wheels. The use of antiskid brakes is essential to minimize the probability of tire skid/blowout.

14.9 EGRESS

14.9.1 Automatic Man/Seat Separation

Following ejection:

1. Immediate automatic man/seat separation should occur regardless of altitude.

2. The seat retrorocket fires for man/seat separation.

3. The pilot parachute and main parachute are deployed for a normal descent.

WARNING

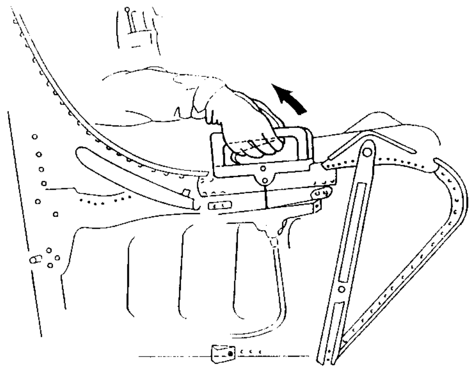
If following ejection initiation, immediate man/seat separation does not occur, a system malfunction should be assumed and manual man/seat separation performed.

14.9.1.1 Man/Seat Separation Failure. In the event of a malfunction interrupting automatic man/seat separation, perform the following procedures to effect manual man/seat separation:

*1. Harness release handle — SQUEEZE/PULL.

Note

Squeeze, then pull handle straight up.



*2. Occupant — ROTATE FORWARD.

*3. Seat — FORCIBLY PUSH AWAY.

WARNING

Automatic parachute deployment will not occur if the crewmember manually separates from the seat. The parachute ripcord must be pulled. Parachute opening shock increases with altitude. In order to prevent possible injury or parachute damage, the altitude must be considered before pulling the parachute ripcord. If over 14,000 feet, freefall to below 14,000 feet. As a rule of thumb, 5 seconds are required to freefall 1,000 feet.

4. Parachute ripcord — MANUALLY PULL.

   a. Left hand, grasp the left riser above the parachute ripcord.

   b. Right hand, grip the parachute ripcord and pull downward to the right side of body.

Note

- Inspect the parachute upon canopy inflation.

- Correction of parachute malfunctions is discussed in detail in NAVAIR 00-80T-101, NATOPS Survival Manual.

CHAPTER 15

Follow-On Procedures

15.1 ENGINE FAILURE

15.1.1 Engine Failure/Fire/Explosion Shutdown Checklist

→ If airstart will be attempted:

OR

1. Go to Primary Method/Assisted Airstart Checklist, paragraph 16.3.

→ If engine restart will not be attempted or engine does not start:

1. EHP — ON.
2. YAW DAMPER — ENGAGE.
3. APU — CHECK ALTITUDE/AIRSPEED/START.
4. APU automatic shutdown — DISARM.
5. APU GEN switch — ON.
6. Generator switch — OFF.
7. Bleed air switch — OFF.
8. Ignition switch — OFF.
9. Hydraulic servo (if No. 2 engine) — OFF.
10. LAND AS SOON AS PRACTICAL.

Note

- Burn the fuel from the operative engine transfer tank before opening the feed tank interconnect valve to minimize asymmetrical fuel loading between transfer tanks.
- Fuel can be transferred from the shutdown engine tanks to the operating engine tanks by opening the feed tank interconnect and using wing down/top rudder to gravity transfer fuel from the higher wing to the lower wing regardless of feed tank quantities. Secure feed tank interconnect when transfer is complete.

→ If No. 1 hydraulic system is operable :

OR

11. Go to Single-Engine Approach Checklist, paragraph 15.1.2.

→ If No. 1 hydraulic system inoperable:

12. Hydraulic servo No. 1 — OFF.
13. Go to Single Engine Failure/No. 1 Hydraulic System Inoperable Approach Checklist, paragraph 15.1.4.

15.1.2 Single-Engine Approach Checklist

1. Fuel — DUMP (as required).
2. External tanks/stores — JETTISON (as required).
3. MASTER ARM/SRCH PWR/ECM ARM switches — OFF.
4. Brakes/selector switch/gauge — CHECK, AS REQUIRED.
5. Altimeter/RAAWS — SET.
6. NAVAIDS/NAV display selection — SET.
7. Arrestment briefing — COMPLETE.
   a. Determine most appropriate gear available.
   b. Notify control tower of intentions.
   c. Adjust gross weight as necessary.
   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

Go to Single-Engine Landing Checklist, paragraph 15.1.3.

15.1.3 Single-Engine Landing Checklist

1. Seats/harnesses — ARMED/GROUP/LOCKED.
2. Speedbrakes — IN.
3. Fuel — DUMP SECURED, ___LBS.
4. Hook (if gear available) — DOWN.
5. Rudder trim — ZERO.
6. Landing gear — DOWN.
7. Flaps — TAKEOFF.
8. DLC (if available) — ENGAGED.
9. Wave-off/bolter procedure — REVIEWED.
   a. Max power operating engine.
   b. Maintain directional control.
   c. Landing gear retract.
   d. Climb at optimum AOA.

Single-Engine Landing Checklist is complete.

15.1.4 Single-Engine Failure/No. 1 Hydraulic System Inoperable Approach Checklist

Note

- NWS, anti-skid, normal brakes, wing/fin fold, launch bar extension, DLC, and arresting hook retraction will be lost.
- If remaining flight time exceeds 3 hours, consider downgrading to EFCS. Refer to EFCS Flight Characteristics, paragraph 12.2 and Dual Hydraulic Failure procedures, paragraph 19.5.
- Flaps will be extended to takeoff position using wing flap emergency procedure.
- Gear will be extended using emergency method.
- Gear extended manually cannot be retracted. Therefore, single-engine climb performance may be marginal to non-existent. Additionally, the drag penalty with gear extended may make it impossible to reach an alternate/Bingo field. Refer to single-engine climb performance, paragraph 32.10 and gear down Bingo charts.
- If arresting gear is available, an arrested landing should be performed due to the possibility of blown tires when using the emergency brake system.

1. Stick — EXTEND (AS DESIRED).
2. External tanks/stores — JETTISON (IF REQUIRED).
3. Fuel — DUMP (AS REQUIRED).
4. MASTER ARM/SRCH PWR/ECM ARM switches — OFF.
5. Brake selector switch — EMER.
6. Emergency brake accumulator — CHARGED/IN THE GREEN.
7. Altimeters/RAAWS — SET.
8. NAVAIDS/NAV display selection — SET.
9. Arrestment briefing — COMPLETE.
   a. Determine most appropriate gear available.
   b. Notify control tower of intentions.
   c. Adjust gross weight as necessary.
   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

Go to Single-Engine Failure/No. 1 Hydraulic System Inoperable Landing Checklist, paragraph 15.1.5.

15.1.5 Single-Engine Failure/No. 1 Hydraulic System Inoperable Landing Checklist

1. Seats/harnesses — ARMED/GROUP/LOCKED.
2. Speedbrakes — IN.
3. Fuel — DUMP SECURED, ___LBS.
4. Hook (if gear available) — DOWN.
5. Wing flap emergency operation — PERFORM.
   a. Slow to appropriate airspeed.
   b. Emergency flap selector switch — EMERGENCY.
   c. Emergency flap toggle switch — ACTUATE TO 65 PERCENT OR LESS (AS REQUIRED).
   d. Flap lever — CORRESPONDING.
6. Landing Gear Emergency Extension Procedure — PERFORM.
   a. Airspeed — 140 KIAS MAXIMUM.
   b. Landing Gear Handle — DOWN.
   c. Landing Gear Emergency Extension Handle — PULL.

Note

Emergency landing gear extension may take up to 90 seconds.

7. Landing gear — VERIFY DOWN.
8. Rudder trim — ZERO.
9. Wave off/bolter procedure — REVIEWED.
   a. Max power operating engine.
   b. Maintain directional control.
   c. Landing gear retract NOT available.
   d. Climb at optimum AOA.

CAUTION

- When using emergency brakes, only very light braking should be used above 80 KIAS.
- Ensure speedbrakes are extended prior to application of brakes.
- Optimum use of emergency brakes will be gained by one smooth brake application of continually increasing pressure until the aircraft stops. Releasing and reapplying brakes will deplete the brake accumulator more rapidly (approximately 10 full applications available).
- The wings should not be folded or spread from the cockpit with the EHP on if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wing.

Single-Engine Failure/No. 1 Hydraulic System Inoperable Landing Checklist is complete.

15.2 FLIGHT CONTROL PROCEDURES

15.2.1 Failure of Aircraft to Respond to Control Inputs Follow-On Procedures

1. Climb — 10,000 AGL MIN.
2. AFCS paddle switch — RELEASE.
3. Aircraft control in landing configuration — CHECK.

OR

→ If controls check in landing configuration is unsatisfactory:

4. Go to Controlled Ejection Checklist, paragraph 25.6.3.

→ If controls are satisfactory for landing:

5. Return for landing as soon as possible, remaining in the landing configuration.

If control was regained by pulling AFCS paddle switch:

6. AFCS paddle switch — RELEASE.

If control failure re-occurs:

7. AFCS paddle switch — PULL AND HOLD.

8. Secure power to AFCS components by one of the following:

   a. Pull AFCS circuit breakers — 1-B-6, 1-E-6, 1-A-12, 1-B-12.

   b. Secure RH/LH Bus switches.

   c. Continue to hold pilot or copilot AFCS paddle switch.

9. LAND AS SOON AS PRACTICAL.

OR

If aircraft remains controllable:

10. Do not attempt to reengage any AFCS modes.

11. LAND AS SOON AS PRACTICAL.

Note

To accurately troubleshoot flight control malfunctions after landings, it is important to perform certain steps before securing either engine, hydraulic systems, or folding the wings. Prior coordination with the landing field/ship will be required. Leave wings spread and perform the speedbrake blowback checks from the After Start checklist (page 8-23, step 8h). Also, reset AFCS circuit breakers (if pulled), and perform the AFCS BITE checks in accordance with the procedures from paragraph 11.4.1.7. Do not secure the No. 1 engine until maintenance has been informed of the nature of the problem. Maintenance personnel will need to perform additional checks before securing power.

15.2.2 Uncommanded Pitch, Roll, Yaw Follow-On Procedures

If control is regained altitude/airspeed permit:

1. AFCS paddle switch — RELEASE.

If uncommanded pitch, roll, or yaw inputs reoccur:

2. AFCS paddle switch — PULL AND HOLD.

3. Secure power to AFCS components by one of the following:

   a. Pull AFCS circuit breakers — 1-B-6, 1-E-6, 1-A-12, 1-B-12.

   b. SECURE RH/LH BUS SWITCHES.

   c. Continue to hold pilot or copilot AFCS paddle switch.

4. LAND AS SOON AS PRACTICAL.

If aircraft remains controllable:

5. Do not attempt to reengage any AFCS modes.

6. LAND AS SOON AS POSSIBLE.

Note

To accurately troubleshoot flight control malfunctions after landings, it is important to perform certain steps before securing either engine, hydraulic systems, or folding the wings. Prior coordination with the landing field/ship will be required. Leave wings spread and perform the speedbrake blowback checks from the After Start checklist (page 8-23, step 8h.). Also, reset AFCS circuit breakers (if pulled), and perform the AFCS BITE checks in accordance with the procedures from paragraph 11.4.1.7. Do not secure the No. 1 engine until maintenance has been informed of the nature of the problem. Maintenance personnel will need to perform additional checks before securing power.

15.3 LANDING

15.3.1 Landing with Blown Tire

If main wheel tire is blown:

1. Brake selector switch — ANTI-SKID OFF.

2. Arrestment briefing — COMPLETE.

   a. Determine most appropriate gear available.

   b. Notify control tower of intentions.

   c. Adjust gross weight as necessary.

OR

d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

3. Normal landing checklist — COMPLETE.
4. Short field arrested landing — PERFORM.

WARNING

- With one or both main wheel tires blown, one or both main gear may collapse on touchdown because of induced resonance from unbalanced rotation of the blown tire(s). Consider diverting to shore for a short-field arrestment. Landing weight should be minimized.
- Tire failure will cause a complete dump of the antiskid brake system. Failure to move the brake selector switch out of the antiskid position will result in complete loss of brakes.
- With a single tire failure, extreme caution should be used not to blow out the remaining good tire. With one or both main landing gear tires failed, directional control will be difficult and without the use of NWS, directional control may be lost.

OR

CAUTION

- Failure to release brakes prior to repositioning the brake selector switch may result in blown tires.
- Do not use brakes on the wheel with a failed tire.

OR

If short field arrested landing is not feasible:

5. Land on the side of the runway opposite the blown tire.
6. NWS — ENGAGE.
7. Brakes — APPLY LIGHTLY.

If nose wheel tires blown:

1. Normal Landing checklist — COMPLETE.
2. Speedbrakes — EXTEND AFTER TOUCHDOWN.

CAUTION

Do not use nose wheel steering.

3. Brakes — APPLY NORMALLY AFTER NOSE WHEEL IS ON RUNWAY.

CHAPTER 16

Engine/APU Abnormal Procedures

16.1 PRECAUTIONARY ENGINE SHUTDOWN

1. EHP — ON.

Note

The No. 1 engine will not be shut down for training without an operating EHP.

2. APU — CHECK ALTITUDE, AIRSPEED/START.
3. APU automatic shutdown — DISARM.
4. APU GEN switch — ON.
5. Generator switch — OFF.
6. Bleed air switch — OFF.
7. Ignition switch — OFF.
8. Throttle — OFF.
9. Hydraulic servo (if No. 2) — OFF.
10. Yaw damper — ENGAGE.
11. LAND AS SOON AS PRACTICAL.

Note

- Burn the fuel from the operative engine transfer tank before opening the feed tank interconnect valve to minimize asymmetrical fuel loading between transfer tanks.
- Fuel can be transferred from the shutdown engine tanks to the operating engine tanks by opening the feed tank interconnect and using wing down/top rudder to gravity transfer fuel from the higher wing to the lower wing regardless of feed tank quantities. Secure feed tank interconnect when transfer is complete.

OR

→ If No. 1 hydraulic system is operable:

12. Go to Single-Engine Approach Checklist, paragraph 15.1.2.

→ If No. 1 hydraulic system inoperable:

13. Hydraulic servo No. 1 — OFF.
14. Go to Single Engine/No. 1 Hydraulic System Inoperable Approach Checklist, paragraph 15.1.4.

16.2 BEFORE AIRSTART

1. APU — CHECK ALTITUDE, AIRSPEED/START.
2. APU automatic shutdown — DISARM.
3. APU GEN switch — ON.

Note

Execution of subsequent steps should not be delayed while waiting for the APU RUN light. The APU is not required for an airstart if the opposite engine is operating.

4. Throttle — OFF.
5. Generator switch — OFF.
6. Engine anti-ice — DESELECT.
7. Bleed air switch — OFF.
8. FIRE pull handle — FORWARD.
9. Ignition switch — ON.

16.3 PRIMARY METHOD, ASSISTED AIRSTART

1. Throttle — ADVANCE TO 80 PERCENT OR ABOVE.

2. START switch — START.

Note

- The starter caution light will illuminate during the start sequence when positioning the START switch to START. The caution light should extinguish after starter cutout speed, indicating that the starter valve has closed.
- Check aircraft altitude. Moving the START switch to START will temporarily secure the air-conditioning system, resulting in a loss of cabin pressure. Oxygen may be required.
- If the APU is running, the APU AIR switchlight will illuminate ON during the start cycle.
- If no N_g is observed and the bleed closed caution light does not extinguish, position the appropriate BLEED AIR switch to ON.
- If the engine fails to accelerate after starter cutout, position the appropriate BLEED AIR switch to OFF.

3. Throttle — IDLE.
4. Engine instruments — MONITOR FOR SUCCESSFUL START.
5. Refer to POSTSTART procedures.

If ITT is greater than 100 °C, motor the engine until start criteria are achieved.

After light-off, monitor ITT for overtemperature. The start switch should return to the STOP position between 54 and 57 percent N_g.

16.4 SECONDARY METHOD, WINDMILL AIRSTART

1. Establish the aircraft inside the airstart envelope.
2. Throttle — IDLE.
3. ITT — MONITOR.

If the starter is inoperative and altitude permits, windmill the engine until ITT is less than 100 °C and N_g is greater than 9 percent.

CAUTION

If necessary to airstart with residual ITT greater than 100 °C, monitor the start closely for overtemperature. Refer to Chapter 4.

Note

- If indication of a light-off does not occur within 20 seconds, retard the throttle to OFF.
- If a hot start occurs, a subsequent start may be attempted after decreasing altitude, increasing airspeed, decreasing residual ITT, or increasing N_g.

16.5 POSTSTART

1. Generator switch — NORM.
2. BUS switches — CHECK NORM.
3. Bleed air switch — ON.
4. Hydraulic servo — ON.
5. APU — AS REQUIRED.
6. APU door (after 30 seconds) — CLOSED.
7. EHP — OFF.
8. Engine ANTI-ICE — AS REQUIRED.

If the engine cannot be started:

1. Throttle — OFF.
2. FIRE pull handle — PULL.
3. Ignition switch — OFF.
4. Hydraulic servo (if No. 2) — OFF.
5. Land as soon as practical — Refer to Precautionary Engine Shutdown Checklist, paragraph 16.1.

16.6 STUCK THROTTLE

If the throttle jams or the system becomes inoperable, the engine can be secured using the FIRE pull handle. Restart is not recommended unless mandatory. If a decision is made to land with the engine operating, an arrested landing should be made.

1. EHP — ON.
2. APU — CHECK ALTITUDE, AIRSPEED/START.
3. APU automatic shutdown — DISARM.
4. APU GEN switch — ON.
5. Generator switch — OFF.
6. Bleed air switch — OFF.
7. Ignition switch — OFF.
8. FIRE pull handle — PULL.

Note

The engine will continue to operate for a short period, and ITT may rise following actuation of the FIRE #1 or FIRE #2 handle.

9. Hydraulic servo (if No. 2) — OFF.
10. Yaw damper — ENGAGE.
11. Land as soon as practical.

If No. 1 hydraulic system is operable:

12. Go to Single-engine Landing Approach Checklist, paragraph 15.1.2.

OR

If No. 1 hydraulic system is inoperable:

13. Hydraulic Servo No. 1 — OFF
14. Go to Single-engine/No. 1 Hydraulic System Inoperable Approach Checklist, paragraph 15.1.4.

16.7 T5 CONTROL MALFUNCTION

Failure of the automatic electronic temperature control can manifest itself as either an oscillating ITT, as a gross ITT shift at 79-percent N_g or above, or as an unstable engine operation. Without automatic temperature control, the ITT response will be very sensitive to throttle movement.

If the automatic temperature control is suspect:

1. Throttle — IDLE.
2. T5 switch — DISABLE.

Operate engine with direct throttle control, observing ITT limits.

CAUTION

Do not use ATS with T5 disabled.

16.8 APU OVERTEMPERATURE/LOW OIL PRESSURE

An APU overtemperature or low oil pressure condition will be indicated by illumination of the APU OV TEMP or APU OIL PRESS caution light and automatic shutdown of the APU.

1. APU T-handle — DOWN (stowed).
2. APU doors (after 30-second, cool-down period) — CLOSE.

CHAPTER 17

Fuel Abnormal Procedures

17.1 FUEL LOW-LEVEL CAUTION LIGHT(S)

17.1.1 Single Light

1. Feed tank quantity — MONITOR.
2. Feed tank interconnect valve — OPEN AS REQUIRED.

Note

Refer to Figure 13-2, for appropriate fuel levels when gravity transferring to feed tanks.

If carrying external fuel tanks:

3. External tank quantity — CHECK.

If fuel remains in the external tanks (not transferred), refer to External Fuel Transfer Failure, paragraph 17.2.

17.1.2 Both Lights. If in-flight refueling is not possible and external fuel has been exhausted or is unavailable:

1. Land as soon as possible.

CAUTION

- Regardless of the feed tank quantity reading, if one or both lights illuminate, assume 400 pounds of usable fuel is remaining in the the respective feed tank(s).
- Avoid less than 1g flight, use of speedbrakes, sideslips (other than to transfer fuel), and steep nosedown attitudes.

Note

Refer to Figure 13-2 for appropriate fuel levels when gravity transferring to feed tanks.

17.2 EXTERNAL FUEL TRANSFER FAILURE

1. IFR probe — RETRACT.
2. REFUEL SEL switch — INT.
3. Landing gear — UP.
4. EXT TRANS switch — AUTO.

If fuel does not transfer after 3 to 5 minutes:

5. O_2 mask — AS REQUIRED.
6. AIR COND switch — CYCLE OFF/ON.
7. Both bleed air switches — SIMULTANEOUSLY CYCLE OFF/ON.

If fuel does not transfer after 3 to 5 minutes:

8. EXT TRANS switch — HOLD IN OVERRIDE.

If fuel does not transfer after 3 to 5 minutes:

9. EXT TK AIR PRESS SOV circuit breaker (4-C-17) — PULL.

If fuel does not transfer after 3 to 5 minutes:

10. IFR probe — EXTEND.
11. REFUEL SEL switch — INT/EXT.

If fuel does not transfer and external store is an ARS:

12. ARS POWER SWITCH — DUMP (AS REQUIRED).

Note

Do not jettison the hose after fuel dump is performed; jettison may ignite trapped fuel in ARS.

If fuel does not transfer and an external tank has more than 500 pounds of fuel, jettison the tank prior to CV recovery or divert to shore for nonarrested landing.

17.3 UNCOMMANDED FUEL VENTING

1. EXT TRANS switch — CYCLE/OFF.
2. IFR probe — CHECK AIRSPEED/EXTEND.

If fuel venting continues:

3. REFUEL SEL switch — INT/EXT.
4. O_2 mask — AS REQUIRED.
5. Both bleed air switches — OFF.

If fuel venting continues:

6. Establish noseup attitude.
7. Landing gear — CHECK AIRSPEED/EXTEND.

If fuel venting continues:

8. External tanks — JETTISON (as required).

If external tanks jettisoned:

9. Both bleed air switches — ON.

Note

- Uncontrollable fuel venting may result in venting fuel down to approximately 4,400 pounds remaining. Maintaining nose-high attitude may break the siphon effect initiated by internal tank overpressurization.
- If bleed air shutoff valves do not close and venting continues, jettisoning drop tanks may secure venting.

17.4 IN-FLIGHT REFUELING PROBE FAILURE

WARNING

Failure to pull the IFR probe actuator circuit breaker prior to manual handcrank operation may result in injury if the probe motor actuates with the handcrank in the manual operation receptacle.

17.4.1 Fails to Extend

1. IFR PROBE ACTUATOR circuit breaker (3-M-9, right hinged circuit breaker panel) — PULL.
2. IFR PROBE control switch — EXTEND.
3. Insert crank and turn counterclockwise.

17.4.2 Fails to Retract

1. IFR PROBE ACTUATOR circuit breaker (3-M-9, right hinged circuit breaker panel) — PULL.
2. IFR PROBE control switch — RETRACT.
3. Insert crank and turn clockwise.

CAUTION

When using the manual crank system for IFR probe extension/retraction, cranking should be stopped when the PROBE OUT advisory light illuminates/extinguishes. Additional cranking is not required and may cause damage to the probe drive system.

CHAPTER 18

Electrical Abnormal Procedures

18.1 APU GENERATOR LOADING/AC BUS DISTRIBUTION WITH ENGINE GENERATOR FAILURES

In the event of an engine generator failure that cannot be reset, the APU generator will assume the bus of the failed generator. With a left engine generator failure, the APU generator (when turned on) will power the left primary and essential buses. With a right engine generator failure, the APU generator (when turned on) will power the right primary bus. With a dual generator failure, the APU generator can power all buses.

18.2 GENERATOR FAILURE/GENERATOR WARNING LIGHT

Each generator drive system has a completely automatic thermal disengage system.

1. Generator — ATTEMPT RESET.

If the generator light remains on:

2. Generator switch — OFF.
3. APU — CHECK ALTITUDE, AIRSPEED/ START.
4. APU automatic shutdown — DISARM.
5. APU GEN switch — ON.

18.3 CONTROL LOGIC ASSEMBLY FAILURES

Note

Individual logic output function failures may occur and will only affect one CLA function. These failures may result in false operate (operation of function without command) or fail to operate (inoperation of function with command) modes affecting individual output functions. If this occurs, applicable procedures shall be followed for corrective action.

18.3.1 Left CLA Failure

1. Land as soon as practical.
2. Refer to Figure 18-1 for additional functions/indications lost.
3. Perform arrested landing (refer to FIELD EMERGENCY ARRESTING GEAR procedure in paragraph 23.5).

CAUTION

- Visual confirmation of gear extension by outside observer will be required; downlock indicators, gear handle light, and approach indexers will be inoperative.
- On landing, the antiskid brakes, antiskid caution light, and nosewheel steering will be inoperative.
- Wing/fin fold will be inoperative.

18.3.2 Right CLA Failure. (Refer to Figure 18-2.)

1. Land as soon as practical.

CAUTION

- Assisted airstarts will not be available (windmill only).
- Leading edge flaps will not be operative.

CAUTION

- Normal and antiskid brakes will not be operative.
- Arresting hook will not retract.
- Rudder will not be fully effective in the event of single-engine waveoff.
- Right engine will not shift to ground idle after touchdown.

2. Refer to Figure 18-2 for additional functions/indications lost.

3. Perform arrested landing (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

18.4 MASTER ARM FAILURE

If the MSTR ARM light gives erroneous indications and the problem cannot be corrected by cycling the MASTER ARM switch, suspect a K6 relay failure that will give a continuous master arm on signal to the ACP.

1. Expend all ordnance in safe area — ATTEMPT.

2. Circuit breakers — PULL.

   a. 3-E-14 (ARMT CONT)

   b. 3-B-13 (ARMING)

   c. 3-D-14 (RELEASE)

   d. 3-E-15 (AUX CONT).

3. If unable to expend all ordnance, land at a field that causes the least exposure of inadvertent expenditure to people and property.

18.5 COMM OV HT LIGHT

Emergency ram air cooling can be provided only during flight.

1. COMM EQUIP COOLING switch — EMER.

OUTPUT FUNCTIONS LOST	EFFECT ON AIRCRAFT
ADVISORY/CAUTION LIGHTS	
ANTISKID caution light Approach lights Approach lights flasher Approach indexers (pilot and copilot/COTAC) ENG OIL PRESS caution light FIN UNLKD caution light FLIR EXTEND advisory light 1 FUEL IDLE caution light 1 HYD PRESS and 2 HYD PRESS caution lights Landing gear handle light LG IND position indicators (NLG and MLG) LNCH BAR EXT advisory light LNCH BAR FAIL caution light MAD BOOM advisory and caution lights NWS ON advisory light WHEELS warning light WINGS UNLKD caution light	The listed advisory, caution, or warning lights will not illuminate.
AUTOMATIC FLIGHT CONTROL SYSTEM	
Channel No. 2 gear handle down Channel No. 2 weight on main landing gear Channel No. 2 hydraulic pressure greater than 1900 psi Channel No. 2 TE flap position greater than 57 percent Channel No. 2 TE flap position greater than 28 percent	If autopilot on, it will disengage. If autopilot off, it can be engaged single-channel only on channel No. 1.
BOMB BAY DOORS	
Bomb bay door electrical control	Bomb bay door will only operate at one-half speed on hydraulic system.
BRAKE SYSTEM	
Antiskid control power	No antiskid system.
ENGINE	
Engine No. 1 rollback idle scheduling	Engine will not change to ground idle on command.
FLIR SYSTEM	
FLIR control	FLIR cannot be extended or retracted.

Figure 18-1. Left CLA Completely Failed (Sheet 1 of 2)

OUTPUT FUNCTIONS LOST	EFFECT ON AIRCRAFT
LAUNCH BAR/ARRESTING HOOK	
Launch bar extend	No normal launch bar extension.
Launch bar switch solenoid	
NOSEWHEEL STEERING	
Nosewheel steering centering valve	No nosewheel centering on gear extension and with hook down.
Nosewheel steering valve	No nosewheel steering.
PITCH TRIM SYSTEM	
Channel 2 high rate command	Channel 2 pitch trim remains in programmed rate with flaps down. Pitch trim may trip when operated and be usable single-channel only.
WING FOLD SYSTEM/FIN FOLD SYSTEM	
TE flap damper brake inhibit	
Fin fold and erect control	No fin fold or erect from cockpit.
Wing fold and spread control (including lock pins and spoilers null)	All wing fold and spread functions lost from cockpit. **Note** Emergency fin and wing fold still operable.
MISCELLANEOUS	
Counting accelerometer	
Hook bypass switch latch	
Wing/empennage deice enable	Wing/empennage deice enabled with wings folded and on ground.
Landing and taxi light	
Upper and lower anticollision lights	
Refuel probe floodlight	
APU automatic shutdown override	Automatic shutdown of APU with overtemperature and low oil pressure cannot be overridden.

Figure 18-1. Left CLA Completely Failed (Sheet 2)

OUTPUT FUNCTIONS LOST	EFFECT ON AIRCRAFT
ADVISORY/CAUTION LIGHTS	
Arresting HOOK handle warning light DOOR OPEN caution light EMER BK ON advisory light 2 FUEL IDLE caution light PITCH TRIM, ROLL TRIM, SPD BRK, channel 1 and channel 2 status lights (FCT panel) PK BK ON advisory light PROBE OUT (in-flight refueling) advisory light RUDDER PWR caution light SPD BRK warning lights (pilot and copilot/COTAC) SPEED BK caution light TRIM/SPEED BK caution light SAR light	The listed advisory, caution, or warning lights will not illuminate.
ARMAMENT SYSTEM	
Kill stores release system	No kill stores release (normal system).
Jettison system	No emergency jettison of search or kill stores.
Search stores power	No search stores release.
SAR buoy power	No SAR buoy power or release.
AUTOMATIC FLIGHT CONTROL SYSTEM	
Channel No. 1 gear handle down Channel No. 1 weight on main landing gear Channel No. 1 hydraulic pressure greater than 1900 psi Channel No. 1 TE flap position greater than 57 percent Channel No. 1 TE flap position greater than 26 percent	If autopilot on, it will disengage. If autopilot off, it can be engaged single-channel only on channel No. 2.
BOMB BAY DOORS	
Bomb bay door hydraulic control	Bomb bay door will operate only at one-half speed on electrical system.
BRAKE SYSTEM	
Normal brakes select	No normal or antiskid brakes.

Figure 18-2. Right CLA Completely Failed (Sheet 1 of 3)

OUTPUT FUNCTIONS LOST	EFFECT ON AIRCRAFT
ENGINE	
Right engine start valve	No assisted engine starts, windmill only.
Left engine start valve	No assisted engine starts, windmill only.
Engine No. 2 rollback idle scheduling	Engine will not change to ground idle on ground.
FUEL SYSTEM	
External tank air pressure shutoff valve	External tanks will pressurize in flight and on the ground. External fuel transfer will occur and cannot be controlled with EXT TRANS switch. Fuel loss through vent system may occur. Fuel transfer/loss can be stopped by securing both bleed valves with the APU OFF.
External tank fueling transfer valves	External tanks cannot be refueled in flight.
LAUNCH BAR/ARRESTING HOOK	
Arresting hook retract control	No hook retraction.
LEADING EDGE FLAPS	
Left LE flap extension	LE flaps inoperable.
Left LE flap retraction	LE flaps indication lost.
Right LE flap extension	
Right LE flap retraction	
LE flaps up indication	
LE flaps loiter indication	
LE flaps down indication	
LE flaps asymmetry light	
PITCH TRIM SYSTEM	
Channel 1 high rate command	Channel 1 pitch trim remains in programmed rate with flaps down. Pitch trim may trip when operated and be usable single-channel only.
REFUELING	
In-flight refueling probe extension and retraction	No powered mode of in-flight refueling operation.
Ram air override	Ram air inlet remains open during in-flight refueling.
RUDDER SYSTEM	
Rudder servo pressure reducer valve systems No. 1 and No. 2	Rudder servo pressure remains in low pressure on takeoff or landing, resulting in less rudder effectivity.

Figure 18-2. Right CLA Completely Failed (Sheet 2)

OUTPUT FUNCTIONS LOST	EFFECT ON AIRCRAFT
SPOILERS	
Left lower spoiler undwell	Lower spoilers will not undwell when TE flaps are retracted.
Left lower spoiler dwell Right lower spoiler undwell Right lower spoiler dwell	Lower spoilers will not dwell when TE flaps are extended.
MISCELLANEOUS	
Waveoff lock out relay	Reduced rate of climb on single-engine waveoff.
ECS on ground signal	ECS remains in low-flow on ground.
Wing/empennage deice enable	Wing/empennage deice enabled on the ground.
Crossbleed start valve	Crossbleed engine starts cannot be performed.
Weight on gear inhibit of radar and RAAWS	Systems operable on ground.

Figure 18-2. Right CLA Completely Failed (Sheet 3)

CHAPTER 19

Hydraulic System Failure Abnormal Procedures

19.1 NO. 1 HYDRAULIC SYSTEM FAILURE

1. No. 1 hydraulic servo — OFF.

2. LAND AS SOON AS PRACTICAL.

Prior to landing, complete the following:

3. EHP — ON.

Note

With the EHP powering the No. 1 hydraulic system, all flight and utility systems will be operable except for cockpit wing fold. Plan a normal landing.

OR

If No. 1 hydraulic system pressure is restored:

4. No. 1 hydraulic servo — ON.

5. Yaw damper — ENGAGE.

   a. Accomplish, ‘Normal Approach and Landing checklists.”

If No. 1 Hydraulic System pressure is not restored (engine pump and EHP inoperable):

1. EHP — OFF.

2. Yaw damper — ENGAGE.

Go to No. 1 Hydraulic System Inoperable Approach Checklist, paragraph 19.2.

19.2 NO. 1 HYDRAULIC SYSTEM INOPERABLE APPROACH CHECKLIST

Note

- NWS, anti-skid, normal brakes, wing/fin fold, launch bar extension, DLC, and arresting hook retraction will be lost. If remaining flight time exceeds 3 hours, consider downgrading to EFCS. Refer to EFCS characteristics, paragraph 12.2 and Dual Hydraulic Failure Procedures, paragraph 19.5.

- Flaps will be extended to takeoff position using wing flap emergency procedure.

- Gear will be extended using emergency method.

- Gear extended manually cannot be retracted. Therefore, single-engine climb performance may be marginal to non-existent. Additionally, the drag penalty with gear extended may make it impossible to reach an alternate/Bingo field. Refer to Single-Engine Climb Performance, paragraph 32.10 and Gear Down Bingo Charts.

- If arresting gear is available, an arrested landing should be performed due to the possibility of blown tires when using the emergency brake system.

1. Stick — EXTEND (AS DESIRED).

2. Fuel — DUMP (AS REQUIRED).

3. MASTER ARM/SRCH PWR/ECM ARM switches — OFF.

4. Brake Selector switch — EMER.

5. Emergency brake accumulator — CHARGED/IN THE GREEN.

6. Altimeters/RAAWS — SET.

7. NAVAIDS/NAV display selection — SET.

8. Arrestment briefing — COMPLETE.

a. Determine most appropriate gear available.

b. Notify control tower of intentions.

c. Adjust gross weight as necessary.

d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

Go to No. 1 Hydraulic System Inoperable Landing Checklist, paragraph 19.3.

19.3 NO. 1 HYDRAULIC SYSTEM INOPERABLE LANDING CHECKLIST

1. Seats/harnesses — ARMED/GROUP/LOCKED.

2. Speedbrakes — IN.

3. Fuel — DUMP SECURED, ___LBS.

4. Hook (if gear available) — DOWN.

5. Wing flap emergency operation — PERFORM.

   a. Slow to appropriate airspeed.

   b. Emergency flap selector switch — EMER

   c. Emergency flap toggle switch — ACTUATE TO 65 PERCENT OR LESS (AS REQUIRED).

   d. Flap lever — CORRESPONDING.

6. Landing gear emergency extension procedure — PERFORM.

   a. Airspeed — 140 KIAS MAXIMUM.

   b. Landing Gear Handle — DOWN.

   c. Landing Gear Emergency Extension Handle — PULL.

Note

Emergency landing gear extension may take up to 90 seconds.

7. Landing gear — DOWN.

CAUTION

- Emergency brake use above 60 KIAS increases the possibility of blown tires.
- Ensure speedbrakes are extended prior to application of brakes.
- Optimum use of emergency brakes will be gained by one smooth brake application of continually increasing pressure until the aircraft stops. Releasing and reapplying brakes will deplete the brake accumulator more rapidly (approximately 10 full applications available).
- The wings should not be folded or spread from the cockpit with the EHP on if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wing.

No. 1 Hydraulic System Inoperable Landing Checklist is complete.

19.4 NO. 2 HYDRAULIC SYSTEM FAILURE

1. No. 2 hydraulic servo — OFF.

2. Yaw Damper — ENGAGE.

3. LAND AS SOON AS PRACTICAL.

   a. The approach and landing should be flown with the flaps in the TAKEOFF position and optimum AOA.

   b. Accomplish Normal Approach and Landing checklists.

Note

- With the No. 2 hydraulic system failed, aileron, rudder, elevator, and spoiler redundancy have been lost. The No. 1 hydraulic system will continue to power all flight controls and all utility subsystems.

- DLC will be lost.

4. No. 2 Hydraulic System Failure Checklist is complete.

19.5 DUAL HYDRAULIC SYSTEM FAILURE

WARNING

- Reversion to EFCS while pushing forward on the stick may result in failure of the elevator control to engage during flight and subsequent loss of longitudinal control authority at all pitch trim and trailing edge flap settings.

- Transfer to EFCS with trailing edge flaps extended will result in a moderate nose-down pitching moment requiring high pull forces (80 pounds or more) and immediate retrimming of the stabilizer.

1. No. 1 AND No. 2 HYDRAULIC SERVOS — OFF.

2. EHP — ON.

If No. 1 hydraulic system pressure is restored:

3. No. 1 HYDRAULIC SERVO — ON.

4. LAND AS SOON AS PRACTICAL.

   a. The approach and landing should be flown with the flaps in the TAKEOFF position and optimum AOA.

   b. Accomplish Normal Approach and Landing checklists.

Note

- With the EHP powering the No. 1 hydraulic system, all flight and utility systems will be operable except for cockpit wing fold.

- DLC will be lost if No. 2 Hydraulic System pressure not available.

5. DUAL HYDRAULIC SYSTEM FAILURE CHECKLIST COMPLETE.

OR

If No. 1 hydraulic system is not restored (both engine pump and EHP inoperable)

3. SPOILER SERVO — OFF.

4. BOMB BAY STORES — DROP.

If flaps are full down at time of failure:

5. EMERGENCY FLAP SELECTOR SWITCH — EMER.

6. EMERGENCY FLAP TOGGLE SWITCH — ACTUATE TO 65 PERCENT OR LESS (AS REQUIRED).

CAUTION

- Limit airspeed to 300 KIAS/0.65M (maximum)/125 KIAS (minimum).

- Limit bank angles to 60° maximum clean.

- Limit bank angles to 30° maximum in the landing configuration.

- Avoid rapid power changes.

Go to Dual Hydraulic System Inoperable Approach Checklist, paragraph 19.6.

19.6 DUAL HYDRAULIC SYSTEM INOPERABLE APPROACH CHECKLIST

WARNING

- If electrical power or pitch trim is not available, landing shall not be attempted on EFCS.

- Single engine EFCS landings should not be attempted unless ejection is impossible.

Note

- NWS, anti-skid, normal brakes, wing/fin fold, launch bar extension, DLC, and arresting hook retraction will be lost.

- Flaps will be extended to takeoff position using wing flap emergency procedure.

- Gear will be extended using emergency method.

- Gear extended manually cannot be retracted. Therefore, single-engine climb performance may be marginal to non-existent. Additionally, the drag penalty with gear extended may make it impossible to reach an alternate/Bingo field. Refer to single-engine climb performance, paragraph 32.10, and Gear Down Bingo Charts.

- If arresting gear is available, an arrested landing should be performed due to the possibility of blown tires when using the emergency brake system.

1. Stick — EXTEND (AS DESIRED).

2. Asymmetric wing stores — JETTISON.

3. Fuel — DUMP (AS REQUIRED).

4. MASTER ARM/SRCH PWR/ECM ARM switches — OFF.

5. Brake selector switch — EMER.

6. Emergency brake accumulator — CHARGED/IN THE GREEN.

7. Altimeters/RAAWS — SET.

8. NAVAIDS/NAV display selection — SET.

9. Arrestment briefing — COMPLETE.

   a. Determine most appropriate gear available.

   b. Notify control tower of intentions.

   c. Adjust gross weight as necessary.

   d. Review hook skip contingencies.

Note

Additional information can be found in Field Emergency Arresting Gear procedures, paragraph 23.5.

Go to Dual Hydraulic System Inoperable Landing Checklist, paragraph 19.7.

19.7 DUAL HYDRAULIC SYSTEM INOPERABLE LANDING CHECKLIST

1. Seats/harnesses — ARMED/GROUP/LOCKED.

2. Speedbrakes — IN.

3. Fuel — DUMP SECURED, ___LBS.

4. Hook (if gear available) — DOWN.

5. Wing flap emergency operation — PERFORM.

   a. Slow to Appropriate Airspeed.

   b. Emergency Flap Selector Switch — EMER.

   c. Emergency Flap Toggle Switch — ACTUATE TO 65 PERCENT OR LESS (AS REQUIRED).

   d. Flap lever — CORRESPONDING.

6. Approach speed — optimum AOA (125 KIAS MINIMUM).

7. Landing gear emergency extension procedure — PERFORM.

   a. Airspeed — 140 KIAS MAXIMUM.

   b. Landing Gear Handle — DOWN.

   c. Landing Gear Emergency Extension Handle — PULL.

Note

Emergency landing gear extension may take up to 90 seconds.

8. Landing gear — VERIFY DOWN.

Dual Hydraulic System Inoperable Landing Checklist is complete.

19.8 LAUNCH BAR FAILS TO RETRACT IN FLIGHT

CAUTION

If the launch bar is not retracted and locked, the landing gear handle may be raised. However, the wheels will not retract and AOA indexers and approach lights will be inoperative. Assume the launch bar to be down regardless of LNCH BAR FAIL light illumination, unless visually confirmed up.

If the launch bar fails to retract normally or with use of EMER RET switch:

1. Landing gear handle — DOWN.
2. Landing gear emergency extension handle — DOWN.

→ If launch bar fully retracts:

3. Landing gear emergency extension handle — STOW.
4. EMER LG RESET switch — PRESS.
5. Landing gear — RETRACT.

OR

→ If launch bar does not fully retract, follow gear malfunction recommendations (Figure 23–1).

19.9 HOOK FAILURE TO EXTEND

1. Arresting hook conv circuit breaker (3-I-13, right hinged circuit breaker panel) — PULL.

If hook does not extend:

2. APU — START.
3. No. 1 HYD servo switch — OFF.

Note

Reactivation of the No. 1 HYD servo switch to the NORM position will retract the hook.

CHAPTER 20

Environmental Control System Abnormal Procedures

20.1 BLEED AIR SHUTOFF VALVE FAILURE

Illumination of the 1 BL CLSD or 2 BL CLSD light on the fault function master caution panel, during normal ACPS two-engine operation, indicates a closure of the respective valve.

1. Bleed air switch — CYCLE.

If light does not go off:

2. Bleed air switch — OFF.
3. DE-ICING switch — OFF.

Note

If unable to open the bleed air shutoff valve, an assisted airstart of the engine will not be available. Windmill airstart will still be possible.

20.2 ANTI-ICING SYSTEM FAILURE

1. ANTI-ICING switch — RECYCLE.

If malfunction persists:

2. ANTI-ICING advisory lights — CHECK BULBS.
3. Engine anti-icing control circuit breaker (4-E-15 or 4-F-15) — PULL.

If lights still do not illuminate:

4. Avoid known icing conditions. If necessary to penetrate, do so at high rates of vertical speed.

20.3 AVIONICS FAN FAILURE

When operating at high airspeed with the auxiliary ventilation system in the AUX VENT mode and the valve fully open, the INT AVIONICS light may illuminate giving a false indication. If this occurs, determine a possible fan failure by resetting the AUX VENT control for lower airflow or by reducing the airspeed below 200 KIAS. If the light goes out, the fan is operating.

In case of loss of an avionics fan, see Figure 20-1.

CAUTION

If the rear seats are not occupied, a FAN OUT caution light on the cockpit master caution panel may indicate an imminent overheat of the communication area in the right aft bay (R AFT BAY caution light); therefore, the COMM EQUIP COOLING switch should be positioned to EMER.

Note

- If the FAN OUT caution light does not extinguish with EMER selected, the COMM EQUIP COOLING switch should be returned to the NORMAL position because the right aft bay cooling fan is operating.
- A false INT AVIONICS fan out light may occur for 3 to 5 seconds when advancing the engine throttle rapidly from IDLE to MAX POWER or when ascending or descending through 3,000 to 5,000 feet.
- A false INT AVIONICS fan out light may occur continuously at airspeeds in excess of 300 KIAS and altitudes of less than 4,500 feet above sea level. When encountering a fan out light under this flight condition, airspeed should be reduced to determine if a true fan failure has occurred. If the light does not extinguish below 250 KIAS, appropriate precautions for a fan failure should be taken.

FAN FAULT LIGHT ILLUMINATED	CIRCUIT BREAKERS CORRESPONDING WITH FAN FAULT LIGHT		
	EQUIPMENT DAMAGE MAY OCCUR IF POWER NOT REMOVED	RETAIN IF ESSENTIAL TO FLIGHT SAFETY	REMARKS
L FWD BAY	FLIR SYSTEM FLIR SYSTEM COOLER	IFF INTRG, 115 VAC (1-J-7)	Power duty cycle of 2 minutes on and 8 minutes off.
		IFF INTRIG, 28 VDC (1-G-13)	Power duty cycle of 2 minutes on and 8 minutes off.
		DOPPLER GRD VEL (3-E-10)	Unit has thermal cutout that will operate with overtemperature condition. Thermal cutout will automatically reset.
R FWD BAY	RADAR SYS POWER SUPPLY		
SENSO CONS	SENSO DISPLAY AUXILIARY READOUT INCOS (L)	INTERCOM SENSO (1-I-10)	Limit use of intercom. Use override mode. Unit has thermal cutout with automatic reset when cooled.
		INRTL NAV SYS (3-M-10)	Inertial measuring unit has thermal cutout and will automatically reset.
TACCO CONS	TACCO DISPLAY DISPLAY GENERATOR INCOS (R)	INTERCOM TACCO (1-H-10)	Limit use of intercom. Use override mode. Unit has thermal cutout with reset when cooled.
FLT STA CONS	PILOT DISPLAY COPILOT DISPLAY LOGIC PWR XFMR NO. 1 LOGIC PWR XFMR NO. 2	INTERCOM, COPILOT, CI and RSCI (1-J-10)	Limit use of intercom. Use backup and override mode. Unit has thermal cutout with reset when cooled.
INT AVIONICS	FLIR FLIR SYSTEM	AFCS CHAN NO. 1, 115 VAC (1-B-6) AFCS CHAN NO.2, 115 VAC (1-E-6) AFCS CHANNEL NO.1, 28 VDC (1-A-12) AFCS CHANNEL NO.2, 28 VDC (1-B-12)	Flight data computer will reject sufficient heat if cabin ambient air is less than 27 °C (80 °F). Unit has no thermal cutout.
		CENTRAL AIR DATA SYSTEM A (1-E-1) CENTRAL AIR DATA SYSTEM B (3-O-5)	Has no thermal cutout but does have an internal fan and will operate several minutes before failing.

Figure 20-1. In-Flight ECS Fan Fault Emergencies (Sheet 1 of 2)

FAN FAULT LIGHT ILLUMINATED	CIRCUIT BREAKERS CORRESPONDING WITH FAN FAULT LIGHT		
	EQUIPMENT DAMAGE MAY OCCUR IF POWER NOT REMOVED	RETAIN IF ESSENTIAL TO FLIGHT SAFETY	REMARKS
	RADAR SYS POWER SUPPLY LOGIC PWR XFMR NO. I LOGIC PWR XFMR NO. 2 GPDC	INRTL NAV SYS (3-M-10) INRTL NAV SYS INTFC AND NAV CONT (3-O-10), (1-H-10)	Inertial navigation system has thermal cutout with automatic reset. Have thermal cutouts with automatic reset.
R AFT BAY			All equipment in right aft avionics bay can be effectively cooled by placing COMM EQUIP COOL-ING switch to EMER.

Note

With a failed internal avionics fan, best cooling for internal avionics equipment is achieved by:

- Selecting maximum AUTO COLD on ECS.
- Flying at lower altitudes.
- Retaining ACPS and avoiding use of AUX VENT mode.
- Securing power to nonessential equipment as listed above.
- Increasing power to increase cabin airflow.

Figure 20-1. In-Flight ECS Fan Fault Emergencies (Sheet 2)

Note

Below 5,000 feet, the cabin outflow valve is held open by blast air from the internal avionics fan. In the event the fan fails below 5,000 feet, cabin pressurization and a possible surging will be noticed because of the closing of the cabin outflow valve.

20.4 FAN OUT LIGHT

Failure of one of the avionics cooling fans is indicated. The failed fan can be identified by observing the ECS fan fault lights at the TACCO station. For ground operations, take action as noted on the placard at the TACCO station. If airborne, refer to Figure 20-1.

CAUTION

If the COMM EQUIP COOLING switch is left in the EMER position, no ram air for cooling will be supplied after landing; therefore, expect possible communications failure after landing while taxiing.

CHAPTER 21

Flight Controls Abnormal Procedures

21.1 TRAILING EDGE FLAPS LOCKED

WARNING

No attempt should be made to change trailing edge flap position after a lockup has occurred. Do not, under any circumstances, reset the trailing edge flap control circuit breaker in flight or interrupt total electrical power by turning off the generators. If electrical power is interrupted, the trailing edge flap circuit breaker trips, or the flap brake releases on its own, one or both trailing edge flaps will move to the flap lever position, regardless of the EMER FLAP NORMAL-EMER switch. A change in trailing edge flap position could cause a change in approach AOA or result in a split flap condition during a critical phase of flight. A short-field arrestment should be executed.

Note

Refer to Landing With Flap Settings Other Than Takeoff or Land Position, paragraph 23.1, and Field Emergency Arresting Gear, paragraph 23.5, if applicable.

21.2 DIRECT LIFT CONTROL SYSTEM FAILURE TO RETRACT

Pilot indication of this failure will be:

1. Higher than expected sink rate.
2. DLC warning light flashing.
3. Master caution light flashing.
4. TRIM/SPEED BK light illuminated.
5. SPD BRK 1 and 2 channel disconnect lights illuminate on the FCT panel.

If these indications occur during DLC operation, climb to a safe altitude:

1. Speedbrake control channel — RESET ONE CHANNEL.
2. Speedbrakes — RETRACT.
3. Speedbrake control channel — RESET REMAINING CHANNEL.
4. DLC switch — OFF.
5. Land without reengaging DLC.

WARNING

Disengagement with trim disconnect or monitor trip will leave speedbrakes in their existing position. If the DLC light flashes, the system must be reset prior to subsequent activation.

21.3 LEADING EDGE FLAP ASYMMETRY

Leading edge flap asymmetry is indicated by illumination of the LE FLAP ASYM caution light.

1. LE flaps — VISUALLY CHECK.

→ If LE flaps appear damaged:

2. Climb — ABOVE 10,000 FEET AGL.
3. Wing flap emergency operation — PERFORM.
   a. Slow to appropriate airspeed.
   b. EMER FLAP SEL switch — EMER.
   c. EMER FLAP toggle switch — ACTUATE TO 100 PERCENT OR LESS.

OR

4. Slow flight in landing configuration.

5. Return for landing as soon as practical.

OR

If LE flaps appear undamaged:

CAUTION

Cycling damaged flaps may cause further damage to LE flaps.

6. LE flaps — RECYCLE (if appropriate).

7. Recommend straight-in approach.

21.4 LEADING EDGE FLAPS RETRACTED

When operational necessity dictates, takeoffs and landings with leading edge flaps retracted can be conducted utilizing the following procedures. Flights in this configuration are not recommended.

Flight tests have shown with leading edge flaps retracted, stall warning and margin are reduced or even eliminated. Stall speed and rolloff tendency at or near the stall are increased with a greater tendency to enter into a poststall condition. With the leading edge flaps retracted, extreme caution is required in the takeoff or land configuration. Refer to Stall Characteristics, paragraph12.11, for further discussion.

1. Takeoff with asymmetric leading edge flaps is prohibited.

Prior to takeoff:

2. With both leading and trailing edge flaps up, pull the LE FLAP OUTBRD ACTUATOR circuit breaker (1-B-2) then lower the trailing edge flaps.

3. Catapult takeoffs with leading edge flaps retracted can be conducted with current NATOPS pitch trim settings if 20 knots excess endspeed is provided.

After takeoff:

4. No turns (including clearing turns) shall be initiated until the trailing edge flaps have been retracted.

Approach/landing:

5. When landing with leading edge flaps retracted, a straight-in approach should be performed.

WARNING

If stall occurs at low altitude with leading edge flaps up/trailing edge flaps extended, recovery and/or successful ejection is unlikely because of significant altitude loss. When operating in this configuration, exercise extreme caution and minimize maneuvering so the aircraft does not decelerate slower than optimum AOA.

CHAPTER 22

Unusual Attitude, Stall/Spin Recovery Abnormal Procedures

22.1 ABNORMAL PITCHUP ON TAKEOFF, TOUCH AND GO, BOLTER, OR WAVEOFF

A pitch rate in excess of normal may occur when full power is applied because of an excessive stabilizer trim setting during an approach or takeoff. Sufficient forward stick is available to counter the maximum pitch rate expected in a full noseup trim situation. Slight power reduction and/or nosedown trim input will moderate required forward stick input.

WARNING

There is little or no aerodynamic warning of impending stall with full power and flaps in the TAKEOFF or LDG position. Unusually high pitch attitudes mark the approach to the stall.

Note

Time permitting, flaps should be placed in the LDG position, if not already in that position, to provide increased nosedown control authority.

22.2 NOSE-HIGH UNUSUAL ATTITUDE RECOVERY

1. Maintain angle of bank.
2. AOA — 18.5 UNITS OR BELOW.
3. Speedbrakes — RETRACTED.

If aircraft departs controlled flight:

4. Perform Out-of-Control Recovery procedures in paragraph 14.5.1.

If aircraft is controllable:

5. Adjust power as necessary to maintain less than 18.5 units.

Note

Reduction of power may be necessary in nose-high, low-airspeed situations because of the increased pitching moment of the engines.

6. Roll wings level when aircraft passes the horizon and AOA can be maintained below 18.5 units.

WARNING

- High power settings may force the aircraft into a stall situation because of excessive noseup pitching moment.
- Rapid power addition at low airspeed/high AOA may cause nose pitchup and resultant stall.
- For recoveries from nose-high unusual attitudes, rudder pedals shall be centered throughout the maneuver. As the nose falls through and speed increases, inadvertent sideslip may cause large rolling moments resulting in an undesired steep spiral dive. In addition, rudder inputs will excite the dutch-roll mode, which makes precise bank angle control difficult.
- During full power-on stalls, there is little or no aerodynamic buffet warning as the stall is approached.

Note

- Significant nosedown attitudes can be expected during recovery from extreme nose-high unusual attitudes.

- Pushover recovery may cause illumination of the OIL PRESS light as a result of sustained less than 1g flight.

- Minimum airspeed in the maneuver may be very low, (below normal 1g stall speed) requiring smooth stick control and thrust inputs. Addition of power at any time in this maneuver will cause a mild noseup pitching moment; therefore, monitor AOA closely.

22.3 EFCS NOSE-HIGH UNUSUAL ATTITUDE RECOVERY

Push stick forward and immediately trim nose down. Use the AOA indicator as the primary recovery instrument. Attempt to maintain AOA between 10 to 15 units. Moderate aileron and rudder inputs may be used to reduce pitch attitude.

If AOA cannot be reduced to between 10 and 15 units, maintain forward stick, then center lateral and directional controls, and attempt to maintain balanced flight.

22.4 NOSE-LOW UNUSUAL ATTITUDE RECOVERY

1. Roll wings level when AOA is below 18.5 units.

2. Power/speedbrakes — AS REQUIRED.

3. Maintain 16.5 to 18.5 units on pullout, not to exceed limit load factor.

CAUTION

Speedbrake extension when the aircraft load factor is above 3.0g should be avoided to preclude inadvertent overstress.

Note

Use of speedbrakes may be required to prevent excessive altitude loss or exceeding airspeed/Mach limitations.

22.5 EFCS NOSE-LOW UNUSUAL ATTITUDE RECOVERY

Pull stick back and immediately trim noseup. As nose approaches horizon, trim nosedown to reduce noseup pitch rate.

22.6 STALL RECOVERY PROCEDURES

Recovery from all stalls is effected by reducing AOA to 18.5 units or below. Retract speedbrakes and apply power. Roll wings level when AOA is less than 18.5 units and adequate airspeed is attained. Maintain 16.5 to 18.5 units until recovery is completed.

WARNING

- Rapid addition of power at low speed or high AOA should be avoided. Longitudinal control may be insufficient to compensate for the rapid noseup trim change with power, and a deeper stall penetration may result.

- Do not attempt to level wings until AOA is below 18.5 units. Lateral control inputs at high AOA and slow airspeed will aggravate the stalled condition and may increase the possibility of a spin.

CHAPTER 23

Landing
Abnormal Procedures

23.1 LANDING WITH FLAP SETTINGS OTHER THAN TAKEOFF OR LAND POSITION

Significant changes in approach characteristics and APC performance result from increased approach speeds (approximately 44 KIAS increase with no flaps) and low power settings (with attendant power response degradation during small power changes). Lateral control throw is also reduced with flaps less than the MANUV position. The capability to correct for a high, fast condition is also degraded because of the low power level in the approach. Carrier landings at flap settings less than takeoff should not be routinely conducted. If required by aircraft malfunction, carrier landings at flap settings less than maneuver are authorized at a maximum aircraft weight of 38,000 pounds and increased wind over deck to reduce the probability of exceeding landing gear design loads. Field landings at less than maneuver flaps are authorized up to 36,000 pounds if a minimum rate of descent landing is executed. The pilots should be cautious of low power settings (less than 70-percent N_g) throughout the approach, particularly in close proximity to the ramp. When correcting from an above glideslope position, the DLC should be used cautiously, as under no-flap conditions, higher than normal sink rates can develop rapidly. DLC will operate normally with flaps in the maneuver position and may be used in the usual manner. Reduced flap approaches at night or in increased atmospheric turbulence levels/sea state conditions increase pilot workload significantly.

CAUTION

FCLP landings with flap setting less than land or takeoff shall not be conducted on shore with weights greater than 36,000 pounds. A minimum rate-of-descent landing shall be executed.

1. Fuel dump (to reduce weight) — AS REQUIRED.
2. EMER FLAP NORMAL-EMER switch — EMER.
3. Flap lever — MANUV.

WARNING

If electrical power is interrupted, the trailing edge flap circuit breaker trips, or the flap brake releases on its own, one or both trailing edge flaps will move to the flap lever position, regardless of EMER FLAP NORMAL-EMER switch. A change in trailing edge flap position could cause a change in approach AOA or result in a split flap condition during a critical phase of flight.

If a runway of suitable length is not available or runway conditions warrant:

4. Make an arrested landing (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).
5. Landing checklist — COMPLETE.
6. Fly a wide pattern.
7. Power on final approach — MAINTAIN 70 PERCENT N_g MINIMUM.

At the completion of a practice approach:

8. Flap handle — UP.
9. Emergency flap NORMAL/EMER switch — NORM.

23.2 LANDING GEAR FAILURES/DAMAGED

If possible, call for an airborne inspection by another aircraft, LSO, FLIR, or fly-by and evaluate landing gear condition prior to determining the best landing or alternate procedures to use.

Note

Refer to Figure 23-1 for shore and carrier emergency landing gear malfunction recommendations.

23.3 NOSEGEAR UNSAFE INDICATION

23.3.1 Nosegear Unsafe (Retracted). An unsafe nosegear indication with the landing gear retracted may indicate a cocked nosegear or launch bar actuator failure. Indications of a launch bar failure include either the launch bar remaining down with the landing gear retracted or separation of the launch bar hydraulic actuator from the launch bar/nose gear. In either case, the launch bar or the actuator may become lodged between the nose gear doors, preventing full retraction of the nose gear.

WARNING

Do not actuate the emergency landing gear extension system. Actuation of the emergency extension system will not result in a safe-down indication if the launch bar actuator has separated and is preventing full gear extension. Subsequent reversion to normal hydraulic power with the landing gear in an intermediate position may cause catastrophic failure of the nosegear downlock roller, leading to erroneous safe-down indication and nosegear collapse on landing.

1. Visual inspection — OBTAIN.

If in-flight inspection confirms the launch bar is not retracted with the landing gear UP, and/or the launch bar actuator has separated from the launch bar, then proceed with steps 2 through 8. If the visual inspection confirms the launch bar is not interfering with gear retraction, then proceed with steps 9 through 15.

OR

→ If the launch bar is not retracted and/or the launch bar actuator is separated:

2. Altitude — MAINTAIN SAFE ALTITUDE.
3. Airspeed/configuration — OPTIMUM +20 KNOTS (TAKEOFF FLAPS).

Yaw aircraft in an attempt to allow actuator to swing clear to the side of the nose strut.

4. Landing gear — EXTEND WHILE MAINTAINING YAW.

If safe indication obtained:

5. Leave landing gear down and execute a normal landing.

If landing gear are still unsafe:

6. Maneuver aircraft — MANEUVER IN PITCH, ROLL, AND YAW; APPLY POSITIVE AND NEGATIVE G.

If safe indication is obtained:

7. Leave landing gear DOWN and execute a normal landing.

If landing gear are still unsafe:

8. Landing — Refer to Landing Gear Malfunction Recommendations (Figure 23-1).

→ If in-flight visual inspection confirms the launch bar is not interfering with gear retraction:

9. Landing gear — EXTEND.
10. Visual inspection — OBTAIN.

OR

→ If nosegear indicates unsafe with gear lowered:

11. Refer to paragraph 23.3.2, Nosegear Unsafe (Extended).

→ If safe indication is obtained and visual inspection confirms the nosegear is cocked:

12. Arresting hook — EXTEND.
13. Landing gear emergency extension procedures — PERFORM.

    a. Airspeed — 140 KNOTS (maximum).

DESCRIPTION OF FAILURE	RECOMMENDED ACTION	
	SHORE	CARRIER
All gear up	• Remove runway arresting cables in landing rollout area to prevent aircraft engagement. • Avoid high sink rates on landing. • Secure both engines after touchdown. Or: Perform controlled ejection.	Divert to shore and perform appropriate procedure. If unable: Perform controlled ejection. **Note** If ejection is not desirable, consult appropriate ARBs for barricade arrestment.
Nose gear up Or: Nose gear not fully extended Or: Both nose gear wheels missing (damaged)	Perform nonarrested landing. • Remove runway arresting cables in landing rollout area to prevent aircraft engagement. • Avoid high sink rates on landing. • Keep nose off runway until elevator effectiveness is lost. • Secure both engines after touchdown.	Divert to shore, if possible. Or: Consult appropriate ARBs for barricade arrestment.
Both main gear up Or: Both main gear not fully extended Or: Both main gear wheels missing	Perform short-field arrestment. • High sink rates on landing must be avoided. • Secure both engines on touchdown.	Divert to shore and perform appropriate procedure. Or: Perform controlled ejection. **Note** If ejection is not desirable, consult appropriate ARBs for barricade arrestment.
One main gear up Or: One main gear not fully extended Or: One main gear wheel missing	Perform short-field arrestment. • High sink rates on landing must be avoided. • Hold wings level after touch-down. • Secure both engines on touchdown.	Divert to shore, if possible. Or: Consult appropriate ARBs for barricade arrestment.

Figure 23-1. Landing Gear Malfunction Recommendation (Sheet 1 of 2)

DESCRIPTION OF FAILURE	RECOMMENDED ACTION	
	SHORE	CARRIER
Nose gear and one main gear not fully extended	Attempt to retract gear and perform all gear up landing If gear cannot be retracted: Perform short-field arrestment. • High sink rates on landing must be avoided. • Hold wings level after touchdown. • Secure both engines on touchdown.	Divert to shore and perform appropriate procedure. Or: Perform controlled ejection. **Note** If ejection is not desirable, consult appropriate ARBs for barricade arrestment.
One nosewheel missing	Perform short-field arrestment. • Avoid high loads on nose gear and high sink rates on landing.	Divert to shore, if possible. Or: Consult appropriate ARBs for barricade arrestment. Remove all arresting pendants.
Launch bar fails to retract	Perform normal landing • Remove all arresting cables to prevent aircraft engagement. • Keep nose off runway until elevator effectiveness is lost.	Divert to shore, if possible. Or: Consult appropriate ARBs. **Note** By following the emergency gear extend procedures, hydraulic pressure is relieved from launch bar, which enables leaf springs to hold launch bar in retract position. If a visual check confirms the launch bar is up, a carrier arrested landing may be performed.

Note

- Retain drop tanks if empty. If not empty, transfer fuel to feed tanks or jettison tanks. Place EXT TRANS switch to OFF to ensure that external tanks are depressurized.
- If available, an LSO is recommended for all field landings.
- Land with fuel weight as low as practical.
- Select-jettison all wing and bomb bay ordnance.
- Fire pull-handles should be closed as soon as possible after securing engines with the throttles.
- Shut down APU prior to landing unless it is essential for electrical power.
- Jettison sonobuoys if aft CG is not advantageous to landing.
- Hatch severance pins removed.
- Perform landing checks.
- Crew access door will be unusable in the event of an all gear up landing or collapsed nose gear. Rear canopies or all canopies may be jettisoned for crew exit.

Figure 23-1. Landing Gear Malfunction Recommendation (Sheet 2)

b. Landing gear handle — DOWN.

c. Emergency landing gear extension handle — DOWN.

WARNING

Landing with the emergency gear extension handle DOWN will result in loss of both nosewheel steering and normal and antiskid brakes. Directional control will be lost below 60 knots.

14. Arrested landing — PERFORM (refer to Field Emergency Arresting Gear procedures, paragraph 23.5).

If safe indication is obtained and visual inspection confirms the nosegear is NOT cocked:

15. Leave landing gear DOWN and execute a normal landing.

23.3.2 Nosegear Unsafe (Extended). If nosegear indicates unsafe when gear is lowered:

1. Inspection — OBTAIN.

If inspection reveals nosegear is damaged, refer to Figure 23-1.

If inspection reveals gear appears to be down and locked, nosegear is not cocked, and no apparent damage:

2. Landing gear —RECYCLE DOWN.

→ If safe indication is obtained:

OR

3. Land —NORMAL LANDING.

→ If still unsafe:

4. Aircraft — MANEUVER IN PITCH, ROLL, AND YAW; APPLY POSITIVE AND NEGATIVE G.

→ If safe indication is obtained:

OR

5. Land — NORMAL LANDING.

→ If still unsafe:

6. Landing gear emergency extension procedure — PERFORM.

   a. Airspeed — 140 KIAS (maximum).

   b. Landing gear handle — DOWN.

   c. Landing gear emergency extension handle — PULL.

WARNING

Subsequent reversion to normal hydraulic power with the landing gear in an intermediate position may cause catastrophic failure of the nosegear lock roller, leading to an erroneous safe-down indication and nosegear collapse on landing.

→ If safe indication is obtained:

OR

7. Arrested landing — PERFORM (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

WARNING

Landing with the emergency gear extension handle down will result in loss of NWS and normal and antiskid brakes. Directional control will be lost below 60 knots.

→ If still unsafe and no other indication of trailing or damaged landing gear:

8. Emergency gear extension handle — STOW.
9. EMER LG RESET switch — PRESS.
10. Hatch severance pins — REMOVE.
11. Landing checklist — COMPLETE.
12. Fuel (to minimum practical) — DUMP.
13. Land — NORMAL LANDING.

WARNING

Landing with an unsafe nosegear indication may result in loss of NWS. Directional control may be lost below 60 knots.

After coming to a stop and prior to taxi:

14. Hatch severance pins — REPLACE.

15. Gear pins — INSTALL.

Note

If landing at an airfield, keep the nose off the runway until elevator effectiveness is lost.

23.4 MAIN GEAR UNSAFE INDICATION

23.4.1 Main Gear Unsafe (Retracted). If main gear indicates unsafe when retracted and if an immediate landing is not anticipated, consideration should be given to not extending the gear. If an immediate landing is available, observe gear limits and lower landing gear.

Note

If gear retraction is necessary, ensure landing gear handle is down, emergency T-handle is stowed, and landing gear reset button is pressed prior to raising the landing gear.

➤ If the main landing gear indicates safe when lowered:

1. Inspection — OBTAIN.

If no apparent damage:

2. Landing gear — LEAVE DOWN AND MAKE NORMAL LANDING AS SOON AS PRACTICAL.

OR

➤ If inspection reveals the main landing gear is unsafe when lowered:

3. Landing gear emergency extension procedure — PERFORM.

   a. Airspeed — 140 KIAS (maximum)

   b. Landing gear handle — DOWN.

   c. Landing gear emergency extension handle — PULL.

WARNING

Landing with the emergency gear extension handle down will result in loss of NWS and normal and antiskid brakes. Directional control will be lost below 60 knots.

➤ If a safe indication is obtained:

4. Arrested landing — PERFORM (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

If the main landing gear visually appears damaged or trailing, refer to Figure 23-1.

OR

➤ If still unsafe and no other indication of trailing or damaged landing gear:

5. Emergency gear extension handle — STOW.

6. EMER LG RESET switch — PRESS.

7. Hatch severance pins — REMOVE.

8. Landing checklist — COMPLETE.

9. Fuel (to minimum practical) — DUMP.

10. Landing — FIELD ARRESTMENT (during CV operations if divert is unavailable, make normal CV landing) (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

CAUTION

The wings should not be folded or spread from the cockpit with the EHP on if the No. 1 pump is not operating. Insufficient hydraulic flow rates will cause ratcheting during the folding/unfolding cycle. This could result in damage to the wings.

After coming to a stop and prior to taxi:

11. Hatch severance pins — REPLACE.

12. Gear pins — INSTALL.

23.4.2 Main Gear Unsafe (Extended). If the main gear indicates safe when retracted but unsafe when extended:

1. Inspection — OBTAIN.

If no apparent damage:

2. Landing gear — RECYCLE DOWN.

→ If still unsafe:

3. Landing gear emergency extension procedure — PERFORM.

OR

   a. Airspeed — 140 KIAS (maximum).

   b. Landing gear handle — DOWN.

   c. Landing gear emergency extension handle — PULL.

→ If safe indication is obtained:

OR

4. Arrested landing — PERFORM (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

→ If still unsafe and no other indication of trailing or damaged landing gear:

5. Emergency gear extension handle — STOW.

6. EMER LG RESET switch — PRESS.

7. Hatch severance pins — REMOVE.

8. Landing checklist — COMPLETE.

9. Fuel (to minimum practical) — DUMP.

10. Landing — FIELD ARRESTMENT (during CV operations if divert is unavailable, make normal CV landing) (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

After coming to a stop and prior to taxi:

11. Hatch severance pins — REPLACE.

12. Gear pins — INSTALL.

Note

- Fly a long, slightly flat approach using full flaps and minimum sink rate if landing is to be made on an airfield.

- If right main gear indicates unsafe, turn on taxi light. If light illuminates, the right main gear is down and locked. If left main gear indicates unsafe, attempt to transfer external fuel. If fuel does not transfer, left main gear is down and locked.

If damage is suspected or confirmed, follow procedures listed in Figure 23-1.

23.5 FIELD EMERGENCY ARRESTING GEAR

Field arresting gear types include the anchor chain cable, water squeezer, and morest-type equipment. Each requires engagement of the hook with a cable pendant rigged across the runway. Location of the pendant in relation to the runway classifies the gear as follows:

1. Midfield gear is located near the halfway point of the runway. Prior notification may be required to rig for arrestment in the direction desired.

2. Abort gear is located 1,500 to 2,500 feet short of the upwind end of the duty runway and usually is rigged for immediate use. This gear may be unidirectional or bidirectional.

3. Overrun gear is located shortly past the upwind end of the duty runway and usually is rigged for emergency use.

Fields may have arresting gear in all three or only one location. Therefore, it is imperative that all pilots be aware of the type, location, and compatibility of the gear with the aircraft and also to the status of the gear at the point of takeoff and/or landing.

Consideration should be given to performing an arrested landing under the following conditions:

1. Single-engine operations.

2. Wet runways with high crosswind conditions.

3. Reported ice, sleet, slush, or standing water on the runway.

4. Braking action reported as poor.

5. RCR reading of less than 13.

23.5.1 Field Emergency Arresting Gear Procedures

The following recommendations are made for guidance and should be tempered with judgment depending upon the existing emergency condition, runway conditions, weather, time, fuel remaining, and other considerations:

1. Determine the extent of the emergency by whatever means are available (instruments, other aircraft, LSO, RDO, tower or other ground personnel).

2. Notify the control tower personnel of the emergency as much in advance as possible and state total fuel remaining in minutes, as well as the estimated landing time in minutes. (If the gear is not rigged, it will require 10 to 20 minutes to prepare.)

3. Determine the most advantageous arresting gear available and the type of arrestment to be made.

4. Burn down fuel as required to attain the lowest aircraft gross weight compatible with the operating situation.

5. Optimum engaging conditions are for the pilot to have the aircraft on the runway centerline in a three-point attitude at as slow an engaging speed as possible, with feet off the brakes, and shoulder harness locked.

6. On runways with centerline lights, the aircraft should be lined up slightly off–centerline to prevent hook skip.

7. After engaging the gear, common sense and existing conditions will dictate whether to keep the engine(s) running.

CAUTION

- If off-center just before engaging the arresting gear, do not attempt to go for the center of the runway. Continue straight ahead and parallel to the centerline.
- After arresting gear engagement when speed has been reduced to approximately 20 knots, braking should be applied to prevent the aircraft with idle power from pulling the gear through to a two-block position. In the event of brake malfunction, the aircraft engines should be shut down. This does not apply to chain-type arresting gear.

23.5.2 Short-Field Arrestment. This is an arrestment with the aircraft hook engaging the pendant just after touchdown. If at any time prior to landing it is known that a directional control problem exists or a minimum rollout is desired, a short-field arrestment should be made and the assistance of an LSO requested. He should be stationed near the touchdown point and equipped with a radio. Inform the LSO of the desired touchdown point. The aircraft weight may have to be reduced to provide an approach speed that will be consistent with the wind conditions and allowable engaging speed. The hook should be lowered while airborne and a positive hook-down check should be made. The midfield gear will normally be used for short-field arrestment; however, if none is available, the abort gear should be used. If the field has unidirectional abort gear, the gear at the upwind end of the runway must be used. If bidirectional abort gear is available at both ends of the runway, either gear can be used. A constant glideslope approach to touchdown is recommended (a mirror or Fresnel lens landing aid utilized) and basic angle setting should not exceed 3°. An approach speed commensurate with the emergency experienced should be used. Touchdown should be on centerline just before the arresting wire.

23.5.3 Long-Field Arrestment. This is an arrestment, after a ground roll, during which the aircraft speed has been reduced. This type of arrestment is used when a stopping problem exists with insufficient runway remaining for rolling to a stop (aborted takeoffs, icy or wet runways, loss of brakes after touchdown, and so forth). Weight limits for long-field arrestment generally exceed those for short-field landings and (at these higher weights) a minimum rate-of-descent landing is usually required to stay within the structural limits of the aircraft. Touchdown should be with the aircraft lined up on the runway centerline. At touchdown, all available means shall be used to slow down prior to engaging the arresting gear. The aircraft should roll into the arresting gear in a pitch-stabilized attitude.

When the decision is made to make a long-field arrestment, lower the hook.

The control tower should be informed of the intention to engage the arresting gear so that the aircraft landing behind may be waved off.

CAUTION

Aircraft brakes should be applied or the engine(s) secured in the final portion of the runout to preclude the aircraft (at idle power) from pulling the arresting gear through to a “two-block” condition. This does not apply to chain-type arresting gear.

23.5.4 Aborted Takeoff. When an aircraft takeoff must be aborted, a roll-in type of engagement is mandatory to prevent overrun. If necessary, the taxi light should be used in locating arresting/abort gear at night. The decision to abort should be based on the normal parameters of remaining runway and distance required for stopping, using brakes. The arresting gear will serve as an assist in keeping the aircraft from rolling onto an unprepared surface.

WARNING

Under no circumstance should a pilot decision to abort a takeoff be delayed because of knowledge that an emergency arresting gear is available at the end of the runway.

CAUTION

Aircraft brakes should be applied or the engine(s) secured in the final portion of the runout to preclude the aircraft (at idle power) from pulling the arresting gear through to a “two-block” condition. This does not apply to chain-type arresting gear.

23.5.5 Field Arrestment Engaging Speeds. The maximum permissible engaging speed, gross weight, and offcenter engagement distance for field arrestment of the S-3B aircraft are listed in Figure 23-2. The data provided in the long-field landing columns may be used for lightweight, aborted takeoff where applicable. Data provided in the abort takeoff columns may be used for a heavy gross weight landing.

23.6 BARRICADE ARRESTMENT

1. Burn down fuel as required to attain lowest aircraft gross weight compatible with the operating situation.
2. Jettison all external stores (except TERs) and empty Aero-1D/ARS tanks that may be retained.
3. Lower hook.
4. Execute normal approach on meatball. On some carriers, the barricade stanchion may obscure the optical landing system late in the approach.
5. Be under positive control of the LSO and follow his instructions explicitly.
6. Touchdown should be on-speed, on-centerline, and with zero drift.

Upon engagement:

7. Secure engines.
8. Safe seats.
9. Exit aircraft as soon as possible.

TYPE OF ARRESTING GEAR	MAXIMUM ENGAGING SPEED (KNOTS) (D)			MAXIMUM OFF-CENTER ENGAGEMENT (FT)
	SHORT-FIELD LANDING	LONG-FIELD LANDING	ABORTED TAKEOFF	
	GROSS WEIGHT UP TO 40,500 LB (J)(K)	GROSS WEIGHT UP TO 45,900 LB (L)	GROSS WEIGHT UP TO 52,500 LB (E)	
E-28	177(B)	177(B)	177(B)	40
E-28 (G)	172(B)	172	160	40
M-21	144	135	135	10
BAK-9	160	160	153	30
BAK-12 (A)	160	160	143	50
DUAL BAK-12 (C)	158(B)	158(B)	158(B)	30
BAK-13	160	160	160	40

A. 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.

B. Maximum engaging speed limited by aircraft limit horizontal-drag load factor (mass item limit g).

C. 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.

D. Maximum engaging speed limited by arresting gear capacity except where noted.

E. Data provided in aborted takeoff column may be used for emergency high gross weight arrestment.

F. Off-center engagement may not exceed 25 percent of the runway span.

G. Only for the E-28 systems at Keflavik and Bermuda with 920-foot tapes.

H. Before making an arrestment, the pilot must check with the air station to confirm the maximum engaging speed because of a possible installation with less than minimum required rated chain length. Arresting gear ratings listed for applicable runways on airfields in IFR Supplement.

I. Maximum of 3.5° glideslope.

J. Consult appropriate section for recommended approach speed.

K. Flared or minimum rate of descent landing.

CAUTION

After arresting gear engagement, when speed has been reduced to approximately 20 knots, braking should be applied to prevent the aircraft with idle power from pulling the gear through to a two-block position. In the event of brake malfunction, the aircraft should be shut down. This does not apply to chain-type arresting gear.

Figure 23-2. Emergency Field Arrestment Data

23.6.1 CV Recovery Decision Matrix. The following matrix (Figure 23-3) is intended to provide guidance for aircrew, tower, or CATCC representatives to make timely recommendations to the Air Boss or the Air Operations Officer during emergency situations. The matrix does not cover every detail of every emergency and the NATOPS Flight Manual should be referenced. General guidance:

1. Aircrew: At a minimum, provide the following to the tower or CATCC representative.

   a. Indications, procedures, actions performed.

   b. Associated systems status.

   c. Fuel state, location, and recovery performance.

   d. Your recommendations.

2. Tower or CATCC representative:

   a. Know divert field specifics: current weather, runway length, arresting gear, NAVAIDS, security, etc.

   b. Bingo profiles: calculate for worst-case configurations, distances, winds, and weather.

23.7 FLAMEOUT APPROACH AND LANDING

Flameout approach and landing should only be attempted when ejection is not possible. The following flameout approach and landing factors should be considered (see Figures 23-4 and 23-5).

With the APU operating:

1. All nonessential equipment should be removed from the RH BUS and the RH BUS switch set to NORM. The EHP can then be turned on to power the No. 1 hydraulic system for flight control.

2. With APU essential bus electrical power, longitudinal trim is available at the single-channel rate and the trailing edge flaps are operable on emergency. Landing gear and flap position indicators operate normally.

Without the APU operating:

1. Reversion to EFCS will occur shortly after flameout/engine failure as the hydraulic pressure drops below 800 psi.

2. Unless the APU is running with the EMER GEN switch ON, all electrical power will be lost. This renders the longitudinal trim inoperative.

3. Without electrical power for trim, the control stick forces to change speed will be high.

4. The ability to slow the aircraft to touchdown speeds without electrical power is a function of horizontal stabilizer position at the time of electrical power loss.

5. Recovery from unusual attitudes may be difficult because the controls will require excessive control stick forces.

With APU essential bus electrical power, longitudinal trim is available at a reduced rate (0.10° per second); the trailing edge flaps are operable on emergency. Landing gear and flap position indicators operate normally.

23.8 DITCHING

Note

Ditching should be the last alternative. The aircraft and the escape systems have been designed such that the crew's chances of survival are greatly enhanced if they get out of the aircraft before it hits the water.

If ditching is unavoidable:

1. Land parallel to and near the crest of a swell.

2. If the wind is above 15 knots, land into the wind.

MALFUNCTION	RECOVERY	NOTES
	FIRE	
Fuselage fire	Pull forward	• Obtain visual inspection if possible.
Wing fire	Pull forward	• Obtain visual inspection if possible.
Engine fire	Pull forward	• Obtain visual inspection if possible.
Single bleed leak light	Next available	• After 4 minutes, may be on essential bus power (see essential power only).
Dual bleed leak lights	Pull forward	• Possible ECS fire. • Essential bus power. • No leading edge flaps. • Obtain visual inspection if possible.
ENGINE		• Consider fuel dump for single-engine climb vs. single engine, gear and flap down Bingo.
No. 1 INOP, no EHP	Next available	• Unable to raise gear if bingo/tank required. • No DLC. • Stiff wing, no hook retract, pin gear. • Tow required: No NWS, emergency brakes.
No. 1 INOP, with EHP	Next available	• Tow required.
No. 2 INOP	Next available	• No DLC. • Tow required.
Stuck throttle	Divert or next available or norm	• May have to secure affected engine in flight or after trap. • Tow may be required. • Consider tanker status and divert fuel.
	FUEL	
Dual low-fuel lights	Barricade	• Twenty minutes or less of fuel remaining. • Possible dual-engine flameout.
Single low-fuel light	Next available	• Possible single engine.
Venting	Next available or norm	• 4400# minimum.
Pressure/filter light	Next available	• Straight-in approach; minimum throttle changes.

Figure 23-3. CV Recovery Decision Matrix (Sheet 1 of 4)

MALFUNCTION	RECOVERY	NOTES
FUEL (cont.)		
AERO 1 D/ARS > 500#	Divert or norm	• If no divert, dump or give remaining. • Jettison hose, if required, before dump. • If dump inoperable jettison ARS before CV recovery.
FLIGHT CONTROLS		
One or more degraded axis	Divert or next available	• If controllable, straight-in approach.
Flaps locked	Next available or norm	• Straight-in approach.
Split trailing edge flaps	Divert or next available	• Straight-in approach.
No leading edge flaps	Norm	• Straight-in approach.
Asym leading edge flaps	Norm	• Straight-in approach.
No pitch trim	Next available or divert	• High-pilot workload. • Straight-in approach.
HYDRAULIC		
Both failed	Divert	• Eject if no divert.
No. 1 failed, no EHP	Next available	• Unable to raise gear if bingo/tank required. • No DLC. • Stiff wing, no hook retract, pin gear. • Tow required: No NWS, emergency brakes.
No. 1 failed, with EHP/No. 2 failed	Next available	• No DLC if No. 2 failed. • Fold wings from left wheelwell.
Launch bar not retracted	Divert or norm	• Visual inspection required. • On deck, reset emergency gear handle to regain utility systems.
Hook fails to extend/damaged	Divert or barricade	• Visual inspection required.
Wing/fin unlocked with No. 1 hydraulic fluctuations	Next available	• Unable to raise gear if bingo/tank required. • On deck, reset emergency landing gear reset switch to “regain” utility systems.
Wing/fin unlocked, no fluctuations	Next available	

Figure 23-3. CV Recovery Decision Matrix (Sheet 2)

MALFUNCTION	RECOVERY	NOTES
ELECTRICAL		
Dual generator fail, no APU		
Night or IMC	Divert or pull forward	• No external lights. • No DLC. • No leading edge flaps. • Section approach (if possible). • Straight-in approach. • No engine instruments. • No AOA. • External hook retract required. • Fold wings from left wheelwell. • Pin gear. • Tow required: No NWS, emergency brakes.
Day and VMC	Divert or next available	
Dual generator fail, with APU		
Night or IMC	Next available	
Day and VMC	Next available	
Single generator fail	Norm	• Possible associated bus failure.
Essential power only	Next available	• Straight-in approach: BULLSEYE only. • No LE flaps. • No DLC. • External hook retract required. • Tow required: No NWS.
LH BUS FAIL	Next available	• Straight-in approach. • No DLC, no yaw damper. • Reduced rudder authority with flaps down. • No LE flaps. • Tow required: No NWS.
RH BUS FAIL	Next available	• No IFR probe retract. If extended, possible fuel in cockpit on landing. • External hook retract required.

Figure 23-3. CV Recovery Decision Matrix (Sheet 3)

MALFUNCTION	RECOVERY	NOTES
ELECTRICAL (cont.)		
LH CLA FAIL	Next available	• Visual gear check required. • Straight-in approach. • No approach lights or indexers. • Wings folded from wheelwell. • Tow required: No NWS.
RH CLA FAIL	Next available	• Straight-in approach. • No LE flaps. • Spoilers will not dwell. • External hook retract required.
ECS		
Windshield/canopy cracked	Divert or next available	• Depends on pilot's visibility.
Windshield/canopy missing	Divert or next available	• Depends on pilot's visibility.
LANDING		
ARS drogue not retracted	Divert or next available	• If no divert, jettison hose prior to recovery. Have wingman observe hose jettison. • If divert unavailable and hose jettison does not work, jettison ARS.
Cabin door open light	Norm or divert	• If door is actually open there is FOD potential during a CV recovery.
Bomb bay doors open	Next available or norm	• Fuel dependent: High drag count and fuel usage.
FLIR extended	Norm	• FOD potential: Recover last. • Attempt to retract with the FLIR RETRACT switch.

Figure 23-3. CV Recovery Decision Matrix (Sheet 4)

23.9 CREW PREPARATIONS FOR DITCHING

1. Pilot/COTAC — NOTIFY CREW, LOWER SEATS.
2. External stores — JETTISON.
3. Hatch severance pins — REMOVE.
4. Landing gear — UP.
5. Flaps — LAND.
6. Hook — EXTEND.
7. O_2 mask — ON.
8. Emergency oxygen (green handle) — PULL.
9. Visor — DOWN.
10. Shoulder harness and lapbelt — TIGHT AND LOCKED.
11. SENSO and TACCO trays — STOW.
12. Loose gear — STOW.
13. Bomb bay doors — CLOSE.
14. IFF, data link — TRANSMIT.
15. SAR buoy — DEPLOY.
16. Canopies/hatches — JETTISON (below 250 KIAS).

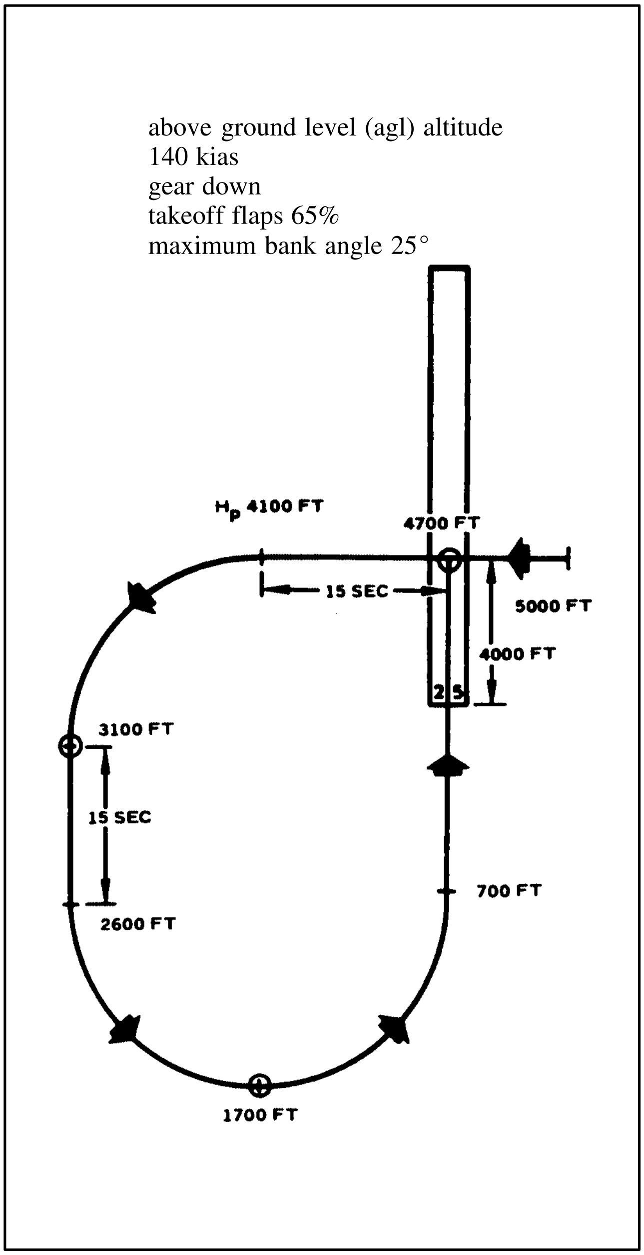


Figure 23-4. Dual-Engine Flameout Landing Pattern

WARNING

The canopy and/or hatches cannot be explosively removed if canopy or hatches are completely submerged.

Note

The aircraft should be flown parallel to the swell pattern, attempting to touch down along the wave crest. The arresting hook transition light will come on as hook contacts the water, indicating imminent impact when no other references are available.

23.10 APPROACH TECHNIQUE WITH ENGINE POWER (DITCHING)

1. Establish heading and constant speed of 2 units AOA above normal approach.
2. Maintain a rate of descent not to exceed 500 fpm until approximately 200 feet above the water.

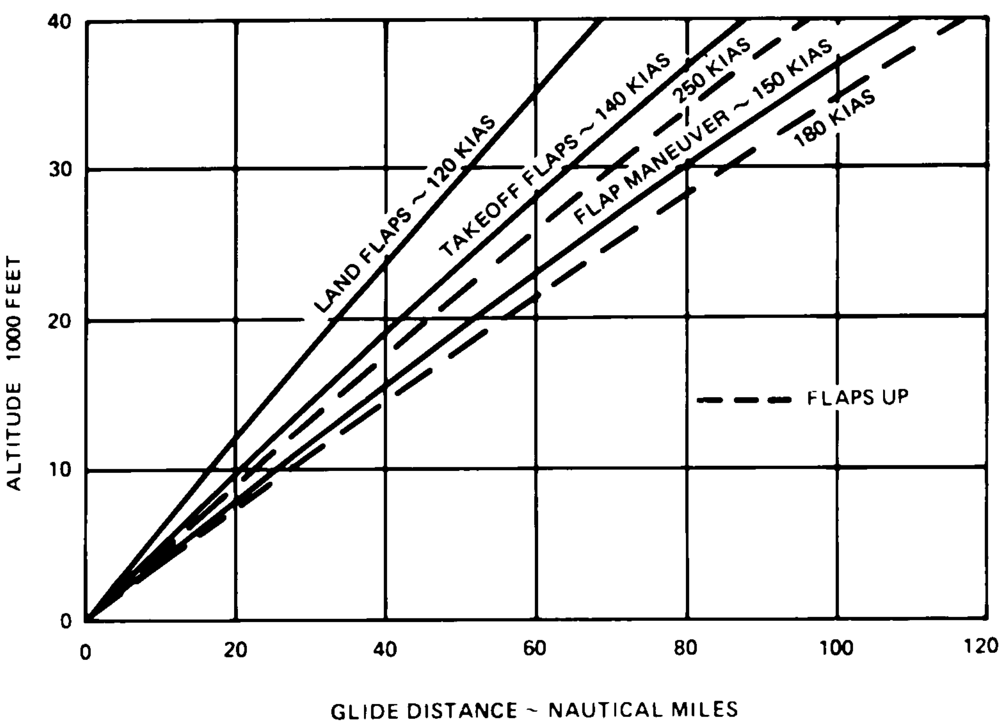
Note

Crew access door will be unusable in the event of an all gear up landing or collapsed nosegear. Rear canopies or all canopies may be jettisoned for crew exit.

BOTH ENGINES WINDMILLING
40,000 LB. – NO EXTERNAL STORES

LANDING GEAR UP

ZERO WIND – STRAIGHT LINE GLIDE



NOTE

EXTENDED LANDING GEAR WILL REDUCE GLIDE DISTANCE APPROXIMATELY 20 PERCENT. BEST GLIDE SPEED WILL BE REDUCED 5 TO 10 KNOTS

ADJUST ABOVE SPEEDS AS FOLLOWS:

ABOVE 40,000 LB –
ADD 2 KNOTS PER 1,000 LB.
BELOW 40,000 LB –
SUBTRACT 2 KNOTS PER 1,000 LB.

Figure 23-5. Glide Performance

3. Drop hook; the hook bounce may provide positive indication of height over surface prior to touchdown.

4. Reduce sink rate to maximum 150 fpm at 200-foot altitude.

5. Monitor radar altimeter.

6. Initiate landing flare, with airspeed 90 to 100 KIAS in landing configuration (gear up), as close to surface as possible.

WARNING

Judging height above the water during low sea states is difficult; therefore, do not attempt a full-stall landing. Maintain as low a sink rate as possible with wings level until hook bounce is felt. Flare slightly at this point. With the high wing configuration of this aircraft, the fuselage will be subject to the full initial impact and may be damaged more than in a comparable mid- or low-wing aircraft.

7. After the aircraft enters the water, hold the elevator slightly aft of neutral. This will aid in reducing this downward pitching moment if the aircraft skips on the surface.

23.11 APPROACH TECHNIQUE WITHOUT ENGINE POWER/ON EFCS (DITCHING)

With the APU operating/flight controls powered:

1. BUS switches — OFF.
2. APU — CHECK ALTITUDE, AIRSPEED/ START.
3. APU GEN switch — ON.
4. APU automatic shutdown — DISARM.
5. Nonessential equipment — OFF.
6. RH BUS/EHP switches — NORM/ON.
7. Trim aircraft. Maintain steady glide at normal approach speed. Sink rate will be approximately 700 fpm.
8. Maintain this condition to approximately 100 feet above the surface.
9. Reduce sink rate with stick force and stabilizer trim.
10. Initiate landing flare as close to the surface as possible.

OR

Without the APU operating/on EFCS:

1. Maintain steady glide as close to normal approach speed as possible with approximately 700 fpm sink rate.
2. Maintain this condition to approximately 100 feet above surface.
3. Reduce sink rate with stick force.

Note

- Reversion to EFCS will occur shortly after flameout/engine failure as the hydraulic pressure drops below 800 psi.
- Without electrical power for trim, the control stick forces to change speed will be high.
- The ability to slow the aircraft to touchdown speeds without electrical power is a function of horizontal stabilizer position at the time of electrical power loss.
- Recovery from unusual attitudes may be difficult because the controls will require excessive control stick forces.

23.12 EXIT FROM AIRCRAFT (DITCHING)

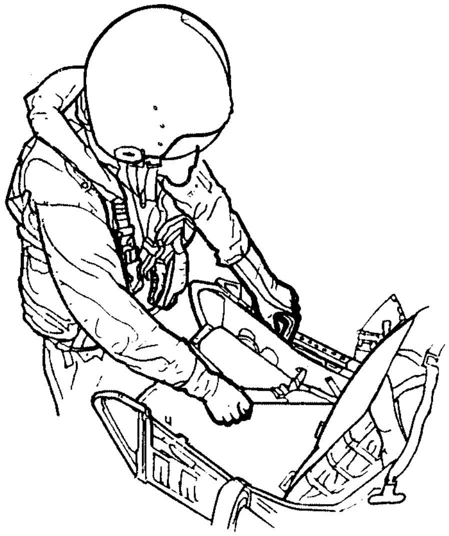
WARNING

Use of the emergency restraint release (vice Koch fittings) increases difficulty of exiting aircraft as the parachute and seat kit will remain attached to the individual.

WARNING

Automatic inflation of the FLU-8/P occurs within 3 seconds of immersion in water and will create extreme difficulty in exiting aircraft.

Once violent motion ceases, emergency exit can be accomplished through the canopies and/or hatches.



1. Seat — SAFE.
2. Disengage from seat.

WARNING

The canopy and/or hatches cannot be explosively removed if canopy or hatches are completely submerged.

3. Exit aircraft.

23.13 EXIT FROM AIRCRAFT

Refer to Emergency Ground Egress procedures, paragraph 25.5. The emergency release handle should also be pulled prior to leaving the seat in order to release the seat pan. If time permits, the seat pan/parachute should be pulled from the aircraft by the lapbelt to provide survival equipment and liferaft for the crewman.

23.14 BRAKE SYSTEM FAILURE IN FLIGHT

In the event hydraulic pressure or electrical power to the normal brake selector valve is lost, the brake system automatically reverts to the emergency system and illuminates the EMER BK ON advisory light when the gear is extended.

If this occurs:

1. Brake selector switch — EMER BRAKE.
2. Emergency brake accumulator — CHARGE.

CAUTION

- Caution must be exercised when applying the normal or emergency brakes without antiskid operative. Speedbrakes should be fully extended prior to applying brakes. Very light braking only should be used above 80 KIAS.
- Optimum use of the emergency brakes will be gained by one smooth brake application of increasing pressure until the aircraft stops. Releasing and reapplying brakes will deplete the brake accumulator more rapidly (approximately 10 full applications available).

If the handpump is not available when the brake pressure gauge is in the red (danger) area:

1. During carrier landings, do not taxi aircraft after arrestment.
2. During field landings, perform field arrestment (refer to Field Emergency Arresting Gear procedure in paragraph 23.5).

23.15 ANTISKID CAUTION LIGHT IN FLIGHT

1. Brake selector switch — ANTI SKID OFF.

23.16 NOSEWHEEL STEERING MALFUNCTION

If a hardover signal to the NWS is experienced, the system should be disengaged and an inspection of the nosegear and tires should be made. Once a NWS hard-over has occurred, do not attempt to reengage NWS.

Failure of the NWS to engage will require use of differential braking to steer the aircraft. The aircraft should not be taxied without operable NWS.

CHAPTER 24

Air Refueling Stores Abnormal Procedures

24.1 AIR REFUELING TANKER INTERNAL FAILURES

24.1.1 Air Refueling Store Aircraft Fuel Transfer Pump Failure

INDICATION:

Internal transfer tanks will deplete asymmetrically during air refueling. Fuel imbalance will be equal to the quantity offloaded to the receiver and/or ARS. Feed tanks remain full.

PROCEDURE:

Air refueling can be continued with the ARS replenishment rate reduced by 48 percent (115 gpm versus 220 gpm). Uninterrupted offloads will be limited by numerous factors including actual store output rate, receiver, and initial ARS fuel level. If the ARS is depleted of all fuel, the low-level float switch will terminate pumping. On the D-704 and 31-300 stores, the TRANS switch will automatically return to the OFF position and must be reset to the TRANS position by the aircrew. On the A/A42R-1, the low-level switch actuates for 30 seconds. After 30 seconds and if sufficient fuel has been transferred to the store, refueling will recommence. It will take 2 to 3 minutes between offloads to replenish the ARS on one pump.

Note

Extended single-pump air refueling operations will cause large asymmetric fuel loads between transfer tanks requiring periodic balancing of fuel using the feed tank interconnect and wing-down/top-rudder operations.

24.1.2 Lower Bleed Air Selector Valve Failure

INDICATION:

Uncommanded transfer of fuel from the ARS into the internal fuel tanks, the ARS will be slow to refill after fuel offload to a receiver, and/or fuel venting from the relief valve at the 6-o'clock position will occur.

PROCEDURE:

Air refueling with a failed bleed air selector valve can be continued. The ARS fuel replenishment rate will be reduced by 20 percent (175 gpm versus 220 gpm). The provisions for low fuel level described in single-pump operation apply.

24.1.3 Air Refueling Store Dump Valve Fails to Open

INDICATION:

The LH EXT fuel quantity gauge remains the same after selecting dump (may indicate a safety circuit failure).

PROCEDURE:

Hold the ARS SAFETY DISABLE DUMP & JTSN switch on the LH hinged load center to ON. Place the ARS control panel switch to DUMP.

24.2 31-301 (A/A42R-1) AIR REFUELING STORE FAILURES

24.2.1 Hose Fails to Retract

1. Airspeed — SLOW TO 200 KIAS, 1g, LEVEL FLIGHT.

2. HOSE switch — CYCLE, THEN RET.

If hose still extended:

3. ARS power — OFF.
4. Cycle the ARS AC and DC control circuit breakers (1-J-10 and 1-H-12).
5. ARS power — ON.
6. Hose switch — Cycle, then retract.

If hose still extended:

7. Refer to Hose/Drogue Jettison, paragraph 24.2.2.

WARNING

Field landings with the hose extended are not recommended. If hose jettison is impossible/impractical, make a normal field landing. Field arresting gear cross-deck pendants shall be derigged. Use minimum braking required for runway conditions. Shipboard landings with the hose/drogue out are prohibited.

24.2.2 Hose/Drogue Jettison

1. Receiver — CLEAR.
2. Airspeed — 250 KIAS OR LESS, 1g, LEVEL FLIGHT.

WARNING

Do not jettison the hose after the ARS fuel dump is performed; jettison may ignite trapped fuel in the ARS.

Note

Avoid all populated areas during hose jettison operation.

3. HOSE SAFE/CUT switch — CUT.
4. Hold the switch in the CUT position until the hose separates (at least 5 seconds).

24.2.3 Hose/Drogue Separation (Other Than Hose Cutter Severance)

1. Receiver — CLEAR.
2. HOSE SAFE/CUT switch — CUT.
3. Hold the switch in the CUT position until the hose separates (at least 5 seconds).

Note

- The hose cut switch must be held in the CUT position until the hose is severed from the store. Anticipate a delay for the hose to be jettisoned since hydraulic pressure must decay below 1,300 psi before the electrical circuit is complete.
- Hose jettison actuates a power lockout of the ARS systems and must be reactivated by maintenance personnel.

24.2.4 Drogue and Coupling Lost and/or Hose Severed (Other Than Hose Cutter Severance). Should the basket or hose be lost, the remaining hose will automatically retract because of the loss of drag from the basket. This retraction is accomplished by the 200-pound force continually applied by the hose reel assembly. The following procedure is recommended to reduce the fire hazard created by actuation of hose jettison.

1. Receiver — CLEAR.
2. HOSE switch — RET.
3. ARS PWR switch — OFF.

Note

Fuel in the store may be dumped, but the refueling master switch shall not be placed on.

Should the hose fail to retract:

4. HOSE SAFE/CUT switch — CUT.
5. Hold the switch in the CUT position until the hose separates (at least 5 seconds).

24.2.5 Ram Air Turbine Fails to Feather

If hose is retracted:

1. ARS AC CONT circuit breaker (1-J-10) — PULL.
2. Perform normal landing.

OR

If hose will not retract:

1. Limit airspeed to 300 KIAS. Refer to Hose Fails To Retract procedure, paragraph 24.2.1.

Note

After landing, do not taxi until checked by ground personnel; the hose may trail out on landing rollout and cause damage/FOD.

24.2.6 Ram Air Turbine Blade Failure/ Separation. RAT blade failures occur most often when power is applied airborne prior to tanking. Removing all electrical power will feather the RAT. However, with the hose extended, the nosecone can crack and disintegrate rapidly. Jettison of the hose is the fastest way to remove power.

If hose is retracted:

1. ARS PWR switch — OFF.
2. ARS AC CONT circuit breaker (1-J-10) — PULL.

OR

If hose is extended:

1. Receivers — CLEAR.
2. HOSE SAFE/CUT switch — CUT. Hold the switch in the CUT position until the hose separates (at least 5 seconds).

If the ARS becomes unstable or conditions warrant:

3. ARS — JETTISON (as required).

WARNING

Turbine blade loss may result in catastrophic failure of the RAT, with the possibility of subsequent damage to the tanker or receiver aircraft, unless loss of turbine blade emergency procedures are rapidly complied with.

24.2.7 Air Refueling Store on Fire

1. Receiver — CLEAR.
2. ARS — EXT/SELECT JETTISON.

24.2.8 Low Reservoir Light

1. Receiver — CLEAR.
2. HOSE switch — RETR.

CAUTION

- The hose and drogue should be retracted promptly after illumination of the LOW RESV or PRESS indicators. If retraction is delayed excessively, insufficient pressure may remain to retract the hose and drogue and hose jettison may be required.
- Keeping POWER switch ON for more than 30 seconds after PRESS (red) indicator light illuminates may cause severe damage to store hydraulic pump and/or ram air turbine.

If hose is stowed:

3. ARS PWR switch — OFF.
4. Terminate tanking operations.

OR

If hose does not stow:

3. HOSE SAFE/CUT switch — CUT.

Note

Offload may be continued after illumination of the LOW RESV indicators if the receiver fuel requirement is critical. Decreasing hydraulic pressure will eventually illuminate the PRESS indicator, and the priority valve will automatically terminate fuel transfer.

24.2.9 Emergency Breakaway (Initiated by Tanker or Receiver)

1. Tanker — MAINTAIN ALTITUDE/AIRSPEED UNTIL RECEIVER CLEAR.
2. HOSE switch — RETR ONCE RECEIVER CLEAR.

Once hose is retracted:

3. ARS Power Switch — OFF

Note

Emergency breakaway may be initiated for any safety-of-flight reason.

24.2.10 Air Refueling Probe Damage. If aircrew suspects any type of damage to the fuel probe during tanker operations:

1. Leave probe extended.
2. Execute normal landing.

24.3 ARS CIRCUIT BREAKERS

See Figure 24-1 for ARS circuit breakers.

Bus	Circuit Breaker	Location Code	Phase	Rating
A	ARS AC CONT	1-J-10		3.0
C	ARS DC CONT	1-H-12		7.5
C	ARS HOSE JETT	1-I-12		3.0
A	ARS LFT TRANS	1-B-10		15.0
A	ARS RT TRANS	1-B-11		15.0

Figure 24-1. ARS Circuit Breakers

CHAPTER 25

Jettison/Eject, Rescue Operation Abnormal Procedures

25.1 EMERGENCY JETTISON

Jettison requirements should be determined prior to takeoff. To jettison wing stations and sonobuoys, appropriate cartridges must be installed and electrical power must be available.

25.2 WING STORES/SONOBUOYS JETTISON

Jettison of a full sonobuoy load will result in a significant forward cg shift and an attendant nosedown trim change; be prepared to use back stick and noseup trim. CG shift caused by jettison of the external stores is negligible.

All wing store stations will jettison SAFE. Fifteen of the sonobuoy chutes will receive a jettison signal, and the chute normally reserved for the SAR buoy will not receive the signal.

1. EXT JETT switch — PRESS.

WARNING

Emergency jettison of sonobuoys is not available when the decode programmer, KY-747/ASQ-147, has been removed from the aircraft. Sonobuoys shall not be carried in aircraft not equipped with a KY-747/ASQ-147 when single-engine gross weight/bingo considerations may require jettison of sonobuoy loads.

Note

- The selective jettison function on the armament control panel may be used as a backup for wing store jettison if external jettison fails.
- Search stores cannot be emergency jettisoned with the search stores power and search stores control circuit breakers pulled.

25.3 BOMB BAY STORES JETTISON

Bomb bay weapons cannot be dropped by activating the emergency jettison switch but can be dropped using the selective jettison switch on the armament control panel.

1. MASTER ARM switch — ON.
2. AUTO/MAN switchlight — MAN.
3. DOORS (OPEN/TRANS) switchlight — OPEN.
4. AUX switch — B1 (if loaded).
5. AUX UNLK switchlight — PRESS.

CAUTION

Do not press the AUX UNLK/S JETT switchlight continuously for longer than 1 second. To do so will render the function inoperative for subsequent jettisoning of remaining stations.

6. S JETT switchlight — PRESS.
7. Select the remaining stations on the AUX switch and repeat steps 5 and 6 as necessary.
8. Bomb bay doors — CLOSE.
9. MASTER ARM switch — OFF.

Note

When an immediate effect in terms of increased aircraft performance is desired, do not jettison bomb bay stores because of increased drag caused by bomb bay doors actuation.

25.4 EMERGENCY EXITS/ENTRANCES

25.4.1 Emergency Exits

25.4.1.1 Crew Door. Emergency exit can be accomplished through the crew door by completing the steps illustrated in Figure 25-1. Pull back the locking pin lever door (1) and rotate the locking pin lever (2) past the door notch (3). Release the lever door and position the locking pin lever to the full aft position (4). To ensure release and full opening of the crew door, the locking pin lever door must again be pulled back (open) (5). With other hand on door handle (6), slowly lower crew door.

25.4.1.2 Canopy Jettison. Under circumstances when egress through the crew door is not possible or desirable (wheels-up landing or fire on right side of aircraft), emergency exit can be accomplished through the canopies and/or hatches shown in Figure 2-145. Internal canopy and/or hatches emergency release T-handles are located as depicted in Figure 25-1. The emergency canopy and/or hatch jettison system is activated by first removing the T-handle safety pin (1) (Figure 25-1), followed by squeezing and pulling the T-handle to actuate the system (2).

WARNING

- To avoid injury from spattering canopy fragments, crewmembers should remain as covered as possible with personnel protective equipment; if possible and time permits, the crew should signal ground personnel to move away from the canopies. Noise is also a hazard. Helmets/cranials should be worn to protect hearing.

- Care should be taken when exiting through the canopy/hatch frame(s) to prevent injury from cut edges.

Note

Both canopies and both hatches can be jettisoned from inside the aircraft by pulling the canopy/hatch severance T-handle located overhead in the cockpit. The TACCO and/or SENSO T-handles will cut only their respective hatches, leaving the others undisturbed. The TACCO and SENSO hatches are not blown clear of the aircraft and must be physically pushed out to permit crew egress.

25.4.2 Emergency Entrance (Through the Two Forward Canopies and Two Aft Hatches)

1. Open the rescue T-handle access door on either side of the aircraft.

2. Verify that all rescue personnel are clear of all canopies and hatches.

WARNING

Canopies and hatches will be separated from the aircraft with a shaped explosive charge that will force pieces of canopy and debris up and away from the aircraft.

3. Pull the hatch severance T-handle away from the aircraft and as far as possible (about 10 feet). Continue with a hard pull; this will free the hatches and canopies from the aircraft.

Note

If one rescue T-handle does not sever the canopies and hatches, try the other one.

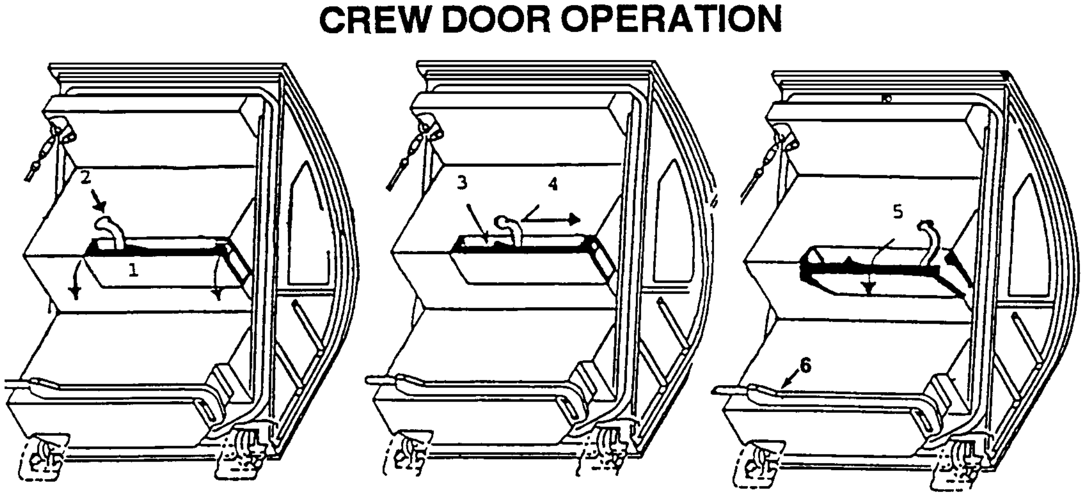
4. Manually remove the canopies and hatch frames to clear the openings.

Note

- Left and right forward access panels and footholds can be opened and used as steps to reach the pilot and copilot/COTAC.

- Right aft fuselage steps and handholds can be opened and used to reach the hatch openings to the two aft occupants.

25.4.3 Break-In Entry. If normal or emergency entry procedures cannot be accomplished, break or cut through the pilot or copilot/COTAC canopy with an axe or electric saw.



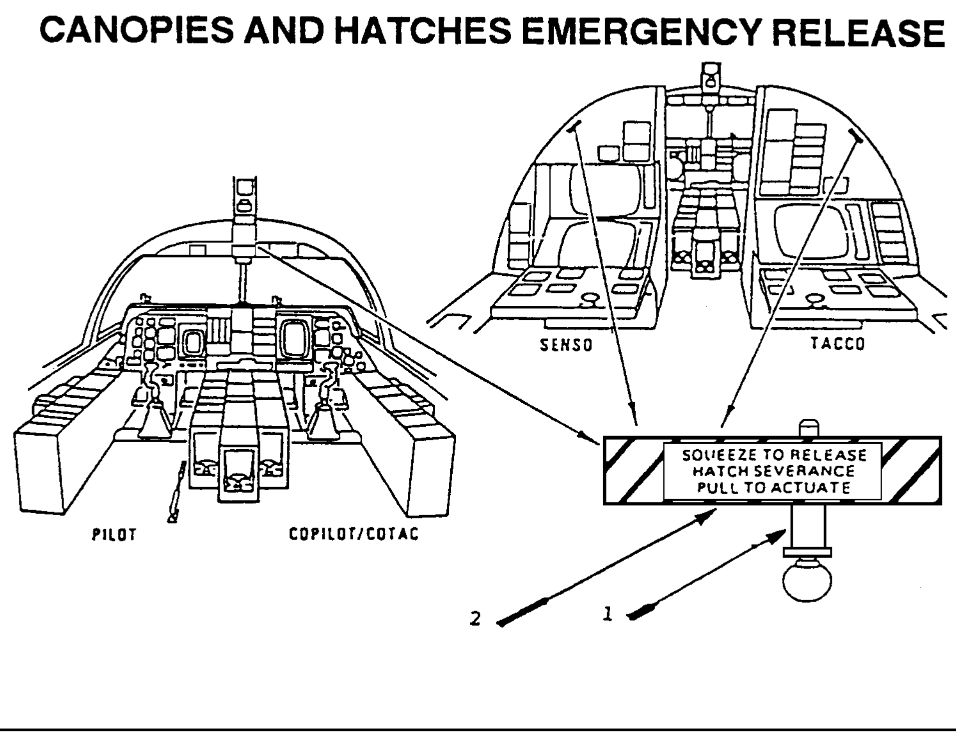


Figure 25-1. Emergency Exit

25.4.4 Occupant Emergency Removal

WARNING

Do not activate either the upper or lower ejection handle on any of the four seats.

1. Place the command eject levers in the SELF EJECT position ① (Figure 25-2).

2. Pull down all four ejection seat safety levers (headknockers)② starting with the pilot and copilot/COTAC (levers are located in the center of the headrest behind each occupant's head).

WARNING

Inadvertent ejection of the seat selected in the command-eject mode (either pilot or copilot/COTAC seat) will eject all four seats regardless of the position of their individual ejection seat safety levers.①

3. Release one side of each occupant oxygen face mask ③ to prevent suffocation.

4. Release the occupant lapbelt and canopy releases④ (if fittings cannot be released, cut the harness at each of the four fittings).

5. Release the oxygen hose quick disconnect.⑤

6. Lift the occupants out of their seats. Push each tray⑥ to its stowed position before attempting removal of the aft two occupants.

7. Remove the occupants through the personnel access door or lift them up and out through their respective canopy or hatch openings.

Note

Both canopies and both hatches can be jettisoned from inside the aircraft by pulling the canopy/hatch jettison handle. Each aft hatch can be individually jettisoned from the aircraft by pulling the handle located forward and above each aft occupant.

25.5 EMERGENCY GROUND EGRESS

1. Engine(s) — SHUT DOWN.

2. Seat — SAFE.

3. Exit aircraft.

WARNING

Emergency egress with the seat survival kit should not be attempted if there is imminent threat of fire, explosion, or other immediate life-threatening emergency.

Note

The TACCO and SENSO station canopies are not blown clear of the aircraft and must be pushed out to permit crew egress.

25.6 EJECTION

WARNING

During ejection seat development and testing, the ESCAPAC 1E-1 was qualified for use by aviators with nude weights from 136 pounds to 213 pounds. Operation of the seat by personnel not within these parameters subjects the occupant to increased risk of injury.

25.6.1 General Injury Risks

1. Operation of the seat by personnel outside the qualified weight range may prevent the seat stabilization system (STAPAC) from maintaining the seat in the proper pitch attitude.

2. 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.

3. Inertial reel performance may be degraded for occupants outside of the qualified weight range. Lighter occupants may be injured during retrac-

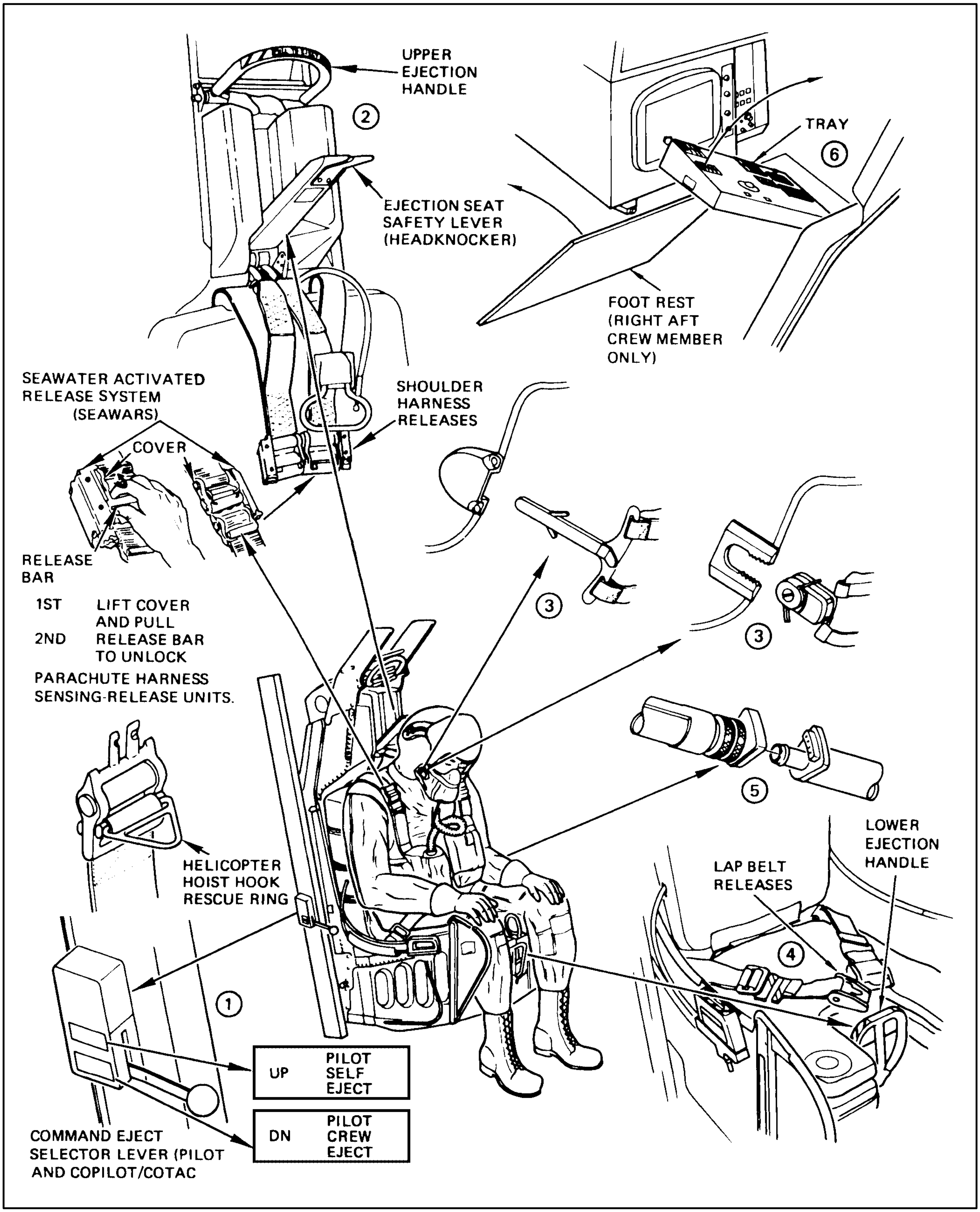


Figure 25-2. Occupant Emergency Removal

tion, and both light and heavy occupants may experience poor ejection positions, resulting in an increased risk of injury during ejection.

4. Spatial separation will be degraded for occupants outside the qualified weight range, and the risk of entanglement between crewmembers increases with the variations between their weights. Separation is best with lighter occupants in aft crew stations.

5. The risk of rocket thrust burns increases with the variation between aircrew weights in the same crew compartment.

25.6.1.1 Injury Risks for Aviators with Nude Weight Less than 136 Pounds

1. The catapults were designed for the ejection seat qualified weight range. Lighter weight occupants are subject to a higher risk of injury on the catapult because of greater accelerations.

2. Lighter weight occupants are at risk for parachute entanglement at low speeds.

3. Lighter weight occupants are at a greater risk of injury because of seat instability before main parachute deployment.

25.6.1.2 Injury Risks for Aviators with Nude Weight Greater than 213 Pounds

1. Larger occupants may not attain sufficient altitude for parachute full inflation in zero-zero cases or at extremely low altitudes and velocities.

2. Larger occupants are at a greater risk of injury during parachute landing due to high descent rates.

3. Larger occupants may not attain sufficient altitude to clear the aircraft's tail structure.

Ejection at airspeeds ranging from stall speed to 250 KIAS results in relatively minor forces being exerted on the body, thus reducing hazard.

WARNING

When ejection is performed above 250 KIAS, appreciable forces are exerted on the body, making escape more hazardous. Whenever circumstances permit, slow the aircraft prior to ejection to reduce the forces on the body.

25.6.2 Immediate Controlled Ejection

WARNING

- When notified by the pilot, crewmembers shall assume proper body position and prepare for an immediate ejection.

- In an immediate ejection, self-ejection is not recommended. The out-of-sequence disruption of the designed command ejection system may cause bodily injury or death. Follow the command ejection sequence except under extreme conditions.

25.6.3 Controlled Ejection

1. Crew — ALERT.
2. Command ejection levers — SELECT.
3. O_2 mask — ON.
4. Visor — DOWN.
5. Harness — LOCKED.
6. Cabin pressurization — DUMP.

WARNING

Above 25,000 feet altitude (if time permits), actuate the cabin pressure dump valve prior to seat ejection. Rapid depressurization during ejection may cause bodily injury.

7. Airspeed — REDUCE.
8. Altitude — AS DESIRED.

WARNING

Successful low-altitude ejection is dependent upon dive angle, airspeed, and angle of bank. Ejection outside of the envelope (see Figure 25-3) may result in bodily injury or death.

9. Mayday message — TRANSMIT.
10. IFF — EMERGENCY.
11. Data link — DOWNED AIRCRAFT REPORT.
12. Loose gear — STOW.
13. INCOS trays — STOW.

WARNING

If time permits prior to ejection, the crewmember should manually stow the INCOS tray to assure clearance during ejection. The trays should be stowed during takeoff and landing. Loose items may impede automatic tray stowage during ejection.

14. SAR buoy — DEPLOY.
15. Altimeter — CHECK.
16. Ejection light — ON.
17. Ejection position — ASSUME.

WARNING

Assuming improper body position increases the possibility of ejection injury. Positioning the legs aft prior to ejection will cause the spine to flex and will increase the possibility of spinal injury.

18. Ejection handle — PULL.

The proper body position for ejection is as follows:

1. Head pressed back against headrest
2. Chin slightly elevated (10° up)
3. Back straight
4. Hips against seat back
5. Thighs flat in seat survival kit
6. Feet on rudder pedals, heels on deck.

WARNING

To prevent head injury or death because of helmet loss during ejection, check the following items to ensure helmet retention:

1. Helmet chin strap tightened
2. Visor down and locked
3. Oxygen mask tightened.

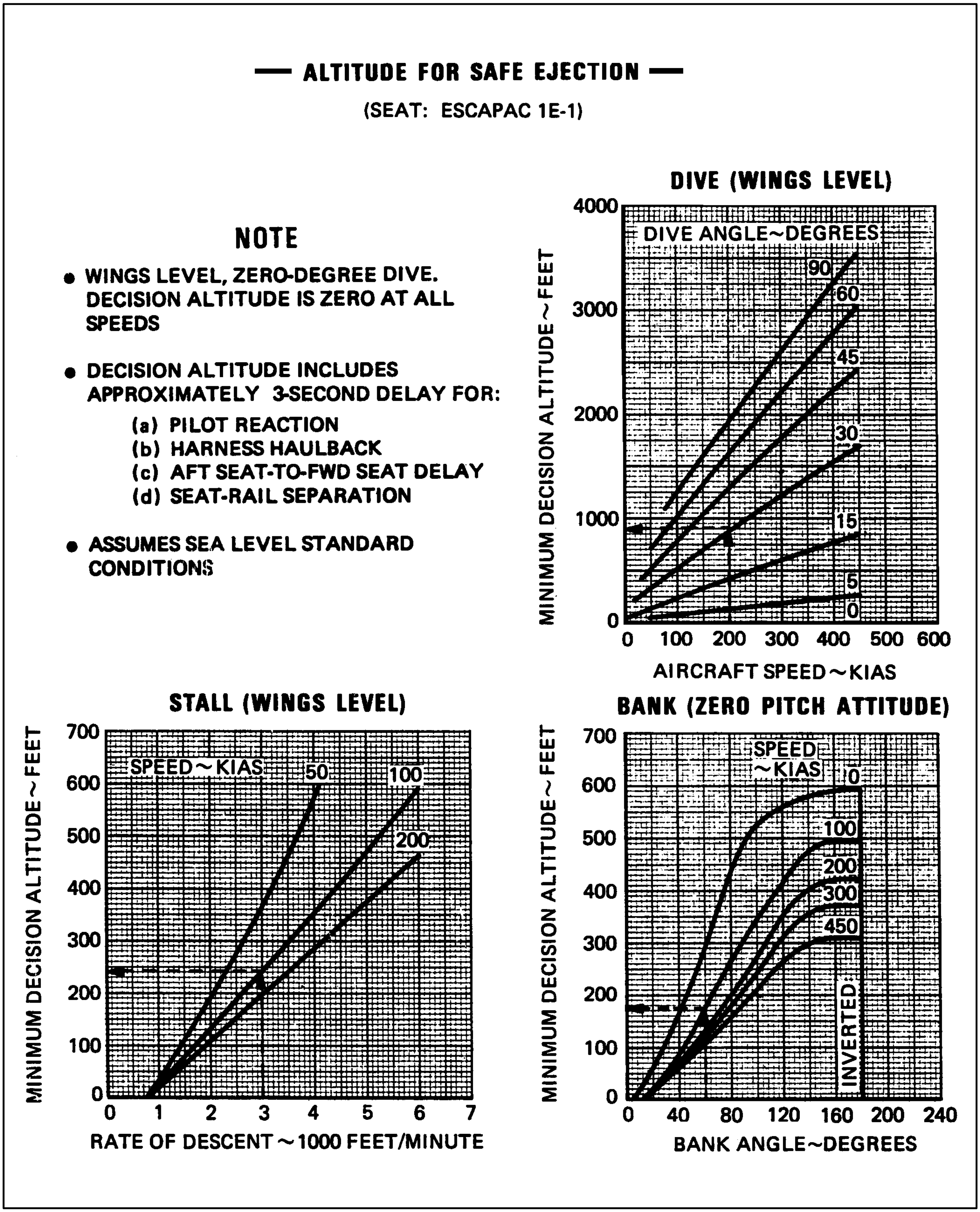
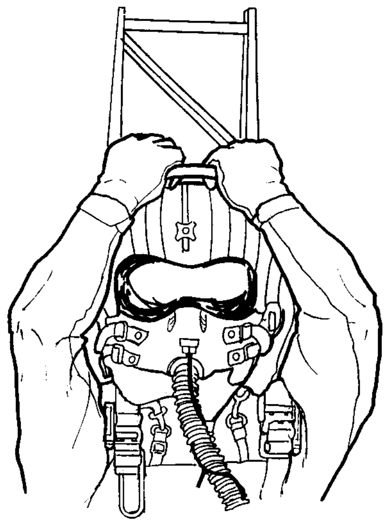


Figure 25-3. Ejection Envelope

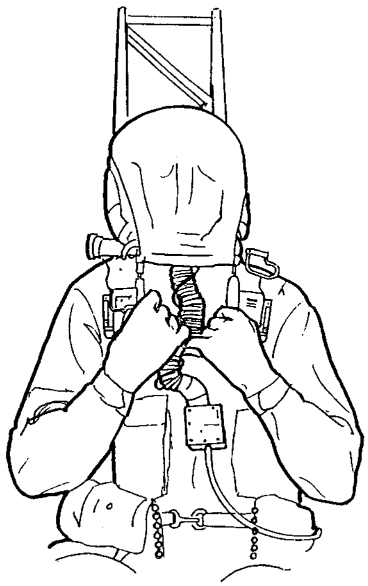
25.6.4 Ejection Initiation

25.6.4.1 Face Curtain. The ejection sequence is initiated by pulling on either the upper ejection handle (face curtain) or the lower ejection handle.

1. Grip the upper handle, palms toward body, using "thumbs around handle" grip. Keep elbows as close together as possible.



2. Pull curtain sharply over head and into chest. Ensure pulling handle to end of travel.



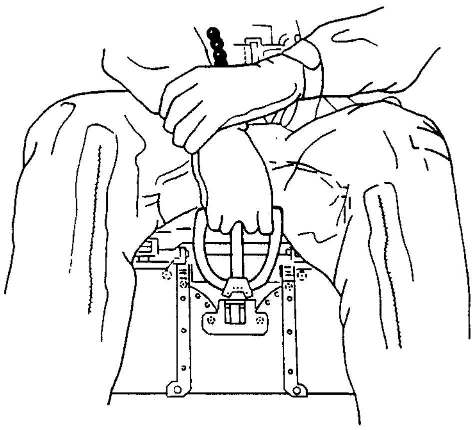
3. If the seat fails to eject after pulling the face curtain handle, continue to hold the face curtain with one hand while grasping the lower ejection handle with the other hand and pull up firmly.

25.6.4.2 Lower Ejection Handle. The recommended method for ejection initiation using the lower ejection handle is the single-hand grip depicted below.

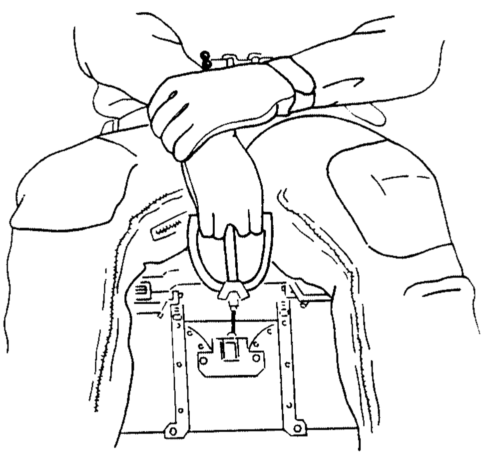
Note

- During any combined low-altitude/low-airspeed condition, as in the landing pattern or immediately after launch, the use of the lower ejection handle should be considered the primary means of ejection.
- On aircraft prior to BuNo 159407 and aircraft not incorporating AAC-339, actuation of the lower ejection handle may require between 85 and 100 pounds of pull force.

1. Grip handle with strong hand, palm inward. Grip wrist of strong hand with other hand, palm toward body and elbows close to body.



2. Pull handle sharply up and toward abdomen, keeping elbows in. Ensure pulling handle to end of travel.



After ejection initiation:

1. The harness retraction unit retracts the shoulder harness, pulling the occupant to an upright position.

2. The seat will eject individually and through the canopy.

25.7 PARACHUTE DESCENT PROCEDURES

1. Check parachute condition.

   a. Remember IROK/ADR.

2. Inflate LPU.

3. Release raft.

4. Options (time permitting):

   a. Four-line release, activate steering system

   b. Visor

   c. Oxygen

   d. Waist lobes

   e. Gloves

   f. RSSK (discard if over land).

5. Koch fittings (release upon water entry).

After water entry:

6. Avoid parachute.

7. Disentangle.

8. Retrieve raft.

25.7.1 LPU Inflation

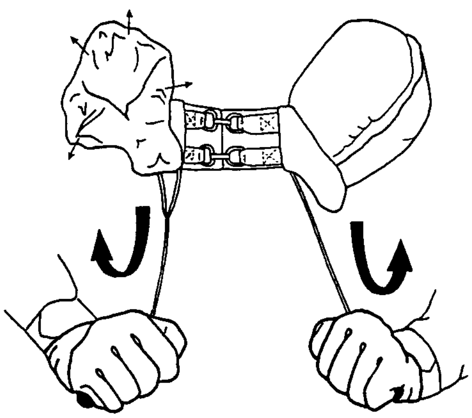
WARNING

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. Release of the Koch fittings as the feet contact the water is the second most important step to prevent entanglement in the parachute shroud lines.

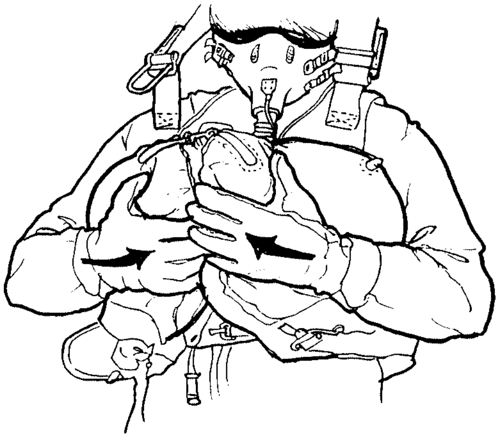
Note

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 inflate the LPU.

1. Locate and pull the LPU beaded handles down and straight out to inflate. If beaded handle inflation fails, use the oral inflation tubes located on both sides of waist lobes.



2. If necessary, squeeze LPU waist lobes together to help release collar lobe or manually release velcro on collar to achieve complete collar lobe inflation.



3. Snap waist lobes together.

WARNING

Failure to snap waist lobes before water entry may result in face-down flotation.

25.7.2 Raft/Seat Kit Deployment

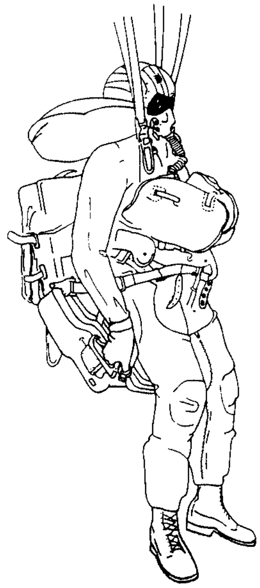
WARNING

When ejection is in the immediate vicinity of the carrier, parachute entanglement combined with wake and associated turbulence can rapidly pull a survivor under. The deployed seat survival kit and detached oxygen mask may contribute to shroud line entanglement. The survivor must be prepared to remove or cut shroud lines that are dragging him down.

Note

Deployment of the survival kit is not recommended over land.

1. After inflating the LPU, prepare to deploy the seat kit.

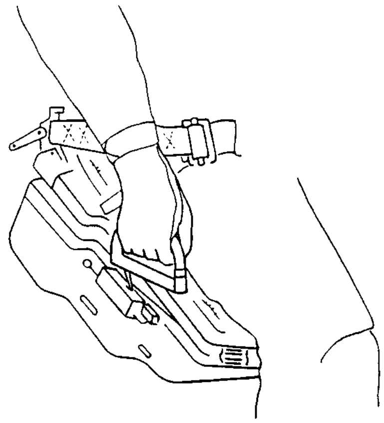


Note

- When the lower part of seat kit falls free, the liferaft will inflate and suspend from approximately a 20-foot line.

- If the survival kit is deployed after water entry, a snatch pull on the dropline near the CO_2 bottle is required to inflate the liferaft. Several tugs of the dropline may be required to inflate liferaft. Tugs of the dropline should be applied below the Y juncture (approximately 18 to 24 inches below the seatpan).

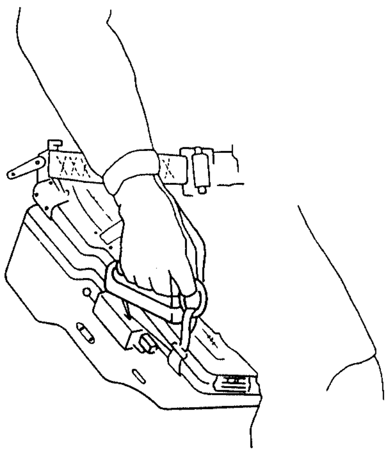
2. With right hand, locate and pull upwards on the RSSK release handle on the right side of the seat kit.



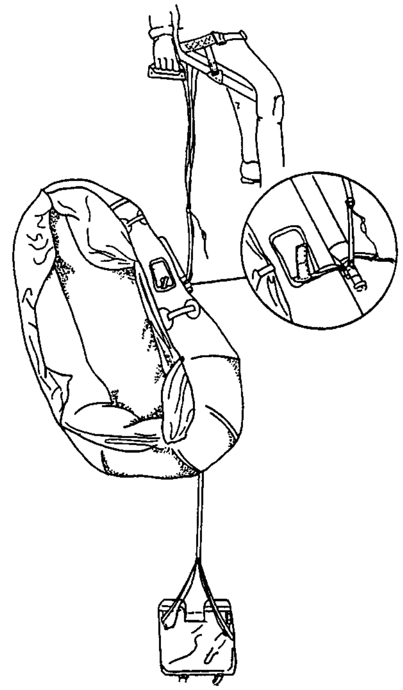
Note

The ejection seat without ACC-377 installed requires the kit strap release handle to be pulled simultaneously with or before the RSSK release handle in order to release the seat kit.

3. Pull upwards on the kit strap release handle with the forefinger of the right hand while at the same time pulling upward on the raft RSSK release handle with the other three fingers.



The seat kit is deployed with the liferaft fully inflated approximately 20 feet below the upper half of the seat kit container.



WARNING

If the survival kit is deployed after water entry, the liferaft may inflate and become entangled in the discarded parachute. The weight of the sinking parachute can submerge the liferaft.

25.7.3 Options. If time permits, the following options may be accomplished in any order deemed appropriate.

1. Activate steering system.

WARNING

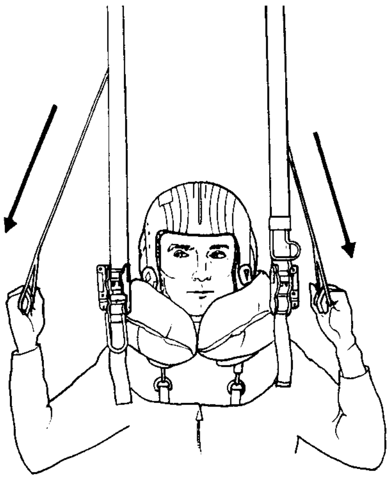
- Four-line release should not be activated if a damaged parachute canopy or broken suspension lines are observed.
- DO NOT use the four-line release at night because parachute damage may be difficult to determine.

Note

- Four-line release system should be utilized to reduce oscillations of the 28-foot flat circular canopy and to make the canopy steerable. A 180° turn can be accomplished in turn about 20 seconds using the steering loops.

- Four-line release system reduces downward airspeed and gains forward airspeed.

a. To activate four-line release, locate the steering lanyards on the inside of rear risers and pull down sharply.



b. Pull down on the right lanyard to steer right.

c. Pull down on the left to steer left.

2. Raise visor.

3. Remove oxygen mask. Oxygen mask/hose assembly should be disconnected from the seat kit and discarded.

Note

The A-13A or MBU series oxygen mask and regulator provide underwater breathing capability and should be retained in low-level overwater ejections.

4. Remove gloves.

Note

Stow gloves in a secure place to prevent loss.

5. Snap lower lobes.

Note

Failure to snap lobes may result in face down flotation of the unconscious survivor.

6. Jettison seat kit.

Note

SEAWARS automatically releases the parachute from the harness upon immersion in seawater. This will help prevent entanglement and/or dragging an injured survivor. SEAWARS does not interfere with the manual operation of the Koch fittings. Manual operation remains the primary mode of release with SEAWARS intended as a backup system.

25.8 LANDING PREPARATION

Try to determine the wind direction at the surface using white caps, smoke from the wreckage, or known surface winds in the vicinity. 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.

25.8.1 Landing Procedures

1. Assume proper body position.

   a. Feet together.

   b. Knees slightly bent.

   c. Toes pointed slightly downward.

   d. Eyes on horizon.

   e. Tuck elbows in prior to impact.

2. Release Koch fittings — RELEASE UPON WATER ENTRY.

WARNING

Do not disconnect Koch fittings until after contact with water.

3. Parachute landing fall — PERFORM (overland).

Note

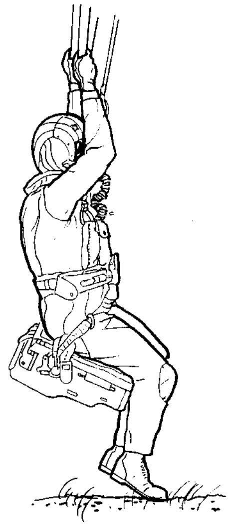
In some instances inflation of the LPU may be undesireable over land.

25.8.2 Parachute Landing Fall Procedures. Upon touching the ground:

1. Arch side of body in direction of the fall.

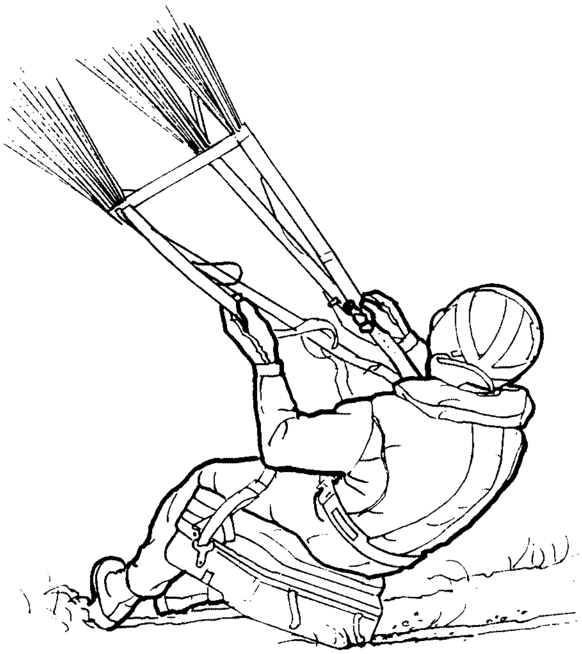
2. Contact the ground at five points of body contact. Proper body ground contact should occur in the following sequence:

   a. Balls of feet



   b. Calf

   c. Buttocks



   d. Thigh

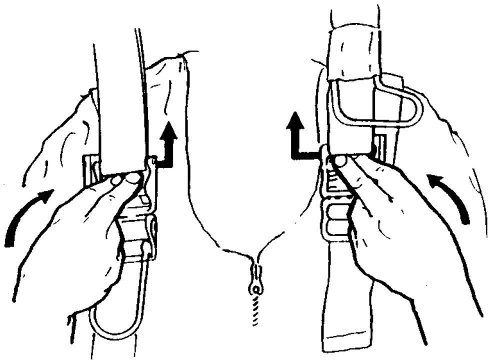
e. Shoulders

25.9 KOCH FITTING RELEASE

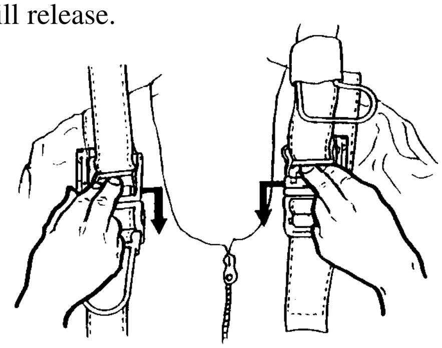
Note

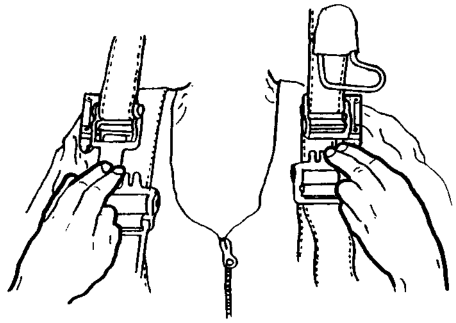
With SEAWARS installed, the upper Koch fittings release automatically upon immersion in saltwater.

1. Push up on Koch fitting release covers.



2. Pull down on Koch fitting release lever. Parachute will release.





WARNING

Do not disconnect the Koch fittings until after contact with ground or water.

3. Avoid parachute after water entry.

   a. Immediately look for canopy and face it.

   b. Back away, sculling with hands only.

   c. Minimize leg movement to reduce possibility of entanglement. Do not kick legs.

4. Disentangle.

   a. Release upper Koch fittings.

   b. If the canopy lands on top of you, reach up with both hands, push up, and pull the canopy from “back to front.” Continue pulling canopy until it is all in front of you.

   c. All movements must be slow and deliberate. Do not kick feet. Scull away facing parachute.

   d. Back away from chute, keep the chute in front of you where you can see it.

e. As you back away, free the suspension lines that may be caught on your equipment.

5. Retrieve raft.

a. Retrieve and inflate liferaft by pulling on lanyard on the CO_2 bottle or oral inflation tube.

b. Locate raft retaining lanyard and attach it to gated D-ring.

25.10 SURVIVAL PROCEDURES, SIGNALING DEVICES, AND RESCUE OPERATIONS

A complete detailed description of survival procedures, signaling devices and rescue operations is contained in NATOPS Survival Manual (NAVAIR 00-80T-101).

PART VI

All Weather Operation

CHAPTER 26

All-Weather Operations

26.1 SCOPE

This chapter contains information and procedures relative to operation and flight under inclement weather conditions. See Figure 26-1 for the environmental envelope of the aircraft.

26.2 COLD WEATHER PROCEDURES

Special precautions must be taken during all phases of operation from ground handling to landing. Pilots must be fully aware of the effects of cold weather and how to combat these conditions safely. Two distinct situations exist depending on whether the aircraft was parked in a heated hangar, preflighted, and towed to the line for manning, or if the aircraft has been exposed to a cold environment for an extended period of time prior to preflight and manning. Placing the aircraft in a hangar is always preferable when OAT is below freezing. In this case, special preflight procedures are limited to inspecting the landing gear struts and tires for snow or slush accumulation and the ramp area in order to assess braking action and the possibility of loose ice in the vicinity of the engine inlet, the APU air inlet, and in the engine exhaust blast areas. When the aircraft has been exposed for an extended period of time to a cold (below freezing) environment, several special checks and procedures must be followed depending on temperature, snow and frost present, ice present, and ramp conditions. The shaded area of Figure 26-1 shows where special procedures must be followed.

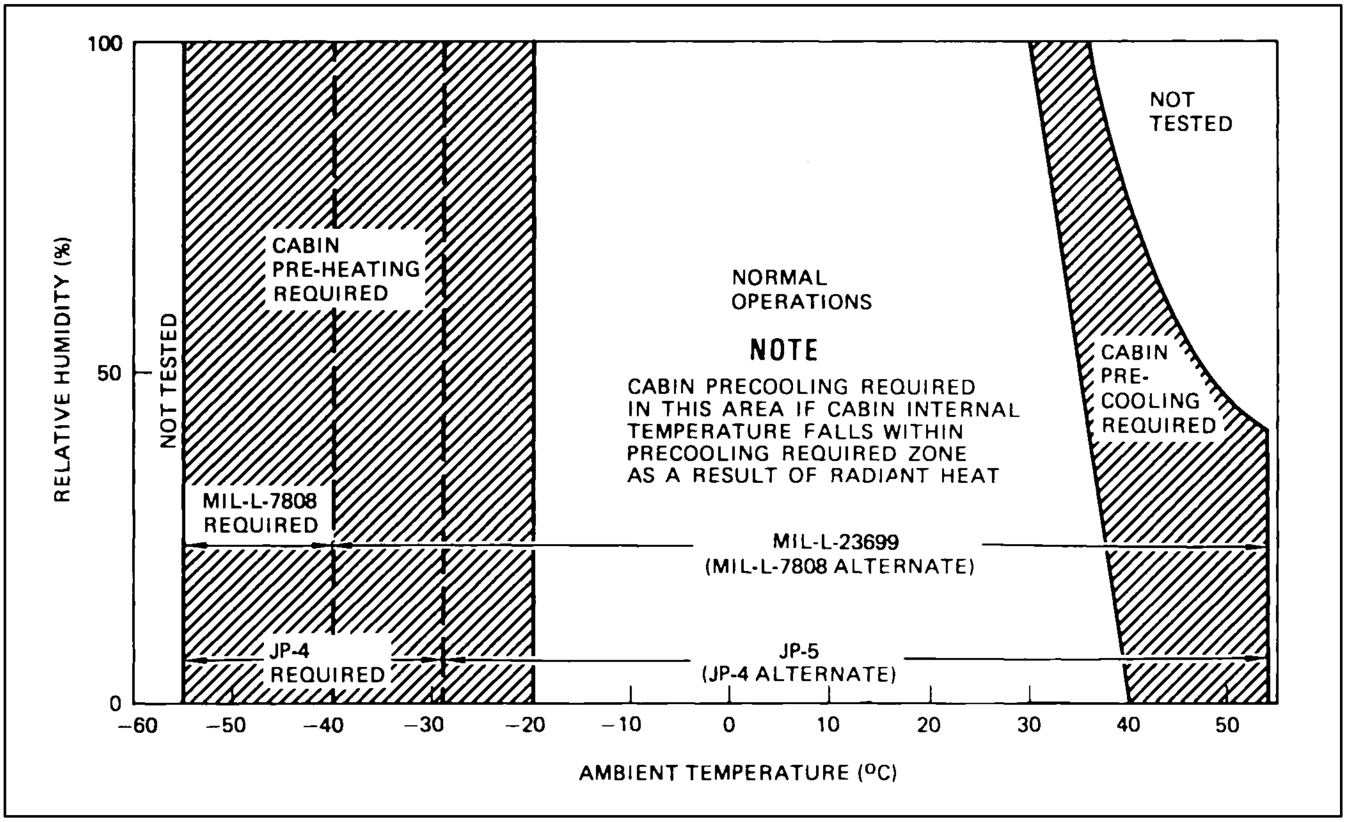


Figure 26-1. Environmental Envelope

26.2.1 Preflight. The procedures under this heading apply only to an aircraft that has been exposed to a cold environment for an extended period. Check the yellow sheet for type and servicing of oil and fuel.

CAUTION

Servicing of the engines, APU, or IDG with oil when the aircraft has been exposed to ambient temperatures below –18 °C (0 °F) for an extended period can very easily result in overfilling of these components. Overservicing can result in rapid failure of the component, particularly the IDG.

Check Chapter 3 for fuel density variation with temperature if fueling at cold temperatures was performed. Figure 26-1 shows that for operations below –29 °C (–20 °F), cold-soaked JP-5 fuel should not be used since JP-5 will not satisfactorily light-off in the engine or APU without use of external preheat. Below –40 °C (–40 °F), MIL-L-23699 oil should not be used because heating of large sections of the engine for extended periods of time would be required. Both JP-5 fuel and MIL-L-23699 oil can be used successfully below the limit temperatures if the aircraft was parked in a heated hangar prior to starting.

A major problem encountered in preflight is that of ice and snow removal. Additional time must be allowed for complete snow removal prior to flight. Ice and snow can be removed rapidly and efficiently if a deicing solution is applied to the wings and horizontal stabilizers prior to the accumulation of snow. The application of a deicing solution will prevent snow from freezing to aircraft surfaces. The snow can then be removed by brushing with a stiff bristle broom. Caution must be employed while removing snow by this method. If the ice and snow accumulation cannot be brushed off, application of heated deicing fluid will aid removal. When applying deicing solution with a sprayer, do not spray fluid into static ports or engine inlets because the fluid can cause corrosion damage. Remove all snow from the forward radome and windshield struts. Do not brush snow or ice from the windshield.

CAUTION

Brushing snow from the windshield should be avoided since damage and subsequent windshield cracking may result.

Note

Loose snow may be carefully removed from the windshield with a soft cloth.

When aircraft are parked outside in slush and snow, it is possible for tires to freeze to the ramp. Ground heaters may be required to release the tires. During normal preflight, accumulators, tailhook dashpot, and emergency oxygen should be checked against the data supplied in Chapter 3. In addition, radar Freon pressure in the waveguide and FLIR helium pressure should be checked. Checking the Freon pressure is important since Freon liquefies at cold temperatures and the supply bottle may not contain sufficient pressure to charge the waveguide. If the aircraft is parked in a cold environment, the Freon supply bottle should be removed and stored at room temperature and replaced on preflight. The fuel dump outlet and the pressure fueling connections may possibly leak slightly at very cold temperatures and should be closely inspected for leakage.

Aircrew exposure suits do not provide sufficient protection to personnel who must preflight and man the aircraft in very cold weather (below –20 °C (–4 °F)). It is recommended that the aircraft be preheated prior to manning until the cabin temperature is at least above –20 °C (–4 °F). Additionally, sufficient cold weather clothing should be worn by the aircrew during preflight to prevent cold exposure.

26.2.2 APU Starting and Operation. The APU will start successfully on JP-5 or JP-8 fuel to –29 °C (–20 °F) and on JP-4 fuel to –32 °C (–25 °F). Below –25 °C (–13 °F), MIL-L-7808 oil should be used for cold-soaked starts. With the application of 15 minutes of external preheat air at 65 °C (149 °F) to the APU inlet, the APU will start on JP-4 fuel at –54 °C (–65 °F). APU starts will normally take slightly longer at the colder temperatures. The actual time increase depends on several factors but can be 8 to 10 seconds longer than a start conducted at 20 °C (68 °F) OAT. In operation, the APU has sufficient capacity to start an engine serviced with MIL-L-23699 oil at –40 °C (–40 °F), the specification limit of the oil.

Below –18 °C (0 °F) the APU door may not open fully. The APU will not start unless the door is fully open. This can be remedied by ground personnel pulling the door until fully open. The door will be heavily damped and a moderate steady pull will open the door as easily and rapidly as pulling harder.

WARNING

With the APU control handle in the first detent, the APU is armed and ready to start when the door is fully opened. Check that ground personnel are clear of the APU when the handle is pulled to the second detent.

26.2.3 Engine Starting and Operation. The main aircraft engines will start satisfactorily on JP-5 or JP-8 fuel down to –29 °C (–20 °F) and on JP-4 down to –54 °C (–65 °F). MIL-L-7808 oil should be used for cold-soaked starts below –40 °C (–40 °F). When utilizing JP-5 or JP-8 fuel, engine starts are characterized by slightly longer light-off and some torching, which is normal below –18 °C (0 °F). Below –18 °C the throttle should remain off until 15- to 20-percent N_g is attained. This will minimize torching. Below –29 °C (–20 °F) application of 15 minutes of preheat air at 65 °C (149 °F) to the combustion section will allow normal starts to –34 °C (–30 °F). The engine cowling doors can be opened just enough to insert the air ducting at the 6-o'clock position on the engine just aft of the IDG. Starts can be expected to take up to 1.5 minutes.

When JP-4 fuel is utilized, light-off is essentially normal and torching can be experienced below –29 °C (–20 °F). As with JP-5, torching can be minimized by leaving the throttle off until 15- to 20-percent N_g is attained. Start times can be as long as 1.7 minutes at the lower temperatures. Engines serviced with MIL-L-23699 oil will be slow to accelerate from 0- to 30- percent N_g, and the engine fan may not begin to turn until after light-off. At –40 °C (–40 °F), up to 1 minute may be required to reach 15-percent N_g. TF34 engine idle characteristics are shown in Figure 26-2.

Note

- At the lower temperatures, oil pressure indication will go to 100 psi and remain there for up to 2 minutes (see Figure 4-9 for engine oil pressure limits). Oil pressure should be monitored carefully until it is within normal operating limits.

- BuNo 159752 and subsequent aircraft are equipped with TF34-400A engines incorporating high-flow oil pumps. Prior aircraft incorporating TF34-400 engines with (GE) PPC 19 are also equipped with these oil pumps. For proper oil pressure readings for modified and unmodified engines, refer to Chapter 4 (see Figure 4-9).

26.2.4 Systems and Avionics Operation. Environmental testing has shown that at –29 °C (–20 °F) and below, approximately 20 minutes of preheat air must be applied at 65 °C (149 °F) to the top of the utility hydraulic reservoir to prevent leakage. The heat should be removed just prior to engine start. Warmup times for other electrical and hydraulic equipment are correspondingly higher. In particular, the computer should be allowed to run for about 10 minutes prior to loading the program, and the INS may require several attempts before it will initiate an align sequence. The ECS should be selected to maximum AUTO HOT until the aircraft interior warms up to a comfortable level.

CAUTION

Positioning the TEMP SELECT switch to full hot in the MAN (manual) mode can overheat and possibly damage the cabin air distribution ducting.

If ice or snow remains on the windshields, use windshield heat to remove it. Windshield heat will remove most coatings of ice, snow, and/or frost in about 5 minutes maximum.

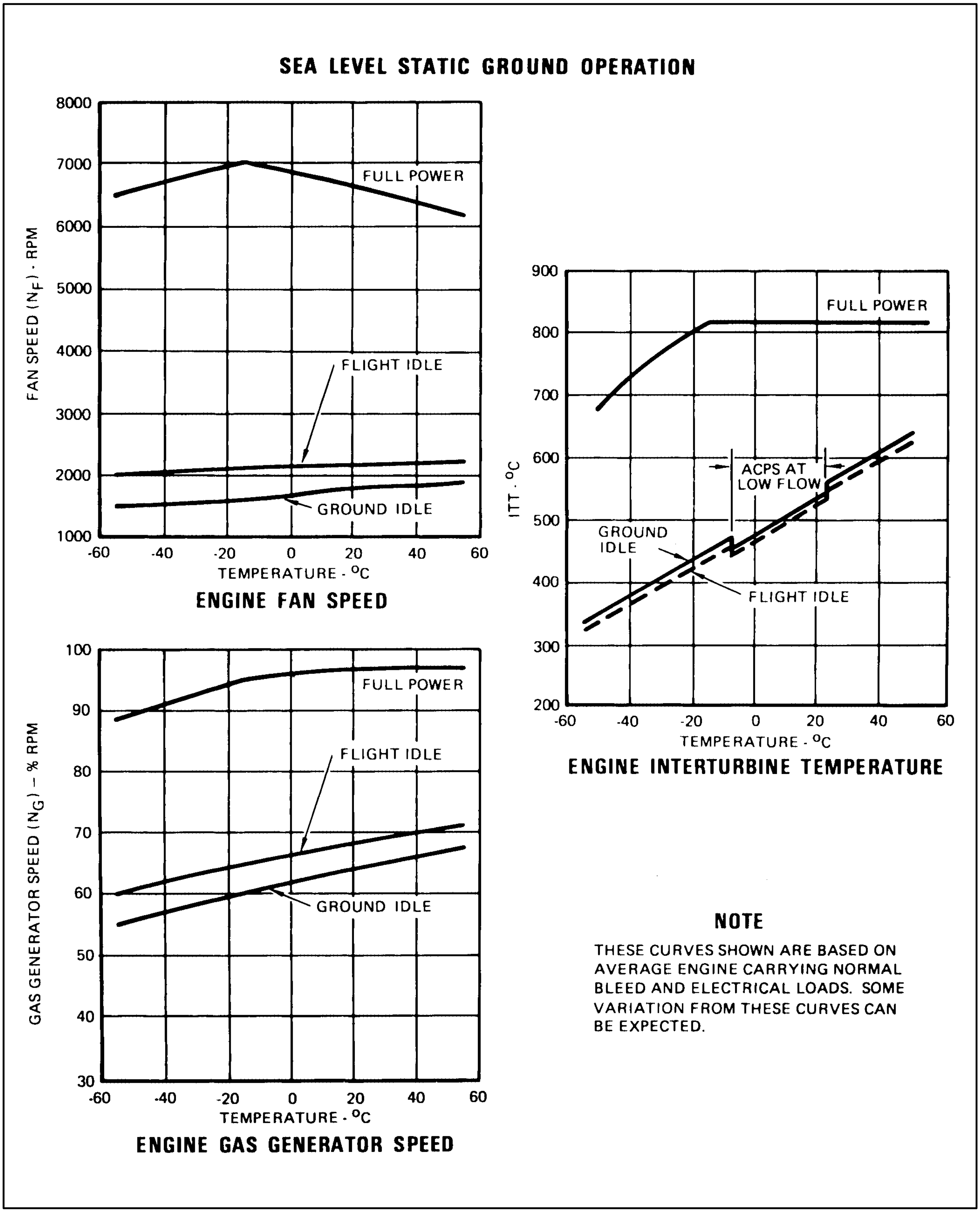


Figure 26-2. TF34 Engine Idle Characteristics

CAUTION

Brushing snow off the windshield should be avoided since damage and subsequent windshield cracking may result.

At low idle, the engines provide very limited bleed air flow for the ACPS and extremely long warmup times will be encountered. Use of APU for cabin warmup is recommended because of its high airflow and heating capability. Higher engine power settings will also produce more heating capability, but care and judgment must be used to avoid higher power settings that could jeopardize ground personnel or equipment. If engine power settings above flight idle are to be used with the APU running, the APU AIR switchlight should be selected to off (extinguished).

Below –40 °C (–40 °F), the fin may not fold or erect. Should this occur, the only solution is to park the aircraft in a heated hangar for 1 or 2 hours. After warmup, the fin will fold and erect normally.

26.2.5 Taxiing. Taxiing on ice and snow is hazardous at best and displays many characteristics similar to driving an automobile on slick roads. Care should be exercised in the use of power, brakes, and nosewheel steering. The pilot should use the minimum power required for slow taxiing and always be prepared to secure the engines should an uncontrolled slide off the taxiway be encountered. Turns should be planned for a large radius where practicable, and stops should be planned so that the main tires are on bare pavement, if possible. On snow and ice, the nosewheel is effective only for steering through 15° to 20° deflection either side of the aircraft nose. Accordingly, sharp turns must be avoided since they will result in the nosewheel sliding while the aircraft continues in a straight line. Asymmetric power can be used to decrease turn radius slightly but should be minimized. Excessively high power settings on one engine can cause loss of aircraft control. Use of anti-skid is the same as for normal operations. Stops that must be made on compacted snow or ice should be made as gradually as possible. Avoid taxiing through drifted snow or deep slush. Operation of the APU during taxi where loose snow or ice is present on taxiway or runways is not recommended unless essential.

CAUTION

Cockpit side window fogging can severely limit crew visibility during taxi evolutions, presenting a hazardous condition during night operations. Fogging on the outside surface of the canopies can occur when the canopy is cold-soaked and not warmed to or above the local ambient dewpoint temperature.

26.2.6 Takeoff. If takeoff on a snow or ice covered runway is necessary, the full-power engine check must be made with the aircraft rolling. At normal takeoff weights (approximately 43,000 pounds), 85-percent N_g power on both engines will cause the aircraft to slide forward in snow with brakes on.

WARNING

Preflight planning must include the status and location of runway arresting gear. An unsatisfactory engine check or other cause for aborted takeoff will require its use.

Nosewheel steering effectiveness is decreased as groundspeed increases and should be disconnected as soon as the rudder becomes effective. Takeoff in slush or where large puddles of water exist on the runway will require longer takeoff distances and may subject the aircraft to minor directional changes that should be corrected smoothly.

26.2.7 Descent. During idle-power descents, air-conditioning and deicing/anti-icing are at minimum effectiveness. Better performance can be obtained, if required, by utilizing higher engine power settings and increased speedbrake deflection to descend.

Note

Fogging on the outside surface of the canopies can occur when the canopy is cold-soaked in flight and not warmed to or above the local ambient dewpoint temperature. Fogging can be prevented by selecting a higher cabin heat setting while at altitude prior to descent. This will provide a warmer air supply to the canopy manifold and will warm the exterior canopy surface sufficiently to prevent condensation at the lower altitudes. Judgment and anticipation of entry into areas of high ambient humidity are required, and, in some cases, a high heat selection may be required.

26.2.8 Landing. Nonarrested landings on runways with less than a RCR of 13 are not generally recommended. In other cases, experience and judgment are required to determine how the landing will be made taking into account RCR, runway length, obstacles in the vicinity of the runway, aircraft weight, wind direction and speed, and availability of arresting gear. Nonarrested landings should be on speed with landing flaps. Deployment of speedbrakes should be complete prior to applying brakes. If the runway conditions are other than uniform (for example, patchy ice), use of normal or emergency brakes is not recommended. If this situation is encountered, where a failure requires landing with normal or emergency brakes, an arrested landing should be made. Prior to turning off the runway, slow the aircraft to the minimum speed required for taxi. Engagement of the nosewheel steering should be delayed until rudder effectiveness is lost and its use is required.

26.2.9 Postflight. The normal practice of securing the right (No. 2) engine while taxiing into the flight line should be weighed against ramp conditions. If good conditions exist on the taxiways and in the line area, the engine can be shut down. If poor conditions exist or sharp turns are required, both engines should be left operating as they may be required for maneuvering. When the aircraft is shut down, it should be towed into a hangar as soon as practicable. If the aircraft must remain on the flight line, it should be fueled and secured using protective covers and tiedowns as necessary. If the temperature will be below freezing, the radar waveguide Freon bottle should be removed and stored at room temperature.

26.3 ADVERSE WEATHER PROCEDURES

26.3.1 Airframe Icing. Flight in icing conditions requires planning and knowledge of the aircraft and its anti-icing/deicing systems. Icing can occur from +4 °C (39 °F) down to as low as –50 °C (–58 °F). The most probable icing zone is between 0 and –10 °C (32 and 14 °F) with –10 to –25 °C (+14 to –13 °F) being the next most probable zone. (See Figure 31-10 for the relationship between ambient temperature and indicated OAT at various flight speeds.) Icing can occur by sublimation without visible moisture but is rarely encountered. The most common icing conditions are present when there is visible moisture within the temperature range for icing. Clear ice presents the greatest danger since it is difficult to remove, covers proportionally larger surface areas, and will, if allowed to accumulate, distort large areas of the wing and empennage surfaces. In a pure state it is usually encountered only in cumuliform clouds with large droplet size and temperature slightly below freezing, or in freezing rain or drizzle. Rime ice is less dangerous since it is easier to remove and does not generally spread over the airfoil surface as does clear ice. In a pure state, it is most frequently encountered between –10 and –20 °C (+14 and –4 °F) in stratus and cumuliform clouds. The most common form of icing encountered is mixed ice that displays the characteristics of both clear and rime ice to some degree. When icing conditions exist, the pilot must constantly be alert for the formation of ice and be prepared to deal with it. By increasing airspeed to 250 knots or greater, ice on the airframe will sublime.

The ice collected on the aircraft can be assessed in several ways. First, the amount of ice collecting on the airframe should be observed. Areas such as the front of the ESM pods, frames around the windshield, and the weapon pylons collect ice that is visible from the cockpit. Second, the type of ice (clear, rime, or mixed) can be determined by watching ice buildup on the windshield wipers. The ice collected on the windshield wipers should not be used as a gauge for accumulation since the airflow past the windshield wipers is not representative of airflow over smooth sections of the aircraft. Third, the rate of accumulation can be observed by the amount that builds up on the wings between deicing cycles. Each wing zone is heated up to 30 seconds out of every 4 minutes. If in the remaining 3 minutes and 30 seconds the ice buildup is observed, a qualitative assessment of rate can be obtained. The most accurate gauge is the width of the ice band on the leading edges of the wing, which can vary from 1 to 2 inches in trace icing to complete coverage of the leading edge in severe icing.

Pitot heat should always be used. Windshield heat shall be used at all times during flight, whether or not icing conditions exist. Failure of the AOA probe heater or of either pitot heater will allow these components to ice up, and the indications of the pitot-static and/or AOA instruments will become unreliable. The AOA transmitter will usually go to zero units at cruise airspeeds when this occurs. Failure of a pitot heater will cause illumination of the left or right pitot heater caution light. Should this occur on the left pitot heater, the pilot can select alternate sources to retain the use of his airspeed indicator, standby altimeter, and vertical speed indicator.

When icing is first noticed forming on the wings or engines, or if flight through visible moisture is required where icing temperatures exist, the engine anti-ice and wing and empennage deicing should be selected without allowing ice to accumulate. Tests have shown that the wing and empennage deicing system is more effective in removing small accumulations of ice than larger accumulations. Monitor the deicing system performance as outlined in Chapter 2. Operation of the APU in icing conditions has not been tested. It is possible that ice could build up on the inlet louvers and restrict inlet air supply. Also ice could possibly build up on the exhaust door and cause damage if the door is closed in this condition. Thus the APU should not be operated in icing conditions unless its use is essential.

Care should also be used in operation of the FLIR equipment since ice will collect on the turret, lens, and leading edges of the FLIR compartment doors. Operation with the FLIR extended should not exceed approximately 3 minutes in moderate icing conditions. Operation may be increased or reduced as different icing conditions are encountered. Under no circumstances should it be left extended when not needed. Data are not available to determine the relative accuracy of ESM system with ice accumulation on the antennas. Ice does collect on the forward edge of all the antennas concerned, and the crew should be alert for errors that might be introduced into these systems by the presence of ice. Ice will also collect on the radome, and if the bomb bay doors are open, on the leading edge of the bomb bay doors and aft bulkhead of the bomb bay. Operation with the bomb bay open should be kept to a minimum consistent with operational requirements.

Preliminary icing tests have not shown any tendency for ice accumulation to interfere with the operation of the landing gear or flaps. However, flight in icing conditions with gear and flaps extended should be minimized whenever possible with the exception that flight with maneuver flaps should be treated the same as flight with flaps up. Descents through icing conditions should be conducted with higher than normal power settings to ensure proper performance of the deicing/anti-icing equipment.

26.3.1.1 Deicing/Anti-Icing Procedures. If removal of ice, snow, or frost is required, refer to the appropriate maintenance manual for guidelines, information, and procedures. The aircraft commander should personally supervise all aircraft deicing and anti-icing evolutions. Both bleed air switches, the APU AIR, and AIR CONDITIONING switch shall be turned off prior to the application of deicing fluid to prevent ingestion of fumes into the cabin.

CAUTION

Ensure that anti-icing/deicing fluid is applied sparingly near aircraft engine and APU exhaust gas areas to avoid accumulations that might ignite.

Note

Engine inlet duct icing can occur without the formation of ice on the external aircraft surfaces. When jet aircraft fly at velocities below approximately 250 knots and at high power settings, as in a climb, the intake air is drawn into the engine rather than being rammed in. This function reduces static air pressure, causing incoming air to expand and cool in the engine inlet. Under these conditions, air at ambient temperatures above freezing may be reduced to subfreezing temperatures as it enters the engine and any water vapor will be deposited as ice in the compressor inlet. The greatest temperature drop occurs at high turbine rpm, such as during takeoff, and decreases with decreasing rpm and increasing airspeed.

26.3.2 Engine Icing. With engine anti-ice on, the engine will collect ice on the fan spinner, the backs of the fan blades, the fan EGV, and, in severe icing conditions, on the engine inlet guide vanes. The fan hub will appear to turn white, which will be the first indication to the pilot that the engine is icing. Since ice accumulates first on the back of the fan blades, ice buildup on the engine fan will not be visible until it has progressed to the point where it is starting to accumulate on the leading edges of the fan blades and EGV. The appearance of an engine running at 4,000-rpm N_f with fan ice is that of the spokes of a wheel radiating out from the fan hub. There are no direct indicators available to the pilot to assess the rate, type, or accumulation of fan ice. However, fan ice will display the same characteristics as airframe ice and the assessment thereof will suffice for both. As ice accumulation increases on the fan blades and inlet guide vanes, it will shed (flake off) at random intervals.

Icing of the engine fan blades is governed essentially by two factors, fan rpm and accumulation rate. The higher the fan rpm, the less ice is accumulated. The higher the accumulation rate, the more often fan blade ice shedding will occur. The effect of fan blade ice shedding is a mild vibration that can be associated in frequency with the engine fan rpm. If shedding occurs from a low fan rpm, it is generally more severe than from a higher rpm. The most important pilot consideration is to determine if fan icing is the probable cause of the vibration. Icing of the engine fan blades is a continuous process of ice buildup followed by sudden shedding on individual blades. Shedding fan ice produces the appearance of light or dark concentric circles in the engine fan that will change radius slowly or abruptly depending upon the rate of shedding. The pilot should be aware that the vibration levels will change suddenly every time a blade sheds and changes the balance of the fan disc slightly. Ice accumulation rate will determine whether this happens every few seconds or every few minutes. If fan ice is encountered at low rpm, the ice can be forced to shed by slowly increasing fan rpm. This will also reduce vibrations that have resulted from previous shedding. Testing has shown that the engines will run satisfactorily and will not incur damage as a result of fan blade ice shedding. However, prolonged operation in this type of environment places greater-than-normal loads on the engine bearings and should be minimized to avoid reducing operational life of the engines.

Note

Conditions exist under which jet engine icing can occur without wing icing. Icing occurs when the adiabatic expansion reduces the air temperature in the engine inlet; ingested water droplets that impact on the engine inlet components will freeze. This phenomenon may occur during ground and takeoff operations when the aircraft velocity is low and engines are operating at high thrust settings.

26.3.3 Engine Anti-Icing for Ground Operations. Engine anti-icing should be used for all ground flight operations when the ram air temperature is 6 °C (42 °F) or below and (1) visible moisture is present or (2) with a temperature/dewpoint spread of 3 °C (5 °F) or less.

26.3.4 Thunderstorms and Turbulence. Avoid thunderstorms whenever possible. The conditions of precipitation and turbulence inside a thunderstorm or a towering cumulus cloud cannot be determined by external appearance. While flying in stable instrument conditions, be alert to the possibility of suddenly encountering conditions of turbulence severe enough to throw the aircraft out of control momentarily. Be prepared for instrument failures. Pitot tube icing, which can take place even with pitot heat on, will cause erroneous airspeed indications not easily detected until they become large. The angle-of-attack indicator should be used as a backup instrument.

The recommended procedure on encountering severe turbulence such as associated with frontal or cumulus activity is to adjust airspeed to between 250 and 260 KIAS (not to exceed 0.7 M). Flaps should be retracted and yaw damper engaged. These airspeeds will provide adequate stall margin without encountering excessive loads.

Fly attitude and heading indicators while in extreme turbulence since airspeed indicators and altimeters will fluctuate. Do not use the altitude hold function since pressure altitude will vary considerably in thunderstorm areas. See Chapter 4 for turbulent air penetration speed.

WARNING

Do not dump fuel when in or near thunderstorms.

Note

The yaw damper should be engaged during flight in turbulence. This will prevent coupling of random lateral gusts with yaw excursions resulting from low damped Dutch roll.

26.3.5 Rain. Operation in rain presents few problems to aircraft operations other than those normally encountered, such as low visibility and longer landing distances. The windshield wipers are adequate for most rain that will likely be encountered. Use of pitot heat is recommended, regardless of temperature. If rain is encountered at a temperature near freezing, the crew should be alert for ice. Use of the rain repellent should be reserved for times when forward visibility is essential and the windshield wipers are inadequate to keep the windshield clear. Use of the FLIR should be minimized in order to avoid any possible damage to the lens.

When sitting statically on the flight line, the aircraft has a tendency to leak around the canopies where the canopy removal handles are attached and where the explosive severance charge is secured to the canopy/hatch assembly. There also can be leakage from the eyebrow panel that usually means the windshields are leaking. These leaks have not shown any effect on equipment installed in these areas or their operation.

26.3.6 Tire Hydroplaning/Wet Runways. Three types of hydroplaning are possible on wet runways.

Dynamic hydroplaning occurs when fluid pressures develop between the tire footprint and the pavement. There is a critical speed beyond which the tire is completely supported by fluid. When a rotating tire travels from a dry to a flooded runway section, this speed is approximated by multiplying the square root of the tire pressure in pounds per square inch by nine. For this aircraft, with main wheel tires inflated to 245 psi (field) or 320 psi (carrier), this occurs at approximately 141 and 161 knots, respectively.

Reverted rubber hydroplaning can occur at speeds as low as 5 knots when a locked tire skids across a slippery wet or icy surface generating steam in the tire footprint.

Viscous hydroplaning results from normal slipperiness on a wet surface and can occur at speeds well below that required for total dynamic hydroplaning.

The obvious results of hydroplaning are the loss of braking action and the potential loss of ground directional stability. Landing on runways with standing water should be made exercising the same caution associated with ice, snow, or slush. Landing performance (minimum stopping distance) should be considered with due regard for planned landing gross weight. Nonarrested landings with less than an RCR of 13 (poor braking or worse) are not recommended. Full or partial hydroplaning, coupled with weather cocking tendencies associated with the large vertical stabilizer of this aircraft, can severely degrade runway directional control. Recommended landing techniques when hydroplaning is anticipated are as follows:

1. Perform arrested landing.
2. Make maximum use of available runway length if arrested landing is not performed (avoid landing long or fast).
3. Make a firm touchdown.
4. Employ all available means to safely and expeditiously decelerate the aircraft (spoilers, antiskid braking, and so forth).
5. Exercise judicious use of all available controls (rudder, ailerons, brakes, and NWS) to maintain directional control.

Refer to Crosswind Landing, paragraph 10.1.7, and cold weather operation landings, paragraph 26.2.8, for additional information.

26.4 DESERT OPERATING PROCEDURES

Operation of the aircraft in hot dry climates presents several difficulties, most of which are heat related. In the presence of radiant heat, the inside of an aircraft can become very hot. The presence of sand or fine dirt that can be picked up by wind or jet blast presents a hazard to the windshields. Preflight will take longer because of precooling requirements.

Note

- An air outlet is installed in the overhead supply duct located between the TACCO and SENSO stations. The outlet diverts cooling air to the aft cabin for cooling of internal avionics.
- A direct indicating thermometer is installed on the aft inboard edge of the left internal avionics rack to monitor aft cabin temperature. The thermometer is mounted such that it can be readily monitored from the TACCO seat.

- Precooling on the ground prior to flight is a requirement in hot weather. This can be achieved by operating with the APU running and the cabin door closed.

26.4.1 Preflight. If ground air-conditioners are available, they should be connected to cool the interior of the aircraft approximately 30 minutes prior to engine start. If not, an air source to power the ACPS system can be used, or, as a last resort, the APU can be used. Preflight should include calculations of takeoff performance data and the location and capability of abort/ overrun arresting gear. At temperatures above 40 °C (104 °F), gloves should be worn to prevent possible burns. Areas of exposed skin should be minimized when manning the aircraft. Accumulators and the emergency oxygen supply gauges should be checked against data contained in Chapter 3.

The following procedures should be utilized for precooling the aircraft:

1. AUX VENT switch — OFF.
2. APU — ON.
3. APU GEN switch — ON.
4. BLEED AIR ENG 1 switch — ON (optimal).
5. AIR COND switch — ON.
6. APU AIR switchlight — ON.
7. TEMP SELECT switch — (MAN) COLD (or OFF).
8. Cabin door — CLOSED.
9. CABIN PRESS switch — NORM.
10. Maintain this configuration until internal cabin temperature has been reduced to an acceptable level (approximately 15 minutes).

CAUTION

- Failure to turn the AUX VENT switch OFF prior to energizing the internal bay avionics will result in recirculation of hot avionics exhaust air, which will lead to rapid overheat of internal bay avionics components.
- To reduce internal avionics and GPDC and overheat and failure, precooling should be cooled to 27 °C (80 °F).

Note

- A combination of electrical and bleed air loads on the APU in conjunction with high ambient temperatures may cause the automatic controls of the APU to reduce bleed air output to prevent exceeding APU EGT limits. Extremely high APU air inlet temperatures may possibly cause all bleed air output to cease and the APU electrical load to drop off followed by an APU overtemperature shutdown.
- If cabin conditions as shown in Figure 26-1 cannot be met and the mission requires the computer be checked on-deck, the computer should be loaded, checked, and then secured until acceptable temperature conditions are obtained airborne.
- Ensure the deicing switch is OFF. If this switch is on, in either position, the air-conditioning system will operate in low flow.

26.4.2 Before Takeoff. Engine operation is similar to that at more normal ambient temperatures (see Figure 26-2). Operation of the APU, however, is limited by its maximum EGT limits. The APU can be successfully started and run up to 57 °C (135 °F). Above that temperature, it may automatically shut down from overtemperature. At high temperatures, unless the APU is used for cooling, the engines should be at flight-idle power setting as a minimum when the aircraft is not taxiing. The APU should be secured or the APU AIR switchlight set to OFF (extinguished) if engines are used for cooling.

Higher power (75-percent N_g) is desirable, if operations permit. This is to supply adequate air-conditioning for internal avionics and to prevent rapid heatup of the aft cabin because of hot air entering from the ECS compartment through the negative pressure relief valve. At high ambient temperatures, takeoff will require more runway and initial climb rates will be slower. Consult performance tables in Part XI to compute takeoff and single-engine performance.

26.4.3 In Flight. If requirements of operation preclude sufficient precooling prior to takeoff, use of avionics should be minimized with all unnecessary equipment secured. If initial internal avionics compartment cooling is inadequate and operations at low altitude (below 3,500 feet) under these circumstances are required, the air conditioning can be shifted to high flow by extending the IFR probe. Shifting to high flow in this manner allows the recirculation valve to remain closed and establishes the same air-conditioning configuration as ground operation.

An alternate method is to pull the RECIRC AIR S/O V circuit breaker (3-K-8) while below 3,500 feet and then turn the AUX VENT switch just out of the off-detent. This procedure establishes high flow with the auxiliary vent essentially closed and the recirculation valve closed. The sequence of the preceding steps is important for the positioning of the various valves.

Note

This configuration should not be used above 4,500 feet.

If mission requirements dictate (emergency situations), the engine can be successfully started during flight by use of APU air at ambient temperatures up to 50 °C (122 °F) by disabling the overtemperature and low oil pressure protection circuit. This is accomplished by pressing the automatic shutdown disarm switch. If such a start is made, the APU overtemperature caution light will likely illuminate and a discrepancy documenting the start condition should be made at the completion of the flight so that an overtemperature inspection can be accomplished. Refer to APU OVERTEMPERATURE/LOW OIL PRESSURE OVERRIDE procedures, paragraph 16.8.

26.4.4 Landing and Securing the Aircraft. Waveoff performance will be slightly reduced at high temperatures. Landings should be planned normally but the pilot should be alert for conditions requiring waveoff (particularly single-engine) and initiate waveoff without delay when required. While taxiing back to the flight line, minimum use of brakes is important to help cool the brakes. This is best accomplished by taxiing slowly with the right engine secured and by using nosewheel steering.

When the aircraft is shut down on the flight line, protective covers, with the exception of the engine covers, should be installed if dust or sand is likely to be present. Engine covers should be installed as soon as the engines cool off sufficiently. Particular care must be taken to protect the windshields from blowing sand or other debris. If possible, the aircraft should be placed in a hangar to get it out of direct sunlight. If the aircraft is to be left in the sunlight, the cabin entrance door should be left open.

Note

Consideration should be given to chocking the aircraft instead of setting the parking brake after field landing rollout to prevent tire overpressure, resulting in possible actuation of the blowout plug.

26.5 TROPICAL OPERATING PROCEDURES

26.5.1 High Humidity Operations. Operation at high temperatures and high humidity is essentially the same as for desert conditions, with the exception that the ACPS will be less effective at cooling the interior of the aircraft and the fatiguing effect of the temperature on personnel will be much more pronounced. Because the ACPS will be less effective, the use of an air-conditioned cart and high ground power settings becomes more important. Also, when the air-conditioning has been started, the cabin entrance door should remain closed as much as possible to avoid the introduction of moisture into the interior of the aircraft. This moisture will condense on the cool interior surfaces as well as being drawn into the avionics (which is undesirable). In addition to other avionics sensitive to high temperatures, the AYK-10 memory units (MU-577) are particularly sensitive to high temperature and high humidity combinations. The computer should not be turned on until cabin conditions are in accordance with Figure 26-1.

CAUTION

- Failure to turn the AUX VENT switch OFF prior to energizing the internal bay avionics will result in recirculation of hot avionics exhaust air, which will lead to rapid overheat of internal bay avionics components.

- After takeoff, and above 4,500 feet, the INT AVIONICS light should go out. If it does not, the only pilot action to combat the situation is to maintain ACPS in manual full cold and seek flight conditions that alleviate the situation. If the situation is allowed to exist, the temperature difference between cockpit and aft internal avionics bay can exceed 15 °C (27 °F) and avionics failure can be expected.

26.5.2 Descent. Descent from altitude into warm moist air will cause fogging of the windshields. To minimize this, windshield heat should be used along with slightly higher cabin temperature. ACPS performance can be increased in effectiveness by descending at higher power settings. After landing and shutdown, arrangement should be made to check the interior of the aircraft at intervals over the next few hours since water will condense on the bottom of the fuel cell over the electronics compartment. If not checked and wiped off periodically, it will fall on the avionics components and form puddles at the aft end of the avionics compartment. This will aggravate cooling and humidity control problems on subsequent flights.

26.5.3 After Landing. When operating the ECS in a high-humidity environment for 30 minutes or longer, the following procedure is recommended to dry out the ducts prior to shutting down the ECS. This procedure may be followed after landing provided that the APU can be operated. If the APU is not operating or if the landing will be aboard a carrier, or at other locations where the APU cannot be operated for 15 minutes, then the procedure should be followed in flight.

1. Turn off all nonessential avionics equipment.

2. Place the ECS flight station TEMP SELECT switch to the AUTO position.

Note

Do not use the manual mode for this procedure.

3. Position the cabin and flight station selector to 26 °C (80 °F) (full right) or the ambient dewpoint (whichever is greater).

4. Operate the ECS for a minimum of 15 minutes to stabilize the cabin and flight station temperature prior to shutting down the system.

PART VII

Communications Procedures

CHAPTER 27

Communications Procedures

27.1 COMMUNICATIONS

The S-3B aircraft is equipped with a highly refined communications system and it is mandatory that every crewmember understand the communications system thoroughly to effectively utilize the high degree of flexibility designed into the aircraft. To operate the communications system, all crewmembers must be familiar with current communications plans. The communications plan of operation orders outlines the reports required, to whom they are to be sent, the frequencies to be used at specific times, the determination of precedence, the use of authenticators and crypto materials, and all other phases of airborne communications necessary to properly carry out the assigned mission. Communications procedures and terminology are standardized by NWP 4, NWP 16, NWP 16-1, and NWP 32. Review these publications frequently and adhere to the instructions contained therein.

Note

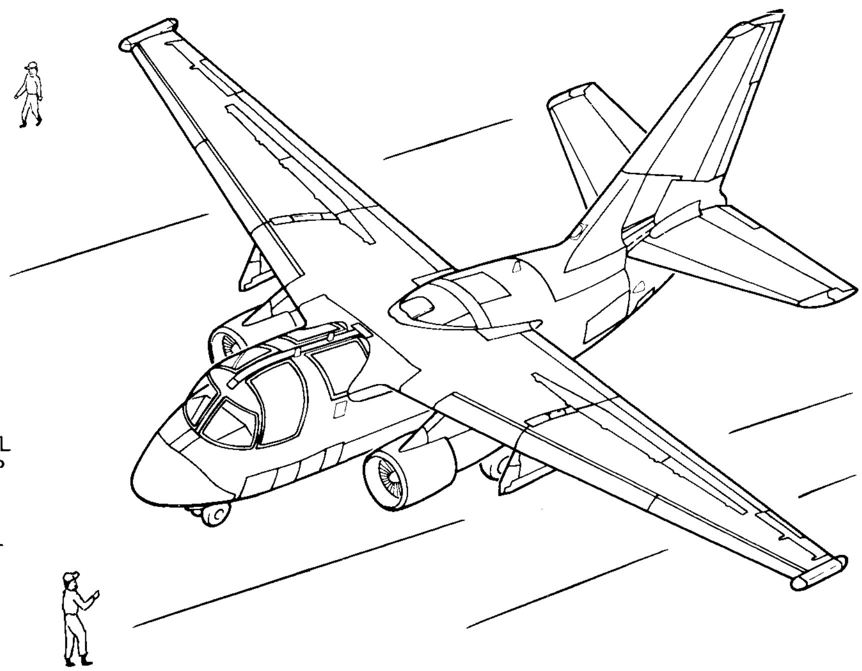
A detailed description of all S-3B aircraft radio and navigation electronic equipment is located in Part I of this manual.

27.2 RADIO COMMUNICATIONS

Two ARC-156 UHF transceivers, an ARC-153 HF transceiver, and the LS-601/AI ICS are available for radio communications.

27.3 VISUAL (HAND) SIGNALS

Standard visual signals used by all naval aircraft are contained in NAVAIR 00-80T-113 and apply to the S-3B aircraft. See Figures 27-1 and 27-2 for typical visual signals.



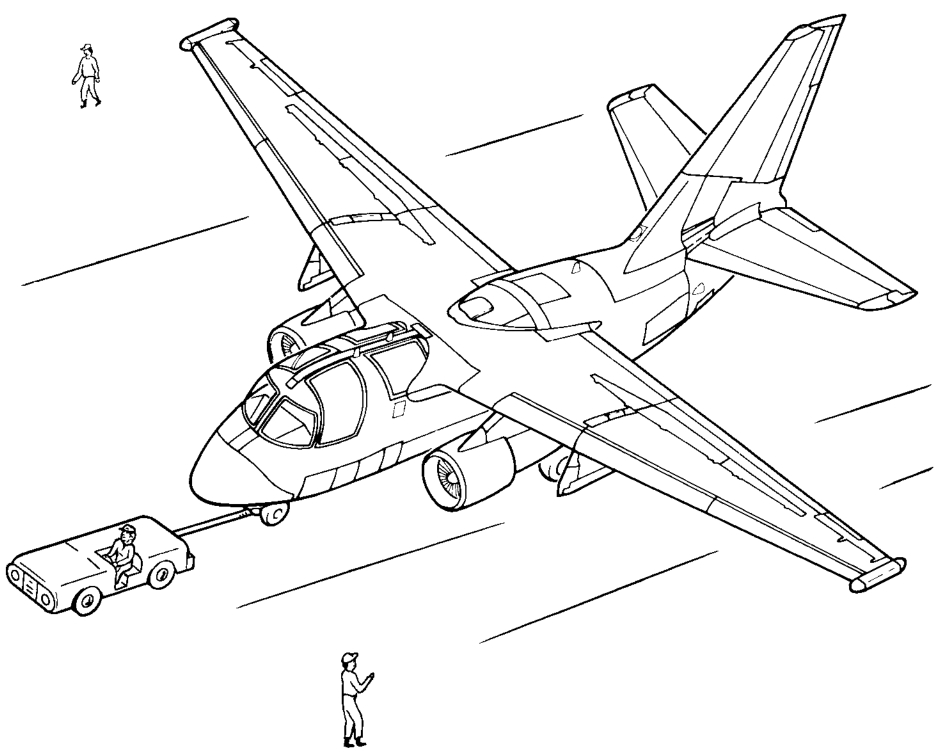


Figure 27-1. Visual Ground Communications (Sheet 1 of 7)

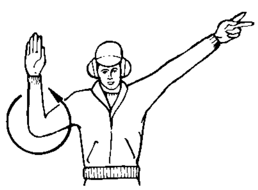
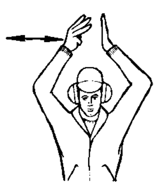
SIGNAL	DAY	NIGHT
 CONNECT/DISCONNECT ELECTRICAL POWER/AIR STARTING SOURCE/SINS	HANDS ABOVE HEAD, LEFT FIST PARTIALLY CLENCHED, RIGHT HAND MOVED IN DIRECTION OF LEFT HAND WITH FIRST TWO FINGERS (ONE FINGER FOR SINS) EXTENDED AND INSERTED INTO (OR RETARDED FROM) CIRCLE MADE BY FINGERS OF THE LEFT HAND	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 PRESSURIZE/DEPRESSURIZE EXTERNAL FUEL TANKS	HAND ABOVE HEAD WITH FOUR FINGERS EXTENDED – PRESSURIZE DROP TANKS OR FIVE FINGERS – DEPRESSURIZE DROP TANKS	HOLD WANDS POINTED UP WITH ARMS EXTENDED HORIZONTALLY FOR PRESSURIZE. HOLD WANDS POINTED DOWN WITH ARMS EXTENDED HORIZONTALLY FOR DEPRESSURIZE.
 START ENGINE (S)	LEFT HAND WITH NUMBER OF FINGERS EXTENDED (TO INDICATE THE NUMBER OF THE ENGINE TO BE STARTED) AND CIRCULAR MOTION OF RIGHT HAND AT HEAD LEVEL	SIMILAR TO DAY SIGNAL EXCEPT THAT THE WAND IN THE LEFT HAND WILL BE FLASHED TO INDICATE THE ENGINE TO BE STARTED
 INSERT/REMOVE LANDING GEAR PINS, OPEN/CLOSE SONO SAFETY DOOR, REMOVE/INSERT HOOK PIN	HANDS ABOVE HEAD, LEFT HAND PALM OPEN, RIGHT HAND WITH THREE FINGERS EXTENDED MOVED TOWARDS–OR RETARDED FROM–OPEN PALM	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 THROTTLE BACK	CLENCHED FIST GRASPING EXTENDED THUMB FROM OTHER CLENCHED FIST AND MOVED AS IF RETARDING A THROTTLE	SAME AS DAY SIGNAL WITH WANDS HELD VERTICALLY ONE ONE TOP OF THE OTHER

Figure 27-1. Visual Ground Communications (Sheet 2)

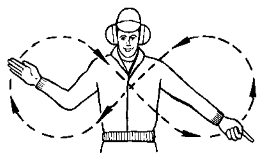
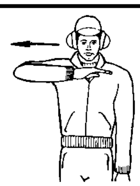
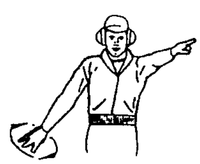
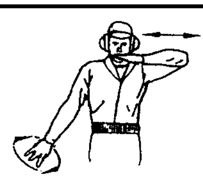
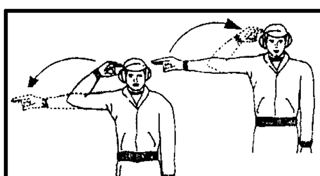
SIGNAL	DAY	NIGHT
 ENGINE FIRE	DESCRIBES A LARGE FIGURE EIGHT WITH ONE HAND AND POINTS TO THE FIRE AREA WITH THE OTHER HAND	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 CUT ENGINE (S)	EITHER ARM AND HAND LEVEL WITH SHOULDER, HAND MOVING ACROSS THROAT, PALM DOWNWARD. THE HAND IS MOVED SIDEWAYS WITH THE ARM REMAINING BENT	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 ENGINE IDLE UNDERSHOOT	HOLD BOTH ARMS OUT, BENT UPWARDS AT THE ELBOW, WITH THE INDEX FINGER POINTED UP, MOVE THE UPPER ARMS ALTERNATELY FORWARD AND BACK	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 START AIRCRAFT AUXILIARY POWER UNIT	POINT TO POWER UNIT EXHAUST WITH LEFT-HAND INDEX FINGER; MOVE RIGHT-HAND IN HORIZONTAL CIRCLE WITH LAST THREE FINGERS EXTENDED.	SAME AS DAY EXCEPT WITH WANDS
 STOP AIRCRAFT AUXILIARY POWER UNIT	MAKE "THROAT CUTTING" ACTION WITH RIGHT HAND WITH LAST THREE FINGERS EXTENDED.	SAME AS DAY EXCEPT WITH WANDS
 APU OPEN DOOR CLOSE	TO OPEN: TOUCH HEAD WITH LAST THREE FINGERS OF RIGHT HAND AND MAKE MOTIONS TO EXTEND ARM PARALLEL TO DECK. TO CLOSE: EXTEND RIGHT ARM PARALLEL TO DECK WITH LAST THREE FINGERS OF HAND OUT AND MAKE MOTION TO TOUCH HEAD.	SAME AS DAY SIGNAL WITH ADDITION OF WANDS

Figure 27-1. Visual Ground Communications (Sheet 3)

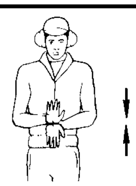
SIGNAL	DAY	NIGHT
 OPEN BOMB BAY DOORS	BODY BENT FORWARD AT THE WAIST, HANDS HELD WITH FINGERTIPS TOUCHING IN FRONT OF BODY AND ELBOWS BENT AT APPROXIMATELY 45 DEGREES, THEN ARMS SWING DOWNWARD AND OUTWARD	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 CLOSE BOMB BAY DOORS	BODY BENT FORWARD AT THE WAIST AND ARMS EXTENDED HORIZONTALLY, THEN ARMS SWING DOWNWARD AND IN UNTIL FINGERTIPS TOUCH IN FRONT OF THE BODY WITH ELBOWS BENT AT APPROXIMATELY 45 DEGREES	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 OPEN SPEEDBRAKES	HANDS IN FRONT, PALMS TOGETHER VERTICALLY, THEN OPENED FROM THE WRISTS CROCODILE-MOUTH FASHION	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 CLOSE SPEEDBRAKES	HANDS IN FRONT, VERTICALLY WITH PALMS OPEN FROM THE WRISTS, THEN SUDDENLY CLOSED	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 LOWER WING FLAPS	HANDS IN FRONT, PALMS TOGETHER HORIZONTALLY, THEN OPENED FROM THE WRIST CROCODILE-MOUTH FASHION	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 RAISE WING FLAPS	HANDS IN FRONT HORIZONTALLY, WITH PALMS OPEN FROM THE WRISTS, THEN SUDDENLY CLOSED	SAME AS DAY SIGNAL WITH ADDITION OF WANDS

Figure 27-1. Visual Ground Communications (Sheet 4)

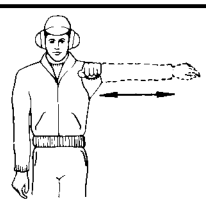
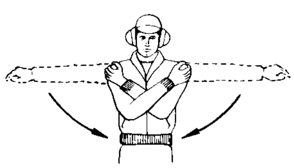
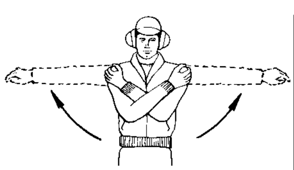
SIGNAL	DAY	NIGHT
 DOWN-HOOK	RIGHT FIST, THUMB EXTENDED DOWNWARD, LOWERED SUDDENLY TO MEET HORIZONTAL PALM OF LEFT HAND	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 UP-HOOK	RIGHT FIST, THUMB EXTENDED UPWARD, RAISED SUDDENLY TO MEET HORIZONTAL PALM OF LEFT HAND	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 EXTEND/RETRACT AIR REFUELING PROBE	TO EXTEND: EXTEND ARM STRAIGHT AHEAD, FIST CLENCHED, SWING ARM 90 DEGREES TO SIDE TO RETRACT: USE THE REVERSE OF THE EXTEND SIGNAL	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 FOLD WINGS	ARMS STRAIGHT OUT AT SIDES, THEN SWEPT FORWARD AND HUGGED AROUND SHOULDERS	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 SPREAD WINGS	ARMS HUGGED AROUND SHOULDERS, THEN SWEPT STRAIGHT OUT TO THE SIDES	SAME AS DAY SIGNAL WITH ADDITION OF WANDS

Figure 27-1. Visual Ground Communications (Sheet 5)

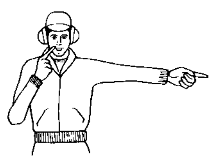
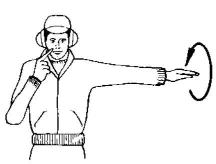
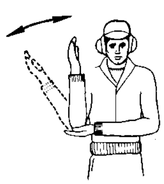
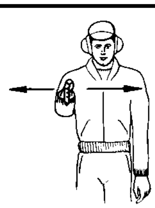
SIGNAL	DAY	NIGHT
 LOCK WINGS	HIT RIGHT ELBOW WITH PALM OF LEFT HAND	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 ENGAGE NOSEWHEEL STEERING	POINT TO NOSE WITH INDEX FINGER WHILE INDICATING DIRECTION OF TURN WITH OTHER INDEX FINGER	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 DISENGAGE NOSEWHEEL STEERING	POINT TO NOSE WITH INDEX FINGER, LATERAL WAVE WITH OPEN PALM OF OTHER HAND AT SHOULDER HEIGHT	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 ERECT FIN FOLD FIN	HOLD RIGHT FOREARM VERTICAL AND GRASP ELBOW WITH LEFT HAND. FOREARM LEFT, THEN RIGHT, TO SIGNAL FOR ERECT FIN AND FOLD FIN	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 RUDDER TRIM CHECK	HOLD ARM FORWARD FROM SHOULDER, PALM OPEN. MOVE ARM RIGHT OR LEFT INDICATING DIRECTION OF RUDDER MOVEMENT	SAME AS DAY SIGNAL WITH ADDITION OF WANDS

Figure 27-1. Visual Ground Communications (Sheet 6)

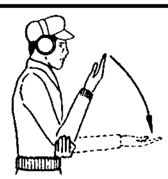
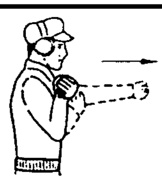
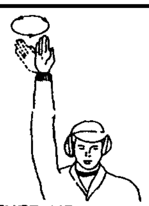
SIGNAL	DAY	NIGHT
 ELEVATOR TRIM CHECK	EXTEND ONE ARM IN FRONT WITH HAND HELD VERTICALLY. MOVE HAND UP AND DOWN FOR ELEVATOR TRIM	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 CONTROL SURFACES CYCLE	MOVE RIGHT HAND, WITH FIST CLENCHED, IN A RECTANGULAR PATTERN AT WAIST LEVEL	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 DIRECT LIFT CONTROL CHECK	MAKE OPEN AND CLOSING MOTION OF FINGERS AND THUMB AT EYE LEVEL. (IN-FLIGHT SPEEDBRAKE SIGNAL)	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 LOWER (LIFT) TOW LINK	REST RIGHT ELBOW IN LEFT PALM AT WAIST LEVEL; BRING RIGHT HAND DOWN TO HORIZONTAL POSITION	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 EXTEND/RETRACT MAD BOOM	LEFT HAND WRAPPED AROUND RIGHT FIST NEAR RIGHT SHOULDER. LEFT HAND STAYS IN POSITION WHILE RIGHT FIST MOVES FORWARD LEAVING LEFT HAND WRAPPED AROUND RIGHT ELBOW. REVERSE TO RETRACT MAD BOOM	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 OPEN/CLOSE SONO SAFETY DOOR	HANDS TO ONE SIDE, ONE RESTING ON TOP OF THE OTHER, BOTH PALMS DOWN. DROP (OR RAISE) THE LOWER HAND IN AN ALLIGATOR FASHION	SAME AS DAY SIGNAL WITH ADDITION OF WANDS
 FEATHER AIR REFUELING PACKAGE RAT	RIGHT ARM HELD VERTICAL PALM FLAT. ROTATE PALM ABOUT ARMS AXIS.	SAME AS DAY SIGNAL WITH ADDITION OF WANDS

Figure 27-1. Visual Ground Communications (Sheet 7)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Thumbs up, (or) nod of head.	Flashlight moved in circular motion.	Affirmative (Yes, I understand).	
Thumbs down, (or) turn of head from side to side.	Flashlight moved horizontally back-and-forth repeatedly.	Negative (No, I do not understand).	
Employ fingers held vertically to indicate desired numerals 1 through 5. With fingers horizontal, indicate number which added to 5 gives desired number from 6 to 9. A clenched fist indicates 0. (Hold hand hear canopy when signaling.)		Numerals as indicated.	A nod of the head. (I understand.) To verify numerals, addressee repeats. If originator nods, interpretation is correct. If originator repeats numerals, addressee should continue to verify them until they are understood.
Formation takeoff-leader raises either forearm to vertical positions.		I have completed my takeoff checklist and am ready for takeoff.	Stands by for signal (thumbs up) from wingman, holding arm up until answered.
Leader lowers arm.		Takeoff path is clear, I am commencing takeoff.	Executes takeoff in order.
Leader pats self on the head, points to wingman.	Lead aircraft flashes lights once, then turns them to bright and turns on anti-collision lights.	Leader shifting lead to wingman.	Wingman pats head and assumes lead. Wingman places lights on DIM, secures anticollision lights, and assumes lead.
Pilot blows kiss to leader.		I am leaving formation.	Leader nods (I understand) (or) waves goodbye.
Leader blows kiss and points to aircraft.		Aircraft pointed out leaves formation.	Wingman indicated blows kiss and executes.
Division leader holds up and rotates two fingers in horizontal circle, preparation to breaking off.		Formation breakoff.	Wingman relays signal to formation leader. Formation leader nods (I understand) (or) waves goodbye and executes.
Leader describes horizontal circle with forefinger.		Breakup (and rendezvous).	Wingman takes lead, passes signal after leader breaks, and follows.

Figure 27-2. Visual In-Flight Communications (Sheet 1 of 4)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Landing motion with open hand:		Refer to landing of aircraft generally used in conjunction with another signal.	
Followed by patting head.		I am landing.	Nods (I understand) or waves goodbye.
Followed by pointing to another aircraft.		Directs indicated aircraft to land.	Aircraft indicated repeats signal, blows a kiss and executes.
Raised fist with thumb extended in drinking position.		How much fuel have you?	Repeat signal, then indicate fuel in hundreds-of-pounds by finger numbers.
Rotary movement of clenched fist in cockpit as if cranking wheels.	Two dashes with external lights.	Lower or raise landing gear, flaps as appropriate.	Execute, when leader changes configuration.
Leader lowers hook.		Lower arresting hook.	Wingman lowers arresting hook. Leader indicates wingman's hook is down by thumbs-up signal.
DLC signal airborne followed by cracking speedbrakes.	Three dashes with external lights, or UHF transmission.	Extend speedbrakes.	Execute when leader extends speedbrakes.
Pointing index finger toward runway/ship in stabbing motion repeatedly, followed by lead change signal.	One dash with external lights, followed by leader switching lights to bright and moving out to side.	Landing runway/meatball and ship in sight.	Ashore: Breakoff and land Carrier. Breakoff and land.
One finger turnup signal.		By receiver: start turbine.	Tanker execute. Receiver gives thumbs-up when turbine starts.
One finger turnup followed by cut signal.	Circular flashlight motion.	Secure air refueling store turbine.	Tanker execute.
Form cone-shape with hand, all fingers extended aft (make signal close to canopy):			Tanker execute. Receiver gives thumbs-up if:
Cone moved aft.	Fly alongside tanker with refueling probe light on; shine flashlight on probe.	By receiver: extend drogue.	Drogue extends properly.
Cone moved forward.	Fly alongside tanker; give UP-signal with flashlight; turn off refueling probe light.	By receiver: retract drogue.	Drogue retracts fully and air turbine feathers.

Figure 27-2. Visual In-Flight Communications (Sheet 2)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Open hand held vertically and moved forward or backward, palm in direction of movement.		Adjust wing-position forward to 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 toward 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 glareshield, palm down.		Leveling off.	Prepare to 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.
Thumb waved backward over shoulder.		Take cruising formation (or) open up.	Execute.
Holds up right (or left) forearm vertically, with clenched fist (or) single wing-dip.		Wingman cross under to right (or left) echelon (or) in direction of wing-dips.	Execute.
Same as above, except with pumping motion (or) double wing-dip.		Section cross-under to right (or left) echelon (or) in direction of wing-dips.	Execute.
Lead plane wags with rudder.		Close-up or join-up; join-up on me.	Execute.
Tap earphones, followed by patting of head, and point to other plane.	UHF transmission.	Takeover communications.	Repeat signals pointing to self and assume communications lead.
Tap earphone, followed by patting of head.		I have taken over communications.	Nod (I understand).
Tap earphones and indicate by finger-numerals, number of channel to which shifting.		Shift to radio frequency indicated by numerals.	Repeat signal and execute.

Figure 27-2. Visual In-Flight Communications (Sheet 3)

SIGNAL			
DAY	NIGHT	MEANING	RESPONSE
Tap earphones and point to plane being called, followed by finger-numbers indicating frequency		You are being called by radio on channel indicated by finger numbers.	Repeat numbers. Check receiving frequency and switch to channel indicated by originator. Dial in manually, if necessary.
Arms bent across forehead weeping.	Horizontal motion of flashlight shone at other aircraft.	General emergency signal meaning: I am in trouble.	Carry out squadron doctrine for escort of disabled aircraft.
Landing motion with open hand.	Circular motion of flashlight shone at other aircraft.	I must land immediately.	Assume lead if indicated and return to base or nearest suitable field.
Point to pilot and give series of thumb-down movements.	Flash a series of dots with exterior lights.	Are you having difficulty?	Thumbs-up: I am all right. Thumbs down: I am having trouble. Lights off once, turn on steady: I am all right. Flash series of dots: I am having trouble.
HEFOE signals (Preceded by general emergency signal):			
One finger.	One flash.	Hydraulic trouble.	Nod of head: I understand.
Two fingers.	Two flashes.	Electrical trouble.	
Three fingers.	Three flashes.	Fuel trouble.	
Four fingers.	Four flashes.	Oxygen trouble.	Series of flashes: I understand.
Five fingers.	Five flashes.	Engine trouble.	

Figure 27-2. Visual In-Flight Communications (Sheet 4)

PART VIII

Weapon Systems

Refer to NAVAIR 01-S3AAB-1.1, Weapon Systems Manual, for S-3B weapon system information.

CHAPTER 28

Weapon Systems

Refer to the NATOPS Weapon Systems Manual, NAVAIR 01-S3AAB-1.1, for S-3B aircraft weapon system information.

PART IX

Flightcrew Coordination

CHAPTER 29

Flightcrew Coordination

29.1 INTRODUCTION

The primary mission of the sea control aircrewman is successful prosecution of the antisurface warfare, surface surveillance, coordinated operations, and tanking missions. Each of the crewmembers, including the pilot, cotactical coordinator (COTAC), tactical coordinator (TACCO), and sensor operator (SENSO), plays a vital role in this mission and the many other missions and tasks that the sea control aircraft may be called upon to perform.

To successfully accomplish the numerous S-3B missions, each crewmember must possess a thorough knowledge of the avionics equipment at his/her station and its operation. In addition, he or she must be familiar with the equipment used by other crewmembers at their stations.

The most successful S-3B crews function well together continuously and know each other's strengths and weaknesses. The mission commander is the overall mission coordinator and is responsible for all mission-related decisions. The pilot is responsible for the safe control of the aircraft throughout its entire mission. The duties of the aircraft flightcrew are necessarily integrated; each must support and contribute to the performance of the others. The importance of each crewmember being completely aware of all his or her responsibilities must be continuously stressed. The crew must realize that successful mission accomplishment and safety depend on flightcrew coordination.

Aircrew coordination training currency is mandated by OPNAVINST 3710.7 and 1542.7 series instructions. These instructions set forth the training and requirements for annual refresher of the critical skills necessary for effective mission performance. The Navy has identified seven common behavioral skills that were related to aviation mishaps. These seven critical skills of ACT are:

1. Decision-making
2. Assertiveness
3. Mission analysis
4. Communication
5. Leadership
6. Adaptability/flexibility
7. Situational awareness.

These skills are used on every flight and should be continually stressed to improve the understanding and effectiveness of aircrewmen. ACT issues of critical flight regimes, takeoffs, landings, catapults, arrested landings, low-level maneuvering, and in-flight refueling shall be thoroughly briefed. The goal of ACT is to increase mission effectiveness, minimize crew preventable errors, maximize crew coordination, and optimize risk management.

29.1.1 Responsibilities

1. Pilot — Ultimately responsible for safety of flight that includes but is not limited to: maintaining diligent lookout doctrine; coordinating internal/external scan sequence; exercising safe and positive control of the aircraft; notifying crewmembers of any planned abrupt aircraft maneuvers, changes in switch positions, or any changes in aircraft configuration.

2. COTAC — Backs up the pilot for safety of flight that includes but is not limited to: maintaining diligent lookout doctrine; coordinating internal/external scan sequence. Notifies the pilot of any safety-of-flight conflicts and acknowledges all switch position and configuration changes.

3. TACCO — Responsible for sensor utilization and weapons employment in support of the mission commander. Backs up the COTAC on communication and navigation.

4. SENSO — Coordinates with the TACCO for nonacoustic sensor utilization.

5. All aircrew — Each crewmember has responsibility toward safety of flight, compliance with NATOPS and standard operating procedures, and mission accomplishment. Within the chain of command, each crewmember must exercise vigilance and support both the pilot in command and mission commander with timely recommendations and backup as requested. Offers suggestions, including opinions on mission parameters, regardless of seniority of other crewmembers.

6. Mission commander — Responsible for all phases of the assigned mission.

7. Sterile Cockpit — A cockpit in which all conversations are limited to pertinent flight information. A sterile cockpit should be maintained during low-altitude maneuvering, takeoffs and landings, approaches, and emergencies.

Note

Crew coordination functions, duties, and responsibilities listed in this section are intended to be a guide and not to be used as an in-flight checklist.

29.2 SPECIFIC RESPONSIBILITIES

29.2.1 Flight Mission Planning

29.2.1.1 Pilot (Pilot in Command). Assists the mission commander or flight leader, as directed.

1. Along with the COTAC, plans mission (using charts, publications, environmentals, NOTAMs, etc.) and determines flight profile (en route, fuel, etc.) to complete assigned mission.

2. Along with COTAC, determines takeoff parameters.

29.2.1.2 COTAC

1. Assists mission commander/pilot with the preparation of materials to plan the mission (charts, publication, environmentals, NOTAMs, flight profile, fuel, etc.).

2. Along with the pilot, determines takeoff parameters.

29.2.1.3 TACCO

1. Assists mission commander/pilot/COTAC with required materials to complete assigned mission.

2. Determines sensor and weapons employment to successfully accomplish assigned mission.

29.2.1.4 SENSO

1. Assists TACCO in collection of mission data, environmentals, and target-of-interest parameters.

29.2.2 Brief

29.2.2.1 Pilot in Command

1. Ensures brief is conducted in accordance with NATOPS preflight briefing guide.

2. Discusses with crew any abnormal handling characteristics because of aircraft loadout, winds, temperature, altitude, etc.

3. Discusses desired use of navigation aids, displays, and cockpit communications.

29.2.2.2 Mission Commander

1. Ensures mission tactics, including sensor utilization, weapon system employment, degraded system operations, ROE, weapons/land standoffs, etc., are briefed.

29.2.3 Preflight. All aircrew shall review ADB and conduct assigned preflight in accordance with NATOPS.

29.2.3.1 Pilot

1. Verifies aircraft configuration, weapons load, and ACP.

2. Ensures required materials are onboard.

29.2.3.2 COTAC

1. Verifies aircraft configuration, weapons load, and ACP.

2. Ensures required materials are onboard.

29.2.3.3 TACCO

1. Verifies loadsheet.
2. Ensures required materials are onboard (TC, etc.).

29.2.3.4 SENSO

1. Verifies loadsheet.
2. Ensures required materials are onboard (TC, etc.).

29.2.4 Engine Start and Ground Procedures

29.2.4.1 Pilot

1. Performs Prestart Checklist in accordance with NATOPS and SOP.
2. Coordinates with crew prior to engine starts and moving generator switches.
3. Along with COTAC, acknowledges removal of pins.
4. Ensures door open light out and No. 2 engine clear before start.
5. Performs Engine Start and After Start in accordance with NATOPS and SOP.
6. Coordinates wing spread with ground crew and COTAC.
7. Notifies crew when pulling chocks.
8. Ensures aircraft is cleared to taxi and taxiway is clear.
9. Completes Takeoff Checklist (challenge and reply) prior to crossing the hold short.

29.2.4.2 COTAC

1. Performs Prestart Checklist in accordance with NATOPS and SOP.
2. Backs up pilot during starts for:
   a. Emergency signals from ground personnel
   b. Master caution lights/warning lights
   c. Abnormal start indications.
3. Reports to pilot number of pins groundcrew has pulled.
4. Verifies door open light out and No. 2 engine clear with a fire bottle manned.
5. Assists pilot with Afterstart Checklist.
6. Coordinates with pilot for wing spread and flight control wipeout.
7. Ensures aircraft is cleared to taxi and taxiway is clear.
8. Completes Takeoff Checklist (challenge and reply) prior to crossing the hold short or going into tension.
9. Visually and verbally verifies:
   a. Pitch trim
   b. Flap position
   c. Speedbrake position
   d. Takeoff parameters.
10. Verbalizes Takeoff Checklist is completed.

29.2.4.3 TACCO

1. Relays appropriate checklist items.
2. Verifies gear pins stowed and hatch closed prior to No. 2 engine start.
3. Coordinates generator transients with the pilot.
4. Conducts system checks and report status to COTAC.
5. Advises the pilot when ready to taxi.
6. Ensures Takeoff Checklist is completed.

29.2.4.4 SENSO

1. Relays appropriate checklist items.
2. Conducts system checks and reports status to TACCO.
3. Ensures gear pins stowed and hatch is closed prior to No. 2 engine start.
4. Ensures Takeoff Checklist is completed.

29.2.5 Takeoff/Departure

29.2.5.1 Pilot

1. Delivers takeoff brief with abort criteria.
2. Performs runup and wipeout, checking engines and configuration.
3. Ensures crew is ready for takeoff prior to brake release/launch signal.
4. Verbalizes when aircraft is clean.

29.2.5.2 COTAC

1. Ensures takeoff brief with abort criteria has been covered and delivers brief to crew.
2. Backs up pilot on engine runup and configuration.
3. Verifies NWS off at 60 knots.
4. After launch, crosscheck AOA, altitude, VSI, and airspeed. Verbalize to crew the status of aircraft (e.g., airborne with two positive rates of climb).
5. Backs up pilot on departure procedures and safety of flight and verbally notes deviations.
6. Confirms aircraft clean at proper airspeeds and completes After Takeoff Checklist.
7. Coordinates switching communication and navigational aids as necessary.

29.2.5.3 TACCO

1. Informs the pilot when ready to take off.
2. Provides backup for departure and verbally notes deviations.

29.2.5.4 SENSO

1. Informs pilot when ready for takeoff.

29.2.6 En Route

29.2.6.1 Pilot

1. Manages fuel, monitors engine instruments and navigation.

29.2.6.2 COTAC

1. Monitors engine instruments and updates navigation as necessary.
2. Monitors fuel and periodically updates bingo/divert information to include en route and destination weather.

29.2.6.3 TACCO

1. Updates the pilot's display as required.
2. Directs crew for upcoming mission.

29.2.6.4 SENSO

1. Operates systems as required.

29.2.7 Sea Control Mission

29.2.7.1 Pilot

1. Initiates navigation and fuel checks.
2. Updates bingo/divert periodically.

29.2.7.2 COTAC

1. Assists both pilot and TACCO in safety of flight and mission completion.
2. Coordinates mission communications with TACCO.

29.2.7.3 TACCO

1. Directs tactics/weapons employment and sensor utilization.
2. Coordinates mission communications with COTAC.

29.2.7.4 SENSO

1. Assists TACCO in recordkeeping, TACPLOT management, and sensor utilization.

29.2.8 Logistics/Tanking

29.2.8.1 Pilot

1. Directs movement of receiver aircraft.

2. Cross-checks configuration and fuel status.

29.2.8.2 COTAC

1. Monitors movement of receiver aircraft.

2. Cross-checks aircraft configuration.

3. Manages fuel transfer system.

29.2.8.3 TACCO

1. Provides backup with the FLIR.

29.2.8.4 SENSO

1. Provides backup with the FLIR.

29.2.9 Recovery/Landing/Shutdown

29.2.9.1 Pilot

1. Ensures Approach Checklist is completed.

2. Verifies landing weight and "on-speed" airspeed.

3. Completes Landing Checklist (challenge and reply).

4. Verbally notes landing aid (VASI, Fresnel lens, etc.).

5. Verbally notes S/Bs after touchdown.

6. Verbally notifies crew when clear of runway and ready to safe seats.

7. Completes After Landing Checklist in accordance with NATOPS.

29.2.9.2 COTAC

1. Completes Approach Checklist.

2. Provides approach brief, backs up pilot on approach.

3. Verifies landing weight and "on-speed" airspeed.

4. Completes Landing Checklist (challenge and reply).

5. Confirms AOA airspeed cross-check prior to final approach.

6. Verbally notes S/Bs after touchdown.

7. Monitors airspeed versus runway remaining.

8. Assists pilot with After Landing Checklist.

29.2.9.3 TACCO

1. Monitors communication and assists as requested.

2. Ensures Landing Checklist is completed.

29.2.9.4 SENSO

1. Monitors communication and assists as requested.

2. Ensures Landing Checklist is completed.

29.2.10 Debrief. All aircrew ensures a thorough debrief is conducted to include an overview of the flight, crew interaction, and overall mission success.

29.3 SPECIAL CONSIDERATIONS

29.3.1 Functional Checkflight

29.3.1.1 Pilot

1. Briefs and debriefs with Quality Assurance representative in accordance with OPNAVINST 4790 series.

2. Briefs special considerations of flight.

29.3.1.2 COTAC

1. Attends QA brief and debrief and completes FCF checklist.

29.3.2 Formation Flights

29.3.2.1 Pilot

1. Briefs in accordance with NATOPS preflight briefing guide.

2. Ensures proper lookout doctrine for safety of flight.

29.3.2.2 COTAC

1. Maintains sight of wingman or lead (as applicable) and complies with standard signals.

2. Ensures proper lookout doctrine for safety of flight.

29.3.3 Emergencies

29.3.3.1 Pilot

1. Maintains positive control of the aircraft and executes appropriate emergency procedures.

2. Discusses emergency contingencies, including abnormal approach and landing.

29.3.3.2 COTAC

1. Assists the pilot in performing all required emergency procedures.

2. Ensures aircraft is under control with immediate action items completed prior to referencing PCL.

3. Discusses emergency contingencies, including abnormal approach and landing.

29.3.3.3 TACCO

1. Assists the pilot and COTAC in referencing the PCL as directed.

29.3.3.4 SENSO

1. Assists the pilot and COTAC in referencing the PCL as directed.

29.3.4 Out of Control Flight

Crew coordination is vital during out of control flight. Short, precise communication between the pilot and COTAC will enable proper analysis of the out of control situation and confidence in the control inputs required to recover the aircraft.

29.3.4.1 Pilot

1. Brief aircrew on OCF procedures and aircrew duties to be performed during recovery. Ejection criteria should be thoroughly discussed as well as communication responsibilities during the evolution.

2. If the aircraft departs controlled flight, perform OCF immediate action steps and inform the crew of your actions.

3. Make an assessment of whether the aircraft is recovering or not and verbalize the assessment.

29.3.4.2 COTAC

1. Ensure OCF immediate action steps are correctly performed

2. Provide pilot back-up by vocalizing pre-briefed instrument reading to include:

   a. Altimeter

   b. AOA

   c. Airspeed with trend (increasing, decreasing, or constant)

   d. Turn needle.

PART X

NATOPS Evaluation

CHAPTER 30

NATOPS Evaluation

30.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating this aircraft. The NATOPS evaluation program is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with the various operational commitments and missions of Navy units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety. Maximum benefit from the NATOPS evaluation program is achieved only through the vigorous support of the program by commanding officers as well as flight crewmembers.

To achieve the goals cited above, the S-3B NATOPS program is designed to individually evaluate pilots and naval flight officers through open and closed book examinations, oral examinations, and flight evaluations conducted in flight, and/or OFT/WST devices. The integrated weapons system utilized mutually by the copilot/COTAC and tactical coordinator necessitates certain redundant knowledge among these crewmen to effectively utilize the weapons system in all mission situations. Additionally, the copilot/COTAC must be able to assist the pilot in the execution of normal and emergency procedures regardless of his designator. To become NATOPS qualified, the evaluation requirements shown in Figure 30-1 must be met.

30.2 DEFINITIONS

The following terms, which are used throughout this section, are defined as to their specific meaning within the NATOPS program.

30.2.1 NATOPS Evaluation. A periodic evaluation of individual flight crewmember standardization consisting of an open-book examination, a closed-book examination, and an oral examination. A flight evaluation is required on initial qualification and on requalification after lapse of currency. Annual NATOPS currency may be maintained by satisfactory completion of the open book, closed book, and oral examination in conjunction with a flight evaluation or (at the unit commanding officer's discretion) a WST evaluation.

30.2.2 NATOPS Reevaluation. A partial NATOPS evaluation administered to a flight crewmember who has been placed in an unqualified status by receiving an Unqualified grade for any of his ground examinations or the evaluation flight. Only those areas in which an unsatisfactory level was noted need to be observed during a reevaluation.

30.2.3 Qualified. That degree of standardization demonstrated by a very reliable flight crewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.

30.2.4 Conditionally Qualified. That degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. He is considered safe to fly as a pilot in command or to perform normal duties without supervision, but more practice is needed to become qualified.

30.2.5 Unqualified. That degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. He should receive supervised instruction until he has achieved a grade of Qualified or Conditionally Qualified.

30.2.6 Area. A routine of preflight, flight, or postflight.

30.2.7 Subarea. A performance subdivision within an area that is observed and evaluated during an evaluation flight.

	Open Book Aircraft and Weapon Systems	Closed Book Aircraft and Weapon Systems	Oral Examination Aircraft and Weapon Systems	Evaluation Flight Aircraft and Weapon Systems
S-3B PILOT[5]	X	X	X	X[1, 3]
S-3B NFO[4, 5]	X	X	X	X[1, 2]
S-3B SPECIAL MISSION CREWMAN[6]	X	X	X	X

NOTES

[1] Aircraft system evaluation may be conducted in device 2F92 with operable visual system for NATOPS evaluation subsequent to initial qualification.

[2] Weapon systems evaluations may be conducted during a WST evolution in the coupled or uncoupled mode.

[3] S-3B pilot evaluation flight should be flown from the left seat and concerned with the safe, standardized control of the aircraft. Weapon system knowledge must be demonstrated by successful completion of open- and closed-book examinations. Other weapon system training/evaluation can be handled through squadron/ command training programs either in-flight or in device 2F92.

[4] S-3B NFO instructor evaluation shall be flown with S-3B evaluators for both the COTAC and TACCO seats.

[5] S-3B pilots and NFOs who do not fly the aircraft on weapons related missions are not required to complete Part Two (Weapon Systems) of the open-and closed-book examinations and flight evaluations.

[6] Special mission crewman qualifications require aircraft portions only.

Figure 30-1. Evaluation Requirements

30.2.8 Critical Area. Any area or subarea that covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

30.2.9 Emergency. An aircraft component, system failure, or condition that requires instantaneous recognition, analysis, and proper action.

30.2.10 Malfunction. An aircraft component, system failure, or condition that requires recognition and analysis but permits more deliberate action than is required for an emergency.

30.3 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. Flight crewmembers desiring to attain/retain qualification in the aircraft shall be evaluated initially in accordance with OPNAV Instruction 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 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. Those who receive a grade of Unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the day the initiated ground evaluation was commenced and the date the flight evaluation is satisfactorily completed. Additionally, the evaluation will include training by the NATOPS instructor/ evaluator to provide the evaluee with the following:

1. A verbal update and demonstration of the latest NATOPS changes, techniques, and procedures.

2. Time for the evaluee to resolve unanswered questions not covered by the fleet readiness squadron, operational squadron, or other training source.

3. Identification of evaluee significant deficiencies and methods recommended to correct them.

30.4 GROUND EVALUATION

Before commencing the flight evaluation, an evaluee must achieve a minimum grade of Qualified on the open- and closed-book examinations, and an OFT/ WST procedures evaluation. 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 Model Manager maintains a bank of questions and answers for use by unit NATOPS instructors in preparing the written examinations. The complete bank of questions is available to them upon request.

30.4.1 Open-Book Examination. Questions in this category may be based on tables, graphs, charts, figures, and other information not conducive to memorization. Up to 50 percent of the questions used may be taken from the appropriate question bank. The purpose of the open-book examination portion of the written examination is to evaluate the crewmember knowledge of appropriate publications, aircraft systems, and weapon systems, as appropriate to crew function. The pilot and NFO open-book examinations shall consist of two parts, one on aircraft systems and one on weapon systems. It is not mandatory that the pilot and NFO open-book examinations be the same. The total number of questions on each part shall not exceed 100 questions nor be less than 25 questions for a total maximum of 200 and total minimum of 50 questions. A grade of Qualified must be attained on each part of the open-book examination.

30.4.2 Closed-Book Examination. Fifty percent of the closed-book examination should be taken from the appropriate question bank and shall include questions concerning normal procedures and aircraft or weapon system limitations, as appropriate to crew position function. The pilot and NFO closed-book examination shall consist of two parts; one on aircraft systems (flight manual) and one on weapon systems. It is not mandatory that the pilot and NFO closed-book examinations be the same. The total number of questions on each part shall not exceed 50 nor be less than 25 questions for a total maximum of 100 and total minimum of 50 questions. At least 40 percent of the questions in the aircraft systems part shall concern emergency procedures safety-related items, and survival equipment. At least 10 percent of the weapon systems part shall be safety related.

Safety-related questions concern warnings, cautions, notes, lights/limitations, noncritical emergency procedures, and crew coordination items. An incorrect response to a safety-related question does not constitute failure of the exam, but shall be thoroughly debriefed. Only memory (asterisked) steps of emergency procedures are considered critical items. An incorrect response to a critical item, as appropriate to crew position/function, will result in a grade of Unqualified. A grade of Qualified must be attained on each part of the closed-book examination. Maximum time for completion of both parts shall not exceed 2 hours (allowing 1 hour for each part).

30.4.3 Oral Examination. This examination is designed to evaluate the examinee's overall knowledge of the aircraft systems and components and his ability to recognize malfunctions. Questions may be taken from this or other appropriate manuals and drawn from the experience of the instructor/evaluator. Such questions should be direct and positive and should in no way be opinionated.

30.4.4 OFT/WST Procedures Evaluation. The OFT/WST (if available) can be used to evaluate the crewmembers efficiency in the execution of normal procedures, and their reaction to simulated emergencies and malfunctions.

Pilot/NFOs shall complete an emergency procedures trainer in the device 2F92 (where available) prior to a front seat NATOPS flight evaluation.

30.4.5 Grading Instructions. Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of Qualified or Unqualified.

30.4.5.1 Open-Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.5.

30.4.5.2 Closed-Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.3.

30.4.5.3 Oral Examination and OFT/WST Procedures Evaluation. A grade of Qualified or Unqualified shall be assigned by the NATOPS instructor/ evaluator on the basis of the following criteria.

30.4.5.4 Normal Procedures

1. Qualified — Demonstrates adequate knowledge of procedures and systems with only minor deviations or omissions.

2. Unqualified — Exhibits obvious lack of knowledge of procedures and systems that results in serious or numerous oversights affecting safety or mission completion.

30.4.5.5 Emergency Procedures and Malfunctions

1. Qualified — Recognizes emergencies promptly, analyzes them properly, and takes the proper corrective action. Slow reaction in situations that cannot be realistically simulated will not justify failure of this section.

2. Unqualified — Demonstrates improper or unsafe cockpit procedures. Fails to recognize emergencies, overlooks probable or possible causes, or takes improper corrective action. Slow reaction in obvious situations that require immediate action until the condition is no longer remediable.

30.5 FLIGHT EVALUATION

The flight evaluation is intended to measure the degree of standardization demonstrated by the crewman being evaluated. It is not intended to measure technique beyond a point necessary to ensure safe completion of the mission. Within reasonable limits, any individual evaluated should be able to attain a grade of Qualified, based on demonstrated knowledge without regard to special proficiency or technique.

Note

All phases of the ground evaluation must be completed prior to commencement of the flight evaluation. Additionally, the evaluee's NATOPS publications will be inspected for completeness and correctness of entries of all changes prior to the evaluation.

The flight evaluation may be completed on any flight that will permit the evaluee to demonstrate standard procedures in the preparation for and execution of a representative type of mission for the model aircraft concerned. With the concurrence of the evaluator/instructor, the unit concerned may select the mission that is best suited to aircraft configuration, training phase, target facilities, and so forth. Only those areas that are required by the particular mission and that can be actually observed by the evaluator/ instructor will be graded. Optimally, performance should be evaluated in both flights and WST periods. It is recognized that lack of aircraft or trainer assets may necessitate evaluation of performance in either of the aforementioned.

Evaluation of copilot/COTAC and TACCO positions may utilize Device 2F92 or 14B50 in either coupled or uncoupled mode. Pilot requalification may be conducted in Device 2F92 with a correctly operating visual and motion system.

Note

Evaluations, whether or not conducted on an actual flight in the aircraft, shall include an aircraft preflight.

The number of flights required to complete the flight evaluation should be kept to a minimum, normally one flight. The areas and subareas to be observed and graded on an evaluation flight are outlined in the grading criteria with critical areas marked by an asterisk (*). Subarea grades will be assigned in accordance with the grading criteria. These subareas shall be combined to arrive at the overall grade for the flight. Area grades, if desired, shall also be determined in this manner.

30.5.1 Safety Considerations During Evaluation Flights. Because of the broad significance of safety, it is impractical to list all contingencies that may fall under the general category of grading criteria in safety. Generally, mission success is subject to compromise when there are any safety infractions, missions, or deviations beginning with mission planning and ending with the postflight debriefing. The following provide additional guidance in these areas:

1. Violations of pertinent directives or procedures that have a direct bearing on the safe completion of the mission, or negligence in following any procedure or directive that jeopardizes the safety of the pilot or aircraft, will constitute an overall grade of Unqualified. The degree of jeopardy involved, in the absence of specific directives, must be determined by the instructor/evaluator, based on good judgment and experience.

2. The latitude given the examiner in grading safety items must be exercised with care. The examiner must observe a discrepancy that directly contributes to an unsafe condition to justify an overall grade of Unqualified for safety reasons.

3. When an in-flight safety discrepancy is imminent, and the pilot appears unaware of the condition, or has not taken the appropriate action, the examiner will correct the situation by directing that action be taken. Safety of flight cannot and must not be compromised because of reluctance on the part of the examiner to correct any discrepancy.

4. If a grade of Unqualified is given for safety reasons, the examiner will include a written statement, describing the deficiency on the NATOPS Evaluation Report. The statement should be clearly titled, Safety Discrepancy.

30.5.2 Flight Evaluation Grading Criteria. The grading criteria establishes the standard for grading flight crew performance, but does not relieve the evaluator/instructor from using good judgment based on experience. In those items where a flight crewmember fails to meet the minimums set forth in the grading criteria, and the examiner (through past experience and judgment) knows that the discrepancy could have been caused by other factors such as weather, turbulence, or partial malfunction of aircraft or weapons systems, he may assign a grade of Qualified. A note to this effect will be included on the NATOPS Evaluation Report. Only those subareas observed or required will be graded. The grades assigned for subareas shall be determined by comparing the degree of adherence to standard procedures with ratings as listed. Momentary deviations from standard procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety or mission performance and the evaluee applies prompt corrective action.

30.6 NONFLIGHTCREW PERSONNEL

All nonflightcrew personnel shall complete either a selected passenger or special mission personnel qualification. These qualifications are designed to ensure these personnel have completed all applicable flight physiology and water survival requirements, and have a basic understanding of applicable S-3B aircraft systems, survival equipment, crew coordination, and emergency procedures. When not specifically addressed, all applicable NATOPS requirements shall be observed.

30.6.1 Selected Passenger. The commanding officer shall ensure that all selected passengers complete the following requirements:

1. Flight physiology and water survival requirements as defined in OPNAVINST 3710.7 for selected passenger

2. Current flight physical

3. Current static seat qualification

4. The aircraft commander is responsible for the S-3 egress system brief to include:

   a. Seat preflight

   b. Canopy/hatch jettison procedures

   c. Ejection procedures

   d. Crew door operation (internal/external).

30.6.2 Special Mission Personnel. Special mission personnel qualification establishes a minimum degree of competence for noncrewmembers flying under temporary flight orders (maintenance personnel) in the S-3. Special mission personnel are qualified to fly in the back seat of the S-3 only. Special mission personnel shall complete the following:

1. Flight physiology and water survival qualifications as defined in OPNAVINST 3710.7 for special mission personnel.

2. A complete NATOPS flight evaluation consisting of open-book, closed-book, and oral examinations and a NATOPS flight evaluation by a qualified NATOPS instructor. The written examinations shall not exceed 40 questions or be less than 25 questions. The following subject area shall be included with a minimum of 50 percent being safety related.

   a. Emergency procedures

   b. Survival equipment

   c. ICS system/operation

   d. Internal and seat preflight

3. All special mission personnel shall complete a NATOPS evaluation annually.

30.7 RECORDS AND REPORTS

A NATOPS evaluation report, OPNAV 3710/7 (4/90) (Figure 30-2) shall be completed for each evaluation and forwarded to the evaluee's commanding officer. Naval aviators shall be designated as S-3B pilot, naval flight officers shall be designated as S-3B NFO. Only special mission personnel who have received an evaluation flight shall be designated as such. This report shall be filed and retained in the individual's flight training record.

NATOPS EVALUATION REPORT

OPNAV 3710/7 (4-90) S/N 0107-LF-009-8000 **REPORT SYMBOL OPNAV 3710-21**

NAME (Last, first, initial)	GRADE	SERVICE NUMBER
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

*WST, OFT, COT, or cockpit check in accordance with OPNAVINST 3710.7 (effective edition)

Figure 30-2. NATOPS Evaluation Report

30.8 PILOT NATOPS FLIGHT EVALUATION

AREA 1: PREFLIGHT

*A. Flight Planning

*1. Performance computations including fuel usage

*2. C and trim calculations

3. Completion of required forms and logs

4. Review of maintenance records and mission essential/special equipment.

B. Briefing

1. Mission

2. Emergency procedures

3. Simulated emergency training

4. Applicable mission sensors/sensor limitations/restrictions.

C. Mission Planning

1. Navigation route/applicable navigation publications

2. Sensor utilization plan

3. ECM plan

4. Communication plan/including voice procedures, frequencies, Link-11 parameters, EMCON restrictions.

D. Aircraft Acceptance

1. Previous discrepancies review

2. Part A, aircraft acceptance form.

E. Personal Flying Equipment

1. Condition/completeness

2. Knowledge of location/usage

3. Ejection seat.

F. Aircraft Preflight

1. Walkaround inspection (interior and exterior)

2. Verify ACP configuration

3. Ejection seat

4. Prestart checklist complete.

AREA 2: PRETAKEOFF

A. Start/Poststart Procedures

1. Limitations

2. Malfunctions

3. Checklist completion.

B. Taxi

C. Takeoff Checklist.

*AREA 3: TAKEOFF

A. Ground Roll

B. Directional Control

C. Lift-off

D. Transition.

AREA 4: DEPARTURE

A. Climb

B. Level Off.

AREA 5: IN-FLIGHT

A. Basic Airwork

1. Stalls

2. Aerobatics/unusual attitudes

3. Speedbrake characteristics.

B. Fuel Management

C. APU Operation

*Critical area/subarea.

D. Navigation

1. INS management

2. Accuracy checks/position updating

3. Degraded mode operations.

*E. Weapons

1. Function of all ACP switches and controls.

2. Operational limitations and safety considerations

3. ECM switches and controls.

F. Alert Management.

*AREA 6: EMERGENCY PROCEDURE

A. EFCS (discuss only)

B. Unusual Attitudes

C. Poststall Gyrations

D. Engine Shutdown/Airstart.

AREA 7: ARRIVAL

A. VFR Entry

1. Break

B. Penetration

C. GCA/Low Approach

D. Missed Approach.

*AREA 8: LANDING

A. Full Flaps

B. No Flaps

C. Crosswinds

D. SSE

E. No Mirror

F. No Yaw, No DLC, No AOA

G. Roll and Go.

AREA 9: POSTFLIGHT

A. Equipment Secure

B. Aircraft Shutdown

C. Postflight Inspection

D. Yellow Sheet/MAF

E. Debriefing.

AREA 10: COMMUNICATIONS

30.9 NFO NATOPS FLIGHT EVALUATION

30.9.1 Aircraft Systems/COTAC Seat

AREA 1: PREFLIGHT

*A. Flight Planning

*1. Performance computations including fuel usage, c, and trim calculations

2. Review maintenance records and mission essential/special equipment.

B. Briefing

1. Mission

2. Emergency procedures

3. Simulated emergency training

4. Applicable mission sensors/sensor limitations/restrictions.

C. Mission Planning

1. Navigation route/applicable navigation publications

2. Sensor utilization plan

3. Communications plan/including voice procedures, frequencies, Link-11 parameters, EMCON.

*Critical area/subarea.

D. Personal Flying Equipment

1. Completeness/condition
2. Knowledge of location/usage
3. Ejection seat.

E. Aircraft Preflight

1. Walkaround inspection (interior and exterior)
2. Verify/ACP configuration
3. Ejection seat
4. Prestart checklist complete.

AREA 2: PRETAKEOFF

A. Start/Poststart Procedures

1. Checklist completion
2. Limitations
3. Malfunctions
4. Radar initialization
5. Communications configuration (RSCI/ KY-58/KG-40/Link-11).

B. Tableau Verification

C. Taxi

D. Takeoff Checklist.

AREA 3: TAKEOFF

A. Monitor Engine Instruments.

AREA 4: DEPARTURE

AREA 5: IN-FLIGHT

A. IFR/VFR Procedures

B. Stalls/Speedbrake Characteristics

C. Confidence Maneuvers/Unusual Attitudes

D. Fuel Management

*E. APU Operation

F. Navigation

1. INS management
2. Accuracy checks/position updating
3. Degraded mode operations
4. NAV ALERT processing

G. Off-Line Functions

1. Radar controls
2. Radar/FLIR recorder operation

H. On-Line Functions

1. Operation of COTAC INCOS panel.

*I. Weapons

*1. Function of ACP switches and controls

2. Kill stores inventory

3. Operation limitations and safety considerations.

J. Data Link

1. RSCI link controls and functions.

*Critical area/subarea.
Complete if program available.

*AREA 6: EMERGENCY PROCEDURES

A. EFCS (discuss only)

B. Poststall Gyrations

C. Engine Shutdown/Airstart

D. Checklists Knowledge/Use

E. Aircraft/Engine Limits

F. Pilot Backup.

AREA 7: ARRIVAL

A. VFR Field Entry

1. Break

B. IFR Holding

C. Penetration

D. GCA/Low Approach

E. Missed Approach

AREA 8: LANDING

A. Checklist

B. Pilot Backup

1. Full flaps

2. No flaps

3. SSE

4. No mirror

5. No Yaw, No DLC, No AOA

6. Roll and go.

AREA 9: POSTFLIGHT

A. Equipment Secure

B. Aircraft Shutdown

*Critical area/subarea.

C. Postflight Inspection

D. MAF

E. Debriefing.

AREA 10: COMMUNICATIONS

30.9.2 Weapon System/TACCO Seat

AREA 1: PREFLIGHT

A. Flight Planning

1. Review maintenance records and mission essential/special equipment

2. Review search/kill stores load.

B. Briefing

1. Mission

2. Area and weather limitations

3. Ordnance load and mission essential/special equipment

4. Tactical brief

a. Preflight responsibilities

b. Navigation/communications responsibilities

c. ALERT management

d. Search stores management

e. Nonacoustic utilization (tactics)

f. Sensor limitations/restrictions.

C. Personal Flying Equipment

1. Completeness/condition

2. Knowledge of location/usage

3. Ejection seat.

*D. Aircraft Preflight

1. Walkaround inspection (interior and exterior).

AREA 2: PRETAKEOFF

A. Program Loading

B. Tableau Verification.

AREA 3: TAKEOFF/DEPARTURE

AREA 4: IN-FLIGHT

*A. Navigation

1. Accuracy checks/position updating
2. Function of GEO NAV option selects
3. Fly-to-point/special pattern utilization
4. Degraded mode operations
5. NAV ALERT processing

B. Off-Line Functions

1. Search stores

*C. On-Line Functions

1. Data processing
   a. Normal operation
2. ESM system
3. Radar system
4. FLIR
5. Data link
6. Kill stores
7. Harpoon/Harpoon simulation
8. ECM
9. Search stores
10. US4-42 Recorder

*Critical area/subarea.

D. Crew Coordination

1. Completion of system checks/KILO report
2. Coordination of sensors with EMCON plan and assigned mission
3. Timeliness of information flow to/from crew
4. Aircraft control
5. Fuel/NAV status
6. ALERT management.

*AREA 5: EMERGENCY PROCEDURES

AREA 6: ARRIVAL/LANDING/POSTFLIGHT

30.10 SPECIAL MISSION PERSONNEL NATOPS FLIGHT EVALUATION

*AREA 1: PREFLIGHT

A. Mission Brief

1. Mission (crew coordination)

*2. Emergency procedures (briefed by pilot).

B. Personal Safety and Survival Equipment

1. Man-mounted equipment
2. Aircraft-mounted equipment.

C. Aircraft Inspection

1. Previous discrepancy record (review)
2. Daily/preflight form (review)
3. Part A, aircraft acceptance form
4. Aircraft exterior and interior inspection (refer to Chapter 8).

*AREA 2: EMERGENCIES

A. Ejection

B. Explosive Decompression

C. Emergency Landings

D. Ditching

E. Fires

F. Emergency Exits

G. Windshield/Canopy Crack.

AREA 3: PRESTART

*A. Ejection Seat

1. Strap-in

2. Safety precautions.

*B. Oxygen System

1. Mask and regulator hookup

2. Proper use of oxygen.

C. Communications

1. Communications control box management

2. Voice procedures (during entire flight).

AREA 4: PRETAKEOFF/POST-TAKEOFF

*A. Checklists (compliance).

*AREA 5: LANDING/POSTFLIGHT

A. Landing Checklist

B. Postlanding Checklist

C. Discrepancies Documented and Turned Into Maintenance

D. Debrief.

*Critical area/subarea.

PART XI

Performance Data

CHAPTER 31

Performance Data — Introduction

31.1 SCOPE AND ARRANGEMENT

These performance data provide information to be used as a guide for safe and efficient operation of the aircraft. The material is intended for use by flight- crews prior to and during flight and has been arranged to yield direct solutions wherever possible. Descriptive text in each section explains the use of the charts. Mission Planning (Chapter 40) is included to show how the individual performance charts for each segment may be combined to plan an entire mission.

31.1.1 Performance Data Basis. The performance data included are based on flight tests. All performance and operating weight ranges included are based on operation with JP-5 fuel. Allowances have not been included in fuel flow values to compensate for variations in aircraft or operational techniques.

31.1.2 Fuel and Fuel Density. The standard fuels for operation of the S-3B aircraft are JP-4, JP-5, and JP-8, with nominal densities of 6.5, 6.8, and 6.7 pounds per gallon, respectively. Since JP-5 weighs approximately 4.5 percent more than JP-4 for an equal volume, range with the same number of gallons will be 4.5 percent greater with JP-5 fuel. Similarly, range will be 3 percent greater with JP-8. To stay within the allowable loading of the aircraft, the weight of the fuel rather than the volume must be considered.

31.1.3 Standard Operating Configurations. Separate flight planning data are provided for various configurations of external stores drag. Where applicable, each chart shows the configuration designation.

31.2 AIRCRAFT CONFIGURATION

The various external stores-carrying capabilities of the S-3B aircraft necessitate a presentation method that will account for the effects of these stores on aircraft performance with a minimum number of charts. A drag count configuration format has been selected to accomplish this objective. In order to obtain aircraft performance, it is necessary to determine the drag counts of the desired configuration prior to selecting the series of charts to be used. Drag counts are obtained by the use of Figure 31-1, which lists drag counts for a variety of external stores configurations. The series of charts to be used is then obtained from Figure 31-2, which relates drag counts to drag configuration.

EXAMPLE:

The external stores configuration is six Mk 82, conical bombs on pylons plus TER racks.

Figure 31-1 shows the store drag count for this configuration is 84 + 12 = 96. Figure 31-2 shows that a drag count value of 96 is between configuration C and D . Determine performance information for this configuration by interpolation between these two configurations.

31.3 AIRCRAFT GROSS WEIGHT

The incremental weights of external stores are shown in Figure 31-1. Figure 31-3 shows the incremental weights for bomb bay stores. A typical aircraft gross weight is illustrated in Figure 31-4. Specific weight and balance data should be obtained from NAVAIR 01-1B-40, Weight and Balance Handbook, Form F.

Drag count and weight columns provide the total drag and weight for each configuration excluding pylon drag and weight (includes drag and weight for racks and launchers, where applicable).

31.4 AIRSPEED POSITION ERROR CORRECTION

The airspeed position error correction, which is applied to indicated airspeed to obtain calibrated airspeed, is determined by Figure 31-5. The amount of correction is valid for either the pilot or copilot/COTAC system, and the conditions where subtractive corrections are required are emphasized by shaded areas.

ITEM	STORES	CONFIGURATION	DRAG COUNT	WEIGHT— LB
Note Drag count for the aircraft's two pylons (12) is not included in this table and must be added after computing external stores drag count. The weight of the pylons is included in the aircraft basic weight (see Figure 31-4).				
1	(2) TER racks		44	208
2	Tanks and refueling stores:			
	(2) Aero-1D fuel tanks	Empty Full JP-4 Full JP-5	23 23 23	414 3,859 4,018
	D-704 Refueling store (hose retracted)	Empty Full JP-4 Full JP-5	20 20 20	691 2,650 2,740
	31-300 Refueling store (hose retracted)	Empty Full JP-4 Full JP-5	20 20 20	671 2,630 2,720
	31-301 (A/A42R-1) Refueling store (hose retracted)	Empty Full JP-4 Full JP-5	20 20 20	808 2,760 2,850
	D-704/3 1-300/31-301 With refueling hose and drogue extended		27	
3	Cargo pods:			
	(2) CNU-188	Empty Full	23 23	436 1,136
	(2) CNU-264	Empty Full	48 48	900 2,900
4	(1) TACTS pods on LAU-7 launcher		12	160
5	Communications relay pod:			
	(1) ARQ-49		26	570

Figure 31-1. External Stores Drag Counts and Weights (Sheet 1 of 3)

ITEM	STORES	CONFIGURATION	DRAG COUNT	WEIGHT— LB
6	Bombs:			
	(2) Mk 20 Rockeye		24	992
	(6) Mk 20 Rockeye on TER racks		82	3,184
	(2) CBU-59 APAM		24	1,480
	(6) CBU-59 APAM on TER racks		82	4,648
	(2) Mk 82 or BDU-45/B	Conical Snakeye	4 10	1,062 1,140
	(6) Mk 82 or BDU-45/B on TER racks	Conical Snakeye	84 94	3,394 3,628
	(2) Mk 83	Conical Snakeye	6 17	1,970 2,114
	(4) Mk 83 on TER racks	Conical Snakeye	14 86	4,148 4,436
	(2) Mk 84	Conical	11	3,978
	(6) Mk 76 or BDU-33 on TER racks		58	358
	(6) Mk 106 on TER racks		70	238
	(6) BDU-48 on TER racks		70	268
7	(2) AGM-84 A/C/D		76	2,330
8	Flare dispensers:			
	(2) SUU-44	Empty Faired Unfaired	29/64 29 64	264 718 718

Figure 31-1. External Stores Drag Counts and Weights (Sheet 2)

ITEM	STORES	CONFIGURATION	DRAG COUNT	WEIGHT— LB
8 (cont)	(3) SUU-44 on TER rack	Empty Faired Unfaired	5 1/102 51 102	500 1,181 1,181
	(2) SUU-25	Empty Faired Unfaired	29/64 29 64	520 1,000 1,000
	(3) SUU-25 on TER rack	Empty Faired Unfaired	5 1/102 51 102	884 1,604 1,604
11	(2) A/B37U TALD on TER rack		76	800
12	(4) Mk 58 MLM on TER racks		70	260
13	Configuration changes:			
	FLIR	Extended	20	BAW
	Bomb bay doors	Open	120	BAW

Figure 31-1. External Stores Drag Counts and Weights (Sheet 3)

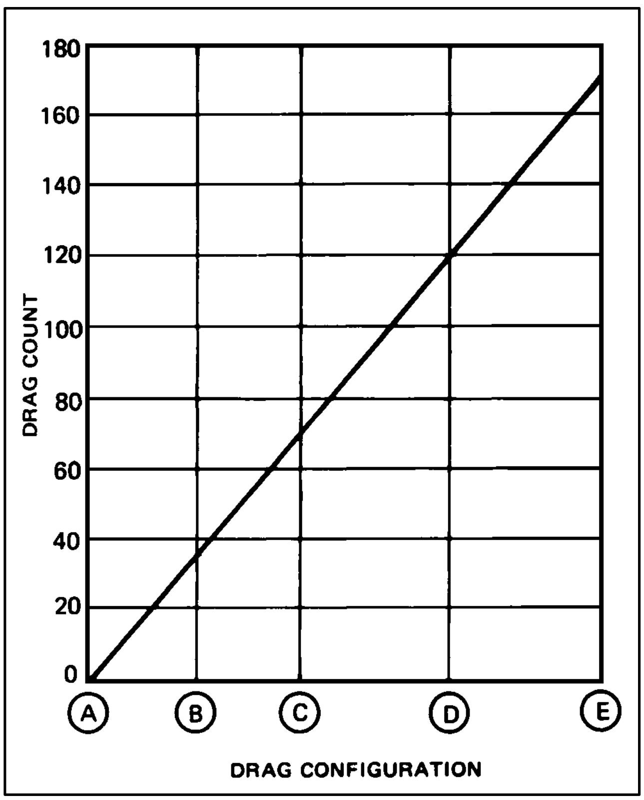


Figure 31-2. Drag Count Conversion

EXAMPLE:

The pilot system indicates 120 knots during an approach with landing flaps and gear down. Figure 31-5 shows a +1.5-knot correction for 120 KIAS with this configuration. Calibrated airspeed, therefore, is 121.5 knots.

31.5 ALTIMETER (STANDBY MODE) POSITION ERROR CORRECTION

Figure 31-6 shows the altimeter position error correction that must be applied to obtain true pressure altitude from the values indicated by the pilot and copilot/COTAC system. The correction is used in conjunction with altimeter instrument calibrations if flight at precise levels is required.

EXAMPLE 1:

Pilot system operating in the standby mode indicates 1,000 feet at 120 KIAS with landing flaps and gear down. Figure 31-6 shows that a correction of +18 feet is applicable. True pressure altitude is 1,018 feet if no instrument calibration correction is necessary.

EXAMPLE 2:

Assigned pressure altitude is 10,000 feet and airspeed is 300 KIAS in the cruise configuration. Figure 31-6 shows that the system reads high under these conditions. Add the 60-foot correction and fly at 10,060 feet indicated pressure altitude to maintain 10,000 feet altitude, if no instrument calibration correction is necessary.

31.6 MACH NUMBER POSITION ERROR CORRECTION

Figure 31-7 shows the position error correction that must be applied to indicated Mach number to obtain true Mach number for either the pilot or copilot/ COTAC system. The shaded area on the figure indicates where subtractive corrections are required. This correction is used in conjunction with Mach number instrument error corrections if exact values are required.

EXAMPLE:

Mach number indicates 0.65 at 40,000 feet indicated pressure altitude. Figure 31-7 shows the position error correction at this condition is +0.005. The true Mach number is 0.655 if no instrument correction is required.

31.7 AIRSPEED — MACH NUMBER CONVERSION

When indicated air temperature is known, a direct conversion from calibrated airspeed or true Mach number to true airspeed can be obtained by using Figure 31-8. Note that the sea level line is used as a base line to relate true Mach number to true airspeed. The following examples illustrate the use of the curve.

EXAMPLE 1:

Calibrated airspeed is 210 knots at 10,000 feet pressure altitude and indicated air temperature is 0 °C. Figure 31-8 shows that the true Mach number is 0.38 for this combination and the true airspeed is 241 knots.

EXAMPLE 2:

The desired true Mach number is 0.50 for flight at 10,000 feet pressure altitude and indicated air temperature is plus 10 °C. Figure 31-8 shows that the calibrated airspeed required is 275 knots and the true airspeed is 319 knots.

31.8 AIRSPEED COMPRESSIBILITY CORRECTION TABLE

Figure 31-9 shows the airspeed compressibility correction that must be subtracted from calibrated airspeed in order to obtain equivalent airspeed. (Equivalent airspeed is the term normally used when making aerodynamic calculations and aircraft performance checks and determining true airspeed.) True airspeed equals equivalent airspeed $\times 1/\sqrt{\sigma}$.

EXAMPLE:

Calibrated airspeed is 250 knots at 20,000 feet pressure altitude. Figure 31-9 shows that 5 knots must be subtracted to obtain the equivalent airspeed of 245 knots.

31.9 TEMPERATURE COMPRESSIBILITY CORRECTION CHART

Indicated outside air temperature is always higher than the actual ambient value in flight because of the temperature rise associated with ram effects on the sensing probe. Figure 31-10 provides a direct means of finding the ambient flight value. Enter the chart at the top with calibrated airspeed and find a point directly opposite, corresponding to the flight pressure altitude. Proceed vertically to the Mach scale and continue vertically to the intersection of this line and a horizontal column corresponding to the indicated temperature; read the ambient temperature directly. Compare this ambient temperature with the standard temperature for the flight pressure altitude shown in the right table and determine the temperature difference, ΔT. Interpolate for flight conditions of temperature and speed which do not fall directly on the table.

EXAMPLE:

Calibrated airspeed is 220 knots at 10,000 feet pressure altitude and indicated outside air temperature is 15 °C. Figure 31-10 shows that the correct ambient air temperature is 6 °C. Standard ambient temperature at this altitude is 5 °C, therefore, the ΔT is +11 °C (11 °C above standard or a so-called 11 °C hot day).

ITEM	STORES	CONFIGURATION	WEIGHT — LB
1	(2) BRU-14 rack		26
2	Bombs:		
	(1) Mk 82 or BDU-45B	Conical Retarded	531 570
	(1) Mk 76 or BDU-33		25
	(1) B-57		510
	(1) BDU-20C		506
3	Torpedoes:		
	(1) Mk 46 MOD 1/2		540
	(1) Mk 46 EXTORP MOD 1/2		500
	(1) Mk 46 MOD5		520
	(1) Mk 50		798
	(1) Mk 50 (Exercise)		805

Figure 31-3. Bomb Bay Store Weights

ITEM	POUNDS
Aircraft empty (includes pylons)	28,005
60 plastic sonobuoy containers (empty)	156
4 Crew	800
Aircraft without fuel	28,961
Internal fuel (JP-5)	13,144
Aircraft without stores	42,105
Aero-1D tank (2)	414
Fuel (JP-5) in pylon tanks(2 × 265 gal.)	3,604
Aircraft weight with maximum fuel	46,123
Note (1): Bomb bay racks (4) and braces weigh 103 lbs. and are not included above.	
Note (2): Weight of sonobuoy containers will be higher if metal containers are used.	

Figure 31-4. Aircraft Gross Weight

31.10 DENSITY ALTITUDE CHART

Figure 31-11 shows the relationship of ambient air temperature, pressure altitude, and density altitude. A line showing the standard-day variation of temperature with altitude is included for reference as is a scale of $1/\sqrt{\sigma}$. To determine density altitude, locate the intersection of pressure altitude and ambient air temperature lines and read density altitude on the left-hand scale.

Note

Pressure altitude should be read from an instrument set to 29.92 inches Hg when the reading is to be used in determining density altitude.

31.11 STANDARD ATMOSPHERE AND DENSITY ALTITUDE TABLES

Figures 31-12 and 31-13 provide standard atmosphere data, which are useful in making aircraft and engine performance check calculations. EAS equals CAS minus the compressibility correction. TAS equals EAS × 1/$\sqrt{\sigma}$.

31.12 TEMPERATURE CONVERSION TABLE

Figure 31-14 is a table for converting degrees Fahrenheit to degrees Celsius and vice versa. To use the table, find the reference temperature in the center column of the table and read the temperature for the desired conversion in the appropriate outer column.

EXAMPLE:

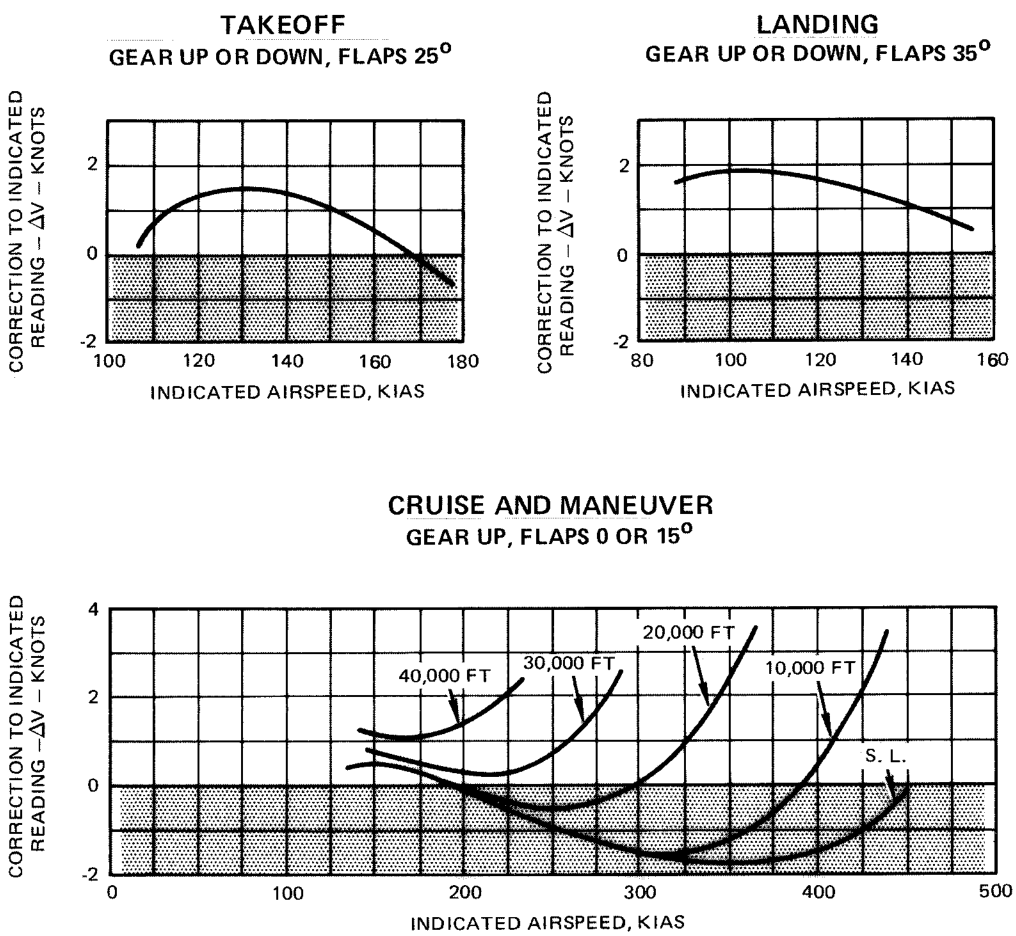
The reference temperature is 0 °C. Figure 31-14 shows that the corresponding temperature on the fahrenheit scale is 32 °F.

AIRSPEED POSITION ERROR CORRECTION

PILOT OR COPILOT/COTAC SYSTEM

MODEL: S-3A
DATA AS OF: 1 JULY 1973
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



NOTE: SHADED AREA INSTRUMENT READS HIGH SUBTRACT ΔV

AIRSPEED SYSTEM	PILOT	COPILOT/COTAC
PITOT/STATIC PROBE	FS 160.68 WL 187.88	FS 160.68 WL 187.88

Figure 31-5. Airspeed Position Error Correction

ALTIMETER (STANDBY MODE) POSITION ERROR CORRECTION

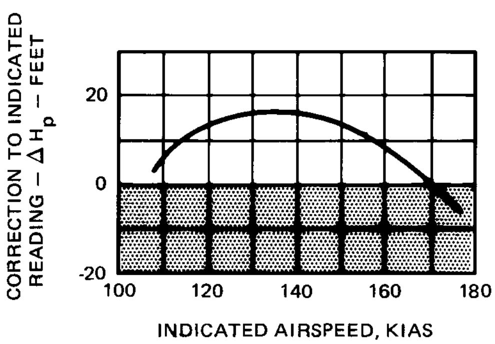
PILOT OR COPILOT/COTAC SYSTEM

MODEL: S-3A
DATA AS OF: 1 JULY 1973
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

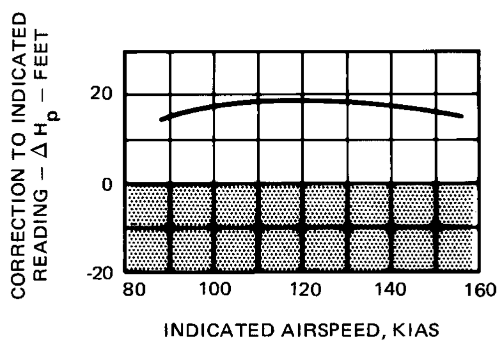
TAKEOFF

GEAR UP OR DOWN, FLAPS 25°



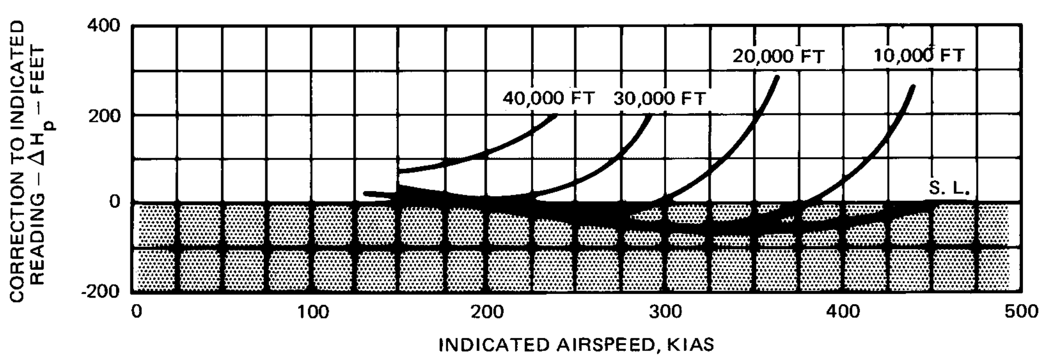
LANDING

GEAR UP OR DOWN, FLAPS 35°



CRUISE AND MANEUVER

GEAR UP, FLAPS 0° OR 15°



NOTE: SHADED AREA INSTRUMENT READS HIGH SUBTRACT ΔH_p

AIRSPEED SYSTEM	PILOT	COPILOT/COTAC
PITOT/STATIC PROBE	FS 160.68 WL 187.88	FS 160.68 WL 187.88

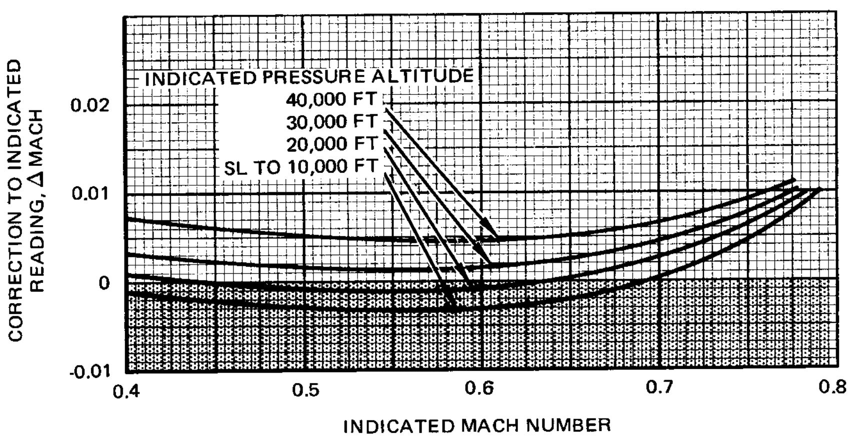
Figure 31-6. Altimeter (Standby Mode) Position Error Correction

MACH NUMBER POSITION ERROR CORRECTION

PILOT OR COPILOT/COTAC SYSTEM

MODEL: S-3A
DATA AS OF: 1 JULY 1973
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



NOTE: SHADED AREA INSTRUMENT READS HIGH SUBTRACT Δ MACH

AIRSPEED SYSTEM	PILOT	COPILOT/ COTAC
PITOT/STATIC PROBE	FS 160.68 WL 187.88	FS 160.68 WL 187.88

Figure 31-7. Mach Number Position Error Correction

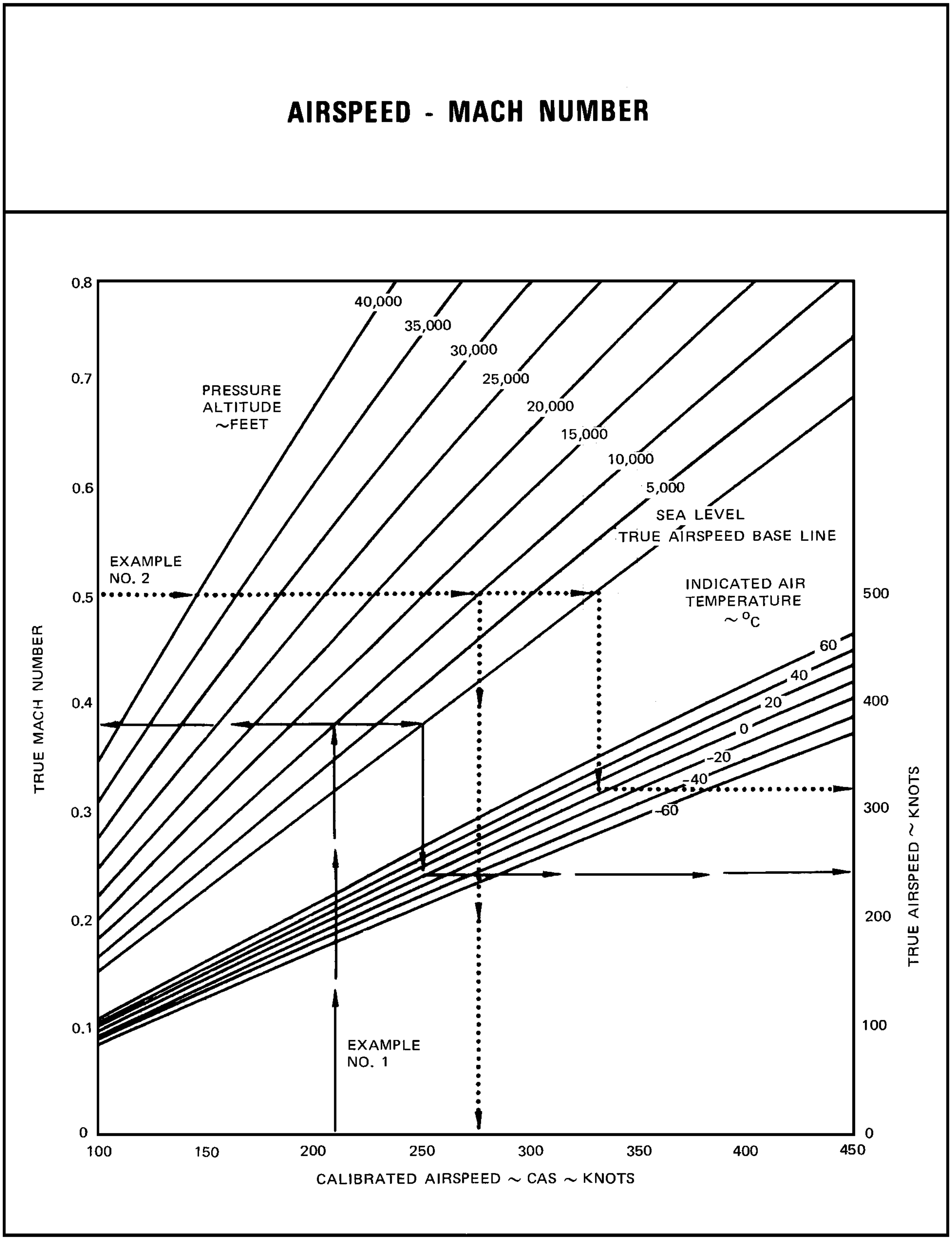


Figure 31-8. Airspeed — Mach Airspeed

Airspeed Compressibility Correction Table

Pressure Altitude (feet)	*Calibrated Airspeed—Knots*						
	150	*200*	*250*	*300*	*350*	*400*	*450*
Sea Level	0	0	0	0	0	0	0
2000	0	0	0	0.5	0.5	1.0	1.5
4000	0	0.5	0.5	1.0	1.5	2.5	3.5
6000	0.5	0.5	1.0	1.5	2.5	4.0	5.5
8000	0.5	1.0	1.5	2.5	4.0	5.5	7.5
10,000	0.5	1.0	2.0	3.5	5.0	7.0	10.0
12,000	0.5	1.5	2.5	4.0	6.0	9.0	12.5
14,000	1.0	1.5	3.0	5.0	7.5	11.0	15.0
16,000	1.0	2.0	3.5	6.0	9.0	13.0	17.5
18,000	1.0	2.5	4.0	7.0	10.5	15.0	
20,000	1.0	2.5	5.0	8.0	12.5	17.5	
22,000	1.5	3.0	5.5	9.0	14.0	20.0	
24,000	1.5	3.5	6.5	10.5	16.0	22.5	
26,000	1.5	4.0	7.5	12.0	18.0		
28,000	2.0	4.5	8.0	13.5	20.5		
30,000	2.0	5.0	9.0	15.0	22.5		
32,000	2.5	5.5	10.0	16.5			
34,000	3.0	6.5	11.5	18.5			
36,000	3.0	7.0	12.5	20.5			
38,000	3.5	8.0	14.0	23.0			
40,000	3.5	8.5	15.5				

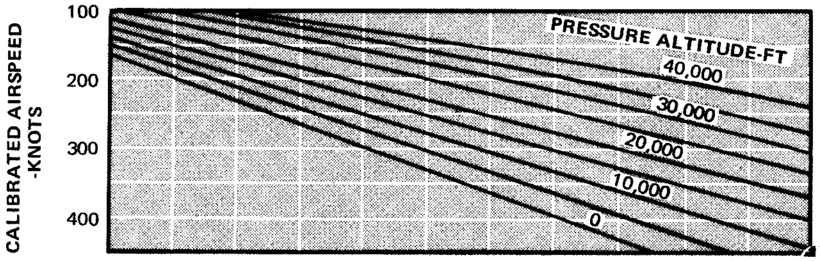
REMARKS: 1. Equivalent airspeed (EAS) equals calibrated airspeed (CAS) minus compressibility correction shown.

2. True airspeed (TAS) equals EAS $\times 1/\sqrt{\sigma}$.

Figure 31-9. Airspeed Compressibility Correction

TEMPERATURE COMPRESSIBILITY CORRECTION

NOTE: TEMPERATURE CORRECTION BASED ON 100% ADIABATIC RISE



Indicated Air Temperature — °C	Mach Number .25	.30	.35	.40	.45	.50	.55	.60	.65	.70	.75	.80
−45	−48	−49	−51	−52	−54	−56	−58	−60	−63	−65	−68	−71
−40	−43	−44	−46	−47	−49	−51	−53	−56	−58	−61	−64	−66
−35	−38	−39	−41	−42	−44	−46	−49	−51	−54	−56	−59	−62
−30	−33	−34	−36	−38	−39	−42	−44	−46	−49	−52	−55	−58
−25	−28	−29	−31	−33	−35	−37	−39	−42	−44	−47	−50	−53
−20	−23	−25	−26	−28	−30	−32	−34	−37	−40	−43	−46	−49
−15	−18	−20	−21	−23	−25	−27	−30	−32	−35	−38	−41	−44
−10	−13	−15	−16	−18	−20	−23	−25	−28	−31	−34	−37	−40
−5	−8	−10	−11	−13	−16	−18	−20	−23	−26	−29	−32	−35
0	−3	−5	−7	−9	−11	−13	−16	−18	−21	−24	−28	−31
+5	+2	0	−2	−4	−6	−8	−11	−14	−17	−20	−23	−27
10	7	+5	+3	+1	−1	−4	−6	−9	−12	−15	−19	−22
15	12	10	8	6	+4	+1	−2	−4	−7	−11	−14	−18
20	16	15	13	11	9	6	+3	0	−3	−6	−10	−13
25	21	20	18	16	13	11	8	+5	+2	−2	−5	−9
30	26	25	23	21	18	16	13	10	6	+3	−1	−4
35	31	30	28	25	23	20	17	14	11	8	+4	0
40	36	35	33	30	28	25	22	19	16	12	8	+4
45	41	39	37	35	33	30	27	24	20	17	13	9
50	46	44	42	40	37	35	31	28	25	21	17	13

AMBIENT AIR TEMPERATURE — °C

Press Altitude (1000 feet)	*Std Temp (°C)*
0	15
2	11
4	7
6	+ 3
8	− 1
10	− 5
12	− 9
14	−13
16	−17
18	−21
20	−25
22	−29
24	−33
26	−37
28	−41
30	−44
32	−48
34	−52
36	−56
38	−56
40	−56

Figure 31-10. Temperature Compressibility Correction

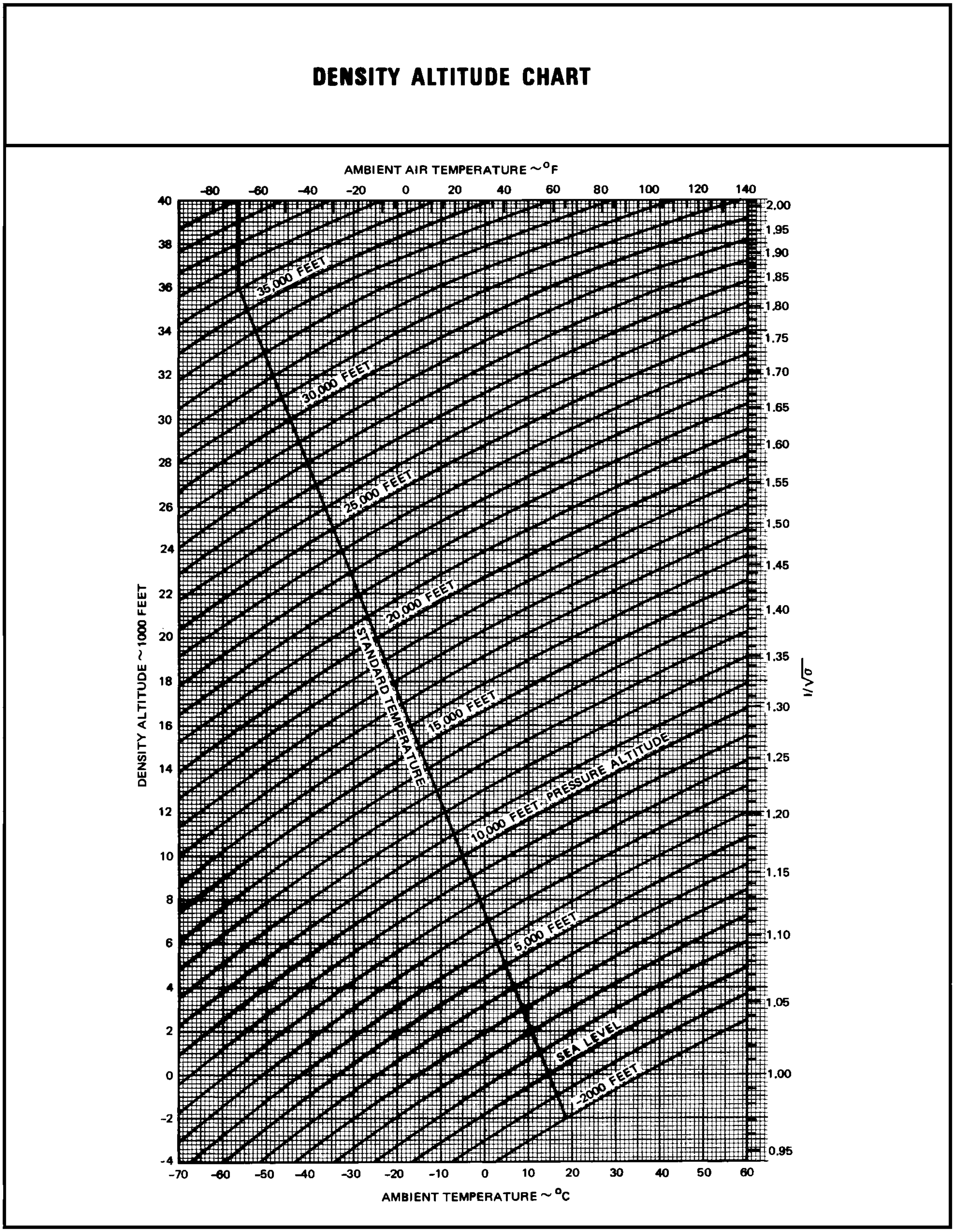


Figure 31-11. Density Altitude

STANDARD ATMOSPHERE TABLE

Standard Sea Level Conditions:
Temperature 15°C (59°F)
Pressure 29.921 in. Hg or 2116.216 lb/sq ft
Density 0.0023769 slugs/cu ft
Speed of Sound 1116.39 ft/sec or 661.7 knots

Conversion Factors:
1 in. Hg = 70.727 lb/sq ft
1 in. Hg = 0.49116 lb/ sq in.
1 knot = 1.151 mph
1 knot = 1.688 ft/sec

Altitude (feet)	Density Ratio (σ)	$\frac{1}{\sqrt{\sigma}}$	Temperature (Deg C)	Temperature (Deg F)	Speed of Sound (knots)	Pressure Inches of Hg	Pressure Ratio (δ)
−4000	1.1224	0.94390	22.925	73.265	670.8	34.5072	1.15327
−3000	1.0908	0.95748	20.943	69.698	668.6	33.3107	1.11328
−2000	1.0598	0.97136	18.962	66.132	666.3	32.1481	1.07442
−1000	1.0296	0.98552	16.981	62.566	664.1	31.0185	1.03667
0	1.0000	1.00000	15.000	59.000	661.7	29.9213	1.00000
1000	0.97106	1.0148	13.019	55.434	659.5	28.8557	0.96439
2000	0.94277	1.0299	11.038	51.868	657.2	27.8210	0.92981
3000	0.91512	1.0454	9.056	48.302	654.9	26.8167	0.89624
4000	0.88808	1.0611	7.075	44.735	652.6	25.8418	0.86366
5000	0.86167	1.0773	5.094	41.169	650.3	24.8959	0.83205
6000	0.83586	1.0938	3.113	37.603	648.0	23.9782	0.80138
7000	0.81064	1.1107	1.132	34.037	645.6	23.0881	0.77163
8000	0.78601	1.1279	−0.850	30.471	643.3	22.2249	0.74278
9000	0.76196	1.1456	−2.831	26.905	641.0	21.3881	0.71481
10,000	0.73848	1.1637	−4.812	23.338	638.6	20.5769	0.68770
11,000	0.71555	1.1822	−6.793	19.772	636.2	19.7909	0.66143
12,000	0.69317	1.2011	−8.774	16.206	633.9	19.0293	0.63598
13,000	0.67133	1.2205	−10.756	12.640	631.5	18.2917	0.61133
14,000	0.65002	1.2403	−12.737	9.074	629.1	17.5773	0.58745
15,000	0.62923	1.2606	−14.718	5.508	626.7	16.8858	0.56434
16,000	0.60896	1.2815	−16.699	1.941	624.3	16.2164	0.54197
17,000	0.58919	1.3028	−18.680	−1.625	621.9	15.5687	0.52032
18,000	0.56991	1.3246	−20.662	−5.191	619.5	14.9421	0.49938
19,000	0.55112	1.3470	−22.643	−8.757	617.0	14.3360	0.47913
20,000	0.53281	1.3700	−24.624	−12.323	614.6	13.7501	0.45954
21,000	0.51496	1.3935	−26.605	−15.889	612.1	13.1836	0.44061
22,000	0.49758	1.4176	−28.586	−19.456	609.7	12.6363	0.42232
23,000	0.48065	1.4424	−30.568	−23.022	607.2	12.1074	0.40464
24,000	0.46416	1.4678	−32.549	−26.588	604.7	11.5967	0.38757
25,000	0.44811	1.4938	−34.530	−30.154	602.2	11.1035	0.37109
26,000	0.43249	1.5206	−36.511	−33.720	599.7	10.6274	0.35518
27,000	0.41729	1.5480	−38.493	−37.286	597.2	10.1681	0.33983
28,000	0.40250	1.5762	−40.474	−40.852	594.6	9.7249	0.32502
29,000	0.38812	1.6052	−42.455	−44.419	592.1	9.2975	0.31073
30,000	0.37413	1.6349	−44.436	−47.985	589.6	8.8854	0.29696
31,000	0.36053	1.6654	−46.417	−51.551	587.0	8.4883	0.28369
32,000	0.34731	1.6968	−48.398	−55.117	584.4	8.1056	0.27090
33,000	0.33447	1.7291	−50.379	−58.683	581.8	7.7371	0.25858
34,000	0.32199	1.7623	−52.361	−62.249	579.3	7.3822	0.24672
35,000	0.30987	1.7964	−54.342	−65.816	576.7	7.0406	0.23530
36,000	0.29810	1.8315	−56.323	−69.382	574.1	6.7119	0.22432
37,000	0.28435	1.8753	−56.500	−69.700	573.8	6.3970	0.21379
38,000	0.27100	1.9209	−56.500	−69.700	573.8	6.0968	0.20376
39,000	0.25829	1.9677	−56.500	−69.700	573.8	5.8107	0.19420
40,000	0.24617	2.0155	−56.500	−69.700	573.8	5.5380	0.18509

Figure 31-12. Standard Atmosphere

DENSITY ALTITUDE and 1/ $\sqrt{\sigma}$

Altitude (feet)	$1/\sqrt{\sigma}$	Altitude (feet)	$1/\sqrt{\sigma}$	Altitude (feet)	$1/\sqrt{\sigma}$	Altitude (feet)	$1/\sqrt{\sigma}$	Altitude (feet)	$1/\sqrt{\sigma}$
0	1.0000	8000	1.1279	16,000	1.2815	24,000	1.4678	32,000	1.6968
200	1.0029	8200	1.1314	16,200	1.2857	24,200	1.4729	32,200	1.7032
400	1.0059	8400	1.1350	16,400	1.2899	24,400	1.4781	32,400	1.7096
600	1.0088	8600	1.1385	16,600	1.2942	24,600	1.4833	32,600	1.7161
800	1.0118	8800	1.1420	16,800	1.2985	24,800	1.4886	32,800	1.7226
1000	1.0148	9000	1.1456	17,000	1.3028	25,000	1.4938	33,000	1.7291
1200	1.0178	9200	1.1492	17,200	1.3071	25,200	1.4991	33,200	1.7357
1400	1.0208	9400	1.1528	17,400	1.3115	25,400	1.5045	33,400	1.7423
1600	1.0238	9600	1.1564	17,600	1.3158	25,600	1.5098	33,600	1.7489
1800	1.0269	9800	1.1600	17,800	1.3203	25,800	1.5152	33,800	1.7556
2000	1.0299	10,000	1.1637	18,000	1.3246	26,000	1.5206	34,000	1.7623
2200	1.0330	10,200	1.1673	18,200	1.3291	26,200	1.5260	34,200	1.7690
2400	1.0360	10,400	1.1710	18,400	1.3335	26,400	1.5315	34,400	1.7758
2600	1.0391	10,600	1.1747	18,600	1.3380	26,600	1.5370	34,600	1.7827
2800	1.0422	10,800	1.1784	18,800	1.3425	26,800	1.5425	34,800	1.7895
3000	1.0454	11,000	1.1822	19,000	1.3470	27,000	1.5480	35,000	1.7964
3200	1.0485	11,200	1.1859	19,200	1.3516	27,200	1.5536	35,200	1.8034
3400	1.0516	11,400	1.1897	19,400	1.3561	27,400	1.5592	35,400	1.8104
3600	1.0548	11,600	1.1935	19,600	1.3607	27,600	1.5649	35,600	1.8174
3800	1.0580	11,800	1.1973	19,800	1.3653	27,800	1.5705	35,800	1.8244
4000	1.0611	12,000	1.2011	20,000	1.3700	28,000	1.5762	36,000	1.8315
4200	1.0643	12,200	1.2049	20,200	1.3746	28,200	1.5819	36,200	1.8396
4400	1.0676	12,400	1.2088	20,400	1.3793	28,400	1.5877	36,400	1.8485
4600	1.0708	12,600	1.2127	20,600	1.3840	28,600	1.5935	36,600	1.8574
4800	1.0740	12,800	1.2166	20,800	1.3888	28,800	1.5993	36,800	1.8663
5000	1.0773	13,000	1.2205	21,000	1.3935	29,000	1.6052	37,000	1.8753
5200	1.0806	13,200	1.2244	21,200	1.3983	29,200	1.6110	37,200	1.8844
5400	1.0838	13,400	1.2284	21,400	1.4031	29,400	1.6170	37,400	1.8934
5600	1.0871	13,600	1.2323	21,600	1.4079	29,600	1.6229	37,600	1.9026
5800	1.0905	13,800	1.2363	21,800	1.4128	29,800	1.6289	37,800	1.9117
6000	1.0938	14,000	1.2403	22,000	1.4176	30,000	1.6349	38,000	1.9209
6200	1.0971	14,200	1.2444	22,200	1.4225	30,200	1.6409	38,200	1.9302
6400	1.1005	14,400	1.2484	22,400	1.4275	30,400	1.6470	38,400	1.9395
6600	1.1039	14,600	1.2526	22,600	1.4324	30,600	1.6531	38,600	1.9488
6800	1.1073	14,800	1.2565	22,800	1.4374	30,800	1.6593	38,800	1.9582
7000	1.1107	15,000	1.2606	23,000	1.4424	31,000	1.6654	39,000	1.9677
7200	1.1141	15,200	1.2648	23,200	1.4474	31,200	1.6717	39,200	1.9771
7400	1.1175	15,400	1.2689	23,400	1.4525	31,400	1.6779	39,400	1.9867
7600	1.1210	15,600	1.2731	23,600	1.4576	31,600	1.6842	39,600	1.9962
7800	1.1245	15,800	1.2773	23,800	1.4627	31,800	1.6905	39,800	2.0058

Figure 31-13. Density Altitude and 1/ $\sqrt{\sigma}$

TEMPERATURE CONVERSION TABLE

°C	°F/°C	°F	°C	°F/°C	°F	°C	°F/°C	°F	°C	°F/°C	°F
−51.1	−60	−76.0	−26.1	−15	5.0	−1.1	30	86.0	23.9	75	167.0
−50.6	−59	−74.2	−25.6	−14	6.8	−0.6	31	87.8	24.4	76	168.8
−50.0	−58	−72.4	−25.0	−13	8.6	0.0	32	89.6	25.0	77	170.6
−49.4	−57	−70.6	−24.4	−12	10.4	0.6	33	91.4	25.6	78	172.4
−48.9	−56	−68.8	−23.9	−11	12.2	1.1	34	93.2	26.1	79	174.2
−48.3	−55	−67.0	−23.3	−10	14.0	1.7	35	95.0	26.7	80	176.0
−47.8	−54	−65.2	−22.8	−9	15.8	2.2	36	96.8	27.2	81	177.8
−47.2	−53	−63.4	−22.2	−8	17.6	2.8	37	98.6	27.8	82	179.6
−46.7	−52	−61.6	−21.7	−7	19.4	3.3	38	100.4	28.3	83	181.4
−46.1	−51	−59.8	−21.1	−6	21.2	3.9	39	102.2	28.9	84	183.2
−45.6	−50	−58.0	−20.6	−5	23.0	4.4	40	104.0	29.4	85	185.0
−45.0	−49	−56.2	−20.0	−4	24.8	5.0	41	105.8	30.0	86	186.8
−44.4	−48	−54.4	−19.4	−3	26.6	5.6	42	107.6	30.6	87	188.6
−43.9	−47	−52.6	−18.9	−2	28.4	6.1	43	109.4	31.1	88	190.4
−43.3	−46	−50.8	−18.3	−1	30.2	6.7	44	111.2	31.7	89	192.2
−42.8	−45	−49.0	−17.8	0	32.0	7.2	45	113.0	32.2	90	194.0
−42.2	−44	−47.2	−17.2	1	33.8	7.8	46	114.8	32.8	91	195.8
−41.7	−43	−45.4	−16.7	2	35.6	8.3	47	116.6	33.3	92	197.6
−41.1	−42	−43.6	−16.1	3	37.4	8.9	48	118.4	33.9	93	199.4
−40.6	−41	−41.8	−15.6	4	39.2	9.4	49	120.2	34.4	94	201.2
−40.0	−40	−40.0	−15.0	5	41.0	10.0	50	122.0	35.0	95	203.0
−39.4	−39	−38.2	−14.4	6	42.8	10.6	51	123.8	35.6	96	204.8
−38.9	−38	−36.4	−13.9	7	44.6	11.1	52	125.6	36.1	97	206.6
−38.3	−37	−34.6	−13.3	8	46.4	11.7	53	127.4	36.7	98	208.4
−37.8	−36	−32.8	−12.8	9	48.2	12.2	54	129.2	37.2	99	210.2
−37.2	−35	−31.0	−12.2	10	50.0	12.8	55	131.0	37.8	100	212.0
−36.7	−34	−29.0	−11.7	11	51.8	13.3	56	132.8	38.3	101	213.8
−36.1	−33	−27.4	−11.1	12	53.6	13.9	57	134.6	38.9	102	215.6
−35.6	−32	−25.6	−10.6	13	55.4	14.4	58	136.4	39.4	103	217.4
−35.0	−31	−23.8	−10.0	14	57.2	15.0	59	138.2	40.0	104	219.2
−34.4	−30	−22.0	−9.4	15	59.0	15.6	60	140.0	40.6	105	221.0
−33.9	−29	−20.2	−8.9	16	60.8	16.1	61	141.8	41.1	106	222.8
−33.3	−28	−18.4	−8.3	17	62.6	16.7	62	143.6	41.7	107	224.6
−32.8	−27	−16.1	−7.8	18	64.4	17.2	63	145.4	42.2	108	226.4
−32.2	−26	−14.8	−7.2	19	66.2	17.8	64	147.2	42.8	109	228.2
−31.7	−25	−13.0	−6.7	20	68.0	18.3	65	149.0	43.3	110	230.0
−31.1	−24	−11.2	−6.1	21	69.8	18.9	66	150.8	43.9	111	231.8
−30.6	−23	−9.4	−5.6	22	71.6	19.4	67	152.6	44.4	112	233.6
−30.0	−22	−7.6	−5.0	23	73.4	20.0	68	154.4	45.0	113	235.4
−29.4	−21	−5.8	−4.4	24	75.2	20.6	69	156.2	45.6	114	237.2
−28.9	−20	−4.0	−3.9	25	77.0	21.1	70	158.0	46.1	115	239.0
−28.3	−19	−2.2	−3.3	26	78.8	21.7	71	159.8	46.7	116	240.8
−27.8	−18	−0.4	−2.8	27	80.6	22.2	72	161.6	47.2	117	242.6
−27.2	−17	1.4	−2.2	28	82.4	22.8	73	163.4	47.8	118	244.4
−26.7	−16	3.2	−1.7	29	84.2	23.3	74	165.2	48.3	119	246.2

HOW TO USE THE TABLE: Use shaded column to find value of temperature to be converted; if in degrees centigrade, read Fahrenheit equivalent in right-hand column; if in degrees Fahrenheit, read centigrade equivalent in left-hand column.

Figure 31-14. Temperature Conversion

CHAPTER 32

Takeoff

32.1 SCOPE

The material presented in this chapter permits development of an effective takeoff plan that allows for a sequence of actions to be put into effect without delay if an emergency should arise. Forecast of normal performance can be made by use of the two-engine acceleration, takeoff, and climbout data. The results of engine failure during various phases of a takeoff (and the performance that remains) can be predicted by use of the refusal speed, critical field length, and single-engine climb gradient charts. Proper use of the material allows calculation of a decision point and a simple operating procedure for each takeoff situation.

32.2 CROSSWIND CHART

Figure 32-1, provides a means for converting reported wind direction and speed to runway and crosswind components. Since windspeeds reported from remote or elevated locations may not represent runway conditions accurately, multiply reported winds by three-fourths when the anemometer is more than 50 feet above the runway elevation.

Note

Use maximum reported gust velocity when computing crosswind components.

32.3 TAKEOFF DISTANCE

Figure 32-2 is used to obtain ground run distance and total distance to clear obstacles up to 200 feet high. The performance shown is based on two engines operating at maximum power and the lift-off/climbout speed schedule shown in Figure 32-3. The climbout distances shown (distance to clear an obstacle) are based on maintaining the lift-off speed. If the aircraft is allowed to accelerate during the climbout segment, these distances should be increased accordingly.

32.4 TAKEOFF SPEED

The recommended speeds for lift-off and obstacle clearance at various gross weights are shown in the upper half of Figure 32-3. Rotation should be initiated so as to lift-off and climbout at the speeds shown.

32.5 VELOCITY DURING GROUND RUN

Velocity during ground run is shown in the lower half of Figure 32-3. This chart is used in determining the distance required to accelerate to a given speed during the takeoff ground run for the purpose of establishing either an acceleration check speed or the distance to accelerate to the refusal speed (refusal distance).

32.6 ACCELERATION CHECK SPEED

When it is desired to monitor progress during the takeoff ground run, predict the two-engine acceleration by use of the velocity during ground run chart shown in the bottom half of Figure 32-3. To obtain the acceleration check speed, follow along the normal acceleration guideline established by the intersection of the takeoff speed and the takeoff ground distance to obtain the speed at a specified distance. This distance could be that of a runway marker, arresting gear, or other landmark at a known distance from takeoff roll. The example in Figure 32-3 uses 1,000 feet.

32.7 CRITICAL ENGINE FAILURE SPEED (V_{CRIT}) AND FIELD LENGTH

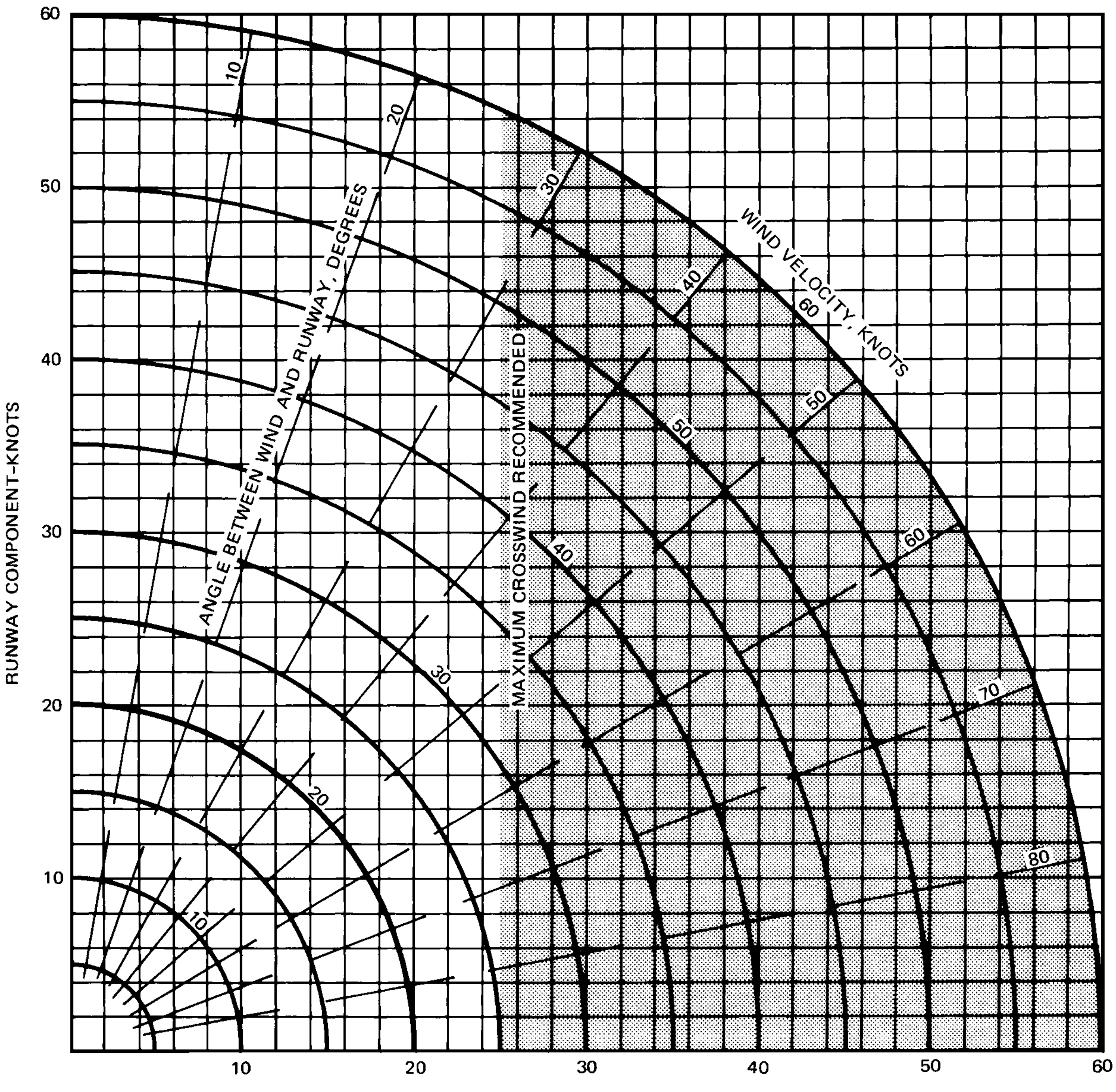
The critical engine failure speed (V_{CRIT}) is that speed from which, if an engine fails, the same runway distance is required to stop as to accelerate on one engine to the takeoff speed. Critical field length is the total length of runway required to accelerate on two engines to V_{CRIT}, experience an engine failure, then continue to take off or stop. Below V_{CRIT}, less runway will be used to abort the takeoff than would be used to accelerate to lift-off if the takeoff were continued. Above V_{CRIT}, less runway will be used to continue the takeoff than would be required to abort the takeoff.

CROSSWIND CHART

TAKEOFF OR LANDING

MODEL: S-3A
DATA AS OF: 1 JULY 1973
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



(NOTE: FOR CROSSWIND COMPONENT ENTER CHART WITH MAXIMUM REPORTED GUST VELOCITY)

Figure 32-1. Crosswind — Takeoff or Landing

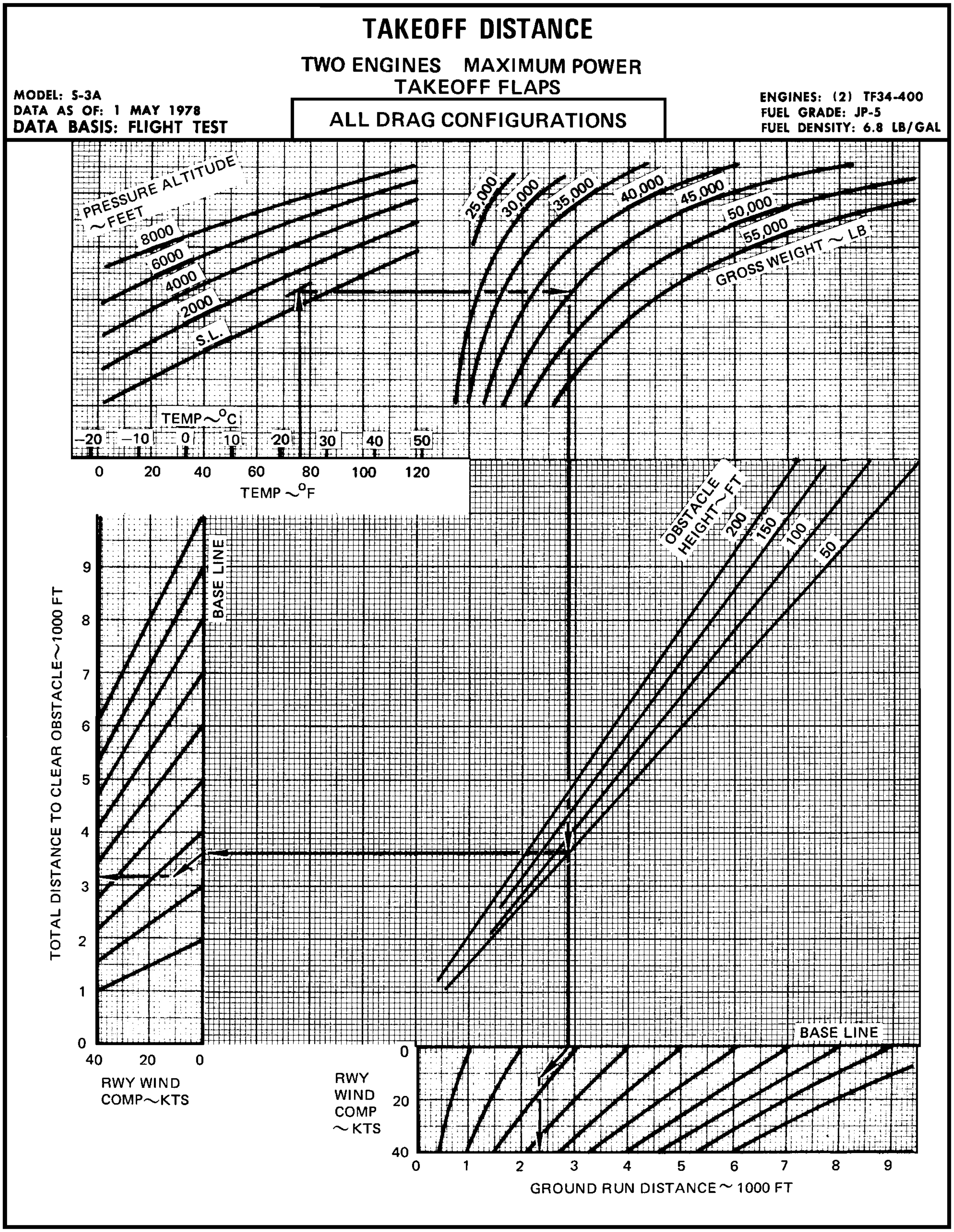


Figure 32-2. Takeoff Distance

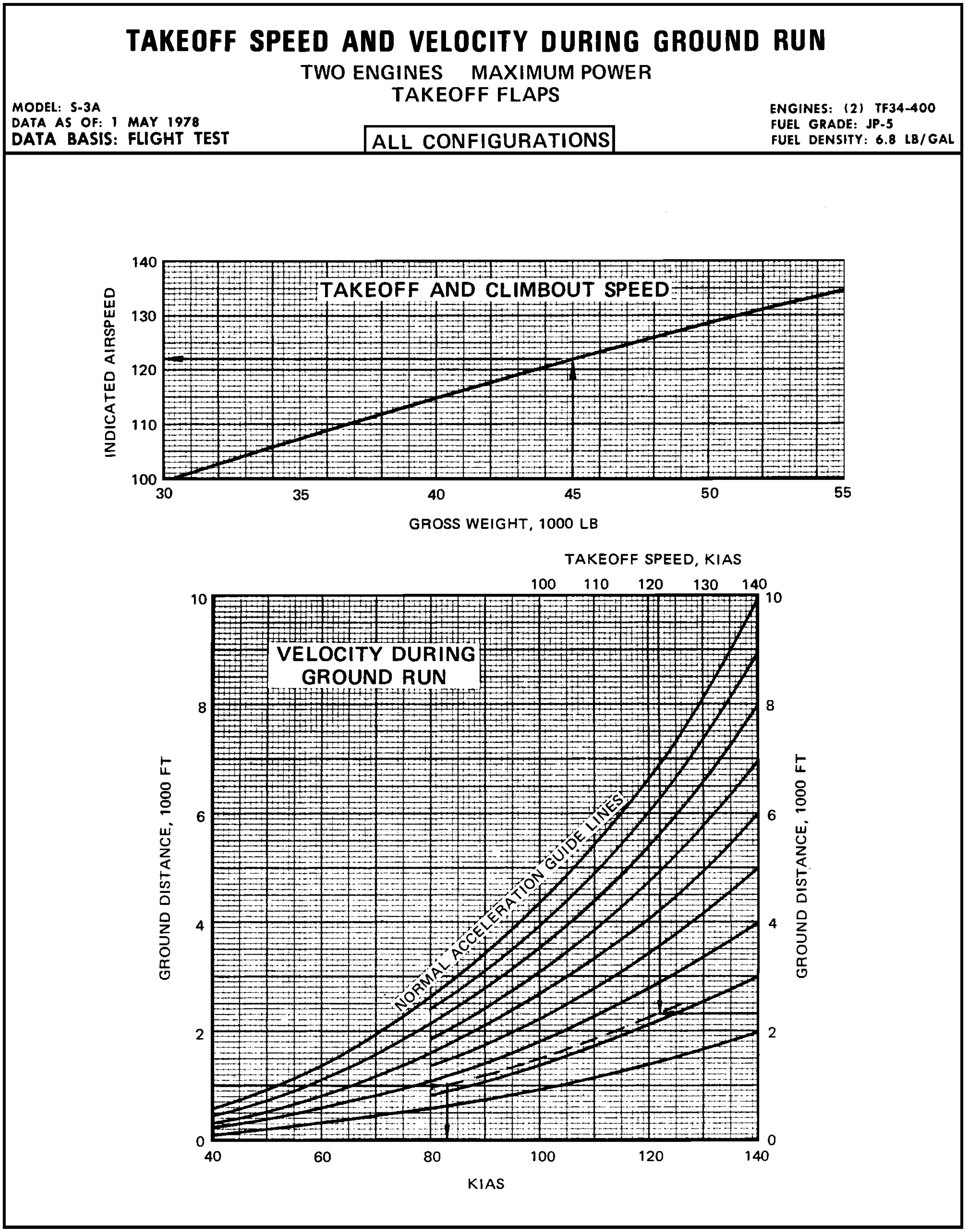
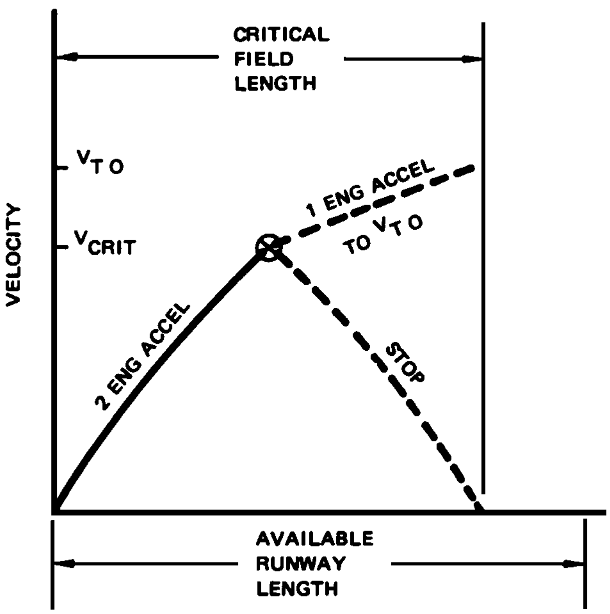


Figure 32-3. Takeoff Speed and Velocity During Ground Run

It is important to understand that determination of critical engine failure speed and the critical field length is totally independent of the available runway length. It is simply a measure of performance for a given set of atmospheric conditions and gross weight.



Since critical field length, by definition, is the distance to accelerate and stop or takeoff, it is obvious that it shall always be equal to or less than the available field length. If a condition occurs where critical field length is greater than available field length, either gross weight shall be reduced, a longer runway shall be used, or wait for more favorable conditions.

Critical field lengths are shown on the upper part of Figure 32-4 for various takeoff conditions; the lower part gives the corresponding $V_{CRIT.}$ Note that the minimum speed for directional control (V_{MC}) is an overriding limit at the low-speed end. The chart is based on a failure of the No. 1 engine (EHP inoperable) that is more critical because of loss of antiskid braking and unrelated half-rate speedbrake operation.

32.8 REFUSAL SPEEDS (V_{REF})

Refusal speed is the maximum speed to which the aircraft can accelerate and then stop in the available runway length. These are shown in Figure 32-5 as a function of weight, ambient conditions, and available runway length. The performance shown is based on the following: a two-engine acceleration to engine failure speed, a continuing single-engine acceleration for 3 seconds to allow for reaction time, followed by instantaneous throttle chop, speedbrake deployment, and moderate braking (no antiskid) to a full stop. This does not assume engagement of any long field or abort arresting gear.

Note

Refusal speeds in Figure 32-5 are for a zero-wind condition. Headwind component must be added to or tailwind component must be subtracted from the calculated refusal speed.

32.9 DECISION SPEED

Decision speed (V_D) is a pilot-selected value and is that speed during the takeoff ground run that, in the event of an engine failure, determines whether or not the takeoff will be continued. If engine failure occurs above the decision speed, a safe takeoff can still be made on one engine.

For the S-3B, there will usually be two speeds that define a range over which the decision speed can be selected. The minimum value is V_{CRIT} as determined from Figure 32-4. The maximum value is determined by V_{TO} or V_{REF} whichever is lower. If V_{CRIT} is chosen as the decision speed, it provides a performance and safety margin because takeoff or stop can be safely made in less than the available runway length. If V_{REF} is chosen, pilot performance will be more demanding to stop the aircraft within the available runway length. Choosing an intermediate value provides a compromise.

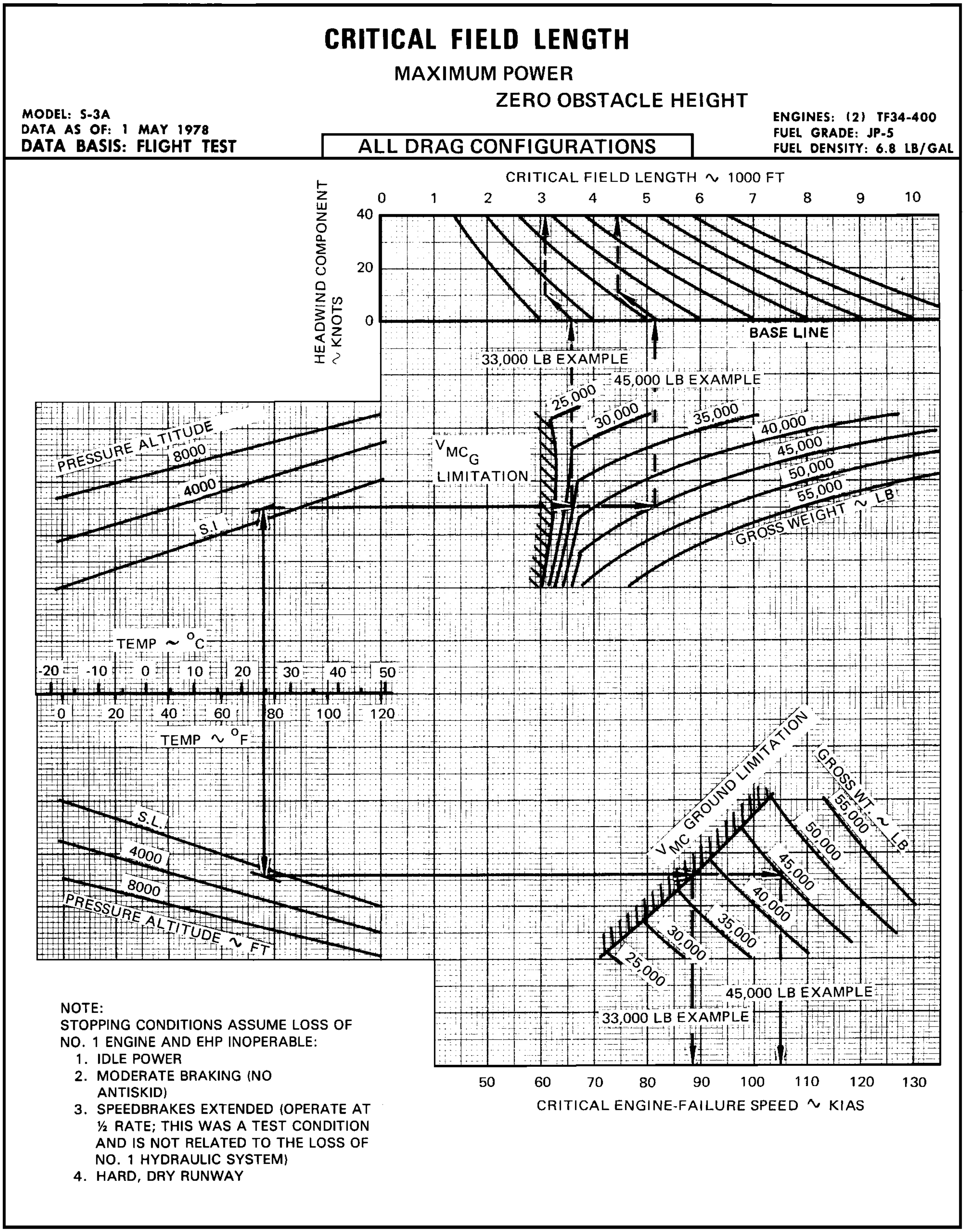


Figure 32-4. Critical Field Length

REFUSAL SPEED

TAKEOFF FLAPS ZERO WIND ZERO SLOPE

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ALL DRAG CONFIGURATIONS

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

NOTE:

- STOPPING CONDITIONS ASSUME LOSS OF NO. 1 ENGINE AND EHP INOPERABLE:
  1. IDLE POWER
  2. MODERATE BRAKING (NO ANTISKID)
  3. SPEEDBRAKES EXTENDED (OPERATE AT ½ RATE; THIS WAS A TEST CONDITION AND IS NOT RELATED TO THE LOSS OF NO. 1 HYDRAULIC SYSTEM)
  4. HARD, DRY RUNWAY
- REFUSAL SPEEDS ARE FOR A ZERO WIND CONDITION. HEADWIND COMPONENT MUST BE ADDED TO OR TAILWIND COMPONENT MUST BE SUBTRACTED FROM THE CALCULATED REFUSAL SPEED BEFORE REFUSAL SPEED CAN BE READ FROM THE COCKPIT AIRSPEED INDICATOR.

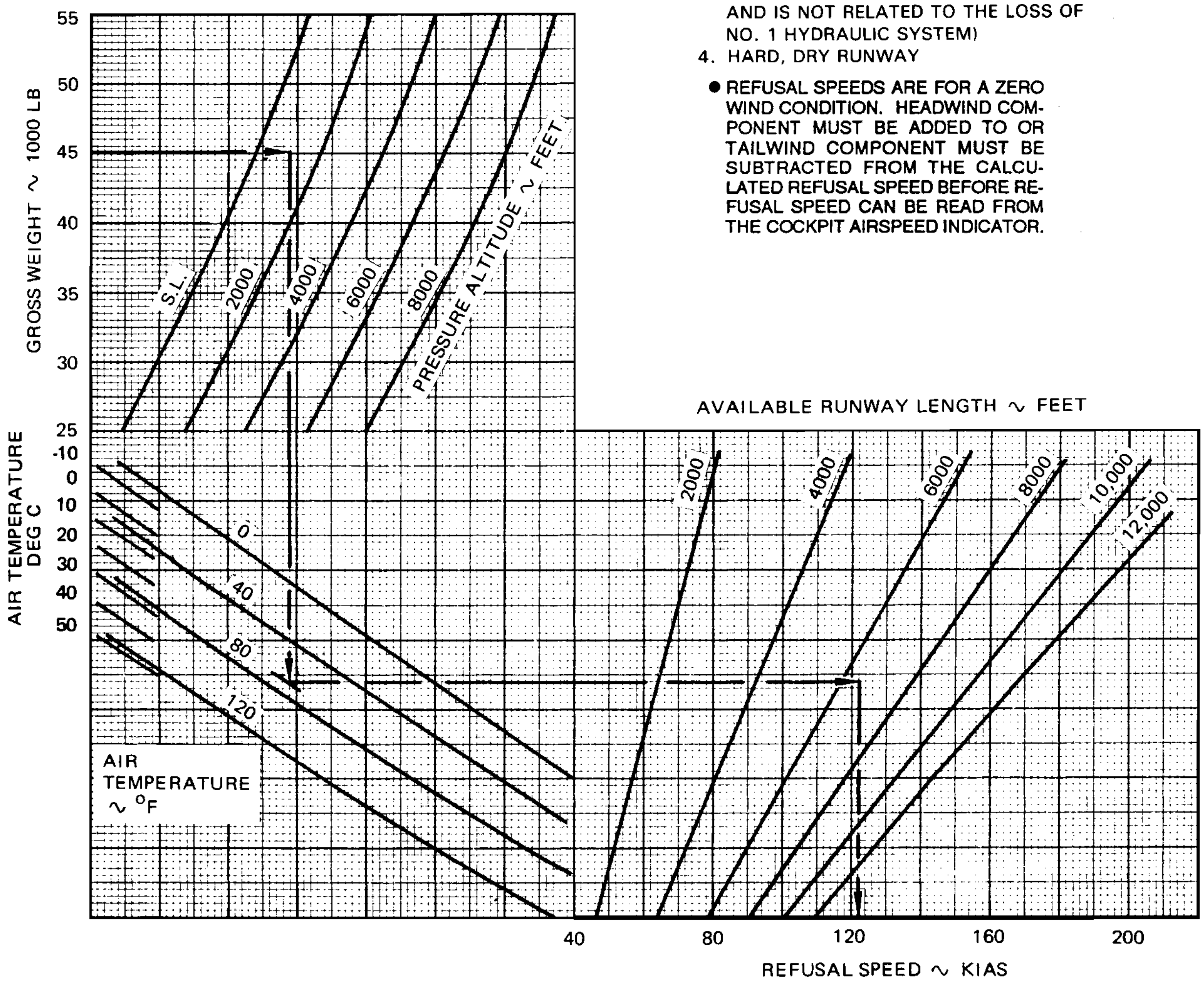
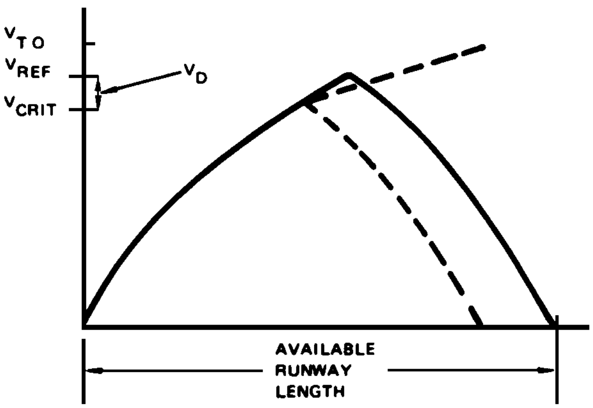


Figure 32-5. Refusal Speed

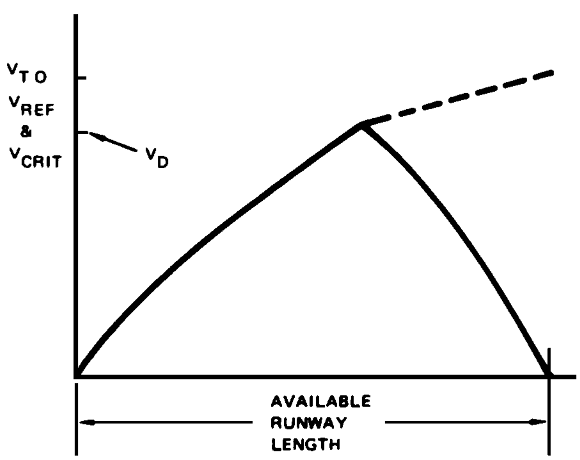
Obviously, the closer together V_{CRIT} and V_{REF} are, the more critical the situation. The most critical condition exists when they are equal and automatically defines a decision speed. It also means the critical field length is equal to the available runway length.

If a condition occurs where V_{CRIT} is greater than V_{REF} (remote), either gross weight must be reduced and/or a longer runway must be used until the values of V_{CRIT} and V_{REF} are at least equal again. In summary:

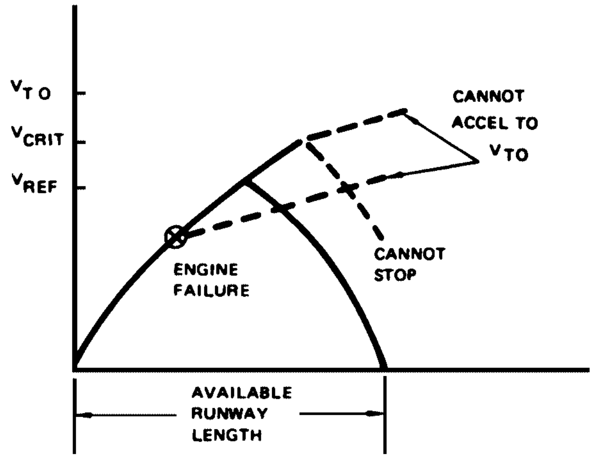
1. If V_{CRIT} is less than V_{REF}, decision speed must be between them.



2. If V_{CRIT} equals V_{REF}, that is the decision speed.



3. If V_{CRIT} is greater than V_{REF}, there is no decision. Single engine takeoff is impossible regardless of the engine failure speed.



32.10 SINGLE-ENGINE CLIMB PERFORMANCE

Single-engine climbout capability for various ambient conditions and gross weights is shown in Figure 32-6 in terms of climb gradient. The chart is based on maximum power on the operative engine with TAKEOFF flaps and gear down and takeoff speed shown in Figure 32-3. Takeoff speed is used to provide maximum obstacle clearance.

Obstacle clearance is more readily accomplished by climbing at a speed as near to takeoff speed as practicable rather than at the speed for best rate of climb. This is because of the distance required to accelerate after takeoff to the higher speed. Maximum rate of climb is obtained at the speed for 15.0 units AOA. A takeoff of a 44,000-pound, drag configuration Ⓐ, aircraft at sea level on a 32 °C day is shown below. In this case, engine failure occurs at V_{CRIT} (103 KIAS) and the takeoff is continued to V_{TO} of 121 KIAS. After takeoff, if the aircraft is accelerated to 15.0 units AOA (132 KIAS), the rate of climb (out of ground effect) is 140 fpm compared to 115 fpm if climbout is performed at the takeoff speed of 121 KIAS. Acceleration from V_{TO} to the velocity for 15.0 units AOA requires 13,800 feet (2.3 nm). If climbout were initiated at takeoff speed, the aircraft would be 127 feet higher than the point of takeoff instead of just beginning climbout. High rates of climb are always desirable after a single-engine takeoff; but this example indicates that location and height of obstacles may dictate an immediate climb after takeoff rather than accelerating to the speed for maximum rate of climb.

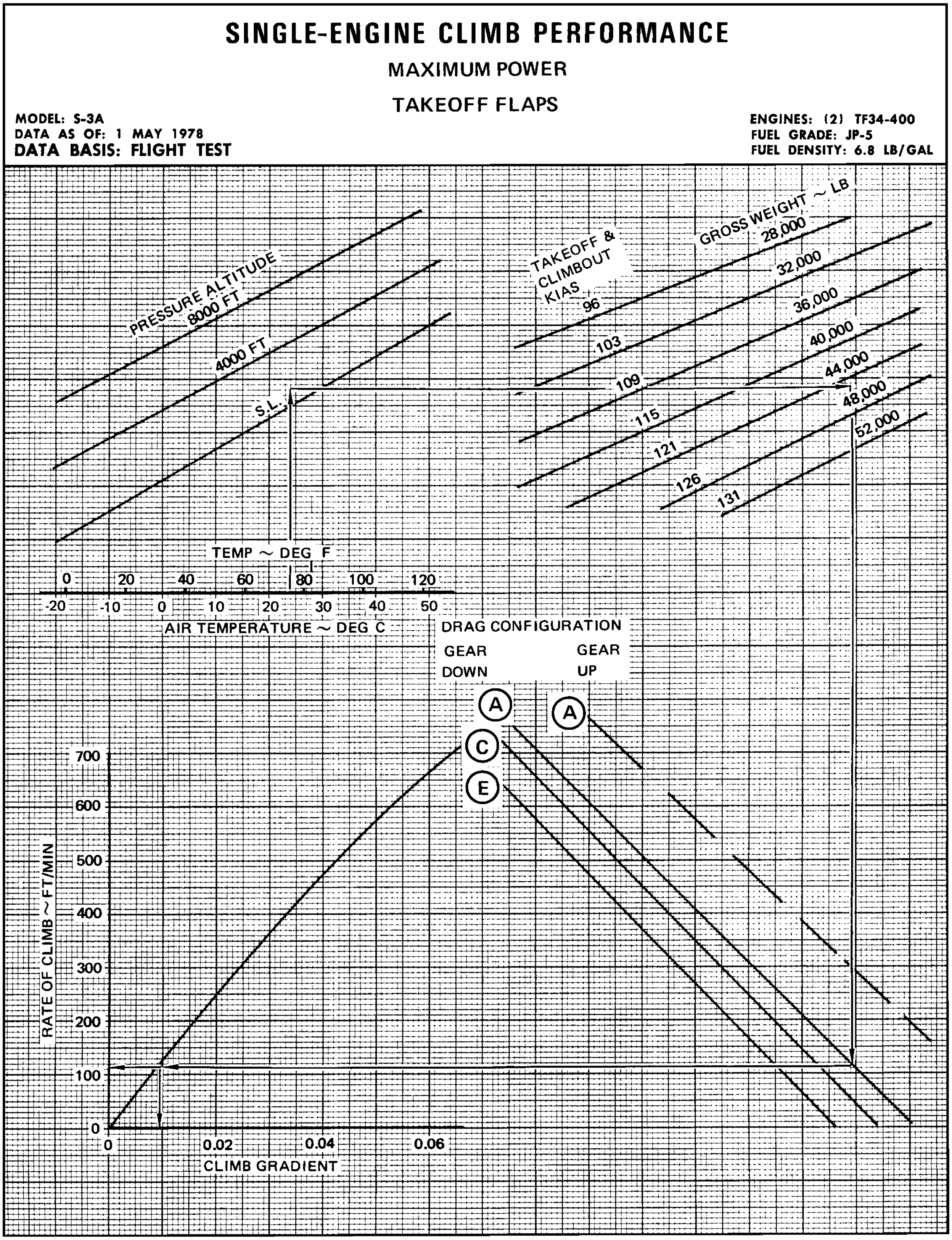


Figure 32-6. Single-Engine Climb Performance

Figure 32-7 is used in determining height for any distance from the takeoff point that the aircraft has achieved in the event of an engine failure prior to or at the point of takeoff. This height is found by multiplying the distance from the lift-off point to the obstacle by the gradient obtained from Figure 32-6. This will be the height above the ground at the obstacle distance for the zero runway slope case. To account for runway slope in determining height above ground, increase the gradient from Figure 32-6 by the amount of runway downhill slope and decrease it by the amount of uphill slope, prior to multiplying by the distance from the lift-off point to the obstacle.

Climbout gradient should be calculated based on gear down/takeoff flaps, with and without external stores (since they can be rapidly jettisoned) and gross weight with and without jettison of external stores and sonobuoys. Climb gradient should not be corrected for weight reduction caused by fuel jettison because of the relatively slow dump rate. If single-engine rate of climb is less than some prescribed value (in no case less than zero without jettisoning), then stores jettison will be required in the event of engine failure. If single-engine rate of climb is calculated to be insufficient after jettison, then a decision should be made to reduce the gross weight or to wait for cooler temperatures so that an acceptable single-engine rate of climb can be attained.

32.11 TAKEOFF PLANNING PROCEDURE

All takeoffs should be planned to determine the following:

1. The appropriate airspeed for lift-off and climbout
2. The airspeed at which to abort or continue the takeoff in the event of an engine failure
3. The amount by which the aircraft performance available exceeds the minimum performance required for safety.

The planning should also provide a means for checking performance during the ground run. A procedure that may be used is described below. An example for illustrating the use of each chart involved is covered under the takeoff planning problem.

1. Determine the length of the runway available for ground run, runway slope, location of critical obstacle(s), probable condition of runway surface, airport altitude, wind velocity, ambient temperature, and the aircraft gross weight.

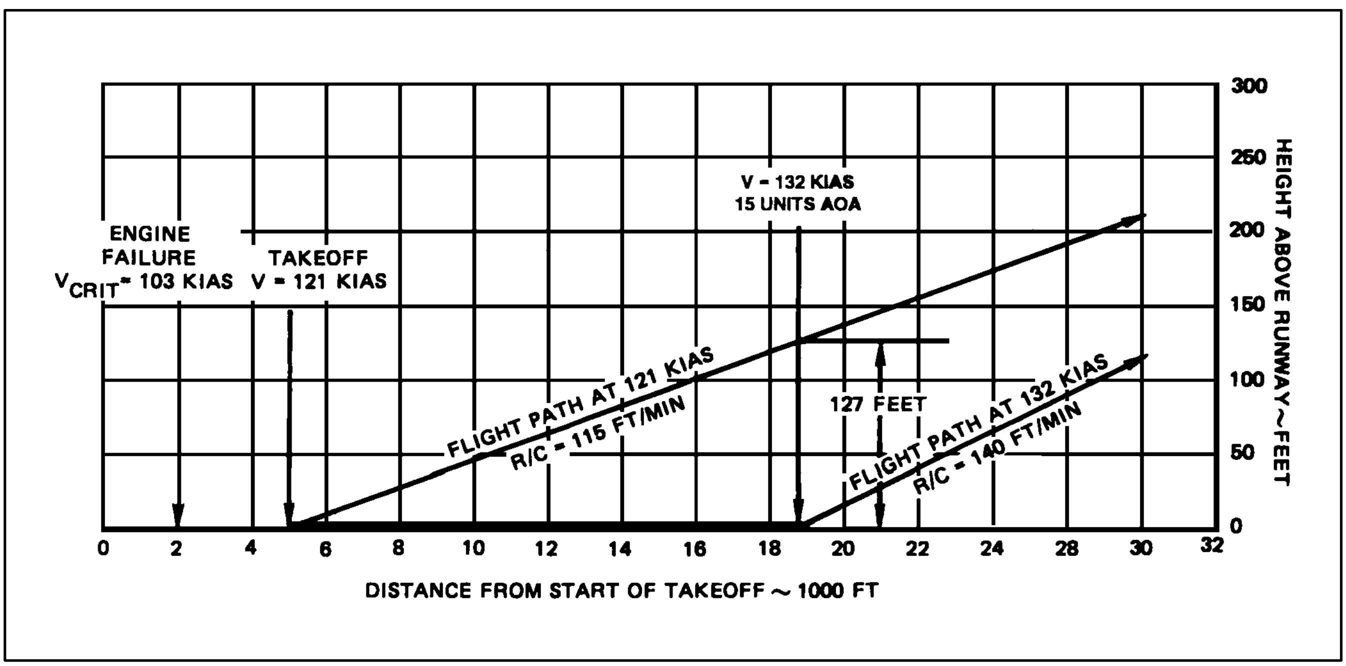


Figure 32-7. Height Above Ground

2. Determine the headwind or tailwind component along the active runway using Figure 32-1. Decide if the magnitude of the crosswind component is critical. Maximum recommended crosswind component for takeoff is 25 knots.

3. Determine the lift-off and climbout speed from the speed schedule shown in Figure 32-3. Rotation should be initiated to achieve and hold lift-off speed until clear of obstacles.

4. Determine the two-engine takeoff distance and distance to clear obstacles from Figure 32-2.

5. Find the critical engine failure speed from the chart shown in the lower chart of Figure 32-4.

6. Determine the refusal speed based on the available runway length from Figure 32-5. The refusal speed should always be equal to or greater than critical engine failure speed; otherwise, the aircraft is overloaded for the given set of takeoff conditions. In this case, if an engine failure were to occur between refusal and critical engine failure speed, the aircraft could neither stop nor continue to lift-off in the distance remaining.

7. Determine the decision speed based on the values obtained in steps 5 and 6. It can be no less than V_{CRIT} and no greater than $V_{REF.}$ Selection of the final value and actions should consider circumstances existing at the time. For example, in light of pilot experience, is an abort or a single-engine takeoff and landing more critical? How probable is a blown tire in the event of an aborted takeoff? If the weather is 100-foot ceiling and one-half mile visibility, it may be better to abort than to get airborne in the clouds with an engine out. Runway conditions (wet, dry ice patches) and abort gear availability are also factors to be considered.

8. To monitor progress during the takeoff run, predict speeds based on normal acceleration at known distances from brake release point, such as runway markers. Utilize the chart in the bottom half of Figure 32-3.

Note

Step 8 is mandatory under adverse runway conditions (e.g., water, ice, slush, snow) and/or when runway length is near critical.

9. Using the critical field length chart, Figure 32-4, forecast the distance to takeoff on one engine after engine failure at the critical engine failure speed. Then determine the distance from the single-engine takeoff point to the critical obstruction by means of the given airfield and obstacle geometry data.

10. Find the single-engine climb gradient from Figure 32-6. Determine the aircraft height at the obstruction by multiplying the distance to the obstacle obtained in step 9 by the gradient available. The aircraft is overweight if it cannot obtain the desired clearance at the obstacle. The possibility of reducing aircraft weight or waiting for more favorable conditions should be considered.

32.12 TAKEOFF PLANNING PROBLEM

The following example illustrates the use of each chart involved in takeoff planning.

TAKEOFF CONDITIONS:

1. Field elevation — 1,000 feet.

2. Ambient temperature — 24 °C.

3. Wind, 14 knots at 30° off runway heading.

4. Runway length available — 6,500 feet after allowing 200 feet for lineup.

5. Critical obstacle — 50 feet high and 800 feet from end of runway.

6. Takeoff gross weight — 45,000 pounds.

7. No external stores (drag configuration Ⓐ).

32.12.1 Wind Component. Enter Figure 32-1 on the 30° angle between the wind and runway line at a wind velocity of 14 knots. The headwind component is 12 knots, and the crosswind component is 7 knots.

32.12.2 Two-Engine Takeoff Distance. The two-engine takeoff distance is determined from Figure 32-2. Enter the upper left scale of ambient temperature at 24 °C and follow the guidelines illustrating the sample conditions to read 2,300 feet for a total ground run distance and 3,200 feet as total distance to clear a 50-foot obstacle.

32.12.3 Takeoff and Climbout Speed. Enter the chart shown in the upper half of Figure 32-3 with a gross weight of 45,000 pounds and determine a lift-off and climbout speed of 122 knots. Rotation should be initiated to lift-off and maintain speed during the climbout segment of the takeoff to achieve performance shown.

32.12.4 Critical Field Length. Critical field length and critical engine failure speed are determined from the upper and lower charts in Figure 32-4. Enter the upper chart on the left side with the 24 °C ambient temperature and follow the sample case guidelines to determine a critical field length of 4,450 feet. Enter the lower chart using 45,000 pounds to find a critical engine failure speed of 105 knots.

32.12.5 Refusal Speed. The refusal speed is determined from Figure 32-5. Enter the upper left part of the chart at 45,000 pounds and follow the guidelines illustrating the sample problem to find a refusal speed of 122 knots. The refusal speeds as shown are for a zero-wind condition. Therefore, the headwind component (12 knots) should be added to obtain the correct refusal speed, 134 knots.

32.12.6 Decision Speed. The minimum decision speed that can be selected is $V_{CRIT,}$ which is 105 KIAS. The maximum speed that can be selected is the lesser of the takeoff and refusal speeds and is 122 KIAS. A decision speed may therefore be selected based on pilot preference anywhere from 105 to 122 KIAS.

32.12.7 Acceleration Check Speed. Using the chart in the lower half of Figure 32-3, enter the takeoff speed scale with 122 knots and the ground distance scale with 2,300 feet. The intercept establishes the normal acceleration guideline for the sample condition. Reading down the guideline and using the 1,000-foot marker as the checkpoint for a speed check, the aircraft should accelerate to 83 knots at 1,000 feet.

32.12.8 Single-Engine Climbout Flightpath. Use the single-engine climbout gradient shown on Figure 32-6 to predict obstacle clearance capability in the event of an engine failure at the critical engine failure speed.

1. Find the total distance from the start of takeoff roll to the obstacle: 6,500 + 800 = 7,300 feet.

2. Subtract the critical field length from the total distance to the obstacle: 7,300 – 4,450 = 2,850 feet.

3. Enter Figure 32-6 at 24 °C on the temperature scale in the lower left corner, follow the guidelines for the sample conditions, and read +0.0092 as the single-engine climb gradient capability and 112 fpm as the rate-of-climb capability.

4. Multiply climb gradient by the distance from point of lift-off (based on critical field length) to the obstacle to obtain the height above the lift-off point the aircraft will have achieved in transversing this distance: 0.0092 × 2,850 feet = 26 feet.

5. Determine the obstacle clearance by subtracting the obstacle height from the aircraft height: 26 – 50 = –24 feet. Under the given conditions, the aircraft is overweight since the obstacle cannot be cleared.

CHAPTER 33

Climb

33.1 TWO-ENGINE CLIMB PERFORMANCE

Climb performance with two engines at intermediate power for various drag configurations is shown in Figure 33-1, Sheets 1 through 3. These charts show fuel, distance, and time to climb, respectively, as a function of initial gross weight, final altitude, and temperature deviation from a standard day. Aircraft performance is based on the use of the climb speed schedule shown in Figure 33-1, Sheet 4, which also shows the standard day rate of climb for various drag configurations. Figure 33-2, Sheets 1 through 4, show fuel, time, distance, climb speed schedule, and standard day rate of climb, respectively, for two-engine climb performance at maximum continuous power.

33.1.1 Sample Problem. Determine the climb performance for a two-engine intermediate power climb from 5,000 to 35,000 feet. The initial gross weight is 40,000 pounds, drag configuration Ⓐ, and the temperature deviation from a standard day is +5 °C.

1. Enter Figure 33-1, Sheet 1, at the gross weight of 40,000 pounds. At the initial altitude of 5,000 feet, read across from the drag configuration Ⓐ guideline to +5 °C deviation from a standard day and read 120 pounds of fuel used. At the final altitude of 35,000 feet, read 1,050 pounds fuel used. Fuel required is 1,050 – 120 = 930 pounds.

2. From Figure 33-1, Sheet 2, read the initial distance as 7 nm. Read the final distance at 35,000 feet as 92 nm. Distance required is 92 – 7 = 85 nm.

3. From Figure 33-1, Sheet 3, read the initial time as 1.0 minute. Read the final time as 17 minutes. Time to climb is 17.0 – 1.0 = 16 minutes.

For climbs starting from sea level, read the fuel used, distance traveled, and time required directly across from the drag configuration guideline and the temperature deviation from a standard day.

33.2 OPTIMUM CRUISE ALTITUDE

Figure 33-3 shows the altitude for maximum range as a function of gross weight and drag configuration for a standard day. This chart is used in conjunction with Figure 33-1, Sheet 1, to determine the start cruise altitude for maximum-range flight.

Example:

For an initial climb gross weight of 40,000 pounds in drag configuration Ⓐ and standard day, Figure 33-1, Sheet 1, shows approximately 1,000 pounds of fuel used climbing from sea level to optimum cruise altitude, giving a gross weight at the top of climb of 39,000 pounds.

Enter Figure 33-3 at 39,000 pounds and read the initial cruise altitude to be 37,800 feet. The second section of Figure 33-3 shows the decrease in optimum cruise altitude caused by increases in air temperature for all drag configurations. The values obtained should be subtracted from the optimum cruise altitude based on the air temperature deviation from a standard day.

33.3 SINGLE-ENGINE CLIMB PERFORMANCE

Fuel, distance, and time to climb with one engine at intermediate power is shown in Figure 33-4, Sheets 1 through 3, respectively. Drag configurations Ⓐ, Ⓑ, and Ⓓ are shown on the charts. The single-engine climb speed for drag configurations Ⓐ and Ⓑ is 180 KIAS; for drag configuration Ⓒ, it is 170 KIAS; and for drag configuration Ⓓ , 160 KIAS. Use of the charts is similar to the two-engine climb charts.

33.4 SINGLE-ENGINE CLIMB PERFORMANCE MAXIMUM POWER WITH LANDING FLAPS

Figure 33-5 presents rate-of-climb and climbpath gradients with landing flaps and maximum power on one engine. The effect of landing gear is shown for drag configuration Ⓐ and that increment is applicable for

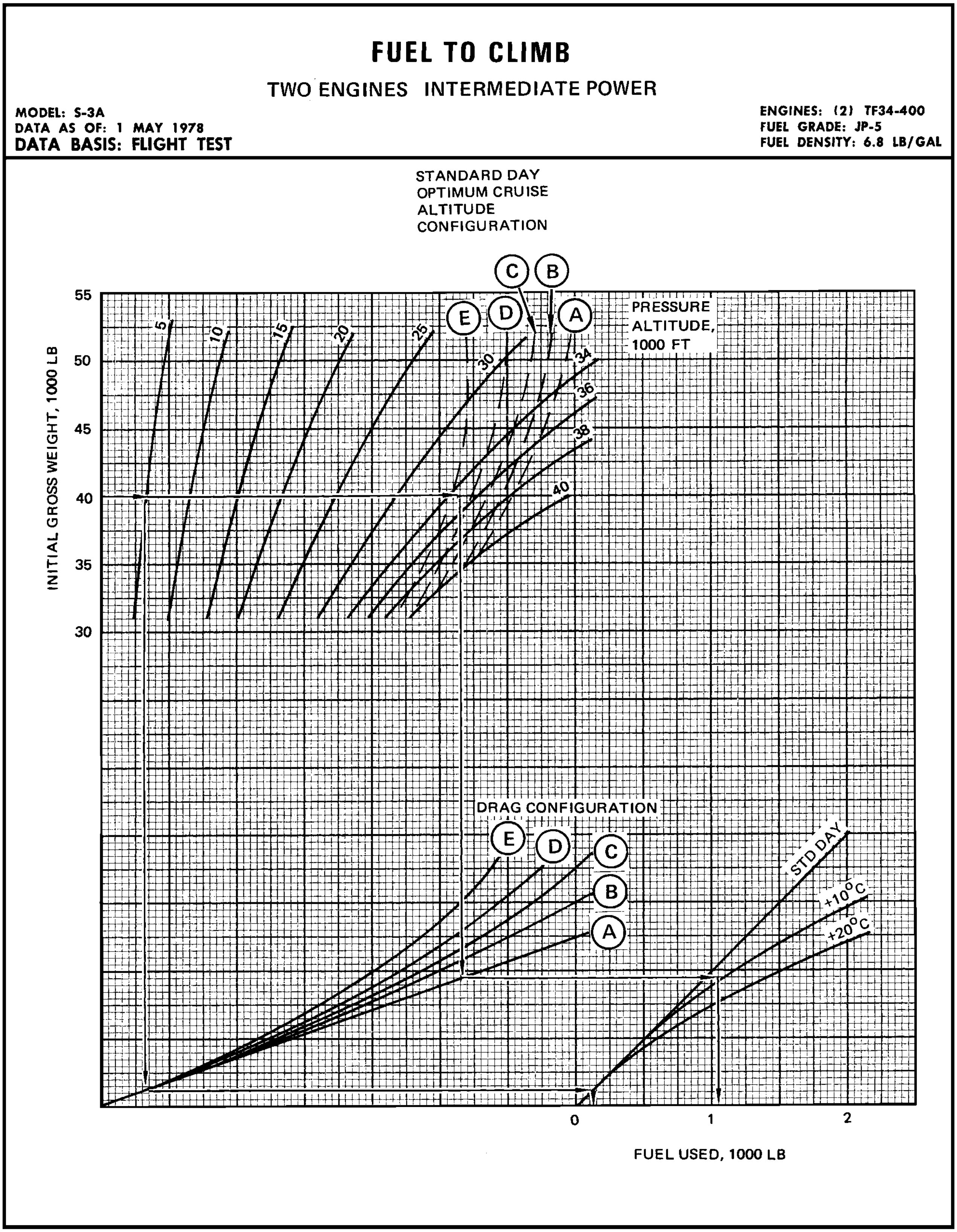


Figure 33-1. Two-Engine Climb Performance — Intermediate Power (Sheet 1 of 4)

DISTANCE TO CLIMB

TWO ENGINES INTERMEDIATE POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

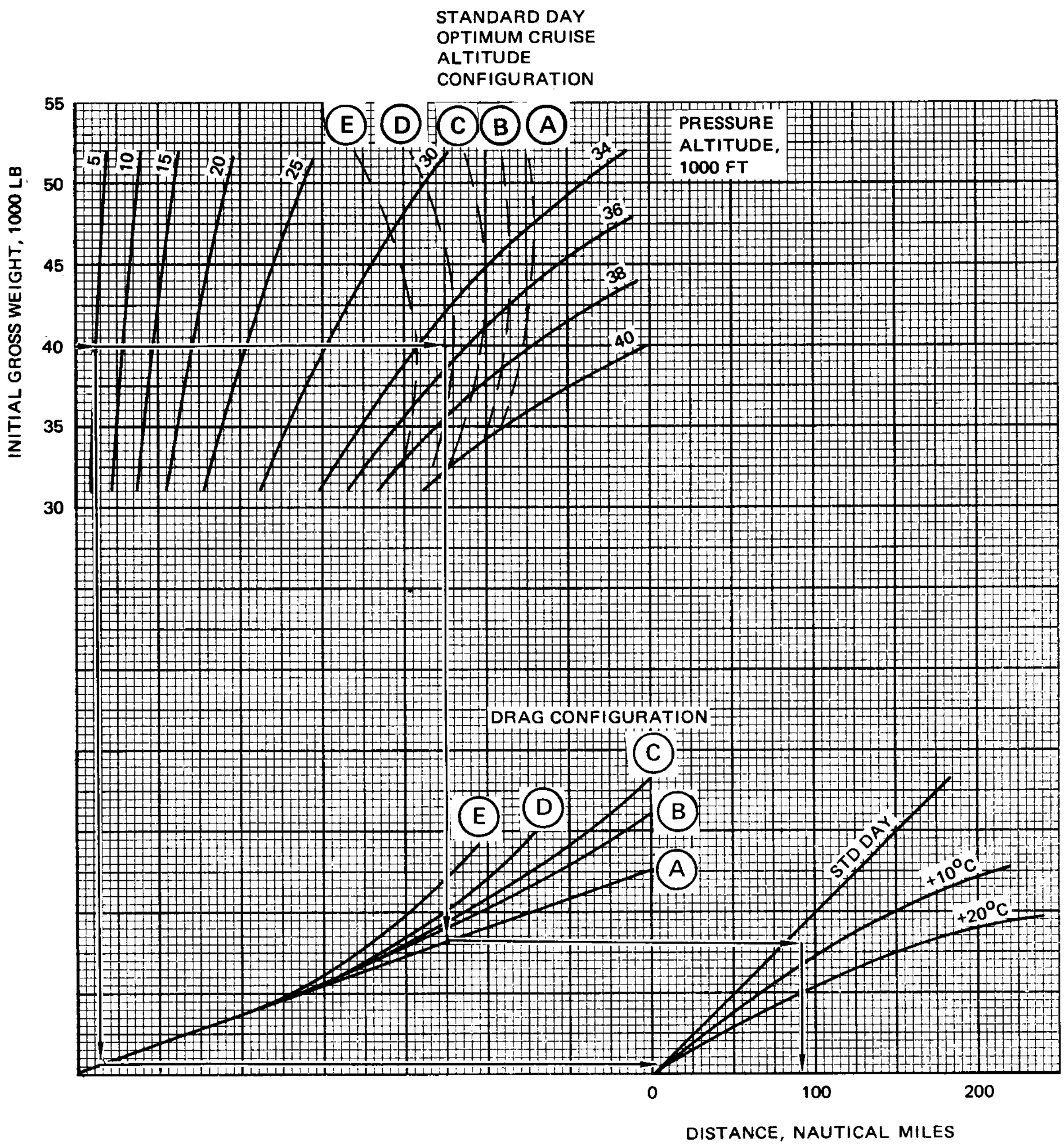


Figure 33-1. Two-Engine Climb Performance — Intermediate Power (Sheet 2)

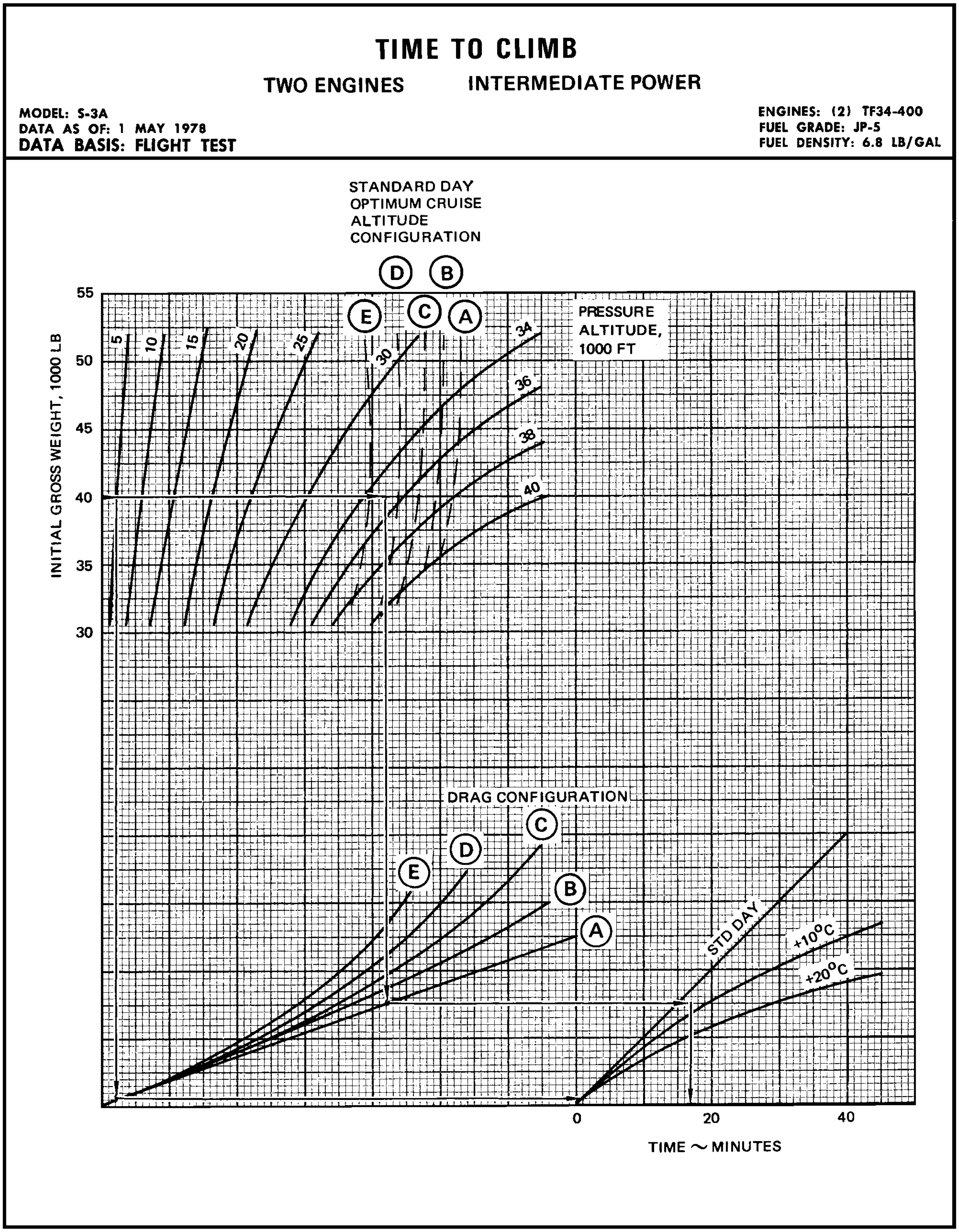


Figure 33-1. Two-Engine Climb Performance — Intermediate Power (Sheet 3)

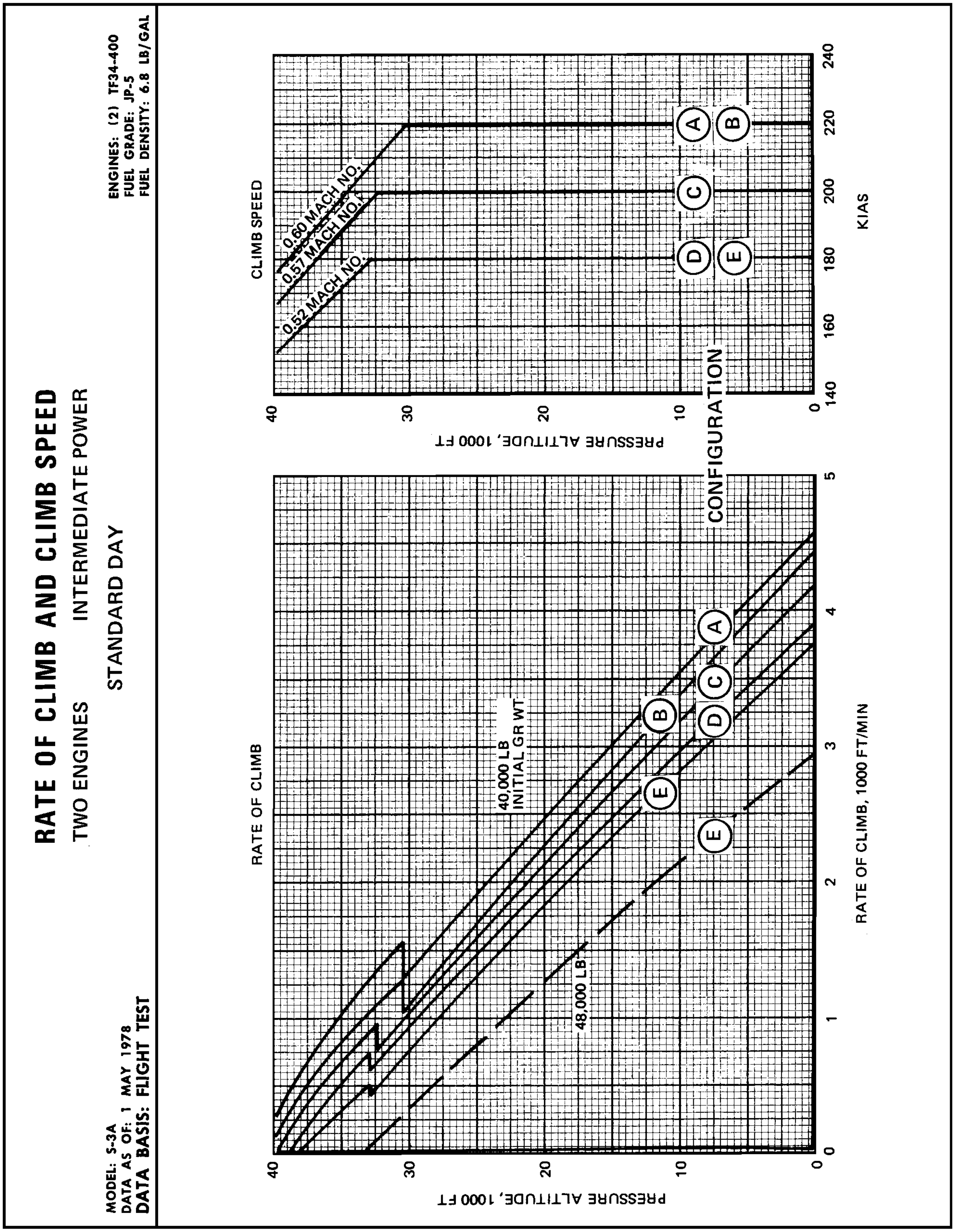


Figure 33-1. Two-Engine Climb Performance — Intermediate Power (Sheet 4)

FUEL TO CLIMB

TWO ENGINES MAXIMUM CONTINUOUS POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

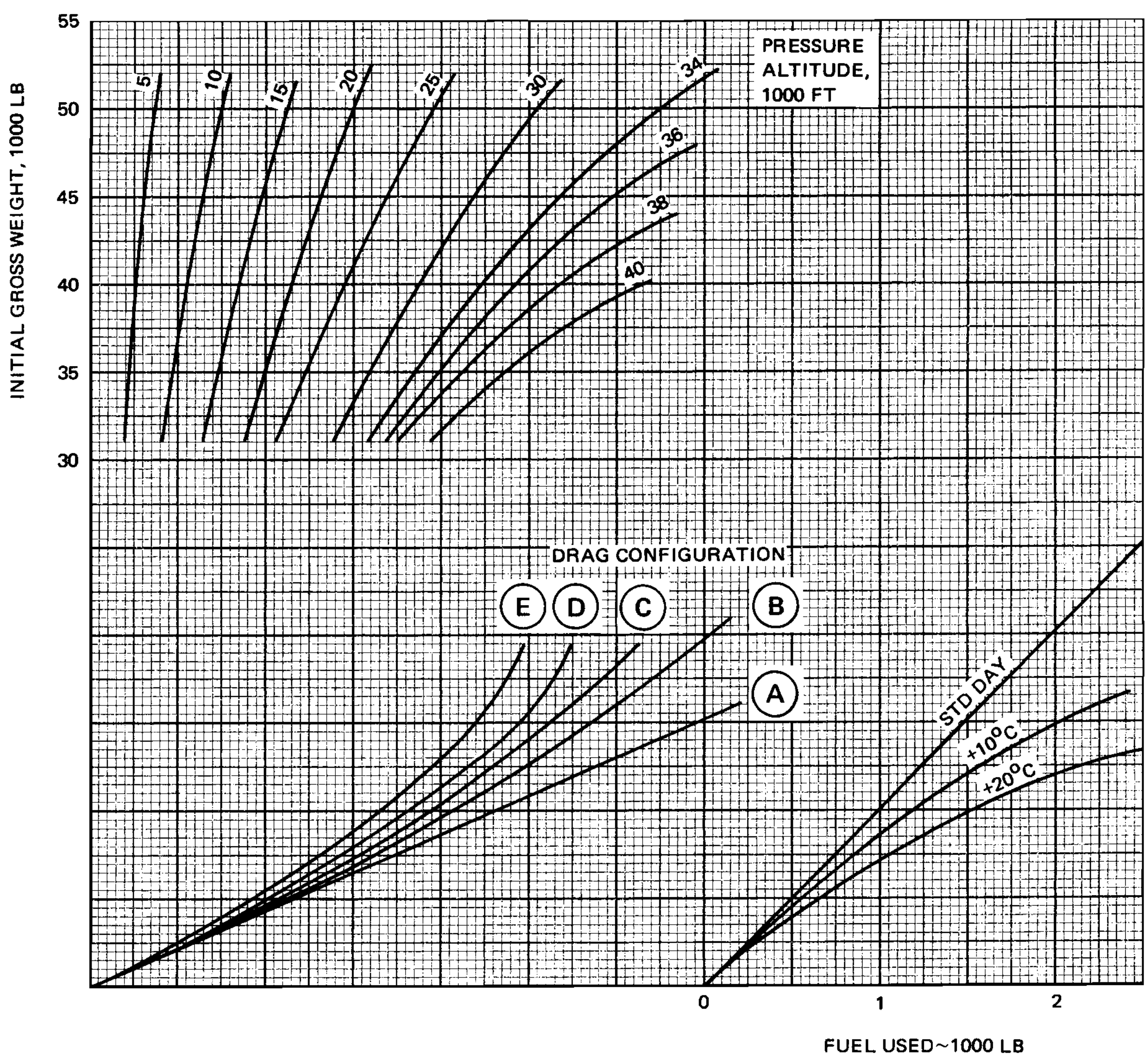


Figure 33-2. Two-Engine Climb Performance — Maximum Continuous Power (Sheet 1 of 4)

DISTANCE TO CLIMB

TWO ENGINES MAXIMUM CONTINUOUS POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

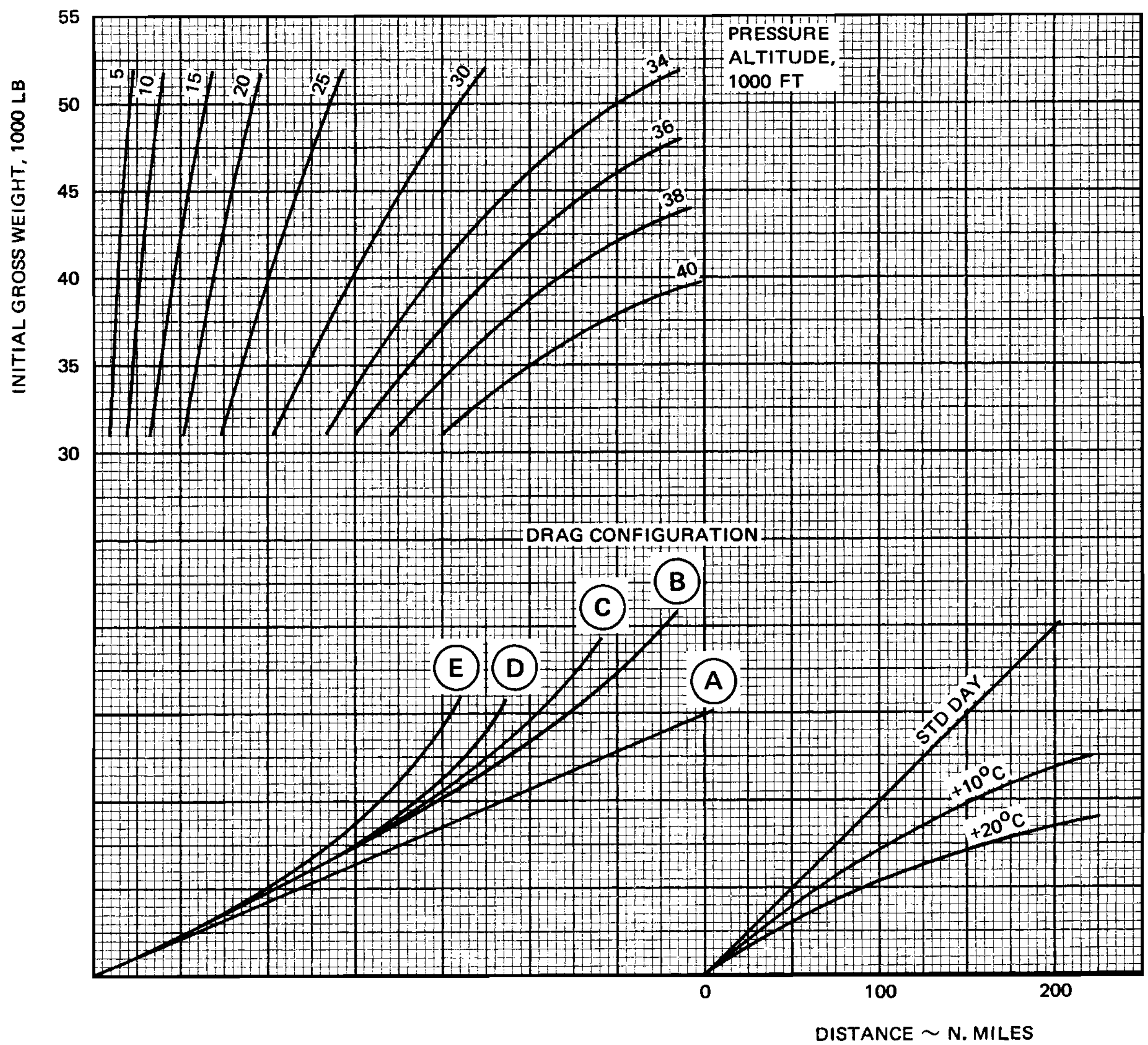


Figure 33-2. Two-Engine Climb Performance — Maximum Continuous Power (Sheet 2)

TIME TO CLIMB

TWO ENGINES MAXIMUM CONTINUOUS POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

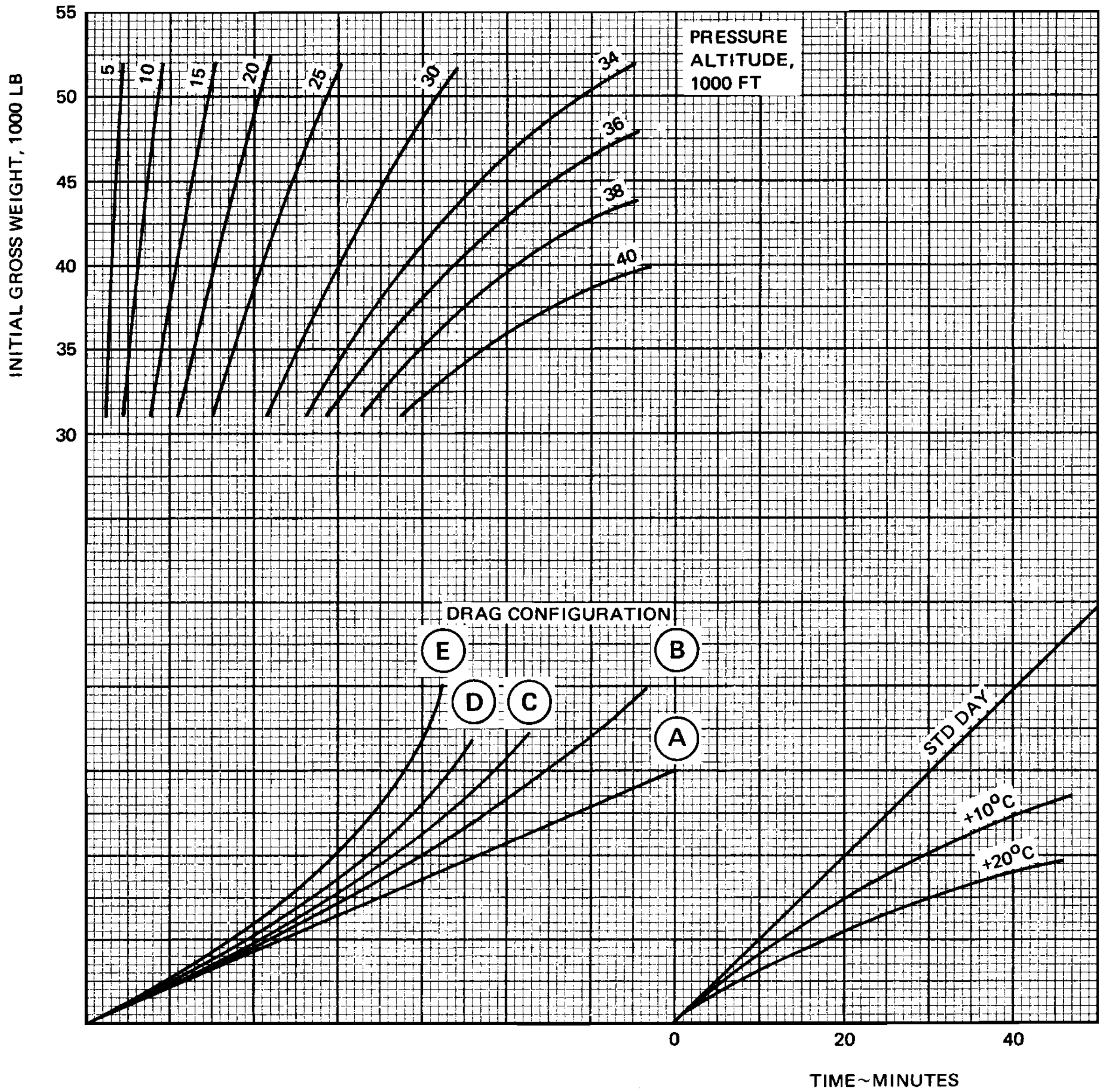


Figure 33-2. Two-Engine Climb Performance — Maximum Continuous Power (Sheet 3)

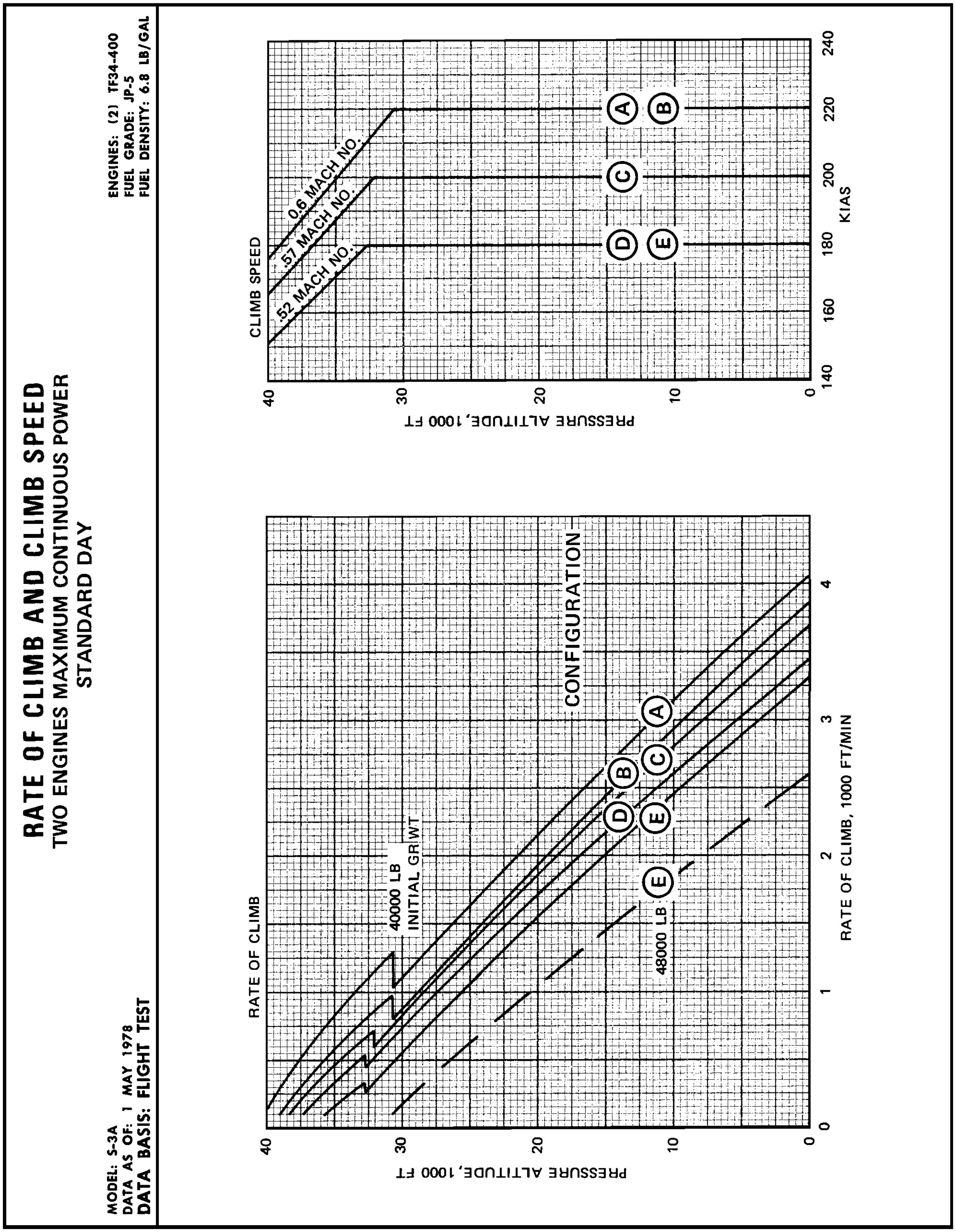


Figure 33-2.Two-Engine Climb Performance — Maximum Continuous Power (Sheet 4)

OPTIMUM CRUISE ALTITUDE

TWO ENGINES

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

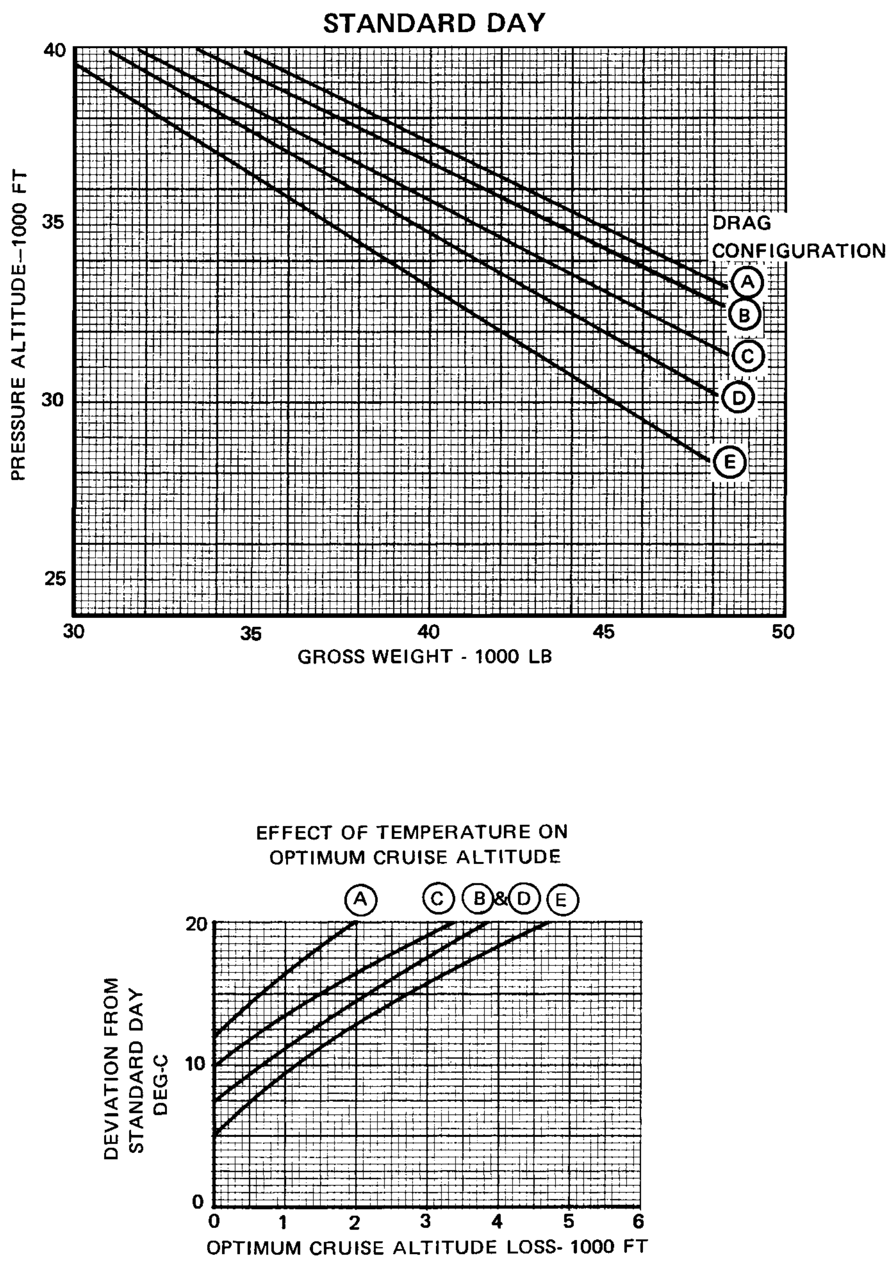


Figure 33-3. Optimum Cruise Altitude

FUEL TO CLIMB

SINGLE ENGINE INTERMEDIATE POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

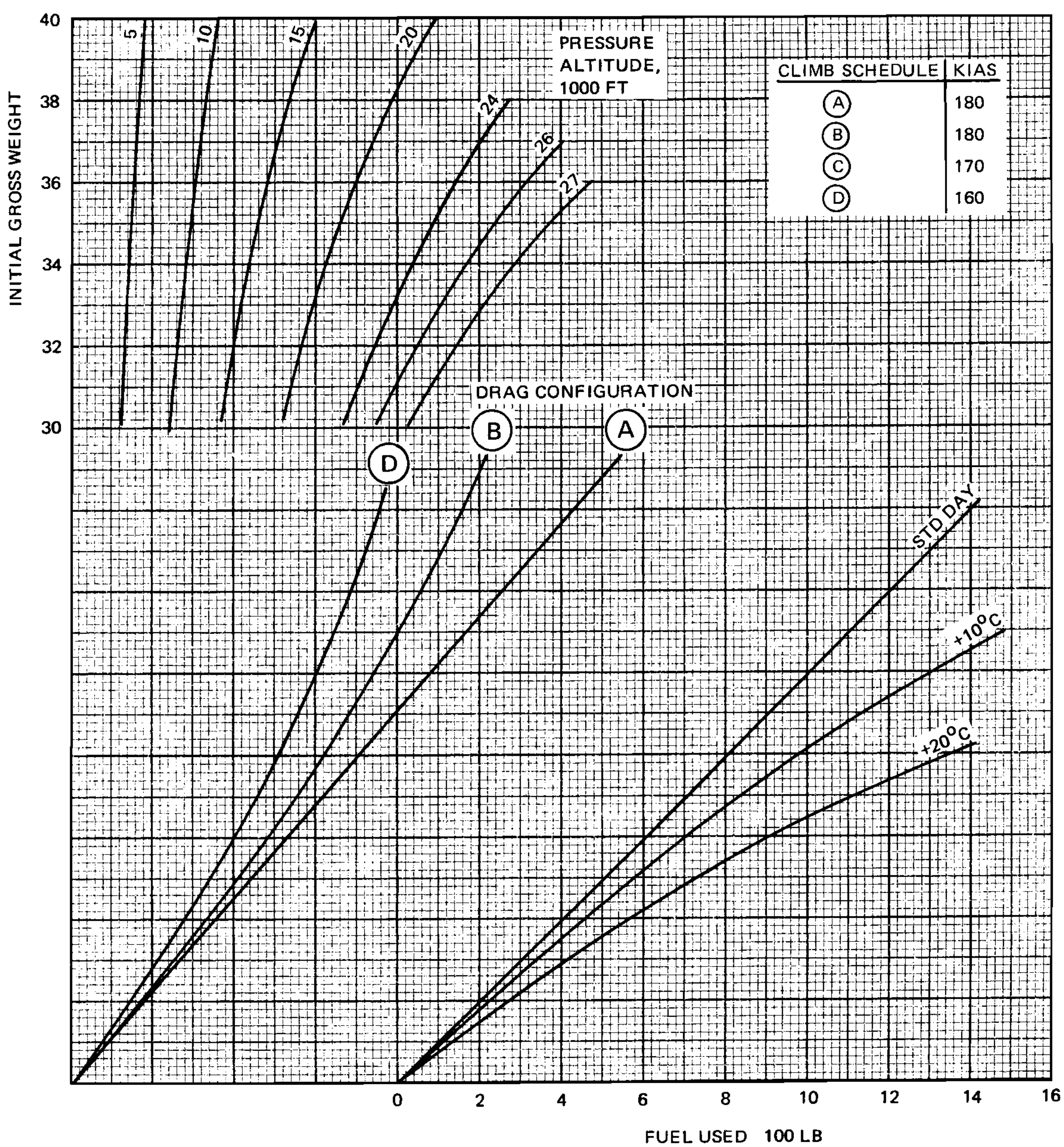


Figure 33-4. Single-Engine Climb Performance — Intermediate Power (Sheet 1 of 3)

DISTANCE TO CLIMB

SINGLE ENGINE INTERMEDIATE POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

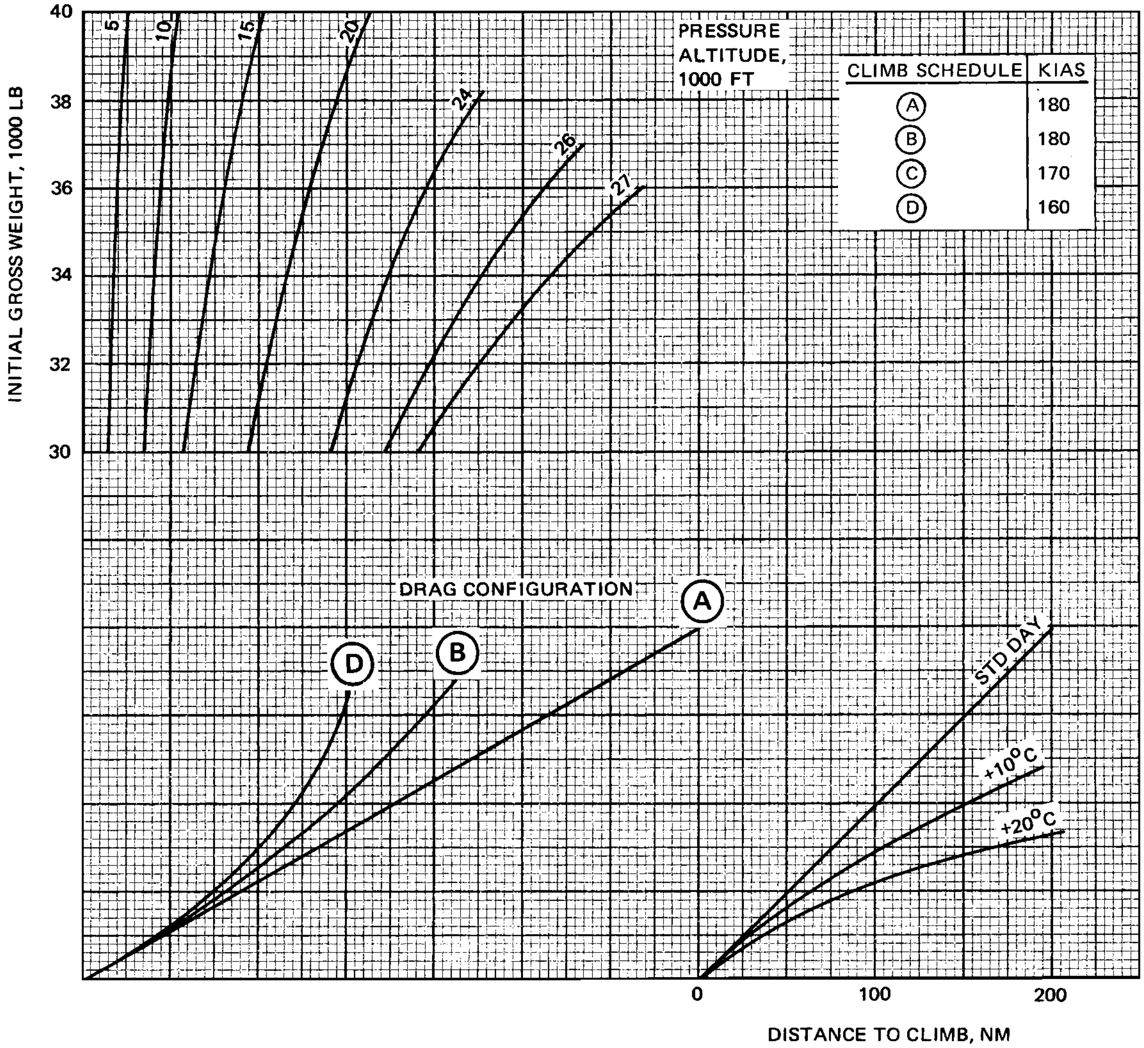


Figure 33-4. Single-Engine Climb Performance — Intermediate Power (Sheet 2)

TIME TO CLIMB

SINGLE ENGINE INTERMEDIATE POWER

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

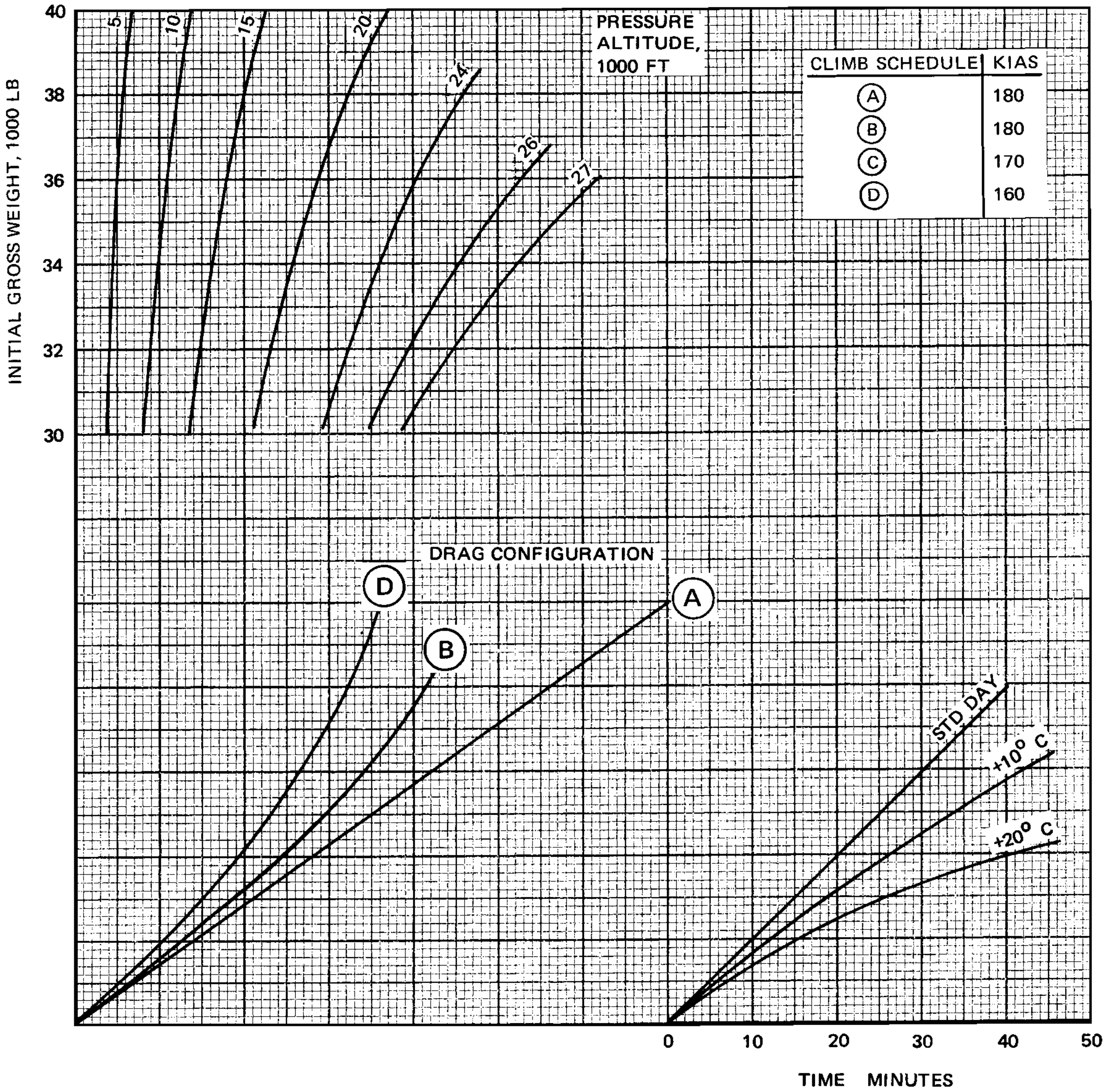


Figure 33-4. Single-Engine Climb Performance — Intermediate Power (Sheet 3)

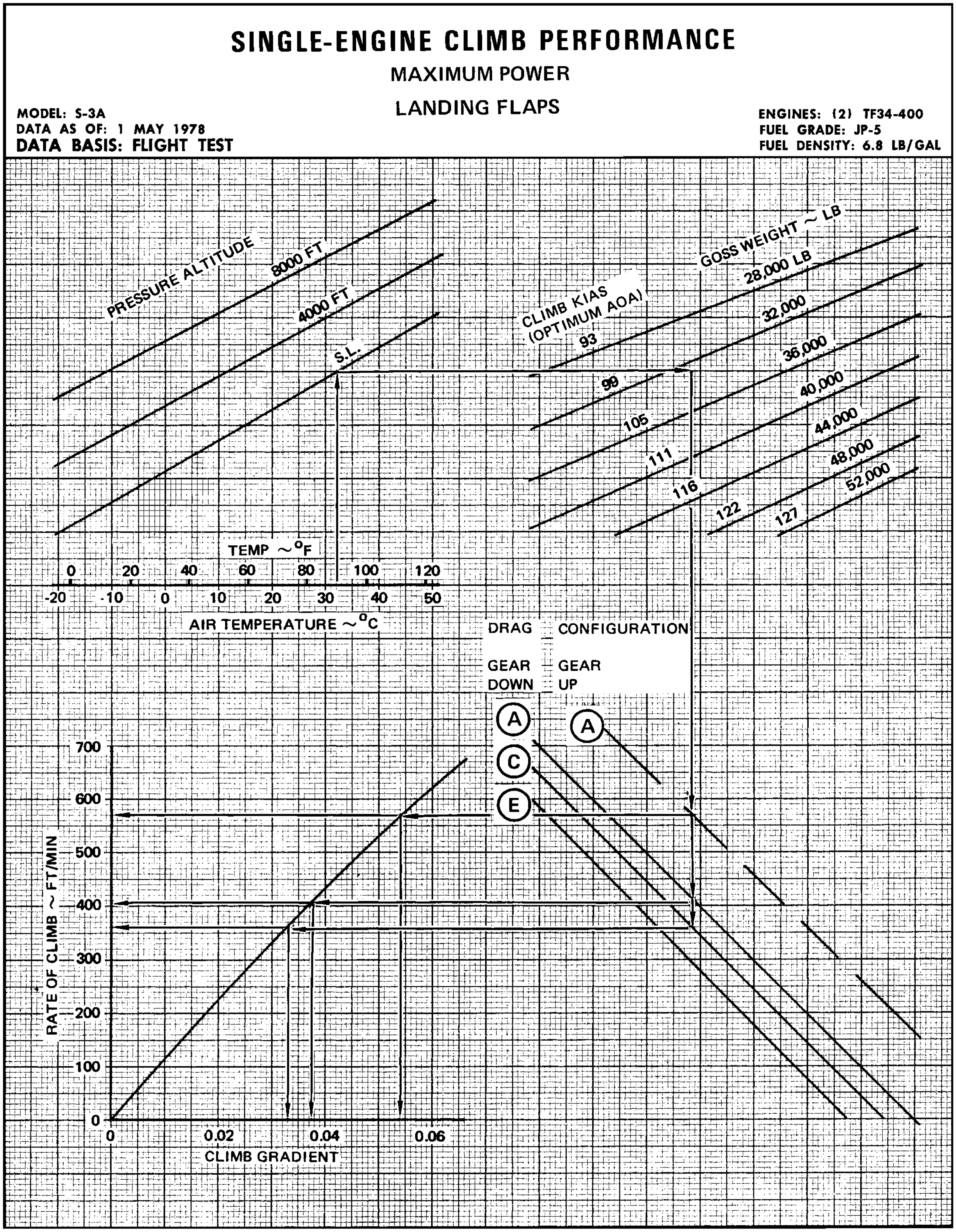


Figure 33-5. Single-Engine Climb Performance — Maximum Power With Landing Flaps

the Ⓒ and Ⓔ drag configurations. Obstacle clearance is more readily accomplished by climbing at optimum AOA speed rather than at the speed for best rate of climb. This is because of the distance required to accelerate from optimum AOA speed to the higher speed. Maximum rate of climb is obtained at the speed for 15.0 units AOA.

33.4.1 Sample Problem. Determine the gear-up climb performance with drag configuration Ⓒ at sea level pressure altitude, +32 °C air temperature and 33,000 pounds gross weight.

Enter Figure 33-5 with the given conditions and determine drag configuration Ⓐ performance. The rate of climb with gear down is 405 fpm and a corresponding climbpath gradient of 3.75 percent; gear-up performance is 570 fpm and a 5.4-percent climbpath gradient; the gear effect is 570   405 = 165 fpm and 5.4   3.75 = 1.65 percent climbpath gradient. For drag configuration Ⓒ, the gear-down performance is 360 fpm and a 3.3 percent climbpath gradient. Gear-up performance would be 360 + 165 = 525 fpm rate of climb and 3.3 + 1.65 = 4.95 percent climbpath gradient.

CHAPTER 34

Range

34.1 MAXIMUM RANGE SUMMARY

Figure 34-1 shows summary charts from which the nautical miles per 1,000 pounds for maximum range flight can be readily found for any altitude and drag configuration. These data are for constant altitude flight at the speeds for maximum range that are also shown in each figure. The same information can be obtained from the nautical miles per 1,000-pound curves of Chapter 38, but only at the specific altitudes shown in Chapter 38. Use of the maximum range summary charts permits the determination of maximum range available for a given amount of fuel without interpolation for altitude.

34.1.1 Sample Problem. Determine the cruise distance at 27,000 feet, if 4,000 pounds of fuel are available for cruise. The initial gross weight is 45,000 pounds, and the aircraft is in drag configuration Ⓑ.

1. The average cruise gross weight is 43,000 pounds (45,000 – 4,000/2).

2. Enter Figure 34-1, Sheet 2, at 27,000 feet and the average gross weight of 43,000 pounds. Read the nautical miles per 1,000 pounds of fuel to be 168.

3. The cruise distance available is 168/1,000 × 4,000 or 672 nm.

4. Average cruise airspeed is 204 KIAS.

34.2 EFFECT OF WIND ON MAXIMUM NAUTICAL MILES PER 1,000 POUNDS OF FUEL AND OPTIMUM CRUISE SPEED

Figure 34-2 shows the effect of a headwind or tailwind on maximum nautical miles per 1,000 pounds of fuel and optimum cruise airspeed for all aircraft weights and drag configurations. This chart is used in conjunction with Figure 34-1. In the example above, the maximum nautical miles per pound was 168 with an average cruise airspeed of 204 KIAS. With a 50-knot headwind at 27,000 feet, enter Figure 34-2 at 50-knot headwind, proceed across to 27,000 feet and down to the baseline. Move radially along the guideline to intersect zero wind, maximum nautical miles per 1,000 pounds at 168 and read the maximum nautical miles per 1,000 pounds with wind of 137. Proceed across at a 50-knot headwind to 27,000 feet and read a ΔV to be added to the zero-wind cruise speed of 10 knots. The optimum cruise speed with a 50-knot headwind is 204 + 10 = 214 KIAS.

34.3 BINGO RANGE CHART

Bingo range data is shown in a series of tables for normal operation and for various failure conditions, Figures 34-3 through 34-8. Time and fuel required to travel distances up to 500 nm are shown on the bingo range charts using a combination of intermediate power climb, maximum range cruise, and long-range flight idle descent. Additional data show the effect of cruising at other than the altitude for maximum range.

34.4 OPTIMUM RETURN PROFILE

The optimum return profile for single-engine operation, Figure 34-9, is a summary presentation for determining directly the maximum range attainable for a given flight condition of fuel remaining and altitude. The distances shown include a 1,000-pound fuel reserve. Enter the chart at fuel remaining and actual altitude and read the range directly. The three segments of the profile are an intermediate power climb, a cruise climb, and a maximum range descent.

34.4.1 Sample Problem. Determine the fuel and time required, single-engine operation, to return to a base 1,010 nm away with a 30-knot tailwind. The aircraft is at 10,000 feet and is in configuration Ⓑ.

1. Enter Figure 34-9, Sheet 1, at 10,000 feet and 1,010 nm to establish an initial point. Read the zero-wind fuel required to be 7,500 pounds. An intermediate power climb followed by cruise climb is required to obtain this performance.

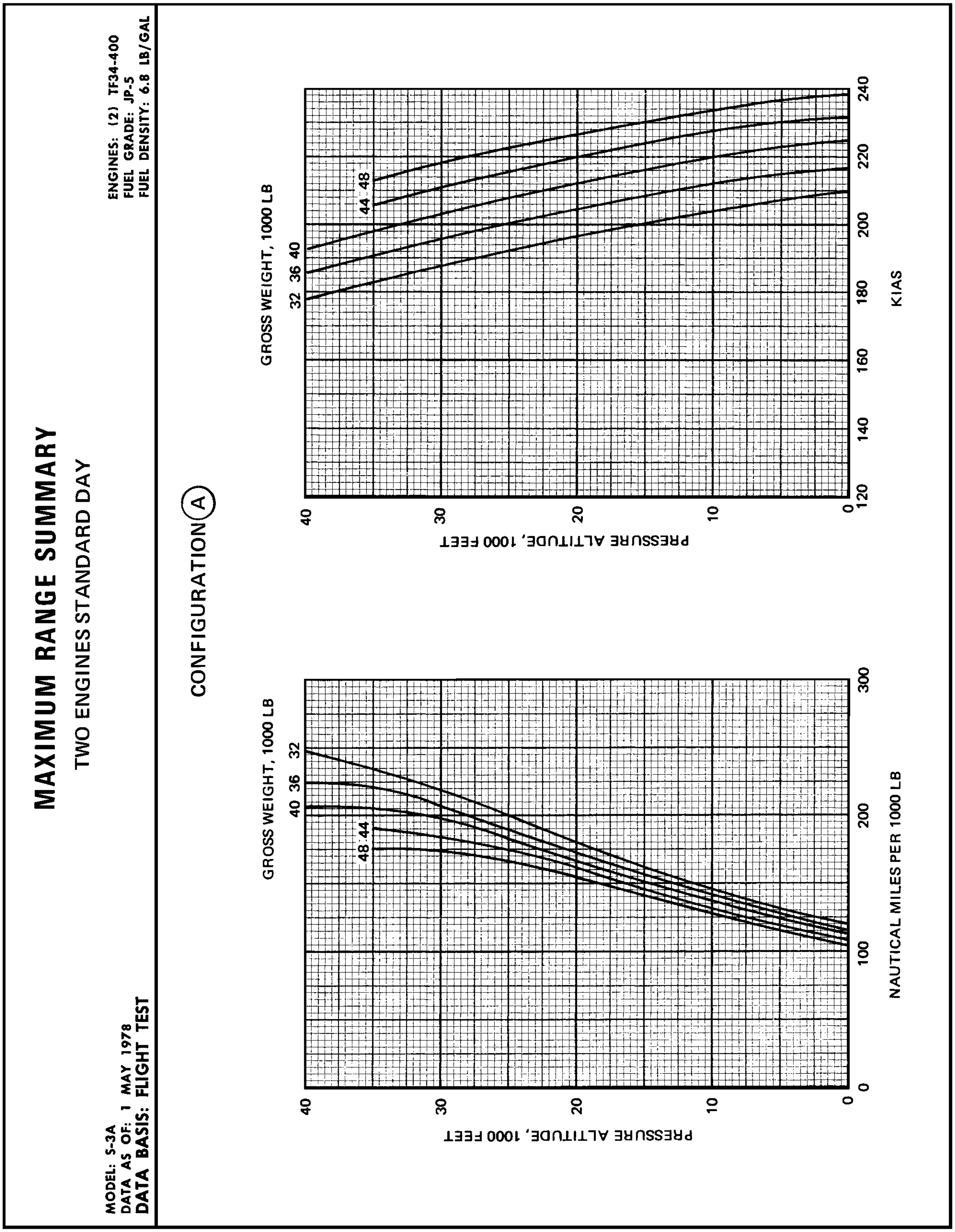


Figure 34-1. Maximum Range Summary (Sheet 1 of 5)

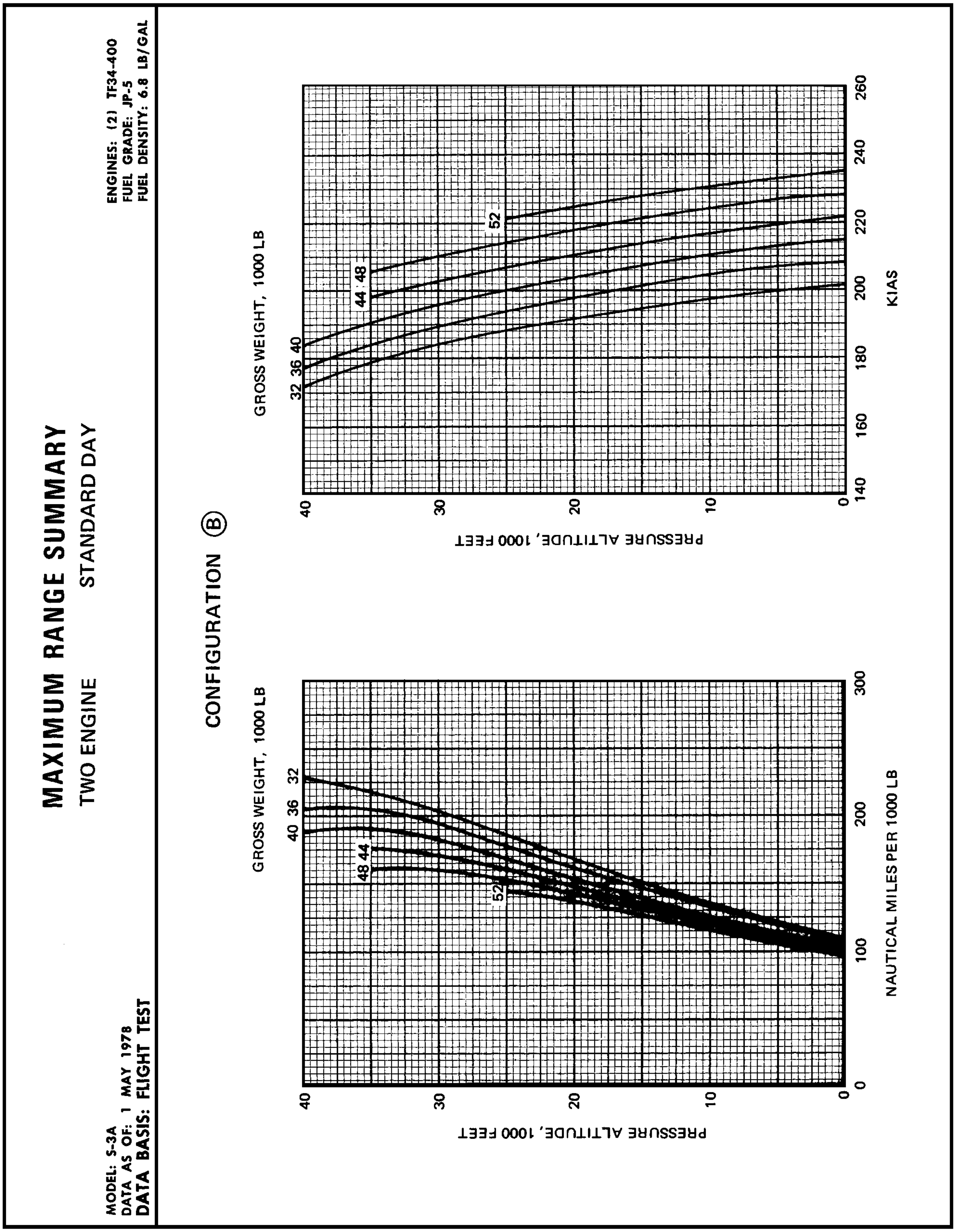


Figure 34-1. Maximum Range Summary (Sheet 2)

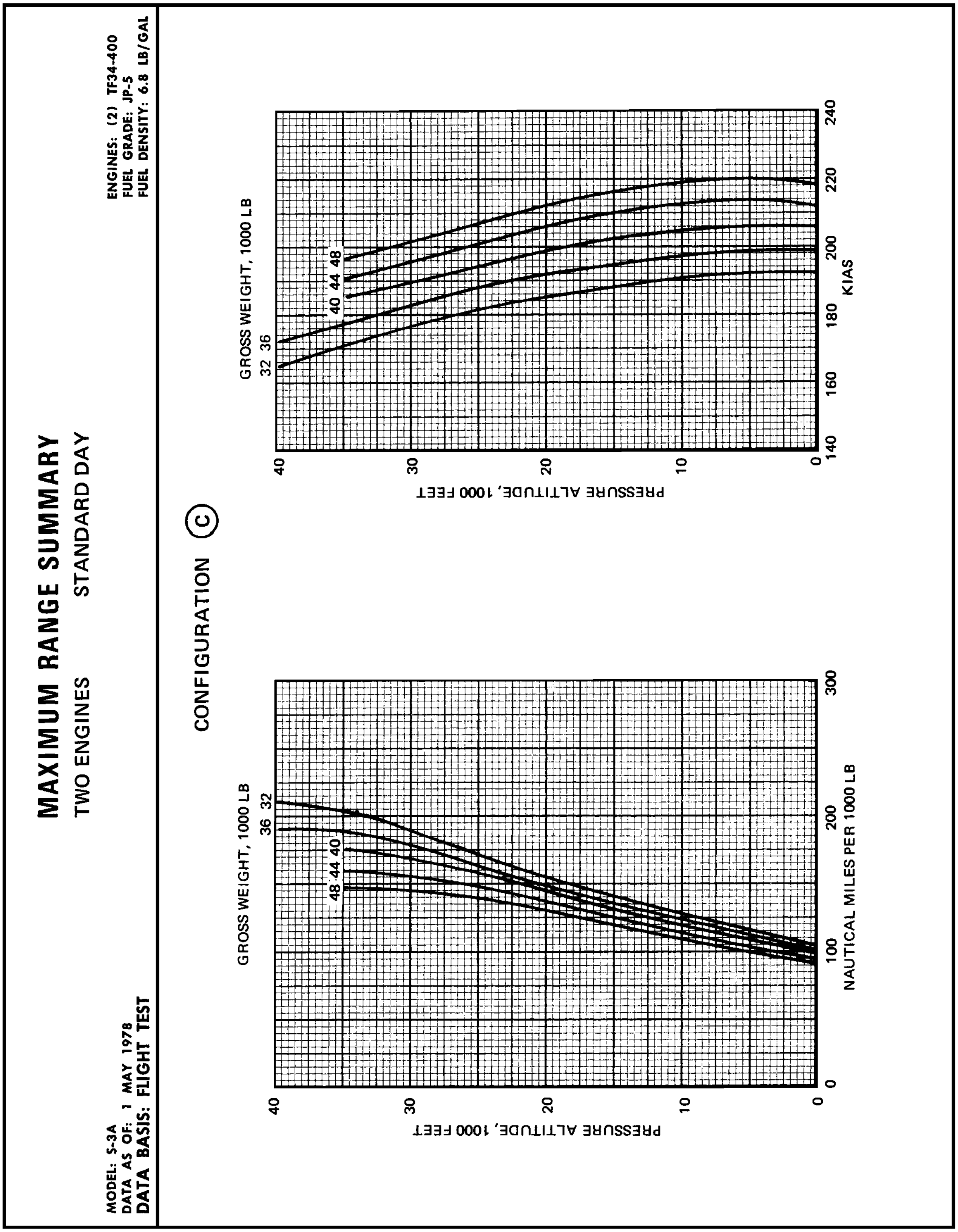


Figure 34-1. Maximum Range Summary (Sheet 3)

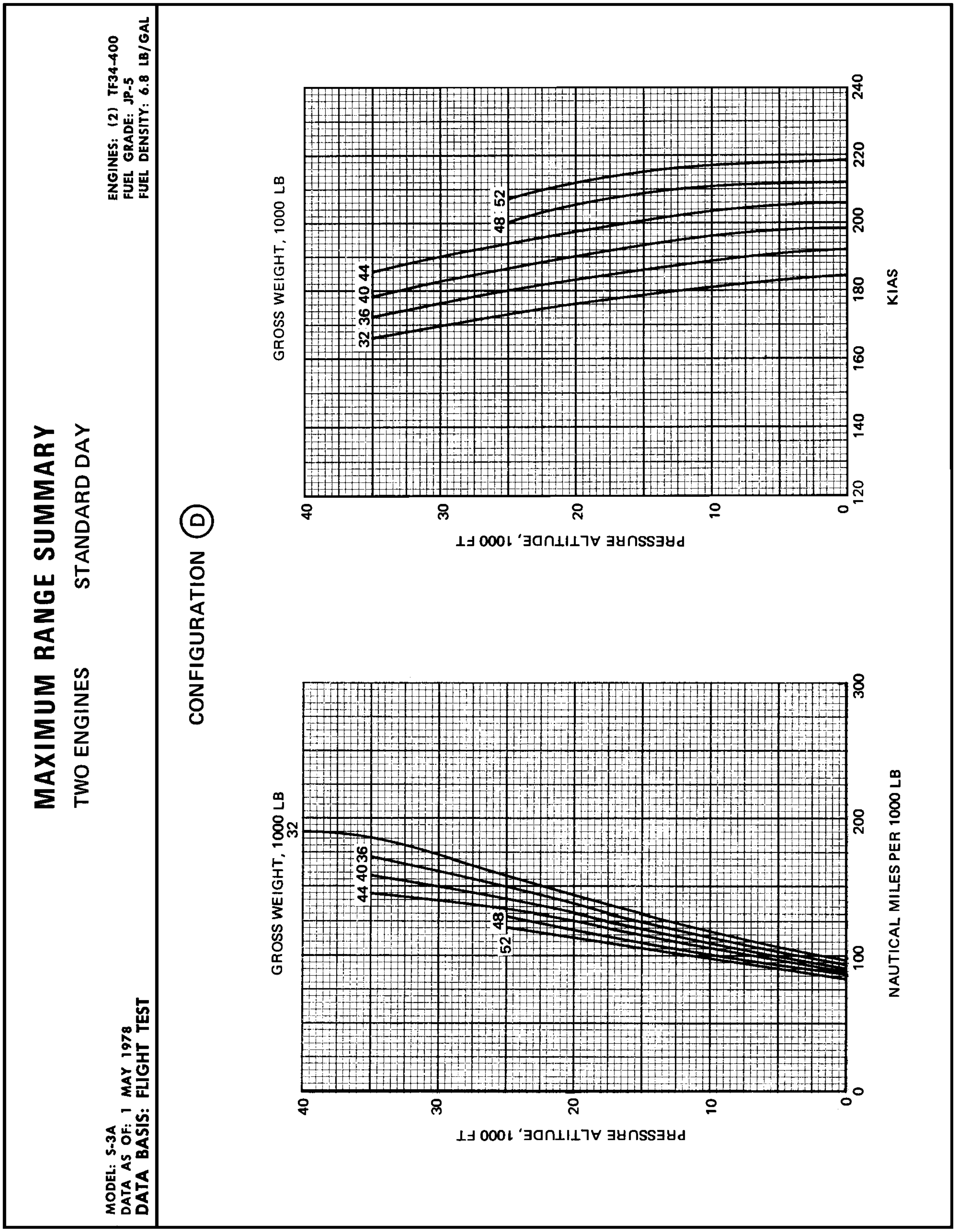


Figure 34-1. Maximum Range Summary (Sheet 4)

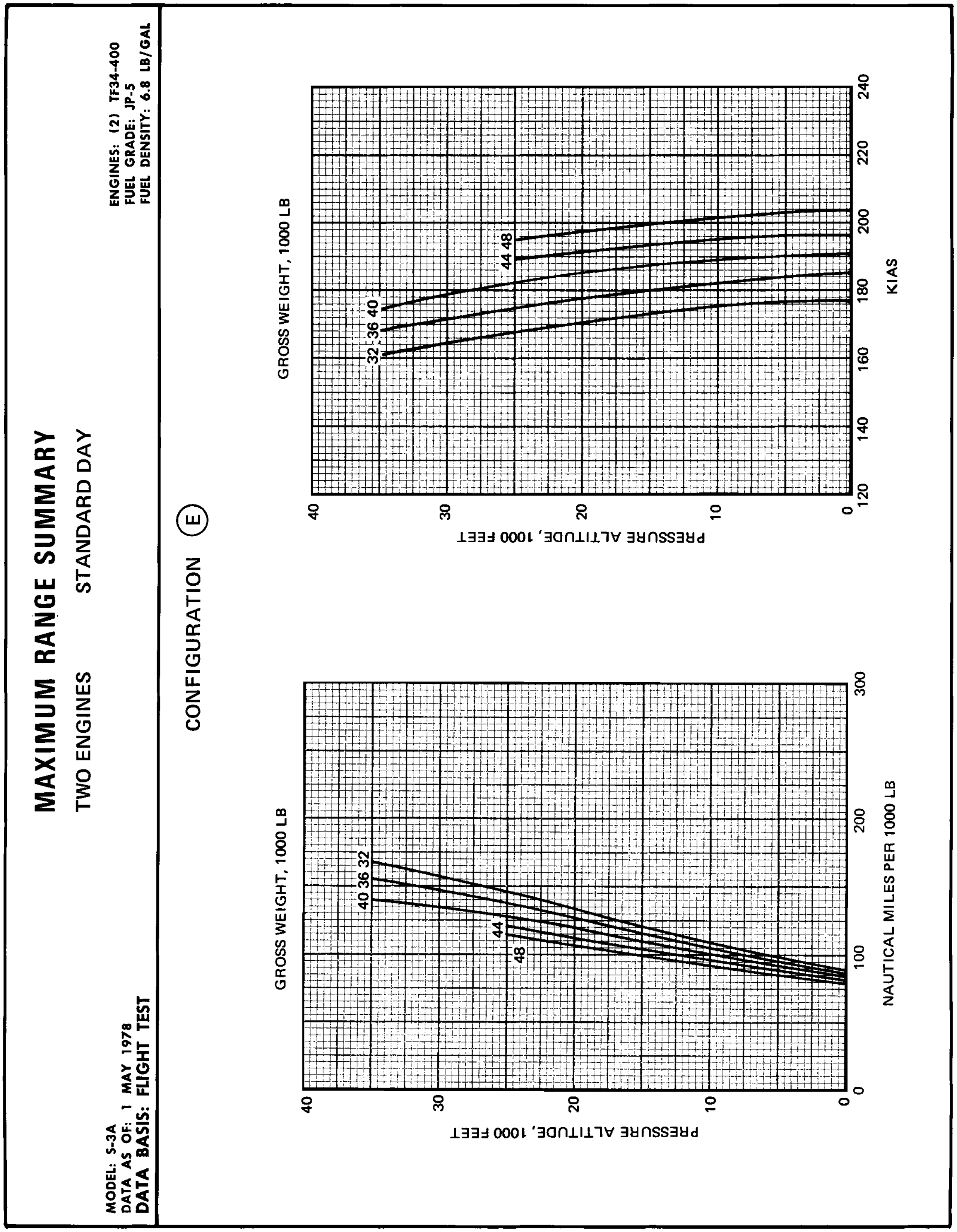


Figure 34-1. Maximum Range Summary (Sheet 5)

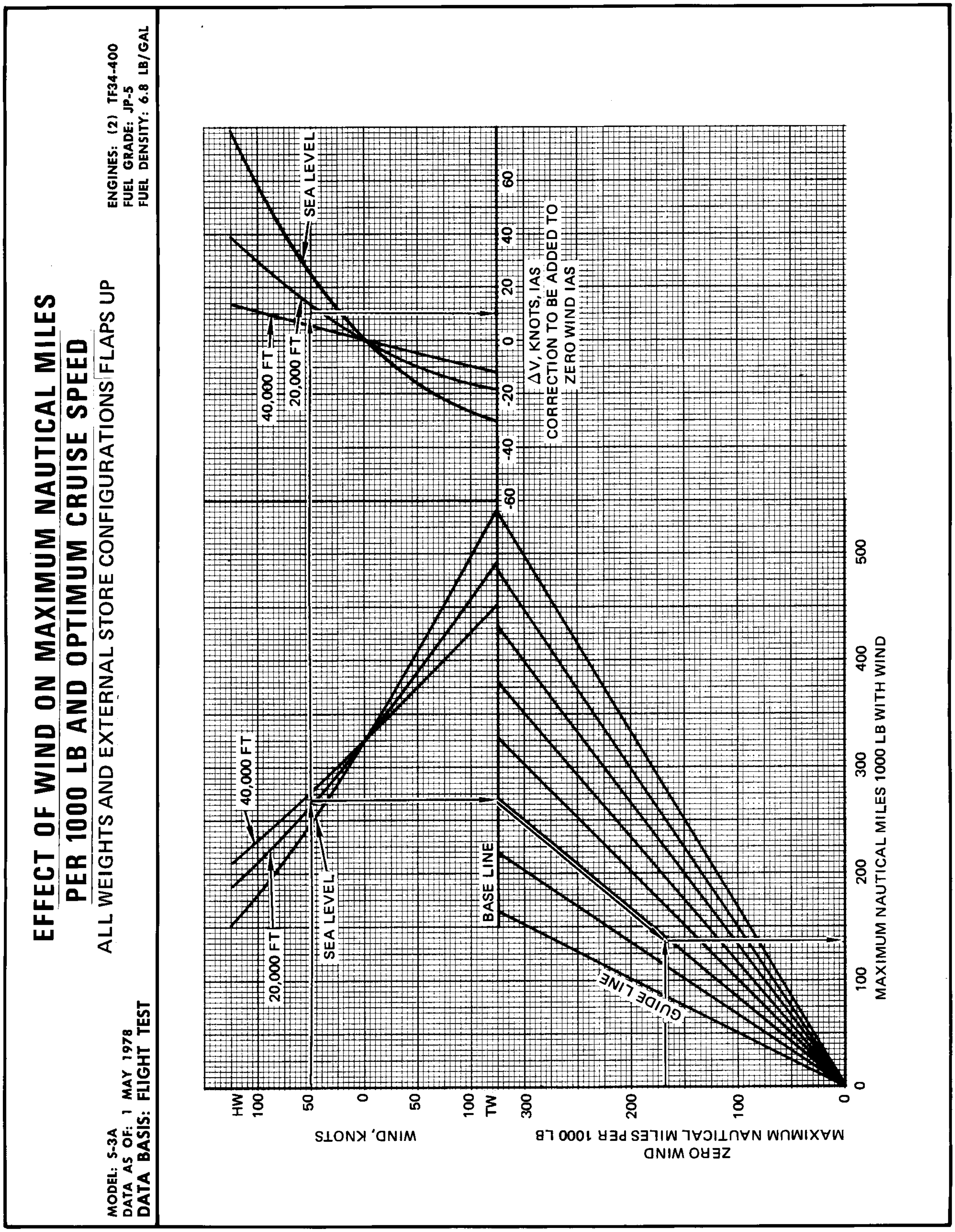


Figure 34-2. Effect of Wind on Maximum Nautical Miles Per 1,000 Pounds and Optimum Cruise Speed

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (A) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 220 KNOTS TO 0.6 MACH AND 0.6 MACH TO DESIRED ALTITUDE
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 212 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1220	8	5000	209	19	1220	7
50	1410	15	9000	207	33	1430	14
100	1740	28	18,000	200	68	1860	28
150	2020	38	25,000	195	95	2290	42
200	2270	49	32,000	188	127	2720	57
250	2490	57	36,000	184	148	3210	71
300	2710	66	39,000	181	168	3580	85
350	2920	74	40,000	180	177	4000	99
400	3130	83	40,000	180	177	4430	113
450	3340	91	40,000	180	177	4850	127
500	3550	100	40,000	180	177	5280	142

ALT FEET	CRUISE KIAS	FUEL REQ'D ~ LB.				
		100 N.M	200 N.M	300 N.M	400 N.M	500 N.M
5000	209	1800	2580	3350	4110	4870
20,000	199	1740	2320	2890	3450	4020

Figure 34-3. Bingo Range — Two Engine (Sheet 1 of 5)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (B) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 220 KNOTS TO 0.6 MACH AND 0.6 MACH TO DESIRED ALTITUDE
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 203 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1230	8	5000	202	17	1230	7
50	1440	14	9000	200	30	1470	15
100	1790	27	18,000	195	61	1930	30
150	2090	38	25,000	189	86	2400	44
200	2360	47	32,000	183	110	2860	59
250	2600	56	35,000	180	122	3320	74
300	2840	65	38,000	176	138	3790	89
350	3080	74	38,000	176	138	4250	103
400	3320	83	38,000	176	138	4700	118
450	3550	91	39,000	175	142	5150	133
500	3790	100	39,000	175	142	5610	148

ALT FEET	CRUISE KIAS	FUEL REQ'D ~ LB				
		100 N.M	200 N.M	300 N.M	400 N.M	500 N.M
5000	202	1870	2710	3540	4370	5200
20,000	193	1790	2420	3040	3660	4270

Figure 34-3. Bingo Range — Two Engine (Sheet 2)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (C) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 200 KNOTS TO 0.57 MACH & 0.57 MACH TO DESIRED ALTITUDE
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 198 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1250	8	5000	198	15	1250	8
50	1470	15	10,000	197	30	1500	15
100	1850	27	20,000	192	60	2000	20
150	2170	38	26,000	187	80	2500	45
200	2460	47	33,000	180	100	3000	61
250	2720	56	35,000	178	108	3500	76
300	2990	66	37,000	176	116	4000	91
350	3250	75	37,000	176	116	4480	106
400	3512	84	38,000	174	120	4960	121
450	3770	93	38,000	174	120	5450	136
500	4030	102	38,000	174	120	6000	152

ALT FEET	CRUISE KIAS	FUEL REQ'D LB				
		100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
5000	198	1940	2842	3740	4630	5520
20,000	192	1850	2530	3200	3870	4530

Figure 34-3. Bingo Range — Two Engine (Sheet 3)

TWO ENGINE BINGO RANGE CHART

CONFIGURATION (D) — STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 180 KNOTS TO 0.52 MACH AND 0.52 MACH TO DESIRED ALTITUDE
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 193 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1280	8	5000	192	13	1280	8
50	1530	14	10,000	190	25	1550	16
100	1940	27	20,000	185	51	2110	31
150	2300	38	26,000	181	65	2660	47
200	2630	47	33,000	176	80	3200	62
250	2940	57	34,000	175	84	3740	78
300	3250	67	35,000	174	88	4290	93
350	3550	76	35,000	174	88	4820	109
400	3860	86	36,000	173	92	5360	124
450	4150	96	36,000	173	92	5900	140
500	4450	105	36,000	173	92	6430	155

ALT FEET	CRUISE KIAS	FUEL REQ'D ~ LB				
		100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
5000	192	2040	3040	4040	5020	6000
20,000	185	1940	2700	3450	4200	4940

Figure 34-3. Bingo Range — Two Engine (Sheet 4)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (E) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 180 KNOTS TO 0.52 MACH & 0.52 MACH TO DESIRED ALTITUDE
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 185 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1290	8	5000	184	11	1300	8
50	1550	15	11,000	182	24	1590	16
100	1980	28	21,000	177	44	2170	32
150	2350	39	27,000	174	59	2750	49
200	2690	47	34,000	169	75	3330	65
250	3010	57	34,000	169	75	3900	81
300	3340	68	35,000	168	79	4470	97
350	3660	78	35,000	168	79	5040	114
400	3980	88	36,000	167	83	5680	130
450	4300	98	36,000	167	83	6320	146
500	4610	109	36,000	167	83	6980	162

ALT FEET	CRUISE KIAS	FUEL REQ'D ~ LB				
		100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
5000	184	2100	3160	4210	5250	6360
20,000	180	1980	2780	3570	4360	5140

Figure 34-3. Bingo Range — Two Engine (Sheet 5)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (A) GEAR DOWN

STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 15.0 UNITS AOA (APPROX 150 KIAS)
- LONG RANGE FLIGHT IDLE DESCENT IS AT 15.0 UNITS AOA (APPROX 135 KIAS)

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 165 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1330	9	5000	165	13	1330	9
50	1630	19	10,000	163	22	1660	18
100	2120	35	20,000	154	45	2320	36
150	2560	50	25,000	138	58	2970	54
200	2990	65	25,000	138	58	3620	73
250	3430	79	25,000	138	58	4270	91
300	3860	94	25,000	138	58	4910	109
350	4290	109	25,000	138	58	5550	127
400	4710	124	25,000	138	58	6180	145
450	5130	139	25,000	138	58	6810	164
500	5547	154	25,000	138	58	7440	182

ALT FEET	CRUISE KIAS	FUEL REQ'D ~ LB				
		100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
5000	165	2250	3440	4620	5790	6950
20,000	154	2120	3020	3910	4790	5660

Figure 34-4. Bingo Range — Two Engine — Gear Down (Sheet 1 of 2)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (B) GEAR DOWN

STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 15.0 UNITS AOA (APPROX 150 KIAS)
- LONG RANGE FLIGHT IDLE DESCENT IS AT 15.0 UNITS AOA (APPROX 135 KIAS)

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 160 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1350	9	5000	160	11	1350	9
50	1660	18	10,000	158	21	1700	19
100	2170	34	20,000	154	43	2380	38
150	2610	49	25,000	138	54	3070	56
200	3050	64	25,000	138	54	3750	75
250	3530	78	25,000	138	54	4420	94
300	4010	93	25,000	138	54	5090	113
350	4460	108	25,000	138	54	5760	131
400	4900	123	25,000	138	54	6420	150
450	5350	138	25,000	138	54	7070	169
500	5790	153	25,000	138	54	7720	188

ALT FEET	CRUISE KIAS	FUEL REQ'D LB				
		100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
5000	160	2300	3550	4790	6010	7220
20,000	154	2170	3110	4050	4980	5890

Figure 34-4. Bingo Range — Two Engine — Gear Down (Sheet 2)

TWO-ENGINE BINGO RANGE CHART

CONFIGURATION (A) & (B) LAND FLAPS GEAR DOWN

STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 15.0 UNITS AOA (APPROX 115 KIAS)
- LONG RANGE FLIGHT IDLE DESCENT IS AT 15.0 UNITS AOA (APPROX 105 KIAS)

MAXIMUM RANGE CRUISE							SEA LEVEL CRUISE 135 KIAS		
DIST TO BASE N.M.	FUEL REQ'D LB (A)	FUEL REQ'D LB (B)	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB (A)	FUEL REQ'D LB (B)	TIME REQ'D MIN
25	1500	1500	11	5000	135	7	1500	1500	11
50	1940	1970	23	10,000	132	14	1970	2000	22
100	2680	2730	41	20,000	127	29	2930	2990	44
150	3330	3410	60	25,000	118	38	3870	3960	67
200	3960	4070	77	25,000	118	38	4810	4930	89
250	4580	4710	95	25,000	118	38	5730	5880	111
300	5190	5350	112	25,000	118	38	6650	6830	133
350	5800	5970	130	25,000	118	38	7600	7810	155
400	6400	6590	147	25,000	118	38	8560	8790	178
450	6990	7200	165	25,000	118	38	9580	9850	200
500	7570	7810	183	25,000	118	38	10610	10910	222

ALT FEET	CRUISE KIAS		FUEL REQ'D ~ LB. 100 N.M.	200 N.M.	300 N.M.	400 N.M.	500 N.M.
10,000	132	(A)	2740	4330	5890	7410	8970
		(B)	2800	4440	6040	7610	9570

Figure 34-5. Bingo Range — Land Flaps — Gear Down

SINGLE-ENGINE BINGO RANGE CHART

CONFIGURATION (A) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 180 KIAS
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 200 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1190	8	2000	200	6	1190	8
50	1370	16	8000	200	24	1370	15
100	1700	29	15000	190	45	1750	30
150	2000	42	20000	185	61	2120	45
200	2270	54	22000	185	66	2480	60
250	2540	65	24000	185	74	2850	75
300	2800	76	26000	180	80	3220	90
350	3050	87	27000	180	83	3580	105
400	3290	97	28000	180	85	3940	120
450	3540	108	28000	180	85	4300	135
500	3780	119	28000	180	85	4660	150

Figure 34-6. Bingo Range — Single-Engine (Sheet 1 of 4)

SINGLE-ENGINE BINGO RANGE CHART

CONFIGURATION (B) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 180 KIAS
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 195 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1210	8	2000	195	5	1210	8
50	1410	16	8000	190	21	1410	15
100	1780	29	15000	185	40	1820	31
150	2110	42	20000	180	54	2230	46
200	2410	55	21000	180	57	2630	62
250	2710	66	22000	180	60	3040	77
300	3000	77	24000	175	65	3440	92
350	3290	89	24000	175	65	3840	108
400	3570	100	24000	175	65	4240	123
450	3860	112	24000	175	65	4640	139
500	4140	123	24000	175	65	5030	154

Figure 34-6. Bingo Range — Single-Engine (Sheet 2)

SINGLE-ENGINE BINGO RANGE CHART

CONFIGURATION (C) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 170 KIAS
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 190 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1230	8	2000	190	5	1230	8
50	1450	16	4000	185	10	1450	16
100	1860	30	10000	180	24	1900	32
150	2220	44	15000	180	37	2340	47
200	2570	56	20000	175	49	2780	63
250	2900	69	20000	175	49	3220	79
300	3240	81	20000	175	49	3660	95
350	3570	94	20000	175	49	4090	111
400	3900	106	20000	175	49	4530	126
450	4220	119	20000	175	49	4960	142
500	4550	131	20000	175	49	5380	158

Figure 34-6. Bingo Range — Single-Engine (Sheet 3)

SINGLE-ENGINE BINGO RANGE CHART

CONFIGURATION (D) STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 160 KIAS
- LONG RANGE FLIGHT IDLE DESCENT IS AT 11.5 UNITS AOA

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 185 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1260	8	2000	185	4	1260	8
50	1510	16	4000	180	8	1510	16
100	2000	31	8000	180	17	2010	32
150	2430	46	13000	175	27	2510	49
200	2850	60	17000	175	35	3010	65
250	3250	73	17000	175	35	3510	81
300	3650	86	18000	170	37	4000	97
350	4030	99	18000	170	37	4490	114
400	4410	112	18000	170	37	4970	130
450	4790	125	18000	170	37	5450	146
500	5180	138	18000	170	37	5930	162

Figure 34-6. Bingo Range — Single-Engine (Sheet 4)

SINGLE-ENGINE BINGO RANGE CHART

GEAR DOWN EMPTY PYLONS INSTALLED

STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 15.0 UNITS AOA (APPROX 148 KIAS)
- LONG RANGE FLIGHT IDLE DESCENT IS AT 15.0 UNITS AOA (APPROX 135 KIAS)

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 155 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1320	10	3000	155	5	1320	10
50	1620	19	4000	155	7	1630	19
100	2170	37	10000	150	18	2240	39
150	2690	53	14000	145	26	2850	58
200	3180	69	16000	145	30	3460	77
250	3660	85	16000	145	30	4050	97
300	4150	101	16000	145	30	4650	116
350	4630	117	16000	145	30	5240	136
400	5100	133	16000	145	30	5830	155
450	5570	150	16000	145	30	6410	174
500	6030	166	16000	145	30	6980	194

Figure 34-7. Bingo Range — Single-Engine — Gear Down — Empty Pylons Installed

SINGLE-ENGINE BINGO RANGE CHART

CONFIGURATION (A) TAKEOFF FLAPS/GEAR DOWN

STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (1) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

- FUEL REQUIRED INCLUDES 1000 LB RESERVE FUEL
- INITIAL ALTITUDE IS SEA LEVEL
- CLIMB IS AT INTERMEDIATE POWER AT 15.0 UNITS AOA (APPROX 115 KIAS)
- LONG RANGE FLIGHT IDLE DESCENT IS AT 15.0 UNITS AOA (APPROX (110 KIAS)

MAXIMUM RANGE CRUISE						SEA LEVEL CRUISE 135 KIAS	
DIST TO BASE N.M.	FUEL REQ'D LB	TIME REQ'D MIN	CRUISE ALT FEET	CRUISE IAS KNOTS	DIST TO DESC N.M.	FUEL REQ'D LB	TIME REQ'D MIN
25	1400	11	2000	135	3	1400	11
50	1790	22	3000	135	5	1790	22
100	2520	45	8000	135	12	2550	44
150	3200	65	10000	130	15	3310	67
200	3850	84	12000	130	18	4060	89
250	4470	104	12000	130	18	4800	111
300	5100	123	13000	125	21	5540	133
350	5690	143	13000	125	21	6260	156
400	6280	162	14000	125	23	6990	178
450	6870	181	14000	125	23	7690	200
500	7460	200	14000	125	23	8470	222

Figure 34-8. Bingo Range — Single-Engine — Takeoff Flaps — Gear Down

OPTIMUM RETURN PROFILE
SINGLE-ENGINE

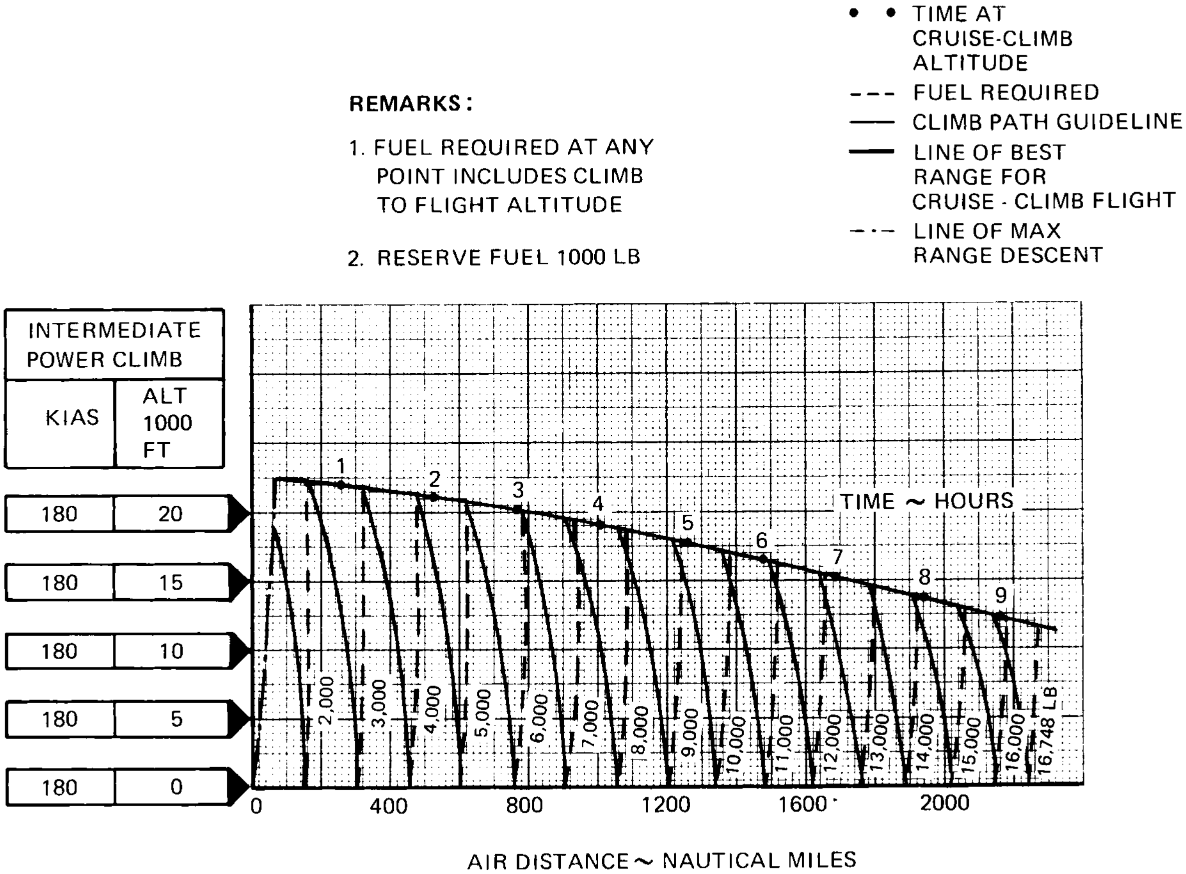
MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ZERO FUEL WEIGHT - 33,000 LB
STANDARD DAY ZERO WIND
CONFIGURATION Ⓑ

ENGINES: (2) TF 34-400
FUEL GRADE JP-5
FUEL DENSITY: 6.8 LB/GAL

REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES CLIMB TO FLIGHT ALTITUDE
2. RESERVE FUEL 1000 LB



CRUISE AIRSPEED

FUEL REQ.	1000-5000	5000-9000	9000-13,000	13,000-16,748
AVG. WT.	36,000	40,000	44,000	47,500
IAS	186	192	202	211
TAS	258	257	256	254

Figure 34-9. Optimum Return Profile — Single-Engine — Configuration Ⓑ (Sheet 1 of 2)

OPTIMUM RETURN PROFILE
SINGLE-ENGINE

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

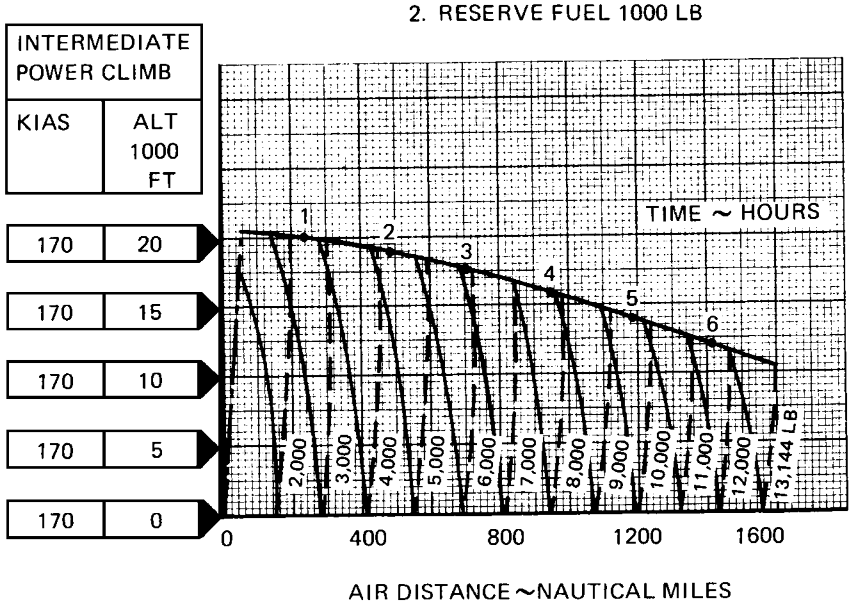
ZERO FUEL WEIGHT - 34,000 LB
STANDARD DAY ZERO WIND
CONFIGURATION Ⓒ

ENGINES: (2) TF 34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

REMARKS:

1. FUEL REQUIRED AT ANY POINT INCLUDES CLIMB TO FLIGHT ALTITUDE
2. RESERVE FUEL 1000 LB

• • TIME AT CRUISE-CLIMB ALTITUDE
--- FUEL REQUIRED
—— CLIMB PATH GUIDELINE
-·- LINE OF MAX RANGE DESCENT
—— LINE OF BEST RANGE FOR CRUISE-CLIMB FLIGHT



CRUISE AIRSPEED

FUEL REQ.	1000-5000	5000-9000	9000-13,144
AVG. WT.	37,000	41,000	45,000
IAS	182	191	202
TAS	243	242	241

Figure 34-9. Optimum Return Profile — Single-Engine — Configuration Ⓒ (Sheet 2)

2. Follow the climbpath guidelines to the cruise-climb line and read initial cruise altitude as 19,400 feet. Read the zero-wind time in cruise climb line and read initial cruise altitude at 19,400 feet. Read the zero-wind time in cruise climb to a fuel reserve of 1,000 pounds to be approximately 3.6 hours.

3. Neglecting the time and distance to climb to the new cruise altitude, the average true airspeed is 1,010/3.6 = 281 knots.

4. Groundspeed is 281 + 30 = 311 knots (true airspeed plus tailwind).

5. Air distance to fly 1,010 nm with a 30-knot tailwind is 281/311 × 1,010 = 914 nm.

6. Reenter Figure 34-9, Sheet 1, at 10,000 feet and 914 nm and read fuel required with a 30-knot tailwind to be 7,000 pounds.

7. Time with a 30-knot tailwind is approximately 1,010/311 = 3.25 hours (3 hours 15 minutes).

CHAPTER 35

Endurance

35.1 MAXIMUM ENDURANCE SUMMARY CHARTS

Maximum endurance summary charts for various drag configurations, Figure 35-1, provide a ready reference for fuel flow and speed for use in calculation of maximum endurance time at any altitude. This same information can be obtained from the miles-per-pound curves of Chapter 38, but only at the specified altitudes shown in Chapter 38, thus requiring interpolation for intermediate altitudes.

35.1.1 Sample Problem. Determine the loiter time at 2,000 feet if 4,000 pounds of fuel are available for loiter. The aircraft is in configuration Ⓑ and weighs 40,000 pounds at the start of loiter point.

1. The average loiter gross weight is 40,000 – 4,000/2 = 38,000 pounds.
2. Enter Figure 35-1, Sheet 2, at 2,000 feet and read 1,680 pounds per hour fuel flow at 38,000 pounds gross weight.
3. Loiter time is 4,000 1,680 = 2.38 hours.
4. Loiter speed is 158 KIAS as shown on the right side of Figure 35-1, sheet 2.

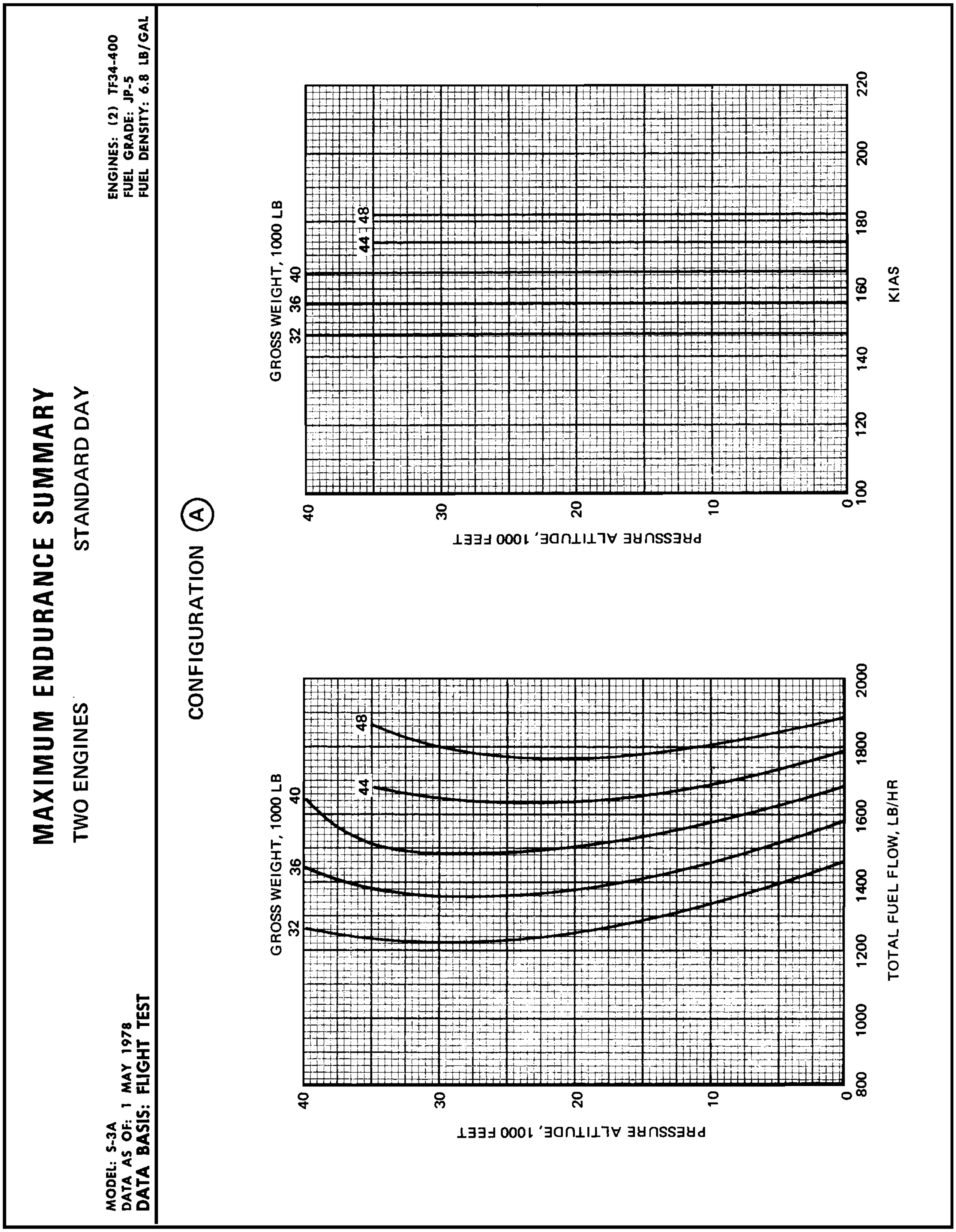


Figure 35-1. Maximum Endurance Summary (Sheet 1 of 5)

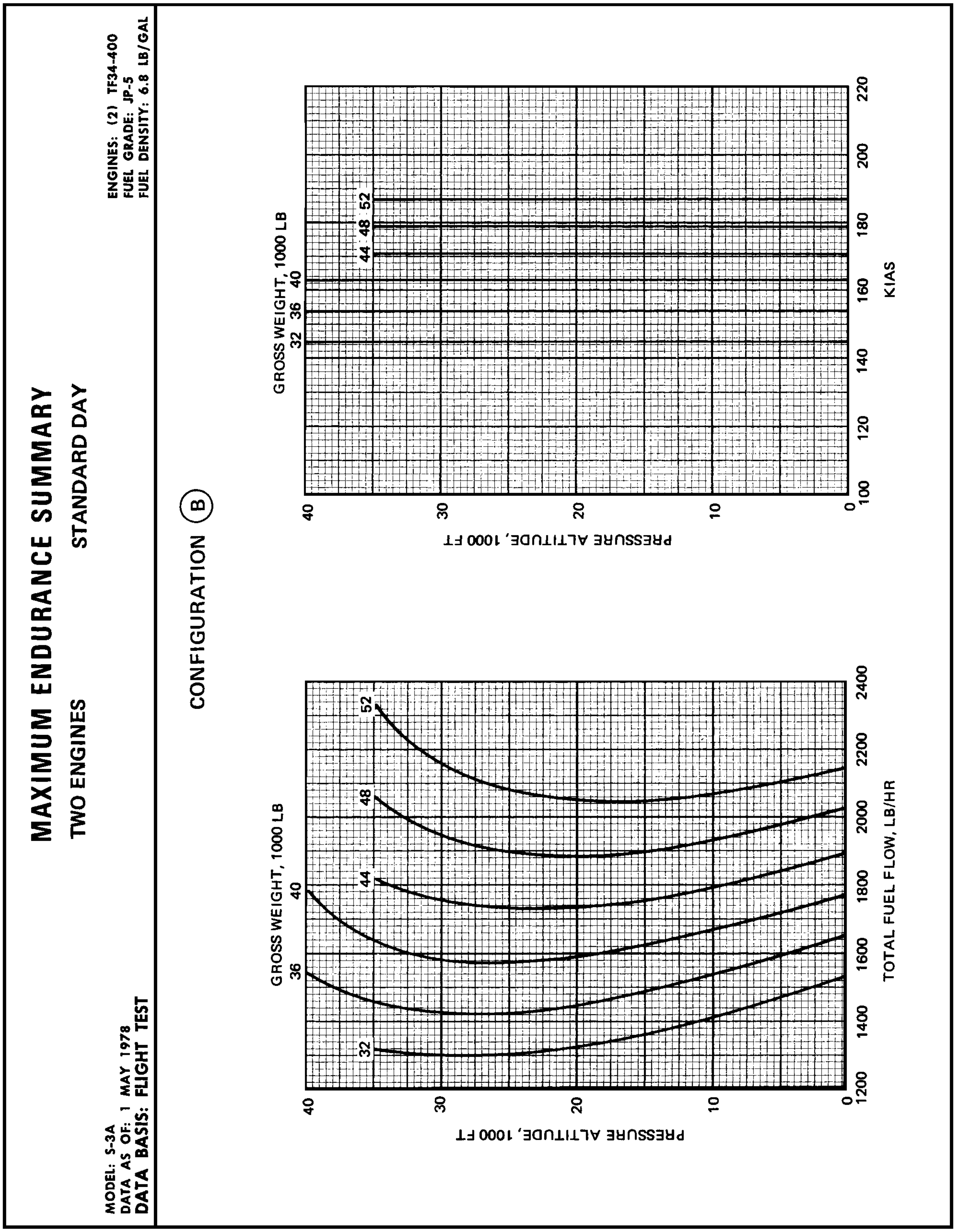


Figure 35-1. Maximum Endurance Summary (Sheet 2)

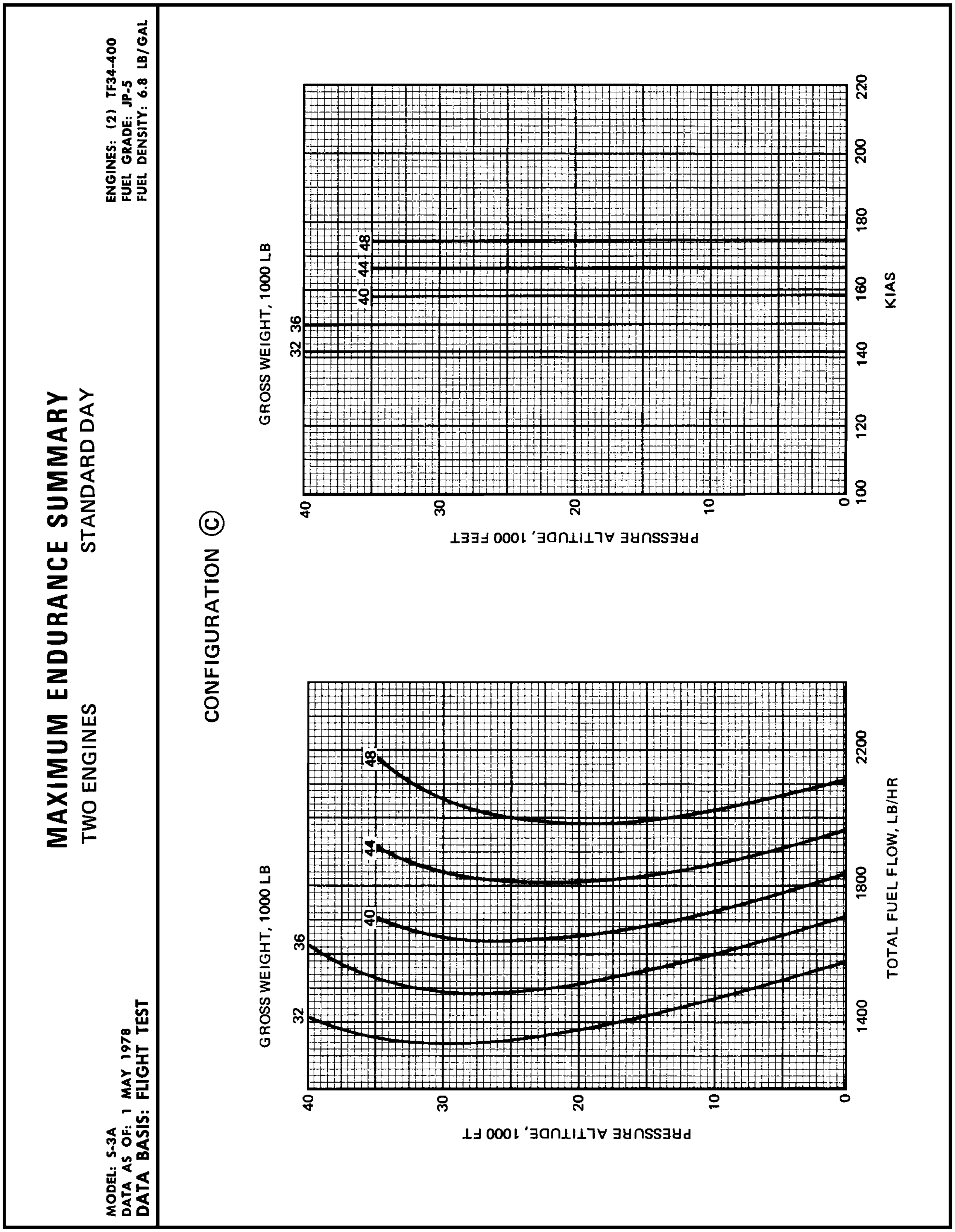


Figure 35-1. Maximum Endurance Summary (Sheet 3)

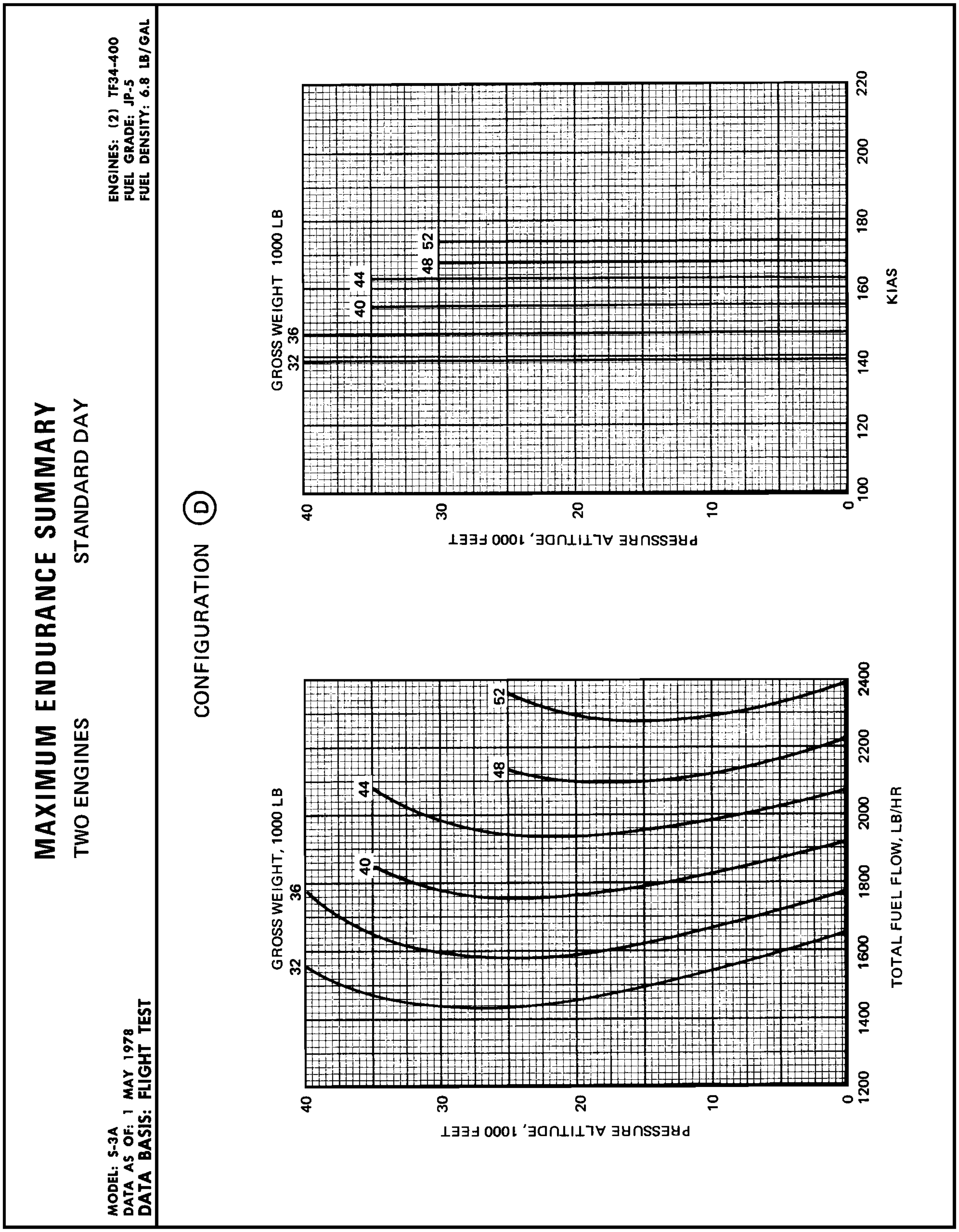


Figure 35-1. Maximum Endurance Summary (Sheet 4)

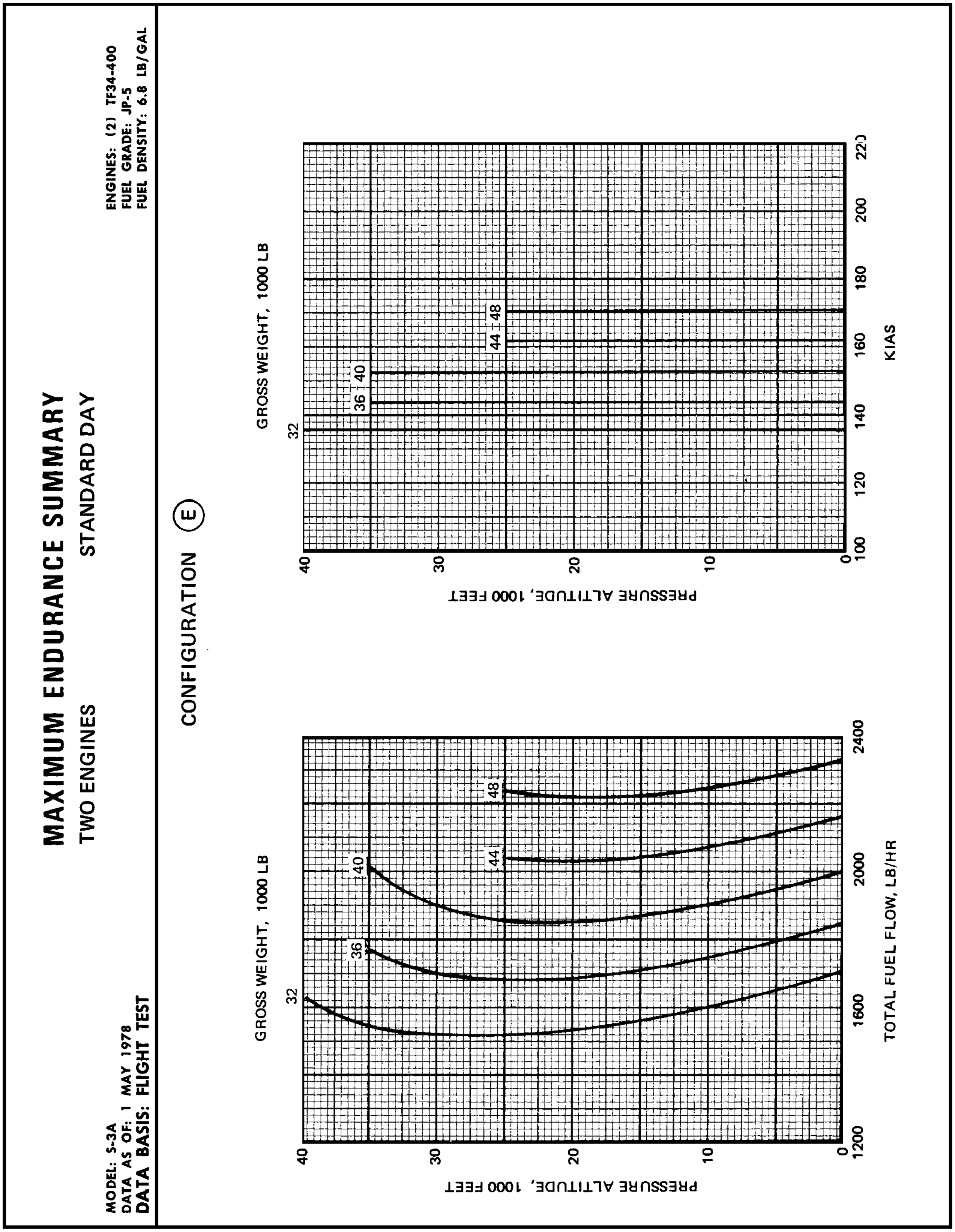


Figure 35-1. Maximum Endurance Summary (Sheet 5)

CHAPTER 36

Descent

36.1 QUICK DESCENT WITH SPEEDBRAKES

Time, fuel, distance, and rate of descent for a quick descent are shown in Figure 36-1. The performance shown is for descent with the use of speedbrakes at 250 KIAS below 36,000 feet and 0.75 Mach number above 36,000 feet.

The chart may be used directly for descent to sea level. For descent between two altitudes, take the difference between the values for the two altitudes to establish the descent data.

36.1.1 Sample Problem. Determine the time, fuel, distance, and initial rate of descent required for an idle descent from 30,000 feet to sea level at a gross weight of 35,000 pounds with the aircraft in drag configuration Ⓐ.

Enter Figure 36-1 with 30,000 feet, interpolate for gross weight, and read 3.2 minutes, 47 pounds, 16.8 nm, and 11,200 fpm.

36.2 MAXIMUM RANGE DESCENT WITHOUT SPEEDBRAKES

Time, fuel, and distance for a typical maximum range descent are shown in Figure 36-2 for various drag configurations. The performance shown is for descent at a constant AOA value of 11.5 units.

The charts may be used directly for descent to sea level. For descent between two altitudes, take the difference between the values for the two altitudes to establish the descent values.

36.2.1 Sample Problem. Determine the time, fuel, and distance required for an idle descent from 36,000 feet to sea level at a gross weight of 35,000 pounds with the aircraft in drag configuration Ⓐ.

Enter Figure 36-2 at 36,000 feet and read 35 minutes, 480 pounds, and 146 nm.

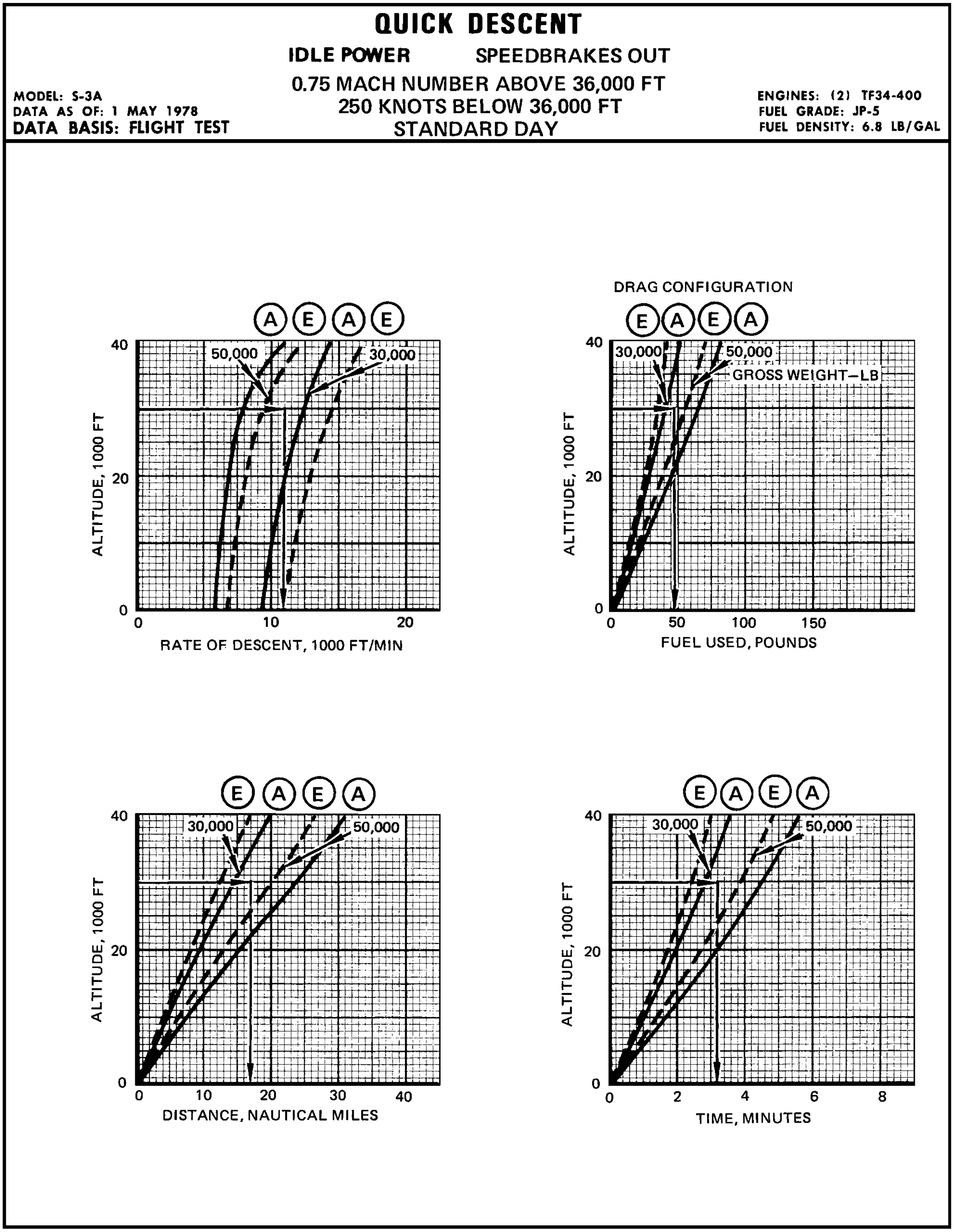


Figure 36-1. Quick Descent

MAXIMUM RANGE DESCENT

TIME TO DESCEND

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

IDLE POWER SPEED BRAKES CLOSED
DESCENT AT 11.5 UNITS AOA

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

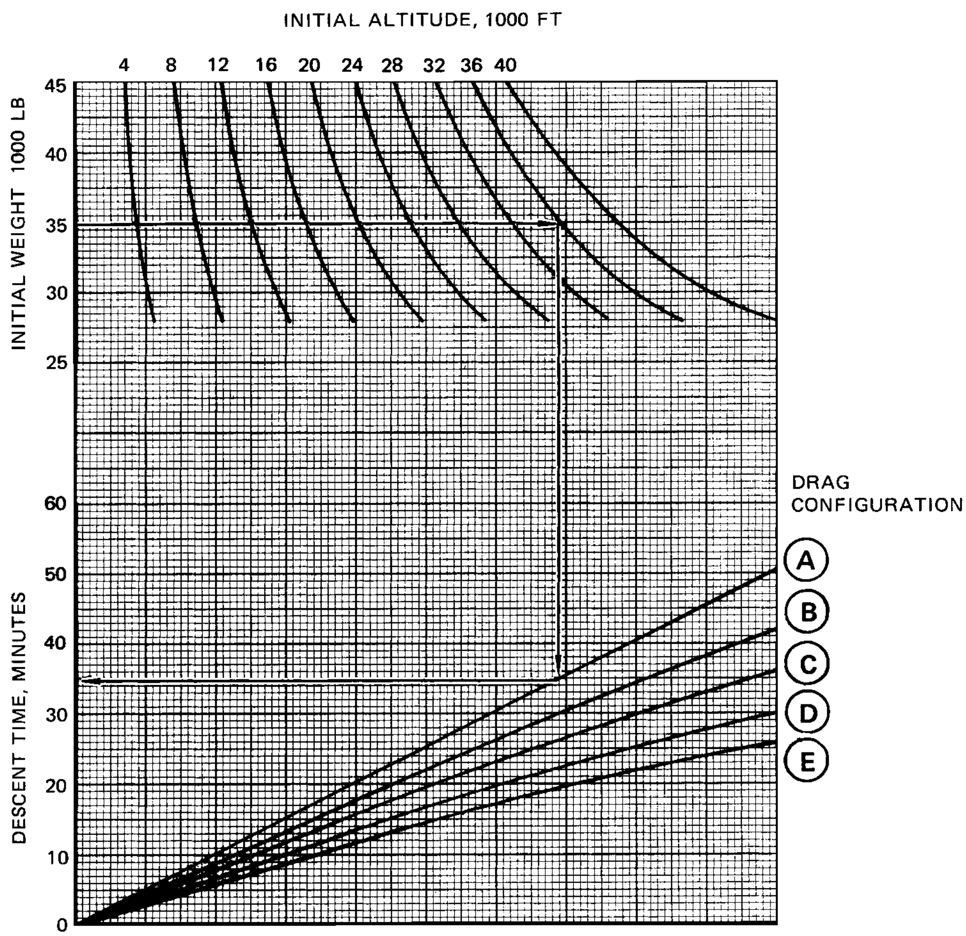


Figure 36-2. Maximum Range Descent (Sheet 1 of 3)

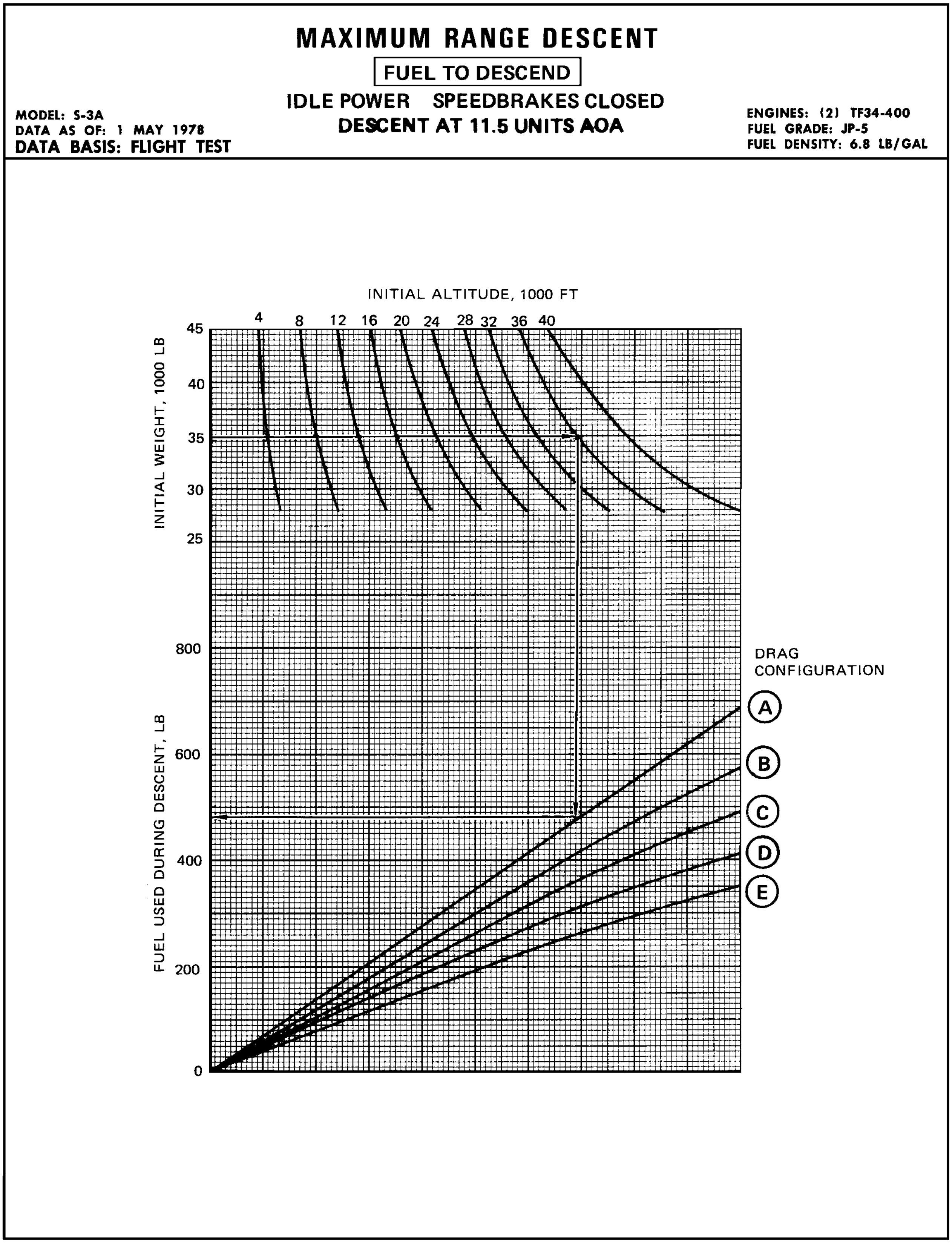


Figure 36-2. Maximum Range Descent (Sheet 2)

MAXIMUM RANGE DESCENT

DISTANCE TO DESCEND

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

IDLE POWER SPEEDBRAKES CLOSED
DESCENT AT 11.5 UNITS AOA

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

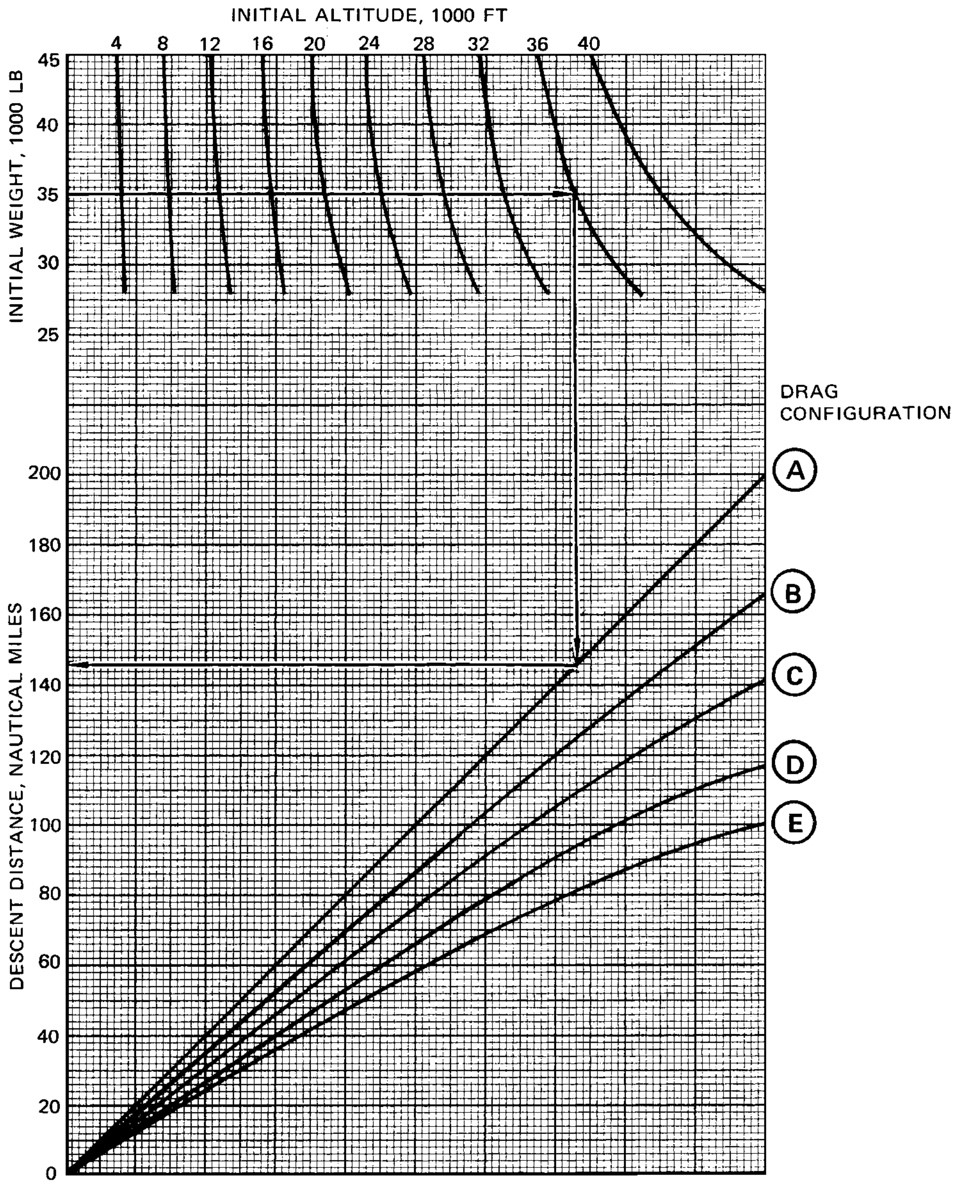


Figure 36-2. Maximum Range Descent (Sheet 3)

CHAPTER 37

Landing

37.1 CROSSWIND CHART

A runway wind component chart applicable to takeoff and landing is shown in Figure 32-1. This chart is used to convert reported winds to crosswind and headwind or tailwind components.

37.2 LANDING PERFORMANCE

Figure 37-1 shows minimum landing distance with heavy braking. Figure 37-2 shows normal landing performance with moderate braking. The chart shows ground roll distance as well as total distance to clear a 50-foot obstacle and stop. The performance is applicable to various combinations of gross weight, pressure altitude, temperature, and wind. Approach and touchdown speeds are included in terms of KIAS versus gross weight.

37.2.1 Sample Problem. Determine the minimum landing ground roll distance and the total landing distance to clear a 50-foot obstacle and stop for the following conditions: 31,000-pound gross weight, 1,500-foot pressure altitude, 36 °C air temperature, and a 10-knot headwind component.

1. From Figure 37-1, approach and touchdown speed is 102.5 KIAS.

2. Zero-wind, ground-roll distance is 2,010 feet. Corrected for wind, this becomes 1,700 feet.

3. The total distance to clear a 50-foot obstacle and stop is 2,650 feet.

37.3 AIRSPEED VERSUS UNITS ANGLE OF ATTACK

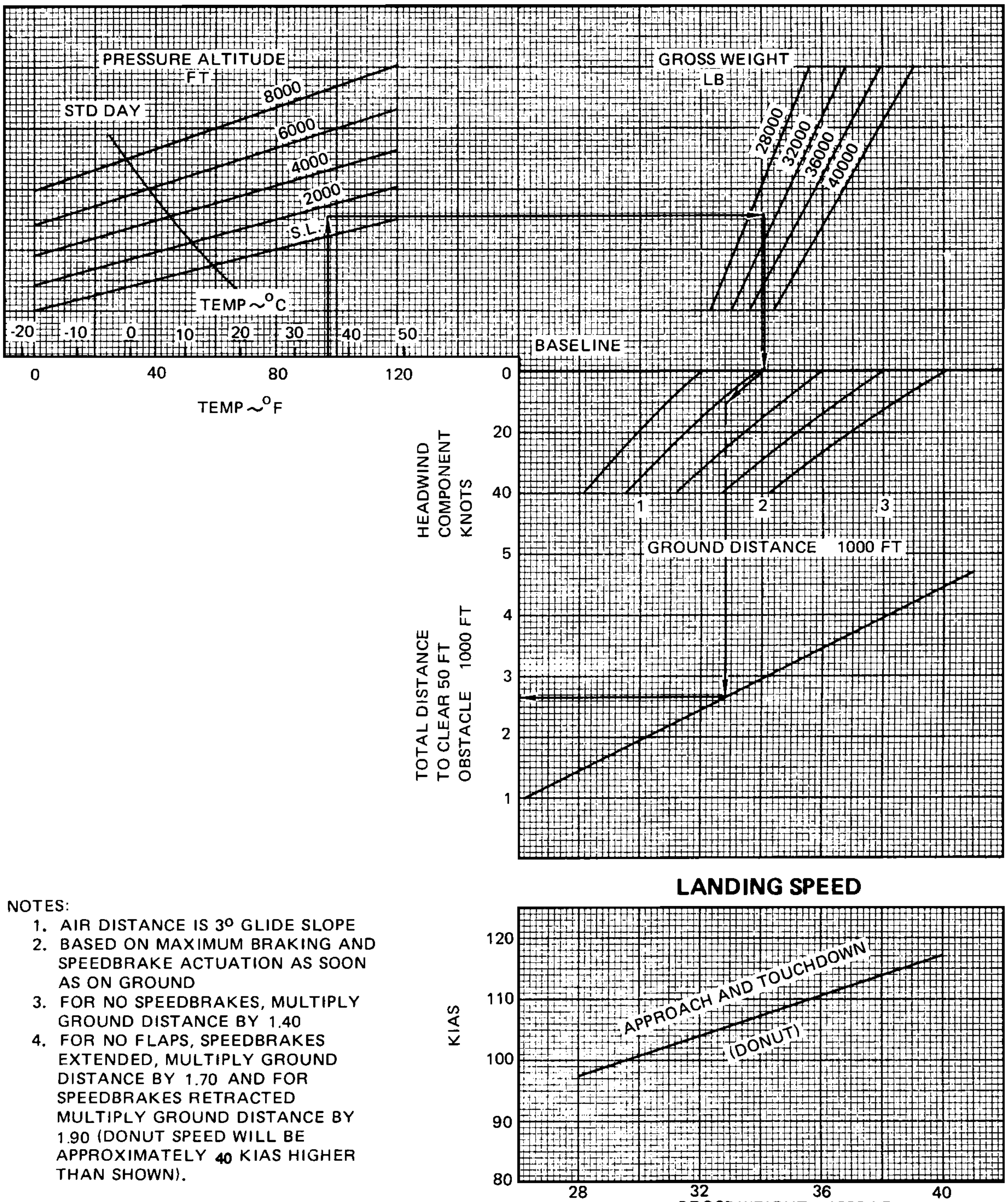
Figure 37-3 shows the relationship between airspeed and AOA for the various aircraft flap configurations and gross weights.

MINIMUM-DISTANCE LANDING

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

LANDING FLAPS WITH SPEEDBRAKES
ANTISKID ON HEAVY BRAKING
ALL DRAG CONFIGURATIONS

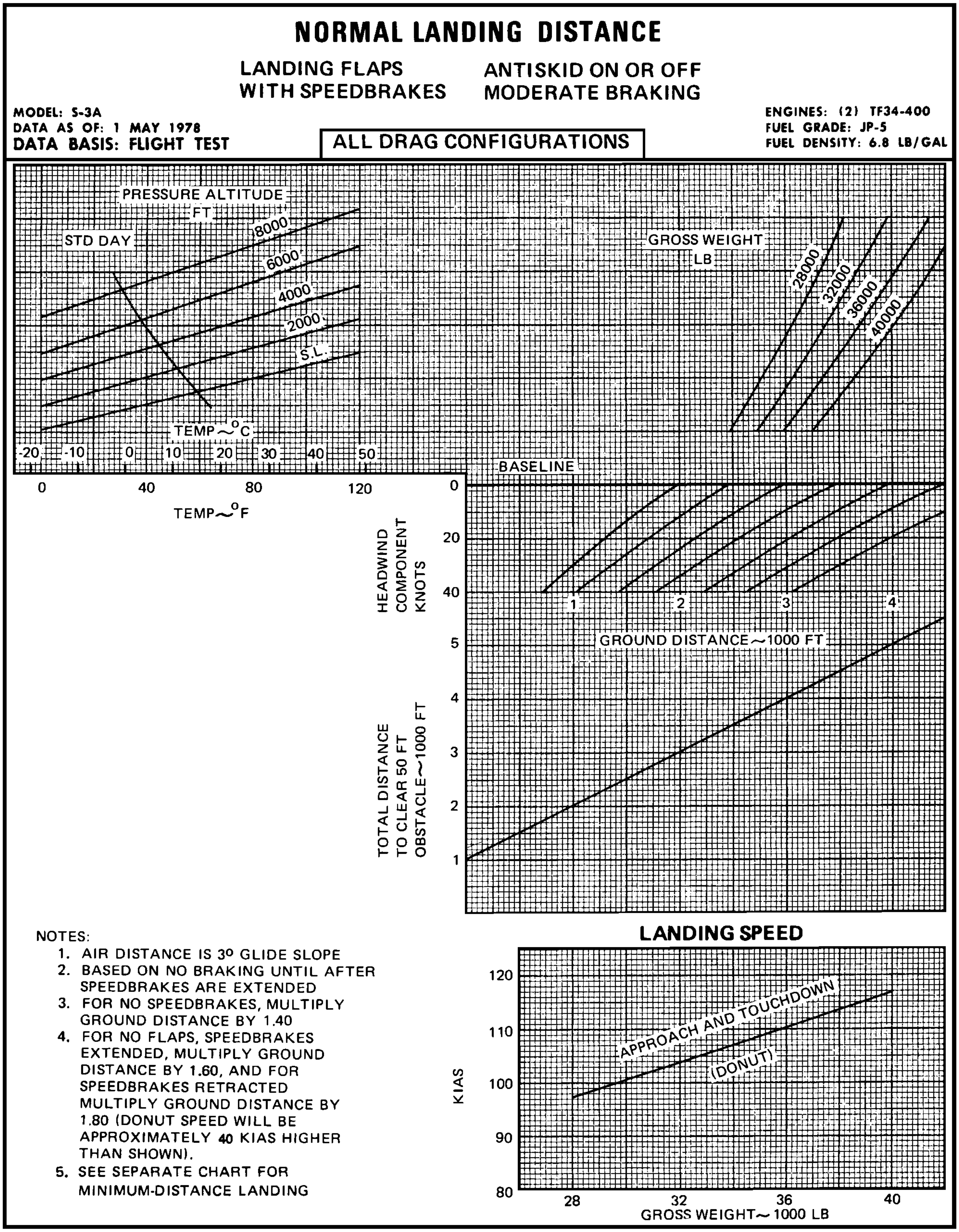
ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL



NOTES:

1. AIR DISTANCE IS 3° GLIDE SLOPE
2. BASED ON MAXIMUM BRAKING AND SPEEDBRAKE ACTUATION AS SOON AS ON GROUND
3. FOR NO SPEEDBRAKES, MULTIPLY GROUND DISTANCE BY 1.40
4. FOR NO FLAPS, SPEEDBRAKES EXTENDED, MULTIPLY GROUND DISTANCE BY 1.70 AND FOR SPEEDBRAKES RETRACTED MULTIPLY GROUND DISTANCE BY 1.90 (DONUT SPEED WILL BE APPROXIMATELY 40 KIAS HIGHER THAN SHOWN).

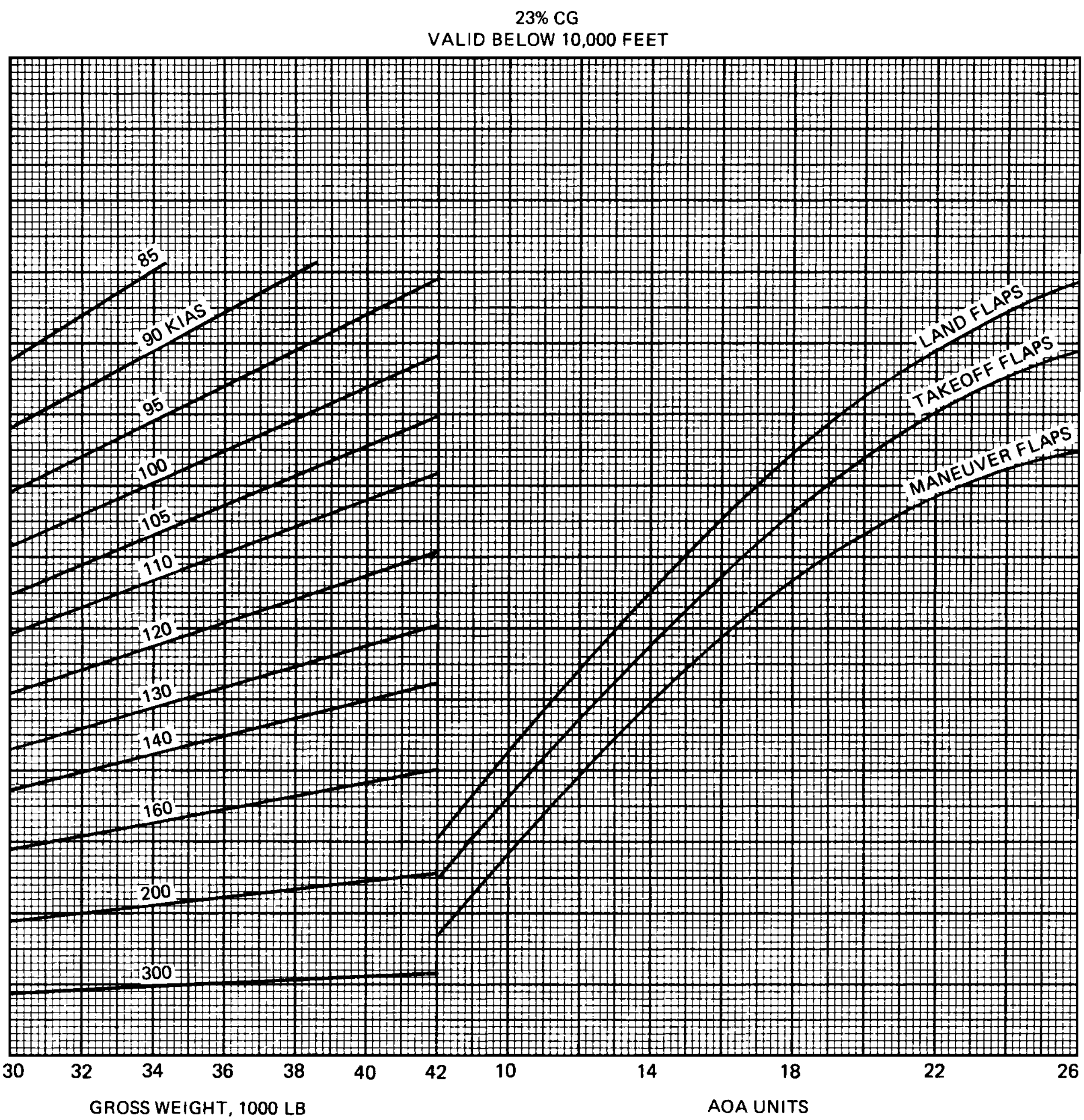
Figure 37-1. Minimum-Distance Landing



NOTES:

1. AIR DISTANCE IS 3° GLIDE SLOPE
2. BASED ON NO BRAKING UNTIL AFTER SPEEDBRAKES ARE EXTENDED
3. FOR NO SPEEDBRAKES, MULTIPLY GROUND DISTANCE BY 1.40
4. FOR NO FLAPS, SPEEDBRAKES EXTENDED, MULTIPLY GROUND DISTANCE BY 1.60, AND FOR SPEEDBRAKES RETRACTED MULTIPLY GROUND DISTANCE BY 1.80 (DONUT SPEED WILL BE APPROXIMATELY 40 KIAS HIGHER THAN SHOWN).
5. SEE SEPARATE CHART FOR MINIMUM-DISTANCE LANDING

Figure 37-2. Normal Landing Distance



GROSS WEIGHT **FLAPS UP AIRSPEED AT 15 UNITS AOA**

GROSS WEIGHT	FLAPS UP AIRSPEED AT 15 UNITS AOA	MAN FLAP AIRSPEED (KCAS)
46,000 LBS	172 KIAS	147
44,000 LBS	168 KIAS	144
42,000 LBS	164 KIAS	141
40,000 LBS	160 KIAS	138
38,000 LBS	156 KIAS	134
36,000 LBS	152 KIAS	131
34,000 LBS	148 KIAS	128
32,000 LBS	144 KIAS	125
30,000 LBS	140 KIAS	120

Figure 37-3. Airspeed Versus Units AOA

CHAPTER 38

Miles Per Pound

38.1 MILES PER POUND CHARTS

The nautical miles per 1,000 pounds of fuel charts provide cruise data for any speed from maximum endurance to intermediate power. Curves encompassing the probable flight weights are shown for various aircraft drag configurations at appropriate altitudes. Information for other altitudes and drag configurations may be obtained by interpolating between charts. Recommended cruise and maximum endurance speeds are shown on each chart.

Figures 38-1 through 38-4 show the nautical miles per pound for two-engine operation, flaps up, in drag configurations Ⓐ, Ⓑ, Ⓒ, and Ⓓ, respectively, for altitudes of sea level, 5,000, 15,000, 25,000, 35,000, and 40,000 feet. Figure 38-5 shows the nautical miles per pound for drag configuration E for altitudes of sea level, 5,000, 15,000, 25,000, and 35,000 feet. Figures 38-6 through 38-11 show the nautical miles per pound for two-engine operation with maneuver flaps in drag configurations Ⓐ, Ⓑ, Ⓒ, Ⓓ and Ⓔ, respectively, for altitudes of sea level, 5,000, and 15,000 feet.

Figures 38-12, 38-13, and 38-14 show single-engine, flaps up, nautical miles per pound in drag configurations Ⓐ, Ⓑ, and Ⓓ, respectively, for altitudes of sea level, 5,000, 10,000, and 20,000 feet.

Figure 38-15 shows single-engine nautical miles per pound for aircraft with flaps up, landing gear extended, and empty pylons installed at altitudes of sea level, 5,000, and 10,000 feet.

38.1.1 Sample Problem. Determine the range available, time required, and fuel flow for two-engine, flaps up, cruise in level flight at a constant 250 KIAS at 25,000 feet. The initial cruise gross weight is 38,000 pounds, and a 1000-pound fuel reserve is desired. Assume that it is a standard day and the aircraft is in configuration Ⓐ with a zero fuel weight of 28,650 pounds.

1. Gross weight with reserve fuel
   28,650 + 1,000 = 29,650 pounds.
2. Average cruise gross weight is
   38,000 + 29,650 ÷ 2 = 33,825 pounds.
3. Enter Figure 38-1, Sheet 4, at 250 KIAS and 33,825 pounds. Read average air nautical miles per 1,000 pounds of fuel to be 179.5 nm.
4. Fuel to be used in cruise is
   38,000 – 29,650 = 8,350 pounds.
5. Range available is 179.5 × 8,350/1,000 = 1,499 nm.
6. From Figure 38-1, Sheet 4, read the standard day true airspeed at 250 KIAS and 25,000 feet to be 363 knots.
7. Time required is 1,499 ÷ 363 = 4.13 hours (4 hours, 8 minutes).
8. From Figure 38-1, Sheet 4, read an initial fuel flow for 38,000 pounds of approximately 2,070 pph (1,035 pph per engine).

The range above is for zero-wind conditions. To determine the range available when wind conditions are known, use the relationship:

Ground miles per pound = air miles per pound × GS/TAS. For the above problem, assume a 30-knot headwind:

9. Groundspeed is 363 – 30 = 333 knots.
10. Ground miles per pound is
    179.5 × 333/363 = 164.7 nm per 1,000 pounds.
11. Range available with a 30-knot headwind is
    164.7 × 8,350/1,000 = 1,375 nm.

For maximum range cruise, the effects of wind on maximum nautical miles per 1,000 pounds and optimum cruise speed can be determined directly from Figure 34-2.

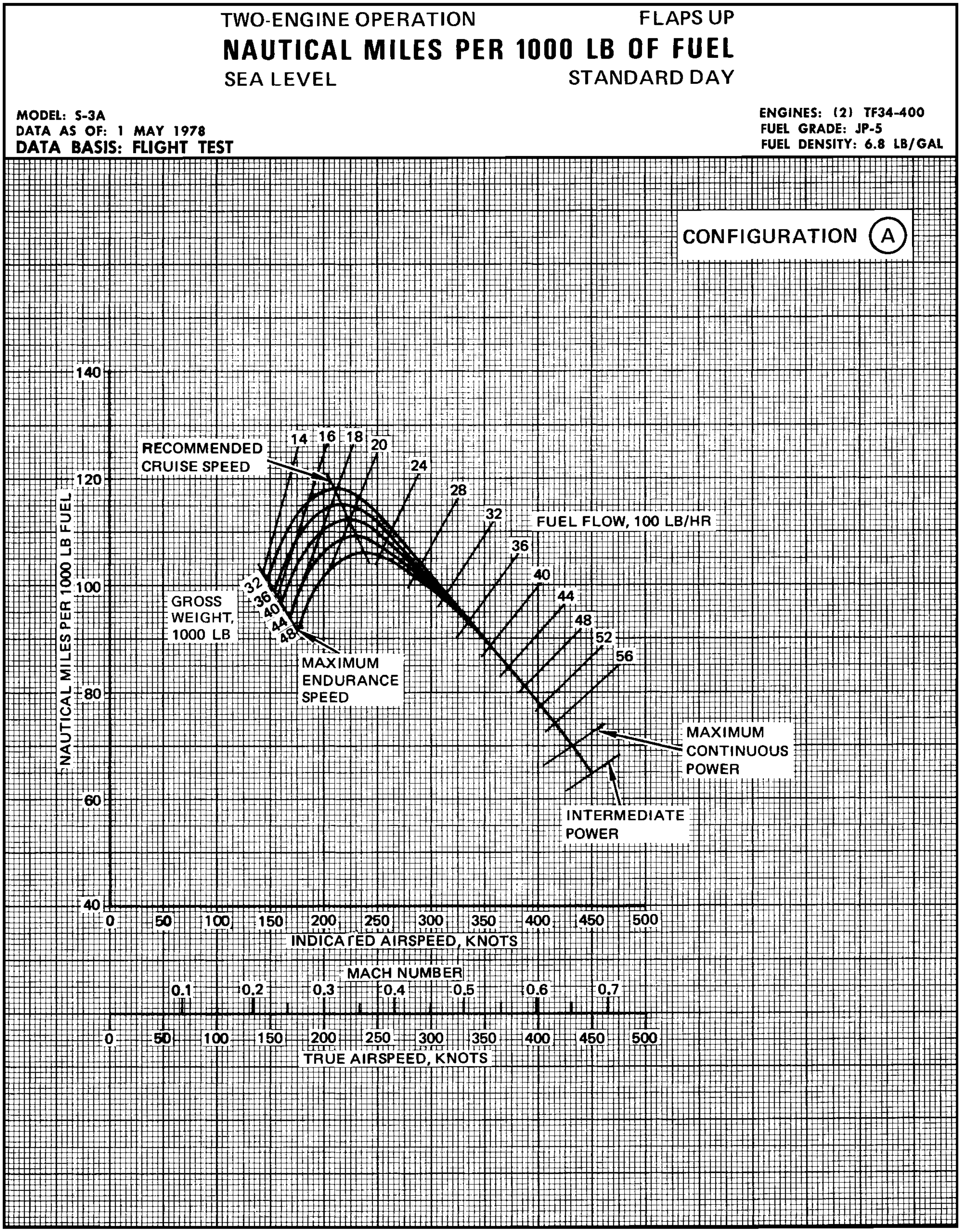


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (A) (Sheet 1 of 6)

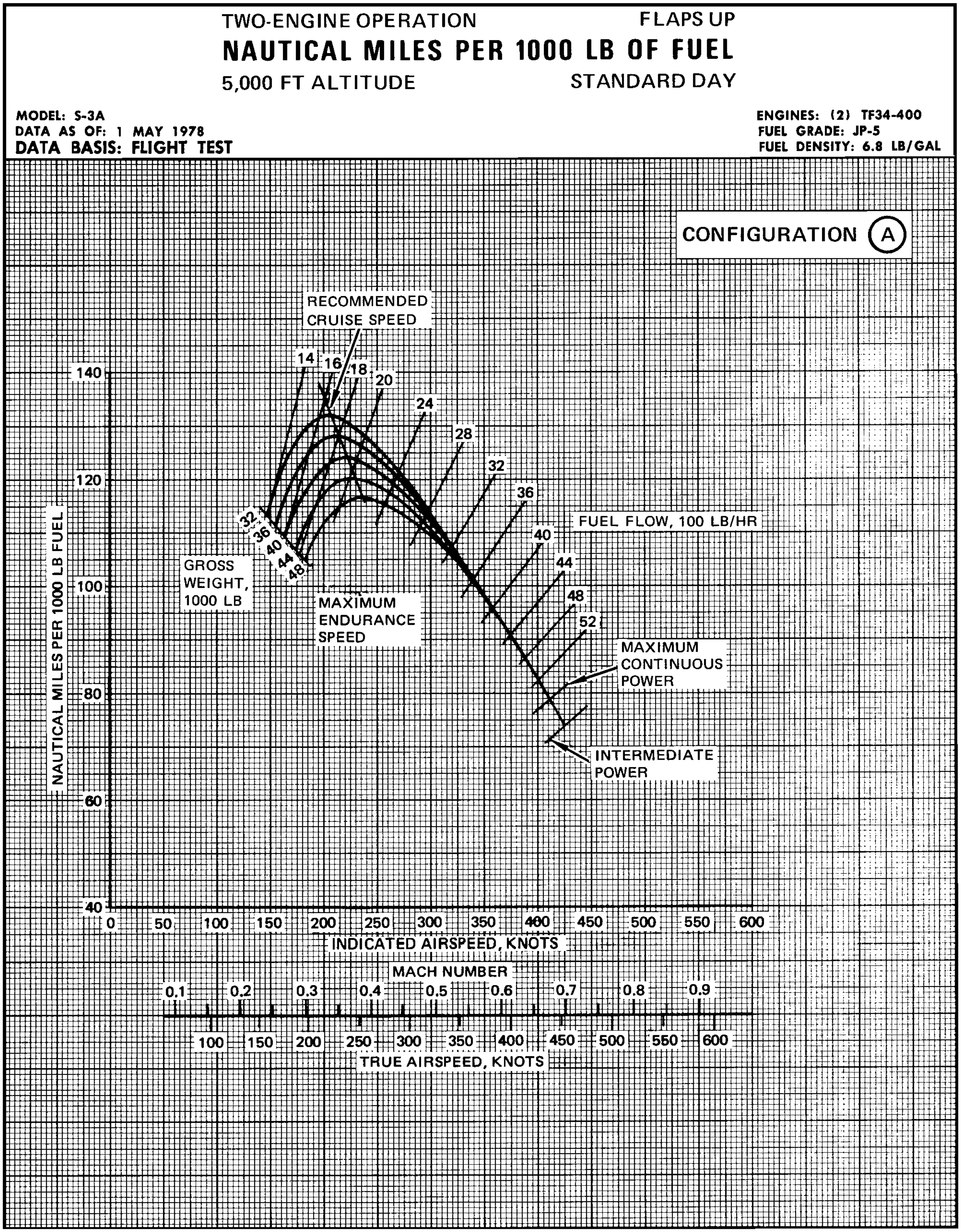


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓐ (Sheet 2)

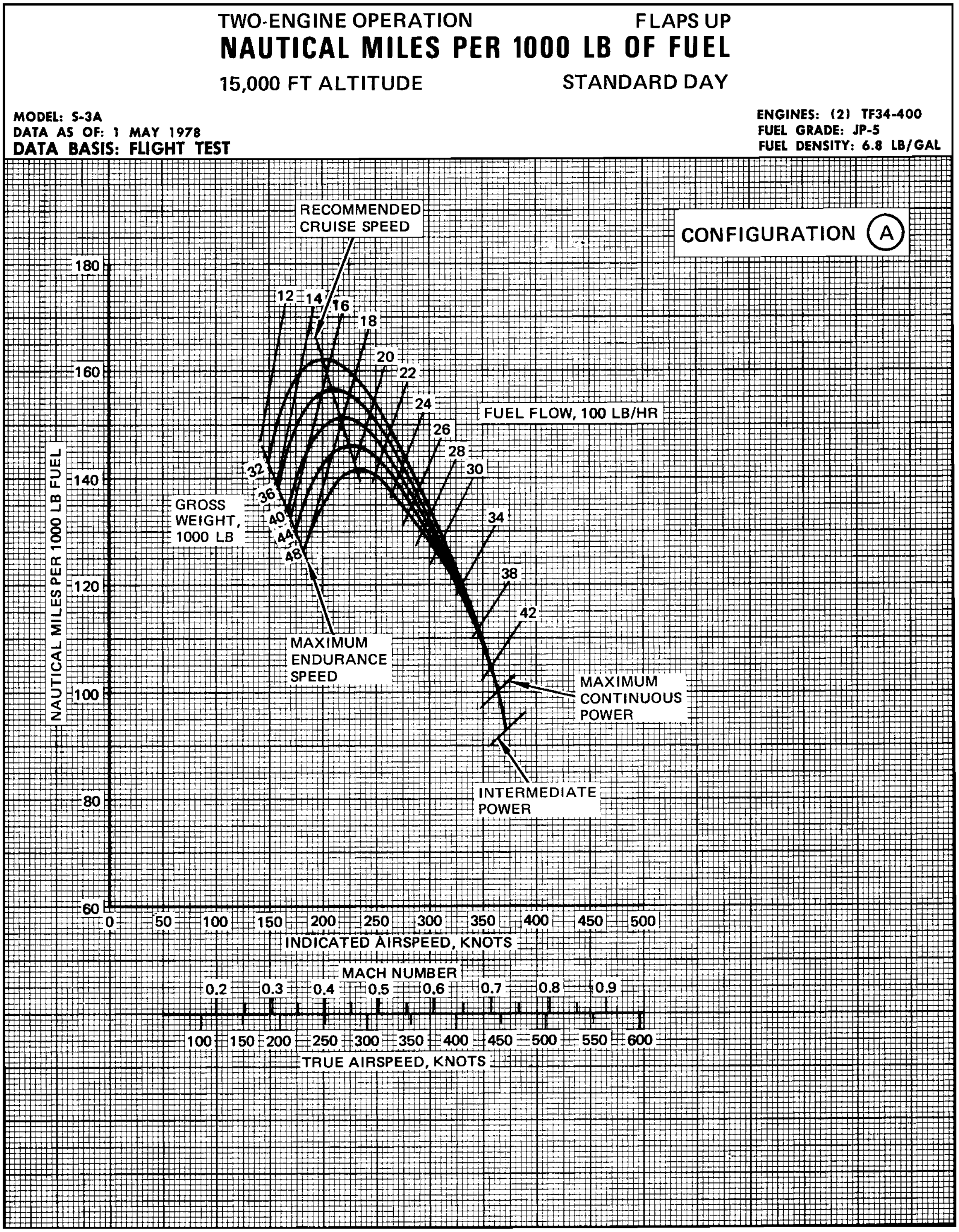


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (A) (Sheet 3)

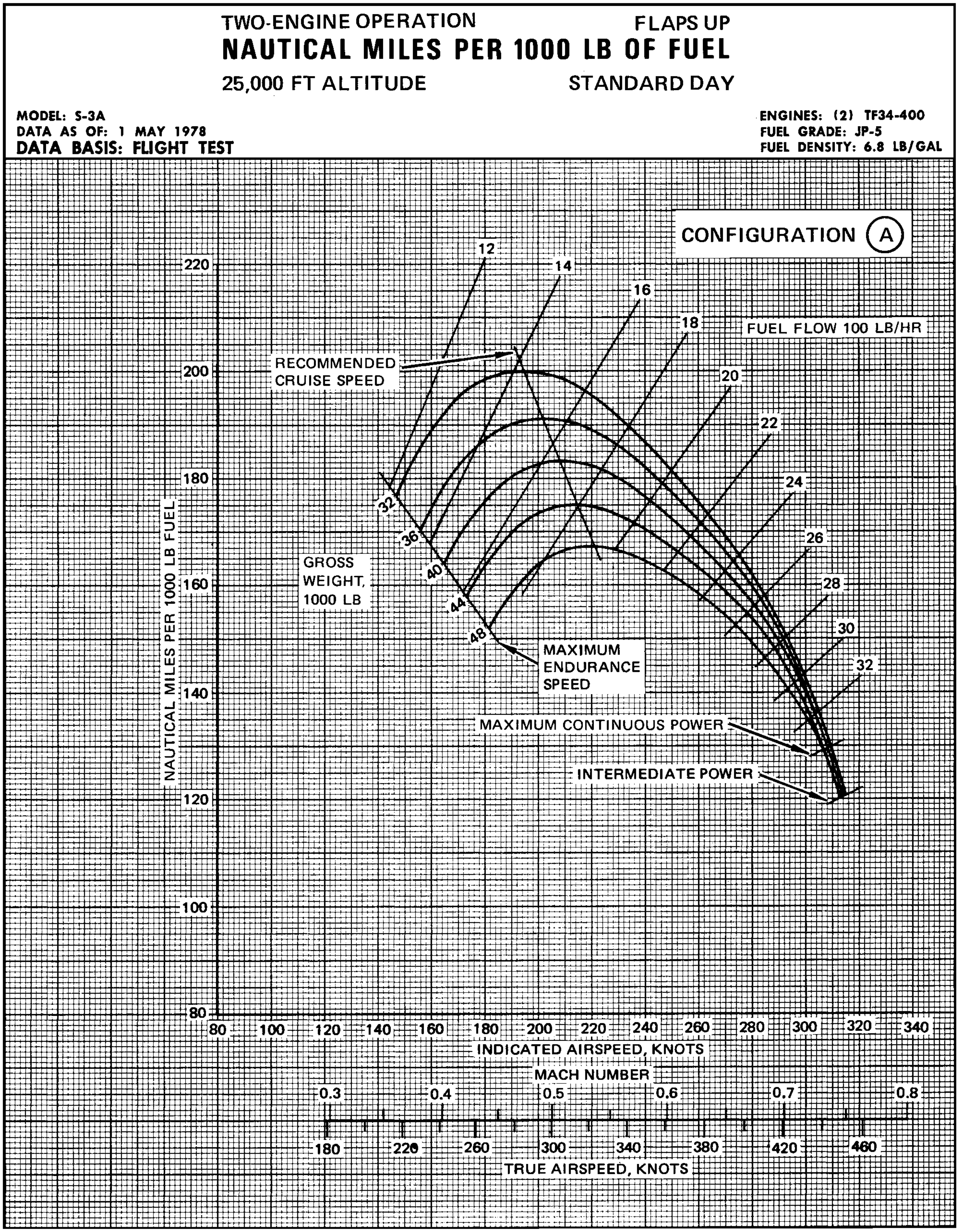


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (A) (Sheet 4)

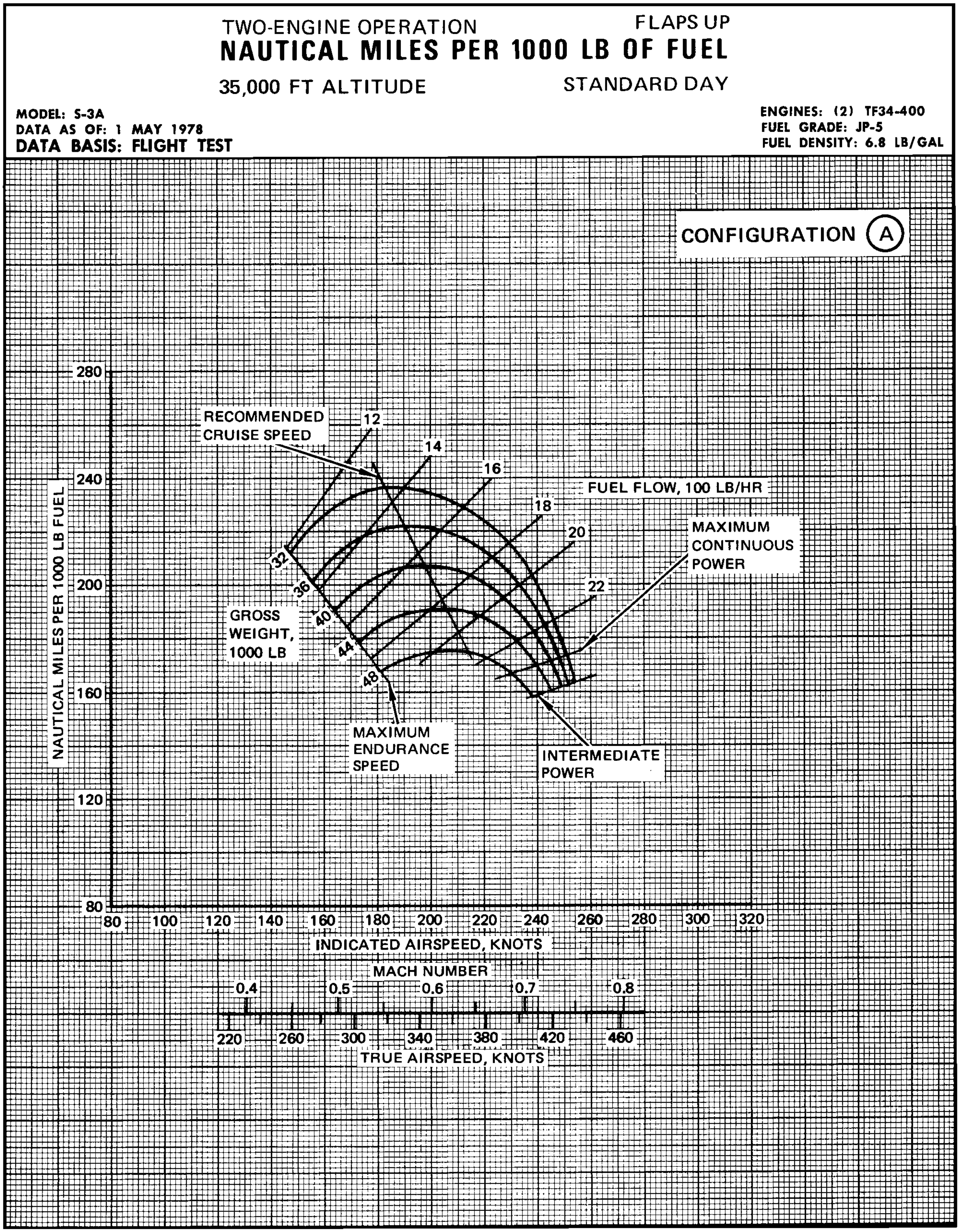


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (A) (Sheet 5)

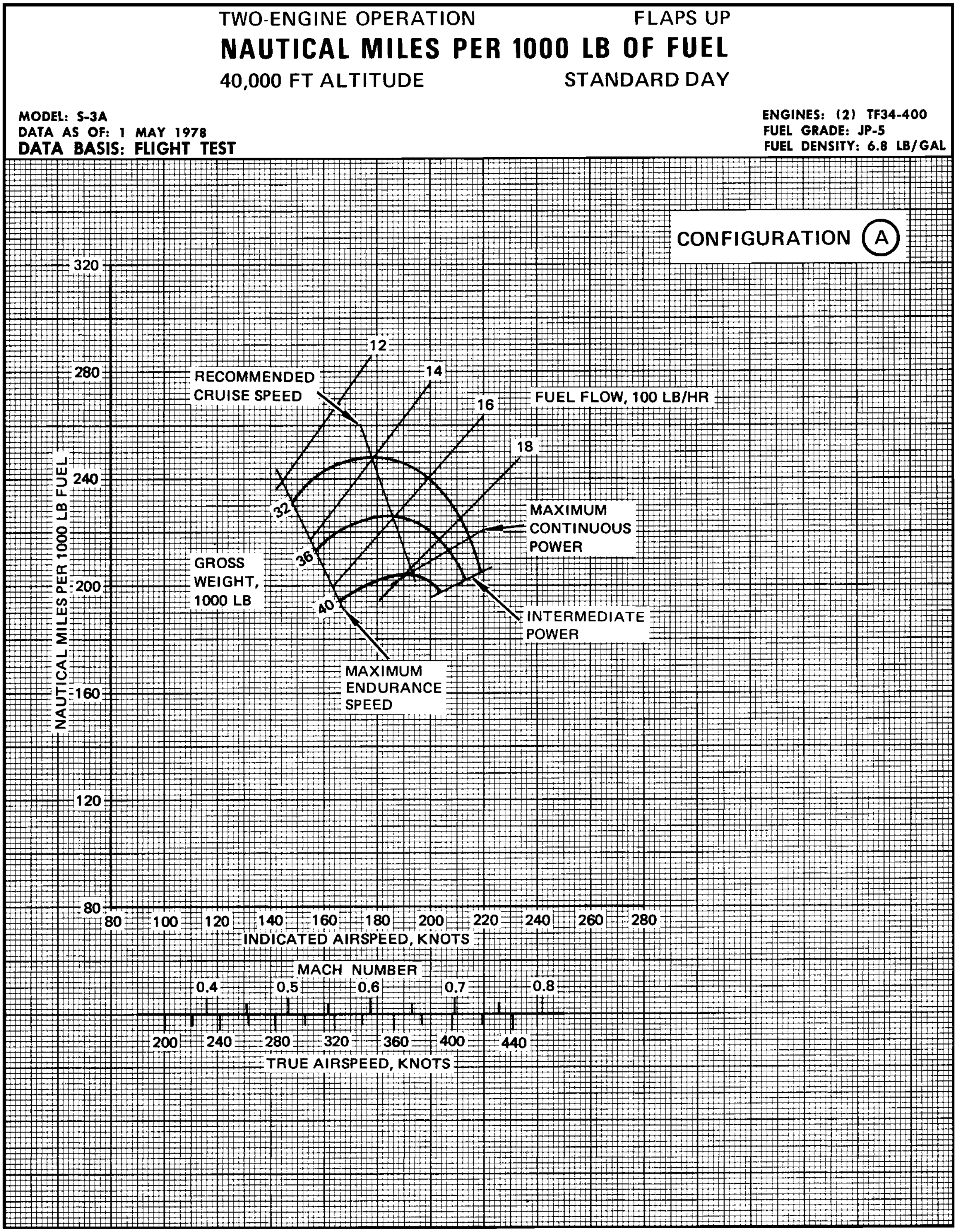


Figure 38-1. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓐ (Sheet 6)

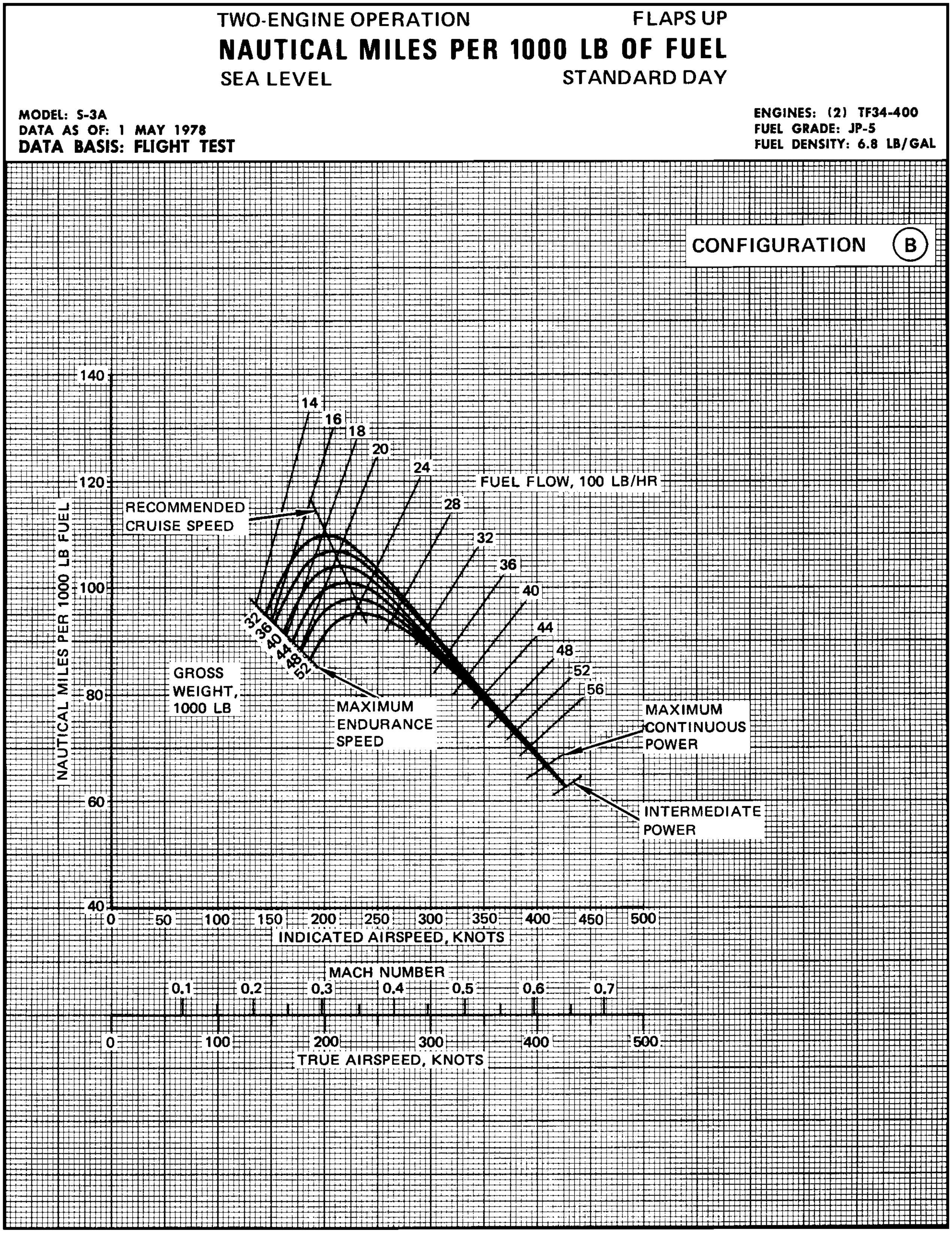


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 1 of 6)

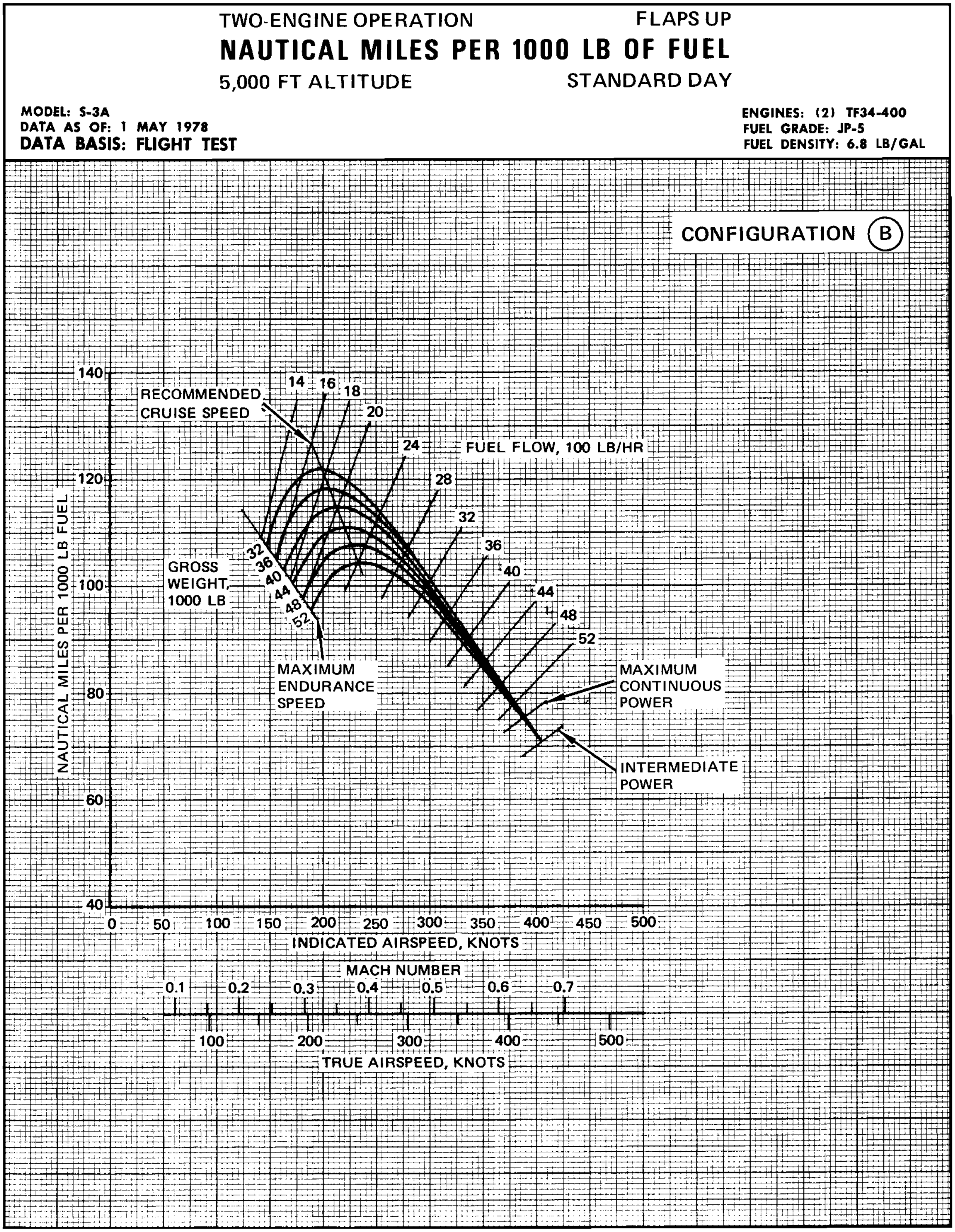


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 2)

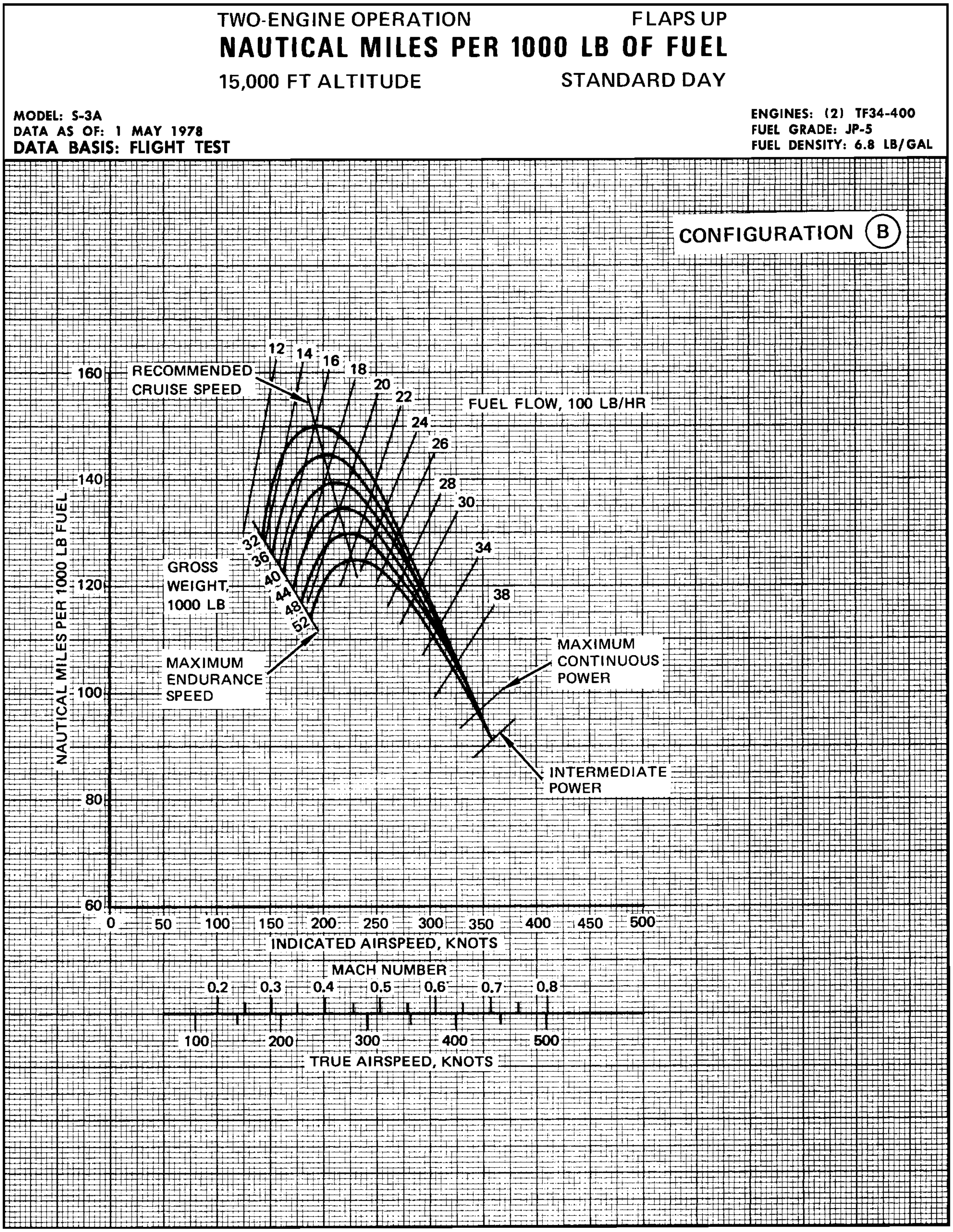


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 3)

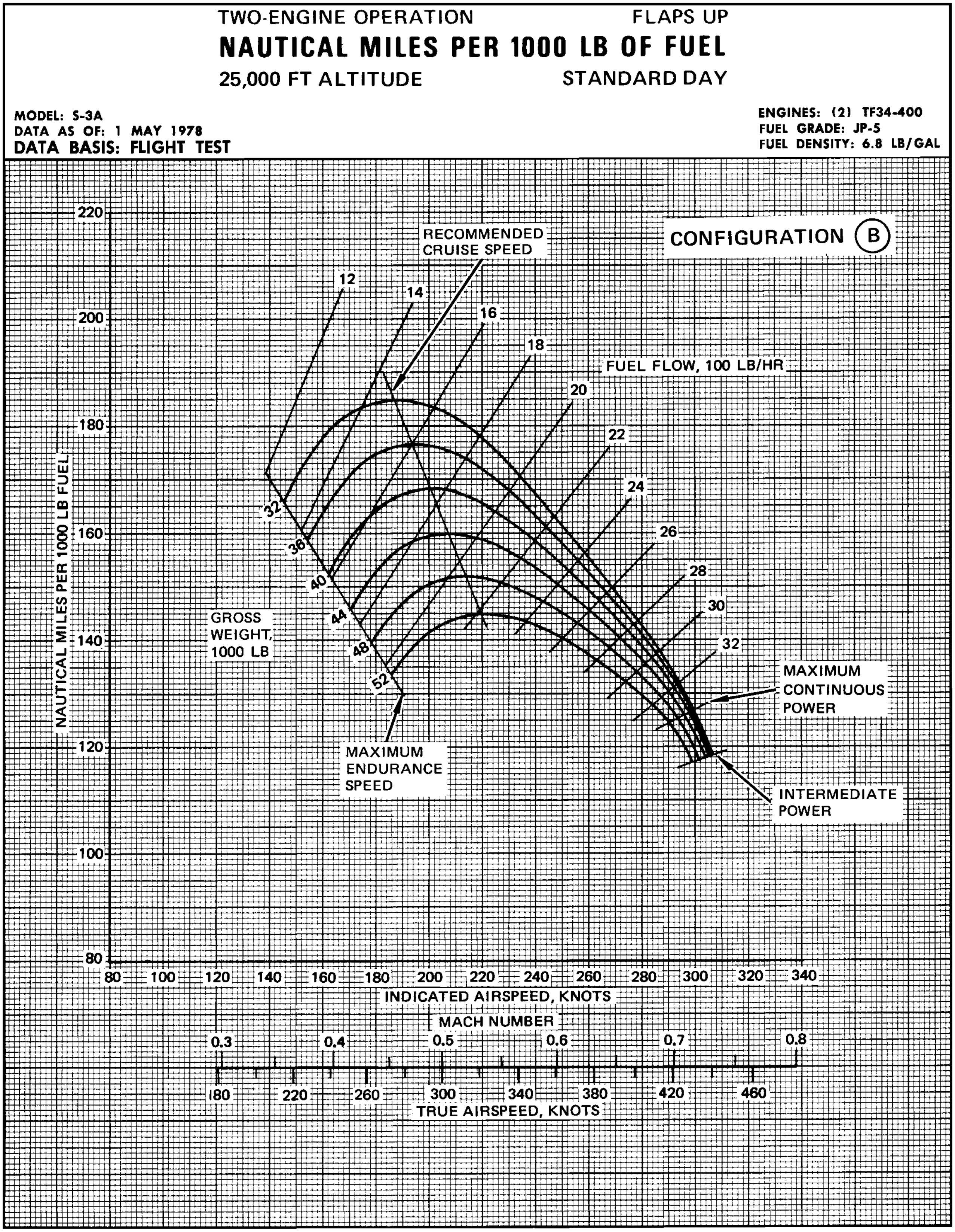


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 4)

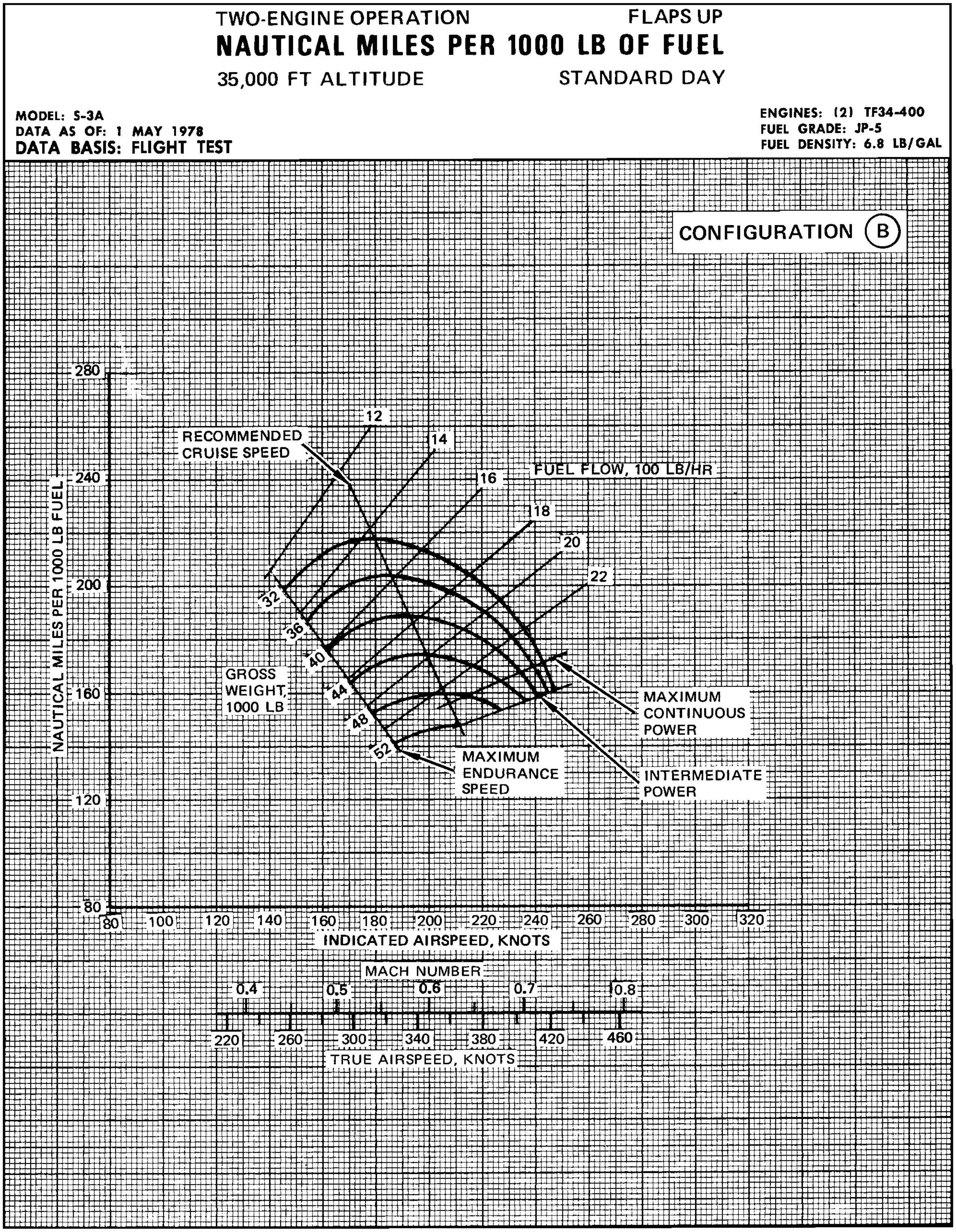


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (B) (Sheet 5)

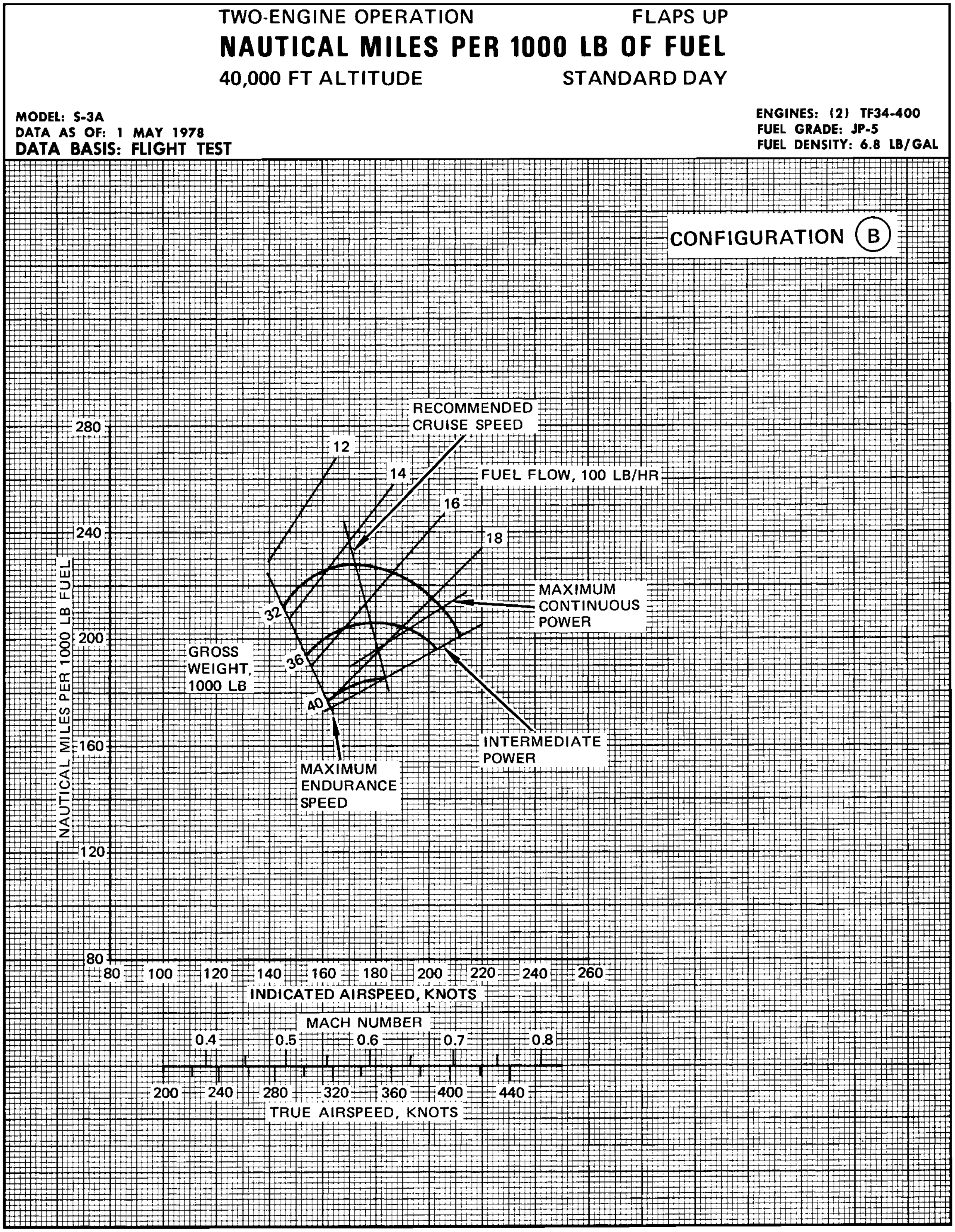


Figure 38-2. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 6)

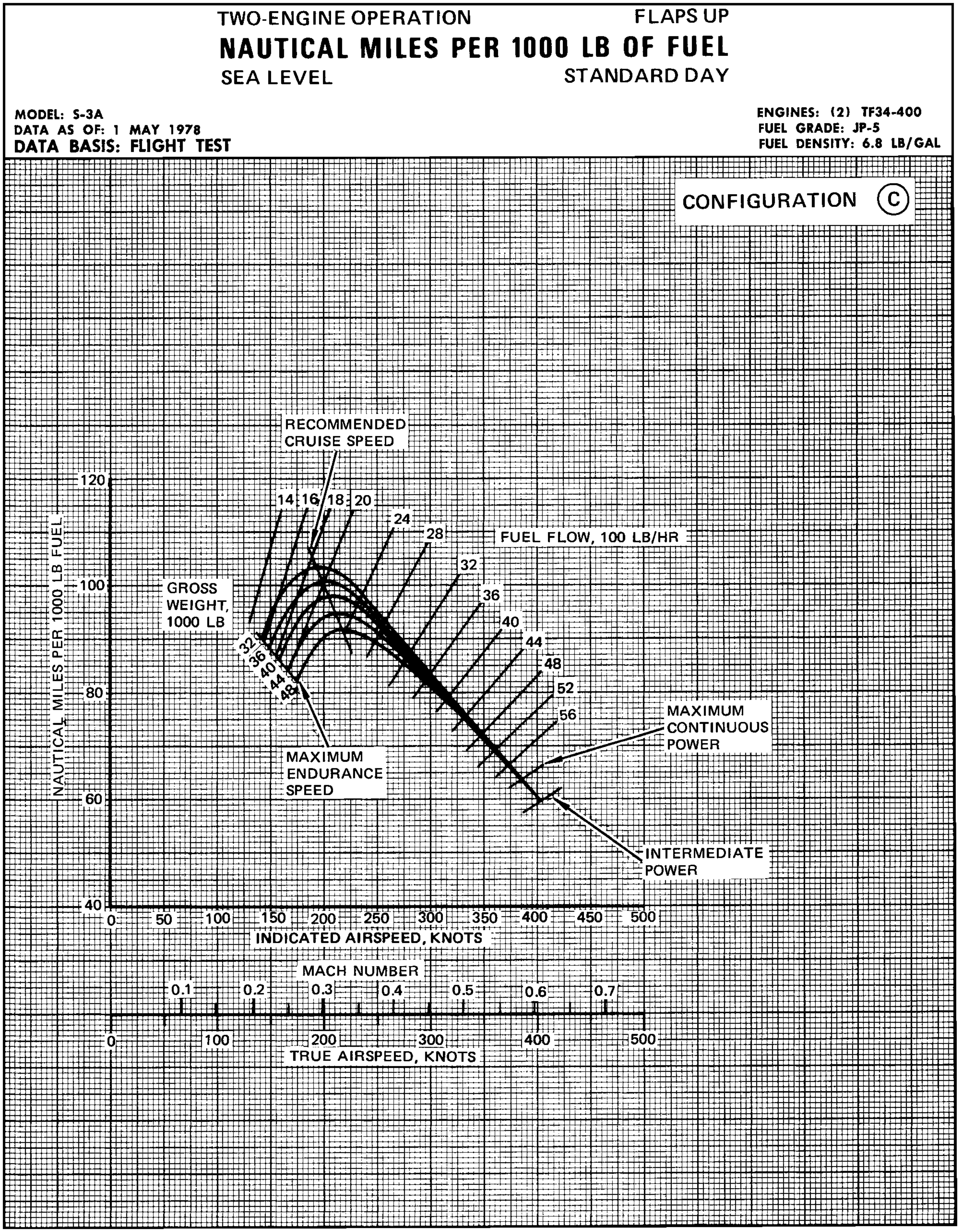


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 1 of 6)

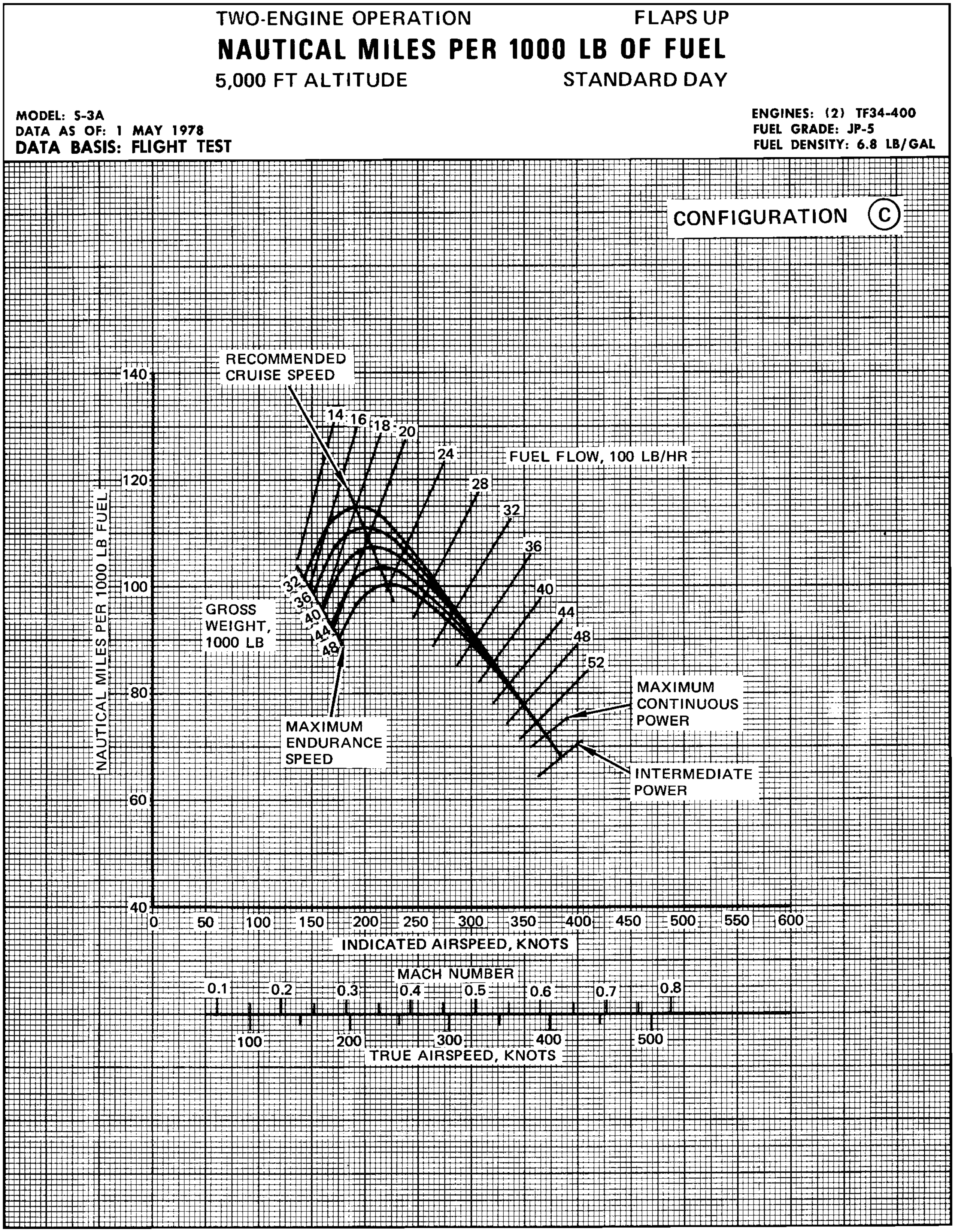


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 2)

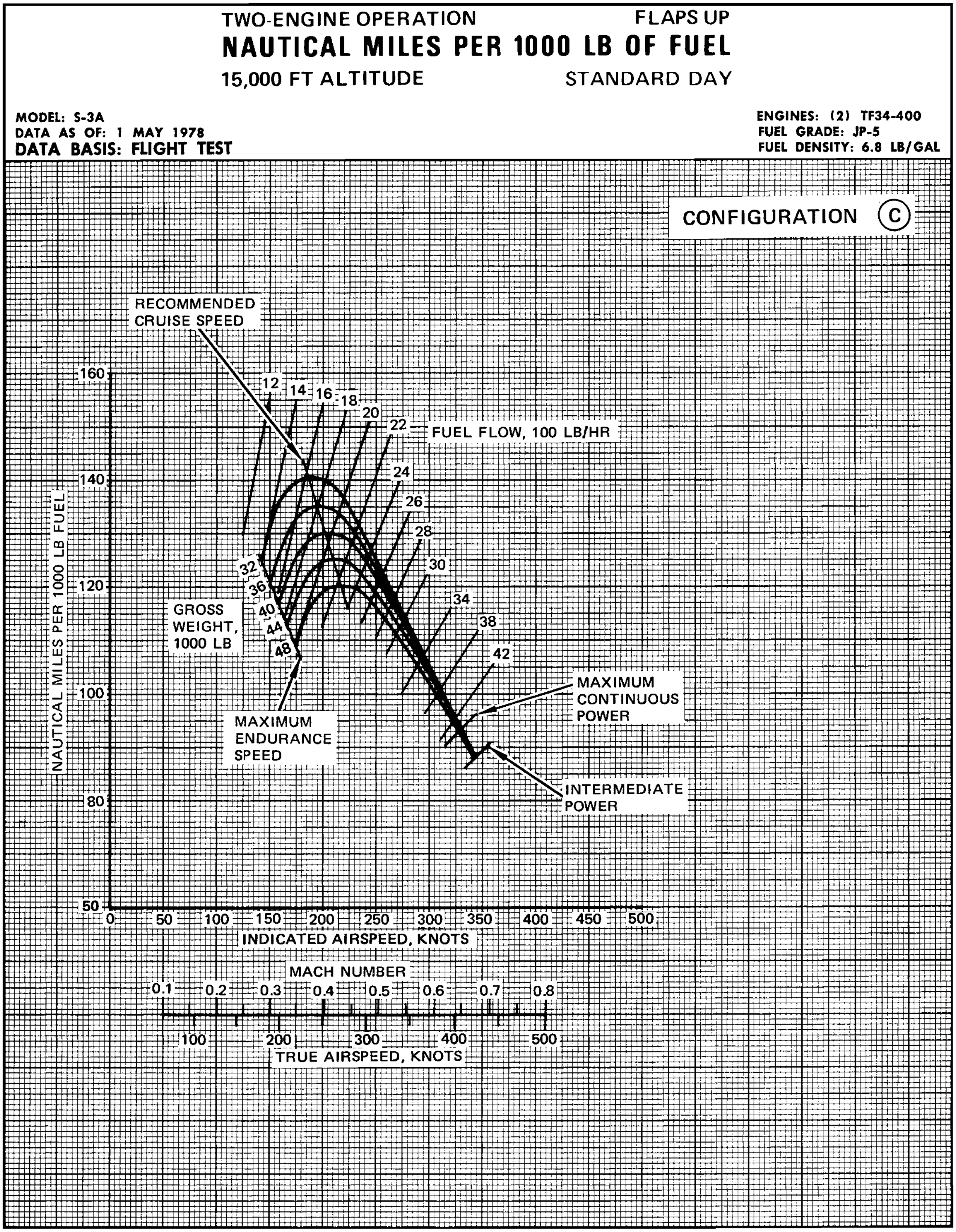


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 3)

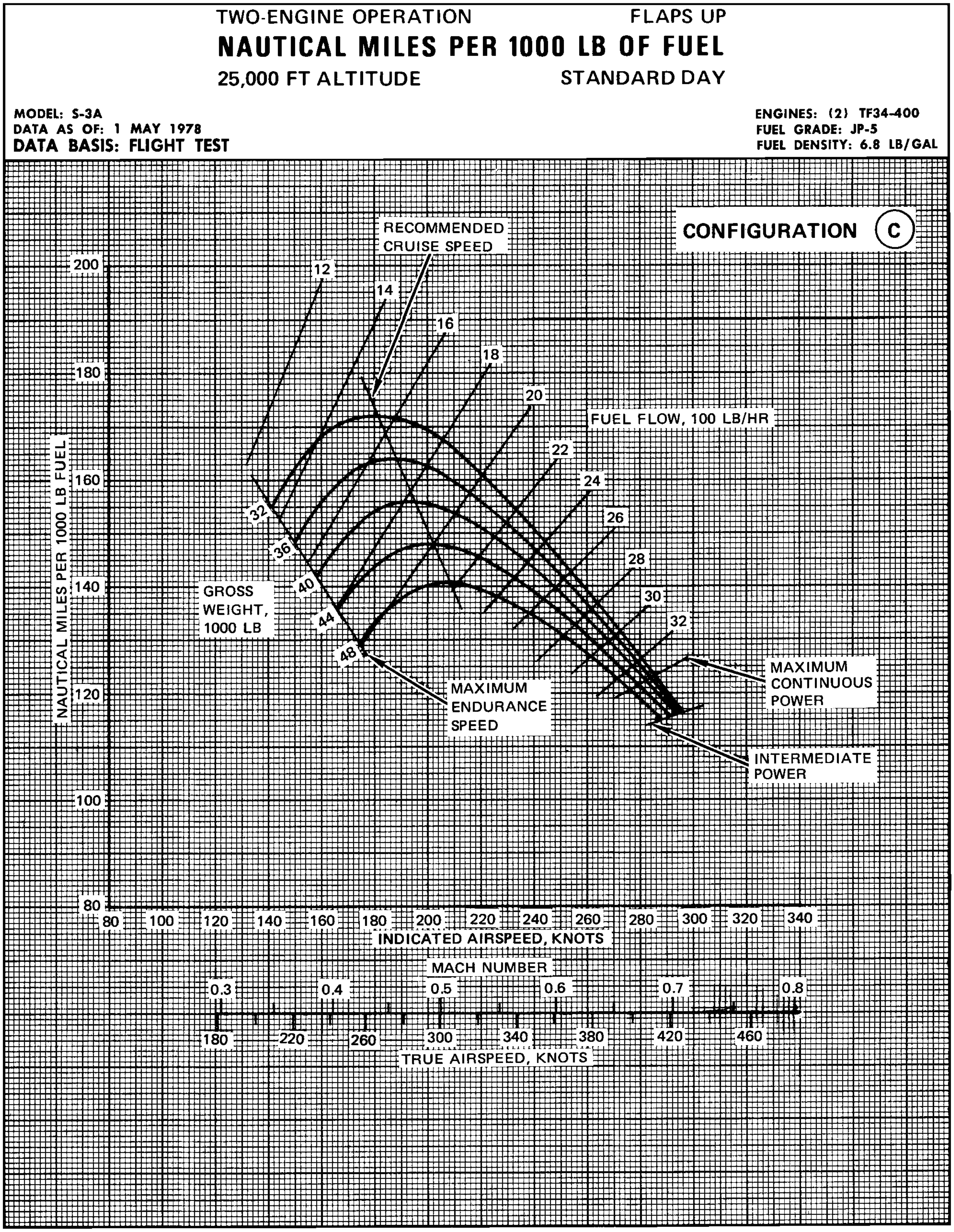


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 4)

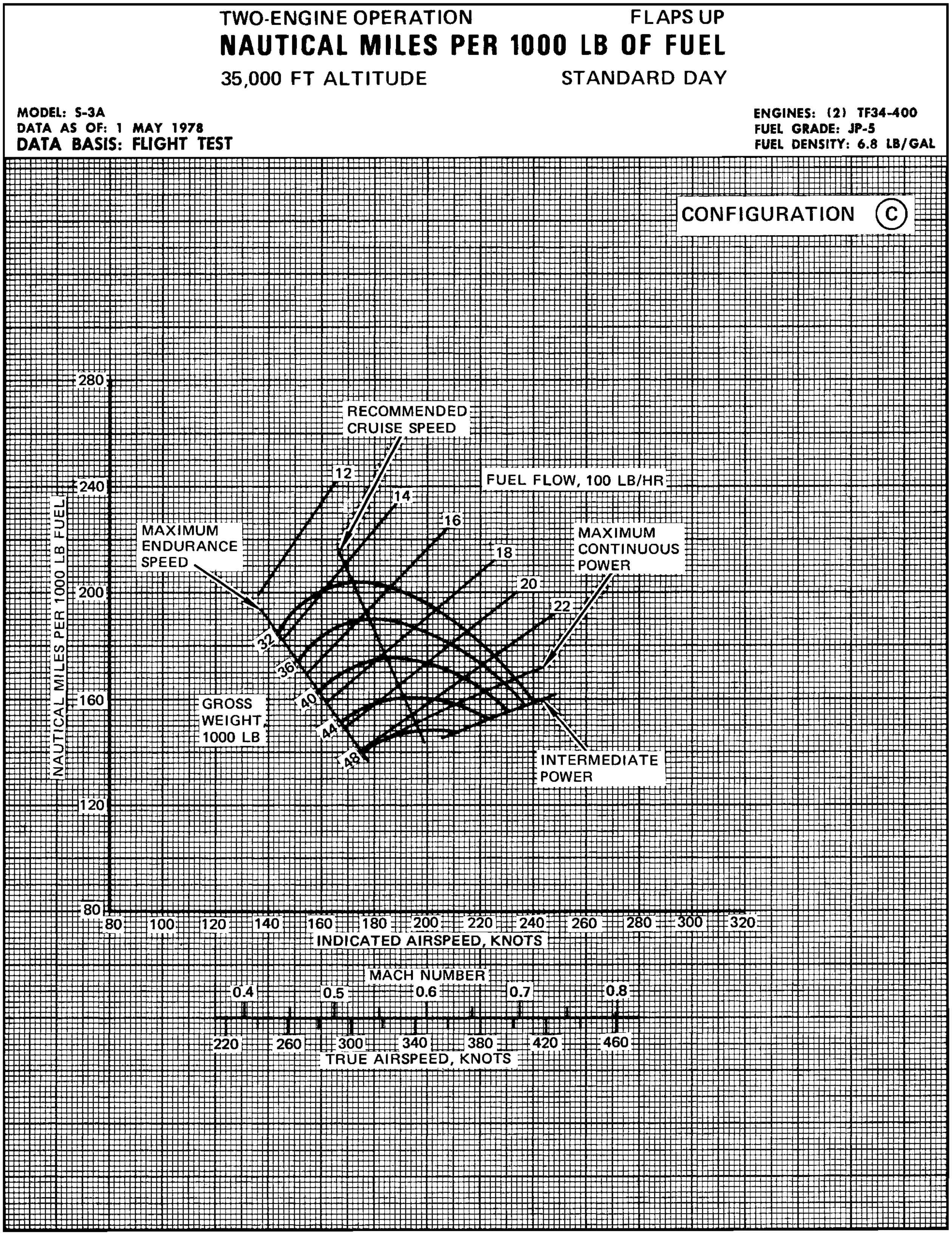


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 5)

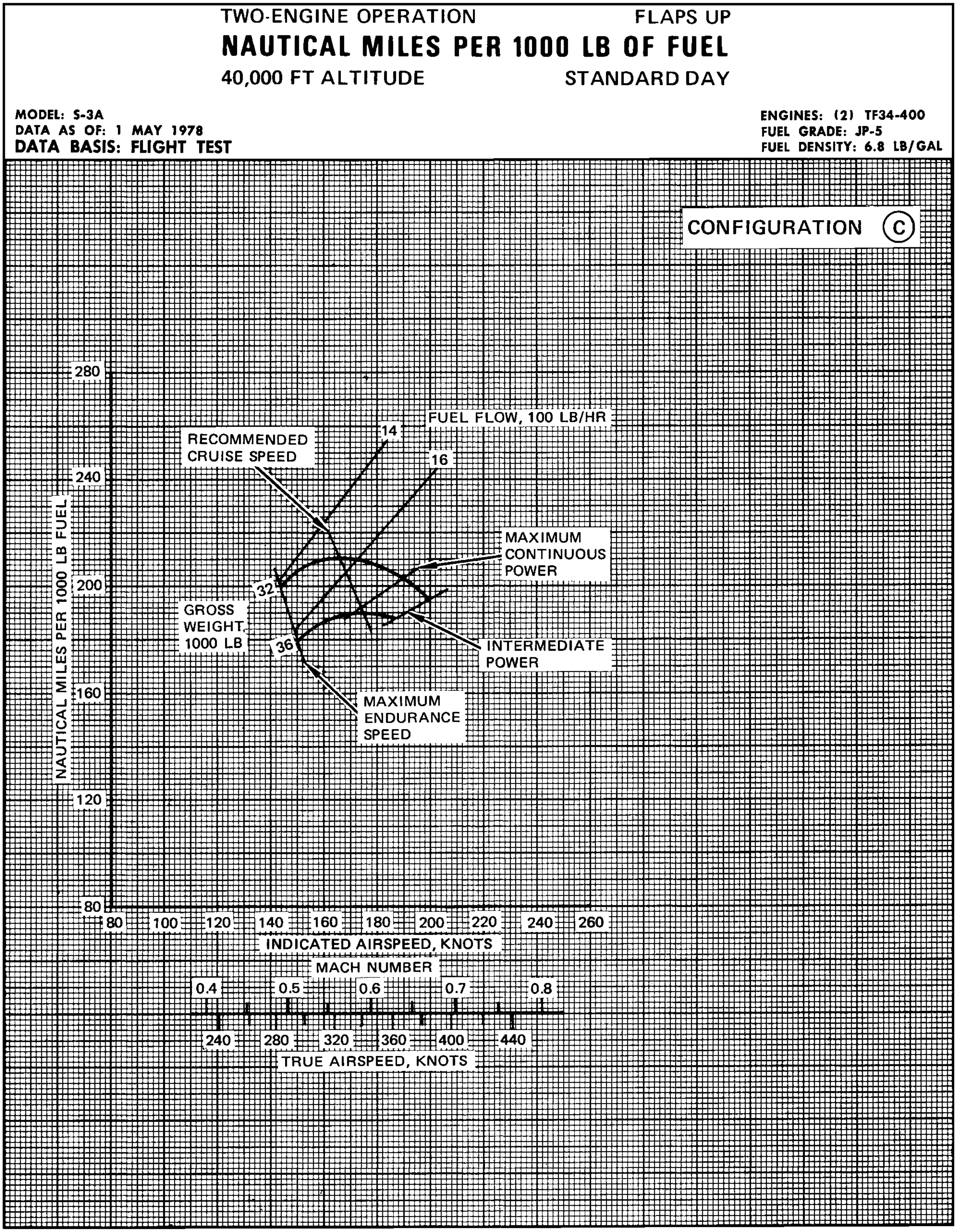


Figure 38-3. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓒ (Sheet 6)

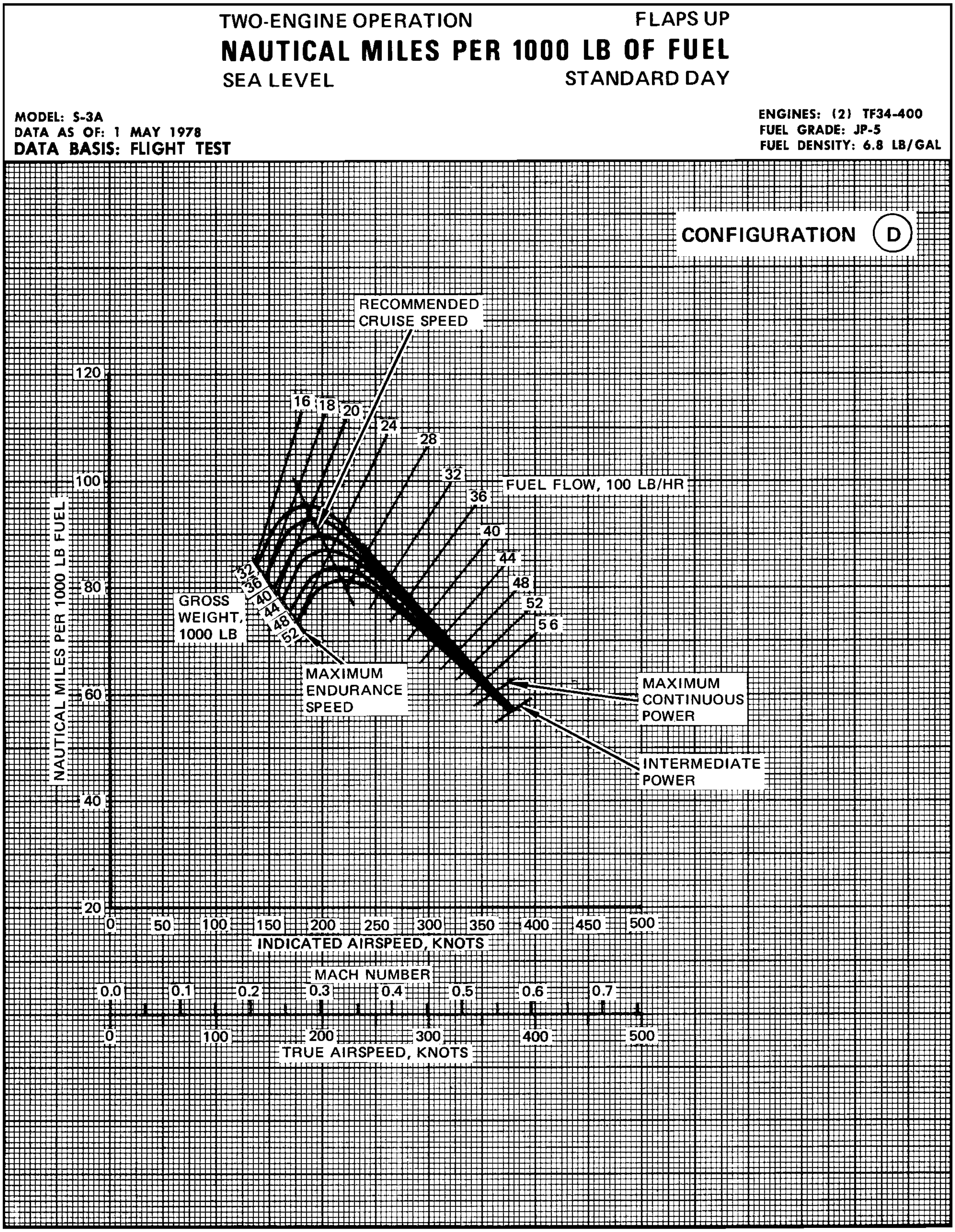


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 1 of 6)

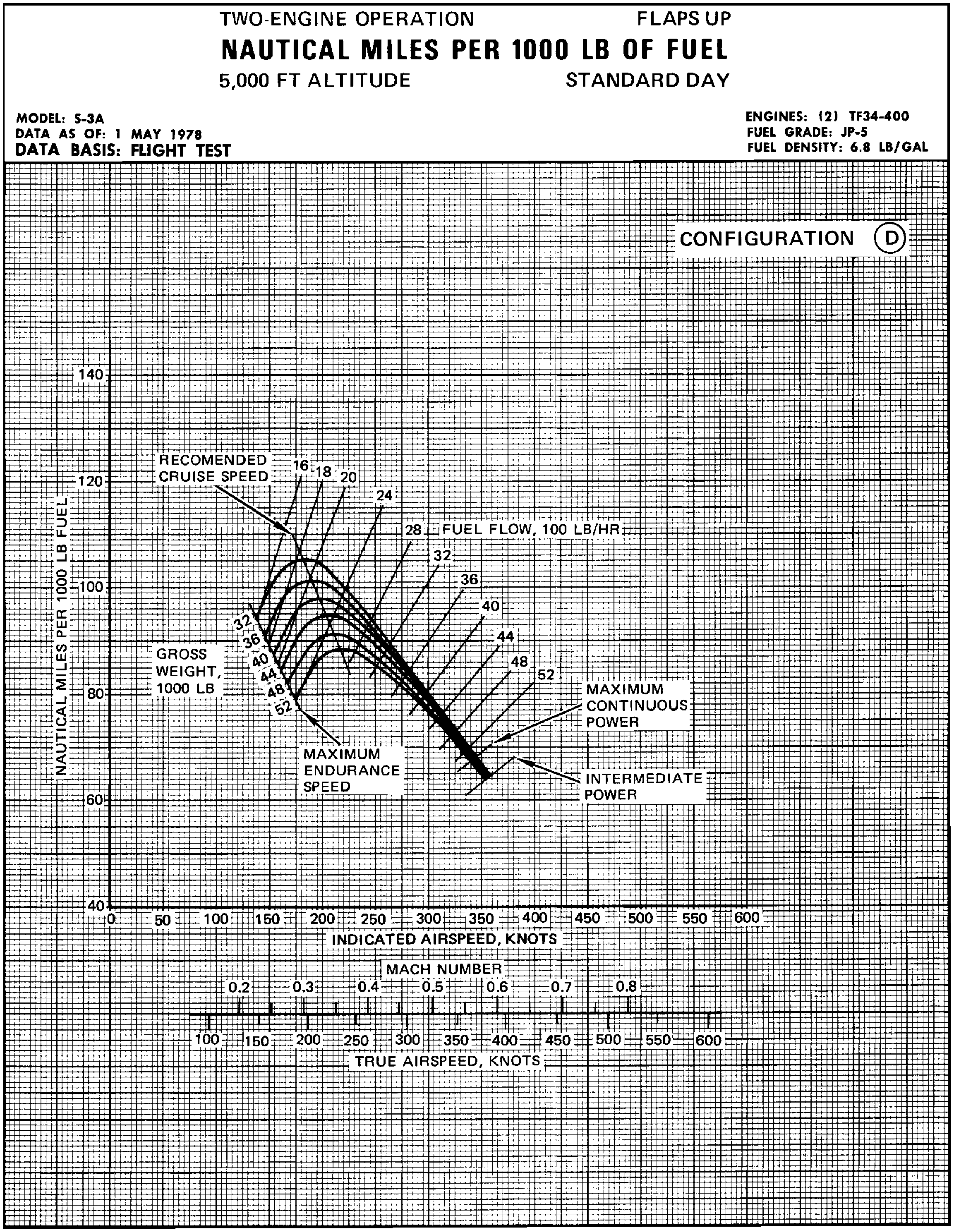


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (D) (Sheet 2)

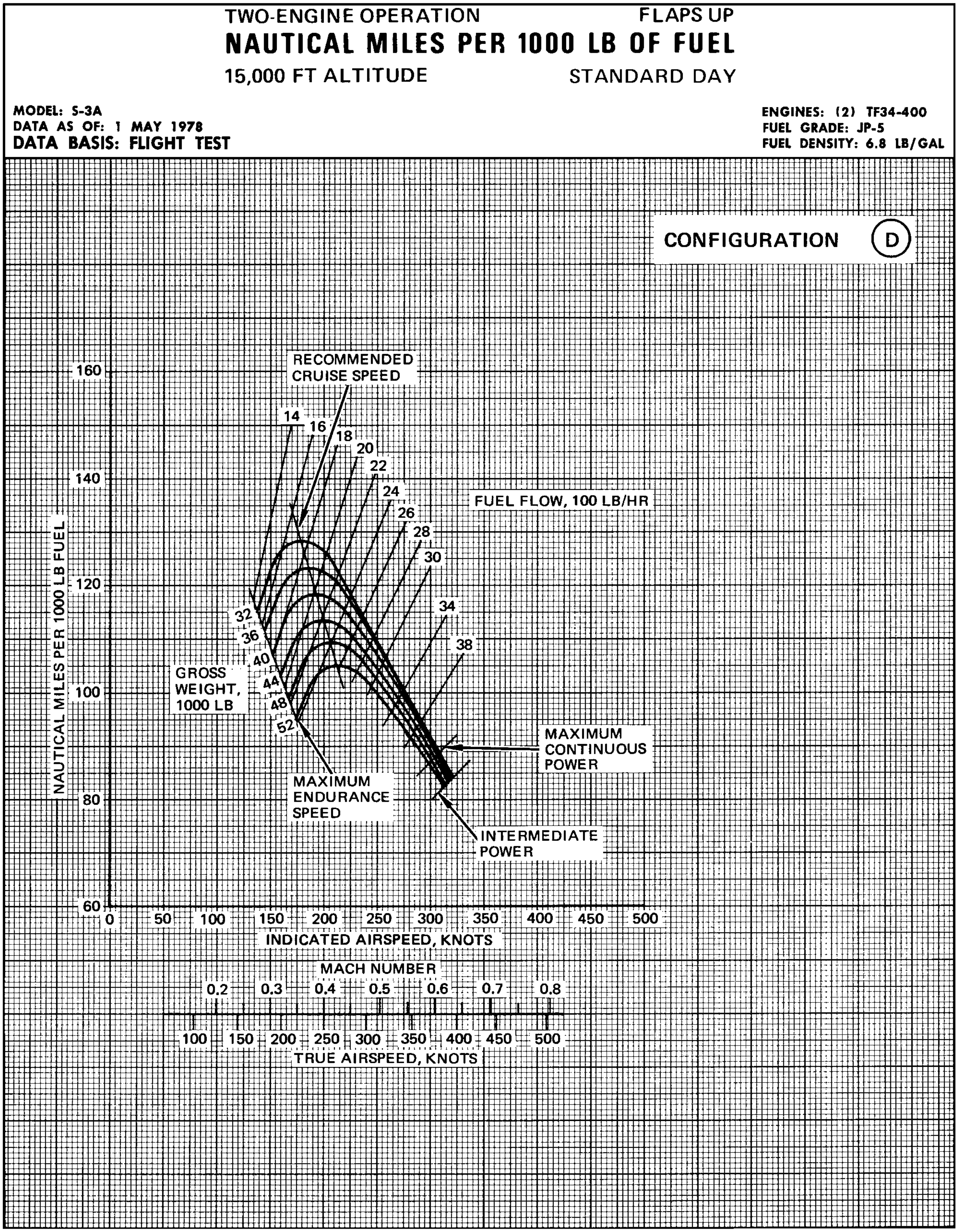


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 3)

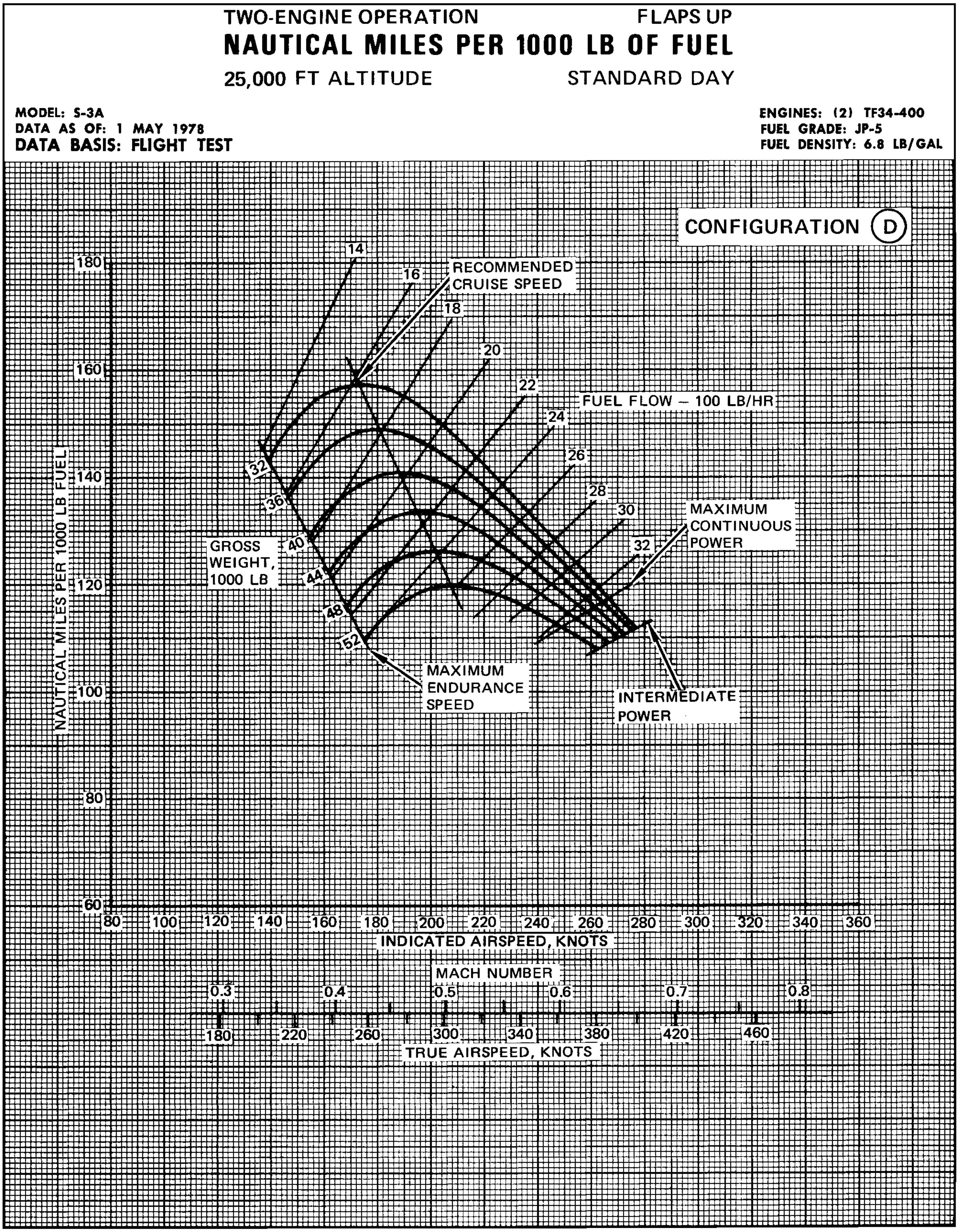


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 4)

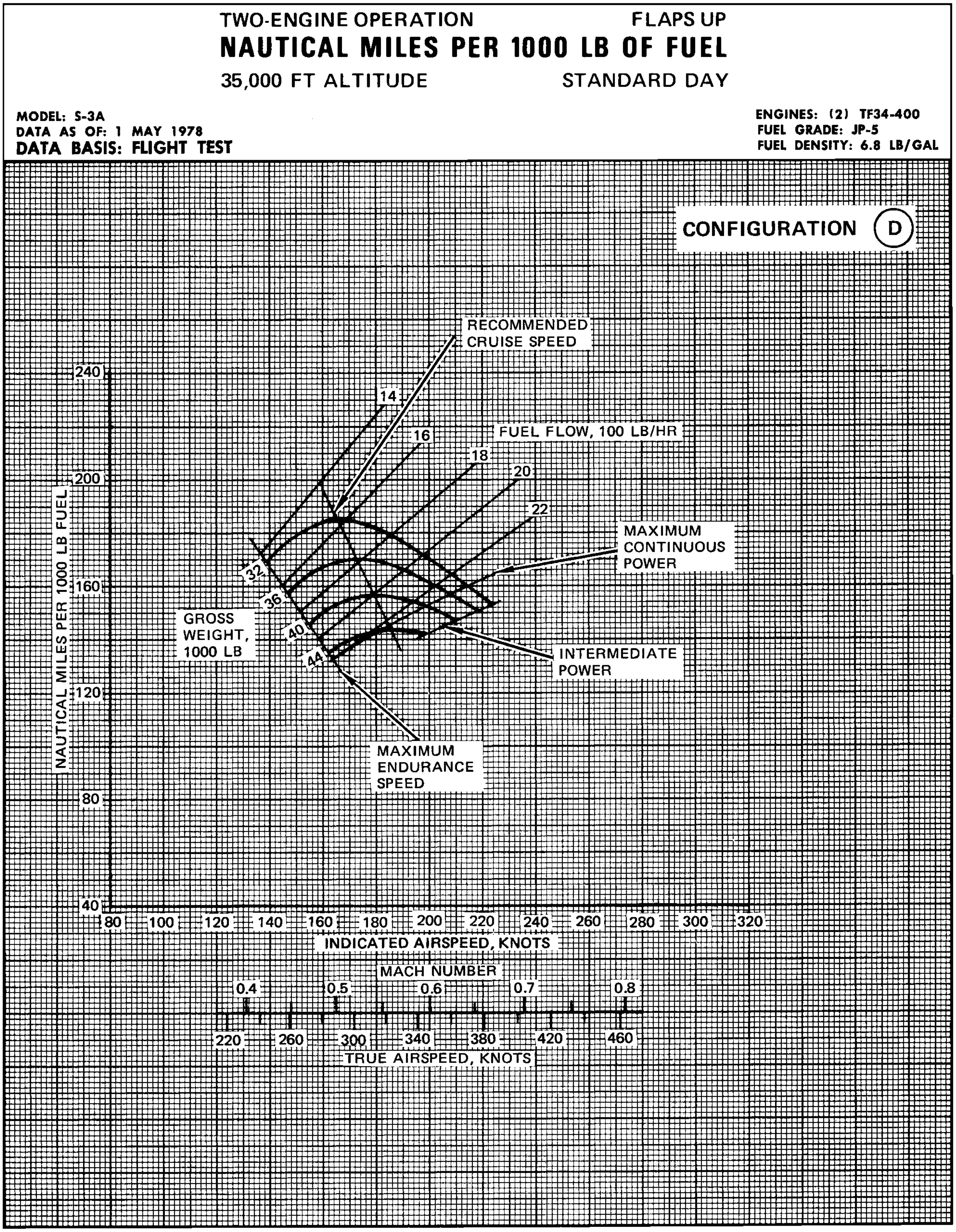


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 5)

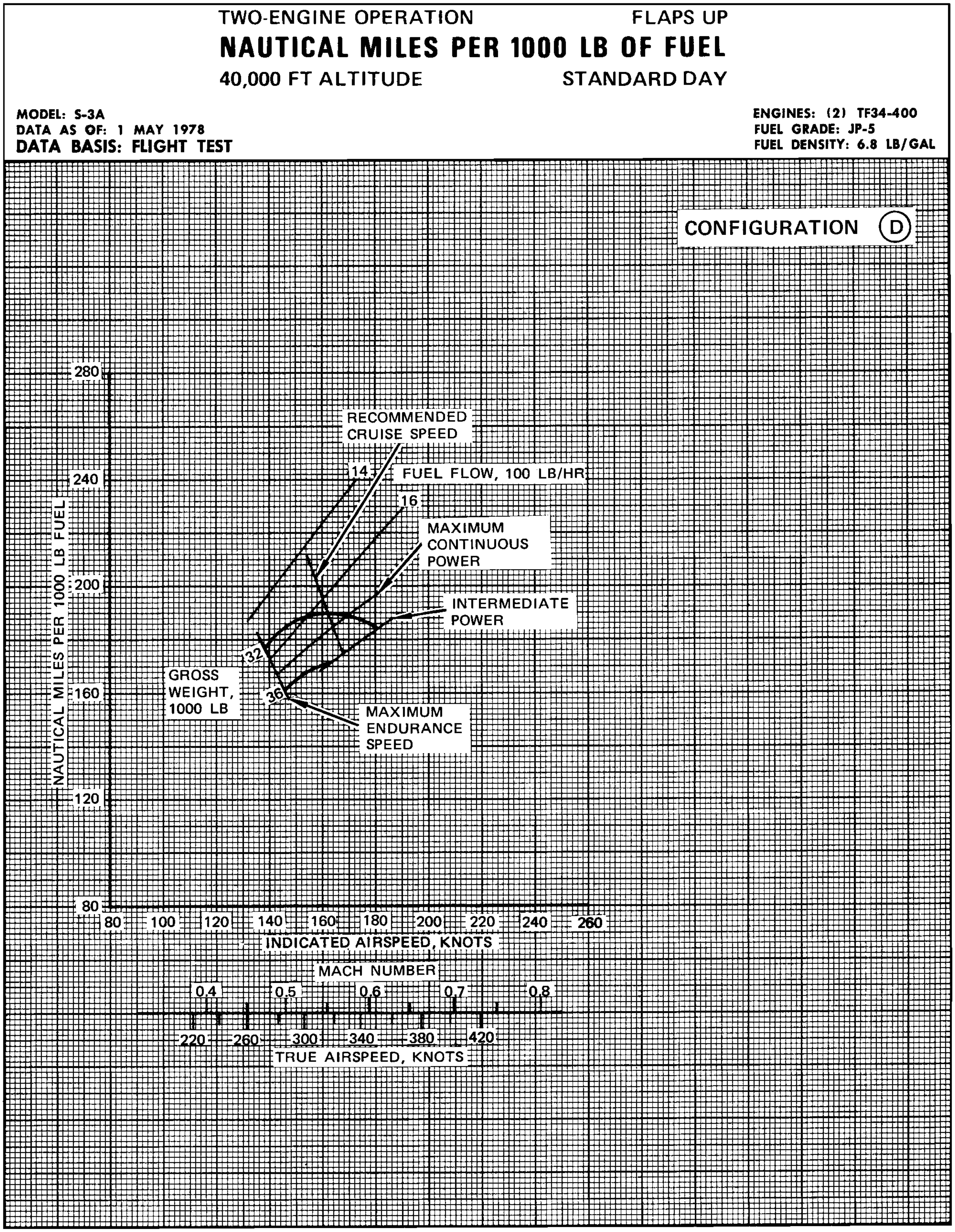


Figure 38-4. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 6)

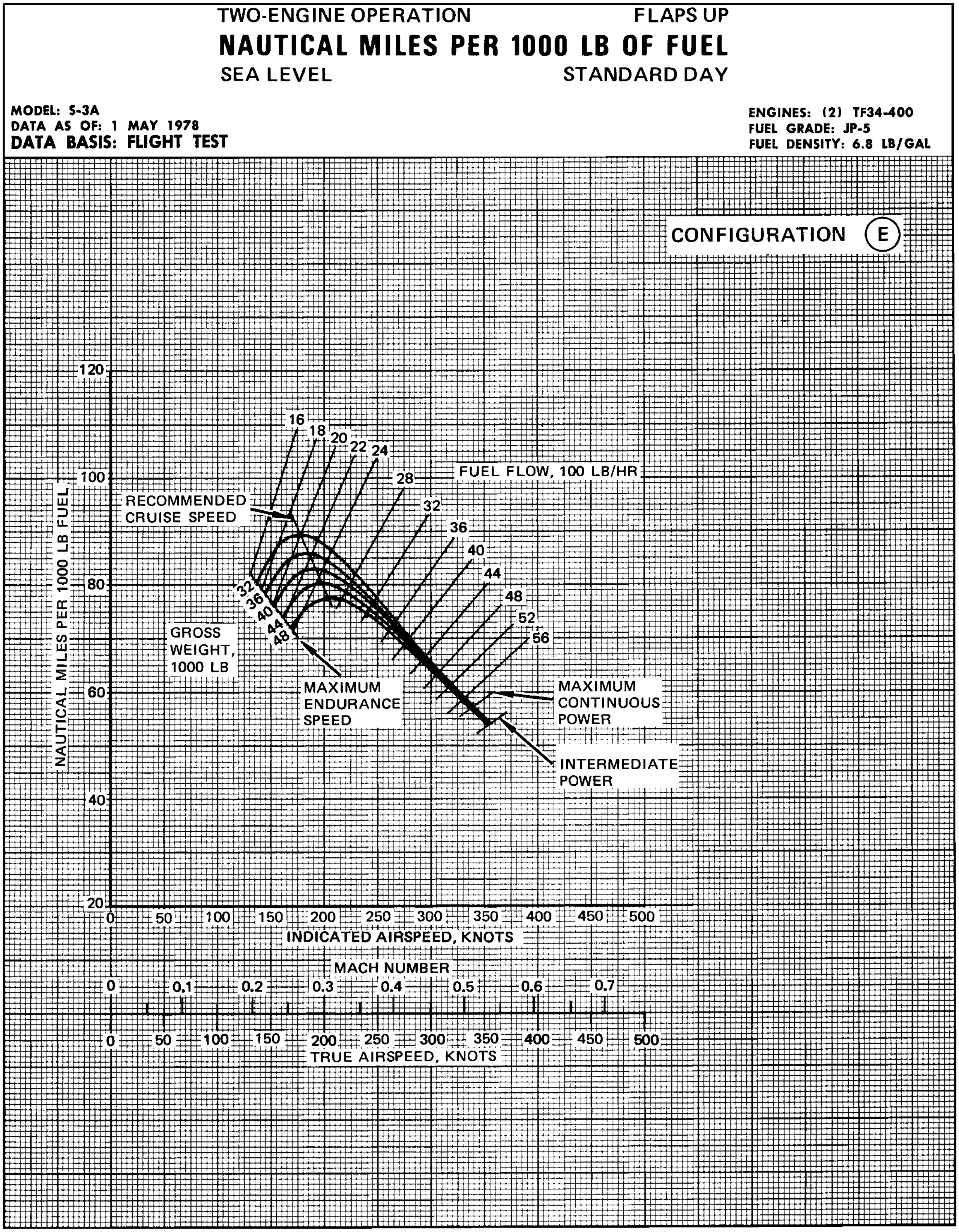


Figure 38-5. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓔ (Sheet 1 of 5)

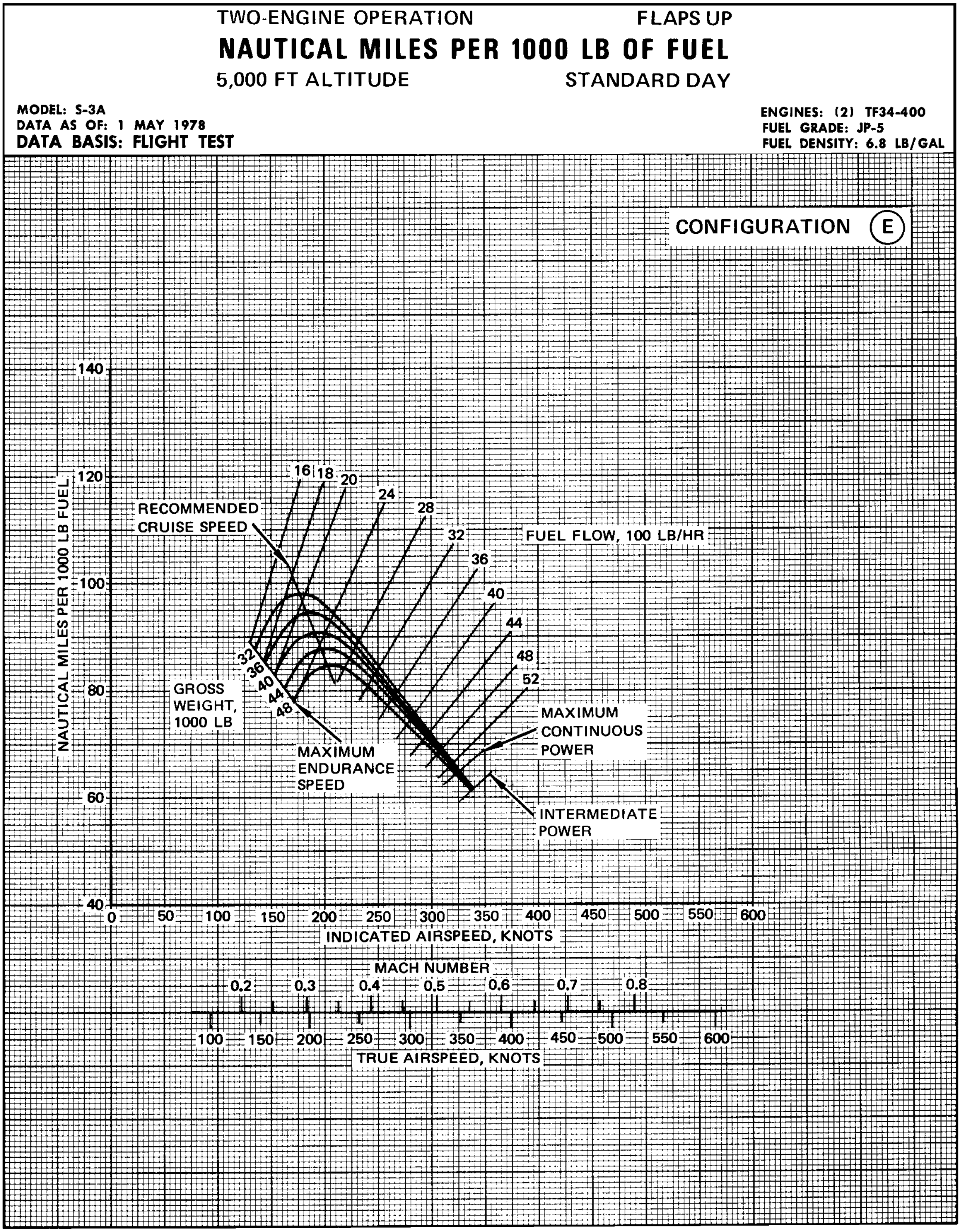


Figure 38-5. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓔ (Sheet 2)

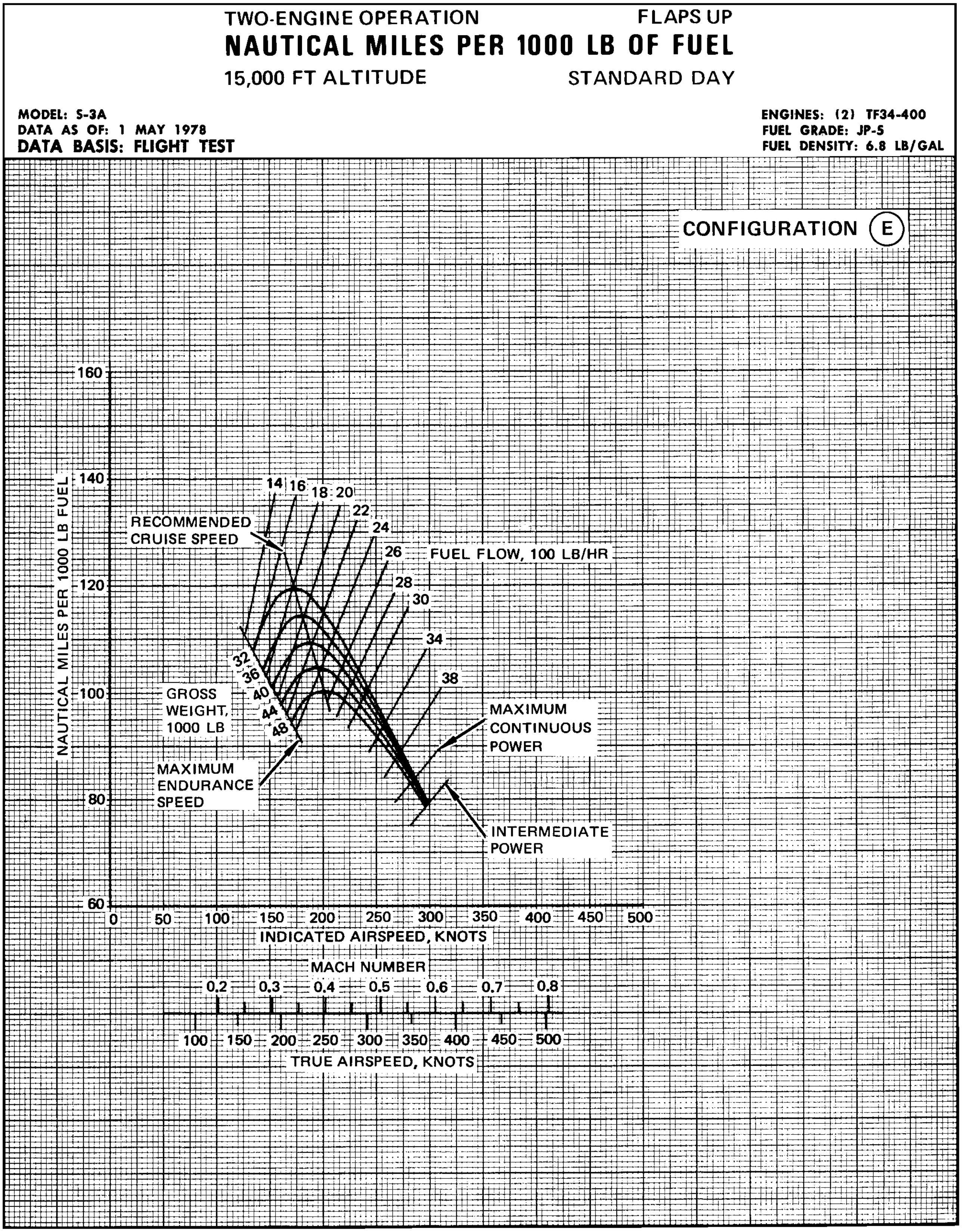


Figure 38-5. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration (E) (Sheet 3)

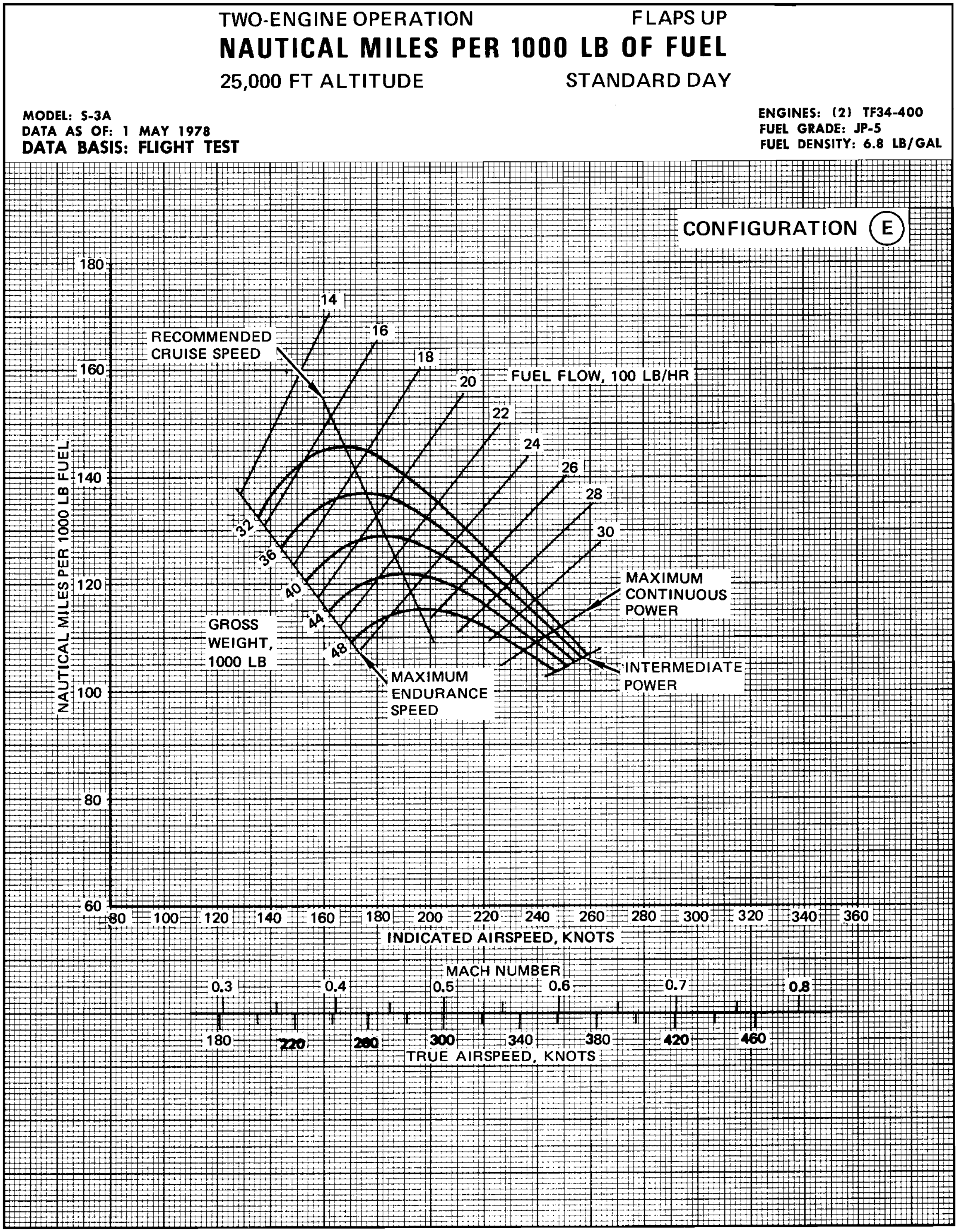


Figure 38-5. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓔ (Sheet 4)

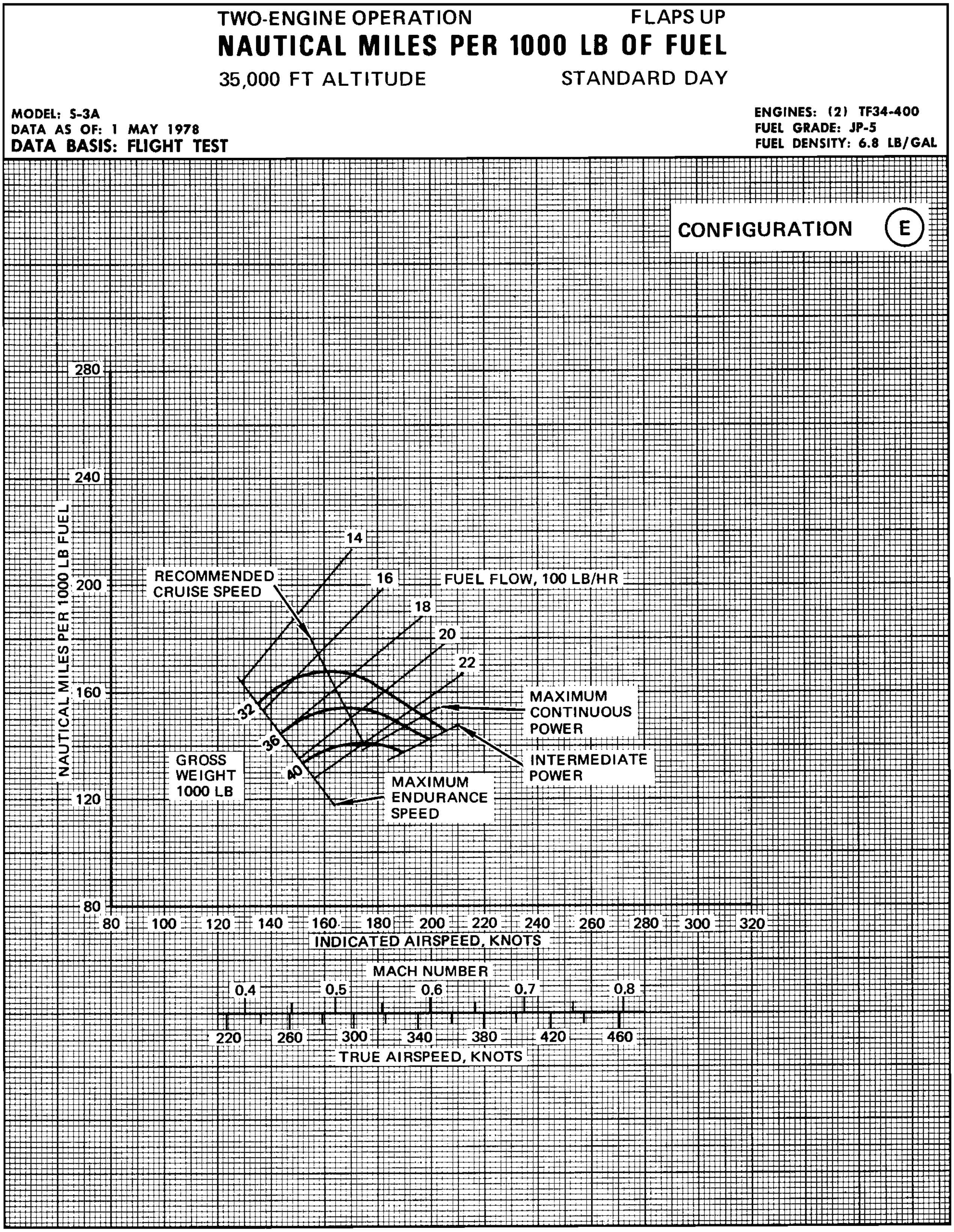


Figure 38-5. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Flaps Up — Configuration Ⓔ (Sheet 5)

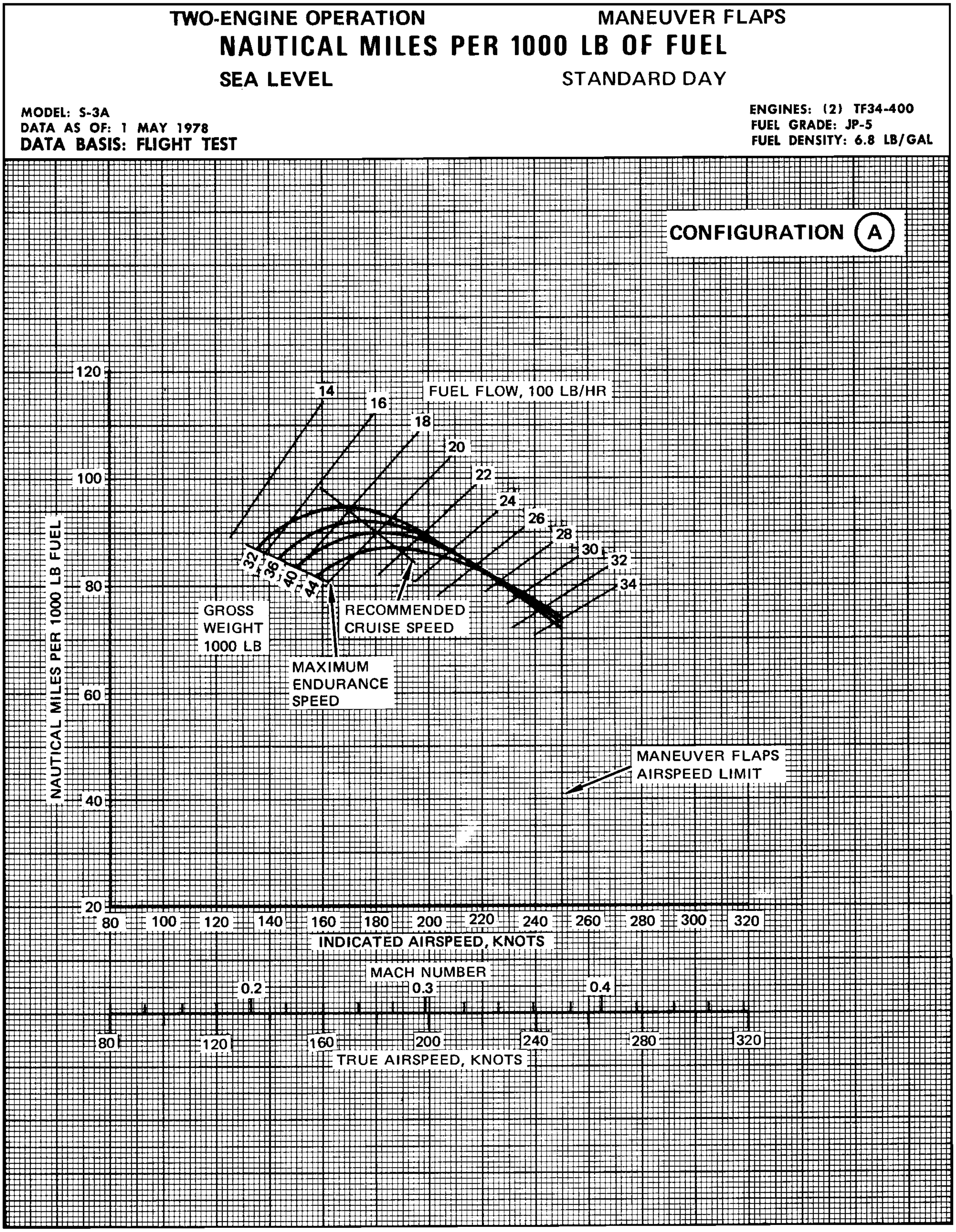


Figure 38-6. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓐ (Sheet 1 of 3)

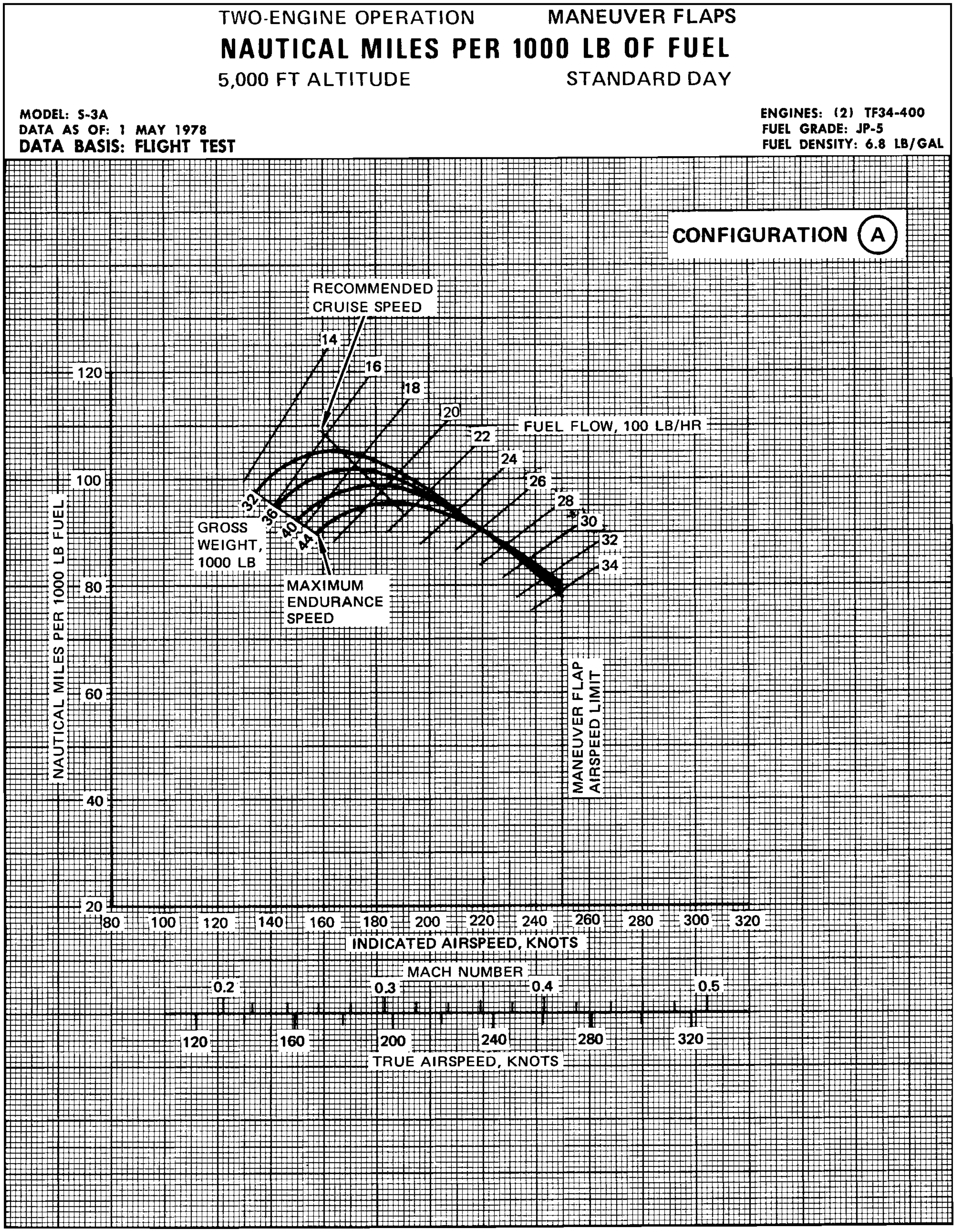


Figure 38-6. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓐ (Sheet 2)

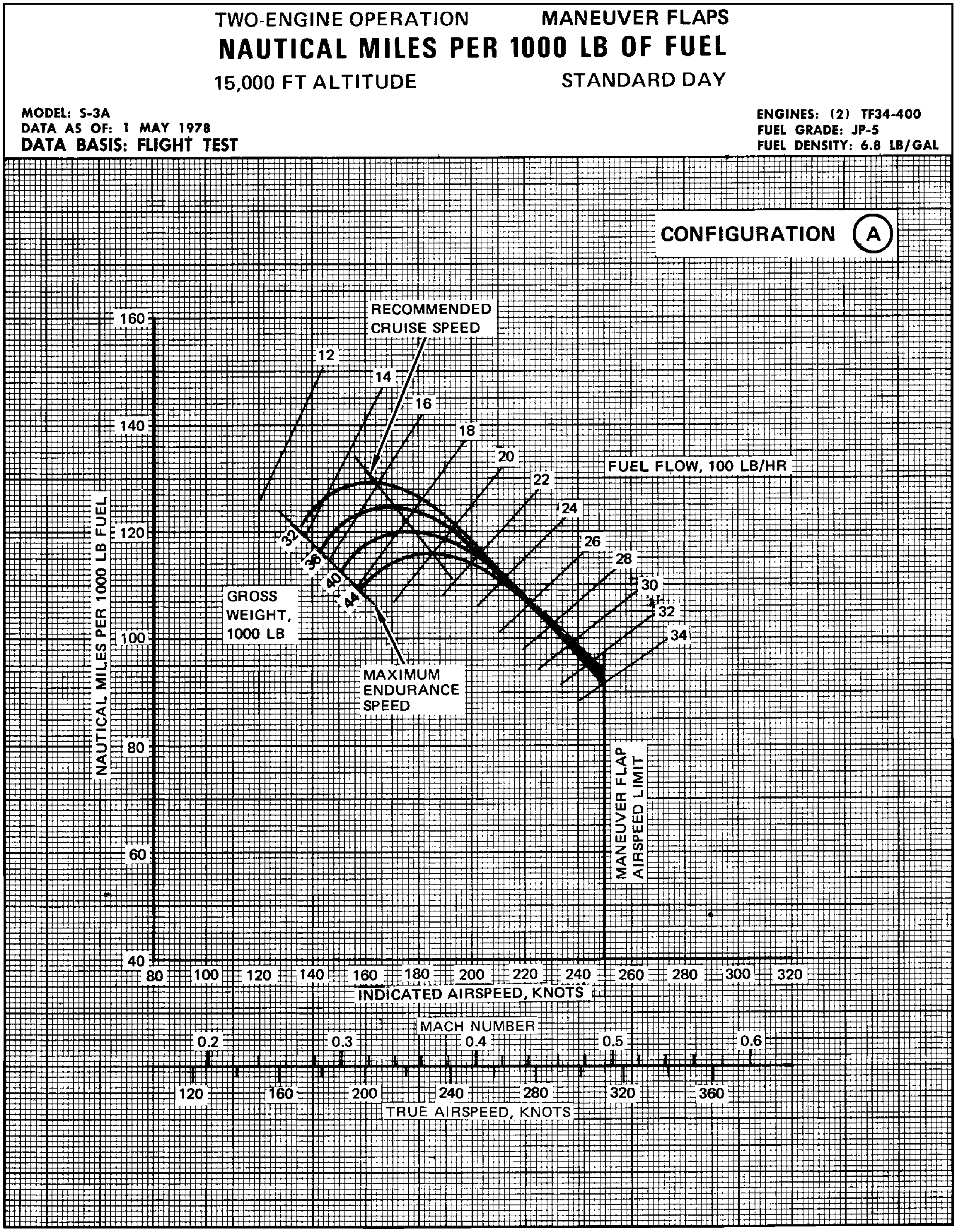


Figure 38-6. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓐ (Sheet 3)

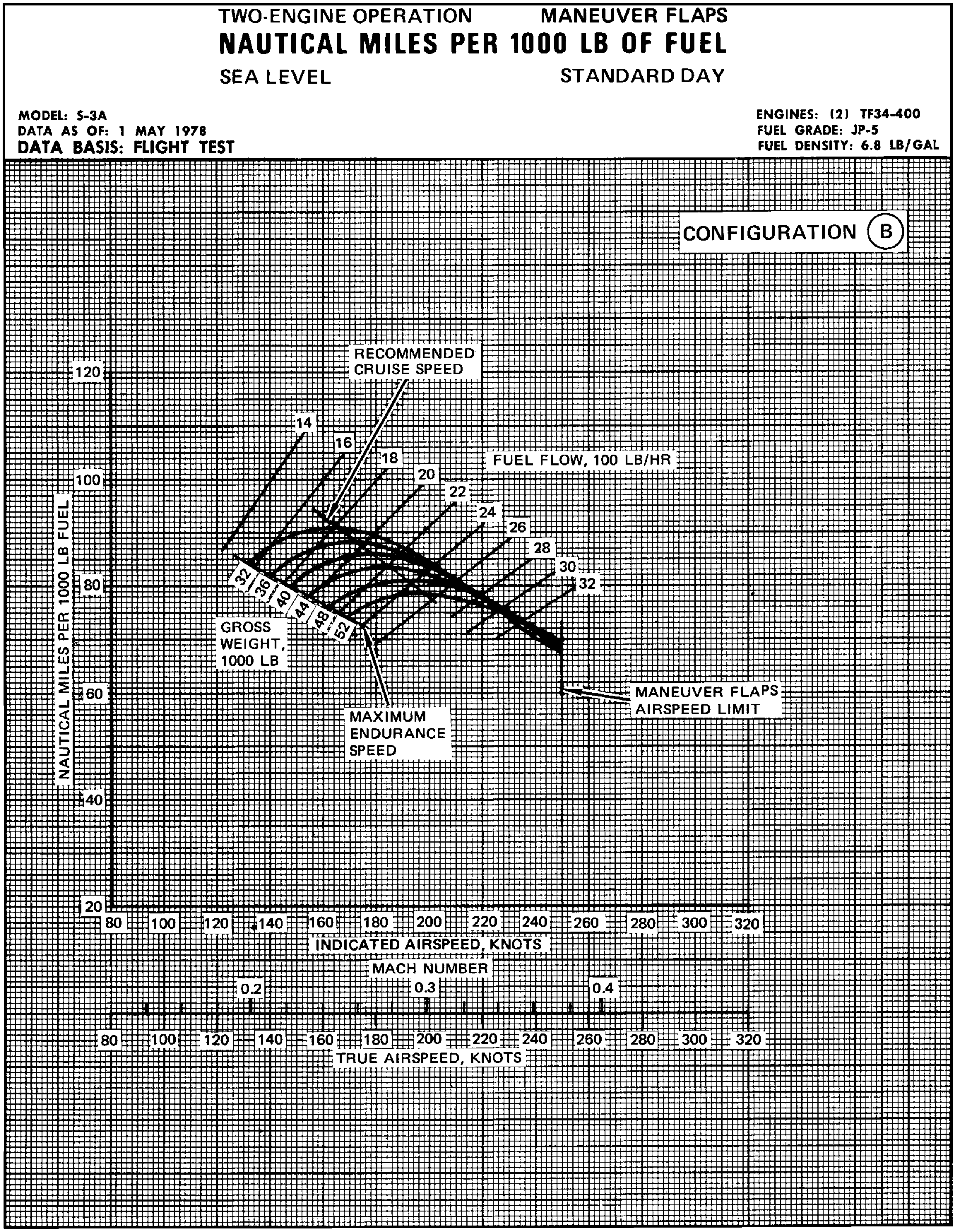


Figure 38-7. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓑ (Sheet 1 of 3)

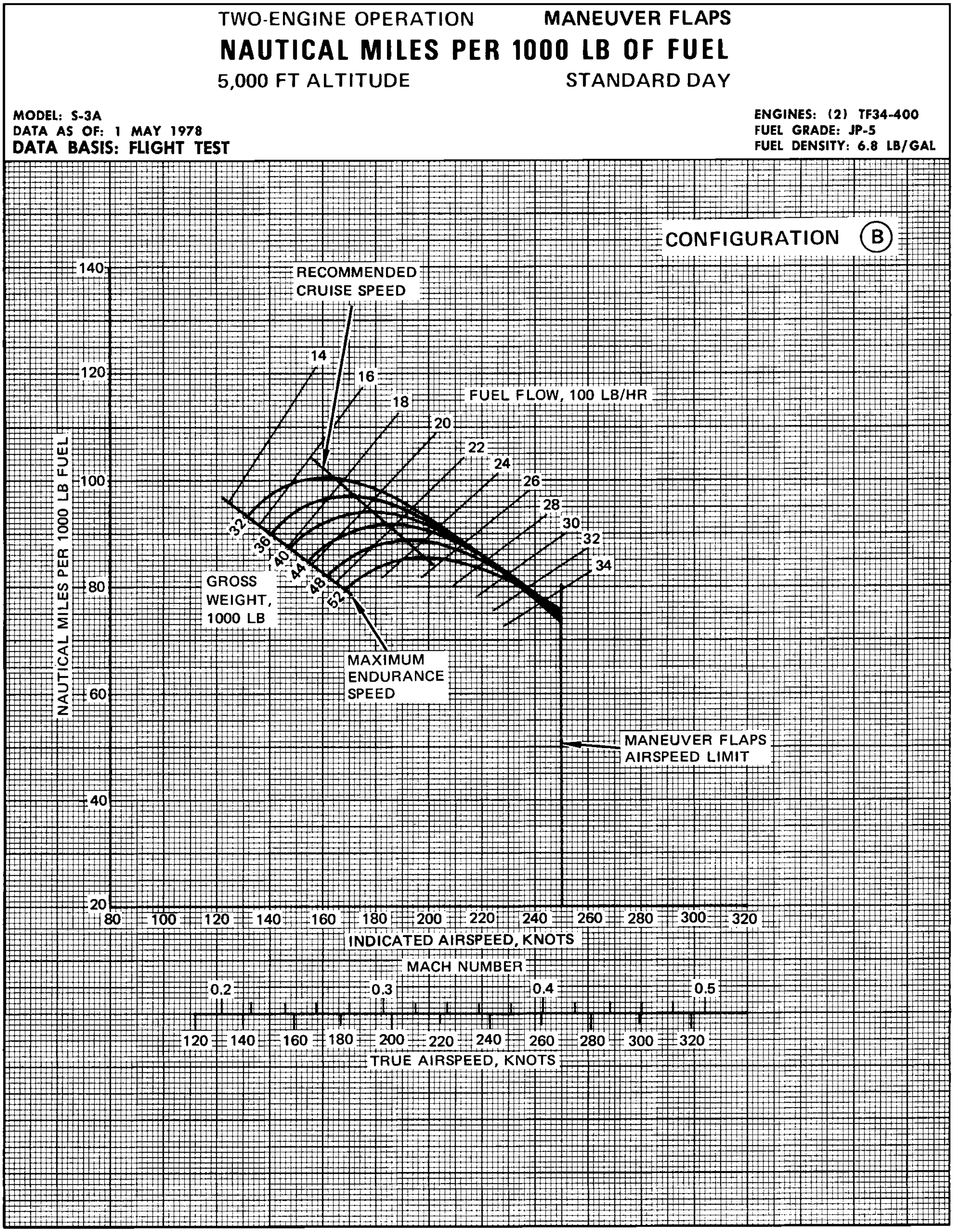


Figure 38-7. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration (B) (Sheet 2)

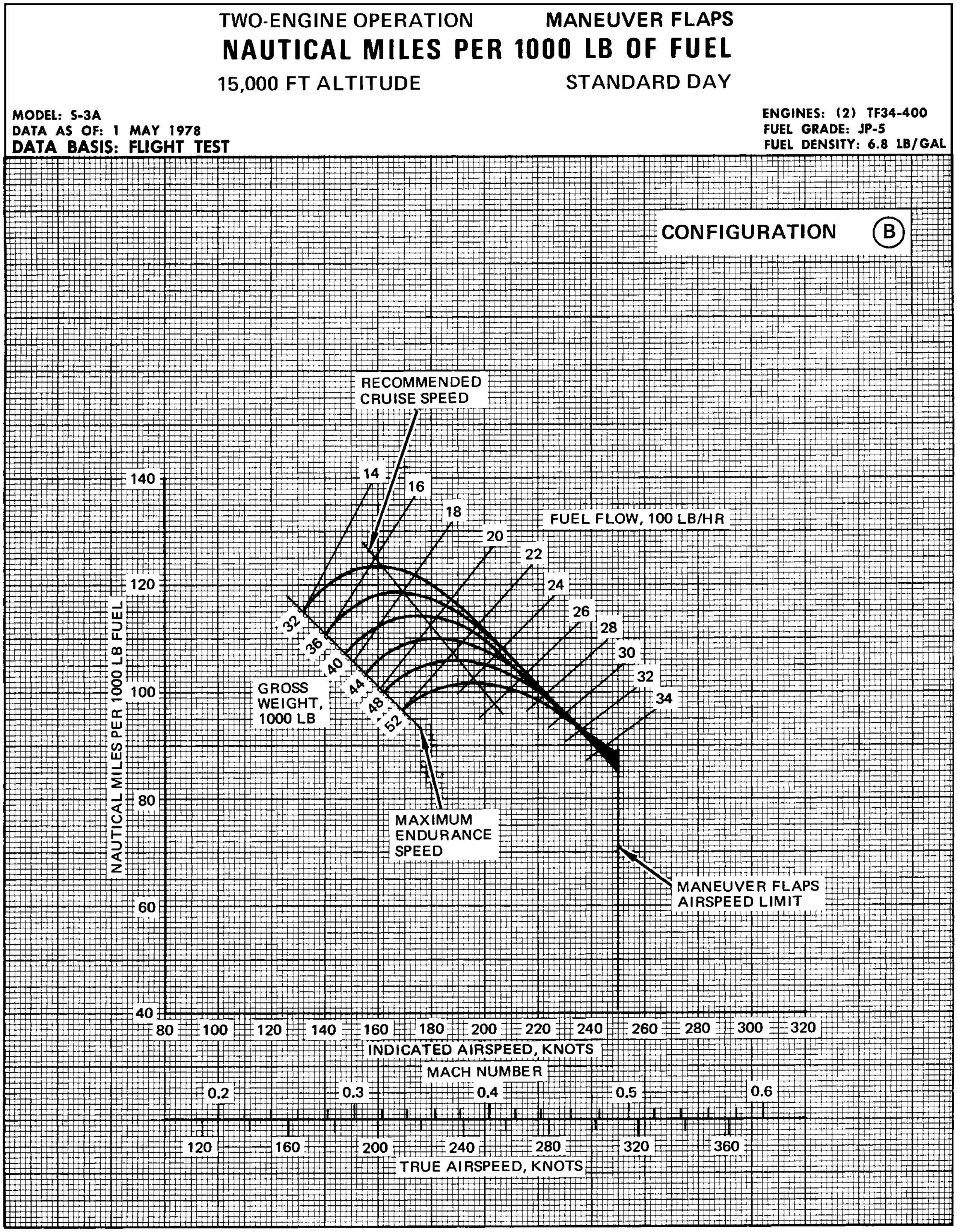


Figure 38-7. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓑ (Sheet 3)

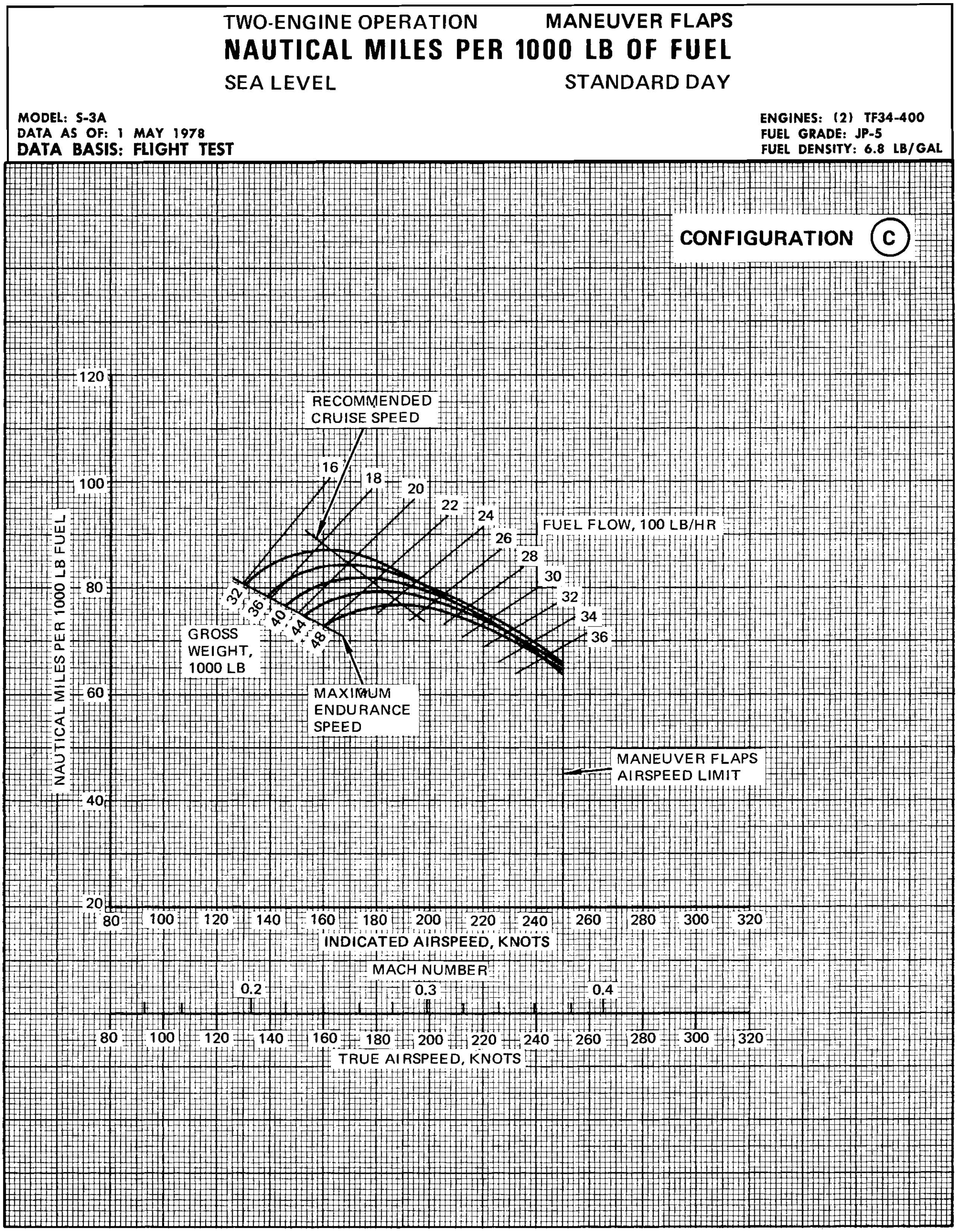


Figure 38-8. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓒ (Sheet 1 of 3)

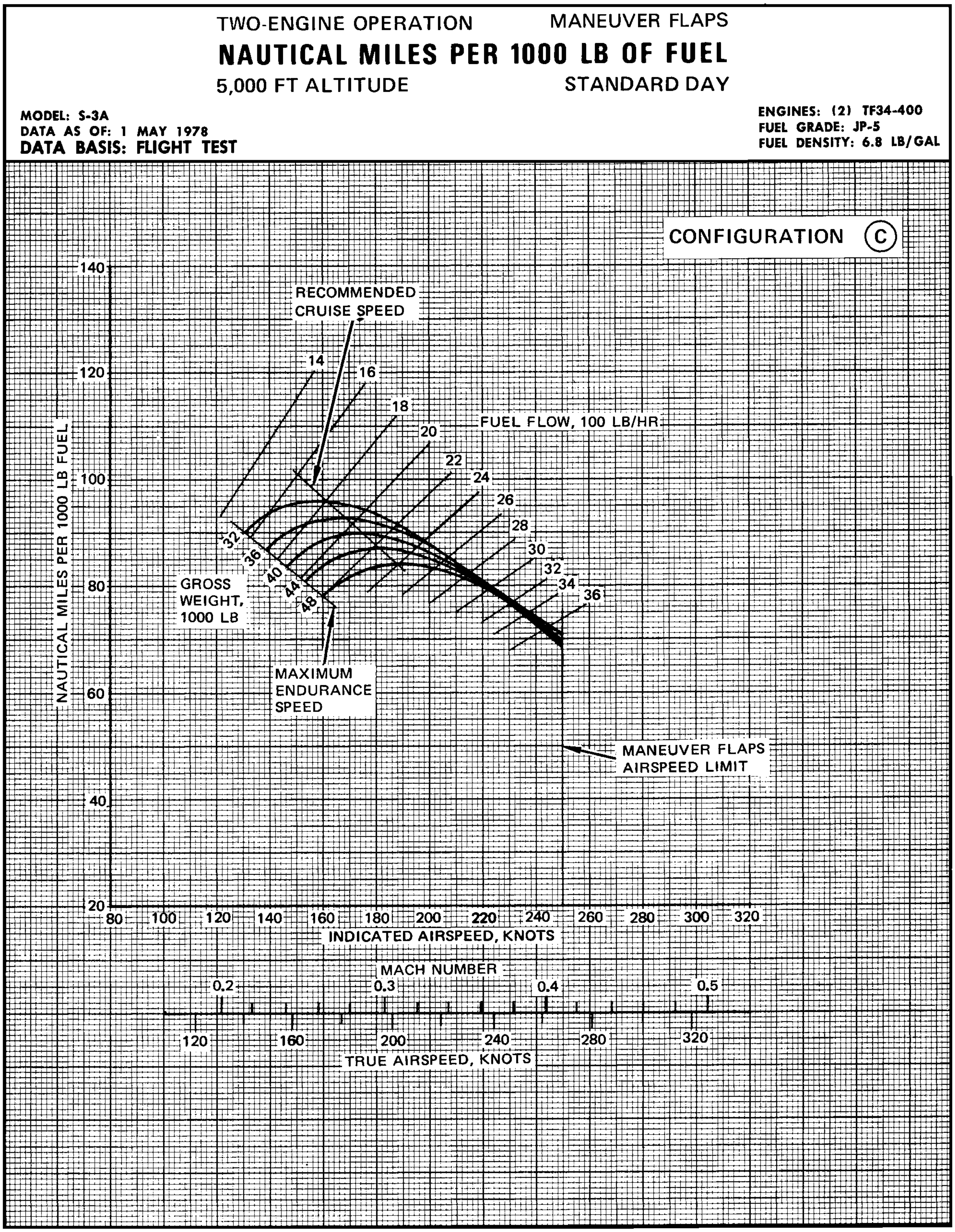


Figure 38-8. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓒ (Sheet 2)

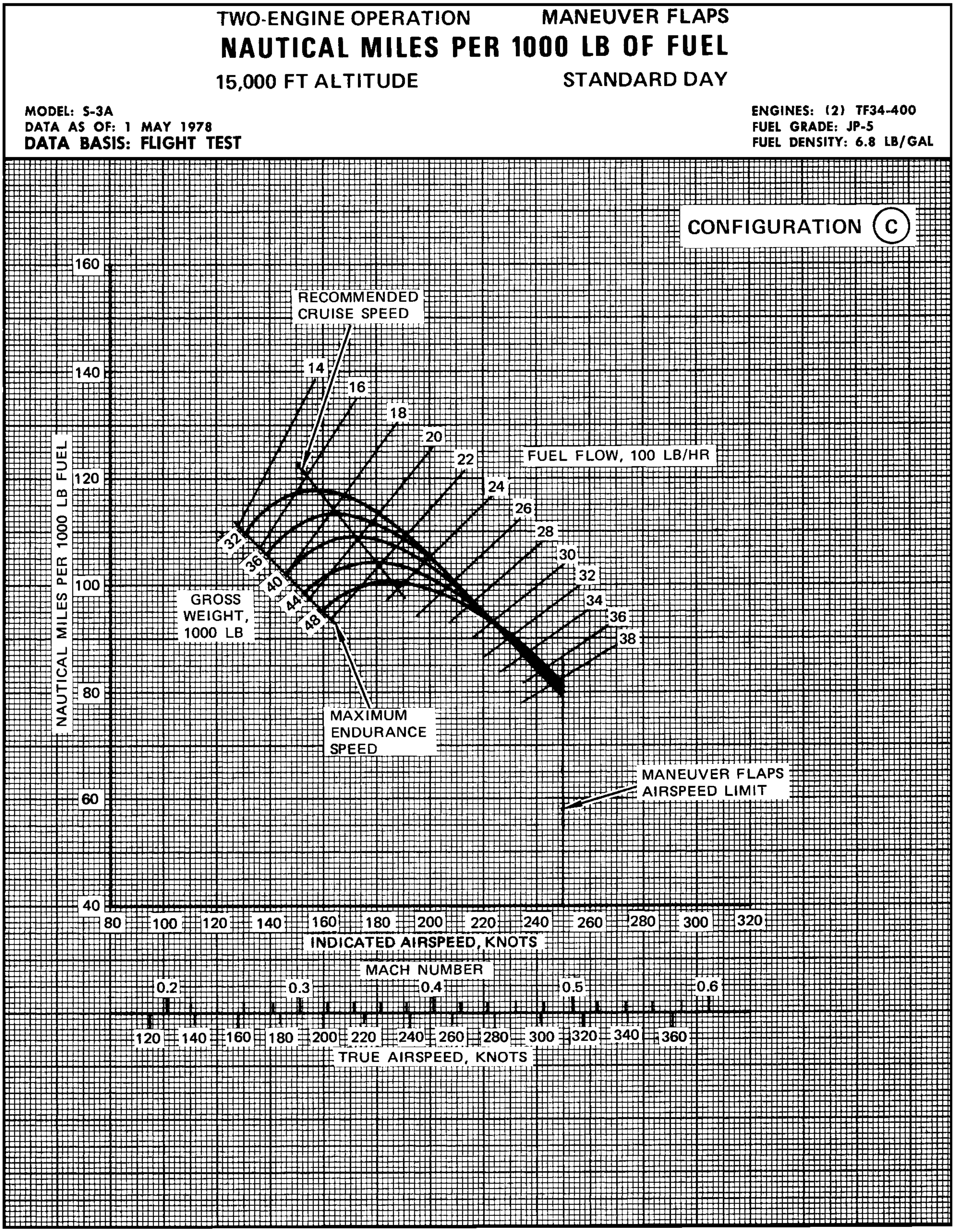


Figure 38-8. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓒ (Sheet 3)

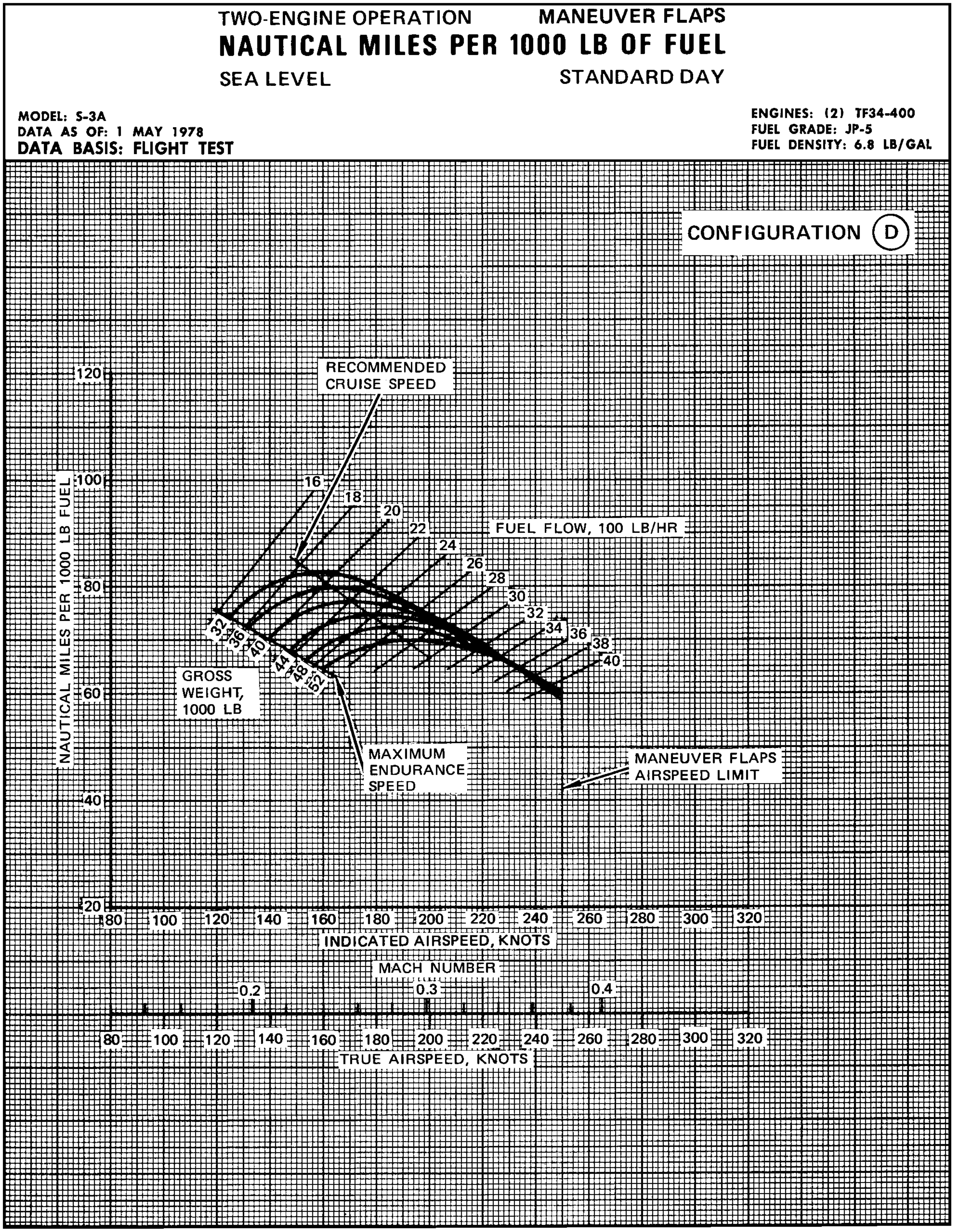


Figure 38-9. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓓ (Sheet 1 of 3)

TWO-ENGINE OPERATION MANEUVER FLAPS

NAUTICAL MILES PER 1000 LB OF FUEL

5,000 FT ALTITUDE STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

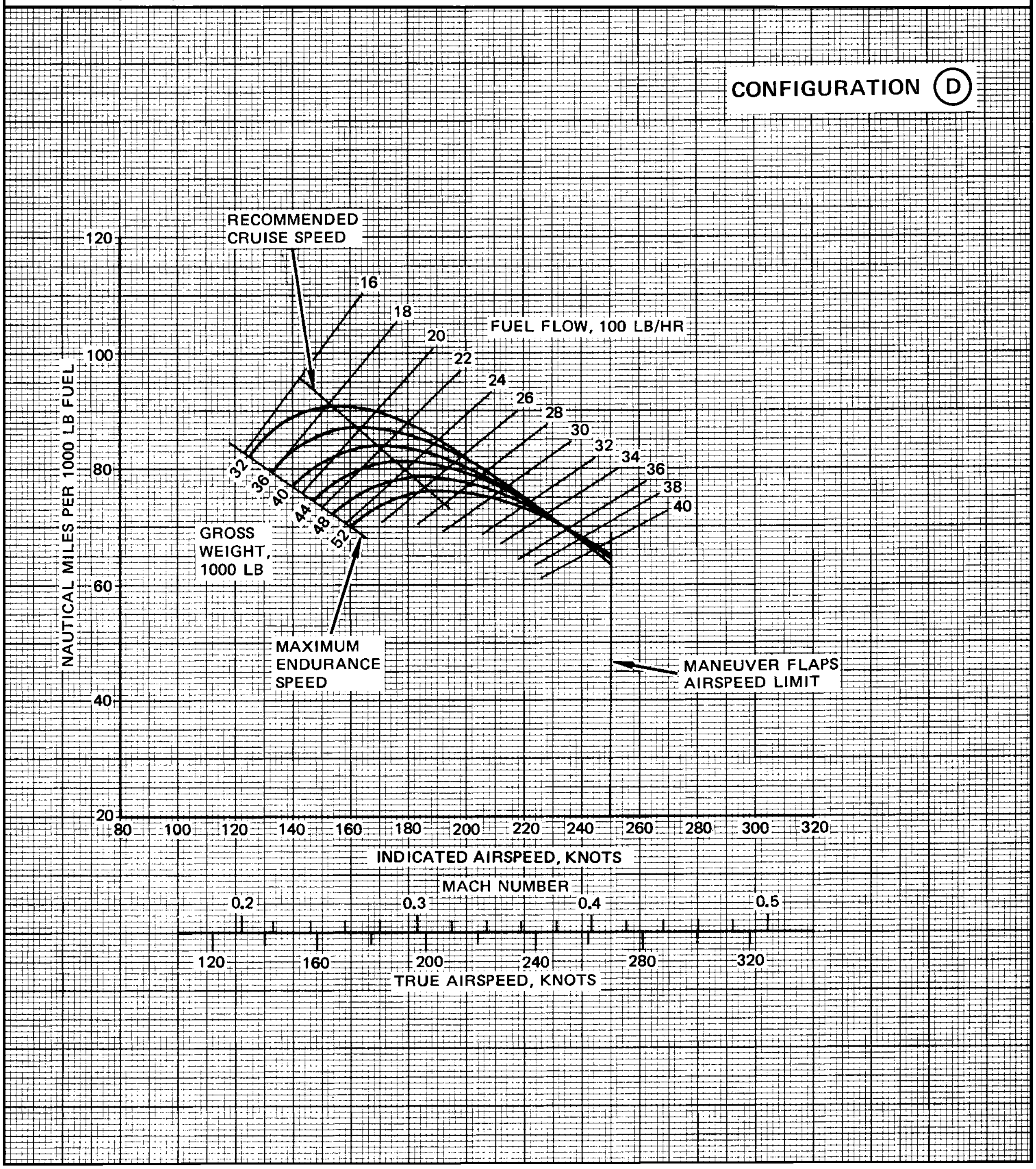


Figure 38-9. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration Ⓓ (Sheet 2)

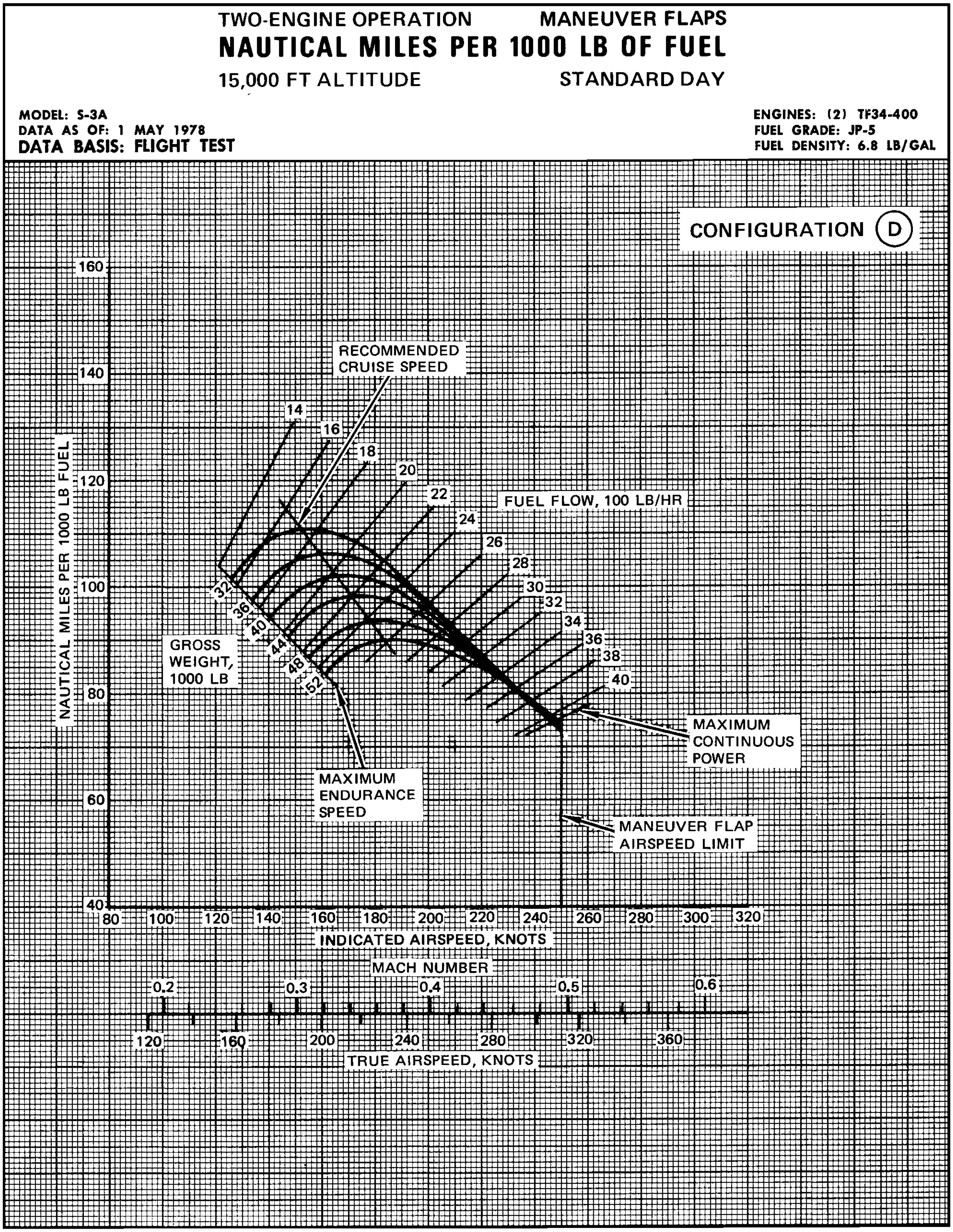


Figure 38-9. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration D (Sheet 3)

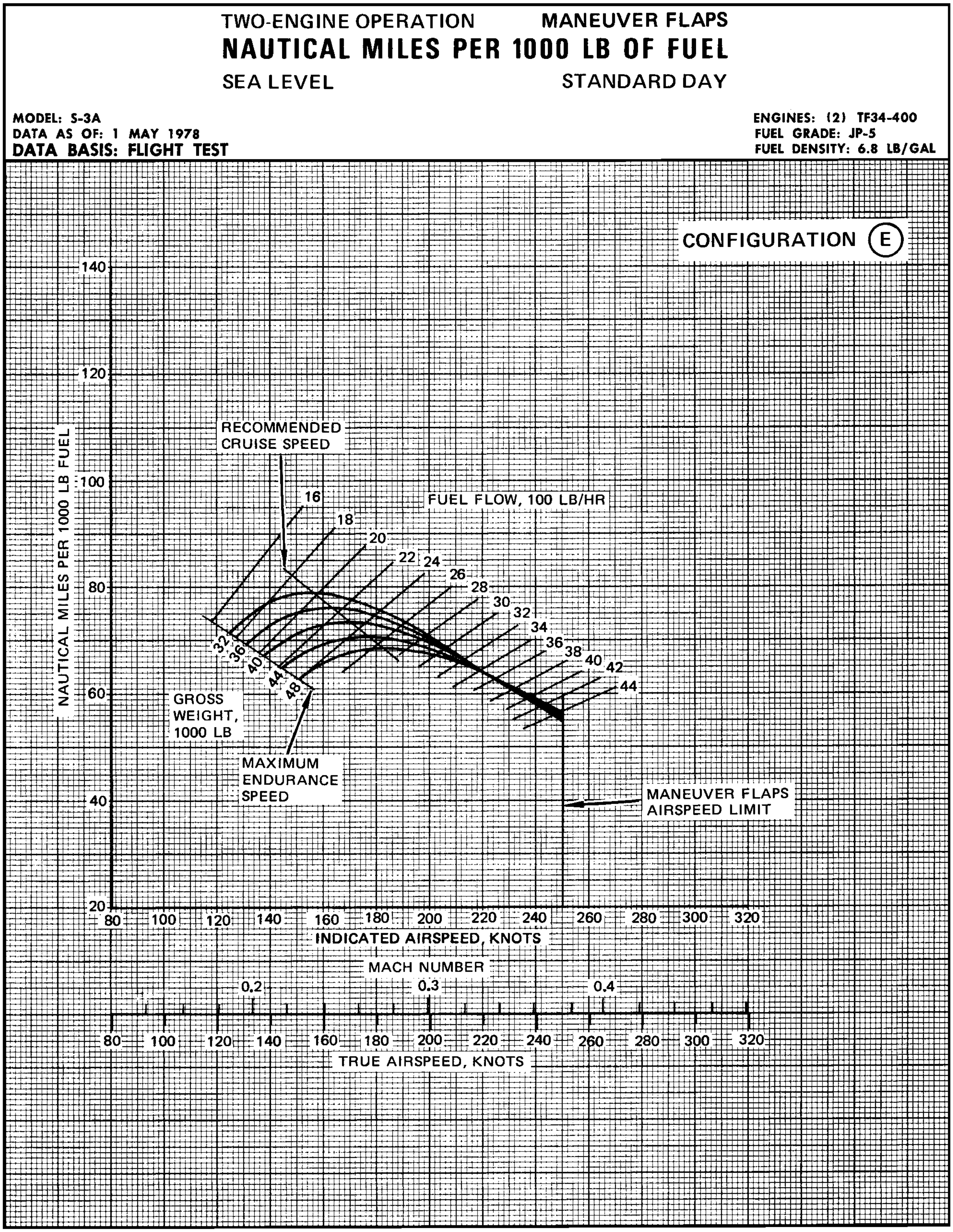


Figure 38-10. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration (E) (Sheet 1 of 3)

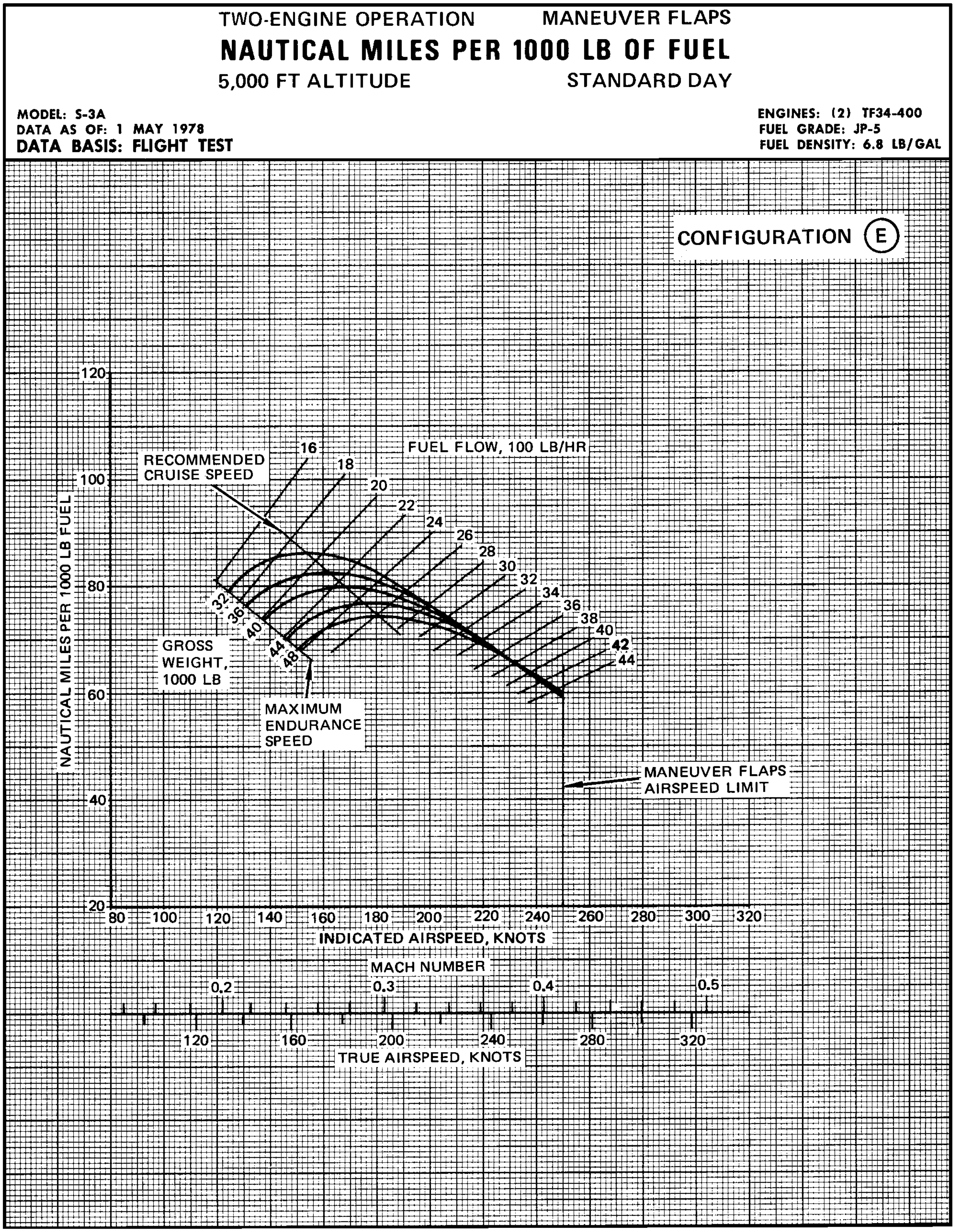


Figure 38-10. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration (E) (Sheet 2)

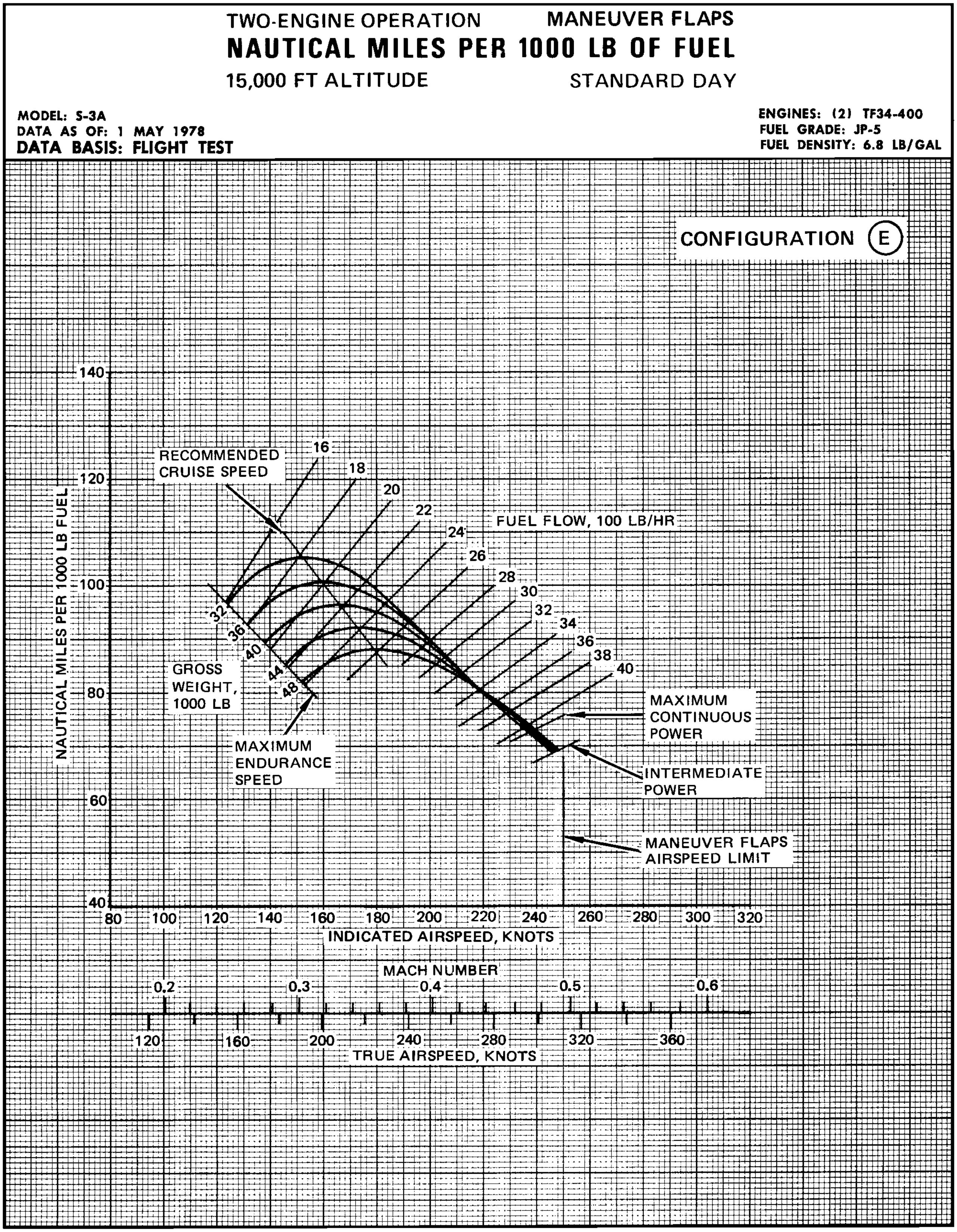


Figure 38-10. Nautical Miles Per 1,000 Pounds of Fuel — Two-Engine Operation — Maneuver Flaps — Configuration (E) (Sheet 3)

SINGLE-ENGINE OPERATION FLAPS UP

NAUTICAL MILES PER 1000 LB OF FUEL

SEA LEVEL STANDARD DAY

MODEL: S-3A
DATA AS OF: 1 MAY 1978
DATA BASIS: FLIGHT TEST

ENGINES: (2) TF34-400
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

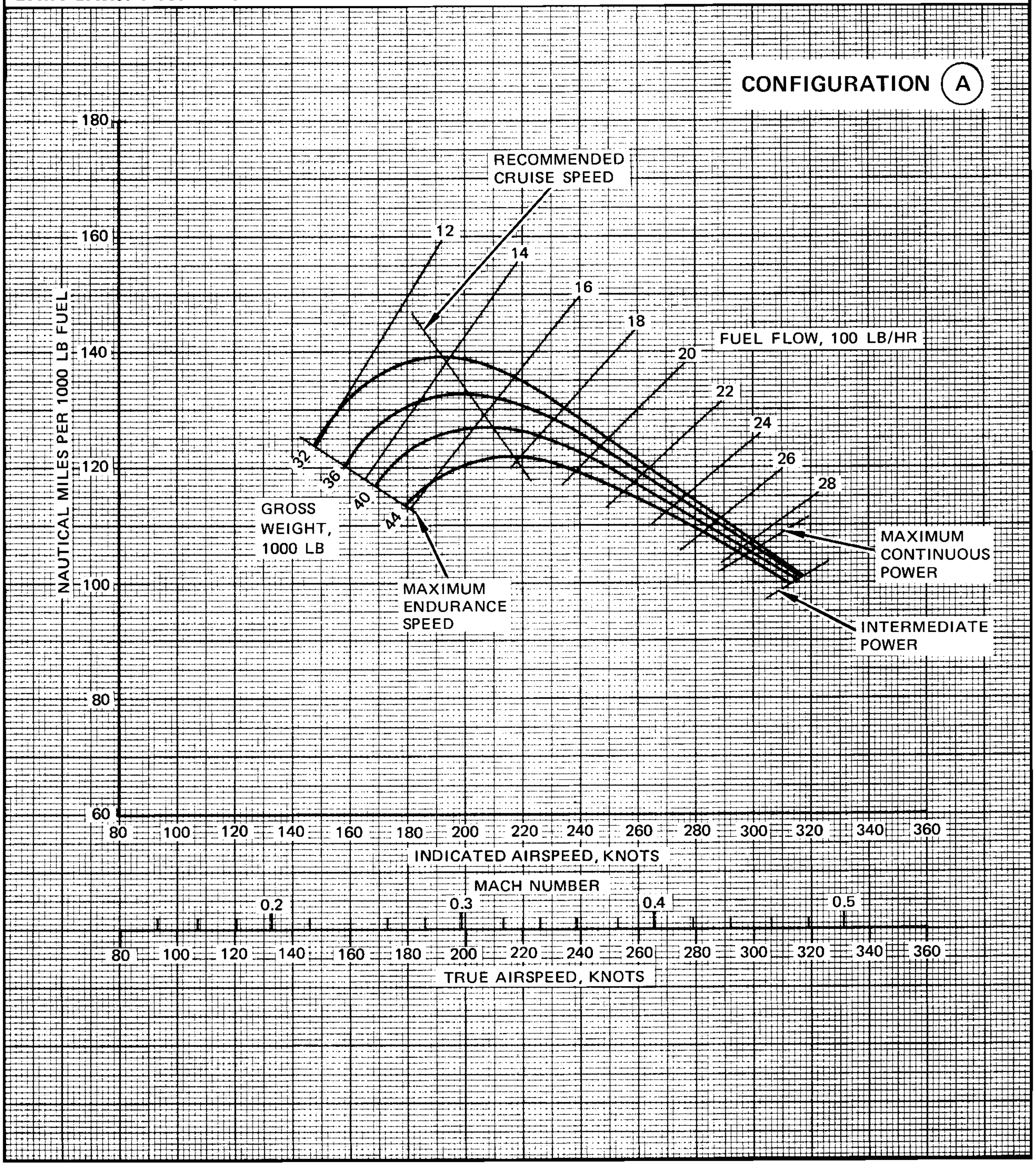


Figure 38-11. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (A) (Sheet 1 of 4)

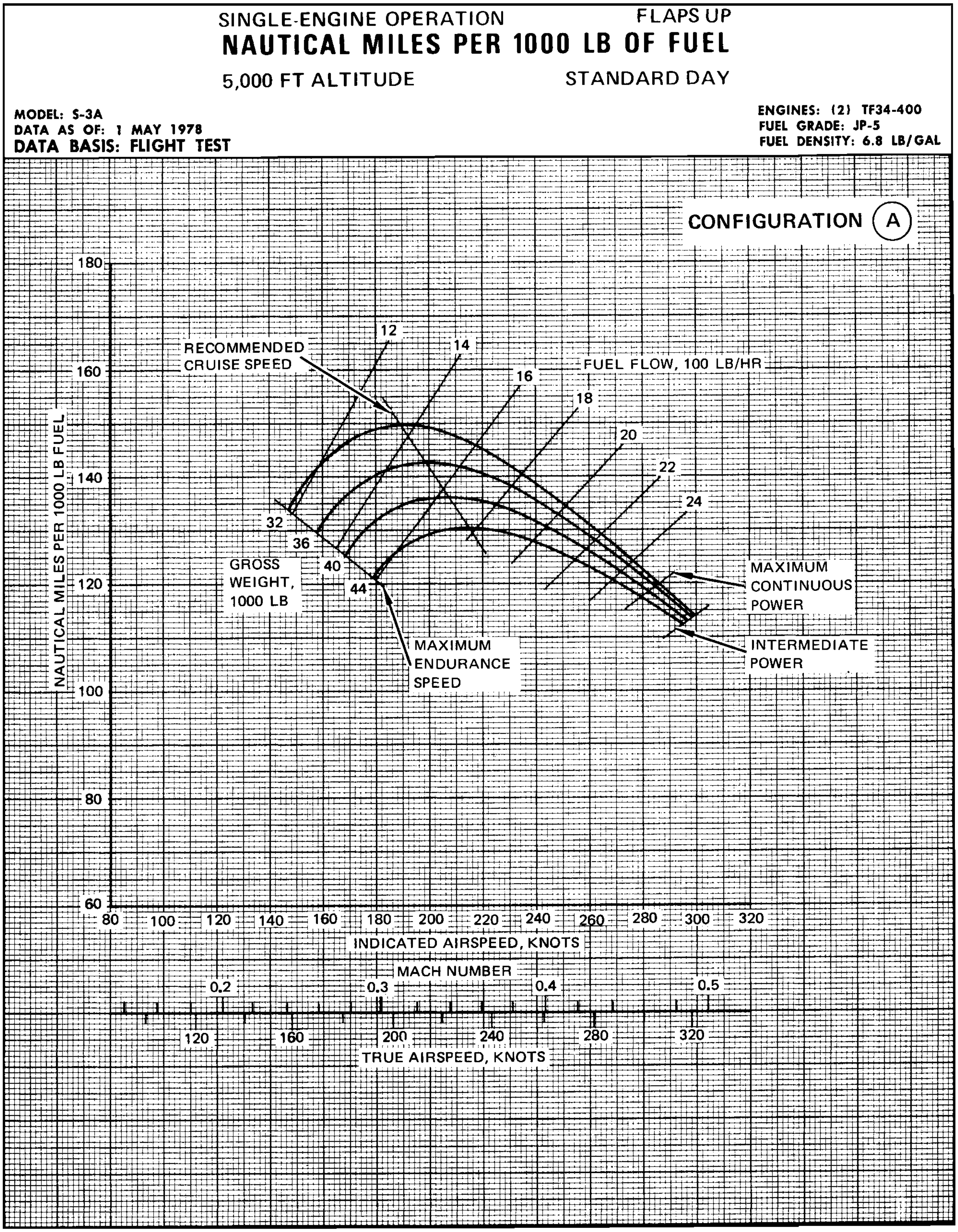


Figure 38-11. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (A) (Sheet 2)

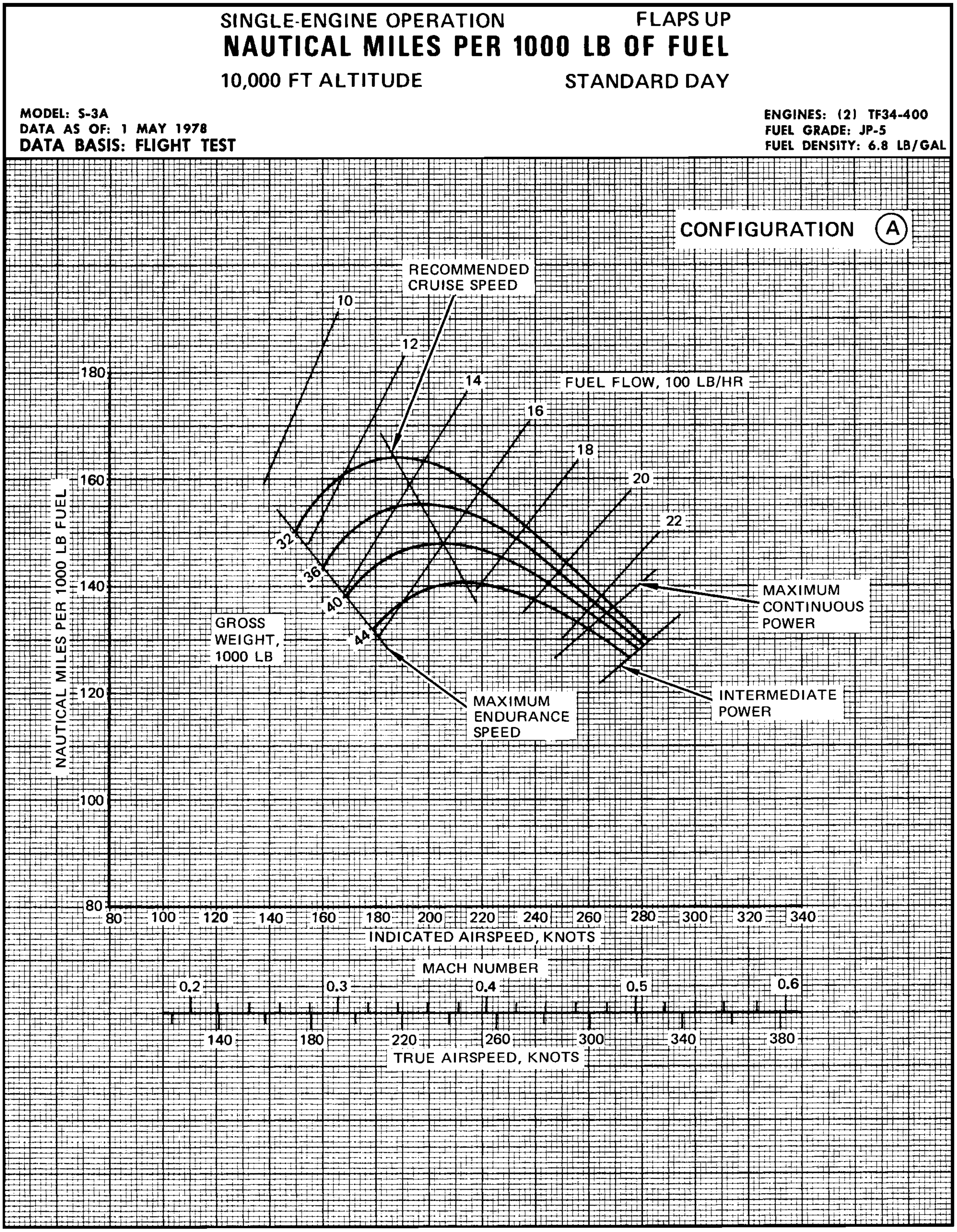


Figure 38-11. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (A) (Sheet 3)

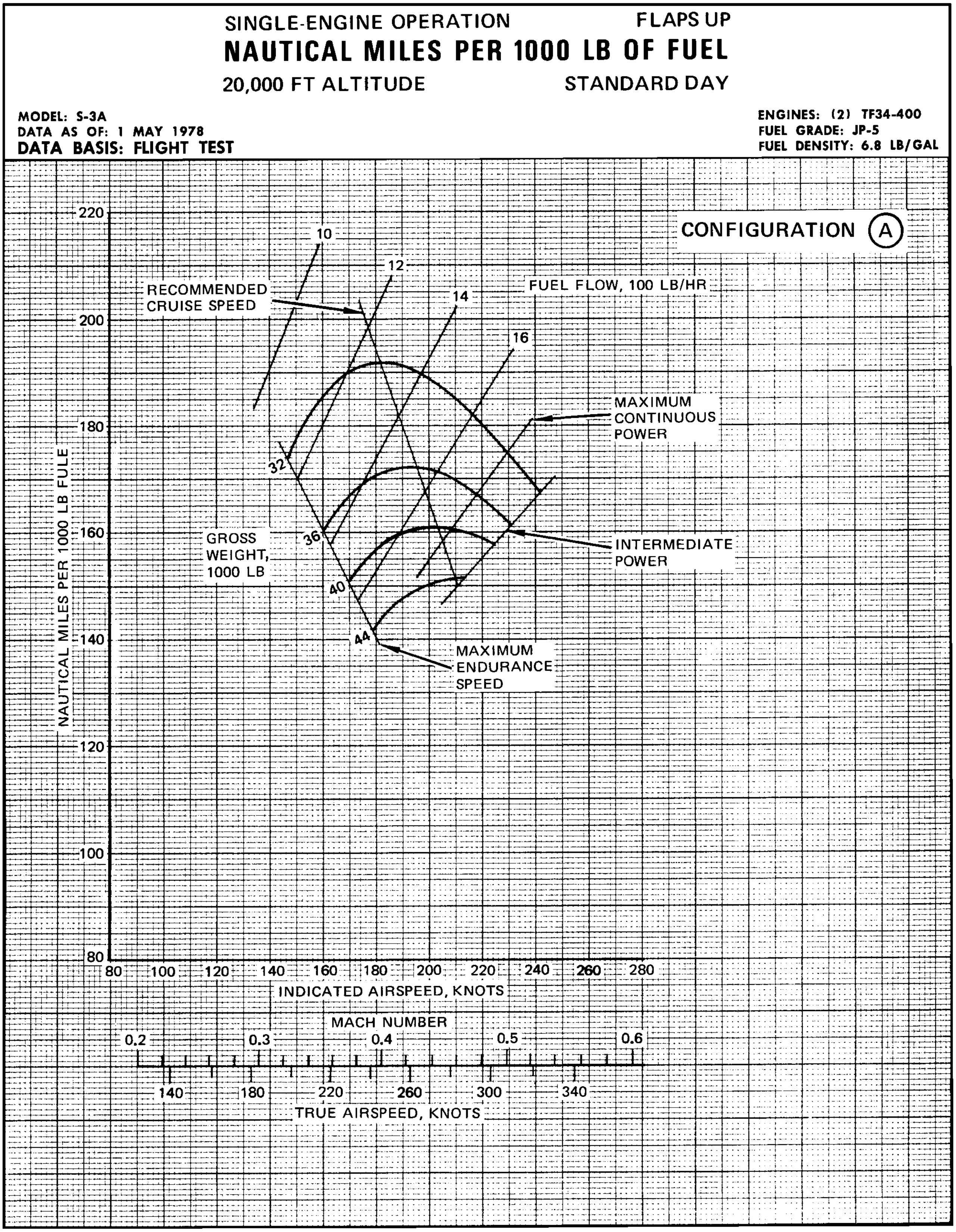


Figure 38-11. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (A) (Sheet 4)

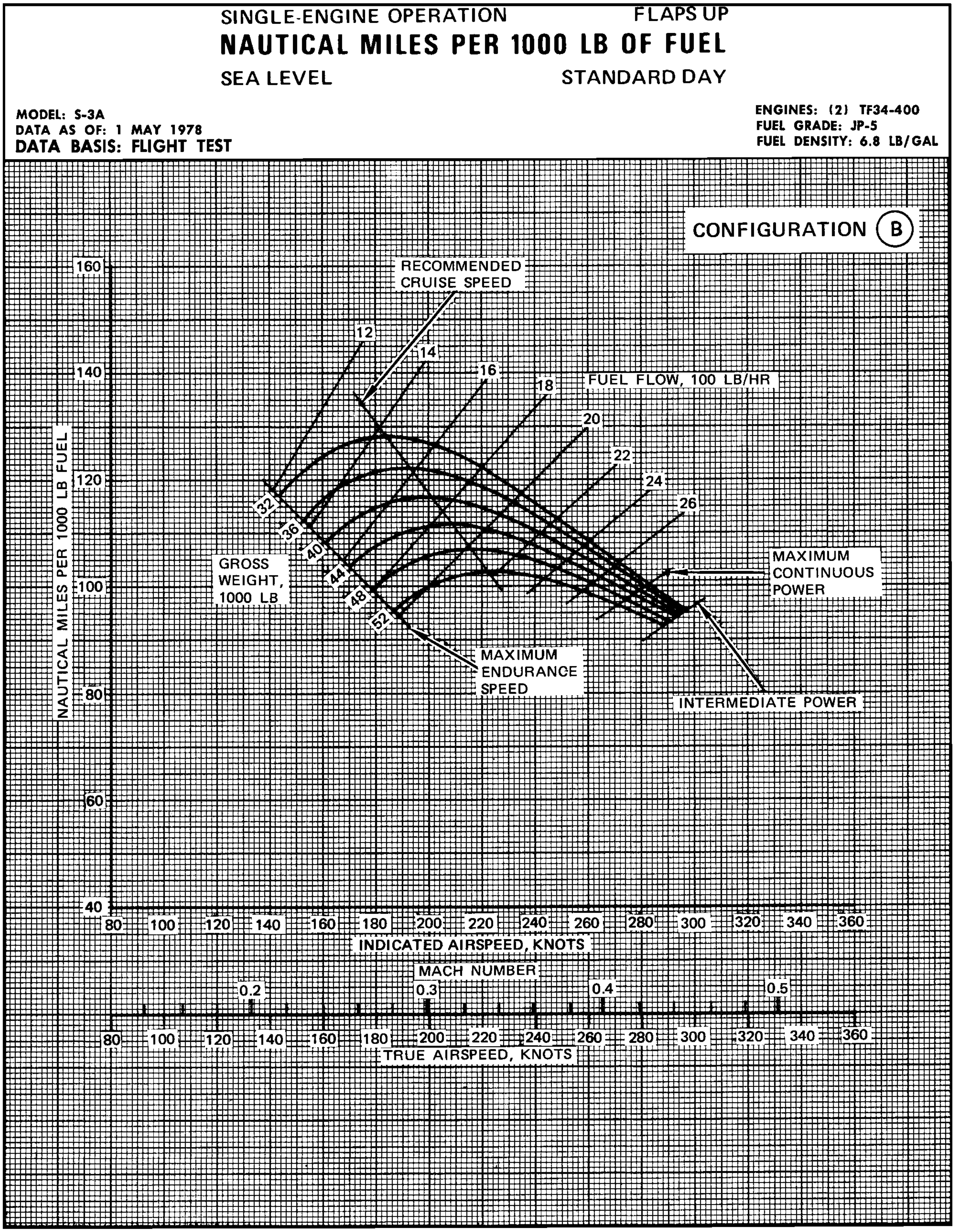


Figure 38-12. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (B) (Sheet 1 of 4)

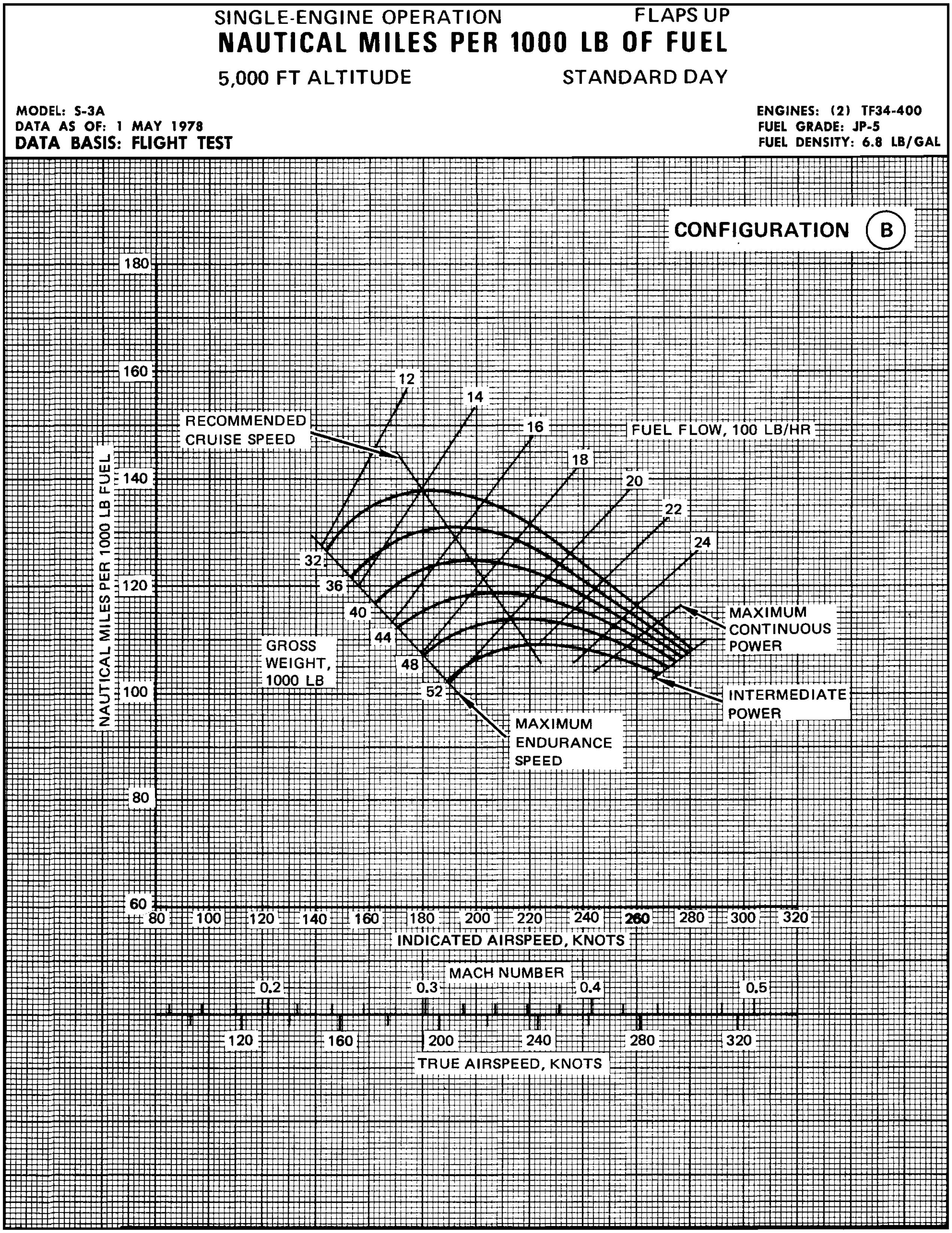


Figure 38-12. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 2)

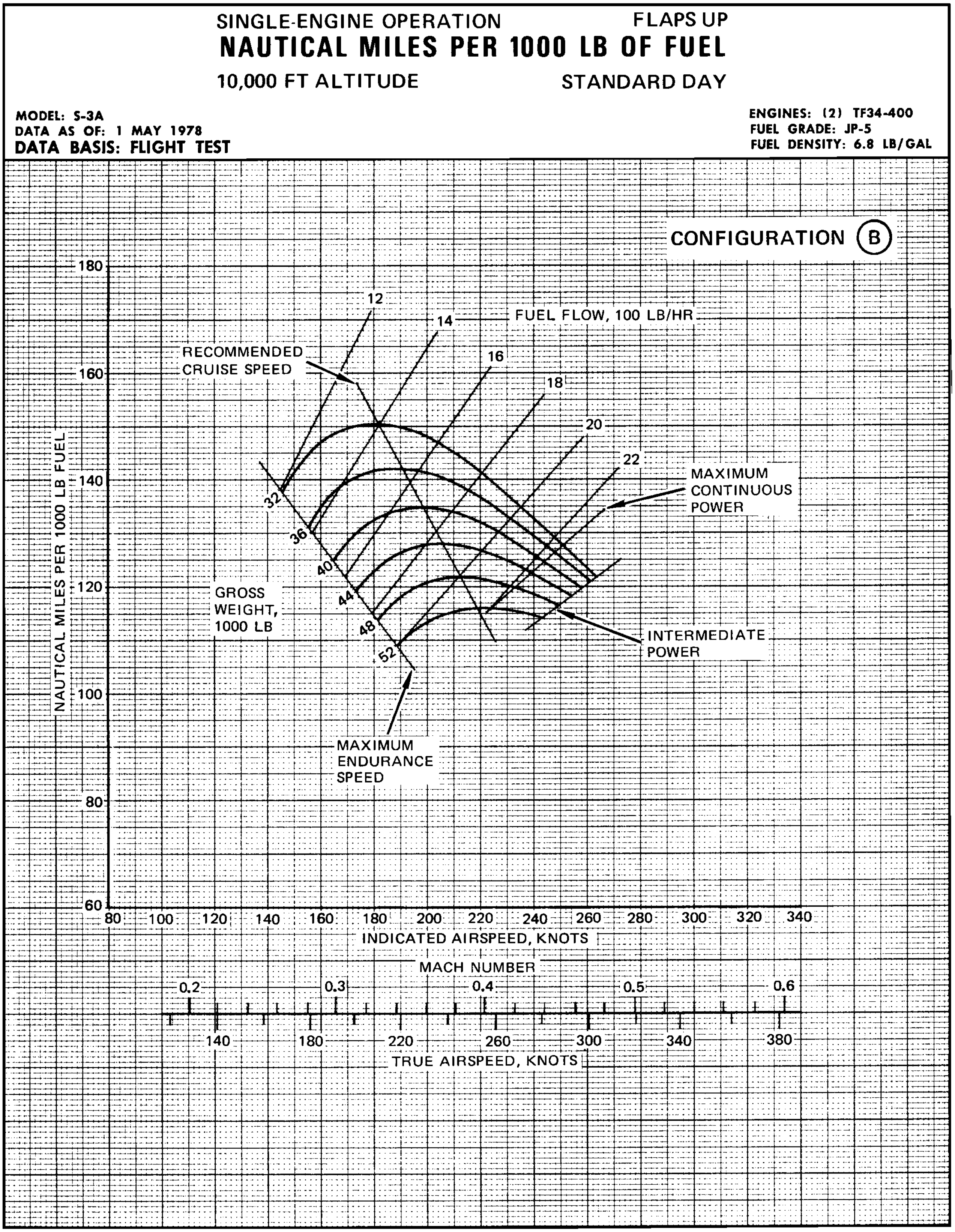


Figure 38-12. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓑ (Sheet 3)

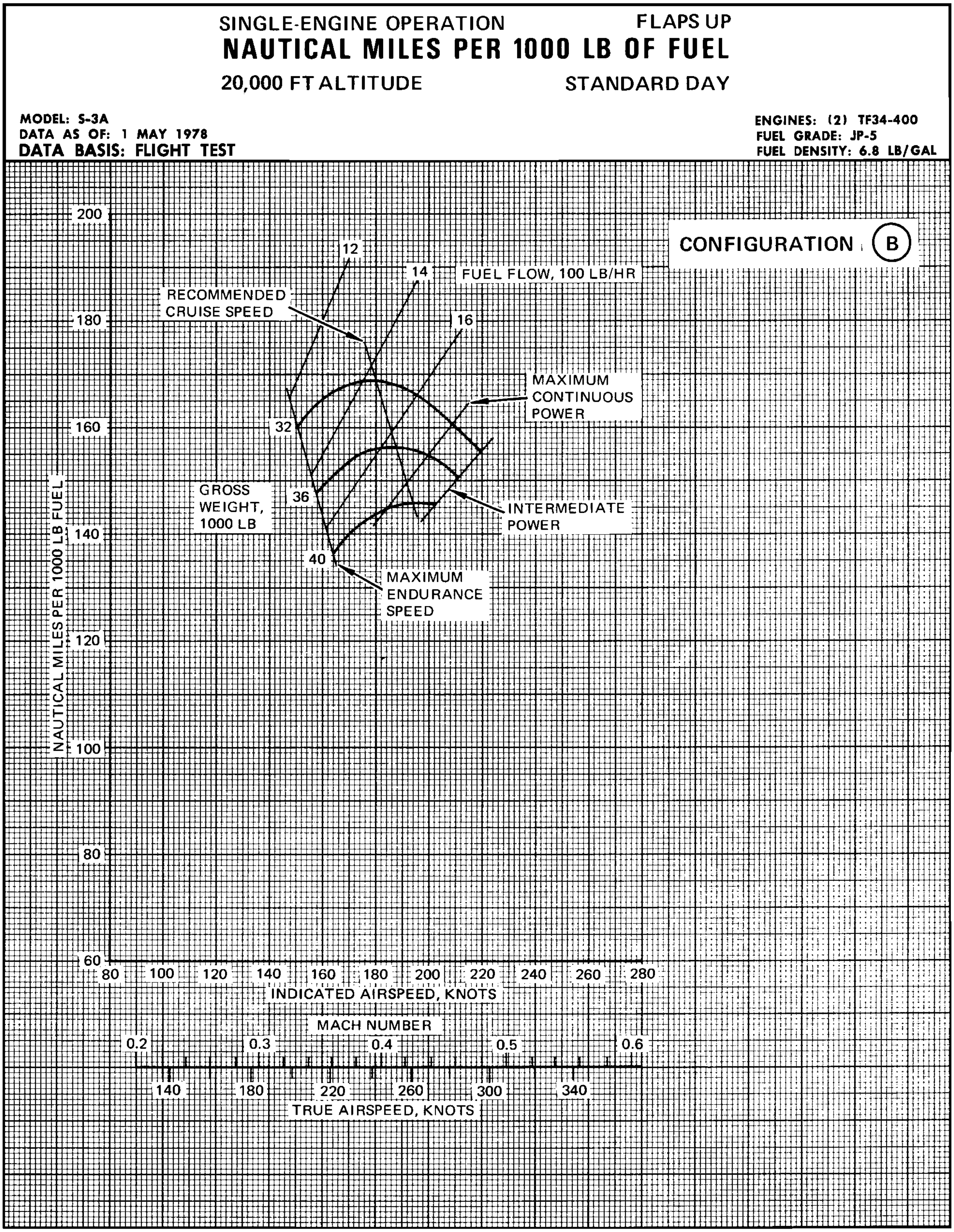


Figure 38-12. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration (B) (Sheet 4)

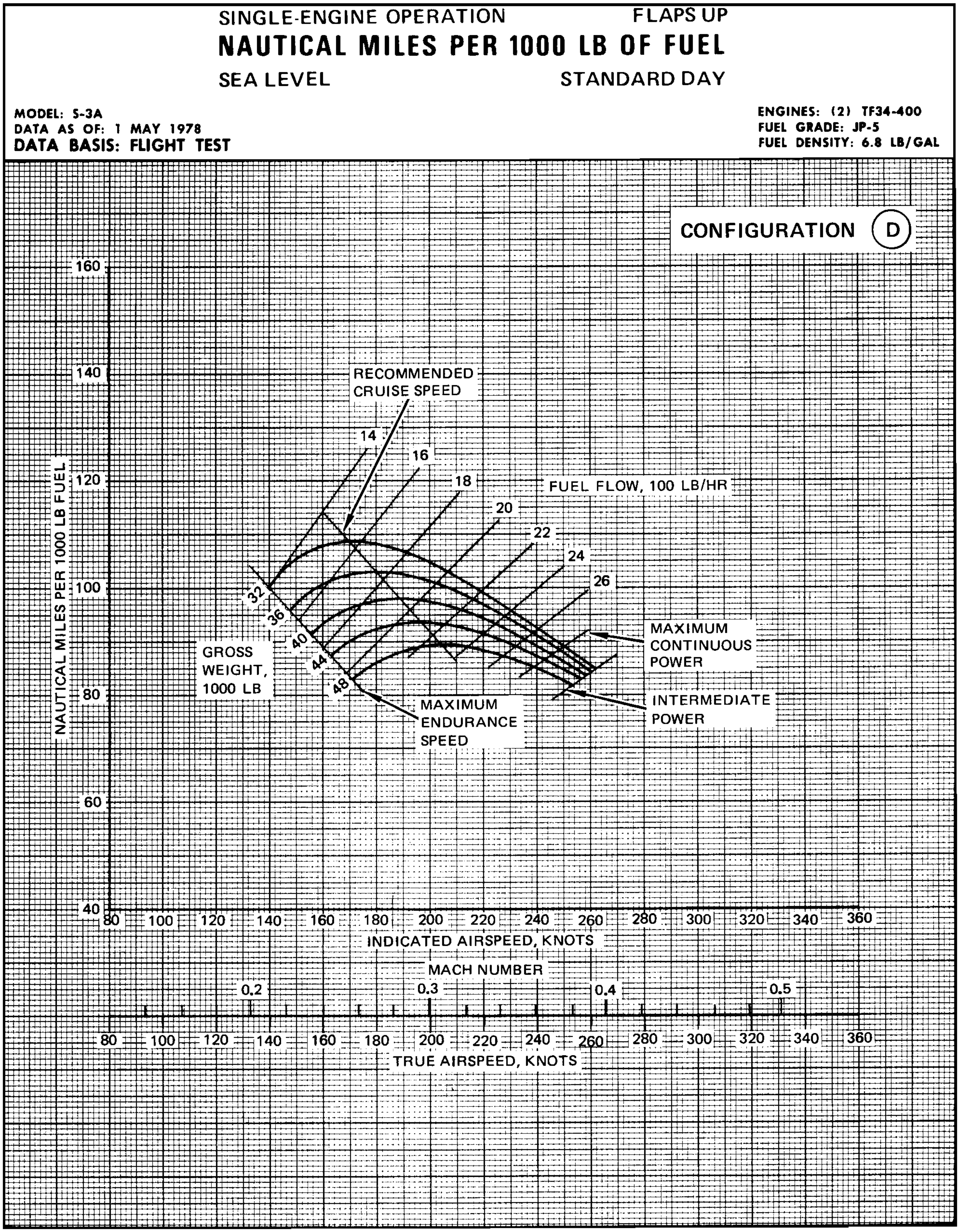


Figure 38-13. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 1 of 4)

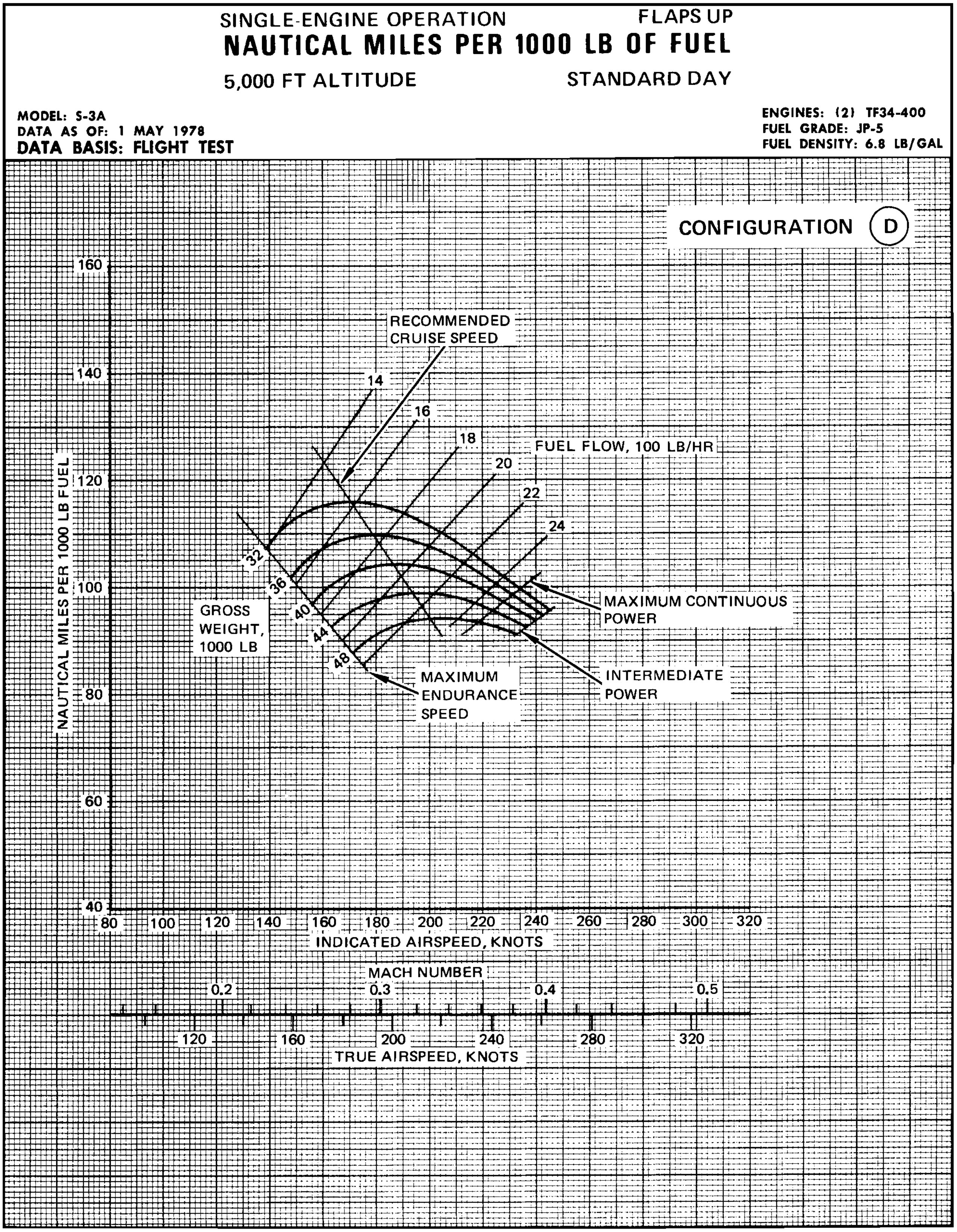


Figure 38-13. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 2)

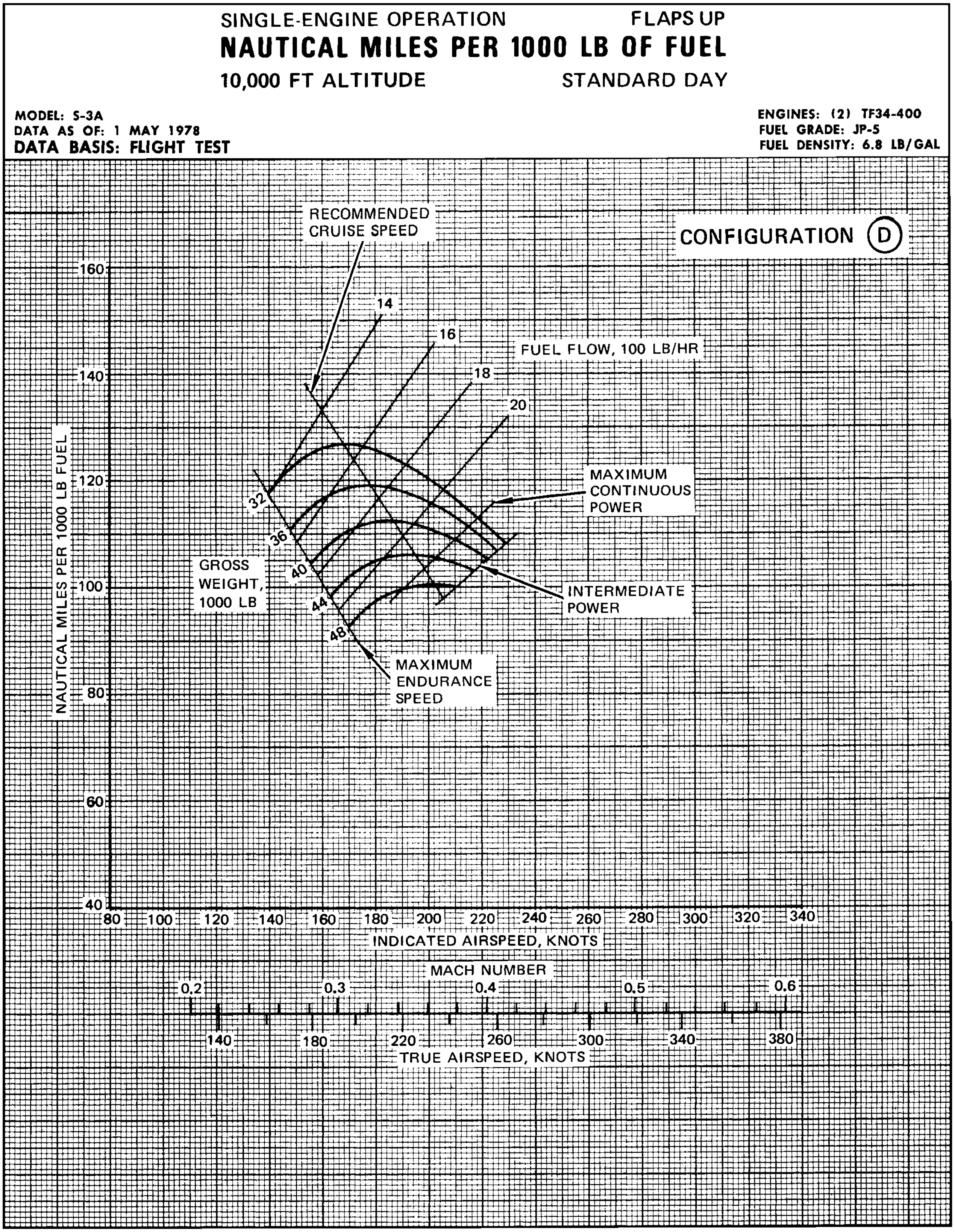


Figure 38-13. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 3)

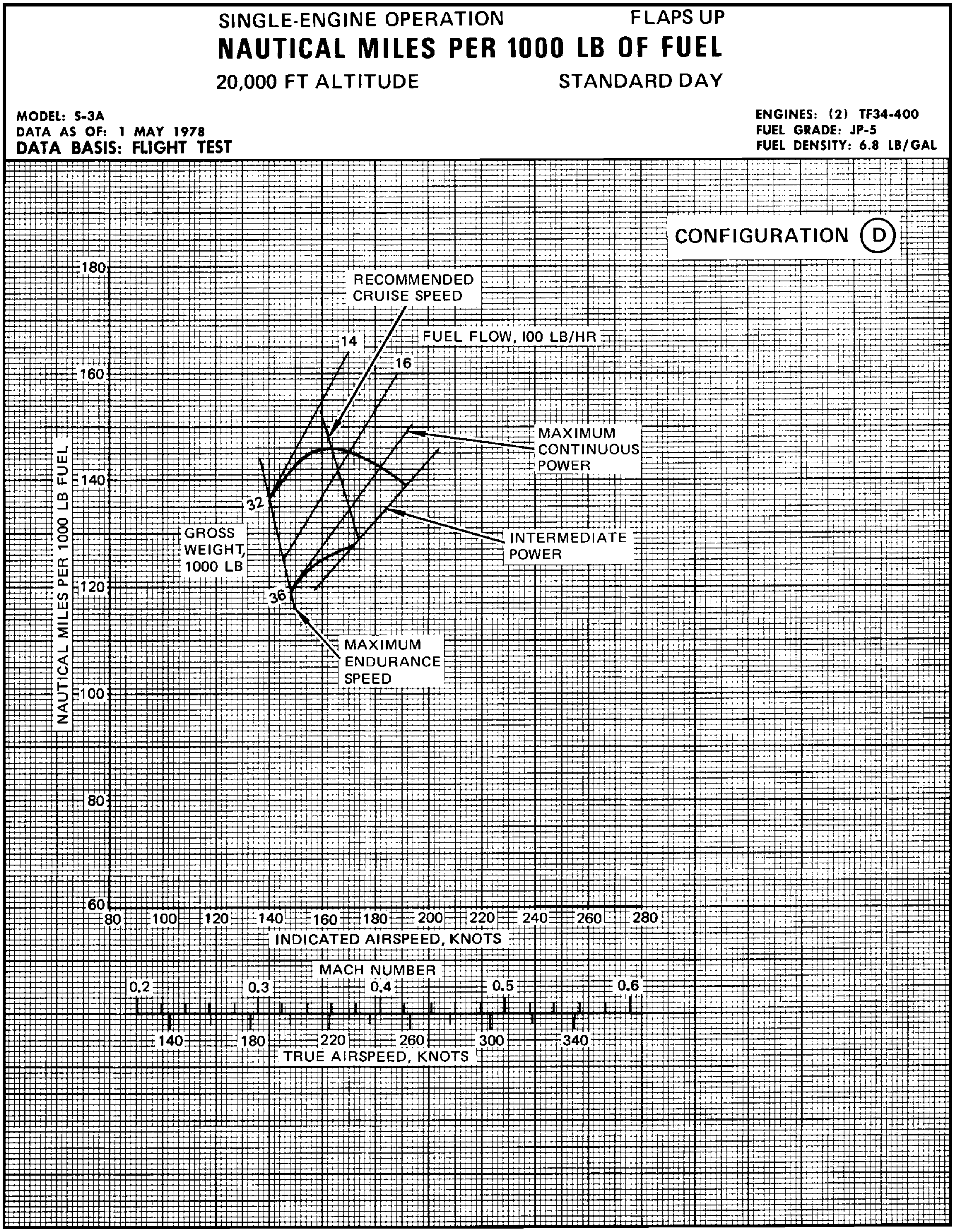


Figure 38-13. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Configuration Ⓓ (Sheet 4)

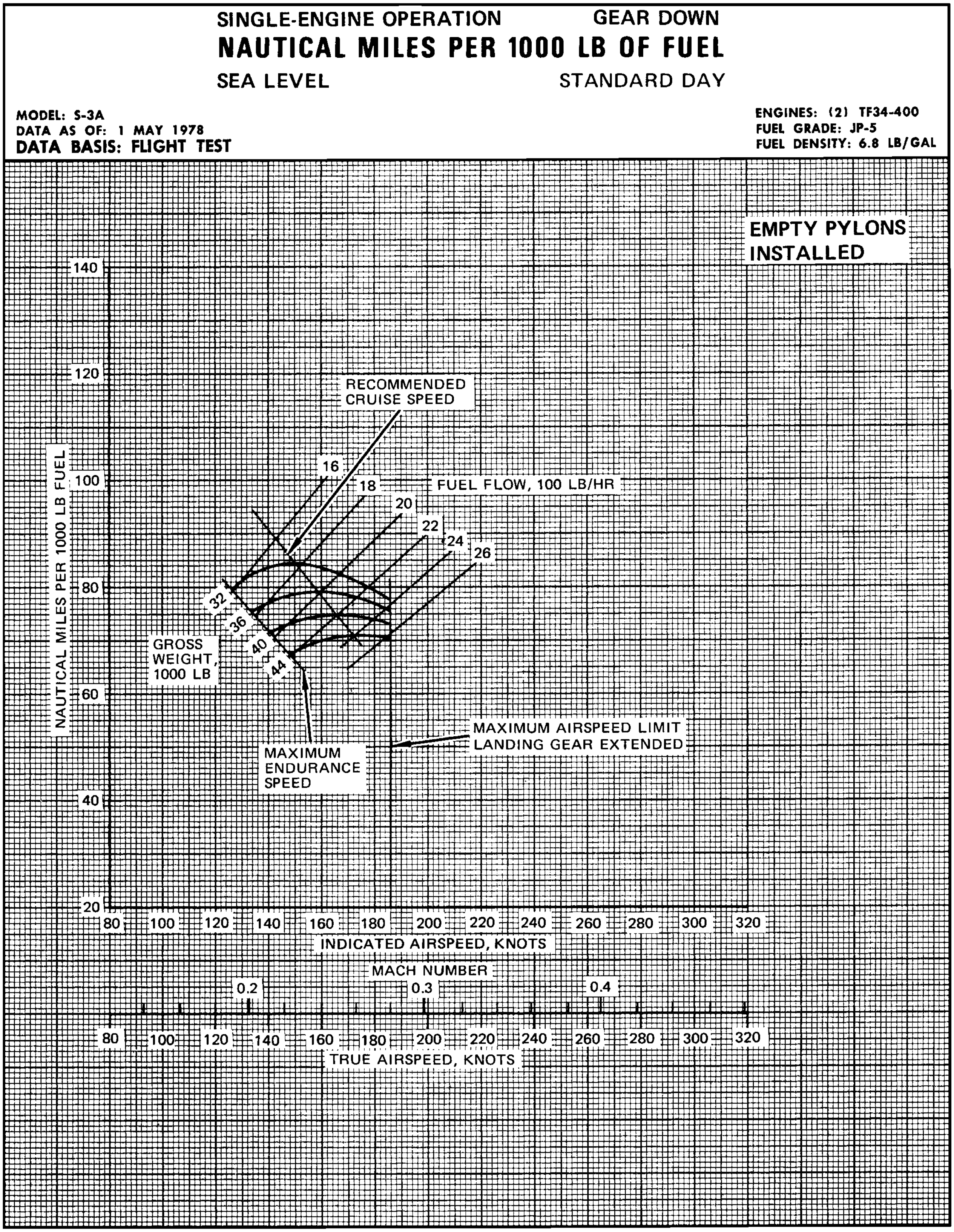


Figure 38-14. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Gear Down — Empty Pylons Installed (Sheet 1 of 3)

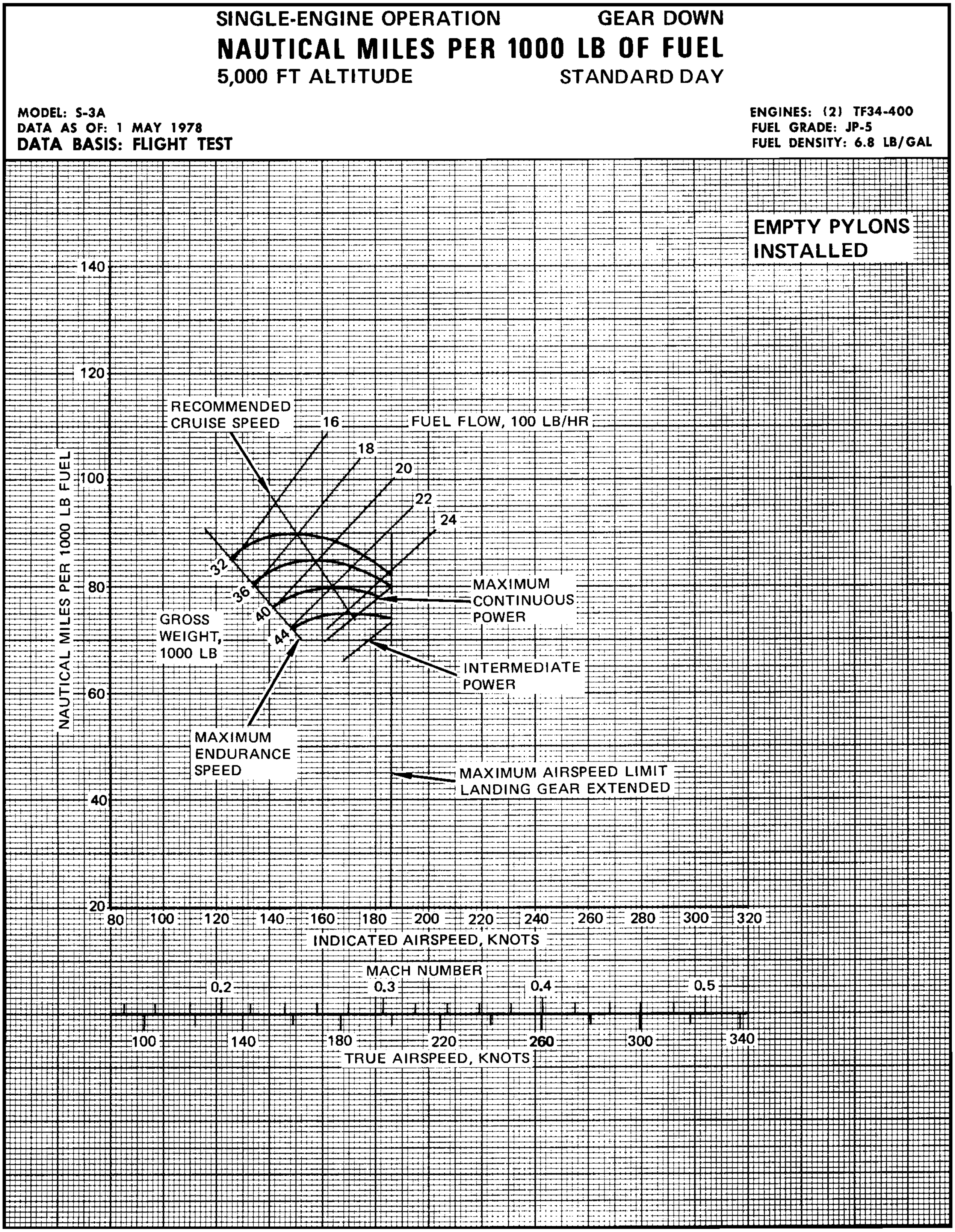


Figure 38-14. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Gear Down — Empty Pylons Installed (Sheet 2)

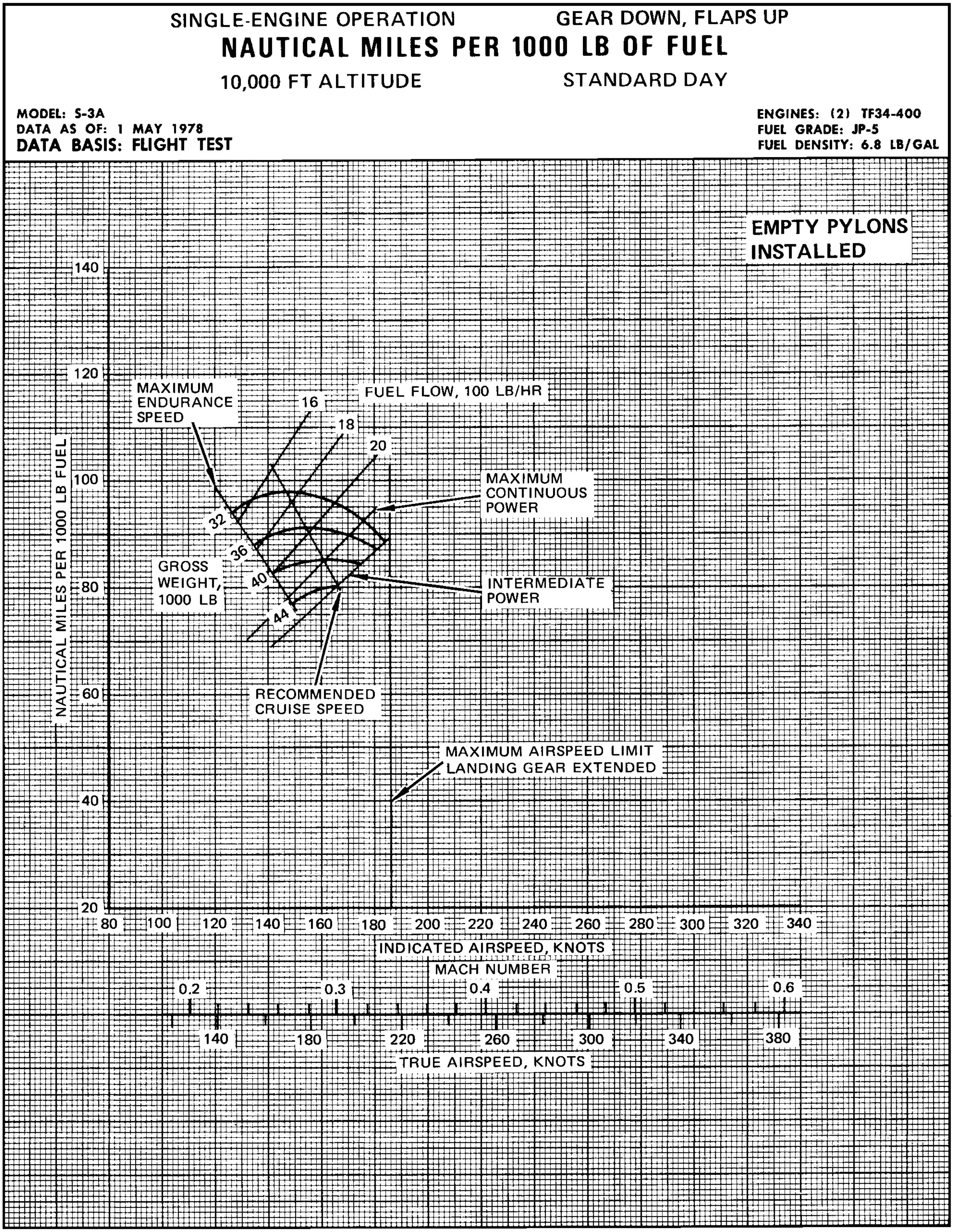


Figure 38-14. Nautical Miles Per 1,000 Pounds of Fuel — Single-Engine Operation — Flaps Up — Gear Down — Empty Pylons Installed (Sheet 3)

CHAPTER 39

Turning Performance

39.1 CONSTANT ALTITUDE TURNING PERFORMANCE

Figure 39-1 shows the turning capability of a 40,000-pound aircraft with flaps up and maneuver flaps. At any indicated airspeed the turn rate and turn radius may be determined for altitudes of 2,000 and 10,000 feet.

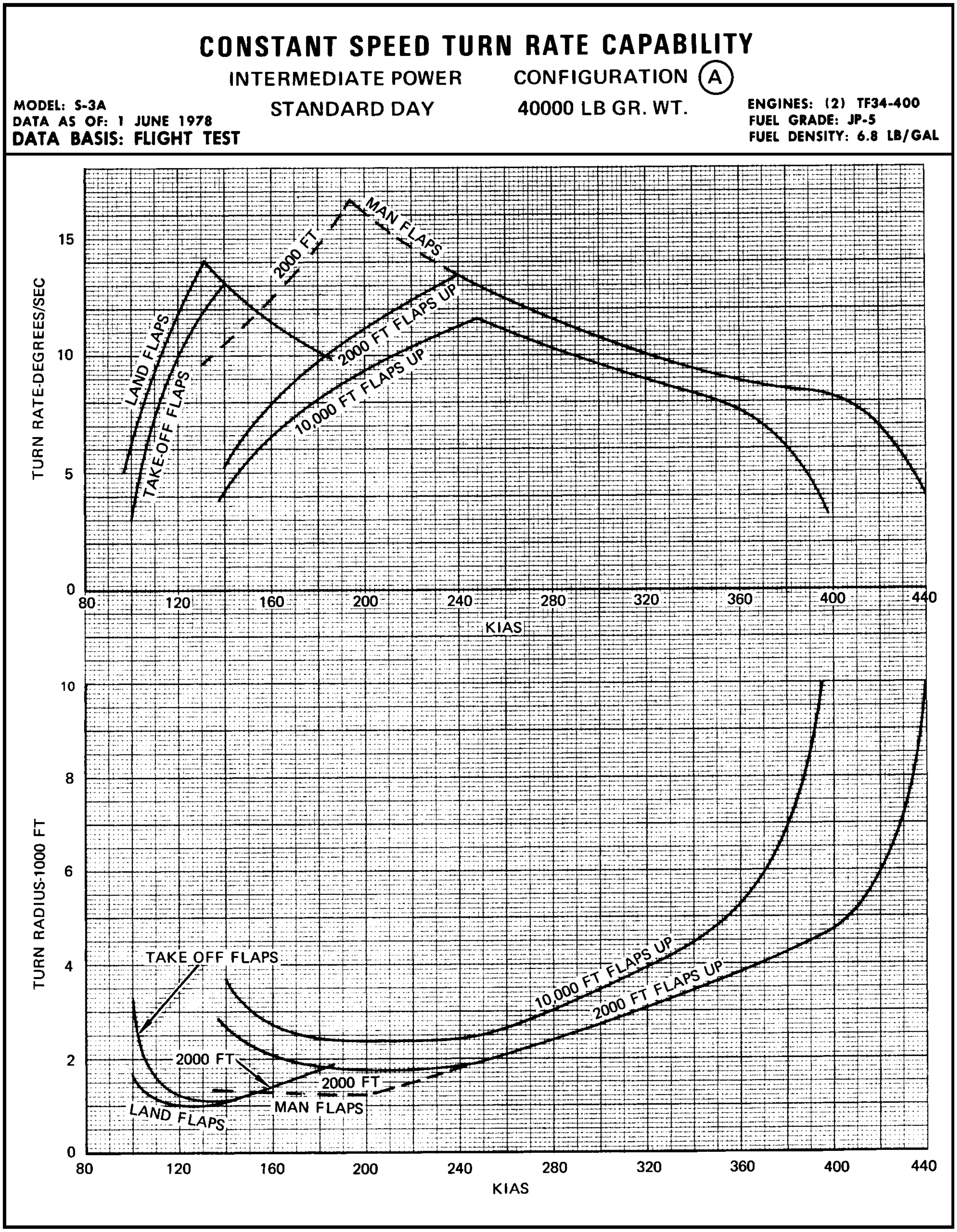


Figure 39-1. Constant Speed Turn Rate Capability

CHAPTER 40

Mission Planning

40.1 MISSION PLANNING

The actual planning of a mission can involve many things that are beyond the scope of this publication. As used here, mission planning involves the preparation of a flight plan so that the aircraft can be employed effectively for the assigned mission. The plan should provide a means of checking forecast against actual performance. It should also provide for certain contingencies and emergencies that could require alteration of the original plan in flight.

40.2 HOWGOZIT CHART

A summary of the flight plan, generally in the form of graphs and tables, is called the Howgozit chart. Checkpoints can be drawn on it as the flight progresses to provide a comparison of forecast and actual performance. The form suggested here, showing fuel versus distance and time, is one of many that have been found useful in the past. Other forms can be used equally well if they provide the answers desired.

Helpful but less essential information that can be added includes:

1. Gross weight data
2. Power, airspeed, and altitude schedules
3. Wind forecasts and corrections
4. Air temperature forecasts
5. Capabilities if reserve fuel is used for cruise.

40.3 MISSION PLANNING PROBLEM

Plan a two-engine mission to conduct a maximum duration search pattern 1,000 miles from base. During the first hour of the search, drop a full load of 48 sonobuoys and at the end of the search, drop four torpedoes. Cruise to the target area at 35,000 feet at maximum continuous thrust to reach the search area in minimum time. The return to base is to be at optimum cruise altitude with allowances for a 30-minute hold at sea level and a 1,000-pound reserve. Use a full fuel load of 16,748 pounds, consisting of 13,144 pounds internal and 3,604 pounds of pylon tank fuel. The zero fuel weight of the aircraft is 33,143 pounds and is based on the following loading:

Basic aircraft (includes crew, pylons and bomb bay rack) . . . . . 29,064 pounds

Pylon tanks (empty) . . . . 414 pounds

48 sonobuoys . . . . 1,505 pounds

Four torpedoes . . . . 2,160 pounds

Zero fuel weight . . . . 33,143 pounds

Reference to Figure 31-1 shows that pylon tanks have an external stores drag count of 23 (item 2). Pylon tanks and pylons have a total drag count of 23 + 12 = 35. This drag count entered in Figure 31-2 shows that charts for drag configuration Ⓑ are to be used.

For ease of understanding and solution, each planning segment of the mission may be tabulated as follows:

1. Takeoff and accelerate to climb speed.
2. Climb to 35,000 feet.
3. Cruise at maximum continuous power at 35,000 feet to the target area 1,000 miles from base.
4. Quick descent to sea level.
5. Drop sonobuoys during first hour of search at sea level.
6. Search at sea level for ___ hours (time to be determined).
7. Drop all torpedoes.

8. Climb to optimum cruise altitude.

9. Cruise climb to base.

10. Quick descent to sea level.

11. Hold for 30 minutes at sea level.

12. 1,000-pound fuel reserve for landing.

40.3.1 Takeoff and Accelerate to Climb Speed. The first steps in solving the sample problem are to determine the takeoff weight and the fuel used for takeoff and acceleration to climb speed. No time or distance allowances are made for this segment. Takeoff gross weight is loaded zero fuel weight plus fuel load 33,143 + 16,748 = 49,891 pounds. The fuel used for ground maneuver, takeoff, and acceleration to climb speed is 448 pounds. Therefore, the weight at the start of climb to 35,000 feet is 49,891 – 448 = 49,443 pounds. Fuel remaining is 16,748 – 448 = 16,300 pounds.

40.3.2 Climb. The time, fuel, and distance requirements for a climb from sea level to 35,000 feet at intermediate thrust are determined using the charts in Chapter 33, for drag configuration Ⓑ, to be 29 minutes (0.48 hour), 1,675 pounds, and 150 miles. The fuel remaining at the end of the climb will be 16,300 – 1,675 = 14,625 pounds. The Howgozit charts are now started by establishing the end points of segments 1 and 2, as shown in Figures 40-1 and 40-2.

40.3.3 Cruise. Segment three of the mission requires a maximum continuous thrust cruise to the target area. To determine the distance remaining to the target area, subtract the distance traversed during climb from total distance 1,000 – 150 = 850 miles. The fuel requirements to traverse 850 miles at 35,000 feet with maximum continuous thrust are determined from the miles per pound chart in Chapter 38 for drag configuration Ⓑ. Assume an amount of fuel consumed, and based on an average weight for that amount of fuel, read nautical miles per pound on the maximum continuous power line. Multiply the miles per pound figure by the assumed amount of fuel to obtain miles traveled. In this case, 5,000 pounds of fuel was assumed. The average aircraft weight is the weight at start of cruise minus 5,000/2, or 47,768 – 2,500 pounds = 45,268 pounds. Reading Figure 38-1, Sheet 5, at 45,268 pounds on the maximum continuous power line gives 163 miles per 1,000 pounds of fuel. The distance traversed is 163 × (5,000/1,000) = 815 miles. The total distance from the base is found by adding the climb distance to the cruise distance 150 + 815 = 965 miles. The distance remaining to the target area is now 1,000 – 965 = 35 miles, and the aircraft weight at this point is 47,768 – 5,000 = 42,768 pounds. Since the remaining distance of 35 miles requires only a small amount of fuel, the value of miles per 1,000 pounds may be read at the existing weight. Reenter Figure 38-1, Sheet 5, at 42,768 and read 165 miles per 1,000 pounds.

The fuel used is determined by dividing miles to go by miles per pound 35 (165/1,000) = 212 pounds. The fuel used during the cruise segment at 35,000 feet is then 5,000 + 212 or 5,212 pounds. The aircraft weight at the end of the cruise segment is 42,768 – 212 = 42,556 pounds. Fuel remaining is 14,625 – 5,212 = 9,413 pounds.

The time used during the cruise is obtained by reading the true airspeed from Figure 38-2, Sheet 5, that corresponds with the miles-per-pound values and dividing by the distance traversed. For the 5,000-pound segment, read an average true airspeed of 383 knots. The time required to go 815 miles at an average airspeed of 383 knots is 815 383 = 2.13 hours. The average airspeed for the last 35 miles is 396, so the time will be 35 396 or 0.09 hour. Total time to climb and cruise is 2.70 hours.

40.3.4 Descent. The descent in this problem is made on station with no distance allowance. The fuel used and time required for a descent from 35,000 feet for an aircraft weight of 42,566 pounds is found from Figure 36-1 to be 60 pounds and 0.07 hour (4.3 minutes). The weight at this point is 42,506 pounds, the fuel remaining is 9,353 pounds, and the total time is 2.77 hours.

The cruise and descent segments of the flight may now be added to the Howgozit charts, by plotting the respective points of fuel remaining versus distance and fuel remaining versus time to complete segments three and four as shown in Figures 40-1 and 40-2.

40.3.5 Search Time While Dropping Sonobuoys. The fuel requirements and the loiter speed for mission segment five, the first hour of search while deploying the sonobuoys, are found by using Figure 35-1, Sheet 2 for configuration Ⓑ. The average weight during the loiter is the start weight minus

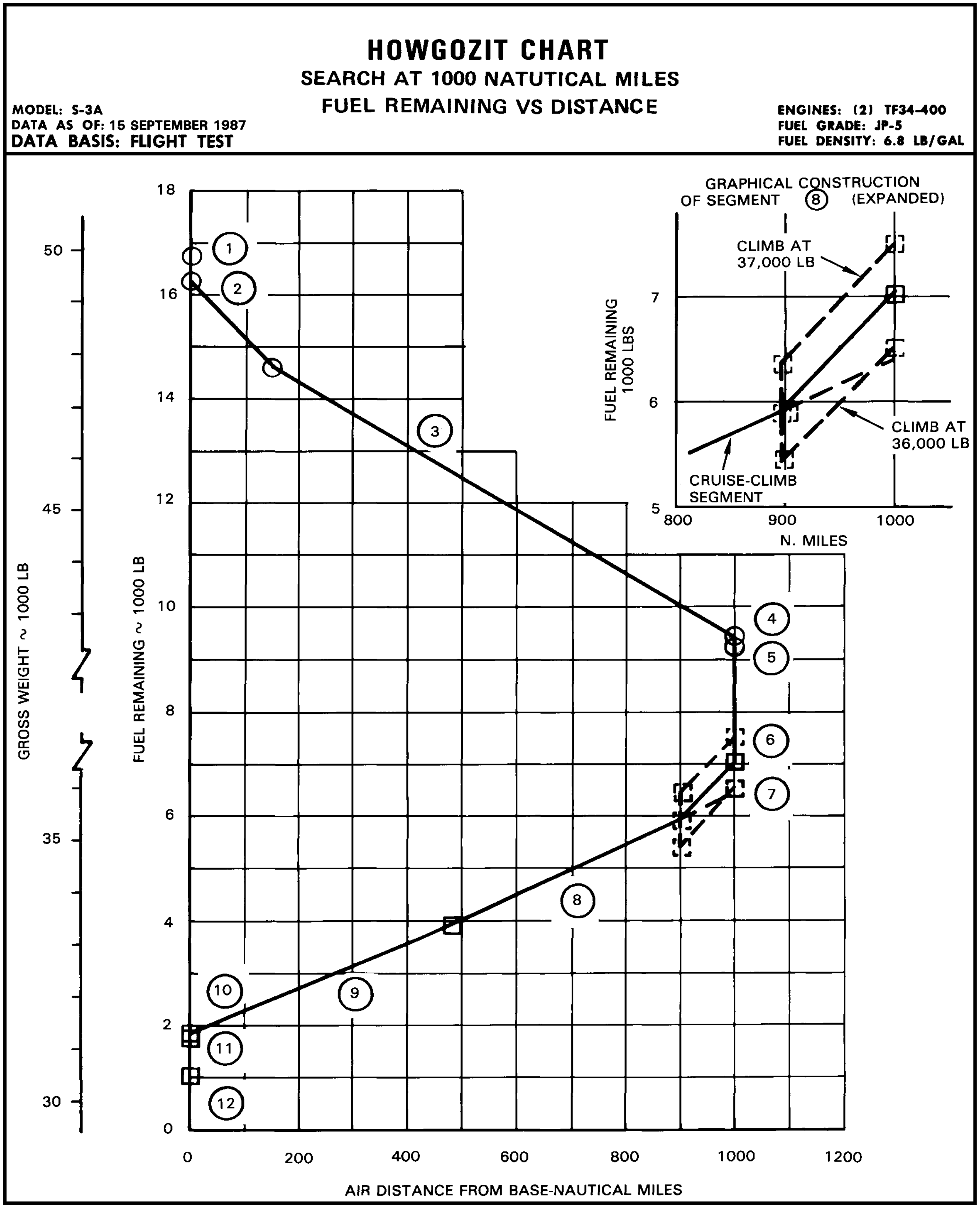


Figure 40-1. Howgozit — Fuel Versus Distance

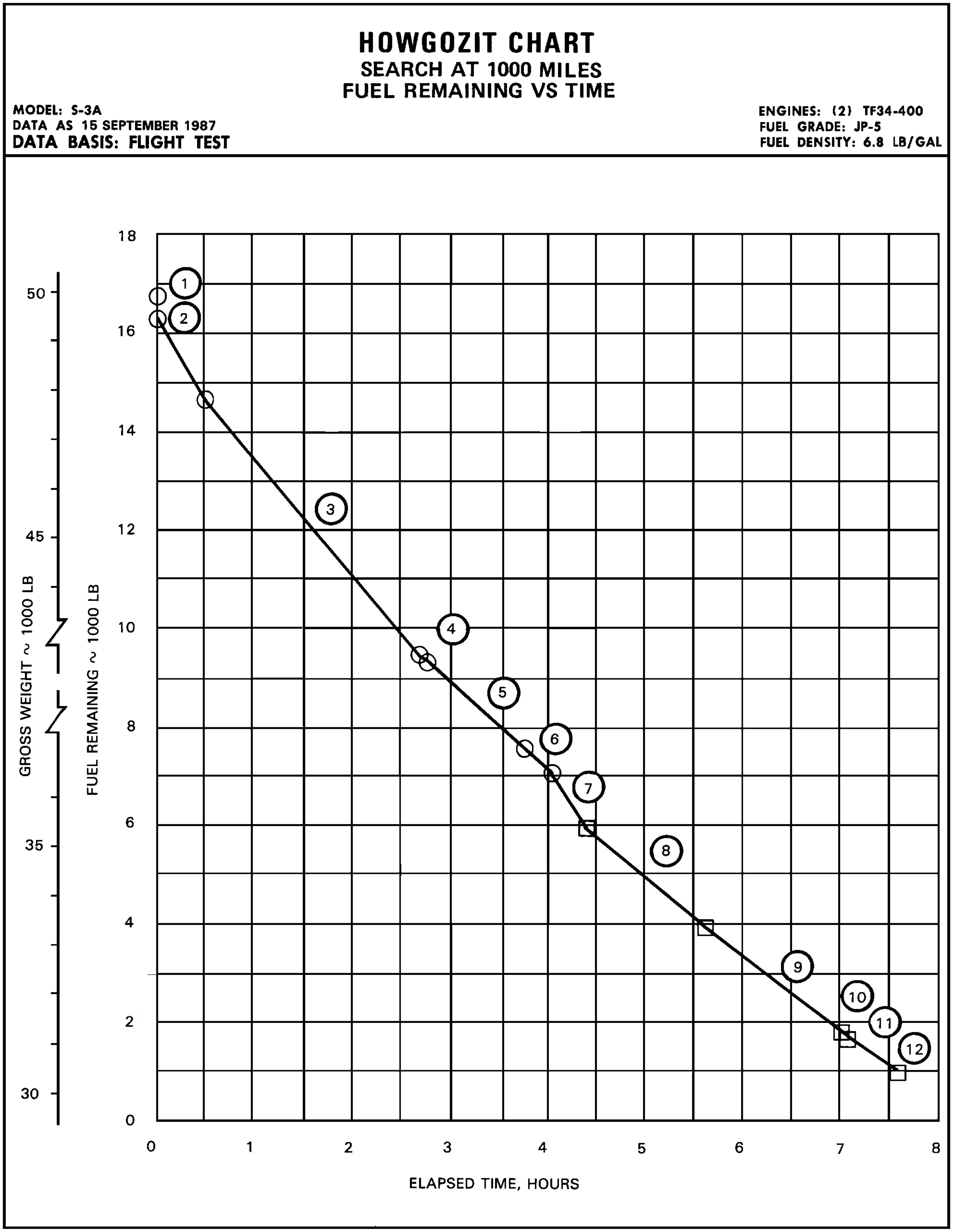


Figure 40-2. Howgozit — Fuel Versus Time

one-half the weight of the sonobuoys (assumes the drops are made equally throughout the 1-hour period) minus one-half the fuel required. The start weight minus one-half the sonobuoy weight is 42,506 – (1,505 ÷ 2) = 41,753 pounds.

Enter Figure 35-1, Sheet 2, at sea level for an aircraft weight of 41,753 pounds and read loiter fuel flow of about 1,820 pph. Using one-half the expected fuel flow, the average weight for the 1-hour segment will be 41,753 – (1820 ÷ 2) = 40,843 pounds. Reenter Figure 35-1, Sheet 2, at 40,843 pounds and read an average fuel flow of 1,800 pph. Therefore, the weight at the end of the 1-hour segment is the initial weight (42,506), minus the sonobuoy load (1,505), minus the fuel consumed (1,800) or 39,201 pounds. The fuel remaining at this point is 9,353 – 1,800 = 7,553 pounds. The average loiter speed is determined from the right side of Figure 35-1, Sheet 2, to be 166 KIAS. These fuel remaining and time points may now be added to the Howgozit charts, Figures 40-1 and 40-2, to complete segment five of the mission.

40.3.6 Return Fuel Versus Distance. In order to determine the fuel available for search after sonobuoys are dropped, mission segment six, it is necessary to construct the return segments of the mission, beginning with the return zero-fuel weight and the reserve requirements and working backwards.

The zero-fuel weight of the aircraft at the end of the mission is 29,478 pounds. The problem specifies a 1,000-pound reserve for landing after a 30-minute hold at sea level. To determine the fuel required for the 30-minute hold, enter Figure 35-1, Sheet 2, at an aircraft weight of 29,478 + 1,000 = 30,478 pounds at sea level and read endurance fuel flow of 1,490 pph. Therefore, the average weight for the 30 minutes will be 30,478 + (0.5 hour × 1,490 pph) = 31,223 pounds. Reenter Figure 35-1, Sheet 2, at the average weight for this segment of 31,223 pounds and read 1,510 pph. The fuel remaining requirement at the initiation of the 30-minute loiter segment is the 1,000-pound reserve plus (0.5 × 1,510) = 1,755 pounds, and the aircraft weight is 29,478 + 1,755 = 31,233 pounds. The loiter speed is found from the right side of Figure 35-1, Sheet 2, to be 142 KIAS. Since there is no distance allowance for the loiter segment, these points, segments 11 and 12, may now be added to Figure 40-1.

40.3.7 Descent For Landing. The next step is to determine the fuel and time requirement for the descent from optimum cruise altitude. The descent is assumed to be over the base and, therefore, no credit is made for descent distance. A quick look at Figure 36-1 will show that the fuel consumed during a flight-idle descent from altitude will be about 100 pounds. Therefore, assuming 100 pounds, the weight at the start of descent would be 31,233 + 100 = 31,333 pounds. Determine the optimum cruise altitude at the start of descent for a weight of 31,333 pounds from Figure 33-3 to be 40,000 feet. Reenter Figure 36-1 to determine the actual fuel and time required for a descent from 40,000 feet at 31,333 pounds to be 50 pounds and 3.8 minutes (0.06 hour). The fuel remaining at the start of descent is therefore 1,755 + 50 = 1,805 pounds, and this point should be added to the Howgozit chart, Figure 40-1, at zero distance to complete segment 10. The aircraft weight at the end of the cruise is 29,478 + 1,805 = 31,283 pounds.

40.3.8 Return Cruise. Several steps are necessary to define the return leg at optimum cruise altitude. The optimum cruise altitude determined from Figure 33-3 is shown to increase using a cruise climbpath as weight is decreased until 40,000 feet is reached, and then below a gross weight of 33,400 pounds, a constant 40,000-foot altitude is maintained.

Since the aircraft weight over the base is 31,283 pounds, the amount of fuel consumed during the 40,000-foot portion of the cruise is 33,400 – 31,283 = 2,117 pounds, and the average weight for this segment is 31,283 + (2,117 ÷ 2) = 32,342 pounds. Figure 38-2, Sheet 6, shows 226 miles per 1,000 pounds of fuel at an indicated airspeed of 173 knots (339 KTAS) for these conditions. The distance traveled is 2,117 × (226/1,000) = 478 miles. The time required is obtained by dividing the distance traveled by the true speed. The time required therefore is 478 miles 339 KTAS or 1.41 hours.

40.3.9 Cruise-Climb. The distance remaining from the base to the target area is 1,000 – 478 = 522 miles. This distance consists of the distance traveled during the climb from sea level to optimum cruise altitude and the undetermined portion of the cruise-climb segment. As a first approximation, estimate the fuel required for this cruise portion to be 2,000 pounds. The average weight is 33,400 + (2,000 ÷ 2) = 34,400 pounds. Using Figure 33-3, the optimum cruise altitude for this weight is 39,500 feet and from Figure 34-1, Sheet 2, find 210 miles per 1,000 pounds for these conditions. The distance traveled is 2,000 pounds × 210 miles/l,000 pounds = 420 miles. The slope of the cruise segment of the mission can now be established on the Howgozit chart by plotting the two cruise points, one at 478 miles with fuel remaining at 3,922 (1,805 + 2,117) pounds and the other at 478 + 420 = 898 miles, and fuel remaining at 3,922 + 2,000 = 5,922 pounds. (See the expanded portion of Figure 40-1.)

40.3.10 Climb Back To Optimum Cruise Altitude. At this point, it is necessary to determine the fuel and distance requirements for a climb from sea level to optimum cruise altitude. A check of the charts in Chapter 33 at the approximate weight of 36,000 pounds (33,400 + 2,000 rounded up) shows about 1,100 pounds will be required, and distance traveled will be about 100 miles. The intercept of the climb segment and the cruise segment can be solved graphically on the Howgozit chart by assuming two different climbs that will bracket the cruise line on the chart. For this case, the fuel required and distance traveled for climbs from sea level to optimum cruise altitude at weights of 36,000 and 37,000 were found from the charts in Part III to be 104 miles and 1,100 pounds, and 105 miles and 1,130 pounds, respectively. The fuel remaining representing these loadings is determined from the zero-fuel weight to be 6,522 and 7,522 pounds. These two climbs are shown on the Howgozit chart by dashed lines and symbols (see expanded portion of Figure 40-1). A line connecting the high altitude end of these climbs intersects the previously established cruise segment at the actual fuel remaining at the top of the climb. This is determined from the chart to be 5,910 pounds, and the aircraft weight is 29,478 + 5,910 = 35,388 pounds. The optimum altitude to begin the return cruise climb for this weight is found from Figure 33-3 to be 39,000 feet. The climb segment of the mission is then added to the Howgozit chart by drawing a line from the point established at the top of the climb to the 1,000-mile distance line using a slope similar to the slope of the two climbs shown in dashed lines. The intersection of this line and the 1,000-mile distance establishes the fuel requirement to complete the return segment of the mission to be 7,060 pounds.

40.3.11 Search Time After Dropping Sonobuoys. The fuel remaining at the end of segment five was previously determined to be 7,553 pounds. Therefore, the fuel available for search after dropping sonobuoys is 7,553 – 7,060 = 493 pounds. The average aircraft weight for this segment is the previously determined weight at the end of segment five minus one-half the fuel required for this segment, 39,201 – 247 = 38,955 pounds. Read from Figure 35-1, Sheet 2, a maximum endurance fuel flow of 1,740 pph. The time available is 493 pounds divided by 1,740 pph or 0.28 hour. This results in a total search time 1,000 miles from base of 1.28 hours. Figure 40-1 is now complete.

40.3.12 Fuel Versus Time. Figure 40-2 should now be completed. Include the time required for the loiter segment. Determine the time required to climb from sea level to optimum cruise altitude at a weight of 35,388 pounds from Figure 33-1, Sheet 3, to be 20 minutes (0.33 hour). The one remaining time increment to be computed is the first portion of the return cruise, segment nine. The distance traversed during this segment is 1,000 miles minus the climb distance minus the 478 miles traversed during the cruise at 40,000 feet. The climb distance from sea level to optimum cruise altitude is read from Figure 33-1, Sheet 2, to be 103 miles. The desired distance is 1,000 miles – 478 miles – 103 miles = 419 miles. The average indicated airspeed for this segment from Figure 34-1, Sheet 2, using the average weight is 176 knots. The Mach number for this airspeed at an average altitude of about 39,500 feet, from Figure 31-8, is 0.59. True airspeed is the speed of sound (Figure 31-12) times Mach number, 0.59 × 573.8 = 338.5 knots. The time to go 419 miles at 338.5 knots is 1.24 hour. The time for the other portion of the cruise segment was previously determined to be 1.41, so the total time for the cruise return, segment nine, is 1.41 + 1.24 = 2.65 hours. Figure 40-2 may now be completed by adding the times for the remaining segments that were previously computed.

40.4 PLANNING CHARTS

40.4.1 Mission Radius Chart. Figure 40-3 shows the mission radius for any drag configuration on a standard day. The chart shows the radius for three different missions, a HI/LO/HI mission, a LO/HI mission and a LO/LO mission. Where missions include a climb, the climb is at intermediate power. Descents are maximum-range descents.

40.4.2 Maximum True Airspeed Chart. Aircraft maximum true airspeeds at intermediate power and maximum continuous power for any drag configuration may be read directly from Figure 40-4. The chart shows standard-day performance for sea level and 15,000-foot altitude.

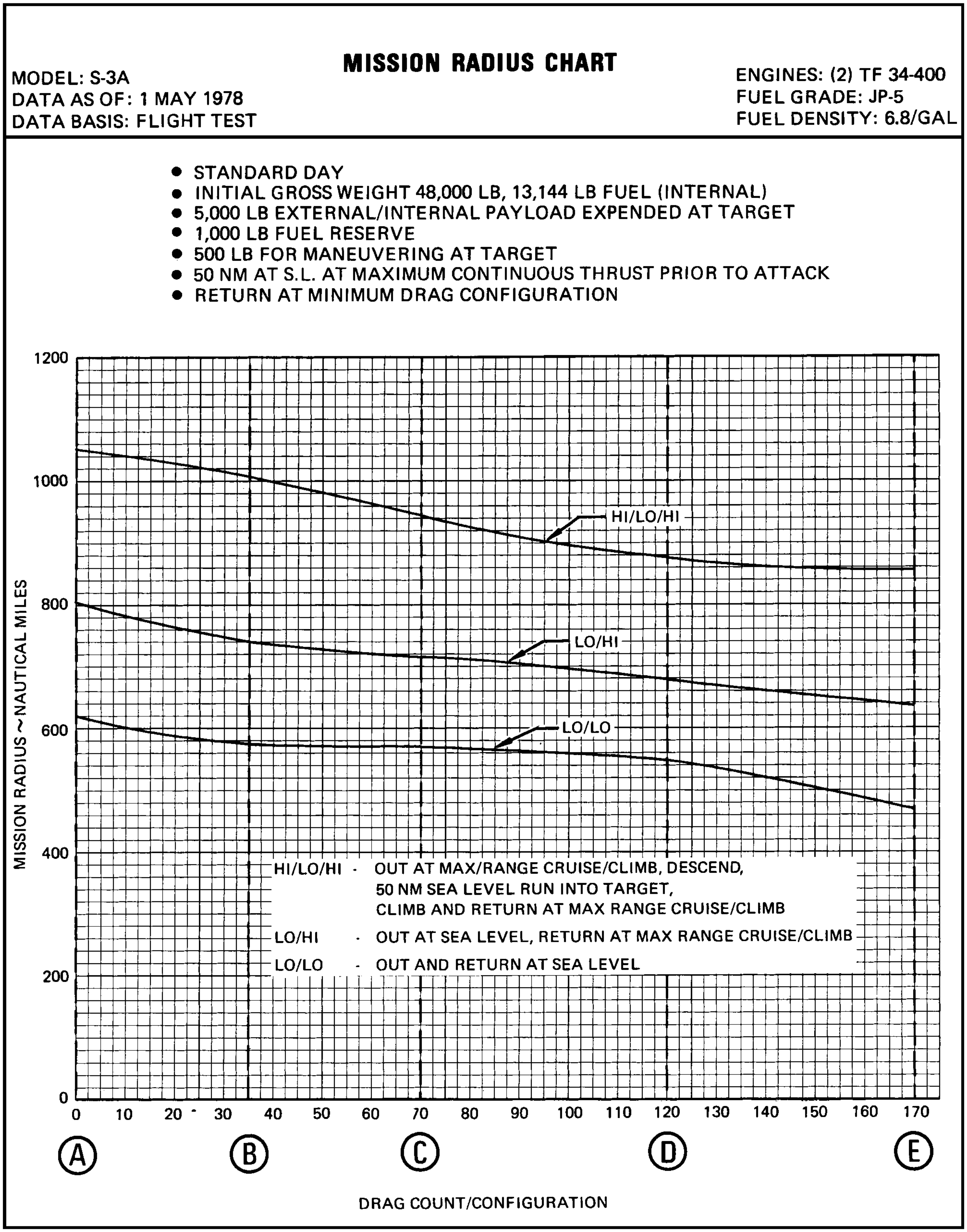


Figure 40-3. Planning Charts — Mission Radius Versus Drag Count/Configuration

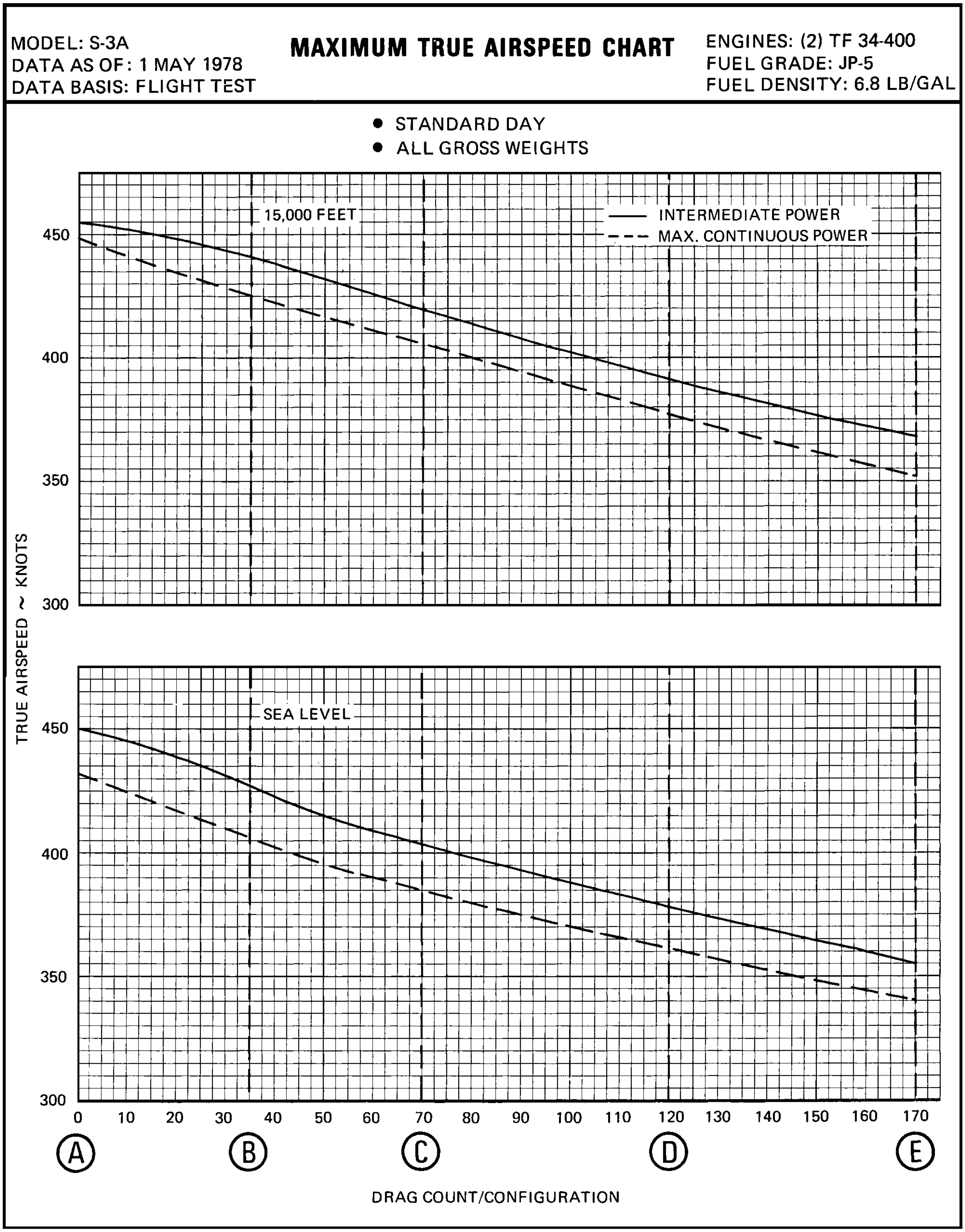


Figure 40-4. Planning Charts — Maximum True Airspeed Versus Drag Count/Configuration

PART XII

S-3A Differences

CHAPTER 41

S-3A Differences

41.1 INTRODUCTION

S-3A aircraft are modified through AFC-208 (ECP S3 400) to upgrade the weapons system and are redesignated S-3B. The flight and airframe systems retain complete commonality between the “A” and “B” models, including APU and ARS fuel system upgrades.

41.2 MODIFICATIONS

1. Cockpit configuration to the following copilot/ COTAC lights:

   a. ENGINE FIRE WARNING

   b. MASTER CAUTION

   c. APU FIRE WARNING

   d. RADAR ALTIMETER WARNING

   e. LANDING GEAR WARNING

   f. ECM READY.

2. Cockpit configuration to the following pilot lights:

   a. ECM READY

   b. MISSILE FIRE STA W5

   c. MISSILE FIRE STA W6

   d. ATR UNLOCKED.

3. Pilot side console throttle panel, moving the automatic bolter ground test switch and adding the ECM controls switches.

4. Cockpit configuration to TACCO forward panels with the ECM programmer/control/initiate panels, HACLCS panel, display generator power panel, and computer power control panel.

41.3 ADDITIONS

1. Payload initiate switch to pilot/copilot throttles

2. Circuit breakers for mission avionics

3. ALE-39 CHAFF/flare dispenser housings to the empennage, including ECM pin

4. ALR-76 ESM pods

5. Tape recorder remote panel to SENSO forward panels

6. Mission avionics changes were also made that added approximately 500 pounds to the S-3A basic weight having negligible effect on cg.

41.4 EMERGENCY PROCEDURES

Emergency procedures are the same for both the S-3A and S-3B.

41.5 COCKPIT LAYOUT AND CIRCUIT BREAKER PANELS

Figures 41-1 through 41-6 and FO-23 show the S-3A cockpit layout and circuit breaker panels.

41.6 CANCELLATION

The S-3A NATOPS manual series (NAVAIR 01-S3AAA-1, 01-S3AAA-1.1, 01-S3AAA-1A, 01-S3AAA-1B, and 01-S3AAB-1F) has been canceled.

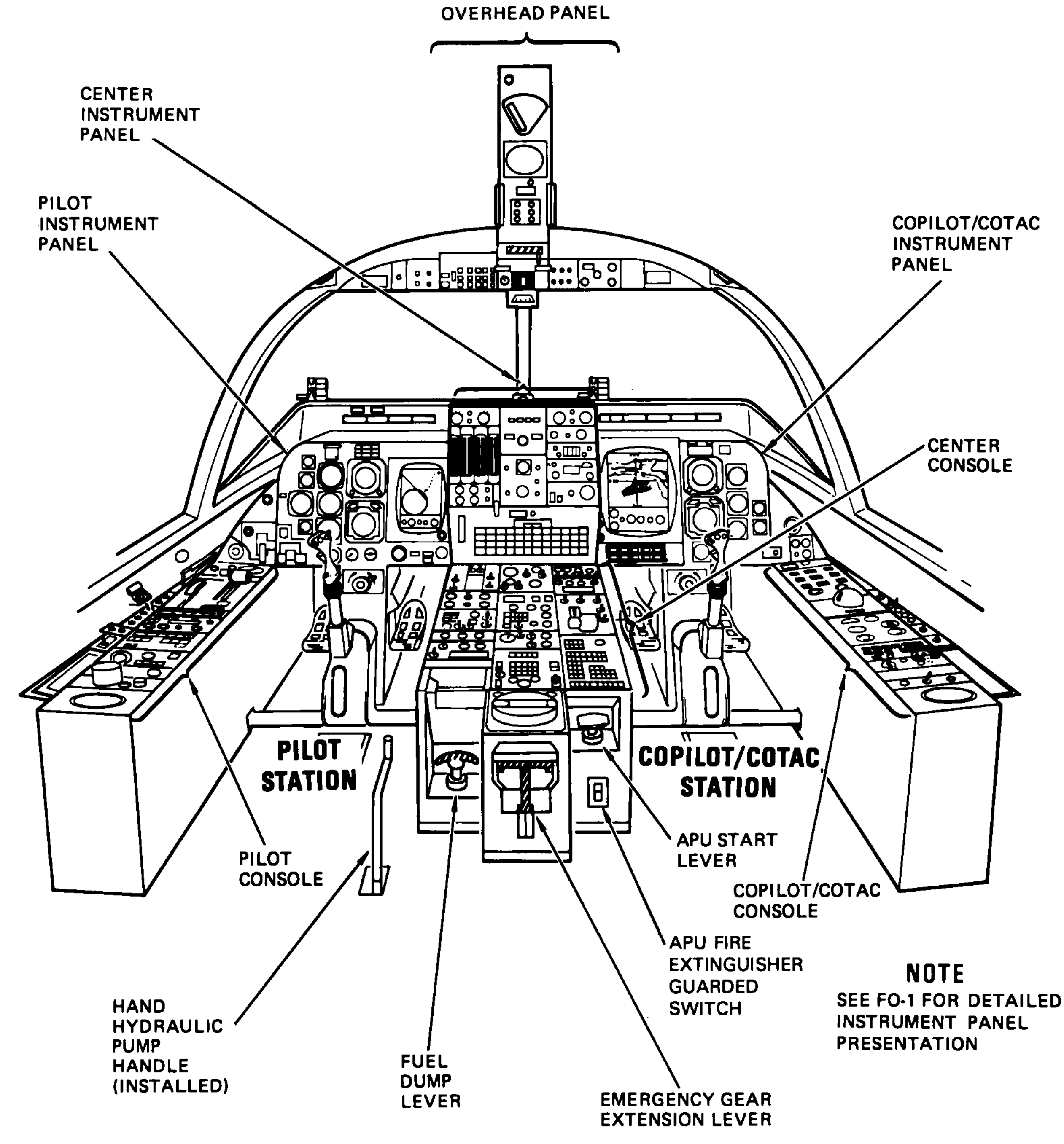
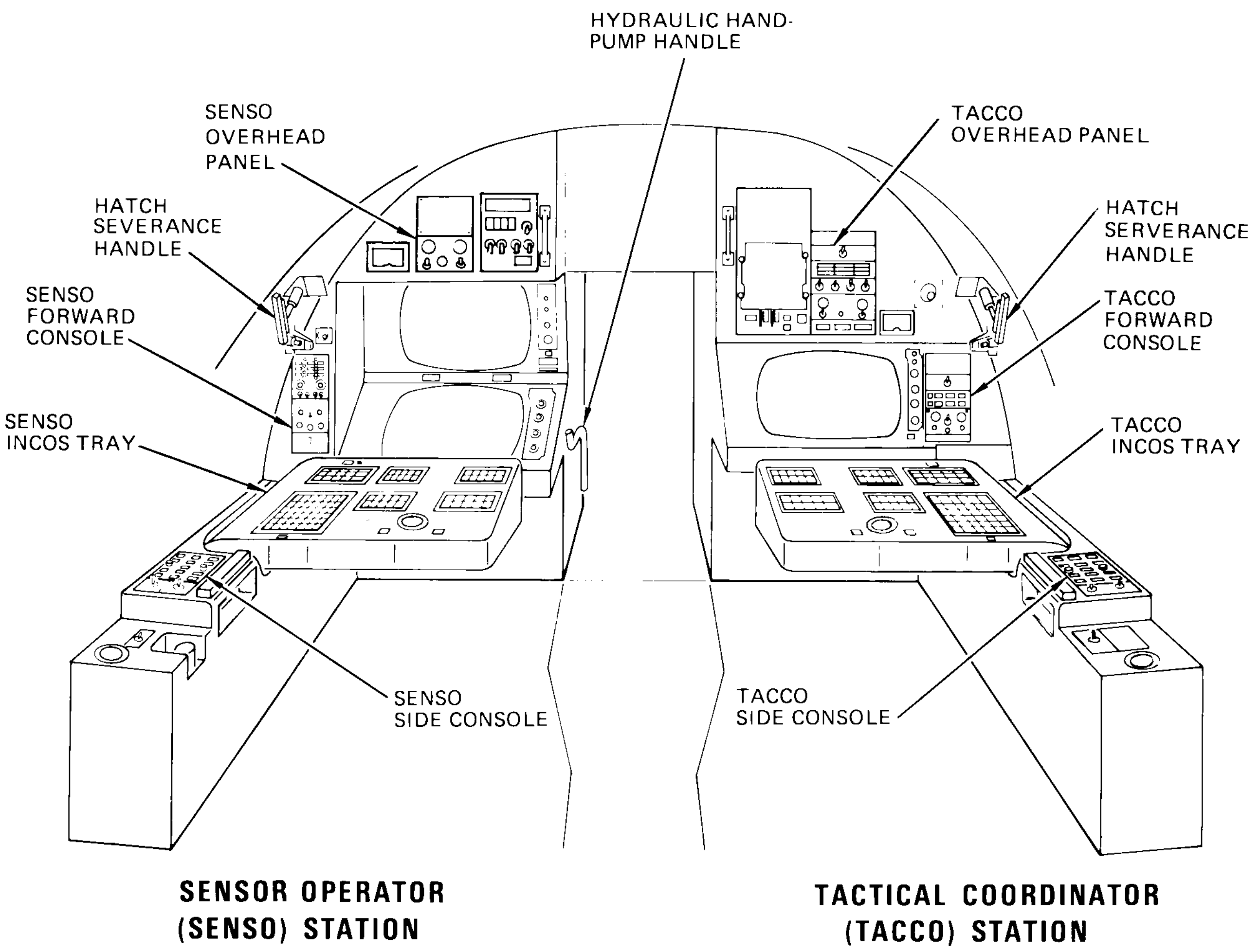


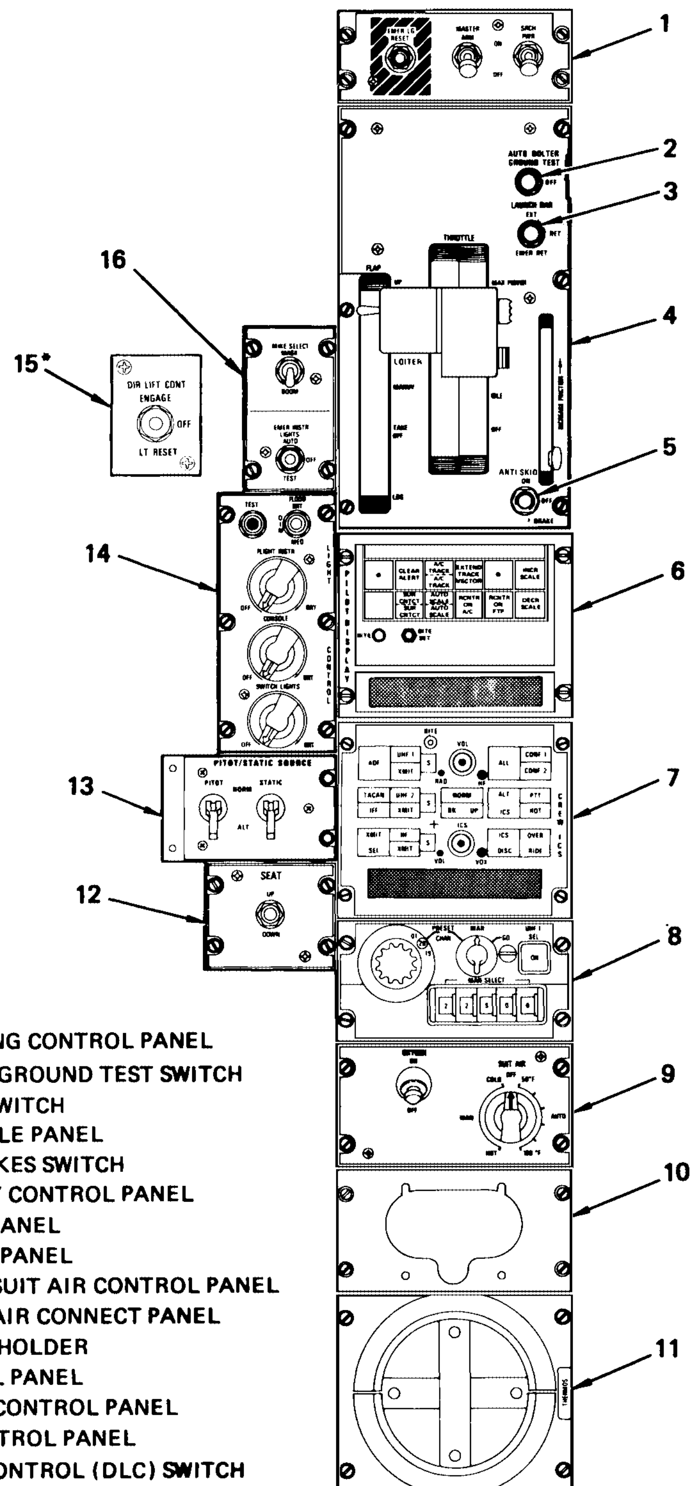
Figure 41-1. Cockpit (Typical)



NOTE

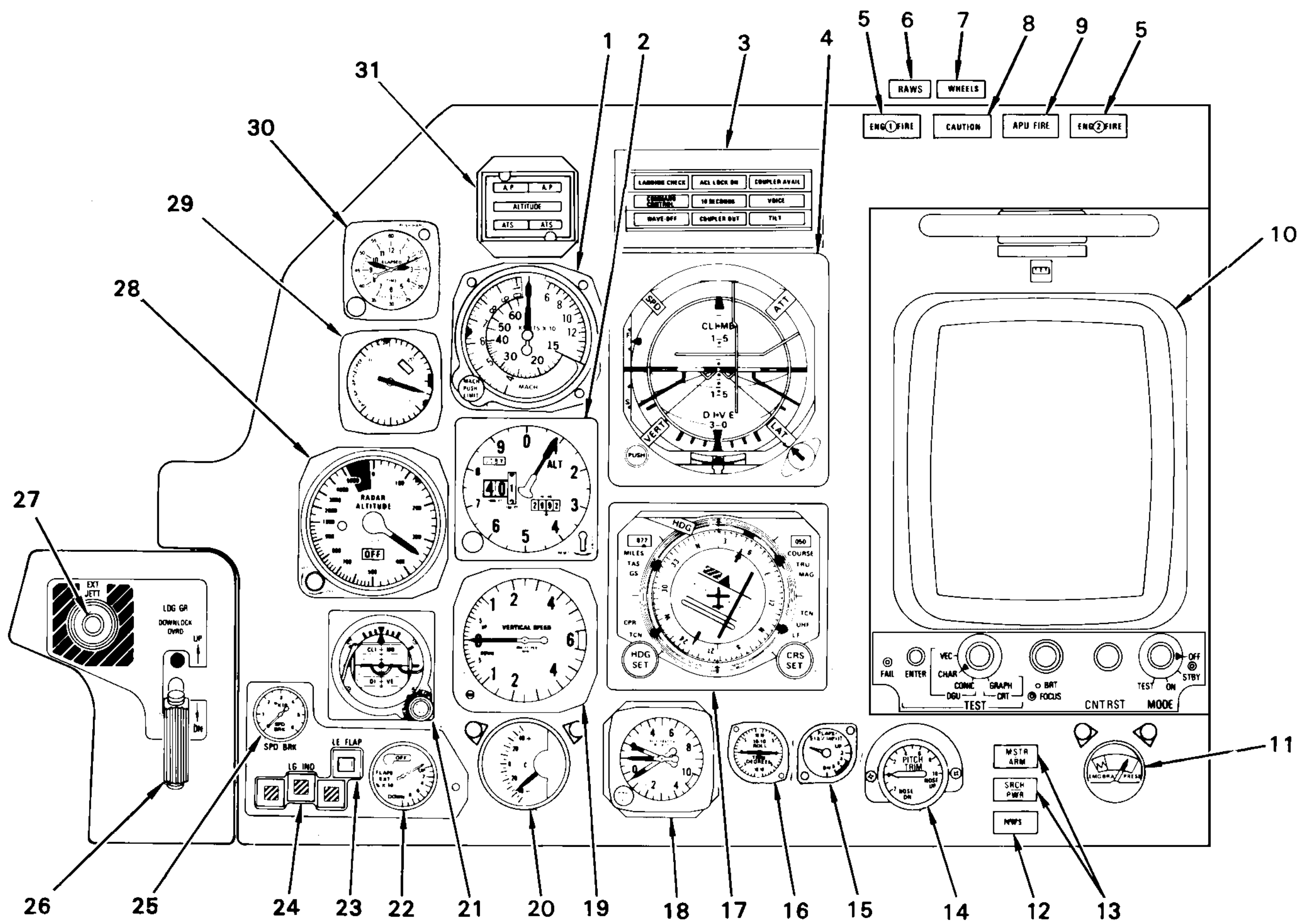
SEE FO-16 AND FO-17 FOR DETAILED INSTRUMENT PANEL PRESENTATION.

Figure 41-2. SENSO/TACCO Stations (Typical)



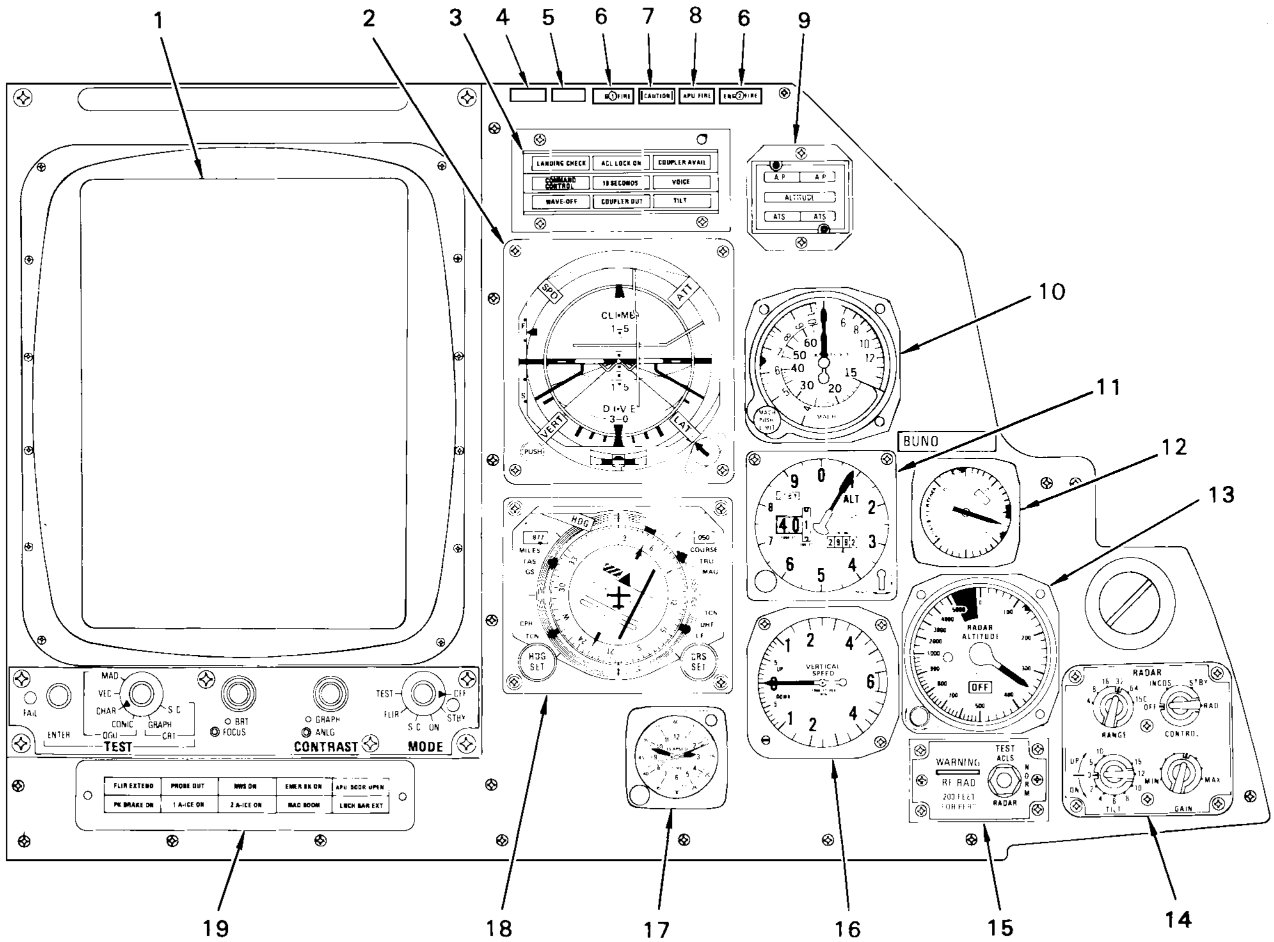
1 MASTER ARMING CONTROL PANEL
2 AUTO BOLTER GROUND TEST SWITCH
3 LAUNCH BAR SWITCH
4 PILOT THROTTLE PANEL
5 ANTISKID BRAKES SWITCH
6 PILOT DISPLAY CONTROL PANEL
7 ICS CONTROL PANEL
8 UHF CONTROL PANEL
9 OXYGEN AND SUIT AIR CONTROL PANEL
10 OXYGEN AND AIR CONNECT PANEL
11 THERMOS JUG HOLDER
12 SEAT CONTROL PANEL
13 PITOT/STATIC CONTROL PANEL
14 LIGHTING CONTROL PANEL
15 DIRECT LIFT CONTROL (DLC) SWITCH
16 MICROPHONE SELECT PANEL

Figure 41-3. Pilot Side Console (Typical)



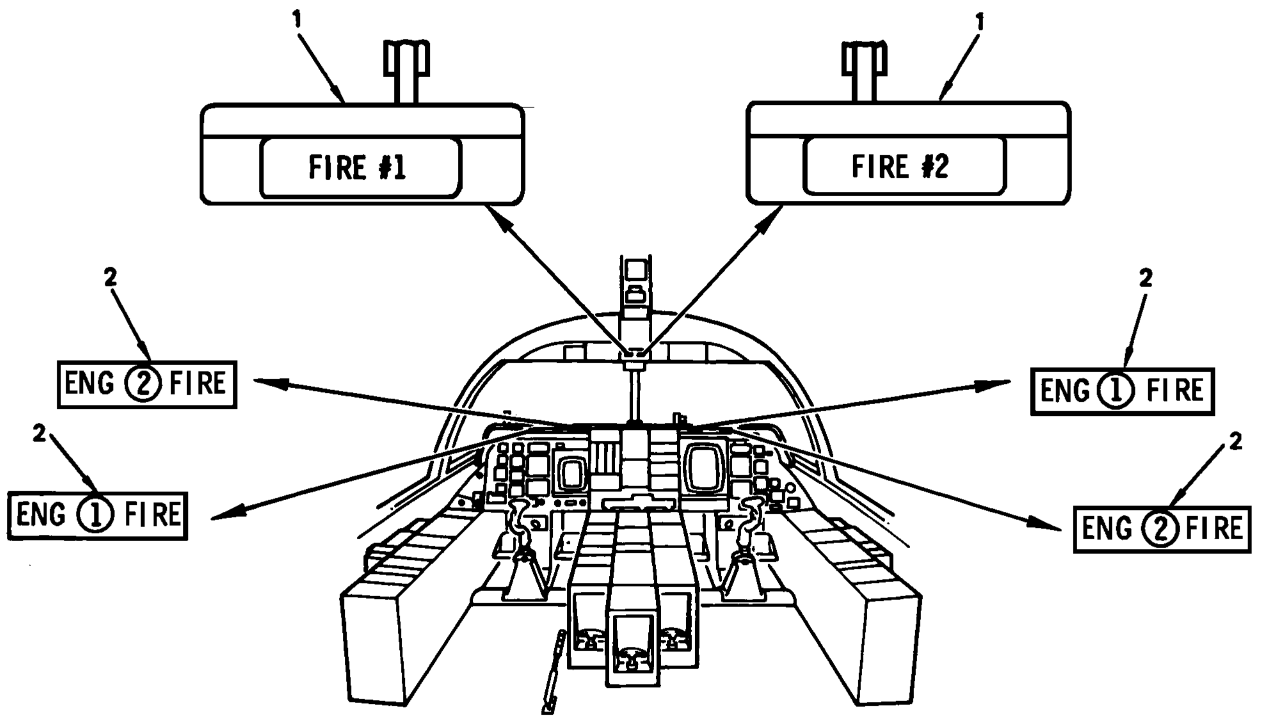
1 AIRSPEED/MACH INDICATOR
2 ALTIMETER
3 AUTOMATIC CARRIER LANDING SYSTEM (ACLS) DISCRETE WORD DISPAY PANEL
4 VERTICAL DIRECTOR INDICATOR
5 FIRE WARNING LIGHTS
6 RADAR ALTIMETER WARNING SYSTEM
7 LANDING GEAR WARNING LIGHT
8 MASTER CAUTION LIGHT
9 APU FIRE WARNING LIGHT
10 PILOT DISPLAY PANEL
11 EMERGENCY BRAKE PRESSURE INDICATOR
12 NWS LIGHT
13 MASTER ARM/SEARCH POWER CUE LIGHTS
14 PITCH TRIM INDICATOR
15 FLAPS/ELEV INPUT
16 ROLL TRIM INDICATOR
17 HORIZONTAL SITUATION INDICATOR
18 ACCELEROMETER
19 VERTICAL SPEED INDICATOR
20 OAT INDICATOR
21 STANDBY ATTITUDE INDICATOR
22 TRAILING EDGE FLAPS POSITION INDICATOR
23 LEADING EDGE FLAPS POSITION INDICATOR
24 LANDING GEAR POSITION INDICATOR
25 SPEEDBRAKES POSITION INDICATOR
26 LANDING GEAR HANDLE/INDICATOR
27 EXTERNAL STORES JETTISON SWITCH
28 RADAR ALTIMETER
29 ANGLE-OF-ATTACK (AOA) INDICATOR
30 CLOCK
31 FAILURE ANNUNCIATOR (FA) PANELS

Figure 41-4. Pilot Instrument Panel (Typical)



1 COPILOT/COTAC MULTIPURPOSE DISPLAY (MPD) PANEL
2 VERTICAL DIRECTOR INDICATOR
3 AUTOMATIC CARRIER LANDING SYSTEM (ACLS) DISCRETE WORD DISPLAY PANEL
4 RADAR ALTIMETER WARNING SYSTEM (RAWS) LIGHT
5 LANDING GEAR WARNING LIGHT
6 FIRE WARNING LIGHTS
7 MASTER CAUTION LIGHT
8 APU FIRE WARNING LIGHT
9 FAILURE ANNUNCIATOR (FA) PANELS
10 AIRSPEED/MACH INDICATOR
11 ALTIMETER
12 ANGLE OF ATTACK (AOA) INDICATOR
13 RADAR ALTIMETER
14 RADAR OFF-LINE CONTROL PANEL
15 ACLS TEST PANEL
16 VERTICAL SPEED INDICATOR
17 CLOCK
18 HORIZONTAL SITUATION INDICATOR
19 ADVISORY PANEL

Figure 41-5. Copilot/COTAC Instrument Panel (Typical)



INDEX	CONTROL/INDICATOR	FUNCTION
1	Emergency shutdown handle/indicators	FIRE handles mechanically shut off fuel to respective engine and hydraulic fluid to respective engine-driven hydraulic pump. Handle illuminates red during overheat condition on respective engine.
2	ENG ① and ENG ② FIRE warning lights	Indicates fire or overheat on indicated engine. Tested by pressing light — causes either FIRE #1 or FIRE #2 handle and both pilot and copilot/COTAC warning lights to illuminate.

Figure 41-6. Engine Fire Controls and Indicators

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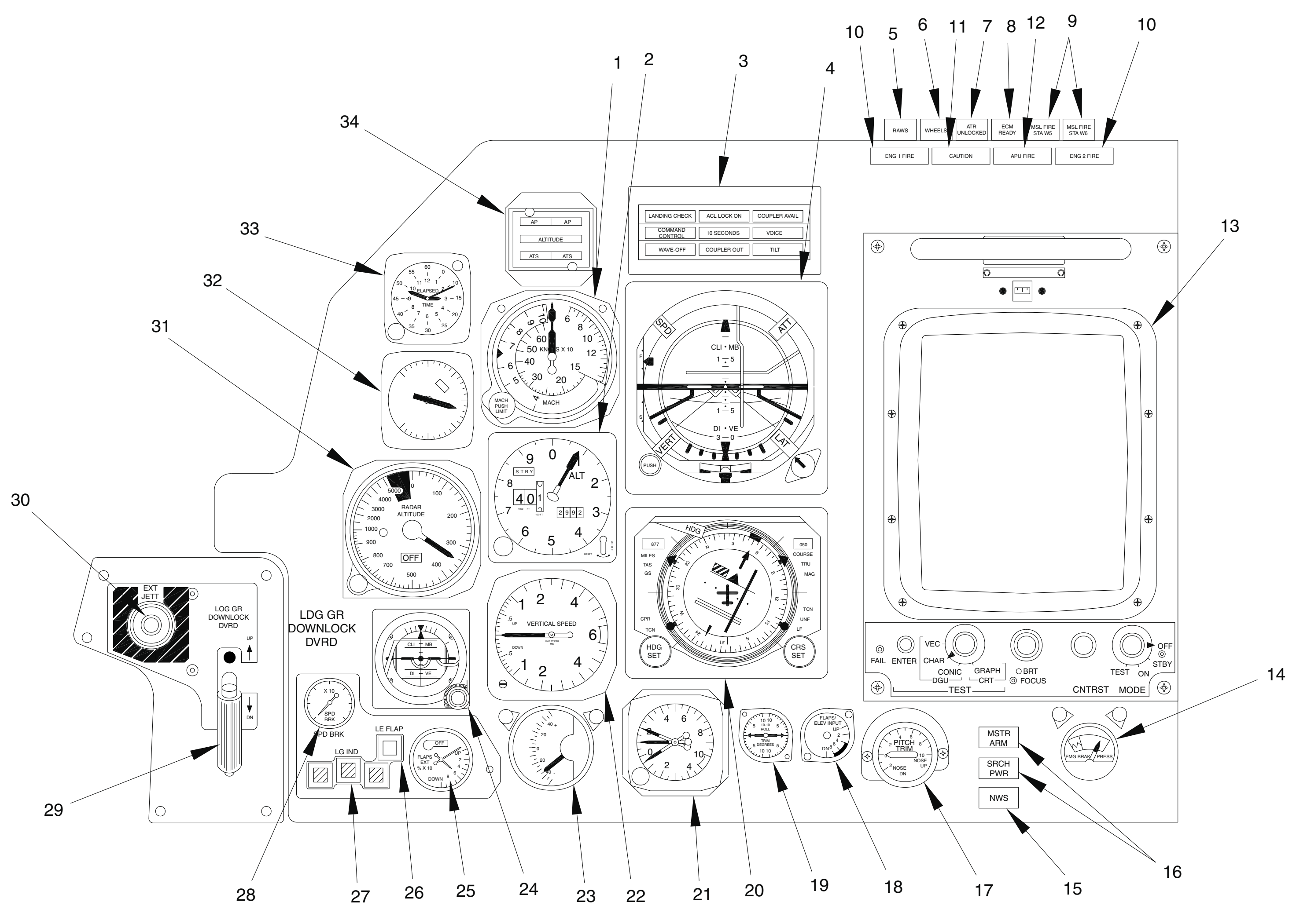
Y

PILOT INSTRUMENT PANEL

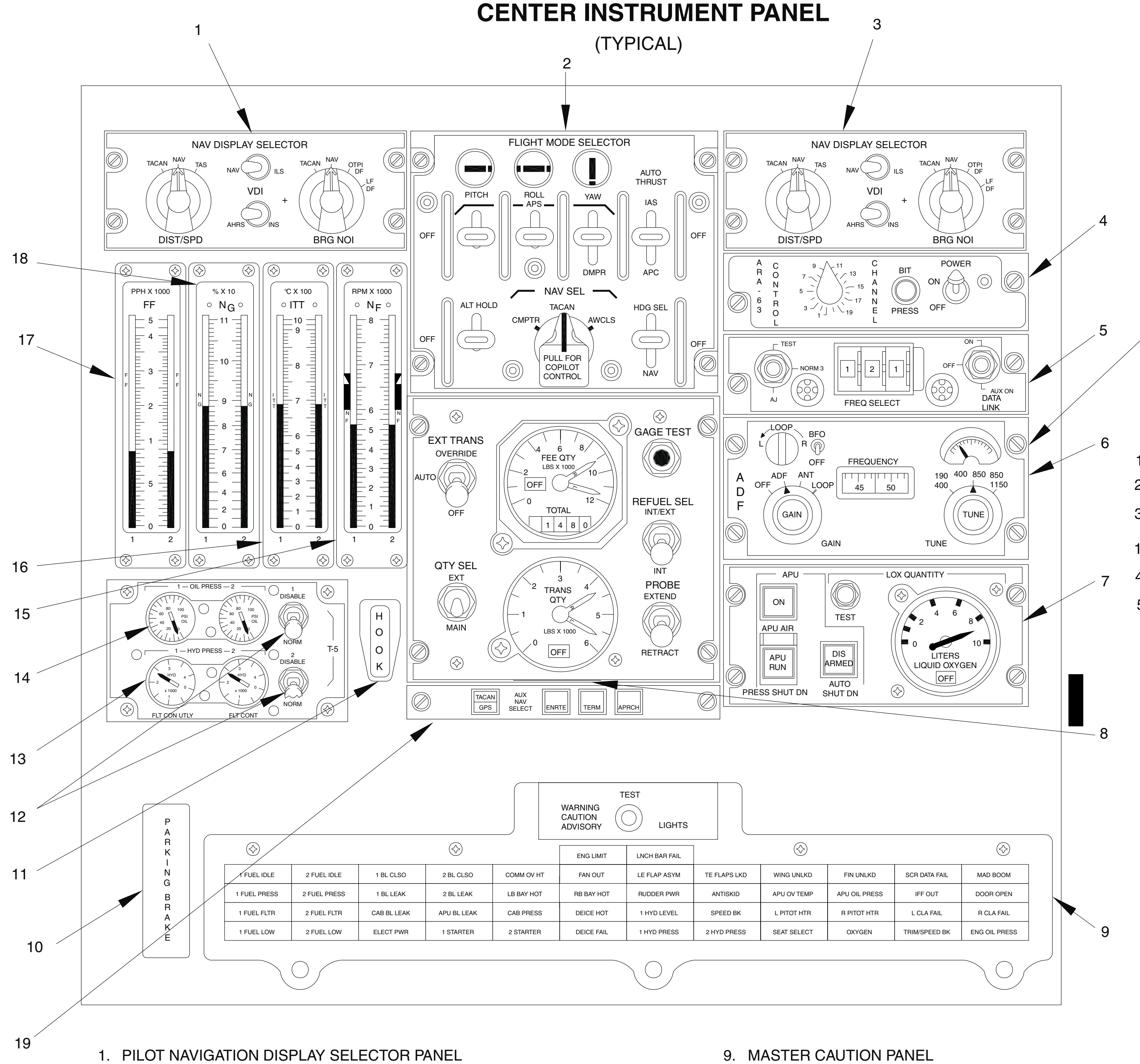
(TYPICAL)



1. AIRSPEED/MACH INDICATOR
2. ALTIMETER
3. AUTOMATIC CARRIER LANDING SYSTEM (ACLS) DISCRETE WORD DISPLAY PANEL
4. VERTICAL DIRECTOR INDICATOR
5. RADAR ALTIMETER WARNING SYSTEM LIGHT
6. LANDING GEAR WARNING LIGHT
7. ANALOG TAPE RECORDER RACK UNLOCKED WARNING LIGHT
8. ECM READY LIGHT
9. MISSILE FIRE WARNING LIGHTS
10. ENGINE FIRE WARNING LIGHTS
11. MASTER CAUTION LIGHT
12. APU FIRE WARNING LIGHT
13. PILOT DISPLAY PANEL
14. EMERGENCY BRAKE PRESSURE INDICATOR
15. NWS LIGHT
16. MASTER ARM/SEARCH POWER CUE LIGHTS
17. PITCH TRIM INDICATOR
18. FLAPS/ELEV INPUT
19. ROLL TRIM INDICATOR
20. HORIZONTAL SITUATION INDICATOR
21. ACCELEROMETER
22. VERTICAL SPEED INDICATOR
23. OAT INDICATOR
24. STANDBY ATTITUDE INDICATOR
25. TRAILING EDGE FLAPS POSITION INDICATOR
26. LEADING EDGE FLAPS POSITION INDICATOR
27. LANDING GEAR POSITION INDICATOR
28. SPEEDBRAKES POSITION INDICATOR
29. LANDING GEAR HANDLE/INDICATOR
30. EXTERNAL STORES JETTISON SWITCH
31. RADAR ALTIMETER
32. ANGLE-OF-ATTACK (AOA) INDICATOR
33. CLOCK
34. FAILURE ANNUNCIATOR (FA) PANELS

CENTER INSTRUMENT PANEL

(TYPICAL)

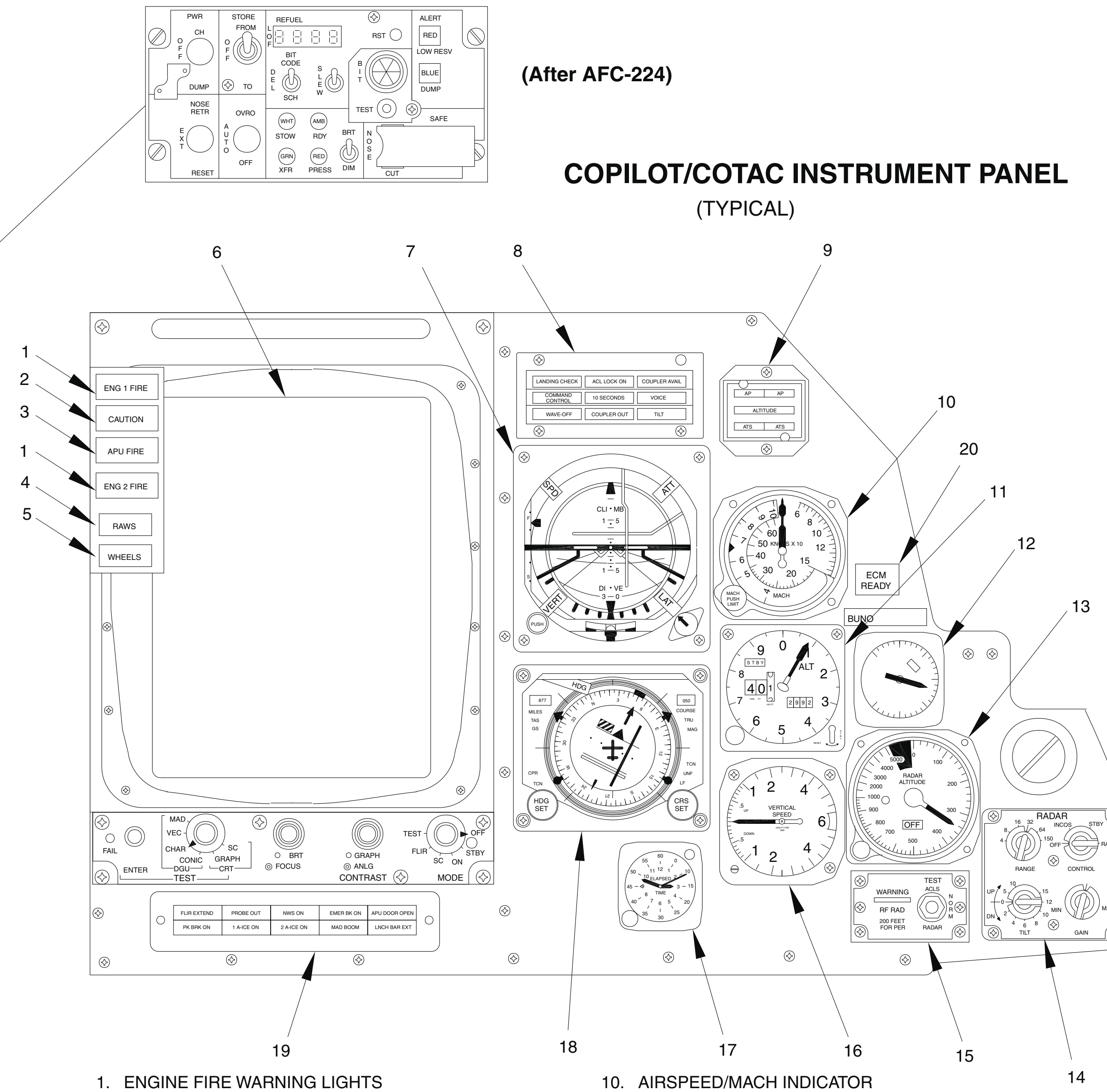


1. PILOT NAVIGATION DISPLAY SELECTOR PANEL
2. FLIGHT MODE SELECTOR PANEL
3. COPILOT/COTAC NAVIGATION DISPLAY SELECTOR PANEL
4. CARRIER INSTRUMENT LANDING SYSTEM (CILS) RECEIVER DECODER PANEL
5. DATA LINK SELECTOR PANEL
6. LF ADF CONTROL PANEL ARS CONTROL PANELS (AFTER AFC 220)
7. CREW OXYGEN QUANTITY/APU CONTROL INDICATORS PANEL
8. FUEL SYSTEM CONTROL PANEL
9. MASTER CAUTION PANEL
10. PARKING BRAKE PANEL
11. ARRESTING HOOK HANDLE
12. T-5 DISABLE (ITT) SWITCHES
13. HYDRAULIC SYSTEM PRESSURE INDICATORS
14. ENGINE OIL PRESSURE INDICATORS
15. ENGINE FAN SPEED (N_F) INDICATOR
16. ENGINE INTERTURBINE TEMPERATURE (ITT) INDICATOR
17. ENGINE FUEL FLOW (FF) INDICATOR
18. ENGINE GAS GENERATOR SPEED (N_G) INDICATOR
19. AUX NAV SELECT PANEL

COPILOT/COTAC INSTRUMENT PANEL

(TYPICAL)

(After AFC-224)



1. ENGINE FIRE WARNING LIGHTS
2. MASTER CAUTION LIGHTS
3. APU FIRE WARNING LIGHT
4. RADAR ALTIMETER WARNING SYSTEM LIGHT
5. LANDING GEAR WARNING LIGHT
6. COPILOT/COTAC MULTIPURPOSE DISPLAY (MPD) PANEL
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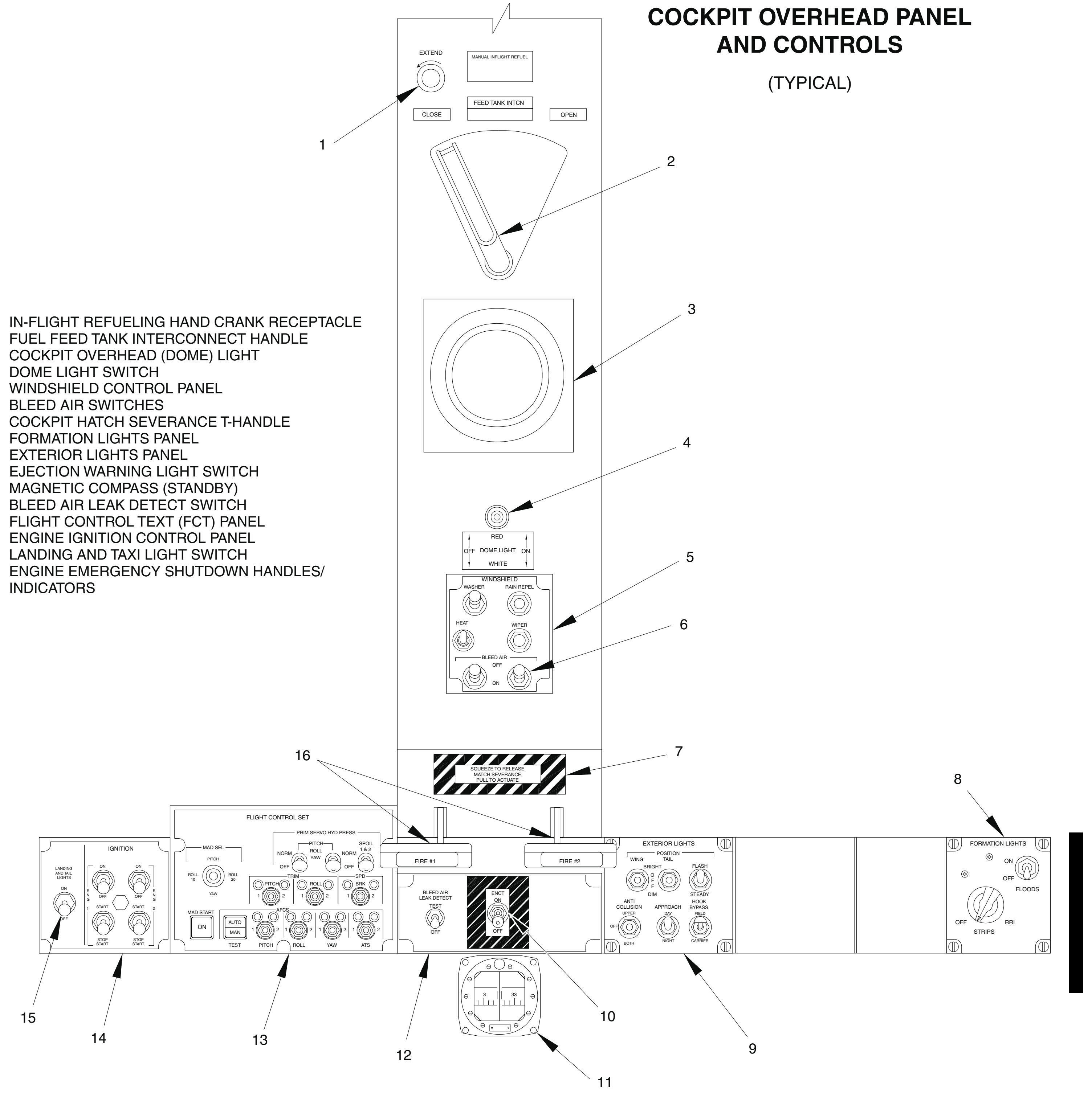
10. AIRSPEED/MACH INDICATOR
11. ALTIMETER
12. ANGLE OF ATTACK (AOA) INDICATOR
13. RADAR ALTIMETER
14. RADAR OFF-LINE CONTROL PANEL
15. ACLS TEST PANEL
16. VERTICAL SPEED INDICATOR
17. CLOCK
18. HORIZONTAL SITUATION INDICATOR
19. ADVISORY PANEL
20. ECM READY LIGHT

COCKPIT OVERHEAD PANEL AND CONTROLS

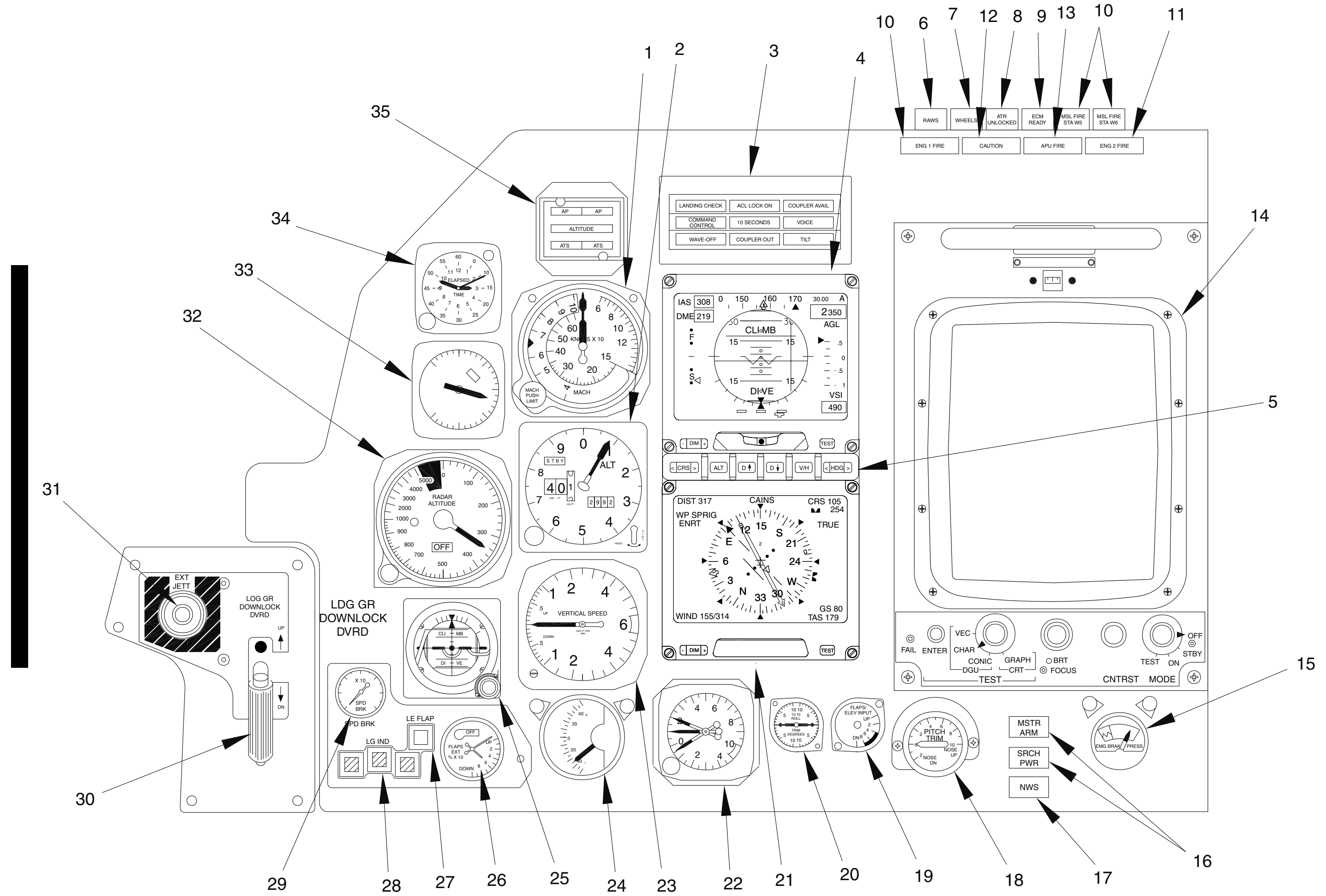
(TYPICAL)



1. IN-FLIGHT REFUELING HAND CRANK RECEPTACLE
2. FUEL FEED TANK INTERCONNECT HANDLE
3. COCKPIT OVERHEAD (DOME) LIGHT
4. DOME LIGHT SWITCH
5. WINDSHIELD CONTROL PANEL
6. BLEED AIR SWITCHES
7. COCKPIT HATCH SEVERANCE T-HANDLE
8. FORMATION LIGHTS PANEL
9. EXTERIOR LIGHTS PANEL
10. EJECTION WARNING LIGHT SWITCH
11. MAGNETIC COMPASS (STANDBY)
12. BLEED AIR LEAK DETECT SWITCH
13. FLIGHT CONTROL TEXT (FCT) PANEL
14. ENGINE IGNITION CONTROL PANEL
15. LANDING AND TAXI LIGHT SWITCH
16. ENGINE EMERGENCY SHUTDOWN HANDLES/INDICATORS

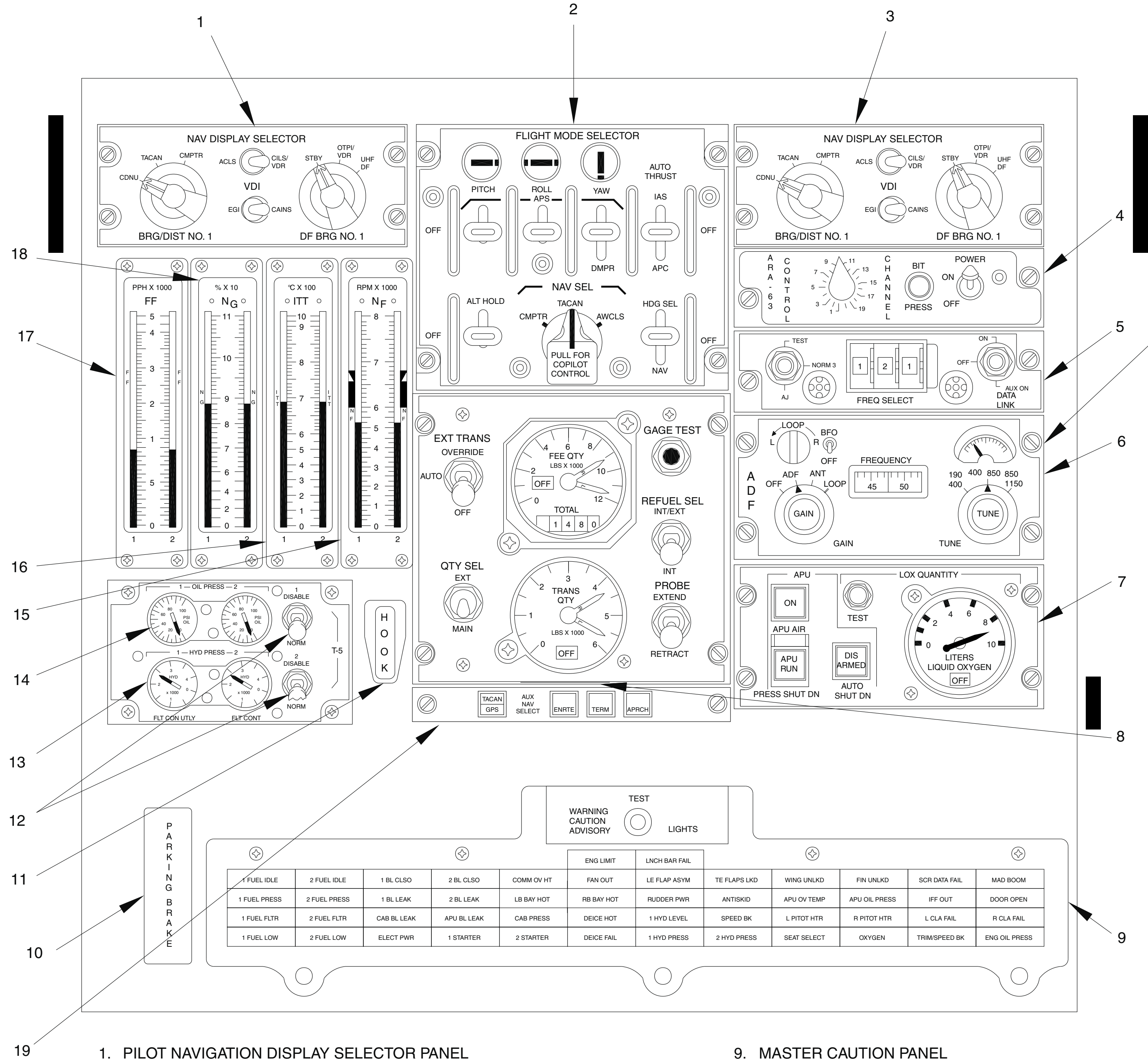
Pilot and Copilot/COTAC Instrument Panel
(Aircraft Not Incorporating AFC-279)

PILOT INSTRUMENT PANEL
(TYPICAL)



1. AIRSPEED/MACH INDICATOR
2. ALTIMETER
3. AUTOMATIC CARRIER LANDING SYSTEM (ACLS) DISCRETE WORD DISPLAY PANEL
4. EFI VERTICAL DIRECTOR INDICATOR
5. EFI CONTROL PANEL
6. RADAR ALTIMETER WARNING SYSTEM LIGHT
7. LANDING GEAR WARNING LIGHT
8. ANALOG TAPE RECORDER RACK UNLOCKED WARNING LIGHT
9. ECM READY LIGHT
10. MISSILE FIRE WARNING LIGHTS
11. ENGINE FIRE WARNING LIGHTS
12. MASTER CAUTION LIGHT
13. APU FIRE WARNING LIGHT
14. PILOT DISPLAY PANEL
15. EMERGENCY BRAKE PRESSURE INDICATOR
16. NWS LIGHT
17. MASTER ARM/SEARCH POWER CUE LIGHTS
18. PITCH TRIM INDICATOR
19. FLAPS/ELEV INPUT
20. ROLL TRIM INDICATOR
21. EFI HORIZONTAL SITUATION INDICATOR
22. ACCELEROMETER
23. VERTICAL SPEED INDICATOR
24. OAT INDICATOR
25. STANDBY ATTITUDE INDICATOR
26. TRAILING EDGE FLAPS POSITION INDICATOR
27. LEADING EDGE FLAPS POSITION INDICATOR
28. LANDING GEAR POSITION INDICATOR
29. SPEEDBRAKES POSITION INDICATOR
30. LANDING GEAR HANDLE/INDICATOR
31. EXTERNAL STORES JETTISON SWITCH
32. RADAR ALTIMETER
33. ANGLE-OF-ATTACK (AOA) INDICATOR
34. CLOCK
35. FAILURE ANNUNCIATOR (FA) PANELS

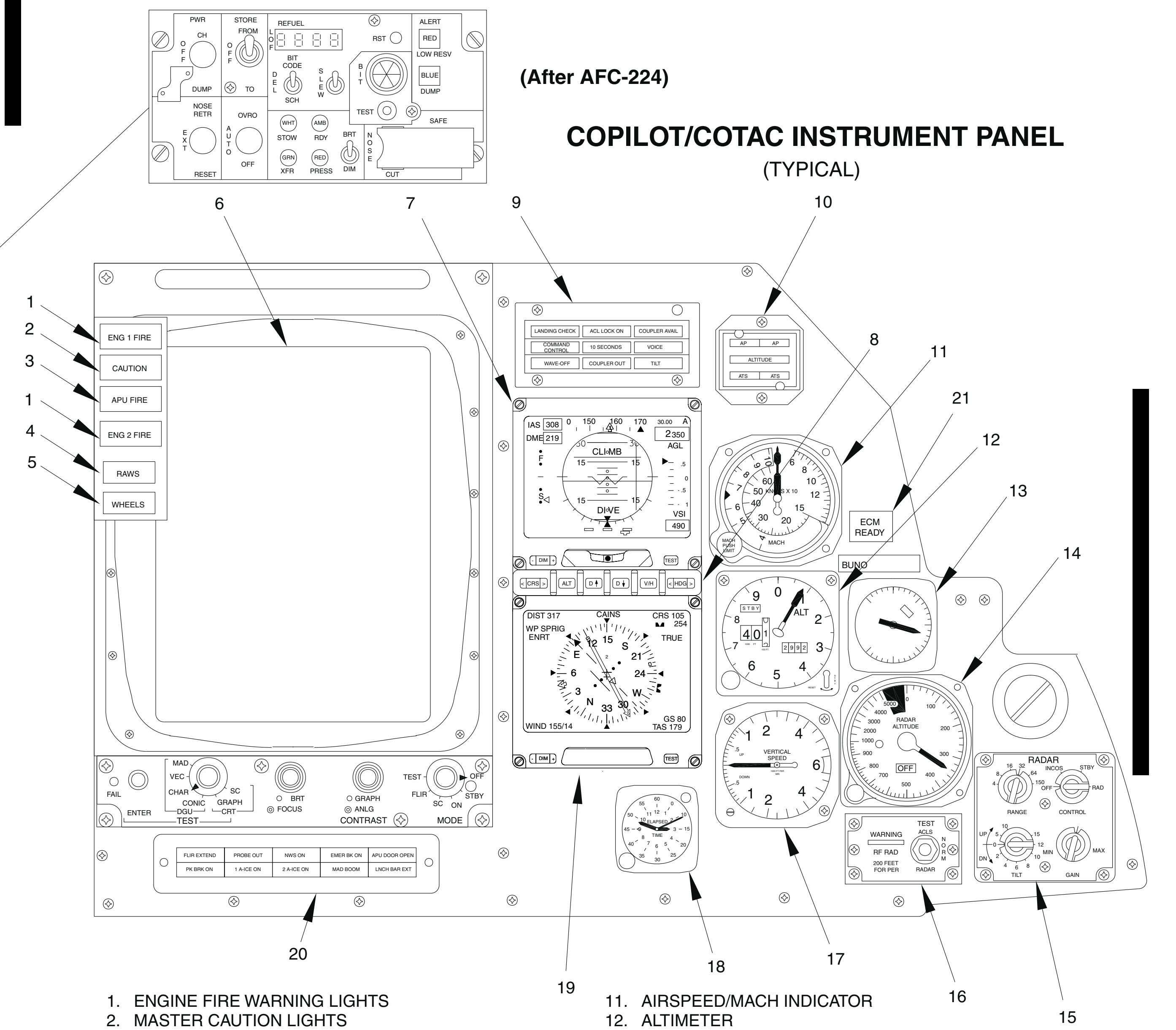
CENTER INSTRUMENT PANEL
(TYPICAL)



1. PILOT NAVIGATION DISPLAY SELECTOR PANEL
2. FLIGHT MODE SELECTOR PANEL
3. COPILOT/COTAC NAVIGATION DISPLAY SELECTOR PANEL
4. CARRIER INSTRUMENT LANDING SYSTEM (CILS) RECEIVER DECODER PANEL
5. DATA LINK SELECTOR PANEL
6. LF ADF CONTROL PANEL ARS CONTROL PANELS (AFTER AFC 220)
7. CREW OXYGEN QUANTITY/APU CONTROL INDICATORS PANEL
8. FUEL SYSTEM CONTROL PANEL
9. MASTER CAUTION PANEL
10. PARKING BRAKE PANEL
11. ARRESTING HOOK HANDLE
12. T-5 DISABLE (ITT) SWITCHES
13. HYDRAULIC SYSTEM PRESSURE INDICATORS
14. ENGINE OIL PRESSURE INDICATORS
15. ENGINE FAN SPEED (N_F) INDICATOR
16. ENGINE INTERTURBINE TEMPERATURE (ITT) INDICATOR
17. ENGINE FUEL FLOW (FF) INDICATOR
18. ENGINE GAS GENERATOR SPEED (N_G) INDICATOR
19. AUX NAV SELECT PANEL

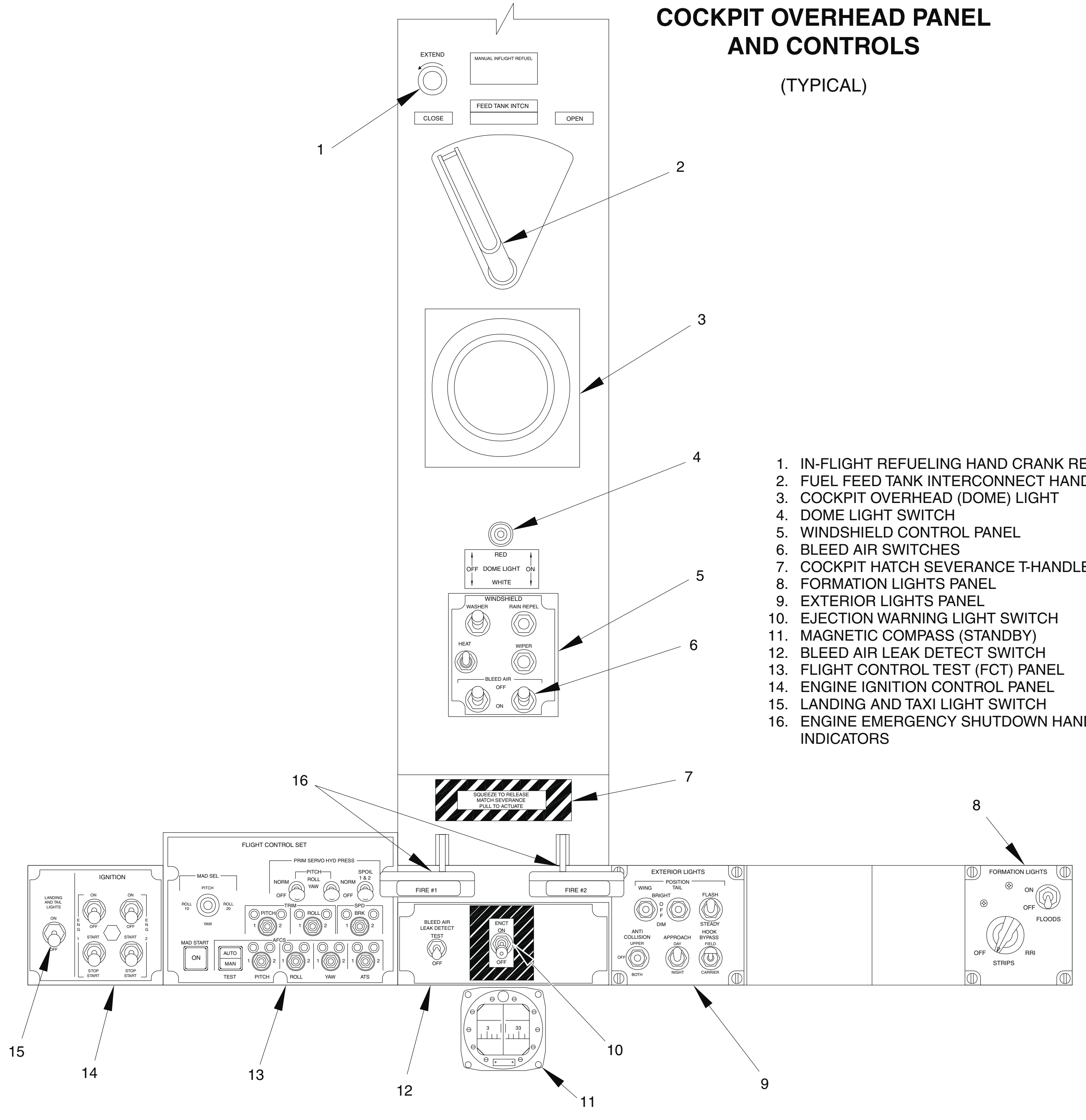
(After AFC-224)

COPILOT/COTAC INSTRUMENT PANEL
(TYPICAL)



1. ENGINE FIRE WARNING LIGHTS
2. MASTER CAUTION LIGHTS
3. APU FIRE WARNING LIGHT
4. RADAR ALTIMETER WARNING SYSTEM LIGHT
5. LANDING GEAR WARNING LIGHT
6. COPILOT/COTAC MULTIPURPOSE DISPLAY (MPD) PANEL
7. EFI VERTICAL DIRECTOR INDICATOR
8. EFI CONTROL PANEL
9. AUTOMATIC CARRIER LANDING SYSTEM (ACLS) DISCRETE WORD DISPLAY PANEL
10. FAILURE ANNUNCIATOR (FA) PANELS
11. AIRSPEED/MACH INDICATOR
12. ALTIMETER
13. ANGLE OF ATTACK (AOA) INDICATOR
14. RADAR ALTIMETER
15. RADAR OFF-LINE CONTROL PANEL
16. ACLS TEST PANEL
17. VERTICAL SPEED INDICATOR
18. CLOCK
19. EFI HORIZONTAL SITUATION INDICATOR
20. ADVISORY PANEL
21. ECM READY LIGHT

COCKPIT OVERHEAD PANEL AND CONTROLS
(TYPICAL)

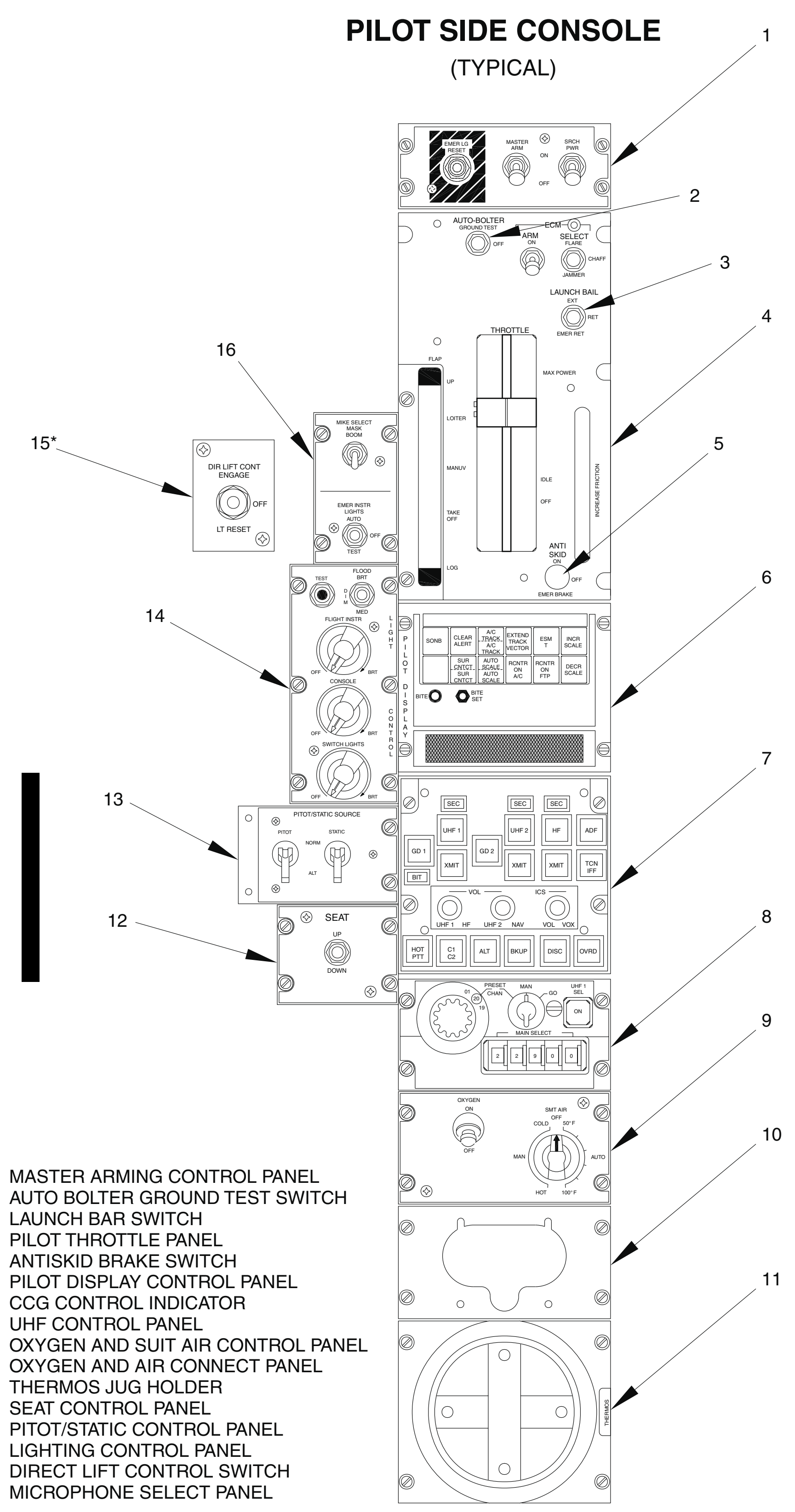


1. IN-FLIGHT REFUELING HAND CRANK RECEPTACLE
2. FUEL FEED TANK INTERCONNECT HANDLE
3. COCKPIT OVERHEAD (DOME) LIGHT
4. DOME LIGHT SWITCH
5. WINDSHIELD CONTROL PANEL
6. BLEED AIR SWITCHES
7. COCKPIT HATCH SEVERANCE T-HANDLE
8. FORMATION LIGHTS PANEL
9. EXTERIOR LIGHTS PANEL
10. EJECTION WARNING LIGHT SWITCH
11. MAGNETIC COMPASS (STANDBY)
12. BLEED AIR LEAK DETECT SWITCH
13. FLIGHT CONTROL TEST (FCT) PANEL
14. ENGINE IGNITION CONTROL PANEL
15. LANDING AND TAXI LIGHT SWITCH
16. ENGINE EMERGENCY SHUTDOWN HANDLES/ INDICATORS

Pilot and Copilot/COTAC Instrument Panel
(Aircraft Incorporating AFC-279)

PILOT SIDE CONSOLE

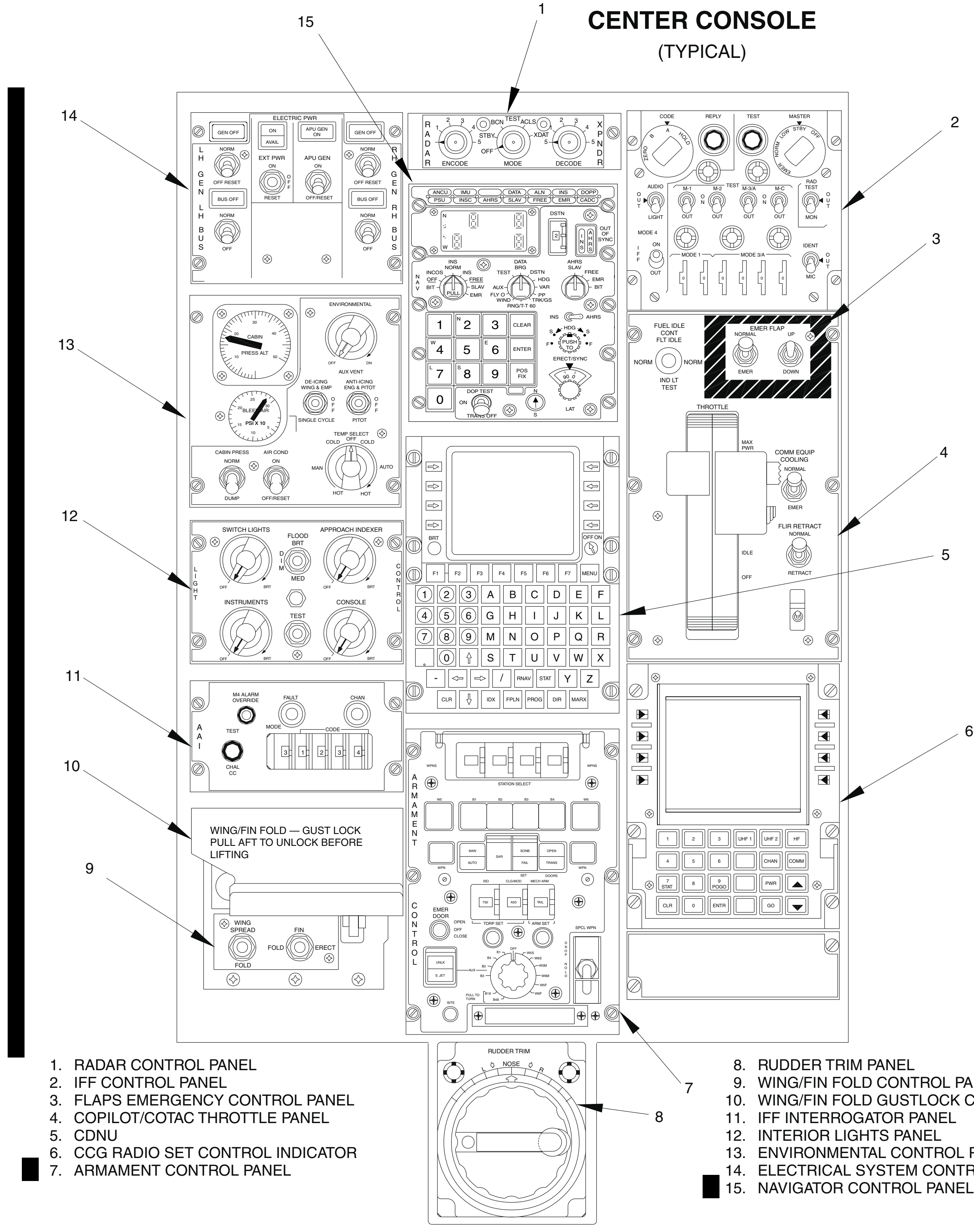
(TYPICAL)



1. MASTER ARMING CONTROL PANEL
2. AUTO BOLTER GROUND TEST SWITCH
3. LAUNCH BAR SWITCH
4. PILOT THROTTLE PANEL
5. ANTISKID BRAKE SWITCH
6. PILOT DISPLAY CONTROL PANEL
7. CCG CONTROL INDICATOR
8. UHF CONTROL PANEL
9. OXYGEN AND SUIT AIR CONTROL PANEL
10. OXYGEN AND AIR CONNECT PANEL
11. THERMOS JUG HOLDER
12. SEAT CONTROL PANEL
13. PITOT/STATIC CONTROL PANEL
14. LIGHTING CONTROL PANEL
15. DIRECT LIFT CONTROL SWITCH
16. MICROPHONE SELECT PANEL

CENTER CONSOLE

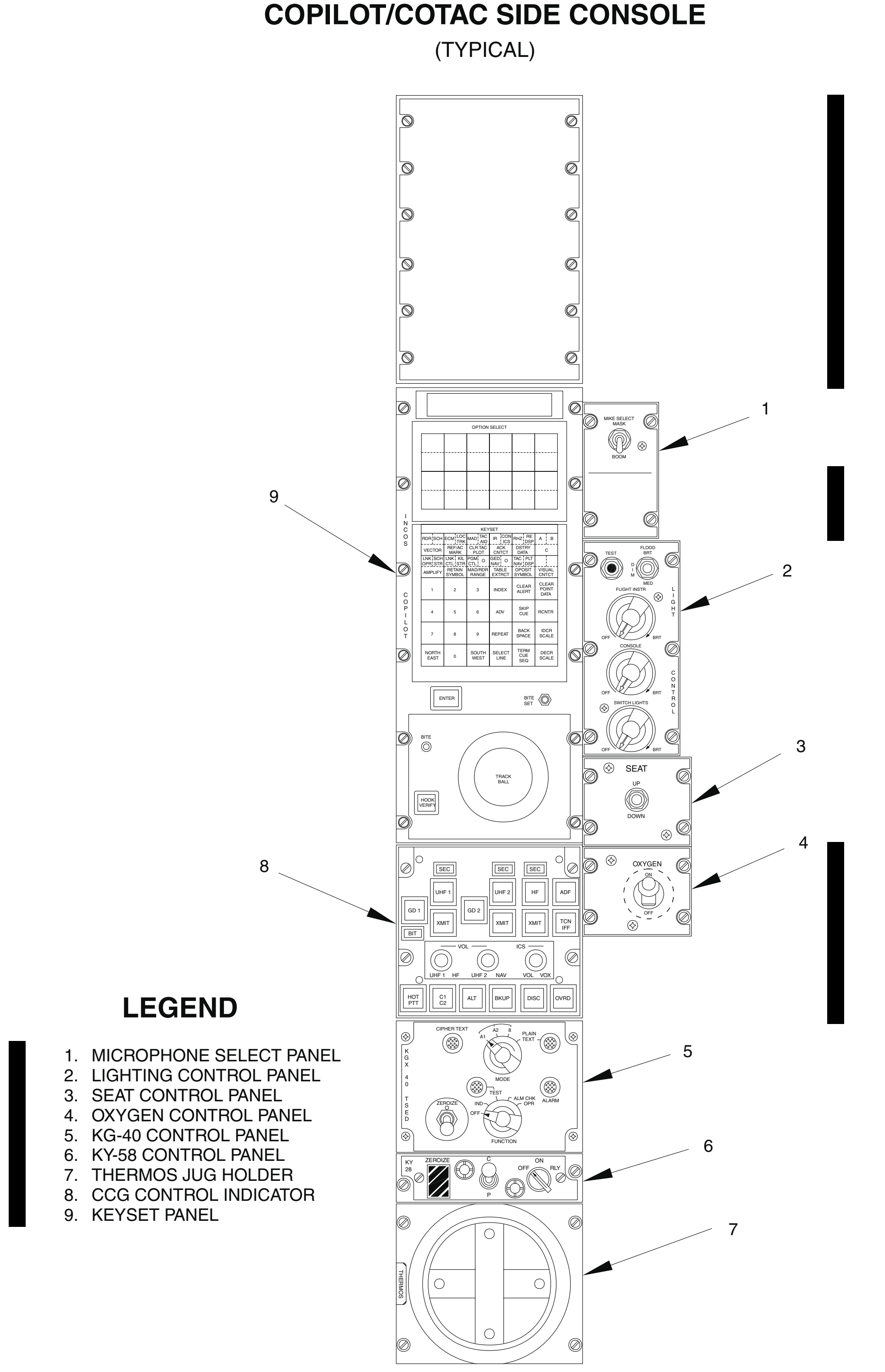
(TYPICAL)



1. RADAR CONTROL PANEL
2. IFF CONTROL PANEL
3. FLAPS EMERGENCY CONTROL PANEL
4. COPILOT/COTAC THROTTLE PANEL
5. CDNU
6. CCG RADIO SET CONTROL INDICATOR
7. ARMAMENT CONTROL PANEL
8. RUDDER TRIM PANEL
9. WING/FIN FOLD CONTROL PANEL
10. WING/FIN FOLD GUSTLOCK COVER
11. IFF INTERROGATOR PANEL
12. INTERIOR LIGHTS PANEL
13. ENVIRONMENTAL CONTROL PANEL
14. ELECTRICAL SYSTEM CONTROL PANEL
15. NAVIGATOR CONTROL PANEL

COPILOT/COTAC SIDE CONSOLE

(TYPICAL)



LEGEND

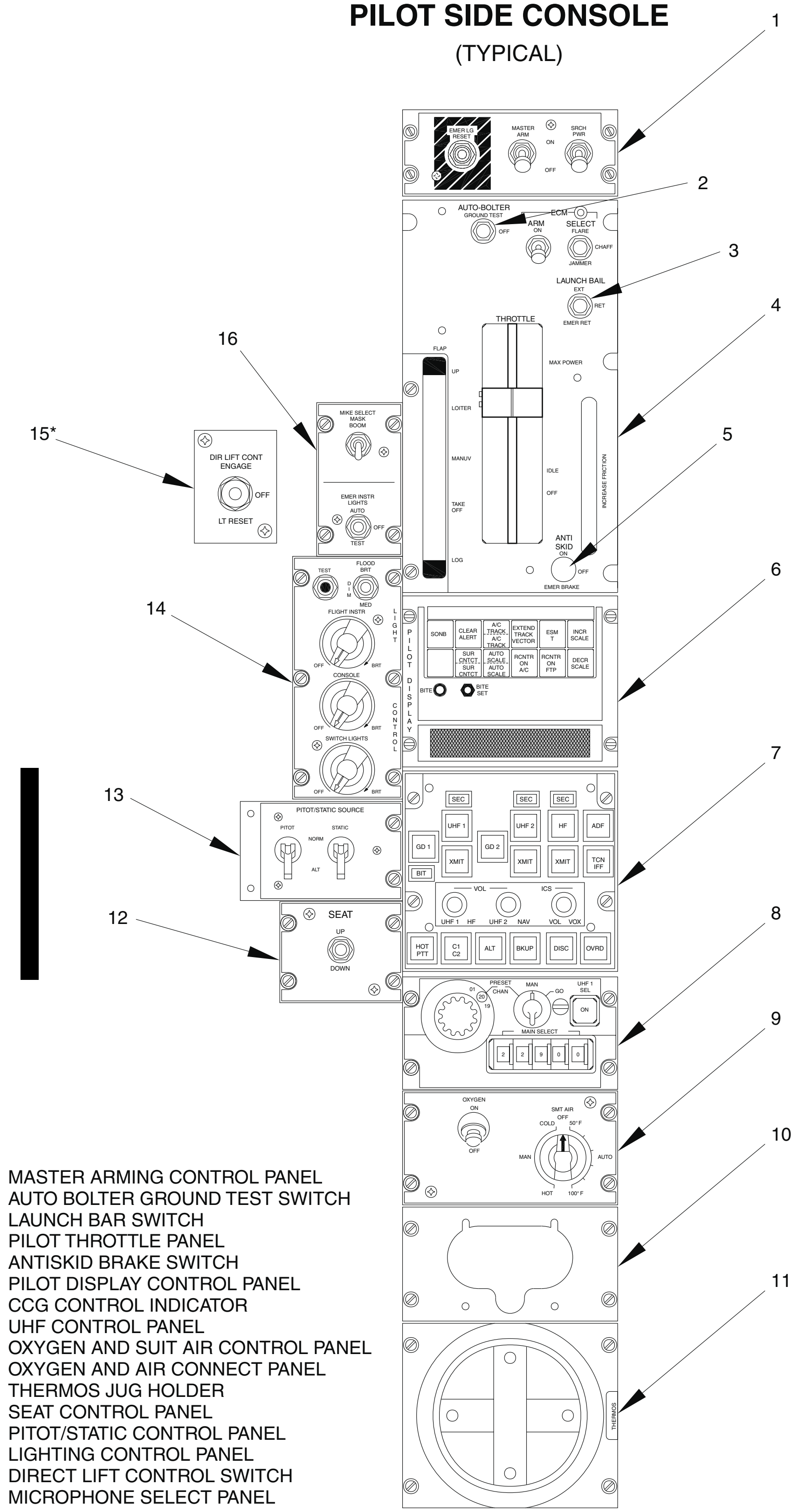
1. MICROPHONE SELECT PANEL
2. LIGHTING CONTROL PANEL
3. SEAT CONTROL PANEL
4. OXYGEN CONTROL PANEL
5. KG-40 CONTROL PANEL
6. KY-58 CONTROL PANEL
7. THERMOS JUG HOLDER
8. CCG CONTROL INDICATOR
9. KEYSET PANEL

Pilot and Copilot/COTAC Consoles
(Aircraft Not Incorporating AFC-279)

FO-3 (Reverse Blank)

PILOT SIDE CONSOLE

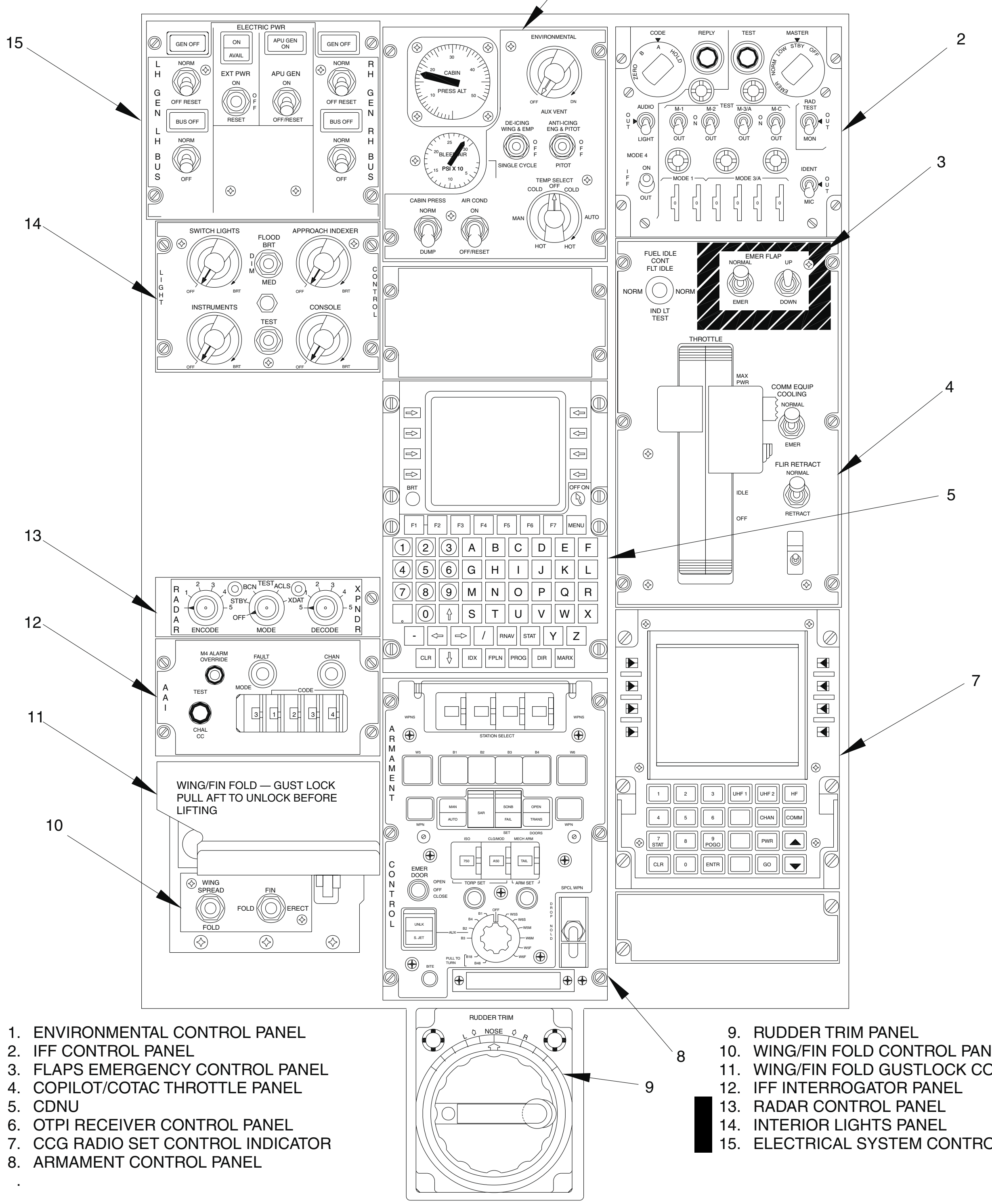
(TYPICAL)



1. MASTER ARMING CONTROL PANEL
2. AUTO BOLTER GROUND TEST SWITCH
3. LAUNCH BAR SWITCH
4. PILOT THROTTLE PANEL
5. ANTISKID BRAKE SWITCH
6. PILOT DISPLAY CONTROL PANEL
7. CCG CONTROL INDICATOR
8. UHF CONTROL PANEL
9. OXYGEN AND SUIT AIR CONTROL PANEL
10. OXYGEN AND AIR CONNECT PANEL
11. THERMOS JUG HOLDER
12. SEAT CONTROL PANEL
13. PITOT/STATIC CONTROL PANEL
14. LIGHTING CONTROL PANEL
15. DIRECT LIFT CONTROL SWITCH
16. MICROPHONE SELECT PANEL

CENTER CONSOLE

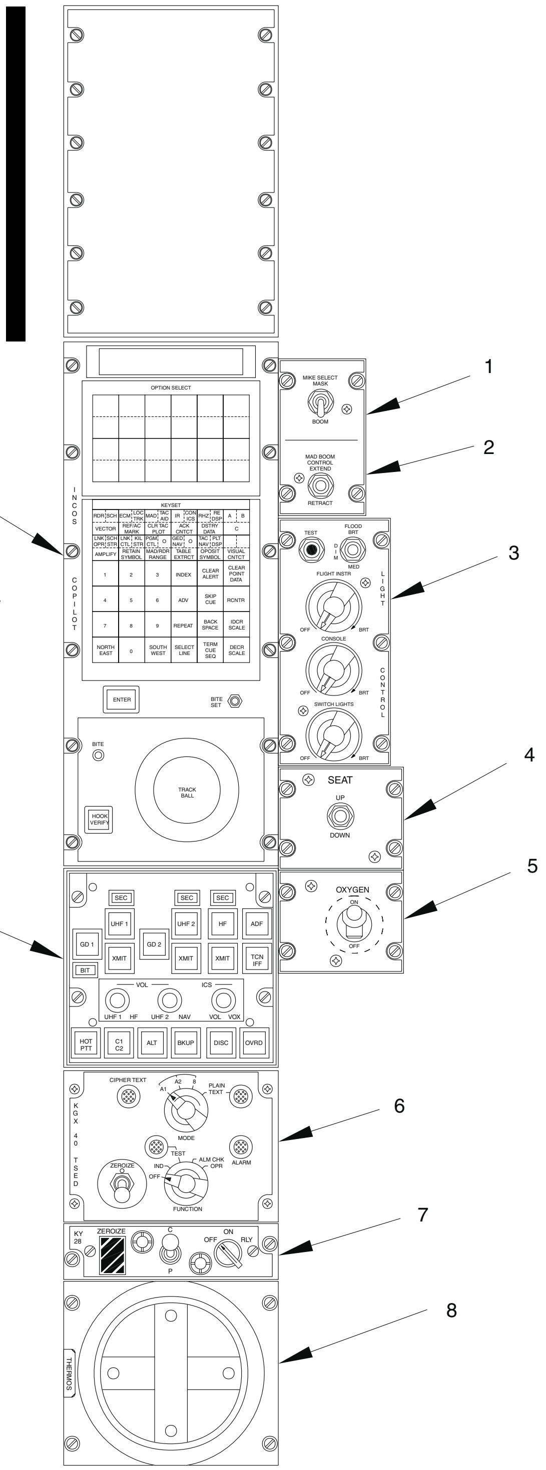
(TYPICAL)



1. ENVIRONMENTAL CONTROL PANEL
2. IFF CONTROL PANEL
3. FLAPS EMERGENCY CONTROL PANEL
4. COPILOT/COTAC THROTTLE PANEL
5. CDNU
6. OTPI RECEIVER CONTROL PANEL
7. CCG RADIO SET CONTROL INDICATOR
8. ARMAMENT CONTROL PANEL
9. RUDDER TRIM PANEL
10. WING/FIN FOLD CONTROL PANEL
11. WING/FIN FOLD GUSTLOCK COVER
12. IFF INTERROGATOR PANEL
13. RADAR CONTROL PANEL
14. INTERIOR LIGHTS PANEL
15. ELECTRICAL SYSTEM CONTROL PANEL

COPILOT/COTAC SIDE CONSOLE

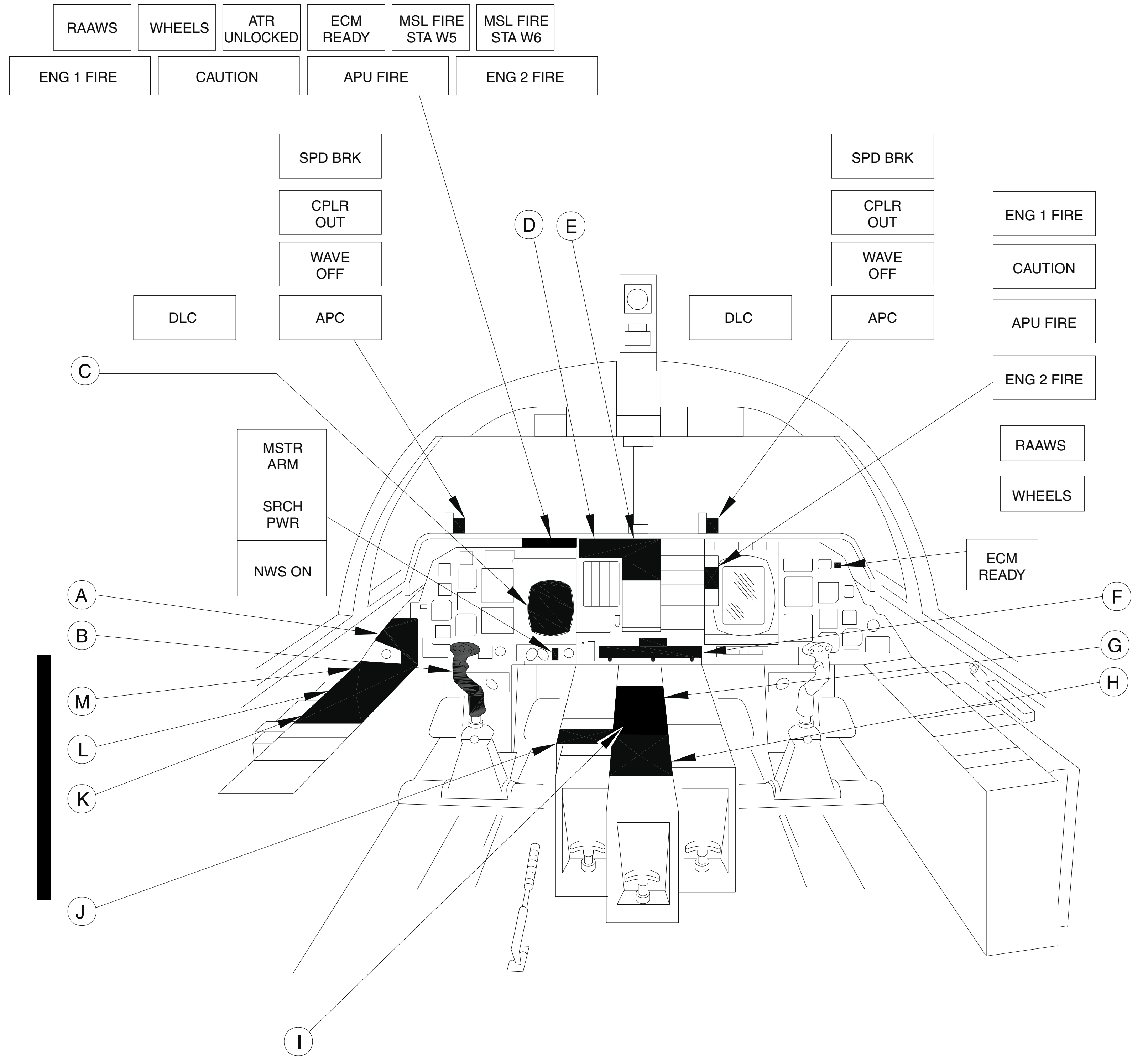
(TYPICAL)



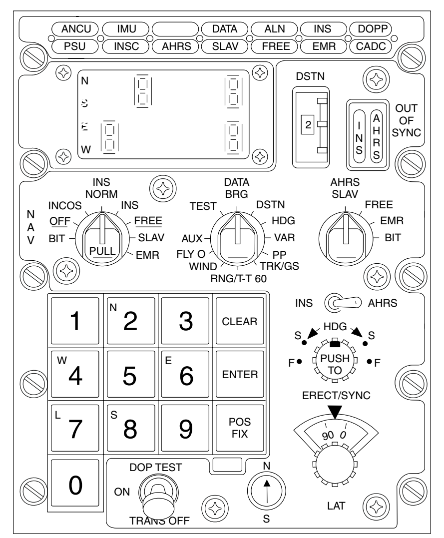
LEGEND

1. MICROPHONE SELECT PANEL
2. MAD BOOM CONTROL PANEL
3. LIGHTING CONTROL PANEL
4. SEAT CONTROL PANEL
5. OXYGEN CONTROL PANEL
6. KG-40 CONTROL PANEL
7. KY-58 CONTROL PANEL
8. THERMOS JUG HOLDER
9. CCG CONTROL INDICATOR
10. KEYSET PANEL

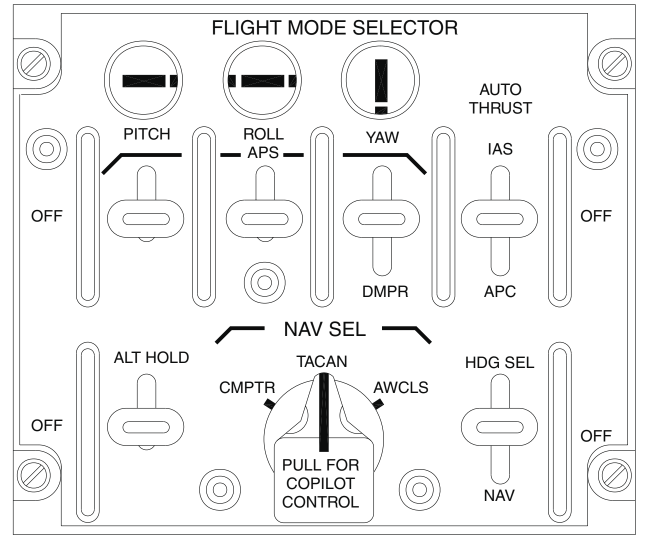
Pilot and Copilot/COTAC Consoles
(Aircraft Incorporating AFC-279)



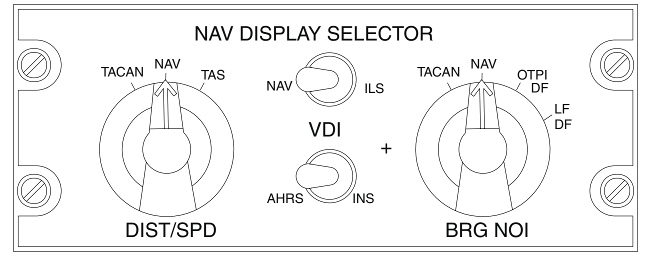
DETAIL I
NAVIGATOR CONTROL PANEL



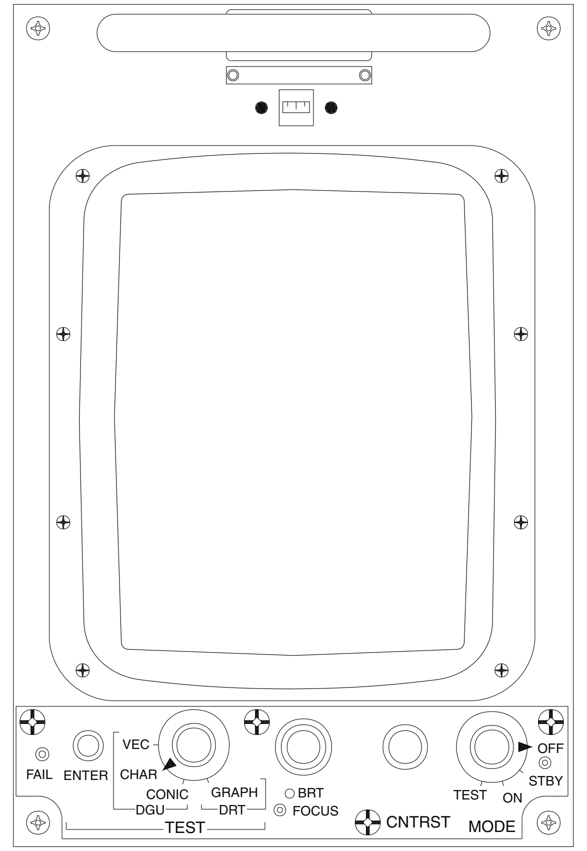
DETAIL E
FLIGHT MODE SELECTOR



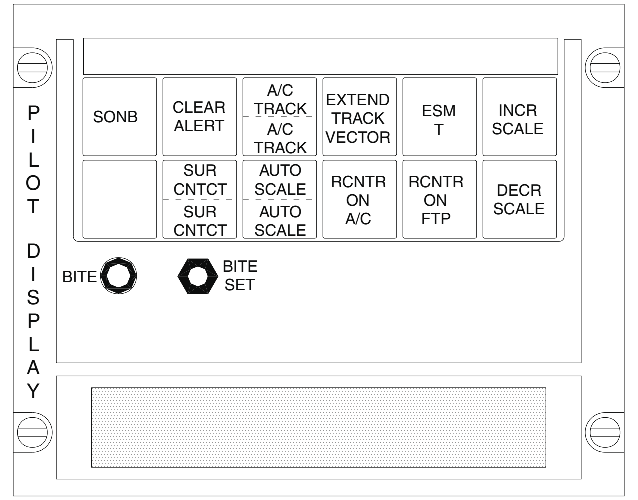
DETAIL D
NAV DISPLAY SELECTOR



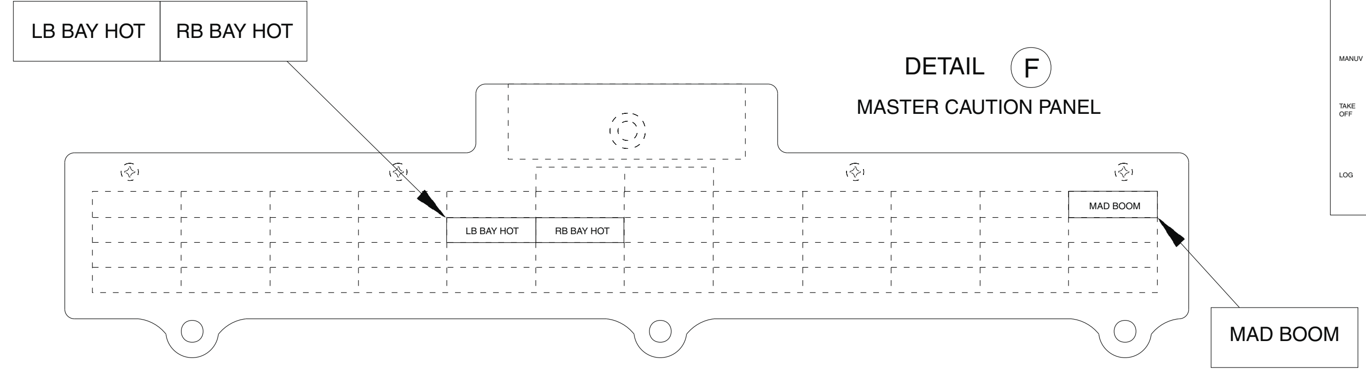
DETAIL C
PILOT DISPLAY UNIT



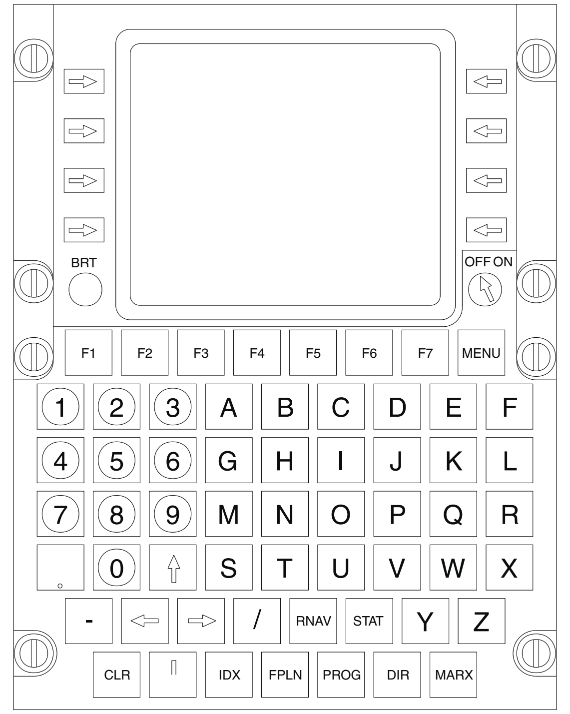
DETAIL K
PILOT DISPLAY CONTROL



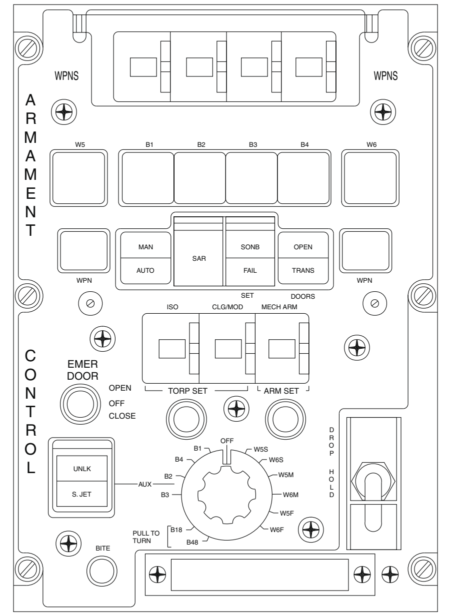
DETAIL F
MASTER CAUTION PANEL



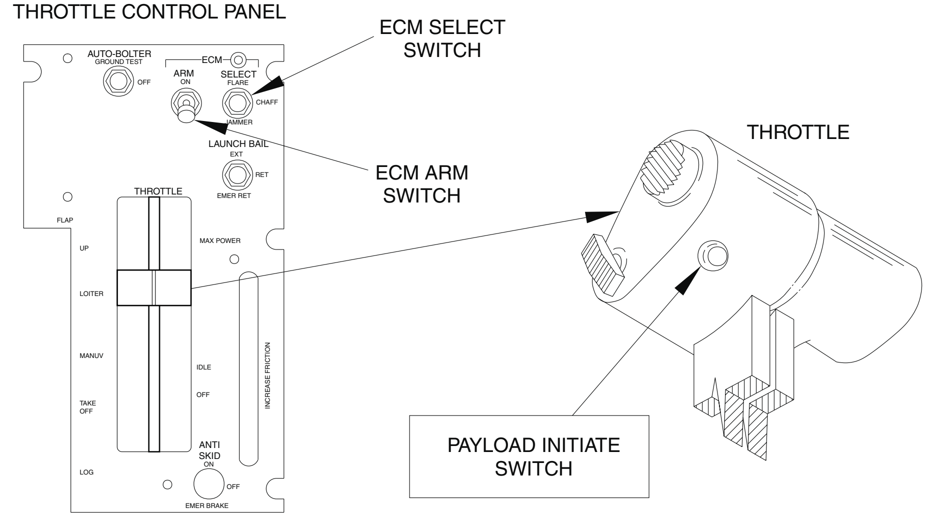
DETAIL G
CDNU



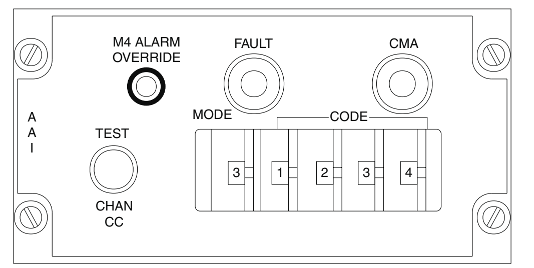
DETAIL H
ARMAMENT CONTROL PANEL



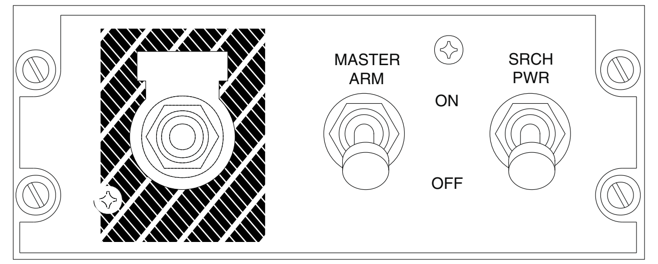
DETAIL L
THROTTLE CONTROL PANEL AND THROTTLE



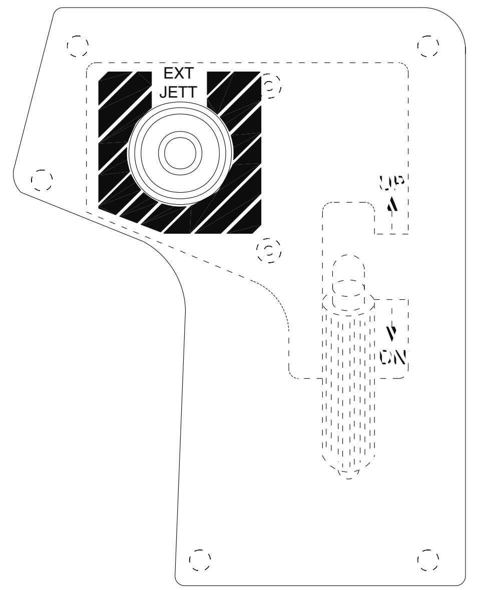
DETAIL J
AAI CONTROL PANEL



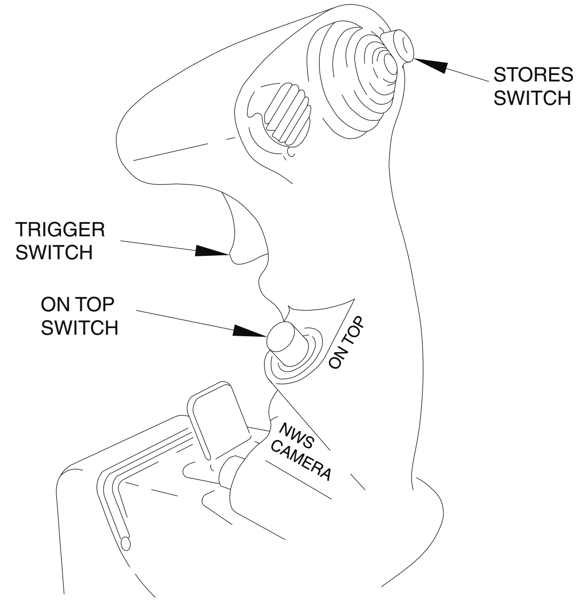
DETAIL M
MASTER ARM AND SEARCH POWER



DETAIL A
EMERGENCY JETTISON SWITCH



DETAIL B
PILOT CONTROL STICK



Pilot Station Weapon System Displays and Controls
(Aircraft Not Incorporating AFC-279)

Pilot Station Weapon System Displays and Controls
(Aircraft Incorporating AFC-279)

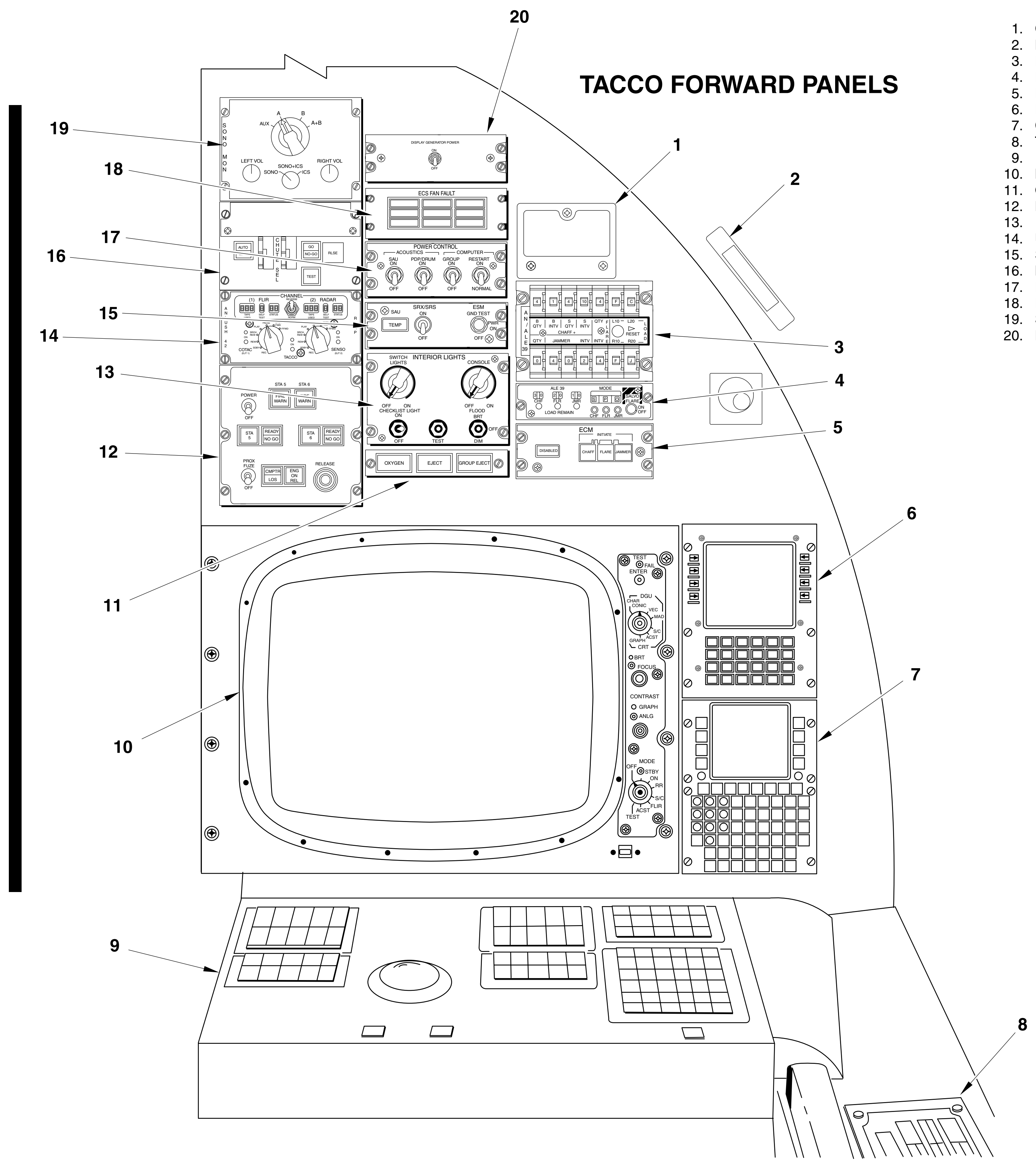
Copilot/COTAC Station Weapon System Displays and Controls
(Aircraft Not Incorporating AFC-279)

FO-7 (Reverse Blank)

Copilot/COTAC Station Weapon System Displays and Controls
(Aircraft Incorporating AFC-279)

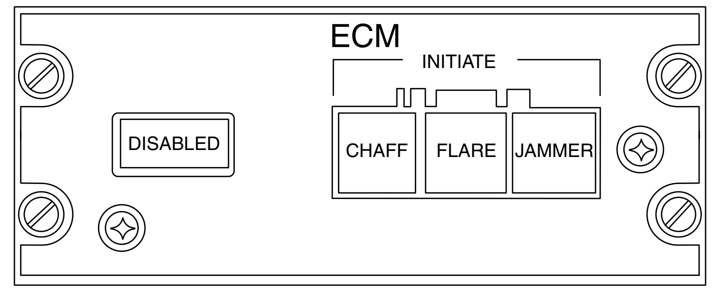
FO-8 (Reverse Blank)

TACCO FORWARD PANELS

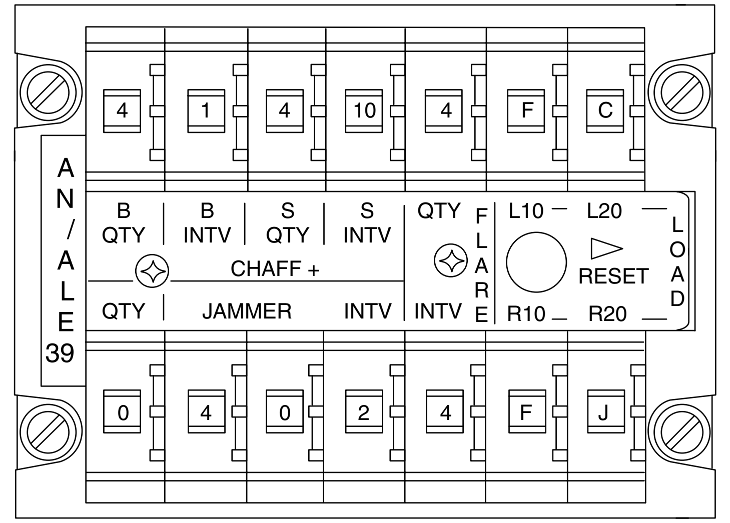


1. CHECKLIST HOLDER
2. HATCH SEVERANCE HANDLE
3. ECM PROGRAMMER PANEL
4. ECM CONTROL PANEL
5. ECM INITIATE PANEL
6. RSCI
7. CDNU
8. TACCO SIDE CONSOLE
9. INCOS TACCO TRAY
10. MPD AND CONTROL PANEL
11. OXYGEN/EJECT ADVISORY LIGHT
12. HACLCS CONTROL PANEL
13. INTERIOR LIGHTS PANEL
14. USH-42 REMOTE CONTROL AND ADVISOR
15. SONOBUOY POWER AND ESM GND TEST PANEL
16. MANUAL SEARCH STORES CONTROL PANEL
17. POWER CONTROL PANEL
18. ECS FAN FAULT PANEL
19. SONOBUOY MONITOR PANEL
20. DISPLAY GENERATOR POWER PANEL

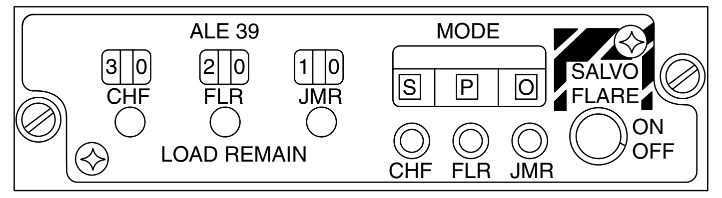
DETAIL 5
ECM INITIATE PANEL



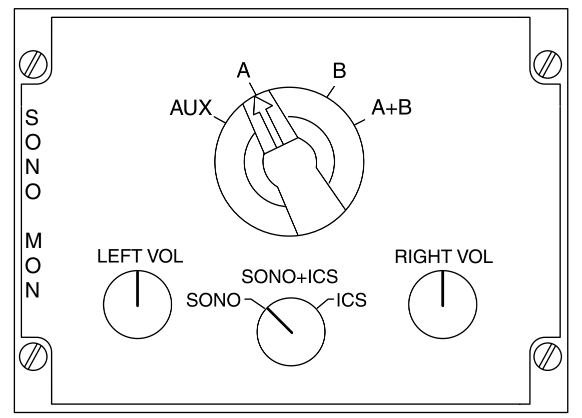
DETAIL 3
ECM PROGRAMMER PANEL



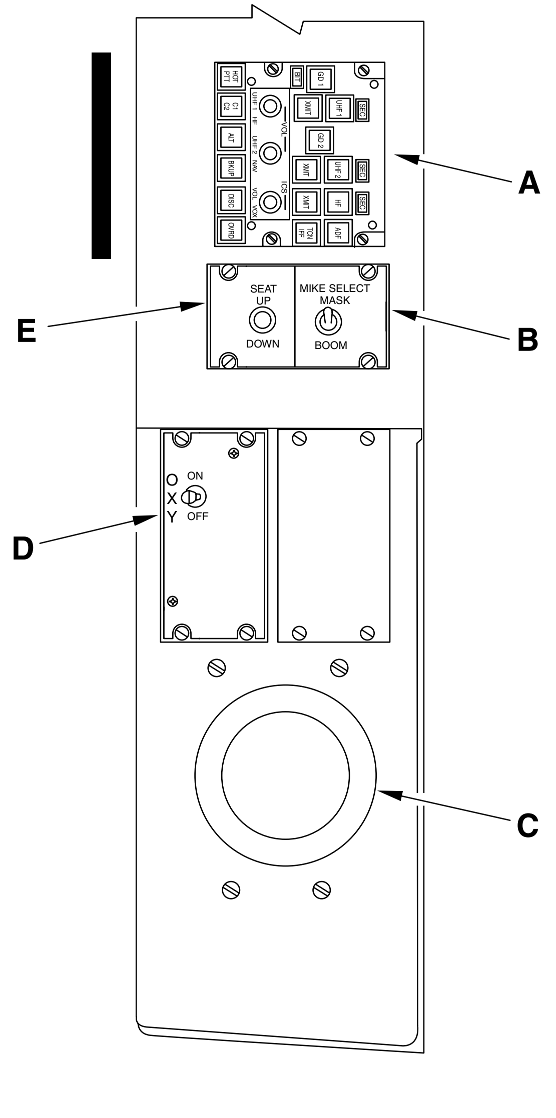
DETAIL 4
ECM CONTROL PANEL



DETAIL 19
SONO MONITOR PANEL

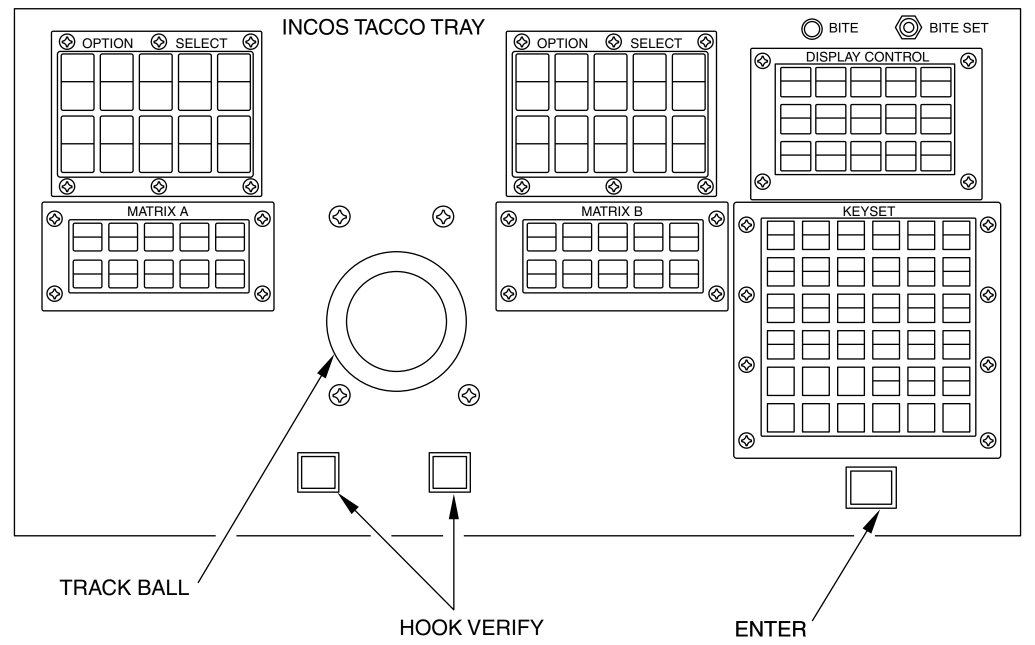


DETAIL 8
TACCO SIDE CONSOLE

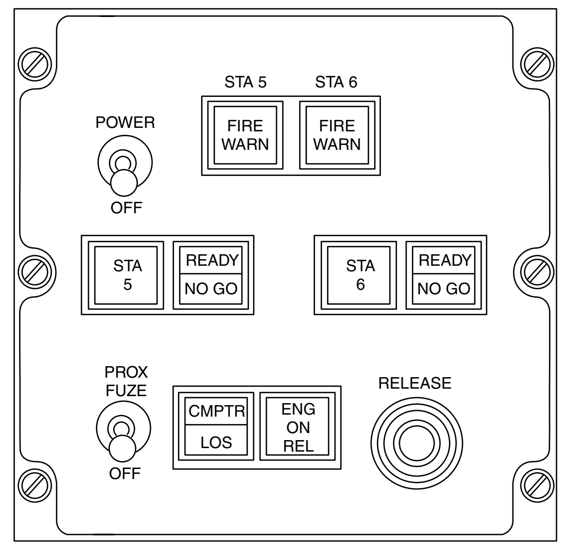


A CCG CONTROL INDICATOR
B MICROPHONE SELECT PANEL
C THERMOS JUG HOLDER
D OXYGEN PANEL
E SEAT ADJUSTMENT PANEL

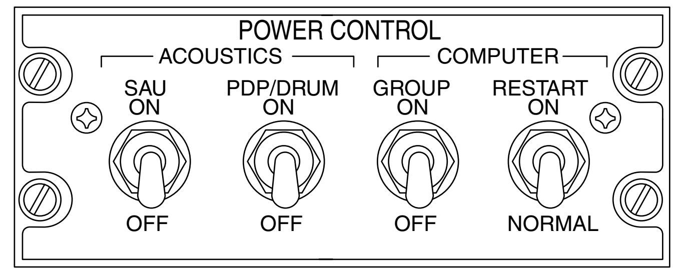
DETAIL 9
INCOS TACCO TRAY



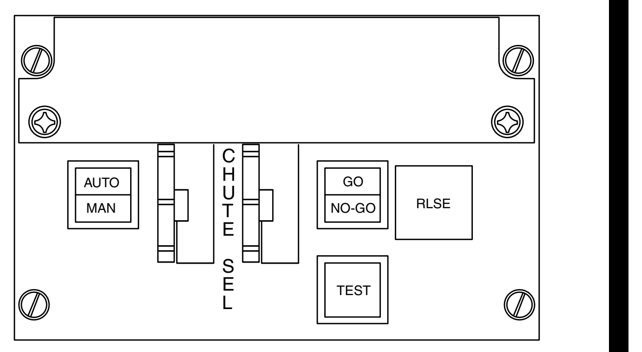
DETAIL 12
HACLCS CONTROL PANEL



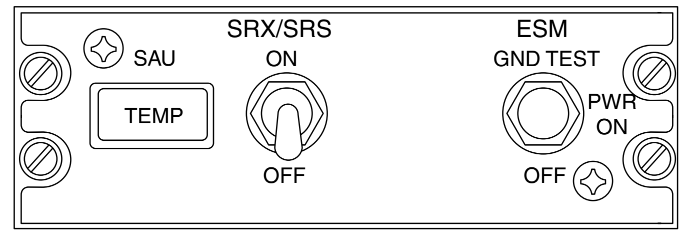
DETAIL 17
POWER CONTROL PANEL



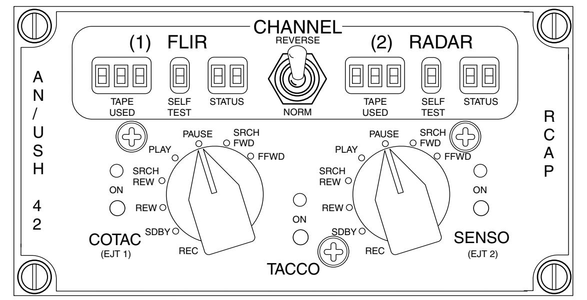
DETAIL 16
MANUAL SEARCH STORES CONTROL PANEL



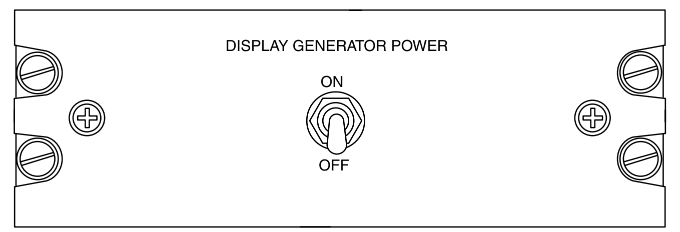
DETAIL 15
SONO POWER/ESM GND TEST PANEL



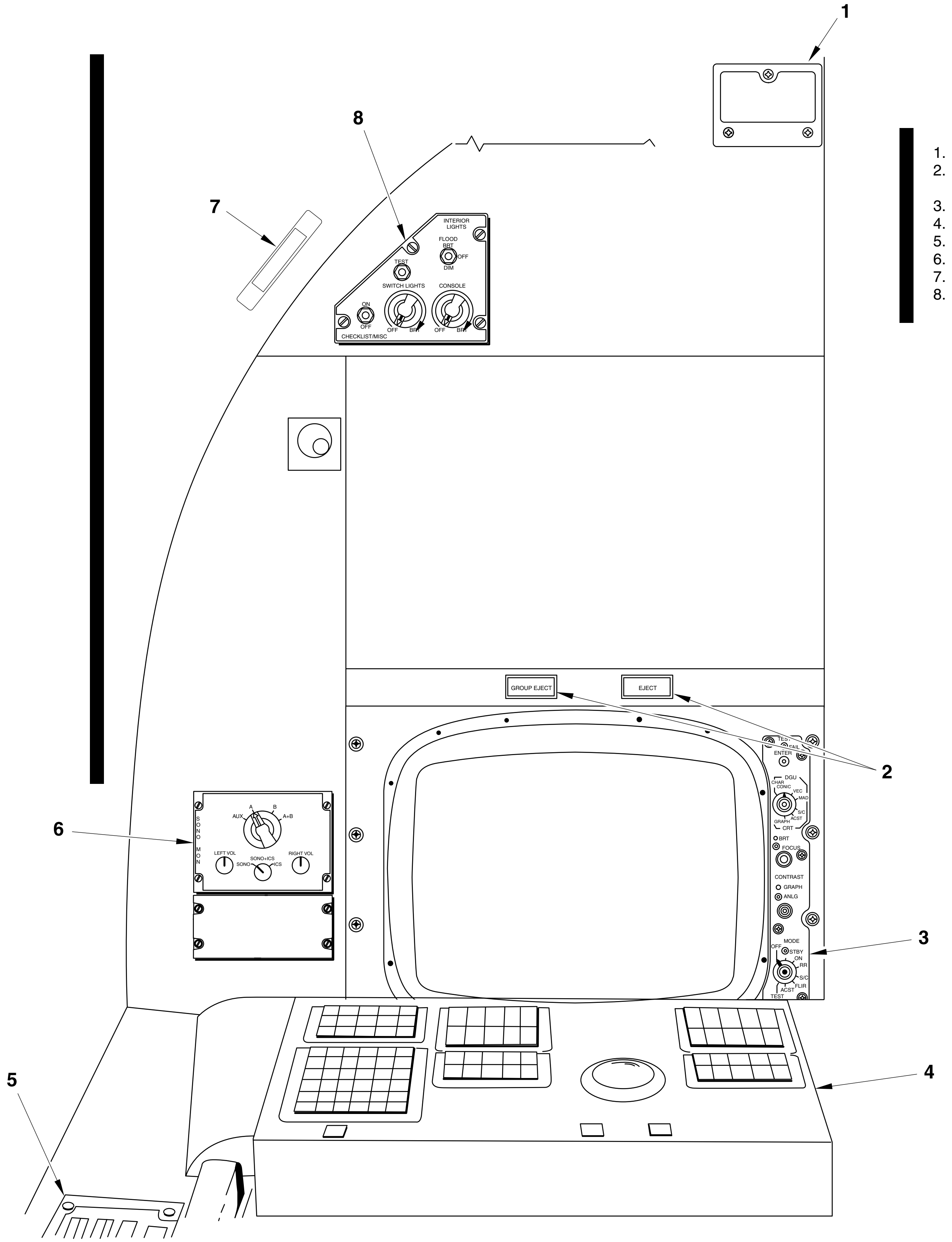
DETAIL 14
USH-42 REMOTE CONTROL AND ADVISOR



DETAIL 20
DISPLAY GENERATOR POWER PANEL



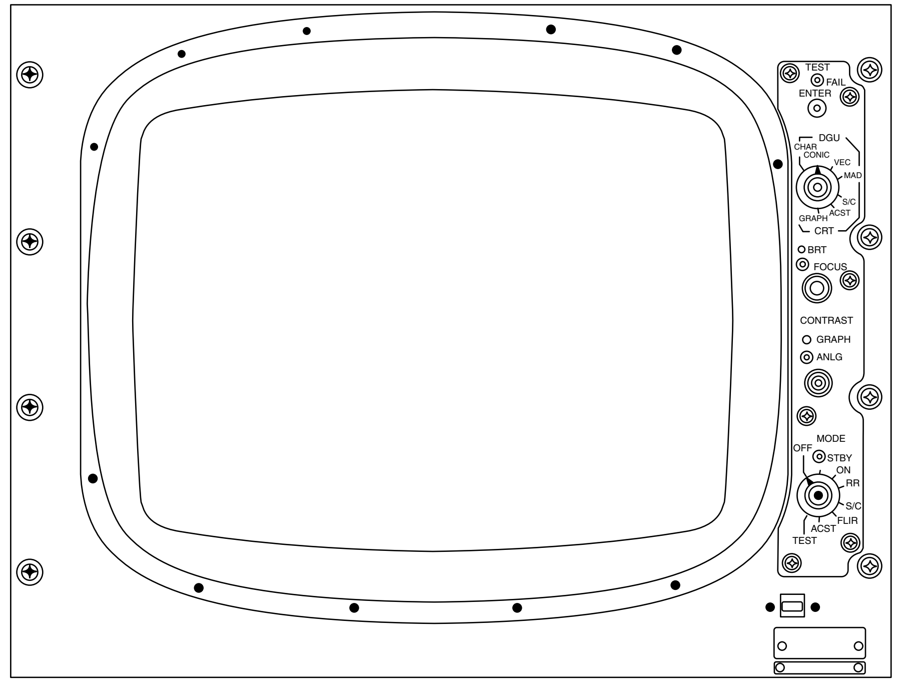
TACCO Station Weapon System Displays and Controls



1. CHECKLIST HOLDER
2. EJECT ALERT WARNING AND GROUP EJECT ADVISORY LIGHTS
3. MPD AND CONTROL PANEL
4. INCOS SENSO TRAY
5. SENSO SIDE PANEL
6. SONO MONITOR PANEL
7. HATCH SEVERENCE PANEL
8. INTERIOR LIGHTS PANEL

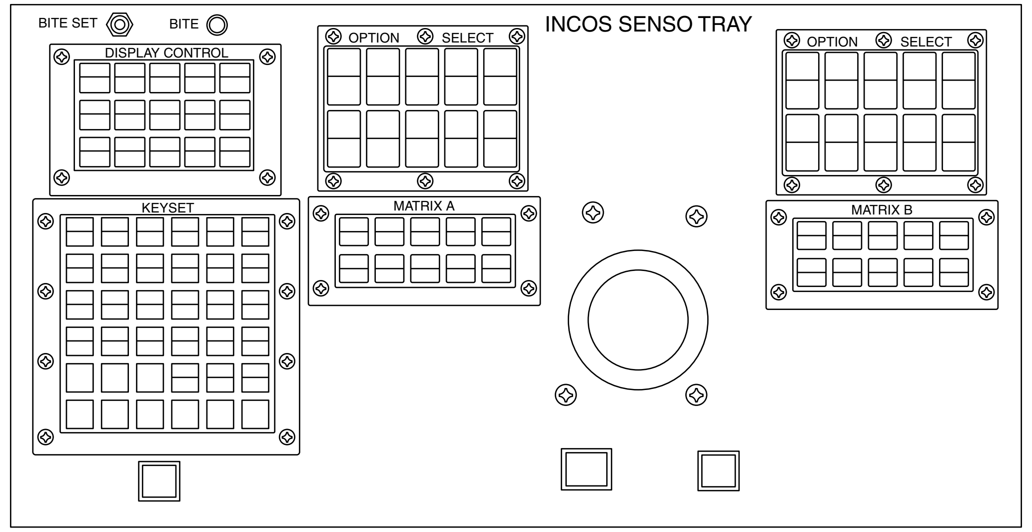
DETAIL 3

MULTIPURPOSE DISPLAY UNIT



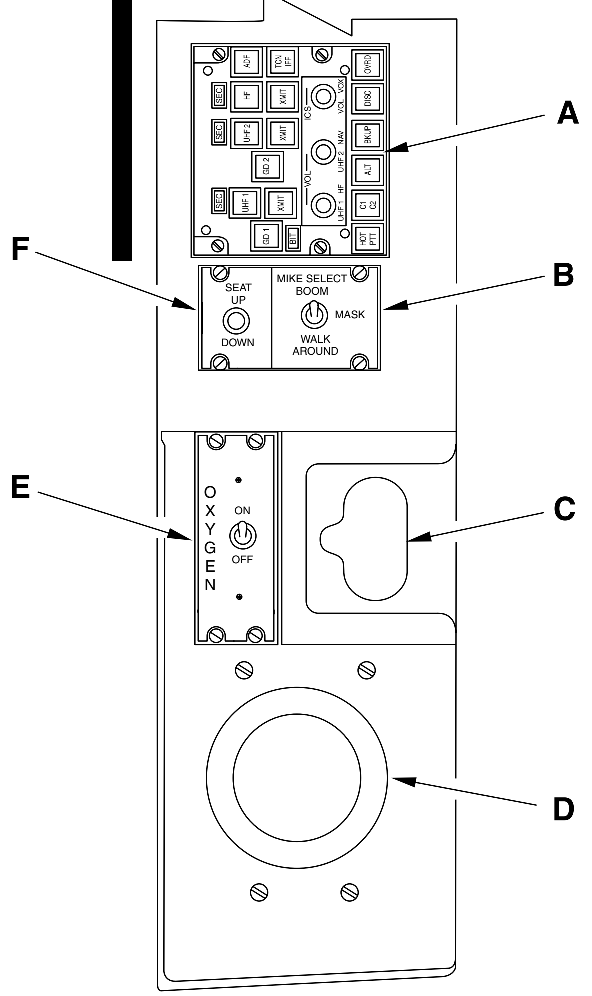
DETAIL 4

INCOS SENSO TRAY



DETAIL 5

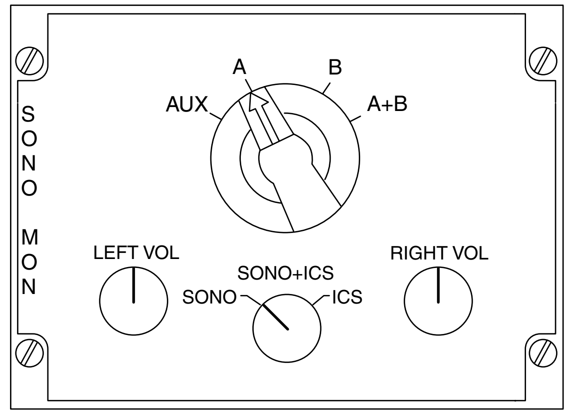
SENSO SIDE CONSOLE



A CCG CONTROL INDICATOR
B MICROPHONE SELECT PANEL
C LIFE SUPPORT (OXYGEN) CONNECTION
D THERMOS JUG HOLDER
E OXYGEN PANEL
F SEAT ADJUSTMENT PANEL

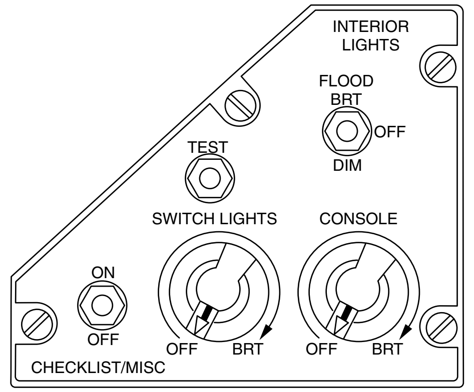
DETAIL 6

SONO MONITOR PANEL

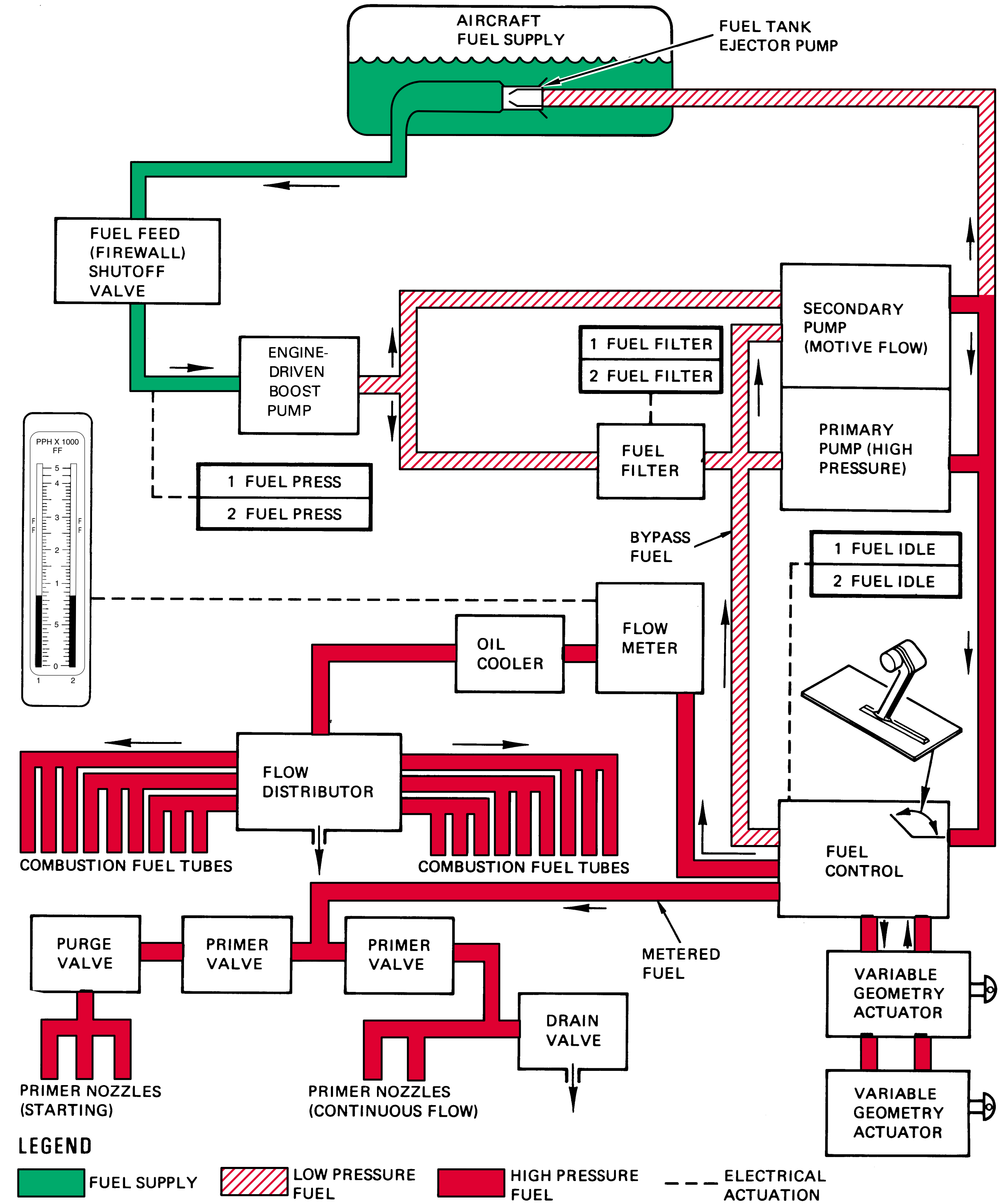


DETAIL 8

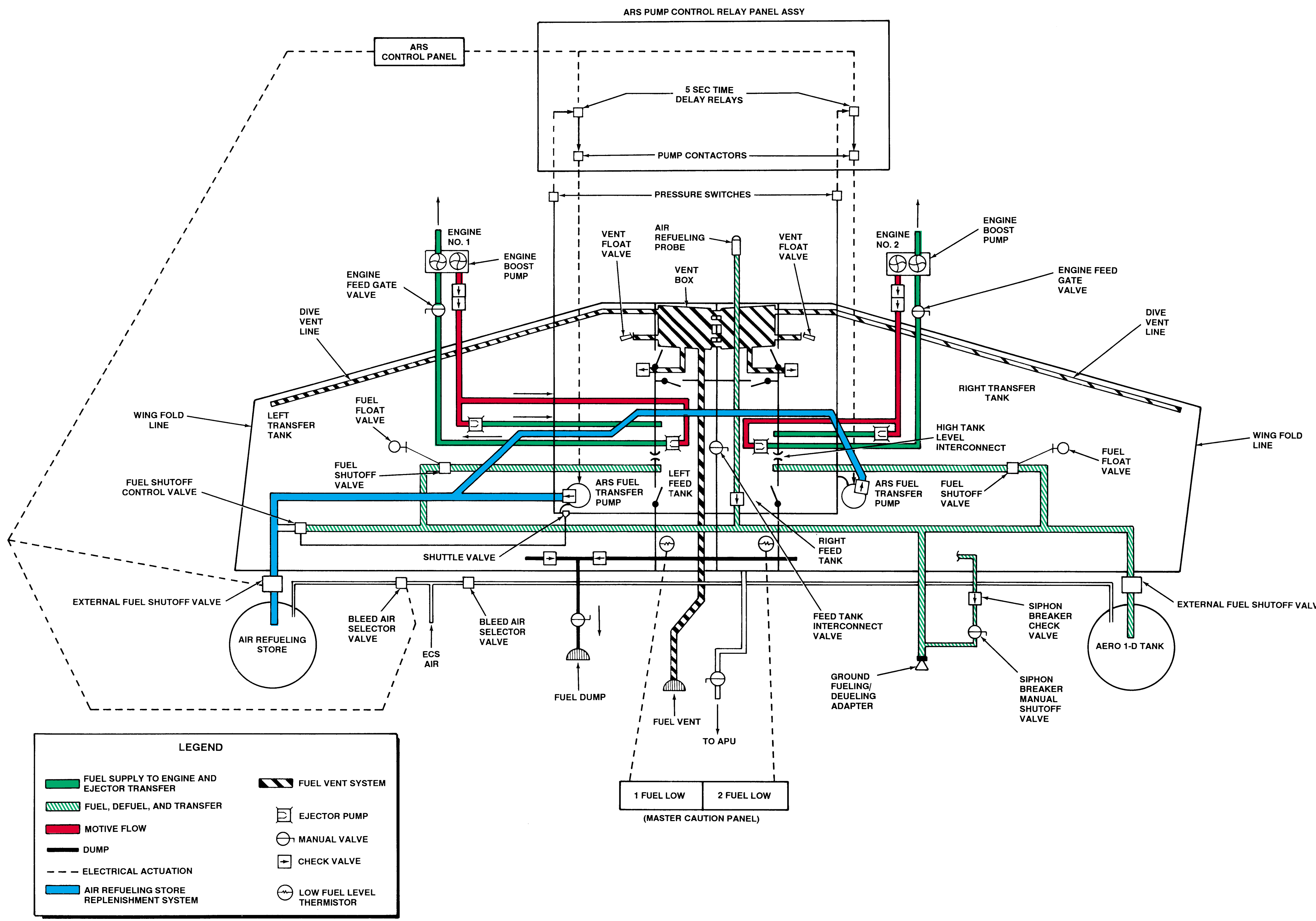
INTERIOR LIGHTS PANEL



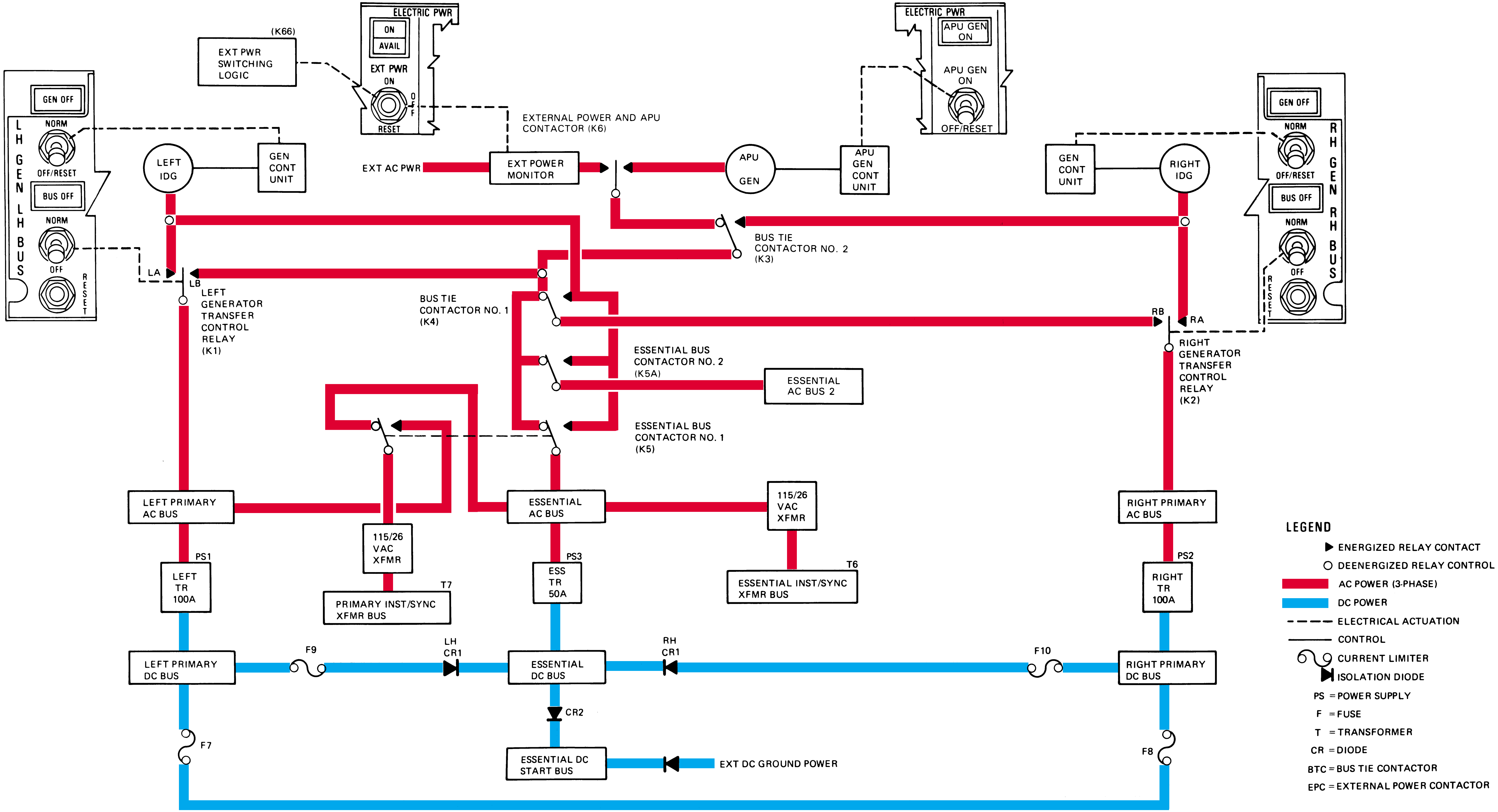
SENSO Station Weapon System Displays and Controls



Engine Fuel System



Aircraft Fuel System



Electrical Power System

A LEFT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
A ARS AC CONT	1–J–10	C	3.0
A ARS LH XFR PUMP PHASE A, B, C	1–B–10	3	15.0
A ARS RH XFR PUMP PHASE A, B, C	1–B–11	3	15.0
A BB BAY DOOR ELEC ACTR	1–B–1	3	15.0
A RADAR SYS POWER SUPPLY	1–B–10	3	10.0
A LE FLAP OUTBD ACTUATOR	1–B–2	3	7.5
A FWD AVIONICS FAN (L)	1–B–4	3	15.0
A WINDSHIELD ANTI ICING (L)	1–B–5	B,C	35.0
A AFCS CHAN NO. 1	1–B–6	3	5.0
A XFMR RECT (L)	1–B–7	3	15.0
A FLIR SYSTEM	1–B–9	3	7.5
A CENTRAL AIR DATA SYSTEM A	1–E–1	3	2.5
A DRUM POWER SUPPLY	1–E–10	3	2.5
A RADAR SYS SCAN CONV	1–E–10	3	2.5
[3] A FLIR/RADAR VIDEO RECORDER	1–E–11	3	2.5
A LWR SPOILER CONT	1–E–3	3	5.0
A PILOT & SENSO SEAT ADJ	1–E–4	3	5.0
A WINDSHIELD WASHER	1–E–5	3	2.5
A AFCS CHAN NO. 2	1–E–6	3	5.0
A SONAR DATA CMPTR NO. 2	1–E–7	3	2.5
A FLIR SYSTEM COOLER	1–E–9	3	5.0
A PRI INSTR SYNCHRO XFMR	1–G–1	A	2.5
A HACLCS STA 5 MGU/SEEKER HTR	1–G–11	A	7.5
A TOT TEMP PROBE HTR (L)	1–G–2	A	5.0
A SENSO SW LT DMR	1–G–3	A	5.0
A PILOT CONSOLE LT DMR	1–G–5	A	5.0
A UHF DF	1–G–7	A	2.5
A HACLCS STA 5 BTRY HTR	1–H–11	B	7.5
A CTR CSL INSTR LIGHT DMR	1–H–3	A	5.0
A SENSO CSL LT DMR	1–H–4	B	5.0
A PILOT FLIGHT INSTR LT DMR	1–H–5	C	5.0
A PITCH TRIM CHAN 2	1–H–7	A	15.0
[7] A COMM CTRLR	1–H–8	3	2.5
A GPDC POWER SUPPLY	1–H–9	3	7.5
A INCOS (L)	1–I–4	B	1.0
A UTIL OUT (L)	1–I–5	A	7.5
A DGTL MAG TAPE	1–I–7	A	5.0
A HACLCS STA 5 MISSILE	1–J–11	3	7.5
A LOGIC PWR XFMR NO. 1	1–J–4	B	5.0
A LAND/TAXI LT	1–J–5	C	5.0
A IFF INTRG	1–J–7	A	5.0
A ANTI COLLISION LT	1–K–5	C	5.0
A NLG STRG CONT	1–K–7	A	5.0
A SP BR & TRIM CONT SYS CHAN 2	1–L–7	A	2.5
A INSI/NAV CONTROL	2–B–2	3	5.0
A SENSO CONSOLE FAN	2–E–2	3	2.5

B PRIMARY INSTR/SYNCHRO TRANSFORMER BUS	LOCATION CODE	PHASE	RATING
B FLT CONT HYDR PRESS	1–L–10	A	2.5
B COPILOT HSI	1–L–11	A	1.0
B RADAR	1–M–10	A	2.5
B COPILOT VDI	1–M–11	A	1.0
B UHF DF	1–N–10	A	2.5
B NAV DATA RPT&CONV CHAN NO. 2	1–N–11	A	1.0
B DLC/AFCS	1–O–11		1.0

C LEFT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
C ARS DC CONT	1–H–2		7.5
C ARS HOSE JTSN	1–I–12		3.0
C ARS SAFETY DISABLE DUMP & JTSN	1–G–12		Toggleswitch
C AFCS CHANNEL NO. 1	1–A–12		7.5
C AFCS CHANNEL NO. 2	1–B–12		7.5
C DLC	1–C–12		5.0
C SENSO FLDT	1–C– 13		2.5
C USH-42 VIDEO RECORDER	1–D–14		10.0
C OUTAIR TEMP IND	1–D–12		1.0
C MISC LT CONT	1–D–13		5.0
[3] C FLIR/RDR VIDEO RECORDER	1–D–14		5.0
C CMPTR GP CONT	1–E–12		2.5
C BB BAY DOOR GRD CONT	1–E–13		1.0
C UHF/DF	1–E–14		2.5
C IFR PROBE FLDT	1–F–13		2.5
C FLIR	1–F–14		5.0
C IFF INTRIG	1–G–13		5.0
C RADAR BCN AGMT	1–H–13		5.0
C PRI CONT LGC ASSY (L)	1–H–14		5.0
C UHF ANT RLY	1–I–13		5.0
C FLT STA CURRENT LMTR I	1–I–14		5.0
C WING FOLD CONT V	1–J–12		7.5
C FLIR TUR BK	1–J–13		2.5
C LOAD CTR CURRENT LMTRS I (L)	1–J–14		5.0
C FIN FOLD CONT V	1–K–12		2.5
C WSHLD AI CONT (L)	1–K–13		1.0
C LOAD CTR CURRENT LMTRS II (L)	1–K–14		5.0
C LAUNCH BAR CONT V	1–L–12		2.5
C WING DCDR (L)	1–L–13		5.0
C HACLCS CONT STA 5	1–L–14		5.0
C LDG GR HDL DN LOCK	1–M–12		2.5
C LIQ RAIN REPEL SYS	1–M–13		2.5
C HACLCS PYRO STA 5	1–M–14		5.0
C NLG STRG CONT	1–N–12		5.0
C WSHLD WASHER	1–N–13		1.0
C HACLCS SIM PWR	1–N–14		5.0

C (Cont) LEFT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
C ANTI SKID CONT	1–O–12		2.5
C HACLCS LOAD/READY	1–O–14		Toggleswitch
[8] C MK 50 HTR STA 1	1–A–13		5.0
[8] C MK 50 HTR STA 2	1–B–13		5.0
[8] C MK 50 HTR STA 3	1–A–14		5.0
[8] C MK 50 HTR STA 4	1–B–14		5.0

D ESSENTIAL AC BUS	LOCATION CODE	PHASE	RATING
[7] D INTERCOM PILOT (CI)	1–G–10	A	5.0
[7] D INTERCOM TACCO (CI & RSCI)	1–H–10	A	5.0
[7] D INTERCOM SENSO (CI)	1–I–10	B	5.0
[7] D INTERCOM COPILOT & IRC (CI & RSCI)	1–J–10	C	5.0
D PITOT HTR (L)	2–A–2	C	7.5
D PITCH TRIM CHAN 1	2–A–3	B	15.0
D CTR CSL SWITCH LT DIMMER	2–A–4	B	5.0
D TACAN	2–A–8	A	5.0
D IFF XPNDR	2–A–9	C	5.0
D STBY ATTD IND	2–B–1	3	1.0
D ANGLE OF ATCK PROBE HTR	2–B–2	A	5.0
D INTERNAL AVIONICS FAN	2–B–2	3	15.0
D SP BK & TRIM CONT SYS CHAN 1	2–B–3	B	1.0
D CTR CONSOLE LT DIMMER	2–B–3	B	5.0
D FLIR EXTEND/RETR ACTR	2–B–4	3	5.0
D PILOT WINDSHIELD WIPER	2–B–5	3	5.0
D UHF RADIO NO. 1	2–B–6	3	2.5
D ESSENTIAL INSTR/SYNCHRO XFMR	2–B–8	A	2.5
D RADAR ALTM	2–B–9	C	2.5
D HACLCS FIRE DET	2–C–2	B	5.0
D POSITION LIGHTS	2–C–3	B	5.0
D PILOT HSI	2–C–8	A	2.5
D COMM CTRLR	2–C–9	C	2.5
D PILOT SEC LIGHTS	2–D–3	B	2.5
D FORMATION LIGHTS STRIP	2–D–4	C	5.0
D PILOT VDI	2–D–8	A	2.5
D LOX QTY IND	2–D–9	C	5.0
D TE FLAPS ACTR	2–E–1	3	7.5
D NAV DATA REP & CONV CHAN 1	2–E–10	3	2.5
D INRTL NAV SYS	2–E–2	3	5.0
D FUEL QTY SYS	2–E–2	C	1.0
D COPILOT SEC LIGHTS	2–E–3	C	2.5
D FORMATION LIGHTS FLOOD	2–E–4	B	5.0
D ESSENTIAL XFMR RECT	2–E–5	3	7.5
D INSTR LDG SYS	2–E–6	3	2.5
D ALTN ESS INSTR SYNCHRO XFMR	2–E–8	A	2.5

D (Cont) ESSENTIAL AC BUS	LOCATION CODE	PHASE	RATING
D BL AIR LEAK DET	2–F–2	C	2.5
D CTR CSL SEC LIGHTS	2–F–3	C	1.0
D PILOT SW LT DMR	2–F–4	B	5.0
D AHRS	2–B–10	3	2.5
D GPS RECEIVER	2–F–7	A	1.0
D SIGNAL DATA CONV	2–E–7	A	1.0

E ESSENTIAL INSTRUMENT SYNCHRO BUS	LOCATION CODE	PHASE	RATING
E TE FLAP POS	2–A–11	A	1.0
E UTIL HYDR PRESS IND	2–B–11	A	2.5
E OIL PRESS IND NO. 1	2–C–11	A	2.5
E OIL PRESS IND NO.2	2–D–11	A	2.5
E GPS/FIWA/TACAN	2–E–11	A	1.0
E NAV DATA REPT & CONV CHAN NO. 1	2–F–11	A	1.0
E PILOT HSI	2–A–12	A	1.0
E PILOT VDI	2–B–12	A	1.0
E AHRS	2–C–12	A	1.0
E TRIM IND	2–D–12	A	1.0
E LF ADF	2–E–12	A	2.5
E BL AIR PRESS IND	2–F–12	A	1.0

F ESSENTIAL DC BUS	LOCATION CODE	PHASE	RATING
[2] F FAN RPM NO. 1	2–A–7		2.5
F AHRS	4–E–l0		2.5
[2] F FAN RPM NO. 2	2–B–7		2.5
[2] F FUEL FLOW NO. 1	2–C–7	B	2.5
[2] F FUEL FLOW NO. 2	2–D–7	C	2.5
F SEA/AIR RSQ BUOY RLSE	4–A–1		10.0
F INSTR LDG SYS	4–A–10		5.0
F ESSENTIAL DC START BUS	4–A–11		20.0
F APU TEMP MON	4–A–12		7.5
F EMER BK SYS LL V	4–A–2		2.5
F FLIR EXTEND/RETR CONT	4–A–3		1.0
F APRCH LT & ANGLE OF ATCK SYS	4–A–4		5.0
F WING DE-ICING V OUTBD & L BL	4–A–5		5.0
F FUEL FLOW CONT NO. 1	4–A–6		2.5
F UHF BACKUP	4–A–7		1.0
F LAUNCH BAR EMER RETR	4–A–8		2.5
F RADAR ALTM	4–A–9		2.5
F WING JTSN	4–B–1		10.0
F TACAN	4–B–10		5.0
F GEN CONT (L)	4–B–11		7.5
F APU HEAT SOV/LH UTIL OUTLET	4–B–12		7.5

F (Cont) ESSENTIAL DC BUS	LOCATION CODE	PHASE	RATING
F LDG GEAR CONT V	4–B–2		2.5
F CAUTION LIGHT PANEL	4–B–4		7.5
F WING DE-ICING V CTR & R BL	4–B–5		5.0
F FUEL FLOW CONT NO. 2	4–B–6		2.5
F CRYPTO ZEROIZE	4–B–7		5.0
F PILOT WSHLD WIPER CONT	4–B–8		2.5
F FIWA	4–C–1		5.0
F IFF XPNDR	4–C–10		5.0
F GEN CONT (R)	4–C–11		7.5
F PAPS DISCONNECT NO. 1	4–C–12		2.5
F TE FLAPS CONT	4–C–2		5.0
F LDG GEAR BYPASS VALVE	4–C–3		2.5
F WING DE-ICING V INBD	4–C–5		5.0
F CABIN OUTFLOW VALVE	4–C–6		2.5
F FUEL QTY SYS CONT	4–C–7		2.5
F LC CURRENT LMTR I (L)	4–C–9		5.0
F FLT STA CDNU	4–D–1		10.0
F IFF XPNDR TEST	4–D–10		5.0
F BUS TIE	4–D–11		5.0
F PAPS DISCONNECT NO. 2	4–D–12		2.5
F EXT LIGHT CONT	4–D–3		5.0
F PRESS REGLTR & SOV L & R WG	4–D–5		5.0
F CABIN SAFETY VALVE	4–D–6		2.5
F LOW FUEL LEVEL IND	4–D–7		1.0
F ADVISORY LIGHT PANEL	4–D–8		2.5
F LC CURRENT LMTR II (L)	4–D–9		5.0
F DIGITAL DATA SET	4–E–1		10.0
F PRI PWR SERVO CUTOFF CHAN NO. 1	4–E–11		7.5
F APU FIRE EXT	4–E–12		7.5
F RUD SVO PRESS REGULATOR NO. 1	4–E–2		1.0
F PRESS REGLTR & SOV EMP & EMP DE-ICING	4–E–5		5.0
F CABIN TEMP CONT	4–E–6		5.0
F TURN RATE GYRO	4–E–7		2.5
F PILOT STEP DMR	4–E–8		5.0
F FLIGHT STA CURRENT LMTR I	4–E–9		5.0
F UTILITY LIGHTS	4–F–1		5.0
F PRI PWR SERVO CUTOFF CHAN NO. 2	4–F–11		2.5
F HACLCS FIRE DET	4–F–12		5.0
F RUD SVO PRESS REGULATOR NO. 2	4–F–2		1.0
F LAMP TEST	4–F–3		5.0
F BL AIR LEAK DET	4–F–5		2.5
F EMER COMM COOLING	4–F–6		2.5
F RAM AIR CONT PWR	4–F–7		2.5
F COPILOT STEP DMR	4–F–8		5.0
F FLIGHT STA CURRENT LMTR II	4–F–9		5.0
F TACCO CDNU	4–O–2		2.5

G ESSENTIAL DC START BUS	LOCATION CODE	PHASE	RATING
[1] G GAS GEN RPM NO. 1	2–A–8	C	2.5
[1] G GAS GEN RPM NO. 2	2–B–8	A	2.5
[1] G INTER TURB TEMP NO. 1	2–C–8	A	2.5
[1] G INTER TURB TEMP NO. 2	2–D–8	B	2.5
G BL AIR SHUTOFF VALVE LEFT	4–A–15		2.5
G MASTER CAUTION LIGHT	4–A–16		2.5
G EXT TK FLG & XFR VALVE LEFT	4–A–17		2.5
G BL AIR SHUTOFF VALVE RIGHT	4–B–15		2.5
G PILOT UTILITY LIGHT	4–B–16		2.5
G EXT TK FLG & XFR VALVE RIGHT	4–B–17		2.5
G START CONT LEFT	4–C–13		5.0
G BL AIR SHUTOFF VALVE FL CONT	4–C–15		2.5
G PILOT INSTR FLDT & BTRY	4–C–16		2.5
G EXT TK AIR PRESS SOV	4–C–17		2.5
G START CONT RIGHT	4–D–13		5.0
G BL AIR ISLN V	4–D–15		2.5
G ESSENTIAL CONT LGC ASSY (R)	4–D–16		5.0
G FIRE DET SYS NO. 1	4–D–17		2.5
[4] G ENG TIME TEMP RCDR	4–E–14		2.5
G AI CONT, L ENG	4–F–15		2.5
G LC CURRENT LMTR I (R)	4–E–16		5.0
G FIR DET SYS NO. 2	4–E–17		2.5
G AI CONT, L ENG	4–F–15		2.5
G LC CURRENT LMTR II (R)	4–F–16		5.0
G ESSENTIAL CONT LOGIC ASSY (L)	4–F–17		5.0

H RIGHT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
H RACK LOCK PWR	3–A–13		5.0
H SAFETY DISABLE KILL	3–A–14		Toggleswitch
H ARMING	3–B–13		5.0
H SAFETY DISABLE SEARCH	3–BC–14		Toggleswitch
H AMAC SWTCHNG PWR	3–C–13		5.0
H SEARCH STORES CONT	3–D–13		15.0
H RELEASE	3–D–14		7.5
H TORP PRESET	3–D–15		5.0
H SEARCH STORES PWR	3–F–13		15.0
H ARMT CONT	3–E–14		5.0
H AUX CONT	3–E–15		7.5
H BB BAY DR CONT V	3–F–l3		2.5
H ARMT CONT & DCDRS	3–F–14		5.0
H HACLCS CONT STA 6	3–G–13		5.0
H PRI CONT LGC ASSY (R)	3–G–14		5.0
H HACLCS PYRO STA 6	3–H–13		5.0
H FLT STA DOME LT	3–H–14		5.0
H FLT STA CURRENT LIMITER II	3–H–15		5.0

H (Cont) RIGHT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
H ARRESTING HOOK CONT V	3–I–13		2.5
H CREW STA DOME LT	3–I–14		5.0
H LOAD CTR CURRENT LIMITER I (R)	3–I–15		5.0
H NORM/EMER BK SEL V	3–J–13		2.5
H TACCO FLDT	3–J–14		2.5
H LOAD CTR CURRENT LIMITER II (R)	3–J–15		5.0
H SDRS	3–K–13		1.0
H CRT BRKR & BAY LT	3–K–14		5.0
H EMER HYD PUMP CONT	3–K–15		2.5
[5] H NAV DATA REP & COMPTR CONV	3–L–13		1.0
H UHF CRYPTO UNIT	3–L–14		2.5
H LF/ADF	3–L–15		5.0
H CMPTR CAL CONT	3–M–13		1.0
H SUIT TEMP CONT	3–M–14		5.0
H RADAR SYS PWR SPLY	3–M–15		5.0
H COPILOT WSHLD WIPER CONT	3–N–13		2.5
H TACCO FAN OUT PANEL	3–N–14		2.5
H ECM SAFETY DISABLE/OFF	3–N–14		Toggleswitch
H AWCLS	3–N–15		5.0
H EXT PWR CONT	3–N–15		5.0
H WSHLD AI CONT (R)	3–O–13		1.0
H ECM RELEASE	3–O–14		10.0
H SAFETY DISABLE SAR JTSN	3–O–15		Toggleswitch
[6] H DSPL GEN PWR CONT	3–P–13		5.0
H ECM CONT	3–P–14		5.0
H SAFETY DISABLE SAR & JTSN	3–P–15		Toggleswitch
H PRI CONT LGC ASSY (R)	C–G–15		5.0

J RIGHT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
J AMAC STA 1B	3–C–12	3	10.0
J AMAC CONTROL MONITOR	3–D–11	3	5.0
J DOPPLER GRD VEL	3–E–10	A	2.5
J HF COUPLER	3–E–9	A	5.0
J TACCO DISPLAY	3–G–10	3	5.0
J HACLCS STA 6 MGU/SEEKER HTR	3–G–11	A	7.5
J HF RADIO	3–G–9	3	10.0
J HACLCS STA 6 BTRY HTR	3–H–11	C	7.5
J PITOT HTR (R)	3–H–8	C	7.5
J COPILOT SWITCH LT DIMMER	3–I–4	A	5.0
J COPILOT CONSOLE LT DIMMER	3–I–5	B	5.0
J COPILOT FLT INSTR LT DMR	3–I–6	A	5.0
J TOT TEMP PROBE HTR (R)	3–I–8	C	5.0
J COPILOT DISPLAY	3–J–10	3	5.0
J HACLCS STA 6 MISSILE	3–J–11	3	7.5

J RIGHT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
J COPILOT HSI	3–J–2	A	2.5
J LOGIC PWR XFMR NO. 2	3–J–3	B	5.0
J SWITCH LT DIMMER CTRL CSL	3–J–4	B	5.0
J CONSOLE LT DIMMER CTR	3–J–5	B	5.0
J UTIL OUT (R)	3–J–6	A	7.5
J UHF RADIO NO. 2	3–J–9	3	2.5
J DATA TERM SET	3–K–1	B	2.5
J COPILOT VDI	3–K–2	A	2.5
J INCOS (R)	3–K–3	B	1.0
J TACCO SWITCH LT DIMMER	3–K–4	C	5.0
J TACCO CONSOLE LT DIMMER	3–K–5	C	5.0
J ECS COMPT UTIL OUT	3–K–6	A	7.5
J RECIRC AIR S/O V	3–K–8	C	2.5
J FLIGHT STA CONSOLE FAN	3–M–1	3	2.5
J PILOT DISPLAY	3–M–11		7.5
J NAV DATA REP & CONV CHAN 2	3–M-11	3	2.5
J ECM RCVR SYS	3–M–10	3	5.0
J WINDSHIELD ANTI ICING (R)	3–M–2	A,B	35.0
J TACCO CONSOLE FAN	3–M–4	3	2.5
J COPILOT WINDSHIELD WIPER	3–M–6	3	5.0
J CRYPTO DATA UNIT	3–M–7	B	1.0
J XFMR RECT (R)	3–M–8	3	15.0
J IFR PROBE ACTUATOR	3–M–9	3	5.0
J FWD AVIONICS FAN (R)	3–O–1	3	15.0
J SENSO DISPLAY	3–O–11		7.5
J SONAR DATA CMPTR NO. 1	3–O–11	3	2.5
J GPDC PWR SPLY	3–O–12	3	7.5
J INTERNAL AVIONICS FAN	3–O–2	3	15.0
J AFT AVIONICS FAN (R)	3–O–4	3	15.0
J CENTRAL AIR DATA SYSTEM B	3–O–5	3	2.5
J COPILOT & TACCO SEAT ADJ	3–O–6	3	5.0
J RADAR SYS XMTR	3–O–8	3	10.0
J AMAC STA 4B	C–F–12	3	10.0

NOTES:

[1] BUNO 158861 THRU 158873 AND 159386 THRU 159420 NOT INCORPORATING AFC-12
[2] BUNO 159421 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-12
[3] BUNO 158861 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-1
[4] BUNO 158861 THRU 158873 AND 159386 THRU 159406
[5] BUNO 159758 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-93
[6] ADDED ON AIRCRAFT INCORPORATING AFC-193
[7] MODIFIED ON AIRCRAFT INCORPORATING AFC-224
[8] ADDED ON AIRCRAFT INCORPORATING AFC-231

Circuit Breaker Listing (Aircraft Not Incorporating AFC-279)

A LEFT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
A ARS AC CONT	1–J–10	C	3.0
[10] A ARS LH XFR PUMP PHASE A, B, C	1–B–3	3	15.0
[10] A ARS RH XFR PUMP PHASE A, B, C	1–B–3	3	15.0
A BB BAY DOOR ELEC ACTR	1–B–1	3	15.0
A RADAR SYS POWER SUPPLY	1–B–10	3	10.0
A LE FLAP OUTBD ACTUATOR	1–B–2	3	7.5
A FWD AVIONICS FAN (L)	1–B–4	3	15.0
A WINDSHIELD ANTI ICING (L)	1–B–5	B,C	35.0
A AFCS CHAN NO. 1	I–B–6	3	5.0
A XFMR RECT (L)	1–B–7	3	15.0
A FLIR SYSTEM	1–B–9	3	7.5
A CENTRAL AIR DATA SYSTEM A	1–E–1	3	2.5
[10] A DRUM POWER SUPPLY	1–E–3	3	2.5
A RADAR SYS SCAN CONV	1–E–10	3	2.5
[3] A FLIR/RADAR VIDEO RECORDER	1–E–11	3	2.5
A LWR SPOILER CONT	1–E–3	3	5.0
A PILOT & SENSO SEAT ADJ	1–E–4	3	5.0
A WINDSHIELD WASHER	1–E–5	3	2.5
A AFCS CHAN NO. 2	1–E–6	3	5.0
A SONAR DATA CMPTR NO. 2	1–E–7	3	2.5
A FLIR SYSTEM COOLER	1–E–9	3	5.0
A PRI INSTR SYNCHRO XFMR	1–G–1	A	2.5
A HACLCS STA 5 MGU/SEEKER HTR	1–G–11	A	7.5
A TOT TEMP PROBE HTR (L)	1–G–2	A	5.0
A SENSO SW LT DMR	1–G–3	A	5.0
A PILOT CONSOLE LT DMR	1–G–5	A	5.0
A UHF DF	1–G–7	A	2.5
A HACLCS STA BTRY HTR	1–H–11	B	7.5
A CTR CSL INSTR LIGHT DMR	1–H–3	A	5.0
A SENSO CSL LT DMR	1–H–4	B	5.0
A PILOT FLIGHT INSTR LT DMR	1–H–5	C	5.0
A PITCH TRIM CHAN 2	1–H–7	A	15.0
[7] A COMM CTRLR	1–H–8	3	2.5
A GPDC POWER SUPPLY	1–H–9	3	7.5
A INCOS (L)	1–I–4	B	1.0
A UTIL OUT (L)	1–I–5	A	7.5
A DGTL MAG TAPE	1–I–7	A	5.0
A HACLCS STA 5 MISSILE	1–J–11	3	7.5
A LOGIC PWR XFMR NO. 1	1–J–4	B	5.0
A LAND TAXI LT	1–J–5	C	5.0
A IFF INTRG	1–J–7	A	5.0
A ANTI COLLISION LT	1–K–5	C	5.0
A NLG STRG CONT	1–K–7	A	5.0
A SP BR & TRIM CONT SYS CHAN 2	1–L–7	A	2.5
A INSI/NAV CONTROL	2–B–2	3	5.0
A SENSO CONSOLE FAN	2–E–2	3	2.5

B PRIMARY INSTR/SYNCHRO TRANSFORMER BUS	LOCATION CODE	PHASE	RATING
B FLT CONT HYDR PRESS	1–L–10	A	2.5
B RADAR	1–M–10	A	2.5
B UHF DF	1–N–10	A	2.5
[9] B NIU CHAN 2	1–N–11		1.0
B DLC/AFCS	1–O–11		1.0

C LEFT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
C ARS DC CONT	1–H–12		7.5
C ARS HOSE JTSN	1–I–12		3.0
C ARS SAFETY DISABLE DUMP & JTSN	1–G–12		Toggleswitch
C AFCS CHANNEL NO. 1	1–A–12		7.5
C AFCS CHANNEL NO. 2	1–B–12		7.5
C DLC	1–C–12		5.0
C SENSO FLDT	1–C–13		2.5
C OUTAIR TEMP IND	1–D–12		1.0
C MISC LT CONT	1–D–13		5.0
[3] C USH–42 VIDEO RECORDER	1–D–14		10.0
C CMPTR GP CONT	1–E–12		2.5
C BB BAY DOOR GRD CONT	1–E–13		1.0
C UHF/DF	1–E–14		2.5
C IFR PROBE FLDT	1–F–13		2.5
C FLIR	1–F–14		5.0
C IFF INTRIG	1–G–13		5.0
C RADAR BCN AGMT	1–H–13		5.0
C PRI CONT LGC ASSY (L)	1–H–14		5.0
C UHF ANT RLY	1–I–13		5.0
C FLT STA CURRENT LMTR I	1–I–14		5.0
C WING FOLD CONT V	1–J–12		7.5
C FLIR TUR BK	1–J–13		2.5
C LOAD CTR CURRENT LMTRS I (L)	1–J–14		5.0
C FIN FOLD CONT V	1–K–12		2.5
C WSHLD AI CONT (L)	1–K–13		1.0
C LOAD CTR CURRENT LMTRS II (L)	1–K–14		5.0
C LAUNCH BAR CONT V	1–L–12		2.5
C WING DCDR (L)	1–L–13		5.0
C HACLCS CONT STA 5	1–L–14		5.0
C LDG GR HDL DN LOCK	1–M–12		2.5
C LIQ RAIN REPEL SYS	1–M–13		2.5
C HACLCS PYRO STA 5	1–M–14		5.0
C NLG STRG CONT	1–N–12		5.0
C WSHLD WASHER	1–N–13		1.0
C HACLCS SIM PWR	1–N–14		5.0
C ANTI SKID CONT	1–O–12		2.5

C C LEFT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
C HACLCS LOAD/READY	1–O–14		Toggleswitch
[8] C MK 50 HTR STA 1	1–A–13		5.0
[8] C MK 50 HTR STA 2	1–B–13		5.0
[8] C MK 50 HTR STA 3	1–A–14		5.0
[8] C MK 50 HTR STA 4	1–B–14		5.0

D ESSENTIAL AC BUS	LOCATION CODE	PHASE	RATING
[7] D INTERCOM PILOT (CI)	1–G–10	A	5.0
[7] D INTERCOM TACCO (CI & RSCI)	1–H–10	A	5.0
[7] D INTERCOM SENSO (Cl)	1–I–10	B	5.0
[7] D INTERCOM COPILOT & IRC (CI & RSCI)	1–J–10	C	5.0
D PITOT HTR (L)	2–A–2	C	7.5
D PITCH TRIM CHAN 1	2–A–3	B	15.0
D CTR CSL SWITCH LT DIMMER	2–A–4	B	5.0
D TACAN	2–A–8	A	5.0
D IFF XPNDR	2–A–9	C	5.0
D STBY ATTD IND	2–B–1	3	1.0
D ANGLE OF ATCK PROBE HTR	2–B–2	A	5.0
D INTERNAL AVIONICS FAN	2–B–2	3	15.0
D SP BK & TRIM CONT SYS CHAN 1	2–B–3	B	1.0
D CTR CONSOLE LT DIMMER	2–B–4	B	5.0
D FLIR EXTEND/RETR ACTR	2–B–4	3	5.0
D PILOT WINDSHIELD WIPER	2–B–5	3	5.0
D UHF RADIO NO. 1	2–B–6	3	2.5
D ESSENTIAL INSTR/SYNCHRO XFMR	2–B–8	A	2.5
D RADAR ALTM	2–B–9	C	2.5
D HACLCS FIRE DET	2–C–2	B	5.0
D POSITION LIGHTS	2–C–3	B	5.0
D PILOT SEC LIGHTS	2–D–3	B	2.5
D FORMATION LIGHTS STRIP	2–D–4	C	5.0
D LOX QTY IND	2–D–9	C	5.0
D TE FLAPS ACTR	2–E–1	3	7.5
[9] D CAINS II	2–E–2	3	5.0
D FUEL QTY SYS	2–E–2	C	1.0
D COPILOT SEC LIGHTS	2–E–3	C	2.5
D FORMATION LIGHTS FLOOD	2–E–4	B	5.0
D MAD BOOM ACTR	2–E–4	3	5.0
D ESSENTIAL XFMR RECT	2–E–5	3	7.5
D INSTR LDG SYS	2–E–6	3	2.5
[9] D NIU REF	2–E–7	A	1.0
D ALTN ESS INSTR SYNCHRO XFMR	2–E–8	A	2.5
D BL AIR LEAK DET	2–F–2	C	2.5
D CTR CSL SEC LIGHTS	2–F–3	C	1.0
D PILOT SW LT DMR	2–F–4	B	5.0
D GPS RECEIVER	2–F–7	A	1.0

E ESSENTIAL INSTRUMENT SYNCHRO BUS	LOCATION CODE	PHASE	RATING
E TE FLAP POS	2–A–11	A	1.0
E UTIL HYDR PRESS IND	2–B–11	A	2.5
E OIL PRESS IND NO. 1	2–C–11	A	2.5
E OIL PRESS IND NO.2	2–D–11	A	2.5
E NIU CHAN NO. 1 & FDC	2–F–11	A	1.0
E TRIM IND	2–D–12	A	1.0
E BL AIR PRESS IND	2–F–12	A	1.0

F ESSENTIAL DC BUS	LOCATION CODE	PHASE	RATING
[1] F FAN RPM NO. 1	2–A–7		2.5
[1] F FAN RPM NO. 2	2–B–7		2.5
[2] F FUEL FLOW NO. 1	2–C–7	B	2.5
[2] F FUEL FLOW NO. 2	2–D–7	C	2.5
F SEA/AIR RSQ BUOY RLSE	4–A–1		10.0
F INSTR LDG SYS	4–A–10		5.0
F ESSENTIAL DC START BUS	4–A–11		20.0
F APU TEMP MON	4–A–12		7.5
F EMER BK SYS LL V	4–A–2		2.5
F FLIR EXTEND/RETR CONT	4–A–3		1.0
F APRCH LT & ANGLE OF ATCK SYS	4–A–4		5.0
F WING DE-ICING V OUTBD & L BL	4–A–5		5.0
F FUEL FLOW CONT NO. 1	4–A–6		2.5
F UHF BACKUP	4–A–7		1.0
F LAUNCH BAR EMER RETR	4–A–8		2.5
F RADAR ALTM	4–A–9		2.5
[9] F NIU CHAN NO. 2	4–A–13		2.5
F WING JTSN	4–B–1		10.0
[9] F COMM CTRLR	4–B–9		3.0
F TACAN	4–B–10		5.0
F GEN CONT (L)	4–B–11		7.5
F APU HEAT SOV/LH UTIL OUTLET	4–B–12		7.5
F LDG GEAR CONT V	4–B–2		2.5
F CAUTION LIGHT PANEL	4–B–4		7.5
F WING DE-ICING V CTR & R BL	4–B–5		5.0
F FUEL FLOW CONT NO. 2	4–B–6		2.5
F CRYPTO ZEROIZE	4–B–7		5.0
F PILOT WSHLD WIPER CONT	4–B–8		2.5
[9] F NIU CHAN NO.1	4–B–13		2.5
F AMAC MON & EMER SAFE	4–C–1		5.0
F IFF XPNDR	4–C–10		5.0
F GEN CONT (R)	4–C–11		7.5
F PAPS DISCONNECT NO. 1	4–C–12		2.5
F TE FLAPS CONT	4–C–2		5.0
F LDG GEAR BYPASS VALVE	4–C–3		2.5
F WING DE-ICING V INBD	4–C–5		5.0

F C ESSENTIAL DC BUS	LOCATION CODE	PHASE	RATING
F CABIN OUTFLOW VALVE	4–C–6		2.5
F FUEL QTY SYS CONT	4–C–7		2.5
F LC CURRENT LMTR I (L)	4–C–9		5.0
[9] F EFI – COPILOT – LOWER	4–C–13		5.0
F FLT STA CDNU	4–D–1		2.5
F TACCO CDNU	4–D–2		2.5
F IFF XPNDR TEST	4–D–10		5.0
F BUS TIE	4–D–11		5.0
F PAPS DISCONNECT NO. 2	4–D–12		2.5
F EXT LIGHT CONT	4–D–3		5.0
F PRESS REGLTR & SOV L & R WG	4–D–5		5.0
F CABIN SAFETY VALVE	4–D–6		2.5
F LOW FUEL LEVEL IND	4–D–7		1.0
F ADVISORY LIGHT PANEL	4–D–8		2.5
F LC CURRENT LMTR II(L)	4–D–9		5.0
[9] F EFI – COPILOT – UPPER	4–D–13		5.0
F DIGITAL DATA SET	4–E–1		2.5
[9] F NDS OTPI ON/OFF RELAY	4–E–7		2.5
[9] F EGI	4–E–10		2.5
F PRI PWR SERVO CUTOFF CHAN NO. 1	4–E–11		7.5
F APU FIRE EXT	4–E–12		7.5
[9] F EFI – PILOT – LOWER	4–E–13		5.0
F RUD SVO PRESS REGULATOR NO. 1	4–E–2		1.0
F PRESS REGLTR & SOV EMP & EMP DE-ICING	4–E–5		5.0
F CABIN TEMP CONT	4–E–6		5.0
F PILOT STEP DMR	4–E–8		5.0
F FLIGHT STA CURRENT LMTR I	4–E–9		5.0
F UTILITY LIGHTS	4–F–1		5.0
F PRI PWR SERVO CUTOFF CHAN NO. 2	4–F–11		2.5
F HACLCS FIRE DET	4–F–12		5.0
F RUD SVO PRESS REGULATOR NO. 2	4–F–2		1.0
F LAMP TEST	4–F–3		5.0
F BL AIR LEAK DET	4–F–5		2.5
F EMER COMM COOLING	4–F–6		2.5
F RAM AIR CONT PWR	4–F–7		2.5
F COPILOT STEP DMR	4–F–8		5.0
F FLIGHT STA CURRENT LMTR II	4–F–9		5.0
[9] F NIWA	4–F–10		2.5
[9] F EFI – PILOT – UPPER	4–F–13		5.0

G ESSENTIAL DC START BUS	LOCATION CODE	PHASE	RATING
[1] G GAS GEN RPM NO. 1	2–A–8	C	2.5
[1] G GAS GEN RPM NO. 2	2–B–8	A	2.5
[1] G INTER TURB TEMP NO. 1	2–C–8	A	2.5

G C ESSENTIAL DC START BUS	LOCATION CODE	PHASE	RATING
[1] G INTER TURB TEMP NO. 2	2–D–8	B	2.5
G BL AIR SHUTOFF VALVE LEFT	4–A–15		2.5
G MASTER CAUTION LIGHT	4–A–16		2.5
G EXT TK FLG & XFR VALVE LEFT	4–A–17		2.5
G BL AIR SHUTOFF VALVE RIGHT	4–B–15		2.5
G PILOT UTILITY LIGHT	4–B–16		2.5
G EXT TK FLG & XFR VALVE RIGHT	4–B–17		2.5
[10] G START CONT LEFT	4–C–14		5.0
G BL AIR SHUTOFF VALVE FL CONT	4–C–15		2.5
G PILOT INSTR FLDT & BTRY	4–C–16		2.5
G EXT TK AIR PRESS SOV	4–C–17		2.5
[10] G START CONT RIGHT	4–D–14		5.0
G BL AIR ISLN V	4–D–15		2.5
G ESSENTIAL CONT LGC ASSY (R)	4–D–16		5.0
G FIRE DET SYS NO. 1	4–D–17		2.5
[4] G ENG TIME TEMP RCDR	4–E–14		2.5
G AI CONT, L ENG	4–E–15		2.5
G LC CURRENT LMTR I (R)	4–E–16		5.0
G FIR DET SYS NO. 2	4–E–17		2.5
G AI CONT, R ENG	4–F–I5		2.5
G LC CURRENT LMTR II (R)	4–F–16		5.0
G ESSENTIAL CONT LGC ASSY (L)	4–F–17		5.0

H RIGHT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
H RACK LOCK PWR	3–A–13		5.0
H SAFETY DISABLE KILL	3–A–14		Toggleswitch
H ARMING	3–B–13		5.0
H SAFETY DISABLE SEARCH	3–BC–14		Toggleswitch
H AMAC SWTCHNG PWR	3–C–13		5.0
H SEARCH STORES CONT	3–D–13		15.0
H RELEASE	3–D–14		7.5
H TORP PRESET	3–D–15		5.0
H SEARCH STORES PWR	3–F–13		15.0
H ARMT CONT	3–E–14		5.0
H AUX CONT	3–E–15		7.5
H BB BAY DR CONT V	3–F–13		2.5
H ARMT CONT & DCDRS	3–F–14		5.0
H HACLCS CONT STA 6	3–G–13		5.0
H PRI CONT LGC ASSY (R)	3–G–14		5.0
H HACLCS PYRO STA 6	3–H–13		5.0
H FLT STA DOME LT	3–H–14		5.0
H FLT STA CURRENT LIMITER II	3–H–15		5.0
H ARRESTING HOOK CONT V	3–I–13		2.5
H CREW STA DOME LT	3–I–14		5.0
H LOAD CTR CURRENT LIMITER I (R)	3–I–15		5.0

H C RIGHT PRIMARY DC BUS	LOCATION CODE	PHASE	RATING
H NORM/EMER BK SEL V	3–J–13		2.5
H TACCO FLDT	3–J–14		2.5
H LOAD CTR CURRENT LIMITER II (R)	3–J–15		5.0
[9] H SDRS	3–K–13		5.0
H CRT BRKR & BAY LT	3–K–14		5.0
H EMER HYD PUMP CONT	3–K–15		2.5
[9] H AWCLS VALIDITY	3–L–13		1.0
H UHF CRYPTO UNIT	3–L–14		2.5
H LF/ADF	3–L–15		5.0
H CMPTR CAL CONT	3–M–13		1.0
H SUIT TEMP CONT	3–M–14		5.0
H RADAR SYS PWR SPLY	3–M–15		5.0
H COPILOT WSHLD WIPER CONT	3–N–13		2.5
H TACCO FAN OUT PANEL	3–N–14		2.5
H ECM SAFETY DISABLE/OFF	3–N–14		Toggleswitch
H AWCLS	3–N–15		5.0
H EXT PWR CONT	3–N–15		5.0
H WSHLD AI CONT (R)	3–O–13		1.0
H ECM RELEASE	3–O–14		10.0
H SAFETY DISABLE SAR JTSN	3–O–15		Toggleswitch
[6] H DSPL GEN PWR CONT	3–P–13		5.0
H ECM CONT	3–P–14		5.0
H SAFETY DISABLE SAR & JTSN	3–P–15		Toggleswitch
H PRI CONT LGC ASSY (R)	C–G–15		5.0

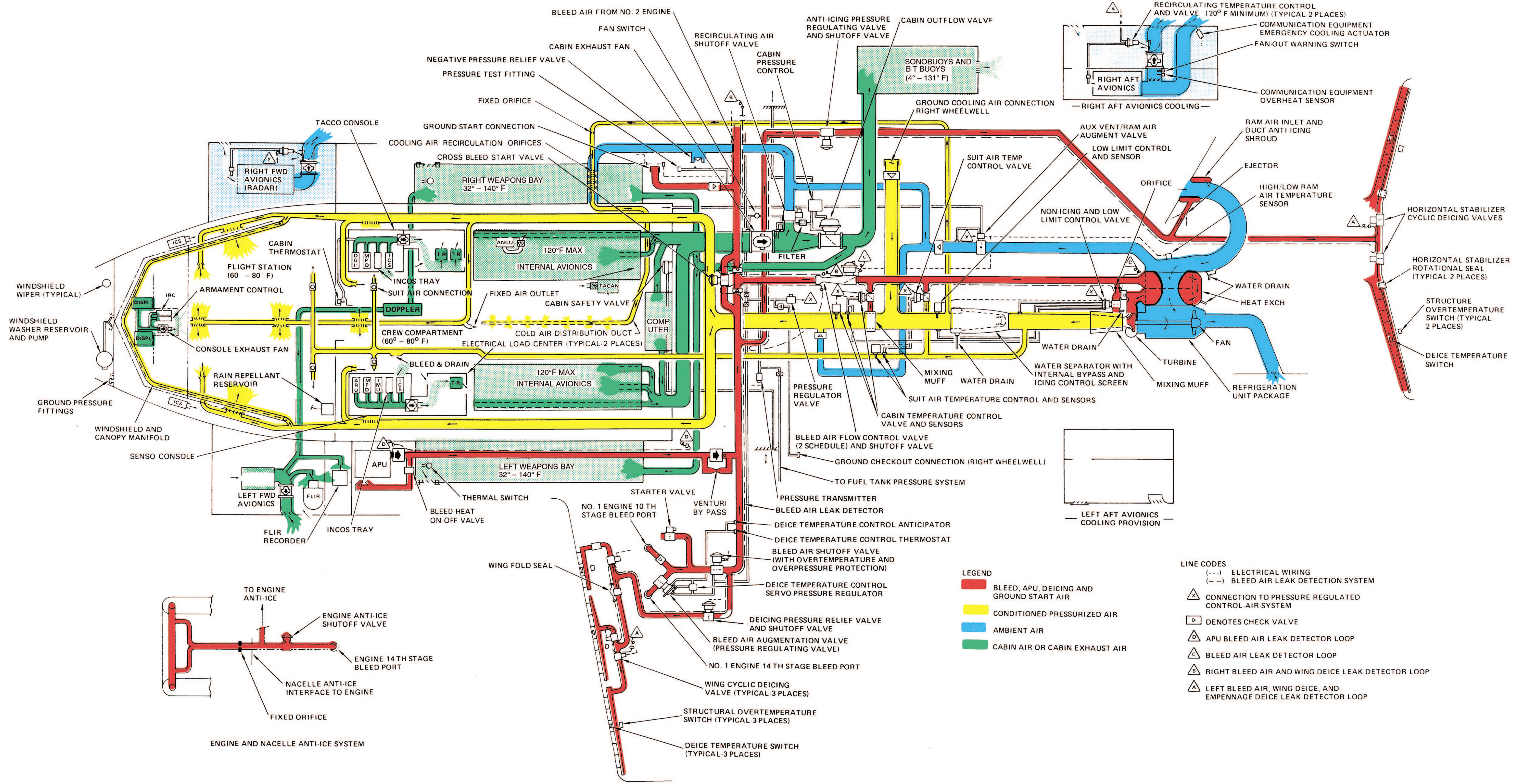
J RIGHT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
J AMAC STA 1B	3–C–12	3	10.0
J AMAC CONTROL MONITOR	3–D–11	3	5.0
J HF COUPLER	3–E–9	A	5.0
J TACCO DISPLAY	3–G–10	3	5.0
J HACLCS STA 6 MGU/SEEKER HTR	3–G–11	A	7.5
J HF RADIO	3–G–9	3	10.0
J HACLCS STA 6 BTRY HTR	3–H–11	C	7.5
J MAD SYSTEM COMP	3–H–12	A	2.5
J PITOT HTR (R)	3–H–8	C	7.5
J COPILOT SWITCH LT DIMMER	3–I–4	A	5.0
J COPILOT CONSOLE LT DIMMER	3–I–5	B	5.0
J COPILOT FLT INSTR LT DMR	3–I–6	A	5.0
J TOT TEMP PROBE HTR (R)	3–I–8	C	5.0
J COPILOT DISPLAY	3–J–10	3	5.0
J HACLCS STA 6 MISSILE	3–J–11	3	7.5
J MAD SYSTEM PWR SPLY AMPL	3–J–12	3	2.5
J LOGIC PWR XFMR NO. 2	3–J–3	B	5.0
J UTIL OUT (R)	3–J–6	A	7.5

J C RIGHT PRIMARY AC BUS	LOCATION CODE	PHASE	RATING
J UHF RADIO NO. 2	3–J–9	3	2.5
J DATA TERM SET	3–K–1	B	2.5
J INCOS (R)	3–K–3	B	1.0
J TACCO SWITCH LT DIMMER	3–K–4	C	5.0
J TACCO CONSOLE LT DIMMER	3–K–5	C	5.0
J ECS COMPT UTIL OUT	3–K–6	A	7.5
J ANALOG TAPE RCDR INTFC UNIT	3–K–7	B	2.5
J RECIRC AIR S/O V	3–K–8	C	2.5
J FLIGHT STA CONSOLE FAN	3–M–1	3	2.5
J PILOT DISPLAY	3–M–11		7.5
[10] J ESM RCVR SYS	3–M–10	3	5.0
J WINDSHIELD ANTI ICING (R)	3–M–2	A,B	35.0
J TACCO CONSOLE FAN	3–M–4	3	2.5
J COPILOT WINDSHIELD WIPER	3–M–6	3	5.0
J CRYPTO DATA UNIT	3–M–7	B	1.0
J XFMR RECT (R)	3–M–8	3	15.0
J IFR PROBE ACTUATOR	3–M–9	3	5.0
J FWD AVIONICS FAN (R)	3–O–1	3	15.0
J SENSO DISPLAY	3–O–11		7.5
[10] J SONAR DATA CMPTR NO. 1	3–O–9	3	2.5
[10] J GPDC PWR SPLY	3–O–10	3	7.5
J INTERNAL AVIONICS FAN	3–O–2	3	15.0
J AFT AVIONICS FAN (R)	3–O–4	3	15.0
J CENTRAL AIR DATA SYSTEM B	3–O–5	3	2.5
J COPILOT & TACCO SEAT ADJ	3–O–6	3	5.0
J RADAR SYS XMTR	3–O–8	3	10.0
J AMAC STA 4B	C–F–12	3	10.0

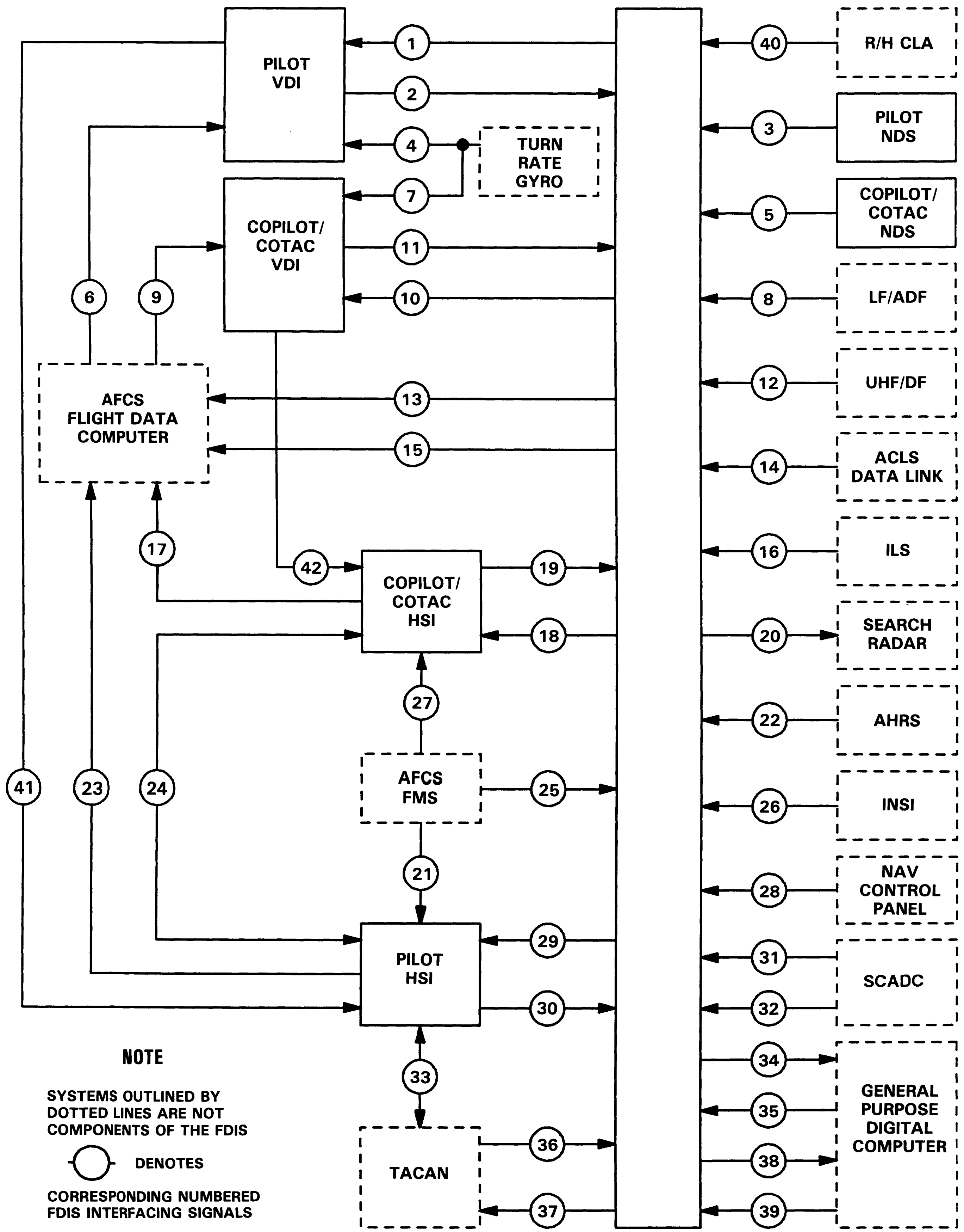
NOTES:

[1] BUNO 158861 THRU 158873 AND 159386 THRU 159420 NOT INCORPORATING AFC-12
[2] BUNO 159421 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-12
[3] BUNO 158861 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-1
[4] BUNO 158861 THRU 158873 AND 159386 THRU 159406
[5] BUNO 159758 AND SUBSEQUENT AND AIRCRAFT INCORPORATING AFC-93
[6] ADDED ON AIRCRAFT INCORPORATING AFC-193
[7] MODIFIED ON AIRCRAFT INCORPORATING AFC-224
[8] ADDED ON AIRCRAFT INCORPORATING AFC-231
[9] ADDED ON AIRCRAFT INCORPORATING AFC-279
[10] MODIFIED ON AIRCRAFT INCORPORATING AFC-279

Circuit Breaker Listing (Aircraft Incorporating AFC-279)



Environmental Control System



NOTE

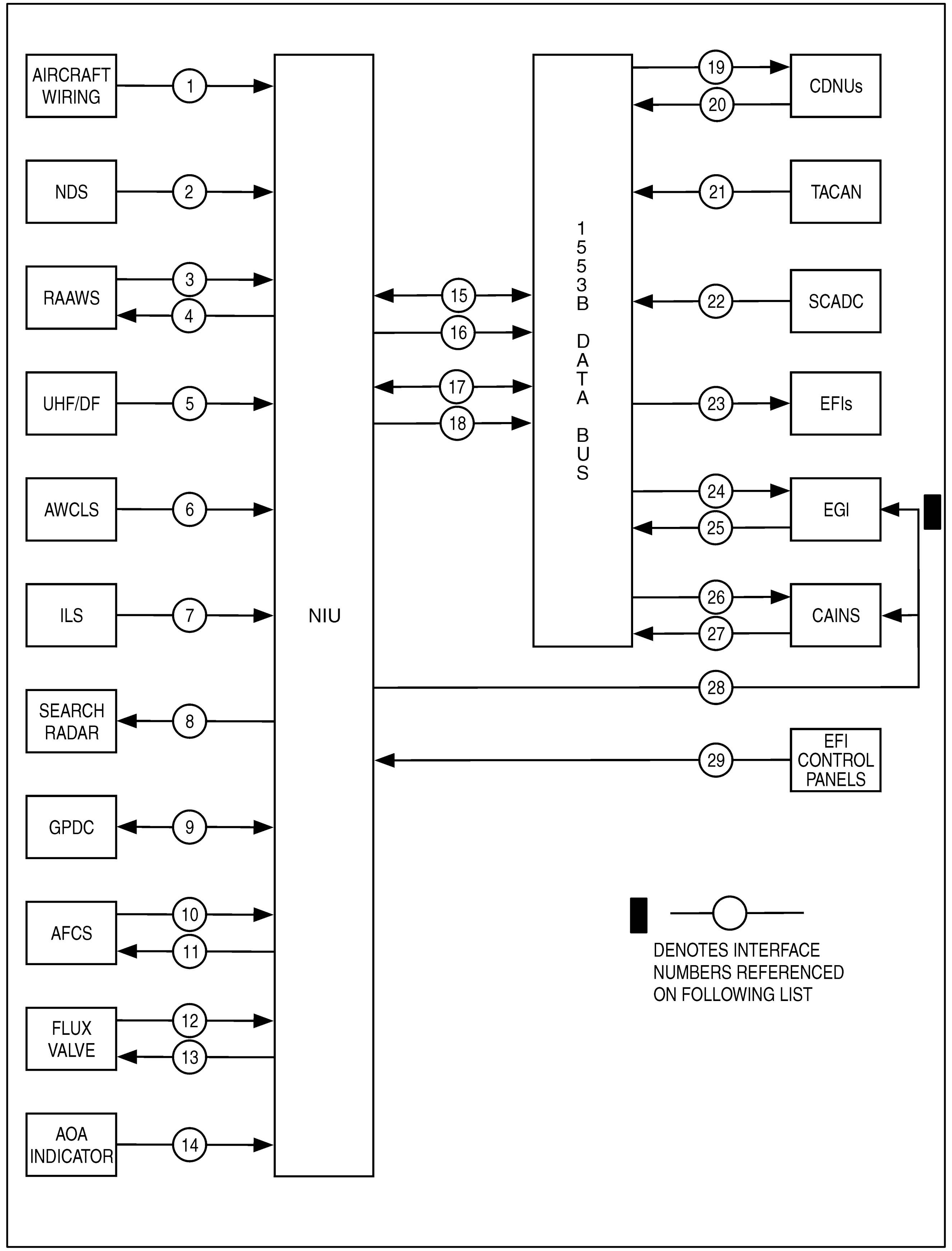
SYSTEMS OUTLINED BY DOTTED LINES ARE NOT COMPONENTS OF THE FDIS

○ DENOTES CORRESPONDING NUMBERED FDIS INTERFACING SIGNALS

FDIS INTERFACING SIGNALS

1 PITCH AND ROLL ATTITUDE; VERTICAL AND LATERAL DISPLACEMENT; ATTITUDE, VERTICAL, AND LATERAL VALIDITY
2 VDI VALIDITY
3 INS/AHRS SWITCH POSITION, NAV/ILS SWITCH POSITION, BRG NO. 1 SWITCH POSITION, DIST/SPD SWITCH POSITION
4 RATE OF TURN
5 INS/AHRS SWITCH POSITION, NAV/ILS SWITCH POSITION, BRG NO. 1 SWITCH POSITION, DIST/SPD SWITCH POSITION
6 IAS HOLD FAST/SLOW ERROR, FAST/SLOW ERROR VALIDITY
7 RATE OF TURN
8 RELATIVE BEARING
9 IAS HOLD FAST/SLOW ERROR, FAST/SLOW ERROR VALIDITY
10 PITCH AND ROLL ATTITUDE; VERTICAL AND LATERAL DISPLACEMENT; ATTITUDE, VERTICAL, AND LATERAL VALIDITY
11 VDI VALIDITY
12 RELATIVE BEARING
13 INS PITCH AND ROLL ATTITUDE, CROSS TRACK ERROR, CROSS TRACK ERROR RATE, ROLL COMMAND, INS VALIDITY, FTP EXISTS/DOES NOT EXIST DISCRETE, GPDC STEERING VALIDITY
14 VERTICAL AND LATERAL DEVIATION, ACLS VALIDITY (TILT)
15 AHRS PITCH AND ROLL ATTITUDE, CROSS TRACK ERROR, CROSS TRACK ERROR RATE, ROLL COMMAND, AHRS VALIDITY, FTP DESIGNATED OR UNDESIGNATED DISCRETE, GPDC STEERING VALIDITY
16 VERTICAL AND LATERAL DEVIATION, VERTICAL VALIDITY, LATERAL VALIDITY
17 SELECTED HEADING ERROR, SELECTED COURSE ERROR
18 HEADING; COMMANDED COURSE; BEARING NO. 1; DRIFT ANGLE; CROSS TRACK/COURSE DEVIATION; TO/FROM INDICATION; DISTANCE OR SPEED; NAV FLAG; HEADING FLAG; DISTANCE/SPEED SHUTTER; CMPTR MODE DISCRETE; HDG DISPLAY SELF TEST INHIBIT DISCRETE; TCN, UHF, LF, CPR BEARING MODE LIGHTS; CPR, TCN DISTANCE MODE LIGHTS; MILES, TAS, GS MODE LIGHTS; MAG, TRU MODE LIGHT; DISTANCE DECIMAL POINT MODE LIGHT
19 HSI VALIDITY
20 PITCH AND ROLL ATTITUDE, HEADING, ATTITUDE AND HEADING VALIDITY
21 PULL FOR COPILOT/COTAC CONTROL SWITCH POSITION
22 PITCH AND ROLL ATTITUDE, MAGNETIC HEADING, AHRS VALIDITY
23 SELECTED HEADING ERROR, SELECTED COURSE ERROR
24 SELECTED HEADING, SELECTED COURSE
25 HDG SEL/NAV SWITCH POSITION, APS ROLL AXIS CHANNEL 1 AND CHANNEL 2 ENGAGEMENT STATUS, NAV SEL SWITCH POSITION
26 GROUNDSPEED, DRIFT ANGLE, PITCH AND ROLL ATTITUDE, MAGNETIC HEADING, TRUE HEADING, INSI VALIDITY
27 PULL FOR COPILOT/COTAC CONTROL SWITCH POSITION
28 INS MODE SELECTOR SWITCH IN INCOS/ANY OTHER POSITION
29 HEADING; COMMANDED COURSE; BEARING NO. 1; DRIFT ANGLE; CROSS TRACK/COURSE DEVIATION; TO/FROM INDICATION; DISTANCE OR SPEED; NAV FLAG; HEADING FLAG; DISTANCE/SPEED SHUTTER; CMPTR MODE DISCRETE; HDG DISPLAY SELF TEST INHIBIT DISCRETE; TCN, UHF, LF, CPR BEARING MODE LIGHTS; CPR, TCN DISTANCE MODE LIGHTS; MILES, TAS, GS MODE LIGHTS; MAG, TRU MODE LIGHT; DISTANCE DECIMAL POINT MODE LIGHT
30 HSI VALIDITY
31 CHANNEL ONE TRUE AIRSPEED, CHANNEL ONE TRUE AIRSPEED VALIDITY
32 CHANNEL TWO TRUE AIRSPEED, CHANNEL TWO TRUE AIRSPEED VALIDITY
33 SELECTED COURSE
34 TACAN BEARING AND DISTANCE, TACAN BEARING AND DISTANCE VALIDITY, PILOT AHRS/INS SWITCH POSITION, COPILOT/COTAC AHRS/INS SWITCH POSITION, NAV SEL SWITCH POSITION, HDG SEL/NAV SWITCH POSITION, APS ROLL AXIS ENGAGEMENT STATUS, NDCR CHANNEL NO. 1 AND NO. 2 VALIDITY , PILOT HSI AND VDI VALIDITY, COPILOT/COTAC HSI AND VDI VALIDITY
35 COMMANDED COURSE, CROSS TRACK ERROR, CROSS TRACK ERROR RATE, ROLL COMMAND, FTP EXISTS/DOES NOT EXIST DISCRETE, FTP BEARING AND DISTANCE, DRIFT ANGLE, GROUNDSPEED, NDCR INITIALIZE COMMAND, NDCR SELF TEST COMMAND, GPDC STEERING VALIDITY, TACAN BEARING AND DISTANCE REQUEST, WRA STATUS REQUEST, ADVISORY WORD REQUEST
36 TACAN BEARING AND DISTANCE, COURSE DEVIATION, TO/FROM, TACAN BEARING AND DISTANCE VALIDITY
37 MAGNETIC HEADING
38 TACAN BEARING AND DISTANCE, TACAN BEARING AND DISTANCE VALIDITY PILOT AHRS/INS SWITCH POSITION, COPILOT/COTAC AHRS/INS SWITCH POSITION, NAV SEL SWITCH POSITION, HDG SEL/NAV SWITCH POSITION, ASP ROLL AXIS ENGAGEMENT STATUS, NDCR CHANNEL NO. 1 AND NO. 2 VALIDITY, PILOT HSI AND VDI VALIDITY, COPILOT/COTAC HSI AND VDI VALIDITY
39 COMMANDED COURSE, CROSS TRACK ERROR, CROSS TRACK ERROR RATE, ROLL COMMAND, FTP EXISTS/DOES NOT EXIST DISCRETE, FTP BEARING AND DISTANCE, DRIFT ANGLE, GROUNDSPEED, NDCR INITIALIZE COMMAND, NDCR SELF TEST COMMAND, GPDC STEERING VALIDITY, TACAN BEARING AND DISTANCE REQUEST, WRA STATUS REQUEST, ADVISORY WORD REQUEST
40 WEIGHT-ON-WHEELS
41 SELF TEST
42 SELF TEST

Flight Displays and Interface System
(Aircraft Not Incorporating AFC-279)



NIU INTERFACING SIGNALS

1. CH1 AND CH2 28 VDC PRIMARY POWER
   CH1 AND CH2 26 VAC REFERENCE VOLTAGE
   115 VAC REFERENCE VOLTAGE

2. PILOT AND COPILOT NDS:
   - ATTITUDE AND HEADING SELECT (EGI/CAINS)
   - COMPUTER
   - UHF
   - CARRIER ILS SELECT
   - CDNU

3. RAAWS DATA

4. RAAWS CLOCK
   RAAWS READ

5. BEARING

6. LATERAL GLIDE SLOPE ERROR
   VERTICAL GLIDE SLOPE ERROR
   TILT
   DATA LINK DATA READY
   DATA LINK DATA

7. LATERAL APPROACH ERROR
   LATERAL APPROACH VALIDITY
   VERTICAL APPROACH ERROR
   VERTICAL APPROACH VALIDITY

8. PITCH
   ROLL

9. CH1 SERIAL DATA
   CH2 SERIAL DATA

10. FDC CH1:
    - CLUTCHED HEADING ERROR
    - GPDC/NIU VALIDITY
    - IAS FAST/SLOW ERROR

    FDC CH2:
    - ATTITUDE/NIU VALIDITY
    - CLUTCHED HEADING ENGAGED
    - GPDC/NIU VALIDITY

    PILOT AND COPILOT FMS:
    - MAGNETIC HEADING
    - APS ROLL AXIS ENGAGED
    - AWCLS MODE
    - TRUE HEADING
    - NAVIGATION COUPLED
    - INDICATED AIRSPEED

11 FDC CH1:
    - ATTITUDE/NIU VALIDITY
    - CLUTCHED HEADING ENGAGED
    - IAS FAST/SLOW VALIDITY
    - NO DESIGNATED FLY–TO–POINT
    - NOMINAL ROLL COMMAND
    - PITCH (COSINE AND SINE)
    - ROLL (COSINE AND SINE)
    - CROSS TRACK ERROR
    - CROSS TRACK ERROR RATE

    FDC CH2:
    - CLUTCHED HEADING ERROR
    - IAS FAST/SLOW ERROR
    - IAS FAST/SLOW VALIDITY
    - NO DESIGNATED FLY–TO–POINT
    - NOMINAL ROLL COMMAND
    - PITCH (COSINE AND SINE)
    - ROLL (COSINE AND SINE)
    - CROSS TRACK ERROR
    - CROSS TRACK ERROR RATE

12. BACKUP MAGNETIC HEADING

13. 23 VAC EXCITATION

14. CENTERED
    DOWN CHEVRON
    UP CHEVRON

15. CH1 DATA
    CH2 DATA

16. BUS ADDRESS
    BUS ADDRESS PARITY

17. CH1 DATA
    CH2 DATA

18. BUS ADDRESS
    BUS ADDRESS PARITY

19. TRANSMIT STATUS WORD
    BACKUP MAGNETIC HEADING
    DATA LINK LABEL WORD
    DATA LINK MESSAGE WORDS 2, 3, AND 4
    RECEIVE COMMAND STATUS WORD

20. TRANSMIT COMMAND WORD
    RECEIVE COMMAND WORD
    DATA VALIDITY
    BEARING
    DISTANCE
    COURSE DEVIATION
    WIND SPEED COUNT
    WIND DIRECTION COUNT
    WAYPOINT TEXT
    NAV STATUS
    MAGNETIC VARIATION
    LATITUDE–PRESENT POSITION
    LONGITUDE–PRESENT POSITION
    N/S VELOCITY
    E/W VELOCITY
    VERTICAL VELOCITY
    UTC MEASUREMENT TIME
    COMMAND COURSE

21. VALIDITY
    DISTANCE
    BEARING
    RANGE RATE
    CHANNEL OUT
    MODE/FUNCTION OUT
    TIME TO STATION

22. SCADC MODE
    BIT
    ALTITUDE PRESSURE
    CORRECTED STATIC PRESSURE
    TOTAL PRESSURE
    IMPACT PRESSURE
    ALTIMETER BAROSET PRESSURE
    INDICATED STATIC PRESSURE
    BAROSET CORRECTED ALTITUDE
    TRUE AIRSPEED
    MACH NUMBER
    CALIBRATED AIRSPEED
    INDICATED AIRSPEED
    INDICATED ANGLE–OF–ATTACK
    TRUE ANGLE-OF-ATTACK
    PRESSURE RATIO
    AIR DENSITY RATIO
    STATIC AIR TEMPERATURE
    TOTAL TEMPERATURE
    ALTITUDE RATE
    MACH RATE

23. VDI:
    - MODE
    - VALIDITY
    - DISCRETES/SELECTS
    - INDICATED AIRSPEED
    - HEADING
    - HEADING SELECT
    - BEARING
    - DISTANCE
    - BARO CORRECTION
    - PITCH
    - ROLL ANGLE
    - VERTICAL VELOCITY
    - TURN RATE
    - LATERAL DEVIATION
    - VERTICAL DEVIATION
    - SPEED ERROR
    - ALTITUDE
    - ANGLE–OF–ATTACK

    HSI:
    - MODE
    - VALIDITY
    - DISCRETES/SELECTS
    - TRUE AIRSPEED
    - HEADING
    - HEADING SELECT
    - BEARING
    - DISTANCE
    - COMMAND COURSE
    - GROUND TRACK
    - GROUNDSPEED
    - COURSE DEVIATION
    - WIND SPEED
    - WIND DIRECTION
    - BEARING TEXT

24. SINS DATA

25. VALIDITY
    TRUE HEADING
    PLATFORM HEADING
    PITCH
    ROLL
    ON TIME
    E/W VELOCITY
    N/S VELOCITY
    VERTICAL VELOCITY
    BLENDED ALTITUDE
    LATITUDE–PRESENT POSITION
    LONGITUDE–PRESENT POSITION
    E/W ACCELERATION
    N/S ACCELERATION
    VERTICAL ACCELERATION
    ALIGNMENT MODE
    NAVIGATION MODE
    ALIGNMENT QUALITY
    ALIGNMENT TIME
    LATERAL ACCELERATION
    LONGITUDINAL ACCELERATION
    NORMAL ACCELERATION
    ROLL RATE
    PITCH RATE
    YAW RATE
    NAV TIME
    VELOCITY TIME TAG
    ATTITUDE TIME TAG

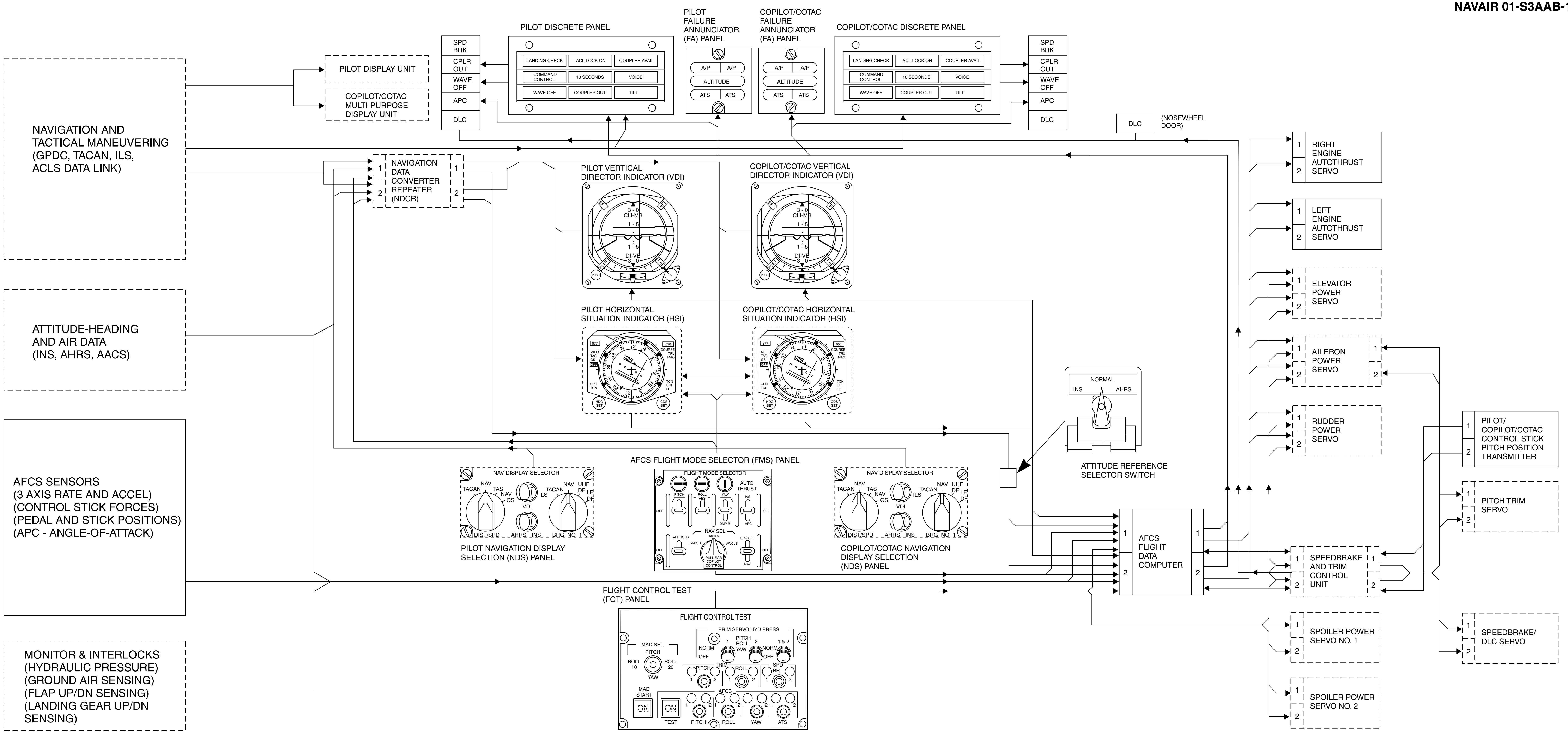
26. SINS DATA

27 VALIDITY
    TRUE HEADING
    PLATFORM HEADING
    PITCH
    ROLL
    E/W VELOCITY
    N/S VELOCITY
    VERTICAL VELOCITY
    BARO INERTIAL ALTITUDE
    LATITUDE–PRESENT POSITION
    LONGITUDE–PRESENT POSITION
    E/W ACCELERATION
    N/S ACCELERATION
    VERTICAL ACCELERATION
    ALIGNMENT MODE
    NAVIGATION MODE
    ALIGNMENT QUALITY
    ALIGNMENT TIME
    LATERAL ACCELERATION
    LONGITUDINAL ACCELERATION
    NORMAL ACCELERATION
    ROLL RATE
    PITCH RATE
    YAW RATE
    VELOCITY TIME TAG

28. SINS DATA AVAILABLE

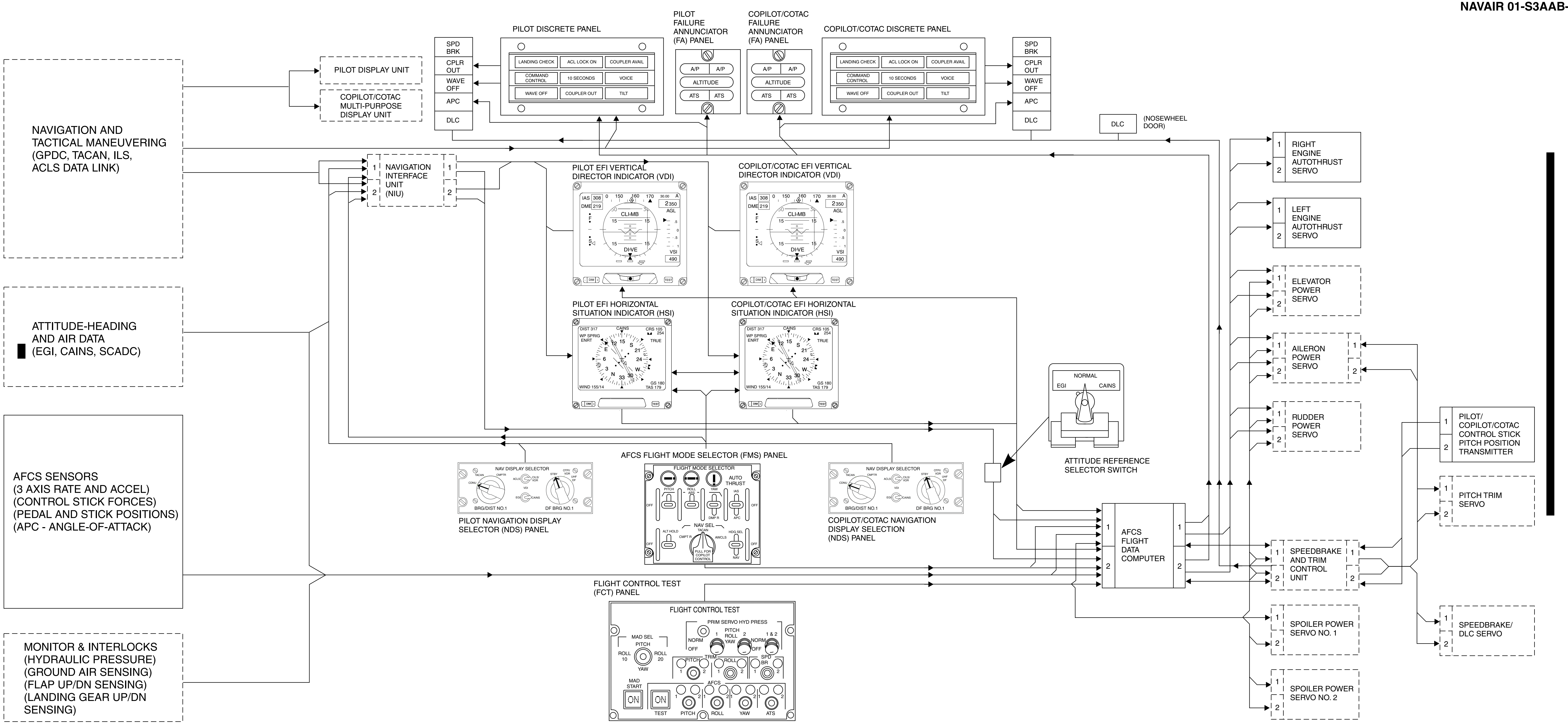
29. PILOT AND COPILOT EFIS:
    - HSI/VDI INVERT
    - TOP DECLUTTER
    - BOTTOM DECLUTTER
    - AUTO RAAWS/BARO ENABLE
    - HEADING SET
    - COURSE SET

Flight Displays and Interface System (Aircraft Incorporating AFC-279)



Automatic Flight Control System
(Aircraft Not Incorporating AFC-279)

FO-19 (Reverse Blank)

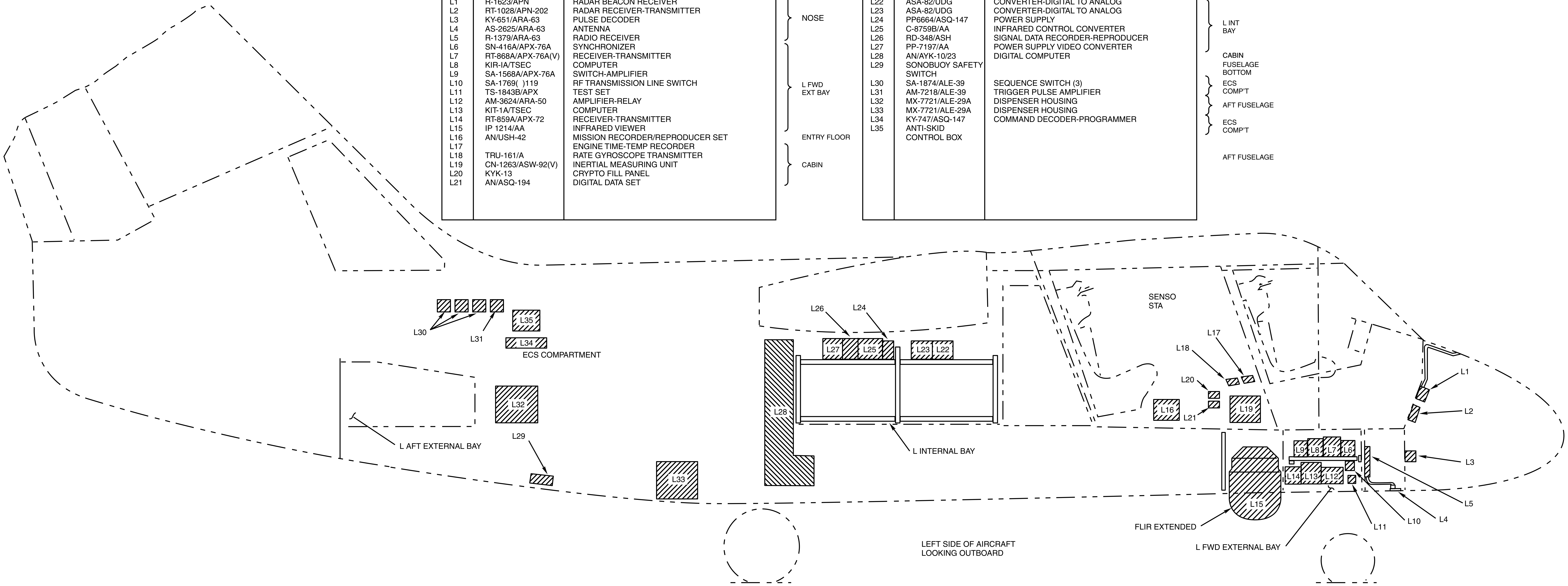


Automatic Flight Control System
(Aircraft Incorporating AFC-279)

FO-20 (Reverse Blank)

ITEM	TYPE DESIGNATOR	NOMENCLATURE	Location
L1	R-1623/APN	RADAR BEACON RECEIVER	
L2	RT-1028/APN-202	RADAR RECEIVER-TRANSMITTER	
L3	KY-651/ARA-63	PULSE DECODER	NOSE
L4	AS-2625/ARA-63	ANTENNA	
L5	R-1379/ARA-63	RADIO RECEIVER	
L6	SN-416A/APX-76A	SYNCHRONIZER	
L7	RT-868A/APX-76A(V)	RECEIVER-TRANSMITTER	
L8	KIR-IA/TSEC	COMPUTER	
L9	SA-1568A/APX-76A	SWITCH-AMPLIFIER	
L10	SA-1769( )119	RF TRANSMISSION LINE SWITCH	L FWD EXT BAY
L11	TS-1843B/APX	TEST SET	
L12	AM-3624/ARA-50	AMPLIFIER-RELAY	
L13	KIT-1A/TSEC	COMPUTER	
L14	RT-859A/APX-72	RECEIVER-TRANSMITTER	
L15	IP 1214/AA	INFRARED VIEWER	
L16	AN/USH-42	MISSION RECORDER/REPRODUCER SET	ENTRY FLOOR
L17		ENGINE TIME-TEMP RECORDER	
L18	TRU-161/A	RATE GYROSCOPE TRANSMITTER	
L19	CN-1263/ASW-92(V)	INERTIAL MEASURING UNIT	CABIN
L20	KYK-13	CRYPTO FILL PANEL	
L21	AN/ASQ-194	DIGITAL DATA SET	

ITEM	TYPE DESIGNATOR	NOMENCLATURE	Location
L22	ASA-82/UDG	CONVERTER-DIGITAL TO ANALOG	
L23	ASA-82/UDG	CONVERTER-DIGITAL TO ANALOG	
L24	PP6664/ASQ-147	POWER SUPPLY	
L25	C-8759B/AA	INFRARED CONTROL CONVERTER	L INT BAY
L26	RD-348/ASH	SIGNAL DATA RECORDER-REPRODUCER	
L27	PP-7197/AA	POWER SUPPLY VIDEO CONVERTER	
L28	AN/AYK-10/23	DIGITAL COMPUTER	CABIN
L29	SONOBUOY SAFETY SWITCH		FUSELAGE BOTTOM
L30	SA-1874/ALE-39	SEQUENCE SWITCH (3)	ECS COMP'T
L31	AM-7218/ALE-39	TRIGGER PULSE AMPLIFIER	
L32	MX-7721/ALE-29A	DISPENSER HOUSING	AFT FUSELAGE
L33	MX-7721/ALE-29A	DISPENSER HOUSING	
L34	KY-747/ASQ-147	COMMAND DECODER-PROGRAMMER	ECS COMP'T
L35	ANTI-SKID CONTROL BOX		
			AFT FUSELAGE



Avionics Equipment Location (Left)

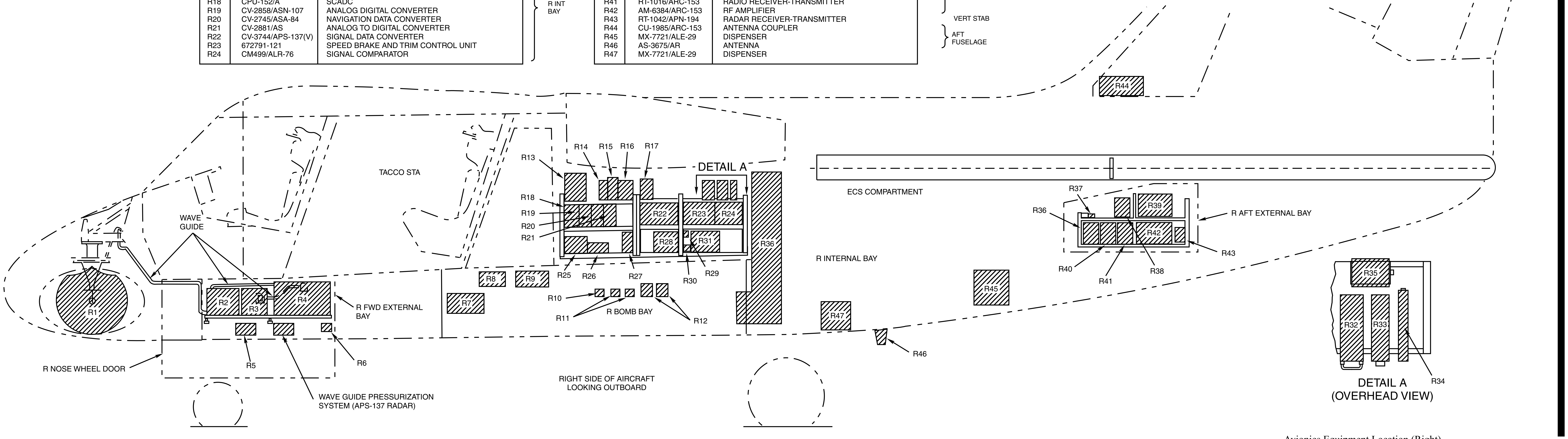
AVIONICS EQUIPMENT LOCATION DIAGRAM

ITEM	TYPE DESIGNATOR	NOMENCLATURE
R1	AS-3637A/APS-137	ANTENNA
R2	R2231/APS-137	RECEIVER-PULSE COMPRESSOR
R3	SN-5468/APS-137	SYNCHRONIZER-EXCITER
R4	T-1203/APS-116	RADAR TRANSMITTER
R5	CV-2230B/ASW-26B	CONVERTER-RECEIVER
R6		STEERING CONTROL AMPLIFIER
R7	CN-1366/ASN-107	DISPLACEMENT GYROSCOPE
R8	J-3036/ASQ-147	ARMAMENT DISTRIBUTION BOX
R9	KY-746/ASQ-147	COMMAND SIGNALS DECODER
R10		PITCH RATE SENSOR
R11	MX-8967/ASW-33	ELECTRICAL ACCELEROMETER (2) (FWD & AFT)
R12	CN-1370/ASW-33	RATE GYROSCOPE ASSEMBLY (2)
R13	KG-40/TSEC	SECURE DATA KEYER
R14	R-139/ARN-83	RADIO RECEIVER
R15	672792-121	SPEED BRAKE AND TRIM CONTROL UNIT
R16	AM6460/ASA-65A	ELECTRONIC CONTROL AMPLIFIER
R17	KY-58/TSEC	SECURE VOICE KEYER
R18	CPU-152/A	SCADC
R19	CV-2858/ASN-107	ANALOG DIGITAL CONVERTER
R20	CV-2745/ASA-84	NAVIGATION DATA CONVERTER
R21	CV-2881/AS	ANALOG TO DIGITAL CONVERTER
R22	CV-3744/APS-137(V)	SIGNAL DATA CONVERTER
R23	672791-121	SPEED BRAKE AND TRIM CONTROL UNIT
R24	CM499/ALR-76	SIGNAL COMPARATOR

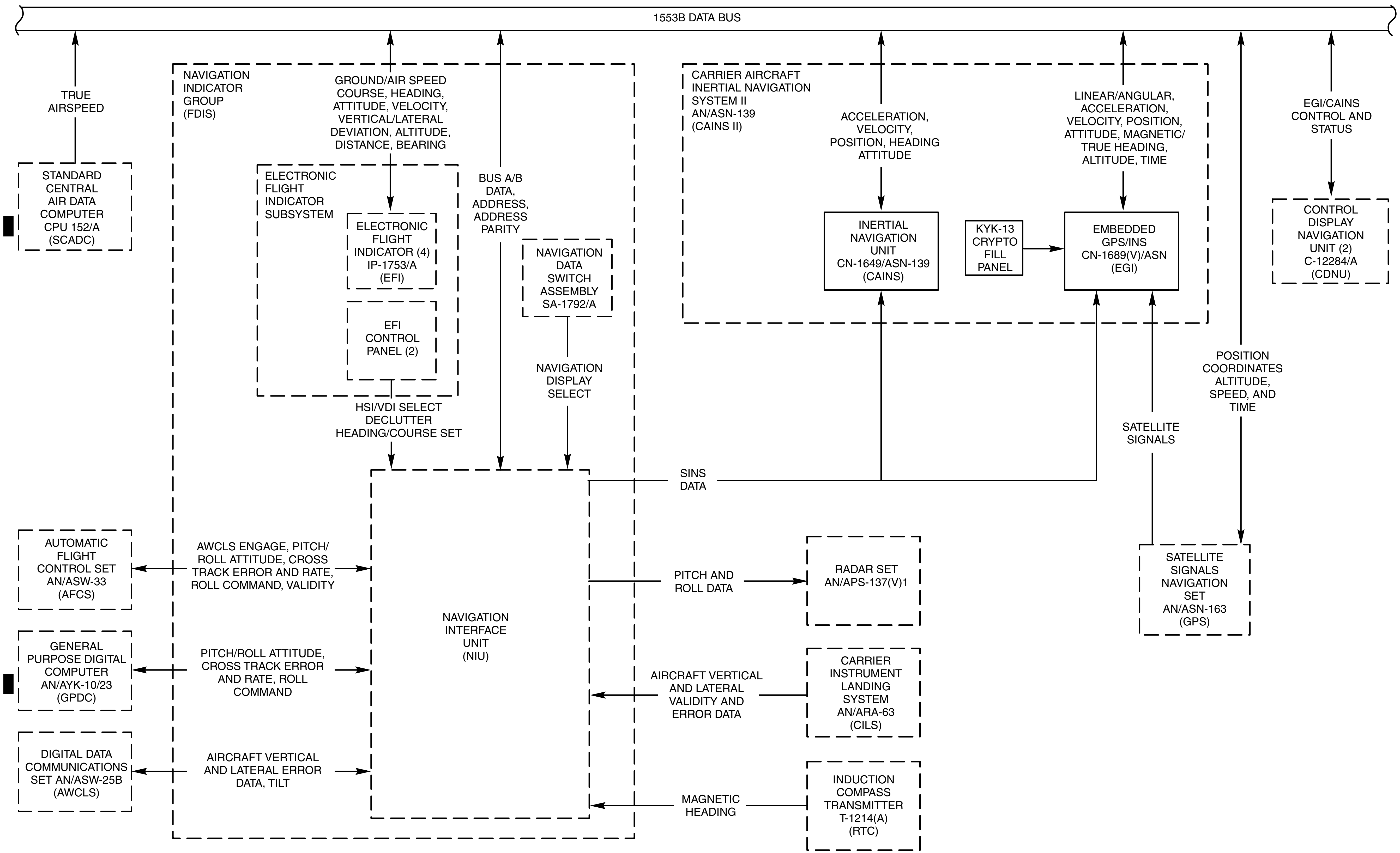
NOSE
R FWD EXT BAY
R FWD EXT BAY CABIN
R BOMB BAY
R INT BAY

ITEM	TYPE DESIGNATOR	NOMENCLATURE
R25	CP964/ASN-92	AIRBORNE NAVIGATION COMPUTER
R26	PP6188/ASN-92V	INERTIAL NAVIGATION POWER SUPPLY
R27	CV-2854/A	NAVIGATION DATA CONVERTER-REPEATER
R28	C-11164/APS-137(V)	RADAR INTERFACE UNIT
R29		(INBD) COAX RELAY-SRS COAXIAL TERMINATION (OUTBD) COAX RELAY-SRS COAXIAL TERMINATION
R30		SELECTOR UNIT
R31	PP7813/APS-137(V)	POWER SUPPLY
R32	RT-1627/ARN-153V-2	TACAN RCVR-XMTR
R33	R-2414/U	GPS RCVR (MAGR)
R34	CV-4138/A	SIGNAL DATA CONVERTER
R35	1223020-101	FIWA
R36	AN/AYK-10/23	DIGITAL COMPUTER
R37	LS 602/A1	INTERCOM STA
R38	CV-2830/AYC	DIGITAL TO ANALOG CONVERTER
R39	CV-3048A/A1	INTERCONNECTING CONVERTER
R40	RT-1017/ARC-156	RADIO RECEIVER-TRANSMITTER (2)
R41	RT-1016/ARC-153	RADIO RECEIVER-TRANSMITTER
R42	AM-6384/ARC-153	RF AMPLIFIER
R43	RT-1042/APN-194	RADAR RECEIVER-TRANSMITTER
R44	CU-1985/ARC-153	ANTENNA COUPLER
R45	MX-7721/ALE-29	DISPENSER
R46	AS-3675/AR	ANTENNA
R47	MX-7721/ALE-29	DISPENSER

R INT BAY
CABIN
R AFT EXT BAY
VERT STAB
AFT FUSELAGE



Avionics Equipment Location (Right)



CAINS II Interface Diagram
(Aircraft Incorporating AFC-279)

FO-23 (Reverse Blank)

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
Original	1 (Reverse Blank)
Original	3 (Reverse Blank)
Original	5 (Reverse Blank)
Original	7 (Reverse Blank)
Original	9 (Reverse Blank)
Original	11 thru 67 (Reverse Blank)
Original	1-1 thru 1-5 (Reverse Blank)
Original	2-1 thru 2-338
Original	3-1 thru 3-26
Original	4-1 thru 4-17 (Reverse Blank)
Original	69 (Reverse Blank)
Original	5-1 thru 5-4
Original	71 (Reverse Blank)
Original	6-1 thru 6-5 (Reverse Blank)
Original	7-1 thru 7-10
Original	8-1 thru 8-29 (Reverse Blank)
Original	9-1 thru 9-10
Original	10-1 thru 10-24
Original	11-1 thru 11-30
Original	73 (Reverse Blank)
Original	12-1 thru 12-14
Original	75 thru 80
Original	13-1 thru 13-8
Original	14-1 thru 14-20
Original	15-1 thru 15-5 (Reverse Blank)
Original	16-1 thru 16-3 (Reverse Blank)
Original	17-1 thru 17-2
Original	18-1 thru 18-7 (Reverse Blank)
Original	19-1 thru 19-5 (Reverse Blank)
Original	20-1 thru 20-3 (Reverse Blank)
Original	21-1 thru 21-2
Original	22-1 thru 22-2
Original	23-1 thru 23-20
Original	24-1 thru 24-4
Original	25-1 thru 25-16
Original	81 (Reverse Blank)
Original	26-1 thru 26-12
Original	83 (Reverse Blank)
Original	27-1 thru 27-12
Original	85 (Reverse Blank)
Original	28-1 (Reverse Blank)
Original	87 (Reverse Blank)

Effective Pages	Page Numbers
Original	29-1 thru 29-6
Original	89 (Reverse Blank)
Original	30-1 thru 30-12
Original	91 (Reverse Blank)
Original	31-1 thru 31-17 (Reverse Blank)
Original	32-1 thru 32-12
Original	33-1 thru 33-15 (Reverse Blank)
Original	34-1 thru 34-24
Original	35-1 thru 35-6
Original	36-1 thru 36-5 (Reverse Blank)
Original	37-1 thru 37-4
Original	38-1 thru 38-60
Original	39-1 thru 39-2
Original	40-1 thru 40-8
Original	93 (Reverse Blank)
Original	41-1 thru 41-7 (Reverse Blank)
Original	Index-1 thru Index-18
Original	FO-1 (Reverse Blank)
Original	FO-2 (Reverse Blank)
Original	FO-3 (Reverse Blank)
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Original	FO-13 (Reverse Blank)
Original	FO-14 (Reverse Blank)
Original	FO-15 (Reverse Blank)
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Original	FO-21 (Reverse Blank)
Original	FO-22 (Reverse Blank)
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Original	LEP-1 (Reverse Blank)