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NATOPS FLIGHT MANUAL NAVY MODEL UC-12B/F/M AIRCRAFT

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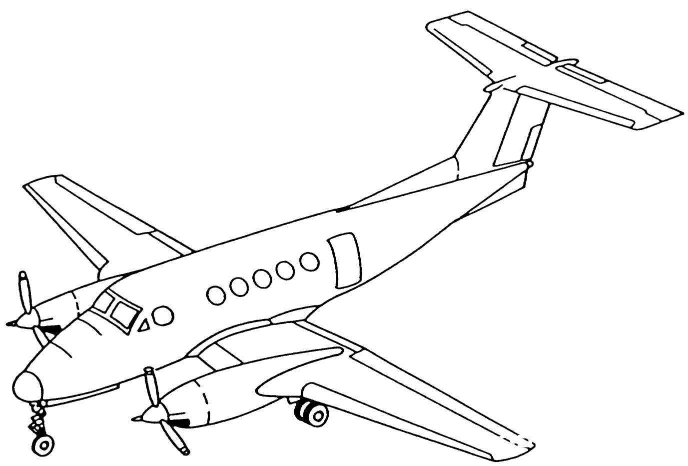

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DEPARTMENT OF THE NAVY
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1 February 2007

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 OPNAV Instruction 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.

S. R. EASTBURG
Rear Admiral, United States Navy
By direction of
Commander, Naval Air Systems Command

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE

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(S)	ORIGINATOR/DATE (or DATE/TIME GROUP)	PAGES AFFECTED	REMARKS/PURPOSE

Summary of Applicable Technical Directives

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

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

Information relating to the following applicable technical directives will be incorporated in a future change.

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

RECORD OF CHANGES

Record entry and page count verification for each printed change and erratum:

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

UC-12B/F/M NATOPS FLIGHT MANUAL

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LIST OF ABBREVIATIONS/ACRONYMS

A

ac. Alternating Current.

AC. Aircraft Commander.

ACFT. Aircraft.

ACT. Active.

ADC. Air Data Computer.

ADF. Automatic Direction Finder.

ADI. Attitude Director Indicator.

ADIZ. Air Defense Identification Zone.

AFCS. Automatic Flight Control System.

AFIS. Airborne Flight Information System.

AGL. Above Ground Level.

AK. Automatic Keying.

ALT. Altitude.

ALTSEL. Altitude Preselect Mode.

AM. Amplitude Modulated.

AN. Army/Navy.

AP. Autopilot.

APP. Approach.

APR. Approach.

ASTM. American Society for Testing Materials.

ATC. Air Traffic Control.

ATIS. Automatic Terminal Information System.

AVGAS. Aviation Gasoline.

B

B. Bravo Model.

BATT. Battery.

BC. Back Course.

BFO. Beat Frequency Oscillator.

BIT. Built In Test.

BL. Bleed.

BTU. British Thermal Unit.

BuNo. Bureau Number.

C

°C. Degrees Celsius.

C. Cipher.

CACT. Contracted Aircrew Training.

CAS. Calibrated Airspeed.

CAUT. Caution.

CB. Circuit Breaker.

CDI. Course Deviation Indicator.

CDU. Control Display Unit.

CFIT. Controlled Flight Into Terrain.

cg. Center of Gravity.

CHAN. Channel.

CHG. Charge.

CND. Conditioner.

CNO. Chief of Naval Operations.

CNV. Cryptonet Variable.

COT. Cockpit Operational Trainer.

CQ. Conditionally Qualified.

CRM. Crew Resource Management.

CU. Computer Unit.

CuFt. Cubic Feet.

CVR. Cockpit Voice Recorder.

CW. Continuous Wave.

D

dB. Decibel.

dc. Direct Current.

DEC. Decrease.

DECR. Decrease.

DET. Detector.

DH. Decision Height.

DISC. Disconnect.

DME. Distance Measuring Equipment.

DOD. Department Of Defense.

DR. Dead Reckoning.

DTK. Desired Track.

E

EAS. Equivalent Airspeed.

EGPWC. Enhanced Ground Proximity Warning Computer.

EGPWS. Enhanced Ground Proximity Warning System.

ELECT. Electric.

ELEV. Elevator.

ELT. Emergency Locator Transmitter.

ENG. Engine.

ENVIR. Environmental.

EODF. Emergency On Deck Fuel.

ETA. Estimated Time of Arrival.

ETE. Estimated Time En Route.

ETP. Equal Time Point.

EXT. Extended.

F

°F. Degrees Fahrenheit.

F. Foxtrot Model.

FAA. Federal Aviation Administration.

FAF. Final Approach Fix.

FCF. Functional Checkflight.

FD. Flight Director.

FDE. Fault Detection and Exclusion.

FDI. Flight Director Indicator.

FDR. Flight Data Recorder.

FL. Flight Level.

FLT DIR. Flight Director.

FMS. Flight Management System.

FOD. Foreign Object Damage.

FPA. Flight Path Angle.

FPL. Flight Plan List.

fpm. Feet Per Minute.

FRS. Fleet Replacement Squadron/School.

F.S. Fuselage Station.

FSB. Fasten Seatbelt.

ft. Feet.

FtLb. Foot Pounds.

G

g. Gravity.

GA. Go Around.

GAL. U.S. Gallon(s).

GCA. Ground Control Approach.

GEN. Generator.

GMT. Greenwich Mean Time.

GPS. Global Positioning System.

GPU. Ground Power Unit.

GPWS. Ground Proximity Warning System.

GRU. Receiver Unit.

GS. Glideslope, Groundspeed.

GS_1. Groundspeed from Takeoff to Midpoint in Flight.

GS_2. Groundspeed from Midpoint to Departure Point.

GS_C. Groundspeed to Continue.

GS_R. Groundspeed to Return.

H

HDG. Heading.

HF. High Frequency.

Hg. Mercury.

HP. Holding Pattern.

Hr. Hour.

HSI. Horizontal Situation Indicator.

HYD. Hydraulic.

Hz. Hertz.

I

IAS. Indicated Airspeed.

ICAO. International Civil Aviation Organization.

ICS. Intercommunication System.

IEC. Interstate Electronics Corporation.

IFF. Identification Friend or Foe.

IFR. Instrument Flight Rules.

ILS. Instrument Landing System.

IMC. Instrument Meteorological Condition.

INC. Increase.

INOP. Inoperative.

INST. Instrument.

INSTR. Instrument.

INV. Inverter.

IOAT. Indicated Outside Air Temperature.

IP. Instructor Pilot.

ISA. International Standard Atmosphere.

ITT. Interstage Turbine Temperature.

IVSI. Instantaneous Vertical Speed Indicator.

J

JOSAC. Joint Operational Support Airlift Center.

JP. Jet Propellant.

K

KCAS. Knots Calibrated Airspeed.

kHz. Kilohertz.

KIAS. Knots Indicated Airspeed.

KTAS. Knots True Airspeed.

L

lb. Pound(s).

LD. Load.

LDG. Landing.

LGND. Landing.

LLWAS. Low Level Windshear Alert System.

LOA. Letter Of Authorization.

LOC. Localizer.

LOM. Locator Outer Marker.

LOP. Line Of Position.

LRU. Line Replaceable Unit.

LS. Left Seat.

LSB. Lower Sideband.

LSK. Left Select (soft) Keys.

LTS. Lights.

M

M. Mike Model.

MAC. Mean Aerodynamic Chord.

MAHP. Missed Approach Holding Point.

MAN. Manual.

MAP. Missed Approach Point.

Mb. Millibars.

MDA. Minimum Descent Altitude.

MEA. Minimum En Route IFR Altitude.

MFD. Multi-Function Display.

MHz. Megahertz.

MIC. Microphone.

MIN. Minutes.

MK. Manual Keying.

MMO. Maximum Mach Operation.

MRT. Minimum Radius Turn.

MSL. Mean Sea Level.

MTC. Minimum Terrain Clearance.

N

N_1. Gas Generator Speed.

N_2. Propeller Speed.

N/A. Not Applicable.

NAC. Nacelle.

NATO. North Atlantic Treaty Organization.

NATOPS. Naval Air Training and Operating Procedures Standardization.

NAV. Navigation.

NAVAIDs. Navigational Aids.

NDB. Non-Directional Beacon.

NFO. Naval Flight Officer.

NiCad. Nickel Cadmium.

nm. Nautical Mile.

NOAA. National Oceanic Atmospheric Administration.

NoPT. No Procedure Turn Required.

O

OAT. Outside Air Temperature.

OBS. Observer.

OFT. Operational Flight Trainer.

OPARS. Optimum Path Aircraft Routing System.

O'RIDE. Override.

ORM. Operational Risk Management.

OXY. Oxygen.

P

PA. Public Address.

PASS. Passenger.

PCMCIA. Personal Computer Memory Card International Association.

PDL. Portable Data Loader.

PF. Pilot Flying.

PGM. Program.

PIREPS. Pilot Reports.

PNEU. Pneumatic.

PNF. Pilot Not Flying.

PNR. Point of No Return.

pph. Pounds Per Hour.

PRES. Pressure.

PROP. Propeller.

psi. Pound per Square Inch.

psid. Pound per Square Inch Differential.

psig. Pound per Square Inch Gauge.

PSR. Point of Safe Return.

PT. Procedure Turns.

PUI. Pilot Under Instruction.

PWR. Power.

Q

Q. Qualified.

R

RA. Resolution Advisory.

RAIM. Receiver Autonomous Integrity Monitoring.

RCP. Radar Computer Unit.

RCR. Runway Condition Reading.

REV. Reverse Thrust/Reverse Course.

RH. Right Hand.

RKV. Remote Keying Variable.

RMI. Radio Magnetic Indicator.

RNAV. Remote Area Navigation.

rpm. Revolutions Per Minute.

RPU. Receiver Processor Unit.

RS. Right Seat.

RSK. Right Select (Soft) Keys.

RT. Receiver/Transmitter.

RV. Receive Variable.

RVS. Reverse.

S

SBY. Standby.

SEC. Second(s).

SHP. Shaft Horsepower.

SID. Standard Instrument Departure.

SL. Sea Level.

SOP. Standard Operating Procedure.

SSE. Simulated Single Engine.

STAR. Standard Terminal Arrival Routes.

STBY. Standby.

STD. Standard.

STO. Store.

SXTK. Selected Cross Track.

SYNC. Syncrophaser.

T

T_1. All Fuel Aboard at Takeoff (Except Fuel for Holding and Flying to Altenet).

T_2. All Fuel Aboard at Takeoff.

T2P. Transport Second Pilot.

T3P. Transport Third Pilot.

TA. Transport Aircrewman; Traffic Advisory.

TACAN. Tactical Air Navigation.

TAD. Terrain (or Obstacle) Alerting and Display.

TAS. True Airspeed.

TBO. Time Between Overhaul.

TCAS. Traffic Collision Avoidance System.

TCF. Terrain Clearance Floor.

TCS. Touch Control Steering.

TDWR. Terminal Doppler Weather Radar.

TEMP. Temperature.

TGT. Turbine Gas Temperature Indicators.

TOD. Time Of Day.

TOLD. Takeoff and Landing Data.

TPC. Transport Plane Commander.

TRA. Traffic Advisory Display.

TRK. Track.

TX. Transmit.

U

U. Unqualified.

UHF. Ultrahigh Frequency.

UQ. Unqualified.

USB. Upper Sideband.

V

V_1. Decision Speed.

V_2. Climbout Safety Speed.

V_A. Maneuvering Speed.

Vac. Volts Alternating Current.

Vdc. Volts Direct Current.

VDP. Visual Descent Point.

V_{FE}. Maximum Flap Extended Speed.

VFR. Visual Flight Rules.

VHF. Very High Frequency.

V_{LE}. Maximum Landing Gear Extension/Extended Speed.

VLF. Very Low Frequency.

V_{LO}. Maximum Landing Gear Operating Speed.

V_{LOF}. Lift-Off Speed.

V_{MC}. Minimum Control Speed.

VMC. Visual Meteorological Condition.

V_{MCA}. Minimum Control Speed Air.

V_{MO}. Maximum Operating Speed.

VNAV. Vertical Navigation.

VOL. Volume.

VOR. VHF Omnidirectional Range.

VOX. Voice Operate Key.

VP. Vertical Profile.

V_R. Rotate Speed.

V_{REF}. Reference Speed.

VS. Vertical Speed.

V_S. Stalling Speed.

VSI. Vertical Speed Indicator.

V_{SSE}. Minimum Safe One-Engine Inoperative Speed.

VSWR. Vertical Scan Weather Radar.

V_{SY}. Best Rate of Climb Speed.

V_X. Best Angle of Climb Speed.

V_{XSE}. Best Single Engine Angle of Climb Speed.

V_Y. Best Angle of Climb Speed.

V_{YSE}. Best Rate of Climb Speed Single Engine.

W

WOD. Word Of Day.

WST. Weapon System Trainer.

X

XPDR. Transponder.

Y

YD. Yaw Damper.

Z

ZFW. Zero Fuel Weight.

PREFACE

SCOPE

NATOPS manuals are issued by the authority of the Chief of Naval Operations and under the direction of the Commander, Naval Air Systems Command in conjunction with the Naval Air Training and Operating Procedures Standardization (NATOPS) program. NATOPS publications provide the best available operating instructions for most circumstances. However, no manual can cover every situation or be a substitute for sound judgment; operational situations may require modification of the procedures contained therein. Read these publications from cover to cover. It is your responsibility to have a complete knowledge of their contents.

Note

See Chapter 1 for more information on the scope and purpose of this manual, and for any special requirements or procedures that compliment those contained in this preface.

OTHER RELEVANT PUBLICATIONS

Current versions of the following publications comprise the family of NATOPS and tactical manual publications that complement the information contained within this manual:

A1-C12BM-NFM-200 (Performance Charts Supplement)

A1-C12BM-NFM-500 (NATOPS Pilot's Card Checklist)

A1-C12BM-NFM-700 (Functional Checkflight Checklist)

A1-C12BM-NFM-800 (Passenger Information Card)

DETERMINING THE CURRENT VERSION OF THIS PUBLICATION

The current versions of NATOPS publications are listed in the NATOPS Status Report which is available online at https://airworthiness.navair.navy.mil. Upon receiving a copy of a NATOPS, consult the NATOPS Status Report to determine its current configuration (through the latest revision, change, and interim change). Before using this publication, users shall ensure that they have the current version of it.

OBTAINING COPIES OF THIS PUBLICATION

One-Time Orders

Copies of this publication and the current changes thereto may be ordered from the Naval Logistics Library (NLL) using NAVICP Pub 2003, which is available online at https://nll.ahf.nmci.navy.mil, or procured through the supply system in accordance with NAVSUP P-409 (MILSTRIP/MILSTRAP). This manual is also available in pdf format and may be viewed on, and downloaded from, the NATEC or AIRWORTHINESS websites (www.natec.navy.mil or https://airworthiness.navair.navy.mil) respectively.

Note

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Note

- An order for a publication that exceeds the maximum order quantity posted on the NLL website will be filled not to exceed the maximum order quantity. Additional orders will be required in order for an activity to receive more than the posted maximum order quantity of a publication.
- Interim changes to NATOPS publications are not stocked within the NLL or NAVSUP systems and must be obtained separately. Active interim changes to NATOPS publications are published in electronic media only and most are available online at www.natec.navy.mil and https://airworthiness.navair.navy.mil for viewing and downloading.

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Note

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- To avoid the gross cost and delivery inefficiencies that have resulted from excessive or insufficient distributions, the NATOPS Program Manager has been granted authority to adjust the automatic distribution quantities of NATOPS publications. Units requiring large or unusual distribution quantities of NATOPS publications should confirm them with the NATOPS Program Manager in advance of distribution to ensure that the quantities they will receive will be acceptable.

KEEPING THIS PUBLICATION CURRENT

To be effective, NATOPS publications must be kept current through an active manual change program. Corrections, additions to, deletions from, and suggestions for improvement of contents should be submitted as NATOPS change recommendations as soon as possible after discovery. Suggestions for improvement should avoid vague and generalized language and shall be worded as specifically as possible. Detailed standards for NATOPS publications are found in MIL-DTL-85025B(AS), which is available online at https://airworthiness.navair.navy.mil. Change recommendations may be submitted by anyone in accordance with OPNAVINST 3710.7-series. All users are encouraged to contribute to the currency, accuracy, and usefulness of this and other NATOPS publications by submitting timely change recommendations for these publications.

SUBMITTING CHANGE RECOMMENDATIONS

Types of Change Recommendations

Change recommendations should be submitted as URGENT, PRIORITY or ROUTINE. Urgent and Priority change recommendations are changes that cannot be allowed to wait for implementation until after the next review conference. These usually involve safety-of-flight matters. Some priority change recommendations may be upgraded to URGENT by NATOPS Program Manager, Program Class Desk, or NAVAIR (AIR-4.0P) following receipt and initial review.

Submitting Change Recommendations to NATOPS Publications

While each type of change recommendation is processed and approved differently, the preferred means of submitting all of them is through the Airworthiness Issues Resolution System (AIRS) which may be accessed online at https://airworthiness.navair.navy.mil, or on SIPRNET at https://airworthiness.navair.navy.smil.mil for classified or otherwise sensitive change Recommendations. AIRS provides the fastest and most efficient means of processing and resolving NATOPS change recommendations. It expedites distribution of the URGENT and PRIORITY change recommendations to those who need to act on them and compiles the ROUTINE change recommendations into their respective review conference agenda packages.

In the event that a worldwide web connection to AIRS is not available, PRIORITY change recommendations may be submitted via Naval message in accordance with OPNAVINST 3710.7-series. When AIRS is not accessible, ROUTINE change recommendations may be submitted on a NATOPS/Tactical Change Recommendation (Form OPNAV 3710/6), a copy of which is contained within the preface of this manual. The completed change recommendations forms for changes to this manual should be sent by U.S. Mail to the NATOPS Model Manager of this publication at:

Message PLAD:COMACCLOGWING PT/ MUGU CA.//N-3//N-9//

Address:

Commander, Airborne Command Control and Logistics Wing COMACCLOGWING
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ISSUING UPDATES TO NATOPS PUBLICATIONS

Interim Changes

Approved NATOPS urgent and priority change recommendations are issued via Naval messages and may involve making pen-and-ink entries and/or replacing pages. Copies of interim change messages and their replacement pages are posted on the NATEC website at www.natec.navy.mil, https://airworthiness.navair.navy.mil, or https://airworthiness .navair.navy.smil.mil for viewing and downloading. Interim change replacement pages are always issued in electronic format and are not distributed in paper format except under unusual circumstances. Following the incorporation of an interim change into this publication, its entry should be recorded on the Interim Change Summary page within this publication.

Revisions, Changes and Errata

Routine change recommendations are compiled into a conference agenda and held for review at the next NATOPS review conference for this publication. Change recommendations approved by the review conference are published by the NATOPS Model Manager in a review conference report and then incorporated into a revision or change to this manual, copies of which are mailed on paper and/or electronic media to users that have a listed requirement for it in the NATEC ADRL system database. Copies of most unclassified publications are also posted on the NATEC and Airworthiness websites. When printing errors are found in publications, errata may also be prepared and posted and/or distributed in electronic or paper form in the same manner as for revisions and changes. After incorporating a change or errata into this publication, you should page check and record its entry on the Record of Changes page within this publication.

NATOPS/TACTICAL CHANGE RECOMMENDATION
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
TO (Model Manager)	Unit

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

Recommendation (Be specific.)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

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FROM	DATE
TO	

REFERENCE

(a) Your Change Recommendation Dated ____________

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

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

/S/ ____________ MODEL MANAGER | ____________ AIRCRAFT

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in the right 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. Change symbols are not normally used to mark the locations of deleted information.

SPECIAL TERMINOLOGY IN NATOPS PUBLICATIONS

The following special terminology and meanings apply to the contents of this and other NATOPS publications:

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to WARNINGS, CAUTIONS, and Notes:

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.

Requirement for compliance

“Shall” is used only when application of a procedure is mandatory.

“Should” is used only when application of a procedure is recommended.

“May” and “need not” are used only when application of a procedure is optional.

“Will” is used only to indicate futurity, and never to indicate any degree of requirement for applicability of a procedure.

Requirement for landing aircraft

Land immediately means execute a landing without delay. The primary consideration is to ensure the survival of the occupants. (Applicable to helicopters and other VTOL aircraft).

Land as soon as possible means land at the first landing site at which a safe landing may be made.

Land as soon as practical means extended flight is not recommended. The landing and duration of flight is at the discretion of the pilot in command.

Aircraft Version Markings

(**B**), (**F**), and (**M**) indicates the aircraft version to which the marked text is applicable (e.g., Bravo (**B**), Foxtrot (**F**), or Mike (**M**)).

PART I

The Aircraft

CHAPTER 1

Aircraft

1.1 AIRCRAFT

The UC-12 aircraft manufactured by Beech Aircraft Corporation is an all-metal, low-wing, twin- turboprop, T-tail monoplane with an axial flow engine mounted on each wing. The flight and cabin compartments are pressurized for high- altitude flight. The cargo and airstair doors are located on the left side of the aircraft aft of the wing. The cargo door swings up to load light cargo, and the airstair door within the cargo door swings down, forming steps for entry and exit. A plug-type ground escape hatch is located on the right side of the aircraft at the forward end of the passenger compartment.

The fuel supply is carried in the integral wing tanks and engine nacelle tanks. Fuel servicing is performed through the gravity flow fuel filler receptacles, one on each upper outboard wing surface and one on each upper inboard wing surface (auxiliary tank).

The basic mission of the UC-12 aircraft is to provide transportation of passengers and/or light cargo.

1.1.1 Aircraft Dimensions

The overall dimensions, wingspan, length, and height of the aircraft (Figure 1-1) are:

1. Wingspan — 54 feet 6 inches.
2. Length — 43 feet 10 inches.
3. (**B/F**) Height — 14 feet 6 inches.

   (**M**) Height — 14 feet 10 inches.

1.1.2 Aircraft Weight

Maximum start or takeoff gross weight:

1. Normal category — 12,500 pounds.
2. Restricted category — 13,500 pounds.
3. Maximum gross ramp and taxi weight:

   (**B**) Normal Category — 12,590 pounds; Restricted Category — 13,590 pounds.

   (**F/M**) Normal Category — 12,595 pounds; Restricted Category — 13,595 pounds.
4. Maximum landing weight — 12,500 pounds.
5. Maximum zero fuel weight — 11,000 pounds.

1.1.3 General Arrangement

For aircraft general arrangement, refer to Figure 1-2.

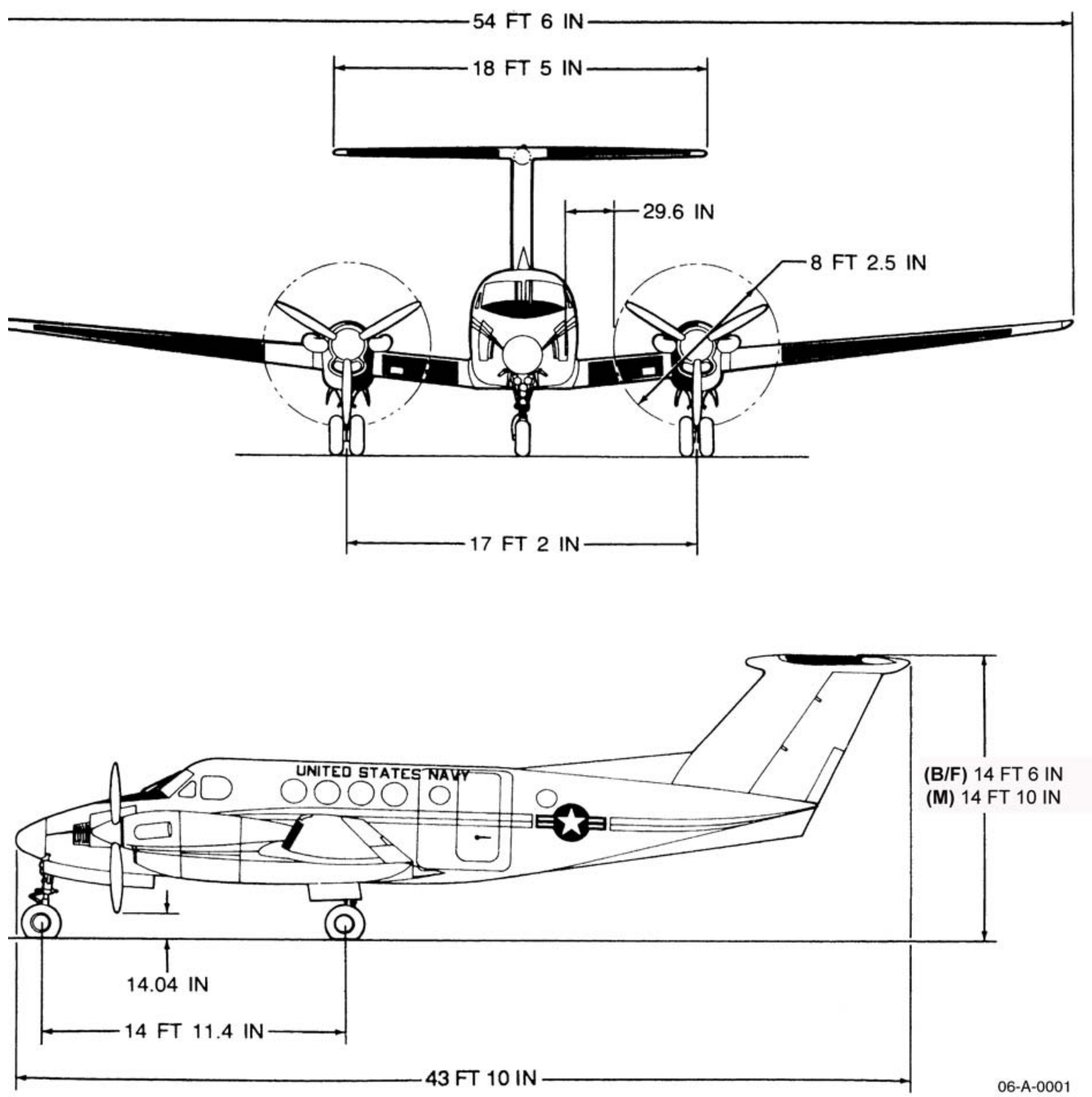
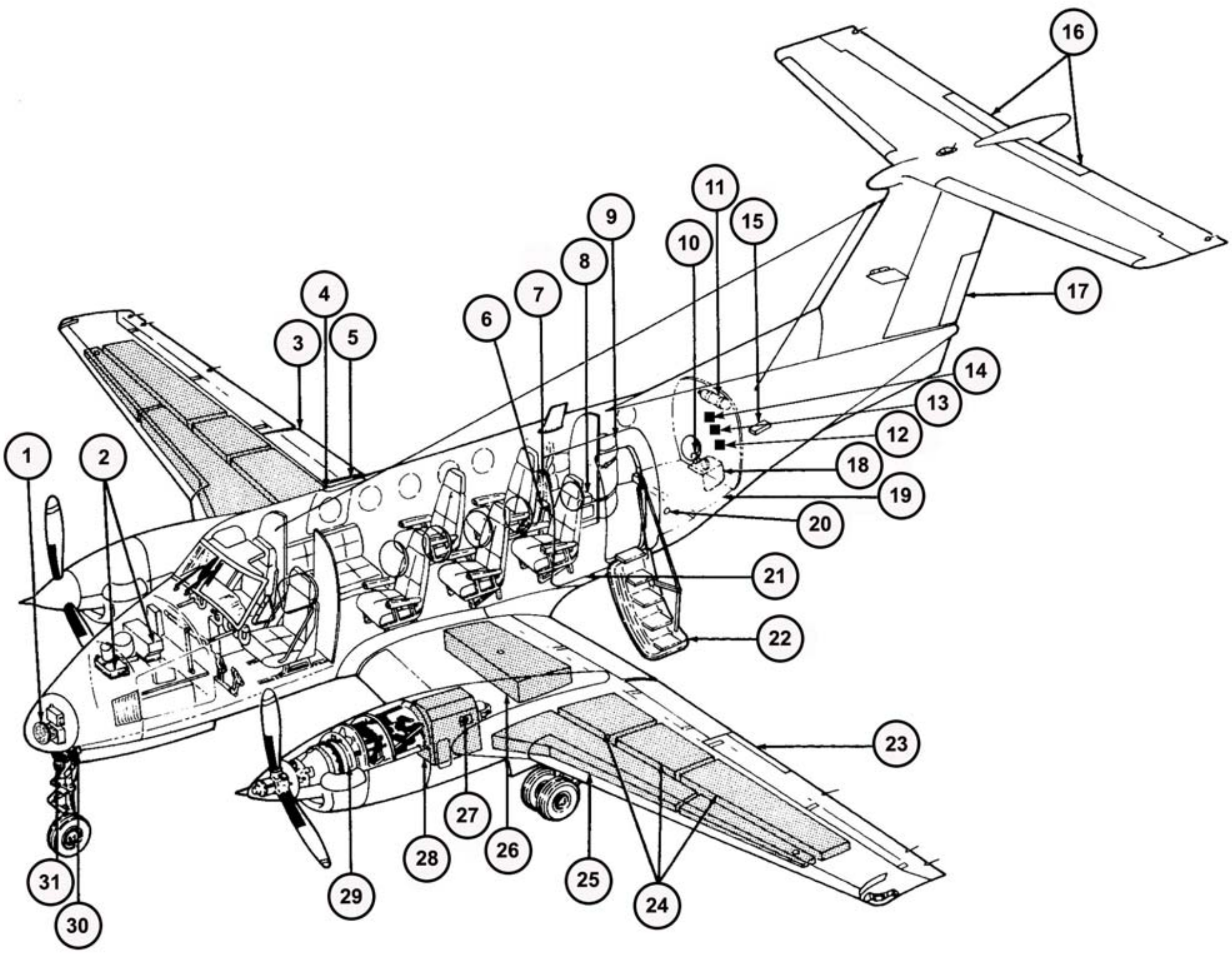


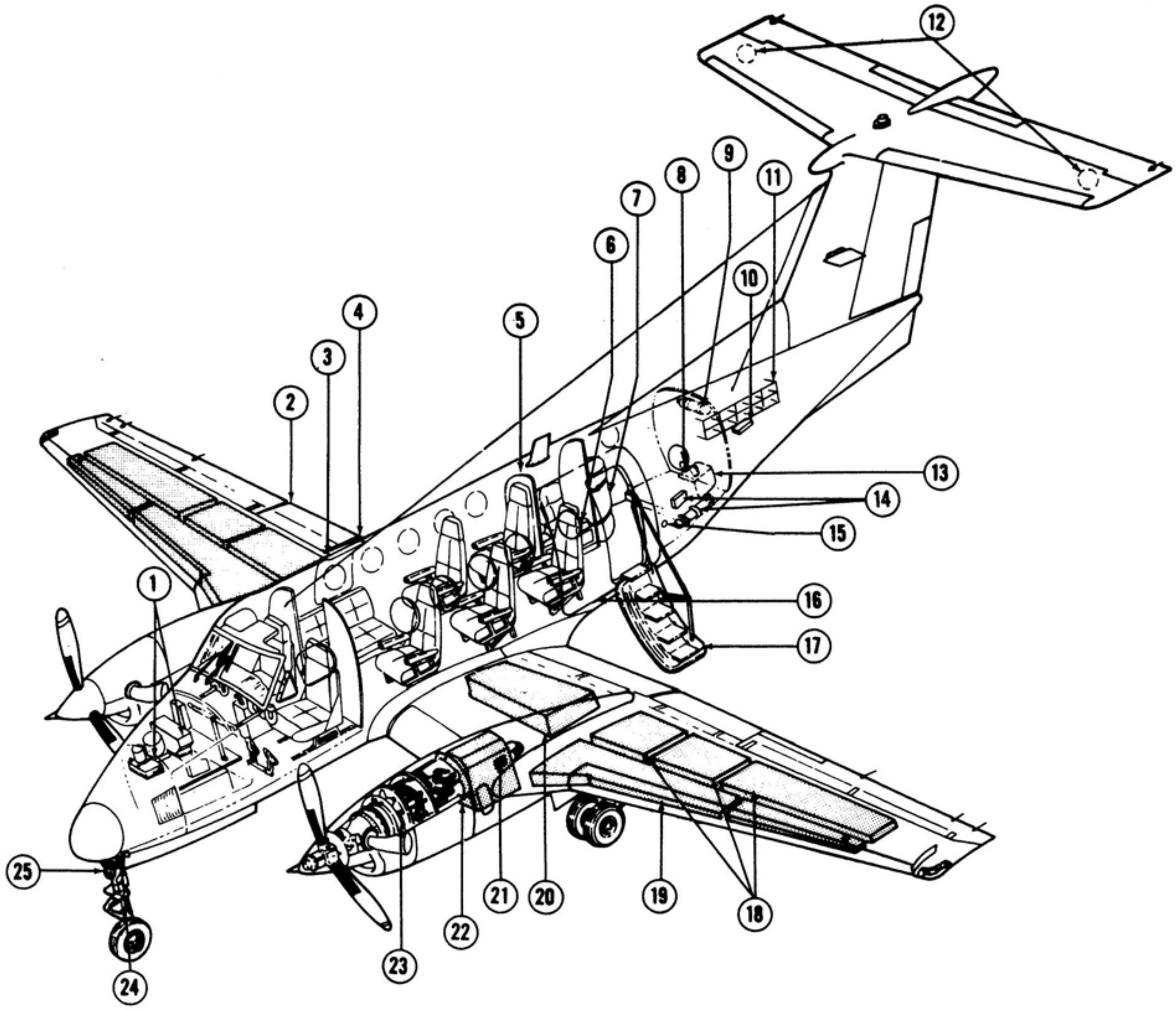
Figure 1-1. UC-12 Aircraft Dimensions



1. WEATHER RADAR ANTENNA
2. COMMUNICATIONS, NAVIGATION AND RADAR EQUIPMENT
3. OUTBOARD FLAP SECTION (TYPICAL BOTH SIDES)
4. GROUND ESCAPE HATCH
5. INBOARD FLAP SECTION (TYPICAL BOTH SIDES)
6. LIQUID STORAGE CABINET
7. LAVATORY PRIVACY CURTAIN
8. BELTED LAVATORY
9. LIFE RAFT AND SURVIVAL EQUIPMENT
10. PRESSURIZATION SAFETY AND DUMP VALVES
11. OXYGEN BOTTLE
12. FLIGHT DATA RECORDER
13. COCKPIT VOICE RECORDER
14. OXYGEN RELIEF VENT
15. EMERGENCY LOCATOR TRANSMITTER
16. ELEVATOR TRIM TABS
17. RUDDER TRIM TAB
18. AFT FUSELAGE ACCESS DOOR
19. BAGGAGE AREA
20. EMERGENCY EGRESS LIGHT
21. CARGO DOOR
22. AIRSTAIR DOOR
23. AILERON TRIM TAB
24. BOX SECTION FUEL TANKS (TYPICAL BOTH SIDES)
25. LEADING EDGE FUEL TANKS (TYPICAL BOTH SIDES)
26. AUXILIARY FUEL TANK (TYPICAL BOTH SIDES)
27. WING ICE CHECK LIGHT (TYPICAL BOTH SIDES)
28. NACELLE FUEL TANK (TYPICAL BOTH SIDES)
29. (B) PT6A-41 OR (F) PT6A-42 TURBOPROP ENGINE (TYPICAL BOTH SIDES)
30. HEATED PITOT MAST (TYPICAL BOTH SIDES)
31. LANDING AND TAXI LIGHTS

06-A-0002

Figure 1-2. (**B**/**F**) General Arrangement (Sheet 1 of 2)



1. Communications, Navigation And Radar Equipment
2. Outboard Flap Section (Typical Both Sides)
3. Ground Escape Hatch
4. Inboard Flap Section (Typical Both Sides)
5. Lavatory Privacy Curtain And Partition
6. Belted Lavatory
7. Life Raft And Survival Equipment
8. Pressurization Safety And Dump Valves
9. Oxygen Bottle
10. Emergency Locator Transmitter
11. Aft Avionics Shelves
12. Flux Valves
13. Aft Fuselage Access Door
14. Cabin Fire Extinguisher & Survival Radio
15. Emergency Egress Light
16. Cargo Door
17. Airstair Door
18. Box Section Fuel Tanks (Typical Both Sides)
19. Leading Edge Fuel Tanks (Typical Both Sides)
20. Auxiliary Fuel Tank (Typical Both Sides)
21. Wing Ice Check Light (Typical Both Sides)
22. Nacelle Fuel Tank (Typical Both Sides)
23. PT6A-42 Turboprop Engine (Typical Both Sides)
24. Heated Pitot Mast (Typical Both Sides)
25. Landing And Taxi Lights

UC-12M-F02

Figure 1-2. (**M**) General Arrangement Sheet 2 of 2

1.1.4 Interior Arrangement

The fuselage is divided into four sections: the nose section, flight compartment (Figure 1-3) (pilot and copilot), cabin section, and tail section (Figure 1-2). The cabin section is divided into two compartments: the passenger/cargo compartment and the utility compartment. The passenger/cargo compartment contains the passenger seats, two-place aisle-facing couch, storage cabinet for hot and cold liquid containers, and aisle-facing seat with a chemical toilet beneath. All of these may be removed or rearranged for transportation of light cargo. The utility compartment contains baggage and the necessary equipment required for overwater flights such as liferaft and survival equipment, etc.

The flight compartment includes seat accommodations for two crewmembers (pilot and copilot). An access assist step, which is stored at the aft end of the extended pedestal when raised, affords protection for the equipment installed in the pedestal extension and is used as an assist step to the crew seats. Refer to Figures 1-3, (**B**) 2-2/(**F**) 2-3/(**M**) 2-4.

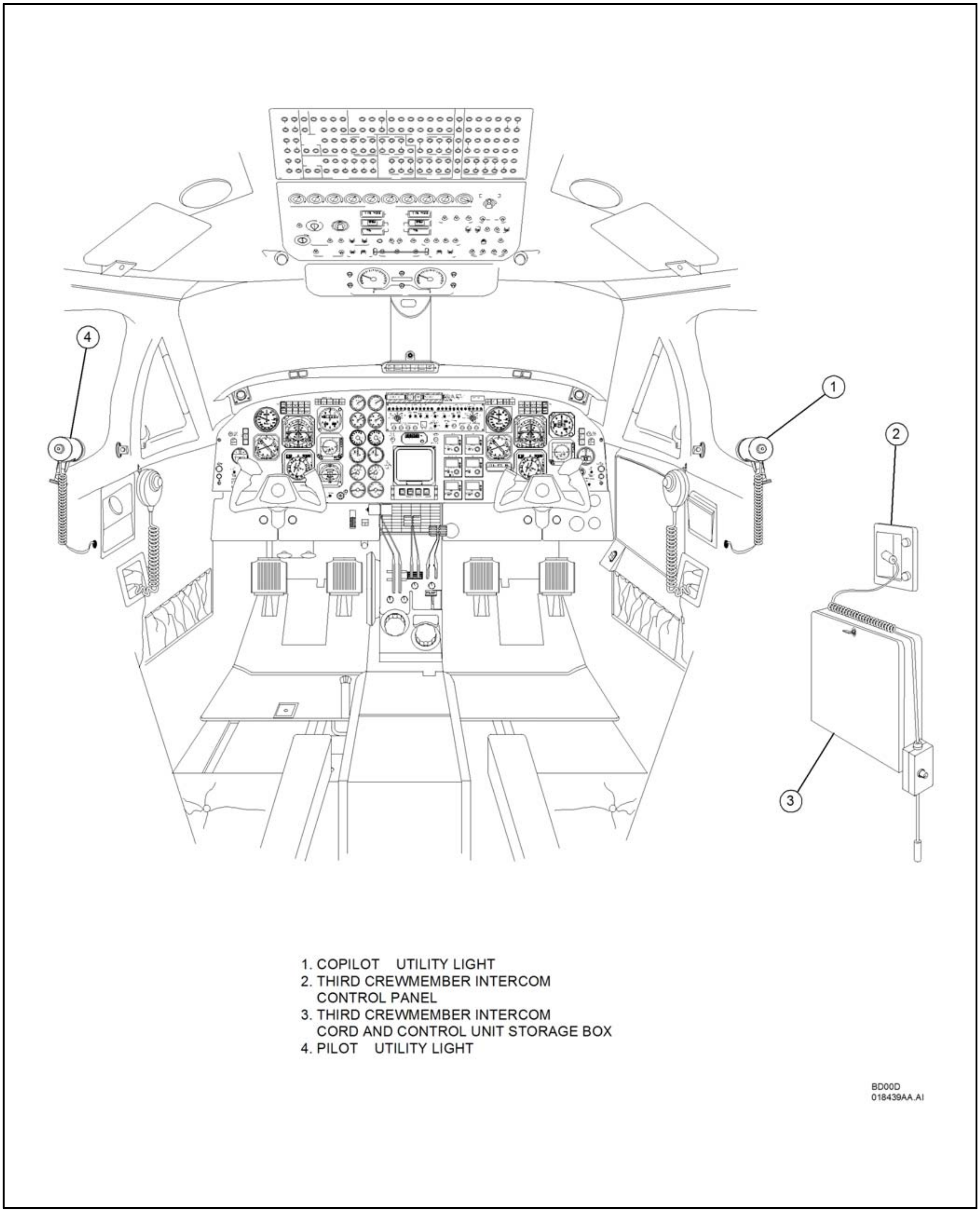


Figure 1-3. Flight Compartment Arrangement

CHAPTER 2

Systems

2.1 ENGINES AND RELATED SYSTEMS

The (**B**) PT6A-41 (**F/M**) PT6A-42 engine (Figure 2-1) has a three-stage axial, single-stage centrifugal compressor driven by a single-stage reaction turbine. The power turbine, a two-stage reaction turbine counter rotating with the compressor turbine, drives the output shaft. Both the compressor turbine and the power turbine are located in the center of the engine with their shafts extending in opposite directions. Being a reverse flow engine, the ram air supply enters the lower portion of the nacelle and is drawn in through the aft protective screens. The air is then routed into the compressor. After the air is compressed, it is forced into the annular combustion chamber and mixed with fuel that is sprayed in through 14 nozzles mounted around the gas generator case. A capacitance discharge ignition unit and two spark igniter plugs are used to start combustion. After combustion, the exhaust passes through the compressor and power turbines and is routed through two exhaust ports near the front of the engine. A pneumatic fuel control system schedules fuel flow to maintain the power set by the gas generator power lever. Propeller speed within the governing range remains constant at any selected propeller control lever position through the action of a propeller governor, except in the reverse range, where the maximum propeller speed is controlled by the pneumatic section of the propeller governor.

The accessory drive at the aft end of the engine provides power to drive the fuel pumps, fuel control, oil pumps, refrigerant compressor (right engine), starter/generator, and tachometer generator.

The reduction gearbox forward of the power turbine provides gearing for the propeller and drives the propeller tachometer transmitter, the propeller overspeed governor, and the propeller governor.

Propeller torque value is measured by a hydromechanical device located inside the first stage reduction gear housing. Oil plumbed from this device is sent to the torquemeter transmitter to give a relative reading of torque.

Aircraft deceleration on the ground is achieved by bringing the propeller blades through beta range into reverse pitch by utilizing the pitch change mechanism. The power levers must be retarded below the IDLE position by pulling them over a detent. Reversing power is available in direct proportion to the retarding of the levers in the reversing range.

2.1.1 Air Induction System

The compressor draws ambient air into the engine through the induction air inlet at the lower front of the engine nacelle. As airspeed increases, ram air pressure rises, compressing the air inside the induction air duct. The air then flows into an annular inlet-air chamber located at the aft end of the engine compartment. The air then passes through a protective screen and into the primary compressor impeller (first axial stage), where it is further compressed. Then the air is forced through a stator ring and successively through the second and third axial-flow compressor stages. It is finally compressed in the centrifugal-flow compressor stage and discharged into the turbine plenum assembly. Air from the plenum enters the annular combustion chamber through a series of holes in the aft end of the combustion chamber and mixes with fuel that is sprayed into the combustion chamber through 14 nozzles mounted around the gas generator case. The air-fuel mixture burns inside the combustion chamber and the hot gases expand forward out of the chamber and pass through the compressor turbine stage, both stages of the power turbine, and out to the atmosphere through two exhaust ports.

2.1.2 Engine Bleed Air Pneumatic System

High-pressure bleed air from each engine compressor, routed through the firewall shutoff valves and regulated at 18 psi, supplies pressure for the surface deice system and vacuum source. Vacuum for the flight instruments is derived from a bleed air ejector. One engine can supply sufficient bleed air for all of these systems.

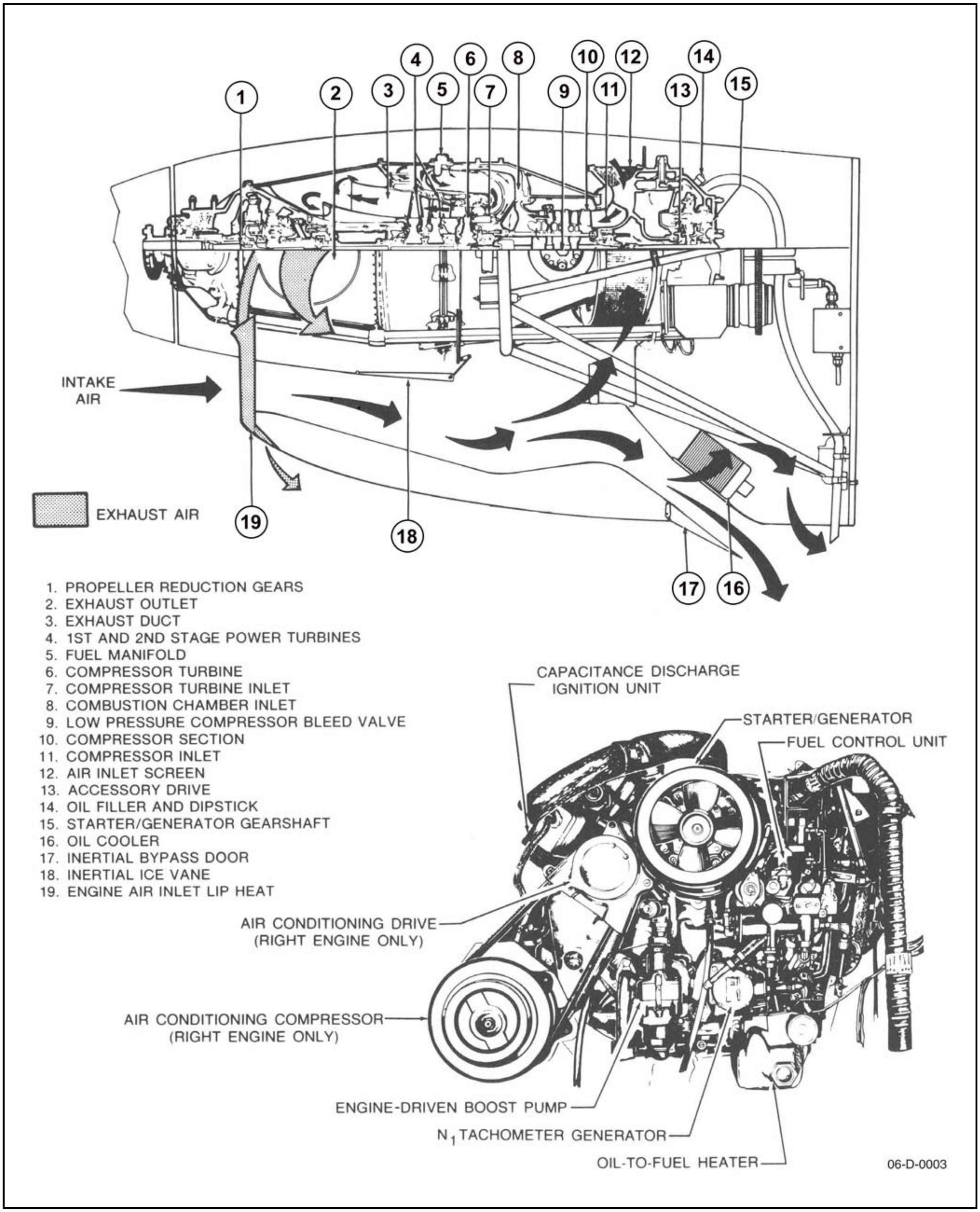


Figure 2-1. PT6A-41/42 Engine

During single-engine operation, a check valve in the bleed air line from each engine prevents flow back through the line on the side of the inoperative engine. A gyro suction gauge (Figure 4-6, sheet 2) calibrated in inches of mercury and located on the copilot subpanel indicates instrument vacuum pressure. A pneumatic pressure gauge, calibrated in psi, indicates air pressure available to the pneumatically powered subsystems.

2.1.3 Bleed Air Warning System

Hot bleed air from the compressor is routed through the nacelle along the leading edge of the wing, through or around an air-to-air heat exchanger, and into the cabin to the mixing plenum. The bleed air lines from the engines to the cabin are shielded with insulation to protect other components from heat. The bleed air lines are closely accompanied by plastic tubing from aft of the firewall to the cabin. One end of the tubing is plugged off at the firewall; the other end is connected to a bleed air source in the cabin to supply the line with pressure. This line does not extend into the engine compartment. Excessive heat on the plastic tubing caused by a ruptured bleed air line will cause the tubing to fail. Upon release of pressure in the tubing, a normally open switch in the line will close, causing a circuit to be completed and lighting the respective BL AIR FAIL light in the warning annunciator panel.

2.1.4 Engine Fuel Control System

The basic fuel control system consists of the engine-driven fuel pump, and engine-driven low pressure boost pump, a fuel control unit, a fuel flow divider, (**B**) a fuel manifold dump valve, (**F/M**) a fuel drain purge valve, a dual fuel manifold, and 14 fuel nozzles. Two automatic fuel drain valves are provided to clear residual fuel after engine shutdown or a discontinued start.

2.1.4.1 (B) Fuel Drain Collector Pump

After engine shutdown, a small amount of fuel present in the fuel nozzle manifolds drains into a small collector tank. The tank is mounted to one of the lower fire shields in the aft engine compartment. An electric float switch senses the tank fuel level and activates an electric pump that transfers the fuel back to the nacelle tank. When the collector tank is emptied, the float switch turns off the pump. The entire operation is automatic.

2.1.4.2 (F/M) Fuel Drain Purge System

A differential pressure fuel purge system is located in the aft compartment of each nacelle. This system purges fuel that is left in the fuel manifolds at engine shutdown. During engine operation, compressor discharge air (P3) is routed through a filter and check valve, pressurizing a small air tank mounted on the engine truss mount. On engine shutdown, the pressure differential between the air tank and fuel manifolds causes air to be discharged from the air tank through the check valve into the fuel manifold. The air forces all residual fuel remaining in the fuel manifolds through the fuel nozzles into the combustion chamber. The fuel into the combustion chamber is consumed, causing a momentary rise in engine rpm.

2.1.4.3 Fuel Control Unit

The fuel control unit is a hydromechanical computing and metering device that determines the proper fuel schedule for the engine. It is located on the accessory case of each engine.

The fuel control unit works with a temperature compensator unit to supply information for the fuel control system. The temperature compensator alters the acceleration fuel schedule of the fuel control unit to compute for variations in compressor inlet air temperature. Engine characteristics vary with changes in inlet temperature, and the acceleration fuel schedule must in turn be altered to prevent compressor stall and/or excessive turbine temperature. The fuel control unit determines the proper fuel schedule so that the engine will produce the power requested by the position of the corresponding power lever. The control of developed engine power is accomplished by adjusting the engine compressor turbine N_1 speed. N_1 speed is controlled by varying the amount of fuel injected into the combustion chamber through the fuel nozzles. All pilot-induced fuel control operations, except engine start, idle speed, and shutdown, are regulated by actuation of the power lever. Engine shutdown is accomplished by moving the appropriate condition lever to the full aft FUEL CUTOFF position, which shuts off the fuel supply. The pneumatic line of each fuel control unit is protected against ice by electrically heated jackets.

2.1.4.4 Engine Torque Limiter

Engine torque is automatically limited by a torque limiter supplied with an input signal from the torquemeter. If a torque pressure of approximately (**B**/**F**) 2,400 foot-pounds; (**M**) 108 percent (value preset by maintenance) is sensed, the torque limiter bleeds off air in the fuel control, reducing metered fuel flow and gas generator speed, thereby limiting torque to the preset value.

2.1.5 Power Levers

The power levers regulate power from idle to maximum and operate so that forward movement increases engine power. Power control is accomplished through adjustment of the N_1 speed governor in the fuel control unit. Power is increased when N_1 rpm is increased. The power levers also control reverse propeller pitch and engine power. Distinct movement (pulling up and then aft on the power lever) is required to achieve beta or reverse thrust. Power lever movement in the beta range (area from IDLE to REVERSE) controls propeller pitch only. In the REVERSE range (stripe marks), power lever movement controls both N_1 rpm and propeller pitch. Placarding is located below the lever travel slots. Control identification reads POWER in large letters. Upper lever travel range is designated INCR (increase), supplemented by an arrow pointing forward. Lower travel range is marked IDLE, LIFT, and REVERSE. An information placard adjacent to the bottom of the lever slots reads CAUTION-REVERSE ONLY WITH ENGINES RUNNING.

2.1.6 Condition Levers

The condition levers are used to start or stop fuel supply and control engine idle speeds. The levers have three placarded positions: FUEL CUTOFF, LOW IDLE, and HI IDLE. Placed in the FUEL CUTOFF position, fuel flow to the corresponding engine is terminated. Forward movement of the levers from the FUEL CUTOFF position will reset the idle stop in the fuel control units to provide (**B**) 52 percent minimum, (**F/M**) 56 percent minimum N_1 in the LOW IDLE position and 70 percent minimum N_1 in the HI IDLE position.

2.1.7 Friction Lock Knobs

Four friction lock knobs are provided on the control pedestal to adjust friction against the power, condition, and propeller control levers. These knobs prevent the levers from creeping when set by the pilot. When rotated clockwise, a knob increases the friction opposing movement of the affected lever. Counterclockwise rotation will decrease the friction.

Note

Inadequate friction lock tension or friction lock failure will allow the power levers to creep aft.

2.2 STARTING SYSTEM

2.2.1 Engine Starters/Generators

One starter/generator is mounted on each engine accessory section. Each is able to function either as a starter or as a generator. In generator function, each unit is capable of 250 amperes dc output. When the starting function is selected, the starter receives power from either the aircraft battery, external power source, or the opposite generator.

CAUTION

The starters are limited to an operating period of 40 seconds ON, 60 seconds OFF for two cycles, then 40 seconds ON, 30 minutes OFF on the third.

2.2.2 Engine Ignition System

The ignition system is manually activated for ground and airstarts and is switched off after engine start. The system consists of an ignition unit, two spark igniter plugs, two shielded ignition cables, and the pilot-controlled (**B/F**) IGNITION AND START/OFF/STARTER ONLY switches, (**M**) START-IGNITION/OFF/STARTER ONLY switches.

2.2.2.1 IGNITION AND ENGINE START/STARTER ONLY Switches

(**B/F**) A three-position toggle switch for each engine is located on the extended pedestal (Figures (**B**) 2-2/(**F**) 2-3). They are placarded IGNITION AND START, OFF, and STARTER ONLY and spring loaded from STARTER ONLY to OFF. The IGNITION AND START switch position completes the starter circuit for engine rotation, energizes the igniter plugs for fuel combustion, and activates the IGNITION ON annunciator light. During engine starting, the start switch can be turned to the OFF position once the N_1 has accelerated beyond 50 percent. The STARTER ONLY position will motor the engine without ignition.

(**M**) Ignition and engine start is controlled by two three-position toggle switches placarded START-IGNITION/OFF/STARTER ONLY, located in the #1 and #2 ENG START sections on the overhead control panel (Figure 2-26). The START-IGNITION switch position completes the starter circuit for engine rotation, energizes the igniter plugs for fuel combustion, and activates the respective (#1 or #2) IGN ON annunciator light. When engine speed has accelerated through 50 percent N_1 or above on starting, the starter drive action is stopped by moving the switch to the center OFF position. The spring-loaded STARTER ONLY position is provided to motor the engine without ignition.

2.2.2.2 Ignition on Indicators

Illumination of the green annunciator panel lights (Figures (**B**) 2-34/(**F**) 2-35/(**M**) 2-36), IGNITION ON, only indicates that the igniter system is receiving electrical power.

2.2.2.3 Auto Ignition System

If armed, the auto ignition system automatically provides combustion reignition of either engine should accidental flameout occur. The system is not essential to normal engine operation, but is used to reduce the possibility of power loss during takeoff, landing, turbulence, penetration of icing conditions or precipitation. Each engine has a separate auto ignition control switch and a green indicator on the annunciator panel. Auto ignition is accomplished by energizing the two igniters in each engine anytime the auto ignition system is armed and the engine is operating below (**B/F**) 410 ±50 foot-pounds; (**M**) 18 ±2 percent torque. For extended ground operations, the system should be OFF to prolong the life of the igniter unit. (**B/F**) The system is protected by the LEFT and RIGHT IGNITER POWER circuit breakers located on the left sidewall circuit breaker panel. (**M**) The system is protected by the #1 and #2 IGNITER CONTR circuit breakers located on the overhead circuit breaker panel.

2.2.2.3.1 Auto Ignition Switches

Two switches placarded LEFT and RIGHT AUTO IGNITION, with positions ARM and OFF, are located on the pedestal (Figures (**B**) 2-2/(**F**) 2-3/(**M**) 2-4) in the sections placarded #1 and #2 ENG START, located on the overhead control panel (**M**) (Figure 2-26). ARM position initiates a readiness mode for the auto ignition system of the corresponding engine. OFF position dearms the system.

2.3 OIL SUPPLY SYSTEM

The engine oil supply is contained in an integral oil tank located between the engine air inlet area and the accessory case. Engine oil cools and lubricates the engine and operates the propeller pitch control mechanism and engine torquemeter system. The oil tank capacity is 9 quarts with the dipstick measuring full to 5 quarts low for adding purposes. The dipstick is attached to the oil filler cap and indicates oil level in HOT and COLD U.S. quart increments. Recommended oil grade, specifications, capacities, and servicing point are shown in Figure 3-1.

1. CONTROL DISPLAY UNIT - FMS
2. GPS DATA LOAD CONNECTOR
3. MULTI-FUNCTION DISPLAY CONTROL PANEL
4. RDR 2000 WEATHER RADAR CONTROL PANEL
5. TCAS/TRANSPONDER CONTROL PANEL
6. P-CODE FILL CONNECTOR
7. UHF COMM. CONTROL PANEL
8. HF COMM. CONTROL PANEL
9. PEDESTAL EXTENSION ASSIST STEP (STORED)
10. COCKPIT VOICE RECORDER CONTROL PANEL
11. TACAN CONTROL PANEL
12. PRESSURIZATION CONTROLLER
13. AUTOPILOT MODE SELECTOR
14. AUTOPILOT MANUAL PITCH AND TURN CONTROL
15. PEDESTAL SWITCH PANEL
16. ENGINE START PANEL

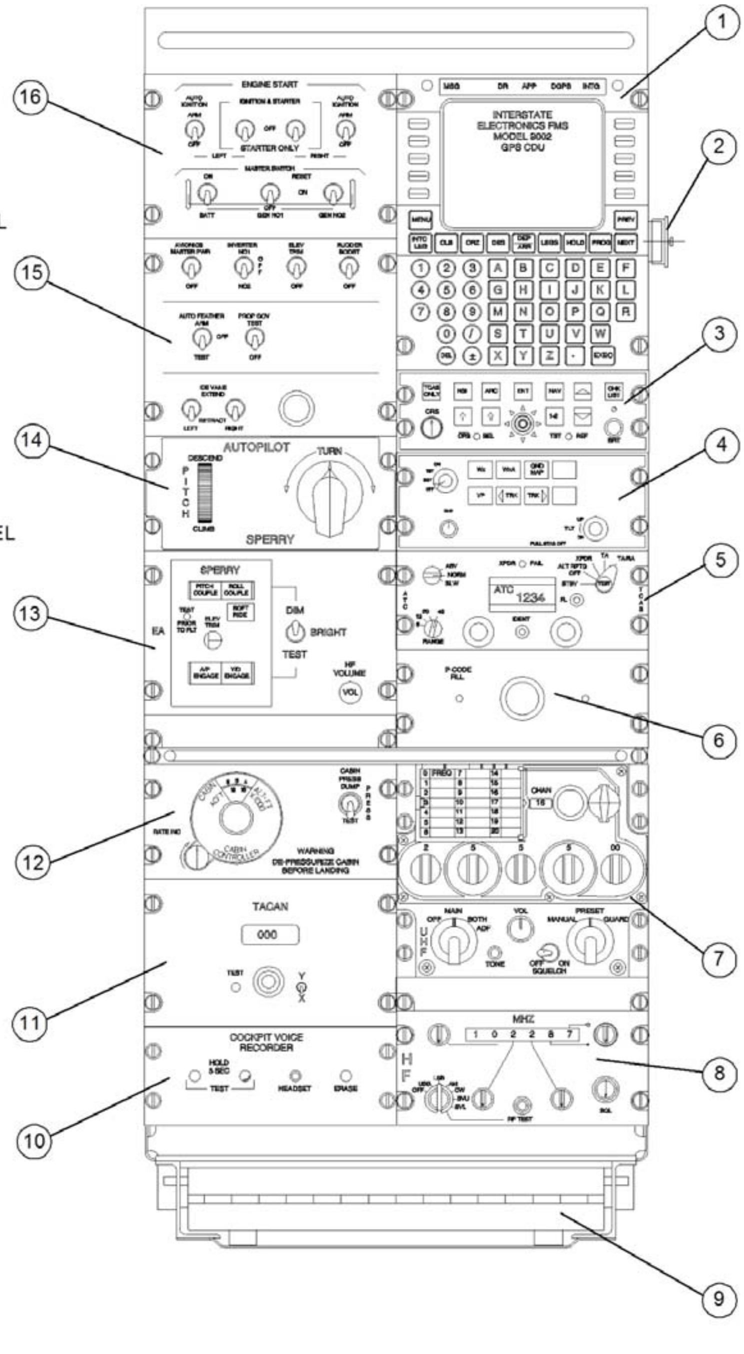


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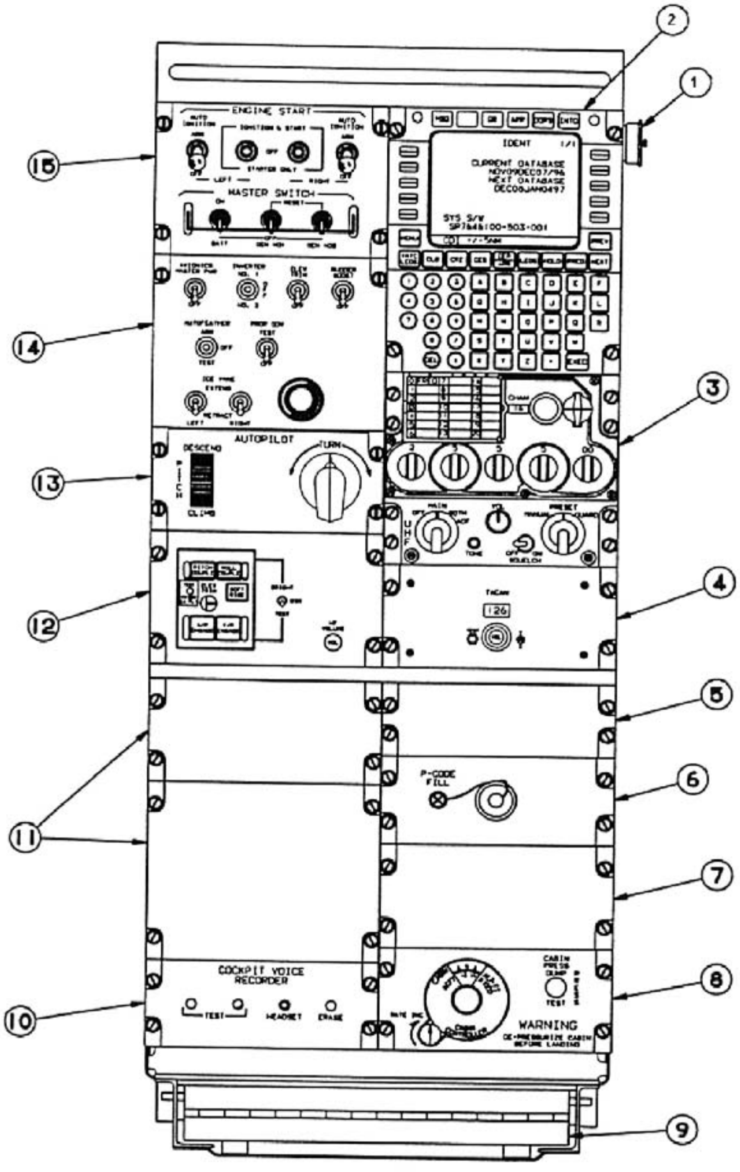
Figure 2-2. (**B**) Typical Control Pedestal Extension



1. GPS DATA LOAD CONNECTOR
2. CONTROL DISPLAY UNIT
3. UHF COMM CONTROL PANEL
4. TACAN CONTROL PANEL
5. PROVISION COVER
6. P-CODE FILL CONNECTOR
7. PROVISION COVER
8. PRESSURIZATION CONTROLLER
9. PEDESTAL EXTENSION ASSIST STEP (STORED)
10. COCKPIT VOICE RECORDER CNTRL PANEL
11. PROVISION COVER
12. AUTOPILOT MODE SELECTOR
13. AUTOPILOT MANUAL PITCH & TURN CONTROL
14. PEDESTAL SWITCH PANEL
15. ENGINE START PANEL

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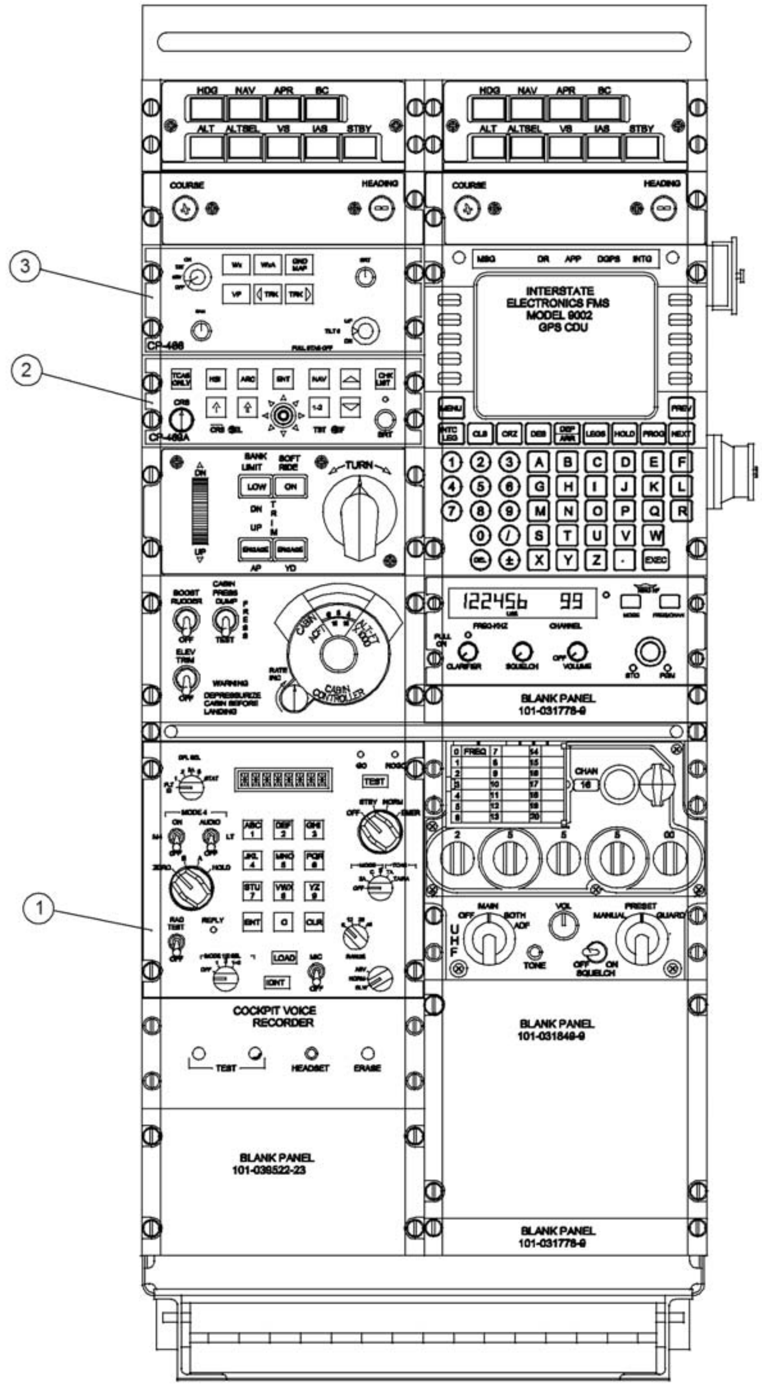
Figure 2-3. (**F**) Typical Control Pedestal Extension



1. TCAS/IFF CONTROL PANEL
2. MULTI-FUNCTION DISPLAY CONTROL PANEL
3. RDR 2000 WEATHER RADAR CONTROL PANEL

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Figure 2-4. (**M**) Typical Control Pedestal Extension

2.3.1 Oil Pressure Pump

Pressure oil is circulated from the integral oil tank through the engine lubrication and propeller system by a self-contained gear-type pressure pump located in the lowest portion of the oil tank. The oil pump consists of two gears and is driven by an accessory gearshaft that also drives the internal double-element scavenge pump. Engine oil pressure is regulated by a pressure relief valve that returns all oil in excess of the regulated pressure to the oil tank.

2.3.1.1 Oil Pressure Transmitter

Oil pressure is measured from the delivery side of the oil pump and is transmitted to the indicator by the oil pressure transmitter located at the 3 o'clock position on the accessory housing.

2.3.2 Engine Oil Cooling

The oil system of each engine is coupled into an oil cooler unit of fin-and-tube design. These cooler units are the only airframe-mounted part of the oil systems and are located inside the lower nacelles. As oil returns from the various integral oil pickups, the oil from the reduction gearcase is returned to the oil cooler. Air passing through the oil cooler maintains the oil within the proper temperature range. A thermal sensor controls a bypass door that regulates the volume of air passing through the cooler, and a bypass valve allows some oil to bypass the cooler. The oil from the other integral pickups is routed either through or around the oil-to-fuel heat exchanger.

2.3.2.1 Oil-to-Fuel Heater

The oil-to-fuel heat exchanger utilizes heat from the engine oil system to preheat the engine fuel. A fuel temperature sensing oil bypass valve regulates the fuel temperature by either permitting oil flow through the heat core or bypassing it through the valve to the oil tank.

2.3.3 Magnetic Chip Detector

A magnetic chip detector plug is installed in the bottom of the reduction gearbox housing to warn the pilot of metallic particles and possible engine failure. The sensor is an electrically insulated gap immersed in the oil, functioning as a normally open switch. If a large metal chip or a mass of small ferrous metal particles bridge the detector gap, a circuit is completed, sending a signal to illuminate the annunciator panel (**B**) red lights placarded L CHIP DET for the left engine or R CHIP DET for the right engine and the MASTER WARNING light on the glareshield; (**F**) YELLOW caution light placarded L CHIP DET or R CHIP DET as well as the MASTER CAUTION; (**M**) (#1 or #2) CHIP DETR warning annunciator and the MASTER WARNING annunciator located on the glareshield. The light associated with the affected engine will illuminate when any ferrous accumulation on the magnetic plug is sufficient to complete the electrical circuit. Operating the warning lights test switch tests the CHIP DET lights.

2.4 ENGINE INSTRUMENTS

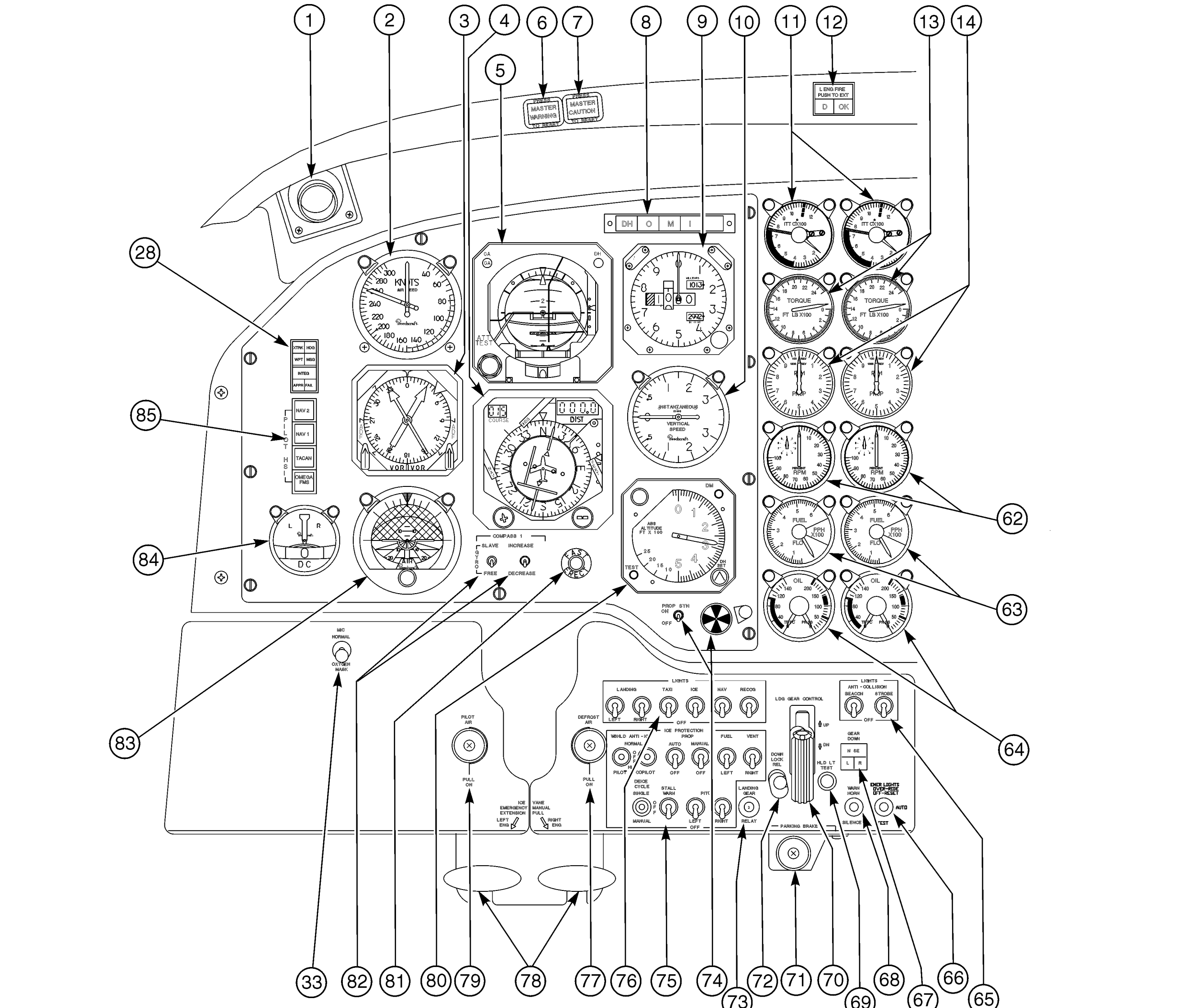
Instruments that display special engine conditions or state of operation are discussed in the following paragraphs. Engine instruments are all located in the left center section of the instrument panel (Figures (**B**) 2-5/(**F**) 2-6/(**M**) 2-7).

2.4.1 (B/F) Interstage Turbine Temperature/(M) Turbine Gas Temperature Indicators (ITT/TGT)

The ITT/TGT gauges are calibrated in °C. Each gauge is connected to self-generating thermal sensing elements. The ITT/TGT gauges register the temperature between the compressor turbine and power turbine for the corresponding engine.

2.4.2 Engine Torquemeters

The engine torquemeters indicate torque applied to the propeller shafts of the respective engines. Each gauge shows torque by (**B/F**) foot-pound measure using 100-pound graduations (**M**) percent of maximum using 2 percent graduations, actuated by a 26 Vac electrical signal from a sensing system located on the respective propeller reduction gear case.



1. Air outlet
2. Airspeed indicator
3. Radio Magnetic Indicator (RMI)
4. Horizontal Situation Indicator (HSI)
5. Attitude indicator
6. Master warning annunciator
7. Master caution annunciator
8. Marker beacon annunciator
9. Encoding altimeter
10. Instantaneous Vertical Speed Indicator (IVSI)
11. Interstage Turbine Temperature (ITT) gauges
12. Engine fire detector/extinguisher switches/annunciators
13. Torquemeters
14. Propeller tachometers (N2)
15. No. 1 VHF control panel
16. Dual audio control panel
17. Approach plate light brightness control
18. Warning annunciator panel
19. GPWS annunciator panel and flap override switch
20. Approach plate holder
21. Annunciator test switch
22. Attitude alerter
23. Cockpit Voice Recorder (CVR) microphone
24. Weather radar control and display
25. No. 2 VHF control panel
26. No. 1 and No. 2 transponder control panel
27. Barometric altimeter
28. FMS annunciators
29. Copilot HSI selector switches and annunciators
30. Copilot turn and slip indicator (air)
31. Pneumatic pressure gauge
32. Oxygen pressure gauge
33. Microphone normal/oxygen mask selector switch
34. Flight hour meter
35. Gyro suction gauge
36. No. 2 gyro compass slaving switches
37. Copilot air control
38. Copilot vertical gyro fast erect switch
39. TACAN indicator
40. Cabin air control
41. Fire detectors and extinguishers test switch
42. Cabin temperature mode control switch

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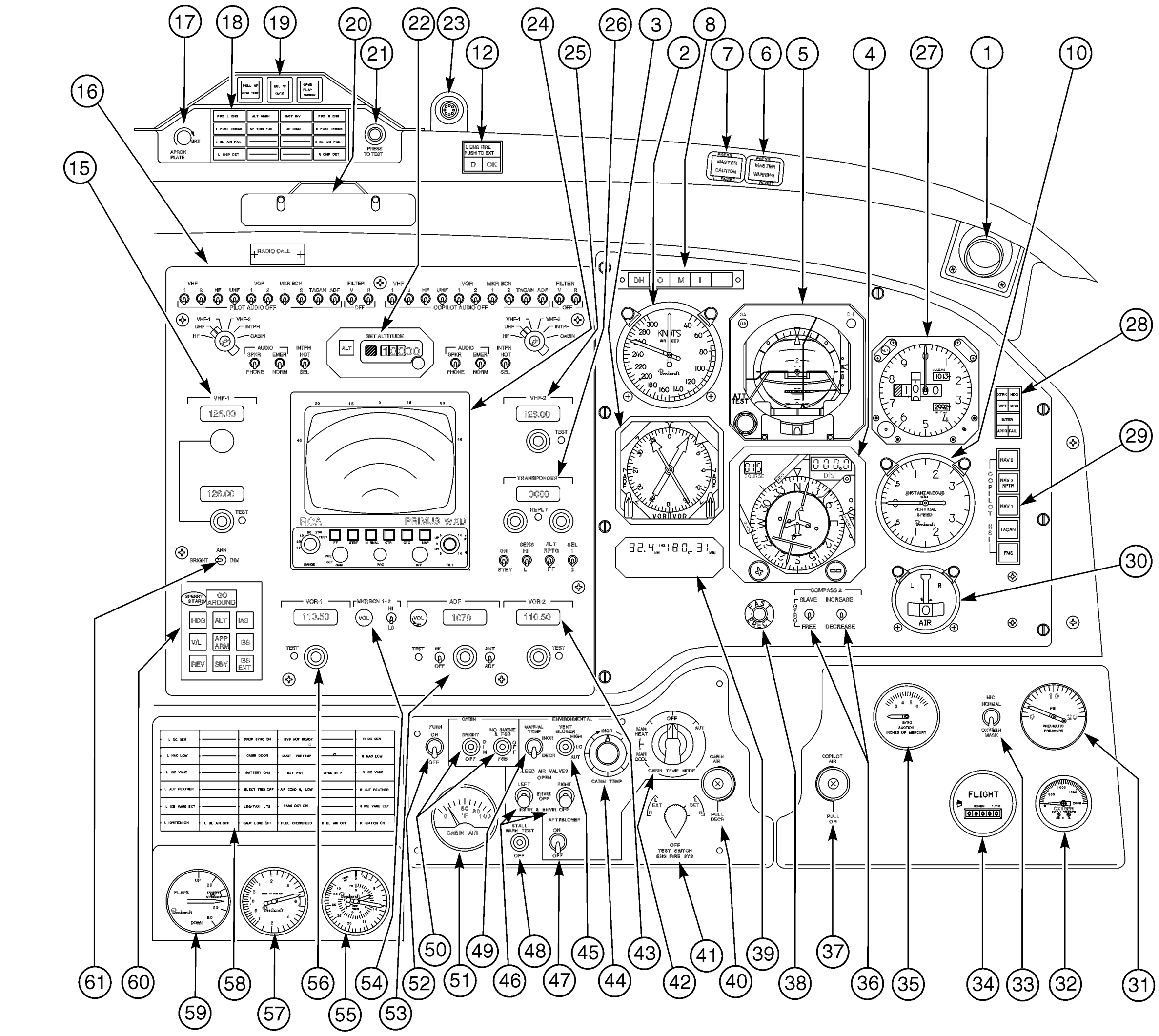
Figure 2-5. (**B**) Instrument Panel (Sheet 1 of 3)



43. No. 2 VOR control panel
44. Cabin temperature control knob
45. Forward vent blower switch
46. Bleed air valve control switches
47. Aft vent blower switch
48. Stall warning and landing gear warning test switch
49. Manual mode temperature control switch
50. Cabin lighting and no smoking/fasten seatbelt sign switches
51. Cabin air temperature gauge
52. Caution legend off switch
53. ADF control panel
54. Marker beacon audio controls
55. Cabin altimeter and differential
56. No. 1 VOR control panel
57. Cabin climb rate indicator
58. Caution and advisory annunciator panel
59. Flap position indicator
60. Flight director control panel
61. Annunciator brightness control switch
62. Gas generator rpm (N1) gauges
63. Fuel flow gauges
64. Engine oil temperature/pressure gauges
65. Beacons and strobe lights switches
66. Emergency lights override and test switch
67. Landing gear position indicator lights
68. Landing gear warning horn silence button
69. Landing gear handle lights test switch
70. Landing gear control handle
71. Parking brake control lever
72. Landing gear handle down lock release
73. Landing dear relay circuit breaker
74. Prop synchrophaser control switch and indicator
75. Surface and propeller deice/anti-ice switches
76. Exterior light switches
77. Defrost air control
78. Ice vane emergency manual extension levers
79. Pilot air control
80. Radio altimeter
81. Pilot vertical gyro fast erect switch
82. No. 1 gyro compass slaving switches
83. Standby attitude indicator (air)
84. Pilot turn and slip indicator (dc)
85. Pilot HSI selector switches and annunciators

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Figure 2-5. (**B**) Instrument Panel (Sheet 2 of 3)

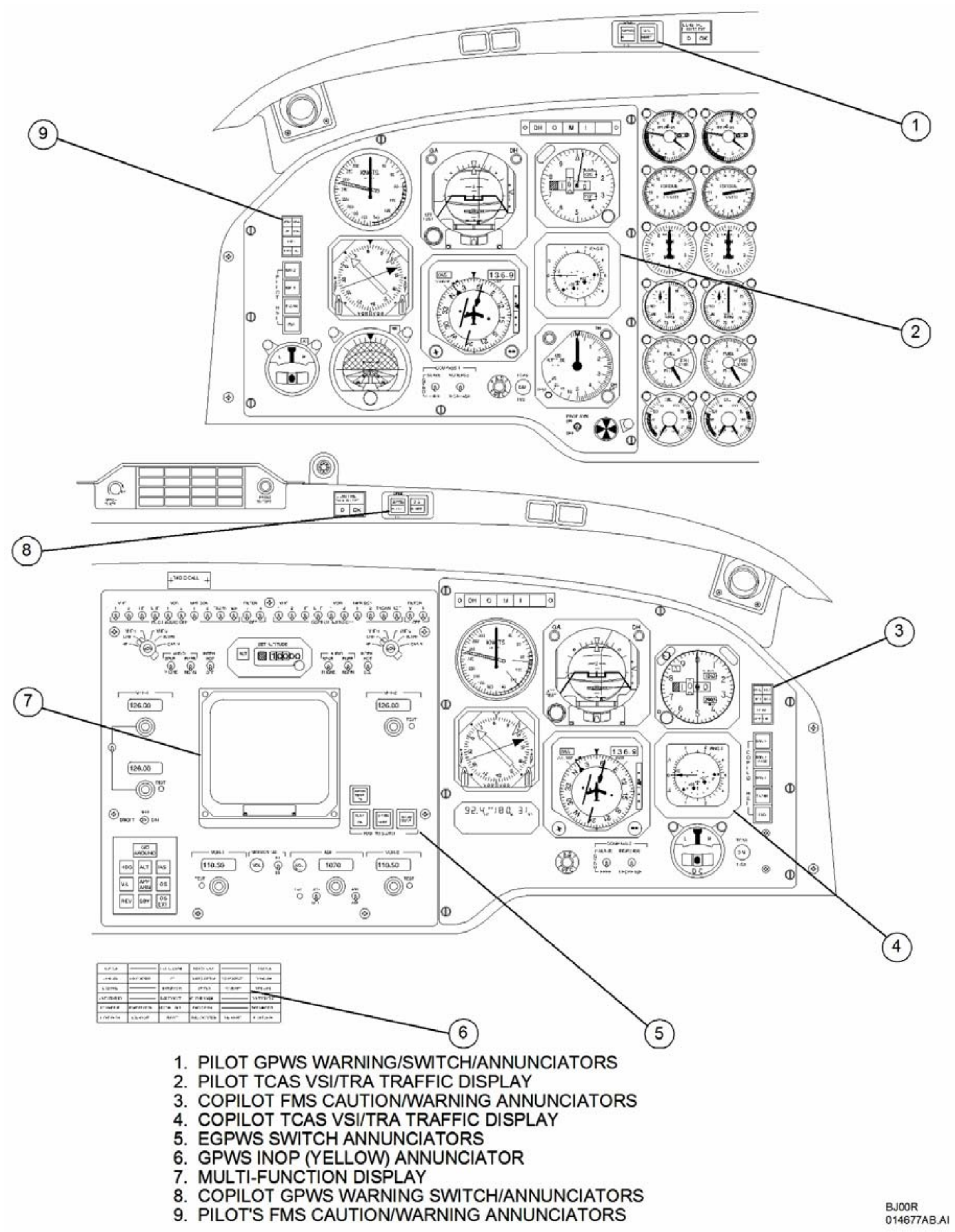
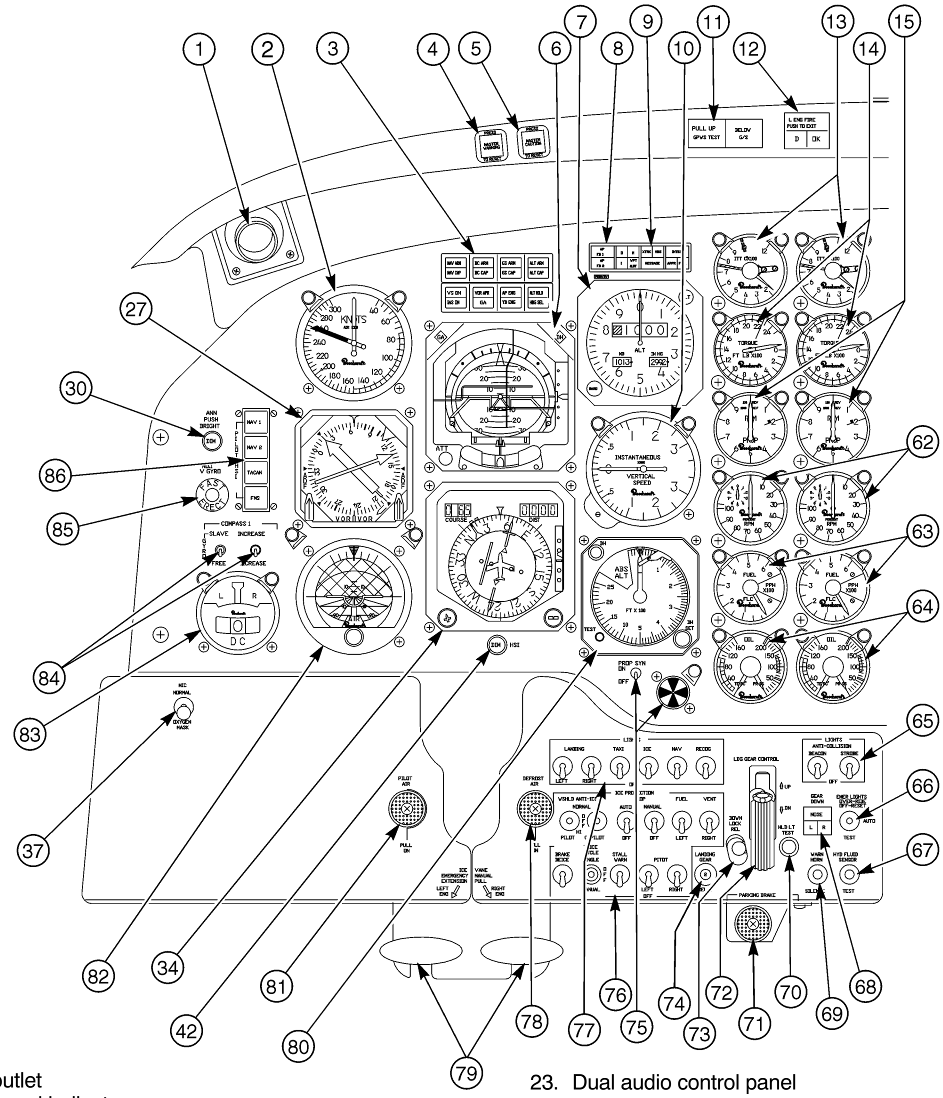


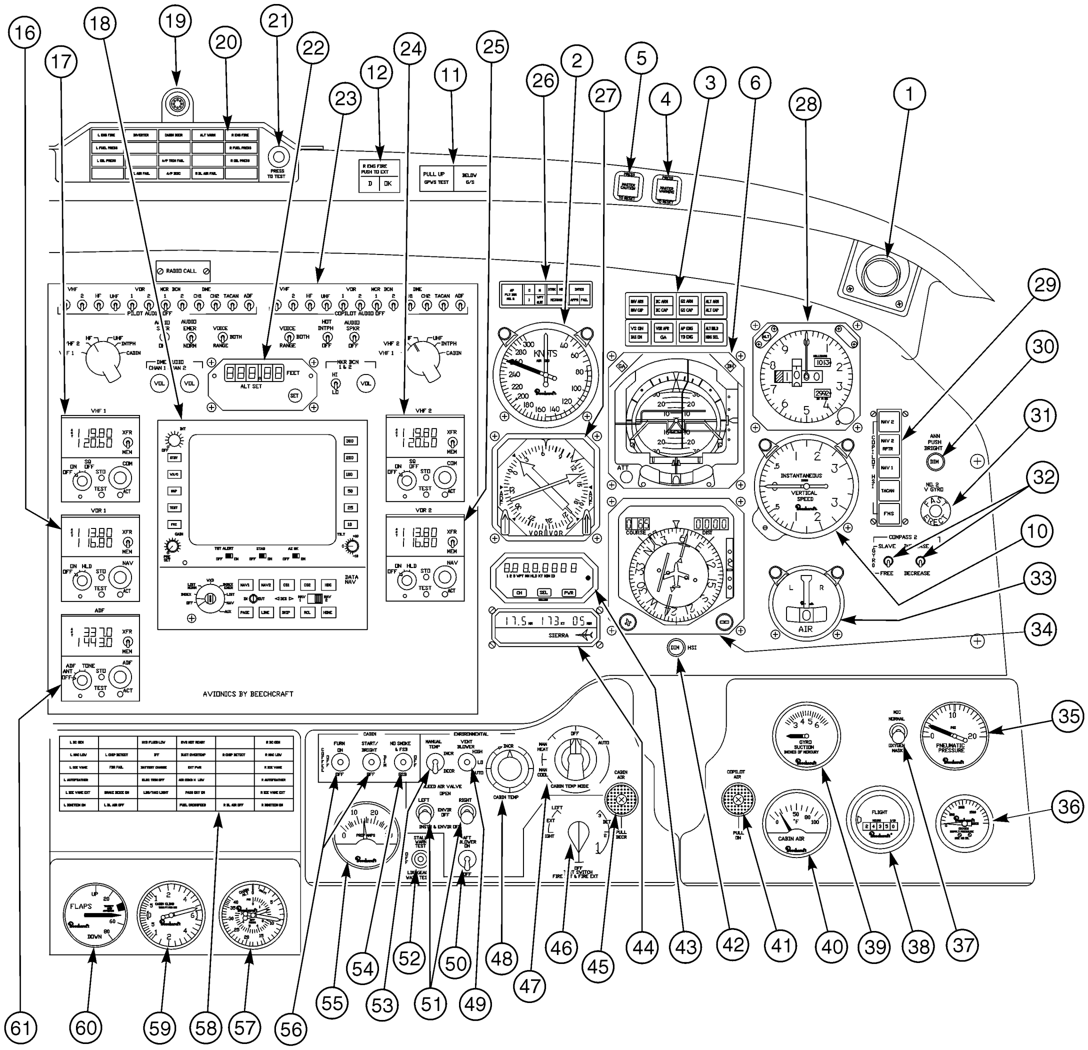
Figure 2-5. (**B**) Instrument Panel (Sheet 3 of 3)



1. Air outlet
2. Airspeed indicator
3. Flight director mode annunciators
4. Master warning annunciator
5. Master caution annunciator
6. Attitude indicator
7. Encoding altimeter
8. AP/FD selector/annunciator
9. MKR BCN and FMS annunciators
10. Instantaneous Vertical Speed Indicator (IVSI)
11. GPWS annunciators
12. Engine fire detector/extinguisher switches/annunciators
13. Interstage Turbine Temperature (ITT) gauges
14. Torquemeters
15. Propeller tachometers (N2)
16. No. 1 VOR control panel
17. No. 1 VHF control panel
18. Weather radar/DATA NAV control and display
19. Cockpit voice recorder microphone
20. Warning annunciator panel
21. Annunciator test switch
22. Altitude select controller
23. Dual audio control panel
24. No. 2 VHF control panel
25. No. 2 VOR control panel
26. AP/FD, MKR BCN and FMS annunciators
27. Radio Magnetic Indicator (RMI)
28. Barometer altimeter
29. Copilot HSI selector switches and annunciators
30. Annunciator brightness control knob
31. Copilot vertical gyro fast erect switch
32. No. 2 gyro compass slaving switches
33. Copilot turn and slip indicator (air)
34. Horizontal Situation Indicator (HSI)
35. Pneumatic pressure gauge
36. Oxygen pressure gauge
37. Microphone normal/oxygen mask selector switch
38. Flight hour meter
39. Gyro suction gauge
40. Cabin air temperature gauge
41. Copilot air control
42. HSI/DME brightness control
43. DME indicator

06-E-0009

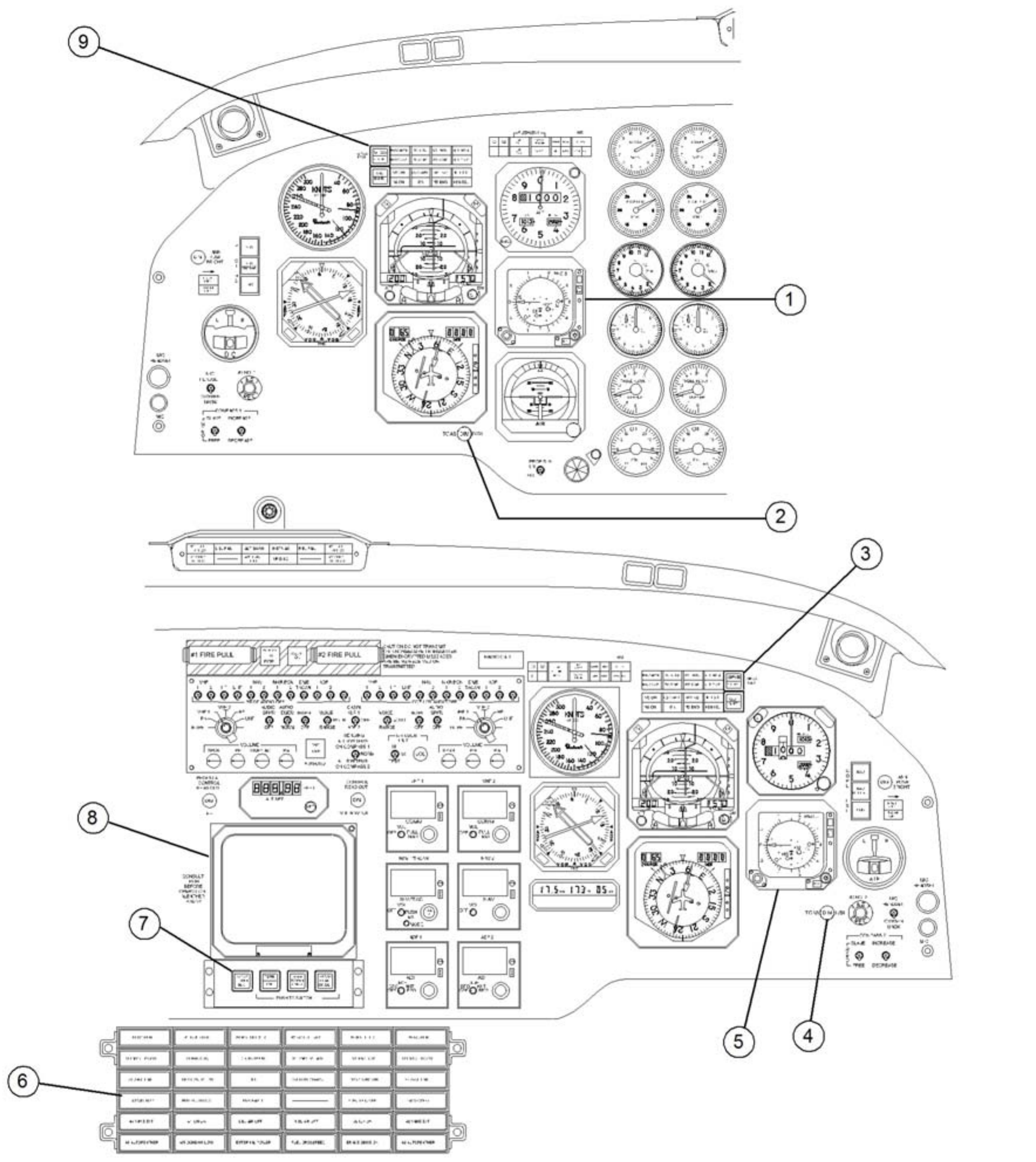
Figure 2-6. **(F)** Instrument Panel (Sheet 1 of 2)



44. TACAN indicator
45. Cabin air control
46. Fire detectors and extinguishers test switch
47. Cabin temperature mode control switch
48. Cabin temperature control knob
49. Froward vent blower switch
50. Aft blower switch
51. Bleed air valve
52. Stall warning and landing gear warning test switch
53. Manual mode temperature control switch
54. No smoking/fasten seatbelt sign switch
55. Prop anti-ice ammeter
56. Cabin furnishings and lighting switches
57. Cabin altimeter and differential pressure gauge
58. Caution and advisory annunciator panel
59. Cabin climb rate indicator
60. Flap position indicator
61. ADF control panel
62. Gas generator rpm (N1) gauges
63. Fuel flow gauges
64. Engine oil temperature/pressure gauges
65. Beacons and strobe lights switches
66. Emergency lights override and test switch
67. Hydraulic fluid sensor test button
68. Landing gear position indicator lights
69. Landing gear warning horn silence button
70. Landing gear handle lights test switch
71. Parking brake control lever
72. Landing gear control handle
73. Landing gear handle down lock release
74. Landing dear relay circuit breaker
75. Prop synchrophaser control switch and indicator
76. Surface and propeller de-ice/anti-ice switches
77. Exterior light switches
78. Defrost air control
79. Ice vane emergency manual extension levers
80. Radio altimeter
81. Pilot air control
82. Standby attitude indicator (air)
83. Pilot turn and slip indicator (dc)
84. No. 1 gyro compass slaving switches
85. Pilot vertical gyro fast erect switch
86. Pilot HSI selector switches and annunciators

06-E-0009(2)

Figure 2-6. (**F**) Instrument Panel (Sheet 2 of 2)



1. PILOT TCAS VSI/TRA TRAFFIC DISPLAY
2. PILOT TCAS/IVSI DIM SWITCH
3. COPILOT GPWS WARNING SWITCH ANNUNCIATORS
4. COPILOT TACAS/IVSI DIM SWITCH
5. COPILOT TCAS VSI/TRA TRAFFIC DISPLAY
6. GPWS INOP (GREEN) ANNUNCIATOR
7. EGPWS SWITCH ANNUNCIATORS
8. MULTI-FUNCTION DISPLAY
9. PILOT'S GPWS WARNING SWITCH ANNUNCIATORS

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Figure 2-7. (**M**) Instrument Panel

2.4.3 Propeller Tachometers

The propeller tachometers register propeller speed (N_2) in hundreds of rpm. Each indicator is slaved to a tachometer generator unit attached to the corresponding reduction gearbox.

2.4.4 Turbine Tachometers

The turbine tachometers register compressor turbine rpm (N_1) for the respective engine. These indicators register a percentage of maximum compressor turbine rpm. Each instrument is slaved to a tachometer generator attached to the respective engine accessory section.

2.4.5 Fuel Flow Indicators

The fuel flow gauges register the rate of flow for consumed fuel as measured by sensing units coupled into the fuel supply lines of the respective engines. (**B/F**) Flow indicators receive electrical dc power from the No. 1 and No. 2 dc dual fed buses through 5 ampere circuit breakers placarded FUEL FLOW in the ENGINES section on the copilot circuit breaker panel and are calibrated to show fuel flow in increments of hundreds of pounds per hour (refer to Figures 2-18 and 2-19). (**M**) Flow indicators receive electrical 26 Vac power from the No. 1 and No. 2 ac buses; the indicators are protected by 1/2 ampere circuit breakers placarded FUEL FLOW, located in the ENGINE section on the overhead circuit breaker panel (refer to Figure 2-20).

2.4.6 Oil Pressure and Oil Temperature Indicators

The combination oil pressure and oil temperature indicators are electrically powered by the No. 1 and No. 2 dual fed dc buses through circuit breakers placarded OIL PRESS and OIL TEMP in the engines section on the (**B/F**) copilot circuit breaker panel/(**M**) overhead circuit breaker panel and indicate oil pressure in psi and oil temperature in degrees Celsius at the delivery side of the oil pump for each engine.

2.5 FIRE DETECTION SYSTEM

(**B/F**) The fire detection system provides immediate warning in the event of fire in either engine compartment. The system consists of three photoconductive cells installed in each engine nacelle, a control amplifier for each engine, two red warning lights on the warning annunciator panel placarded FIRE L ENG — FIRE R ENG, two red lenses placarded L ENG FIRE PUSH TO EXT — R ENG FIRE PUSH TO EXT on the fire extinguisher switches, a TEST SWITCH on the copilot subpanel, and a circuit breaker placarded FIRE DETR on the right side panel. The six photoconductive cell flame detectors, sensitive to infrared radiation, are positioned in each engine compartment to receive both direct and reflected rays, thus monitoring the entire compartment with three photocells. Heat level and rate of heat rise are not factors in the sensing method.

(**B/F**) Conductivity through the photocell varies in direct proportion to the infrared intensity and ratio of radiation striking the cell. To prevent stray light rays from signaling a false alarm, a relay in the control amplifier closes only when the signal strength reaches a preset level. When the relay closes, the appropriate left or right warning annunciators and the MASTER WARNING lights illuminate. When the fire has been extinguished, the output voltage drops below the alarm level and the relay in the control amplifier resets. No manual resetting is required to reactivate the fire detection system. The rotary switch on the copilot left subpanel, placarded TEST SWITCH — FIRE DET & FIRE EXT, has six positions: OFF — RIGHT EXT — LEFT EXT — 3-2-1. The three test positions for the fire detector system are located on the right side of the switch (3-2-1). When the switch is rotated from OFF to any one of three positions, the output voltage of the corresponding flame detector in each engine compartment is increased to a level sufficient to signal the amplifier that a fire is present. The following should illuminate: the red pilot and copilot MASTER WARNING flashers, the red FIRE L ENG and FIRE R ENG warning annunciators, and the red lenses placarded L ENG FIRE — PUSH TO EXT and R ENG FIRE — PUSH TO EXT on the fire extinguisher switches. The system may be tested either on the ground or in flight. The TEST SWITCH should be placed in all three positions to verify the circuitry for all six fire detectors is functional. Failure of the fire detection system annunciators to illuminate when the TEST SWITCH is in any of the three flame detector TEST positions indicates a malfunction in one or both of the detector circuits (one in each engine). The fire detector system circuitry receives electrical power from the No. 1 dual fed bus and is protected by the circuit breaker placarded FIRE DETR in the ENGINE section on the right side circuit breaker panel.

(**M**) A pneumatic fire detection system is installed to provide an immediate warning in the event of a fire or overtemperature in the engine compartment. The main element of the system is a temperature-sensing tube routed continuously throughout the engine compartment, terminating in a responder unit. The responder unit is mounted in the accessory area on the upper left-hand engine truss just forward of the engine firewall. The responder unit contains two sets of contacts: a set of integrity switch contacts for continuity test functions of the fire detection circuitry, and a set of alarm switch contacts that complete the circuit to activate the fire warning system when the detector cable senses an overtemperature condition in critical areas around the engine.

2.6 FIRE EXTINGUISHER SYSTEM

The engine fire extinguisher system is comprised of a supply cylinder, explosive squib, and valve located in each of the main gear wheelwells. A gauge calibrated in psi is provided on each supply cylinder for determining the level of charge. The charge level should be checked during each preflight. When fired, the explosive squib opens the valve, releasing the entire pressurized extinguishing agent into a plumbing network. The plumbing network terminates in spray nozzles strategically located in the probable fire areas of the engine compartment.

(**B/F**) The fire extinguisher control switches used to activate the system are located on the glareshield at each end of the warning annunciator panel. (**M**) The fire control T-handles used to arm the extinguisher system are centrally located on the instrument panel, immediately below the glareshield. The power for the control switches and T-handles is derived from the hot battery bus.

(**B/F**) Each push-to-actuate switch incorporates three indicator lenses. The red lens, placarded L (or) R ENG FIRE - PUSH TO EXT, warns of the presence of fire in the engine compartment. The amber lens, placarded D, indicates that the system has been discharged and the supply cartridge is empty. The green lens, placarded OK, is provided for the test function only. Raising the shear-wired clear plastic cover and pressing the face of the lens discharges the cartridge. This system is a one-shot system and will be completely expended upon activation. The amber D light will illuminate and remain illuminated, regardless of battery switch position, until the cartridge is replaced. The fire extinguisher system test functions incorporated in the TEST SWITCH - FIRE DET & FIRE EXT test the circuitry of the fire extinguisher pyrotechnic cartridges. To test the system, the pilot should rotate the TEST SWITCH to each of the positions (RIGHT EXT and LEFT EXT) and verify the illumination of the amber D light and the green OK light on each fire extinguisher activation switch on the glareshield.

(**M**) The fire detector system will indicate an engine fire by illuminating the respective #1 or #2 FIRE PULL lights in the fire control T-handles. Pulling the fire control T-handle will electrically arm the extinguisher system and close the fuel firewall shutoff valve for that particular engine. This will cause the light in the PUSH TO EXTINGUISH FIRE button and the respective #1 and #2 FUEL PRESS light in the warning annunciator panel to illuminate. Pressing the lens of the PUSH TO EXTINGUISH FIRE button will fire the squib, expelling all the agent in the cylinder at one time. A hinged plastic guard covers the PUSH TO EXTINGUISH FIRE button to prevent inadvertently actuating the fire extinguish switch squib circuit. The respective #1 or #2 EXTGH DISCH caution light on the caution/advisory annunciator panel will remain illuminated regardless of the master switch position, until the squib is replaced.

CAUTION

If both fire control T-handles are pulled, both fire extinguishing systems will be armed and if the PUSH TO EXTINGUISH FIRE button is subsequently depressed, both cylinders will be fired.

(**M**) The test switches located on the copilot left subpanel, placarded ENGINE FIRE PROTECTION TEST, DET-EXT, LEFT and RIGHT, provide a test of the fire detection and extinguisher circuitry. When either TEST switch is placed in the EXT position, the SQUIB OK and corresponding EXTGH DISCH annunciators should illuminate. The system may be tested either preflight, postflight, or in flight as desired.

2.7 PROPELLERS

A three-bladed (**B/F**) Hartzell (**M**) McCauley aluminum propeller is installed on each engine. These propellers are hydraulically controlled, constant speed, full feathering, and reversing. Each propeller is controlled by engine oil acting through an engine-driven propeller governor that varies the amount of oil allowed into the propeller. High oil pressure/volume in the propeller equates to a high rpm, low-pitch propeller. Low or no oil pressure/volume equates to a low rpm, feathered propeller. Feathering is accomplished by feathering springs assisted by centrifugal force applied to blade shank counterweights. Governor-boosted engine oil pressure moves the propeller blades to the high rpm (low pitch) hydraulic stop and into reverse pitch. The low pitch propeller position is determined by a mechanically actuated hydraulic stop. (**M**) An independent propeller hub oil reservoir provides lubrication for the propeller blade bearings and pitch rack and pinion gears.

2.7.1 Feathering Provisions

The aircraft is equipped with both manual and automatic propeller feathering. Manual feathering is accomplished by pulling the corresponding propeller lever aft past a friction detent. To unfeather, the propeller lever is pushed forward into the governing range. An automatic feathering system, if armed, will sense loss of torque oil pressure and will feather the unpowered propeller.

2.7.2 Propeller Governors

Each propeller system uses two governors—one primary and one overspeed (backup)—to control propeller rpm. Each propeller lever establishes rpm for the respective propeller by altering the setting of a primary governor mounted on the engine reduction housing. The primary governor contains both a hydromechanical and pneumatic (fuel topping) section. The hydromechanical section controls propeller rpm through the entire normal operating range of 1,600 to 2,000.

If a malfunction of the primary governor allows the propeller to exceed the normal operating rpm range, an overspeed governor is activated when propeller rpm reaches 2,080 ±40 rpm. This action dumps excess oil pressure from the propeller hub to be routed back to the engine oil sump, thus reducing propeller rpm by increasing propeller blade angle and aerodynamically slowing the propeller. Regardless of the propeller rpm selected, if power is rapidly applied, the propeller may overshoot the desired rpm. If propeller rpm reaches 106 percent of selected rpm during this transient condition, the fuel topping portion of the primary governor bleeds air from the pneumatic side of the fuel control unit. This limits fuel flow into the engine, thereby reducing power to the propeller and decreasing its rpm until the primary governor regains control. For example, if the primary governor is set at 2,000 rpm, the fuel topping portion of the primary governor activates to ensure propeller will not exceed 2,120 rpm. During propeller operation in the reverse range, the fuel topping portion of the primary governor is automatically reset to limit propeller rpm to 1,900 before the propeller reaches a negative pitch angle. This ensures that the engine power is limited to maintain a propeller rpm somewhat less than the primary governor setting to prevent the propeller from reaching the governing range, degrading its reversing capability.

2.7.2.1 Propeller Governor Test Switch

(**B**/**F**) A two-position switch on the extended pedestal (Figures (**B**) 2-2/(**F**) 2-3) is provided for operational test of the propeller systems. The switch is placarded PROP GOV TEST. A solenoid actuated by the PROP GOV TEST switch enables the overspeed governor to be reset for test purposes (1,830 to 1,910 rpm).

(**M**) A two-position switch placarded GOVERNOR TEST, located in the PROP section on the overhead control panel (Figure 2-26), is provided for operational test of the propeller governors. This switch, when placed in the GOVERNOR TEST position, actuates a solenoid that resets the overspeed governor to 1,830 to 1,910 rpm for test purposes.

2.7.3 Propeller Synchrophaser

The propeller synchrophaser electronically matches the rpm of both propellers and maintains a preset phase angle relationship between the left and right propellers. This is accomplished automatically via a magnetic speed pickup mounted in each propeller overspeed governor and magnetic phase pickups mounted on each propeller deice slip ring that transmit electronic pulses to a control unit. The control unit converts any pulse rate differences into correction commands.

(**B**) These correction commands are then transmitted to an actuator motor mounted on the right engine. The actuator motor then trims the right propeller governor assembly to match the left propeller rpm exactly while leaving the propeller control lever position constant. If the synchrophaser system is unable to adjust the right propeller to the left, the actuator has reached its travel limit. To recenter the actuator, position the PROP SYNC switch OFF, synchronize the propellers manually, then position the PROP SYNC switch ON.

Note

The recentering process will take approximately 6 seconds.

To prevent the right propeller from losing excessive rpm if the left propeller is feathered while the synchrophaser is in use, the system is limited to ±30 rpm from the governor setting. Adjustment of rpm with both propeller levers at the same time will retain the right propeller governor setting within the ±30 rpm range of the left propeller. The system is designed for in-flight use only.

(**F**/**M**) These correction commands will be transmitted to the lower rpm propeller actuator motor. The motor will always increase the lower rpm propeller, never decrease the higher rpm propeller as long as rpms are within 25 rpm of each other. The system is operated by manually synchronizing the propellers to within the capture range (approximately 15 rpm) and turning the synchrophaser on by actuating the switch placarded PROP SYN — ON— OFF to ON. During flight, adjusting both propeller levers at the same time will keep the setting within the controlling range (25 rpm). The propeller synchrophaser may be used on takeoff at the pilot's discretion (the limited range of the synchrophaser will be reduced near maximum propeller rpm).

2.7.3.1 Propeller Synchronization Switch

A two-position switch located on the pilot subpanel is placarded (**B**) PROP SYNC ON — OFF FOR T/O & LDG or (**F**/**M**) PROP SYNC ON — OFF and completes the circuit for propeller synchronization. (**B**) When the switch is placed in the OFF position, the actuator will automatically run to the center range before stopping. This ensures the control will function normally when the ON position is next selected. System operation requires synchronization of the propellers in the normal manner and then selecting the ON position of the PROP SYNC switch.

2.7.3.2 (B) PROP SYNC ON Light (Annunciator)

The propeller synchronization system is designed for in-flight use only and is placarded to be OFF for takeoff and landing; therefore, if the system is in use and the landing gear is extended (as in an approach for landing), a yellow annunciator light placarded PROP SYNC ON and the MASTER CAUTION lights will illuminate.

2.7.4 Propeller Levers

Two propeller levers on the control pedestal, placarded PROP, are used to regulate propeller speeds. Each lever controls a primary governor that acts to regulate propeller speeds within the normal operating range. The full forward position is placarded TAKEOFF, LANDING AND REVERSE, and HIGH RPM. Full aft position is placarded FEATHER. When a lever is placed at HIGH RPM, the propeller may attain a static rpm of 2,000, depending upon power lever position. As a lever is moved aft, passing through the propeller governing range but stopping at the feathering detent, propeller rpm will correspondingly decrease to the lowest limit. Moving the propeller lever aft past the detent into FEATHER will feather the propeller.

2.7.4.1 Propeller Reversing

The propeller blade angle may be reversed to shorten landing roll. To reverse, propeller levers are positioned at HIGH RPM (full forward), and the power levers are lifted up to pass over an IDLE detent, then pulled aft into REVERSE.

2.7.4.2 Propeller Reverse Not Ready Annunciator Light

One yellow caution light, placarded RVS NOT READY, on the annunciator panel alerts the pilot that full reverse capability is not available. This light illuminates only when the landing gear handle is down and if propeller levers are not at HIGH RPM (full forward).

2.7.5 Autofeather System

If the autofeather system is armed and both power levers are at a position that would normally correspond to approximately 90 percent N_1 or greater, and an engine loses power, the autofeather system will automatically feather the unpowered propeller. When torque drops below (**B/F**) 260 ± 50 foot-pounds/(**M**) 11 ± 2 percent, torque-sensing switches in the engine will send an electrical signal to a dump valve to release the oil pressure that held an established pitch angle on the blades of the affected propeller. Following release of the oil pressure, feathering movement is accomplished by the feathering springs assisted by centrifugal force applied to the blade shank counterweights. The autofeather system has a cross-interlock feature designed into the control circuit to prevent automatic feathering of both propellers. Before the unpowered propeller feathers, the interlock disarms the autofeather circuit of the opposite propeller. After autofeathering has occurred, feathering of the opposite propeller must be accomplished using manual procedures.

2.7.5.1 Propeller Autofeather Switch

A three-position switch on the (**B/F**) extended pedestal/(**M**) overhead control panel arms the autofeather system. The switch is placarded AUTOFEATHER, ARM, OFF, and TEST, and is spring loaded from TEST to OFF. Although the system is armed by placing the switch in the ARM position, completion of the arming phase occurs through a power lever arming switch that is activated at approximately 90 percent N_1. Arming is verified by illumination of the (**B/F**) right and left/(**M**) #1 and #2 autofeather annunciator lights. The TEST position bypasses the power-lever position switch to allow the pilot to ground check the readiness of the autofeather system with the power levers at less than approximately 90 percent N_1.

2.7.5.2 Autofeather Lights

Two annunciator panel function lights, placarded (**B/F**) L or R/(**M**) #1 or #2 AUTOFEATHER, illuminate to verify complete arming of the autofeather system. Both lights will illuminate when the power levers are advanced through approximately 90 percent N_1 and will remain illuminated until the system is disarmed by placing the AUTOFEATHER switch in the center OFF position, a propeller has autofeathered, or the power levers have been retarded below approximately 90 percent N_1.

2.8 FUEL SYSTEM

The fuel supply system (Figures (**B**) 2-8/(**F/M**) 2-9) consists of two identical systems sharing a common fuel management panel and a valve-controlled crossfeed line that passes through the pressure vessel just forward of the main spar. Each system is further divided into a main and an auxiliary system. Provisions for extended range tanks are provided.

The main fuel system consists of a 57 gallon nacelle tank and 5 interconnected fuel tanks in each wing. The 6 tanks hold a total of 195 gallons, of which 193 gallons are usable. The main fuel system holds a total of 390 gallons of fuel, of which 386 gallons are usable. All five interconnected fuel tanks in each wing are filled at the filler access located near the wing tip and drain by gravity into the nacelle tank.

The auxiliary fuel supply system consists of a 79.5 gallon center section tank, of which 79 gallons are usable, and an automatic fuel transfer system to transfer the fuel into the nacelle tank. The auxiliary tanks are filled at a separate filler opening located inboard of the nacelles. When the auxiliary tanks are utilized, that fuel will be used first. During the automatic transfer of auxiliary fuel, the main system nacelle tanks are maintained full until all auxiliary fuel is transferred. When all auxiliary fuel has been transferred, normal gravity transfer of fuel into the nacelle tank will begin.

The aircraft contains provisions for a fuselage- mounted extended range fuel system. The system includes 2 fuel tanks with a combined capacity of 240 gallons.

2.8.1 Fuel Pumps

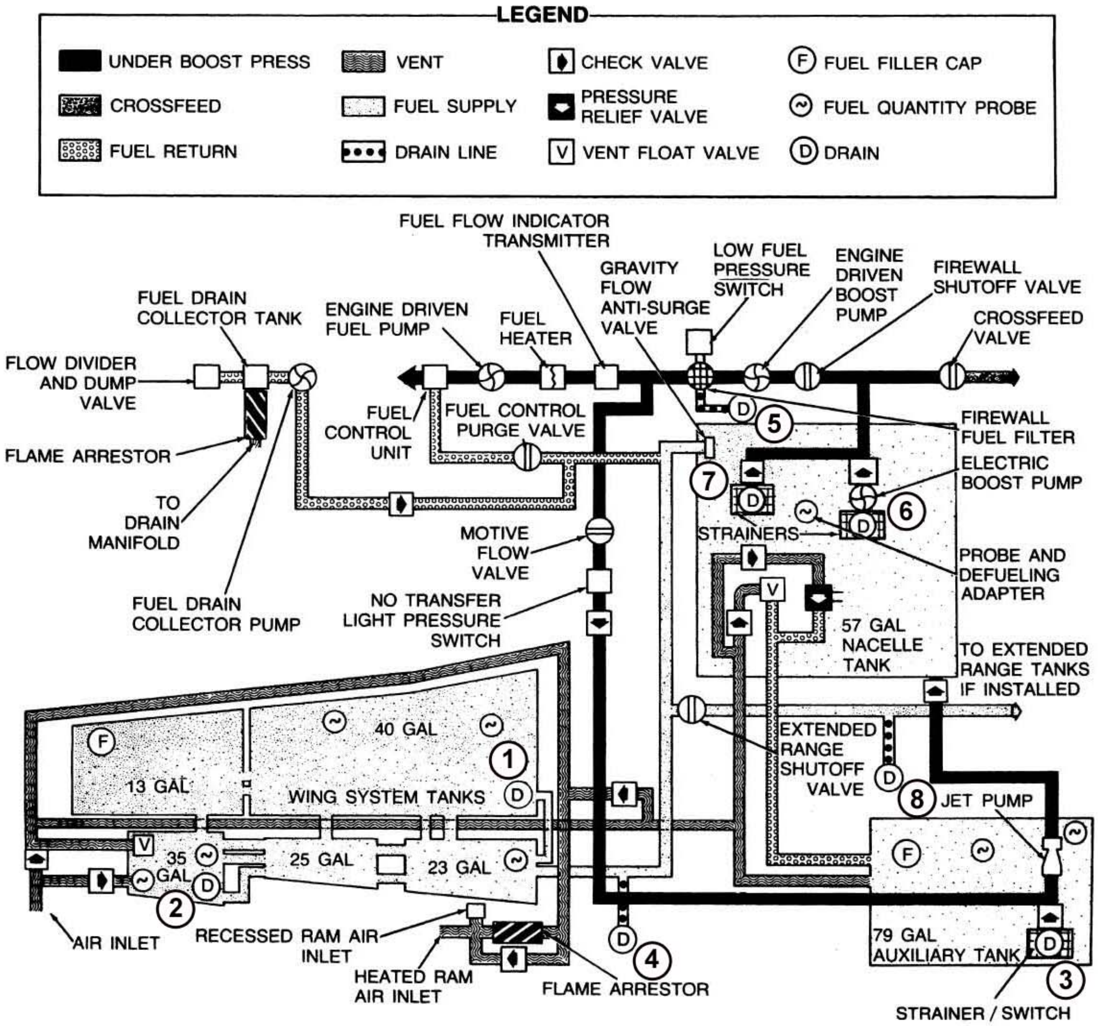
Fuel is delivered under pressure to the engine-driven primary (high-pressure) pump by either of two boost pumps. The engine-driven boost pump is bolted to and driven from the aft accessory section of the engine. In addition to supplying boosted fuel pressure, this pump also furnishes the motive fuel flow for fuel transfer from the auxiliary to the nacelle tank. The engine-driven primary pump provides sufficient fuel for start, takeoff, all flight operations except those on aviation gasoline above 20,000 feet, and crossfeed. Failure of the engine-driven boost pump is indicated by steady illumination of the red FUEL PRESS annunciator light. The light will extinguish when the standby boost pump is activated and fuel pressure is restored.

An electrically driven standby boost pump is located in the bottom of the nacelle tank and has three functions. It is a backup pump used if the primary boost pump fails, when operating on aviation gasoline above 20,000 feet, and during crossfeed.

The electrical power to operate the standby boost pumps is controlled by lever-lock-type toggle switches on the fuel management panel placarded STANDBY PUMP — ON — OFF. The standby boost pumps receive electrical power from two independent sources. (**B/F**) One source of power is from either the No. 3 or No. 4 feeder buses; this source is protected by a circuit breaker on the fuel management panel. (**M**) The standby boost pumps receive electrical power from the #1 and #2 feeder buses. The power from these buses is only available if the battery switch is ON. (**B/M**) Another source of electrical power is directly from the battery through the hot battery bus. This source is available regardless of the battery master switch position. Both electrical source circuits are protected by diodes to prevent the failure of one circuit from disabling the other.

2.8.2 Fuel Drains

Eight drains (Figures 7-1 and 3-4) are provided to check for and drain each wing fuel system of moisture and sediment. The eighth drain is located in the extended range provisions for use when ferry tanks are installed and utilized.



NOTE

- RIGHT SYSTEM IS IDENTICAL TO LEFT EXCEPT THE LATER CONTAINS THE CROSSFEED VALVE.
- FUEL WILL NOT GRAVITATE THROUGH THE CROSSFEED SYSTEM.
- A FUEL CAPACITANCE GAUGING SYSTEM UTILIZES A FUEL QUANTITY GAUGE FOR EACH WING FUEL SYSTEM. THIS GAUGE CAN BE SWITCHED TO DESIGNATE THE AMOUNT OF FUEL IN THE AUXILIARY TANK OR IN THE MAIN SYSTEM.
- TOTAL USABLE FUEL 544 GALLONS.
- THE FUEL DRAIN NUMBERS CORRESPOND TO THE NUMBER SHOWN IN THE FUEL DRAINS DESCRIPTION IN FIGURE 3-4.

Figure 2-8. (**B**) Fuel System

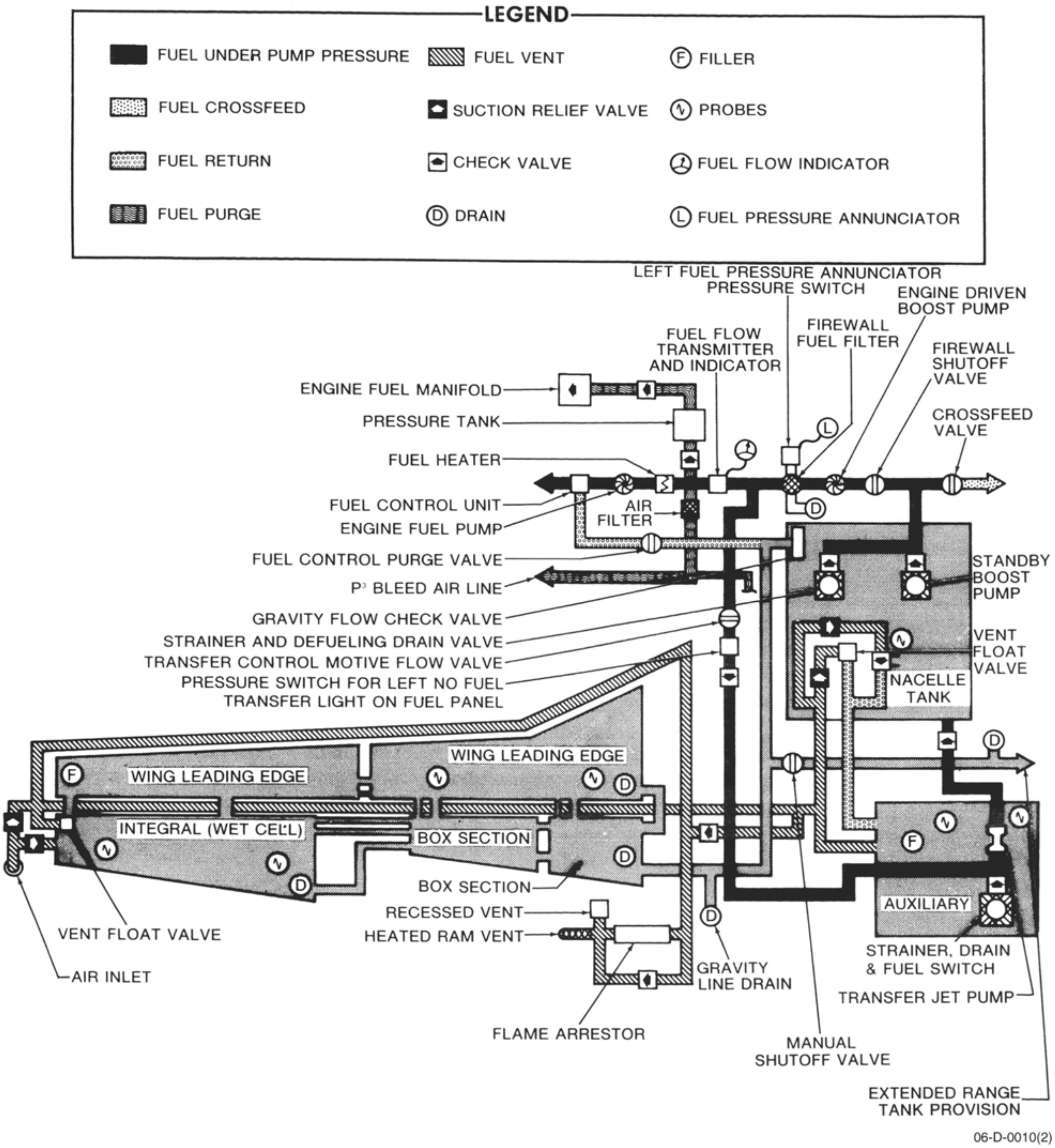


Figure 2-9. (**F**/**M**) Fuel System

2.8.3 Fuel Vents

The fuel system is vented to the atmosphere to maintain a satisfactory pressure condition during static or flight conditions. The wing tanks are vented cell to cell and to the atmosphere through a vent line that extends aft to the recessed and heated ram vents. The primary purpose of the vent is to provide a proper balance of pressure within each tank to prevent collapse or excessive expansion of the cells and to ensure proper fuel transfer. Each wing has a recessed (to prevent icing) ram vent coupled to a protruding heated ram vent as a backup. These vents are located under each wing adjacent to the aft portion of the nacelle. The heated section of each vent is controlled by two two-position toggle switches located in the ICE section of the pilot subpanel and placarded FUEL VENT — LEFT — RIGHT.

2.8.4 Auxiliary Fuel Transfer System

The auxiliary fuel transfer system transfers fuel from the auxiliary fuel tank to the nacelle tank. Fuel is transferred by means of a jet pump located in the auxiliary tank sump. The jet pump is operated by motive fuel flow obtained from the engine fuel system, downstream from the engine-driven boost pump, and routed through a motive flow valve to operate the jet pump. When the motive flow valve is deenergized, motive fuel flow is shut off and transfer is prevented. When electrical power is applied to the motive flow valve, the valve opens and applies motive flow to the jet pump to transfer fuel.

Note

Auxiliary fuel transfer will be unavailable in the event of a total loss of electrical power.

The auxiliary fuel transfer system is pilot controlled by two switches located on the fuel management panel and placarded (**B/F**) AUX TRANSFER — OVERRIDE — AUTO/(**M**) AUX XFER OVRD — AUTO. With the switch in the AUTO position, the motive flow valve will open and fuel transfer will begin approximately 40 seconds after a fuel pressure switch senses pressure in the engine fuel line (to prevent fuel depletion during engine start). Transfer will continue until the fuel in the auxiliary tank is depleted. The empty auxiliary tank is secured by a float switch that causes the motive flow valve to close and shut off motive flow.

Note

The motive flow valve on the side being fed is automatically closed when CROSSFEED FLOW is selected to prevent fuel transfer from the auxiliary tank in the side being fed.

The OVERRIDE position of the auxiliary transfer control switch bypasses the 40-second time delay and automatic control circuitry and energizes the motive flow valve directly to provide a manual backup to the automatic system.

(**B/F**) Left and right NO TRANSFER lights (located on the fuel management panel)/(**M**) #1 and #2 NO FUEL XFER annunciator caution lights are provided to indicate when fuel is not being transferred. The appropriate light will illuminate when there is fuel in the auxiliary fuel tank and no motive fuel pressure is applied to the jet pump.

2.8.5 Fuel Management Panel

(**B/F**) Control of the fuel system is directed from the Fuel Management Panel (Figure 2-10). This panel is located on the pilot left sidewall and contains the switches for the firewall shutoff valves, standby boost pumps, auxiliary transfer override, crossfeed flow, fuelquantity select, no fuel transfer lights, and fuel quantity indicators. Full forward movement of the pilot seat with left armrest down obstructs the left firewall shutoff valve switch.

(**M**) Control of the fuel system is directed from the Fuel Management Panel (Figure 2-11), located in the cockpit overhead. This panel contains the switches for the standby boost pumps, auxiliary transfer override, crossfeed flow, fuel quantity select, and the fuel quantity indicators.

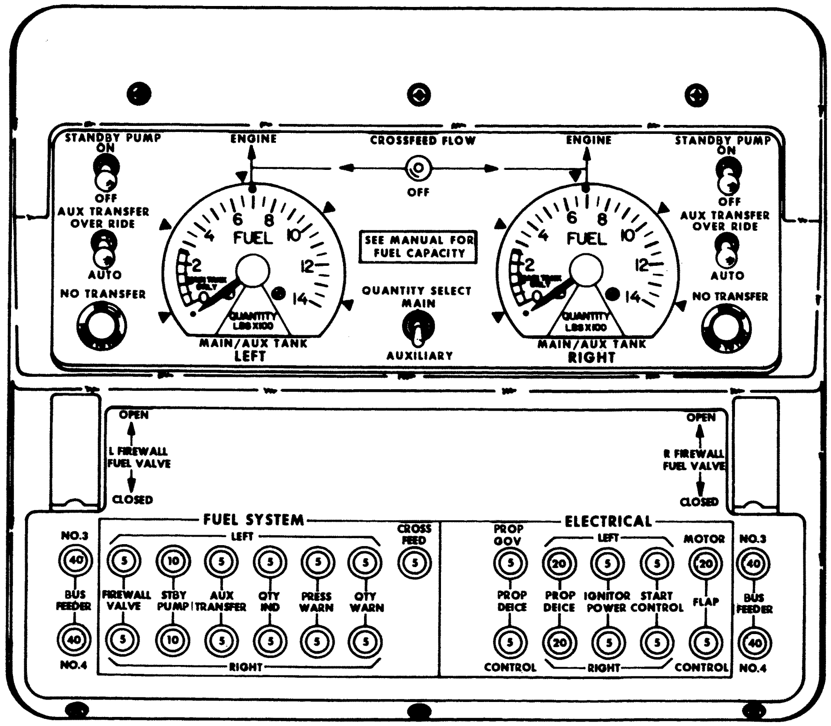


Figure 2-10. (**B**/**F**) Fuel Management Panel

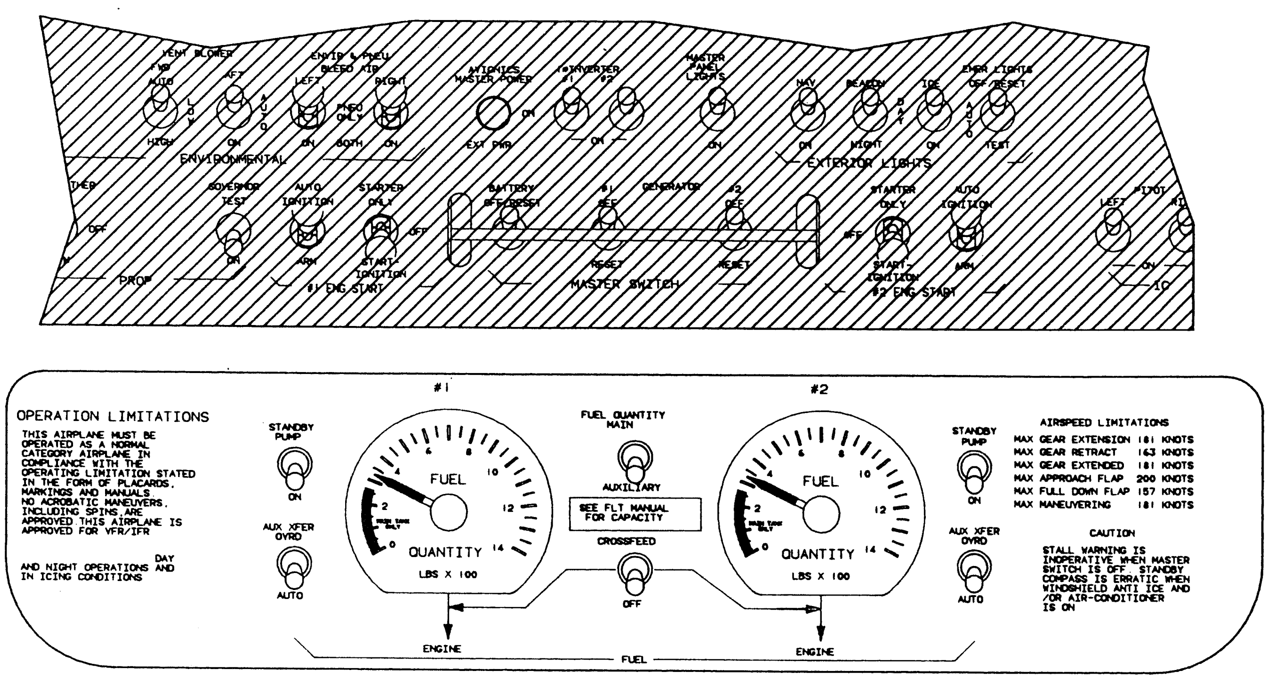


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Figure 2-11. (**M**) Fuel Management Panel

2.8.5.1 Fuel Crossfeed

During normal fuel system operation, the fuel systems on each side are isolated and each engine is supplied fuel under boosted pressure from its own system. Crossfeed does not transfer fuel from one system to the other; it allows one engine to receive fuel from the opposite side. The crossfeed system is placarded with a diagram on the fuel management panel. When crossfeed is desired, place both standby boost pump switches in the OFF position and lift and place the lever-lock switch placarded CROSSFEED FLOW from the center OFF position left or right depending on the desired fuel flow direction. This action opens the crossfeed valve, energizes the standby pump on the side from which crossfeed fuel is desired, deenergizes the motive flow valve to the closed position on the side being fed, and illuminates the green FUEL CROSSFEED annunciator light. Illumination only means the crossfeed valve is energized and does not verify fuel crossfeed flow. During crossfeed operation, fuel delivered will be supplied from the side with the operative boost pump only; thus, opposite wing loads will become unbalanced.

Note

Crossfeed is intended to allow continued single-engine operations, not to correct minor fuel imbalance in flight. Crossfeed to support dual-engine operations is not recommended.

2.8.5.2 NO TRANSFER Indicator Lights

A pressure switch senses the loss of motive flow fuel pressure when there is fuel remaining in the auxiliary tank and will illuminate the respective (**B**/**F**) NO TRANSFER light on the fuel management panel (Figure 2-10)/(**M**) #1 or #2 NO FUEL XFER caution annunciator (Figure 2-36). The loss of pressure could be the result of a failure of the motive flow valve or the associated control circuitry. A manual override is available if the automatic transfer malfunctions as indicated by the (**B**/**F**) NO TRANSFER/(**M**) NO FUEL XFER light illumination. It is activated by placing the AUX TRANSFER switch on the fuel management panel to the OVER RIDE position.

2.8.5.3 Standby Boost Pump Switches

(**B**/**F**) Two switches on the fuel management panel, placarded STANDBY PUMP — ON — OFF, (Figure 2-10) control submerged boost pumps in the corresponding nacelle tanks. Each is a two-position lever-lock-type toggle switch. At each ON — OFF position, the toggle lever is restrained to prevent inadvertent movement. To reposition the switch, a distinct action is required. The toggle lever must be pulled out, moved to the desired position, and released. During normal operation of the aircraft, these switches are in the OFF position.

(**M**) Two switches, placarded STANDBY PUMP — ON, located on the overhead Fuel Management Panel (Figure 2-11), control a submerged boost pump in the corresponding nacelle tanks. During normal operations, these pumps are off and the switches are in the STANDBY PUMP position.

2.8.5.4 Firewall Valves

A fuel line shutoff valve mounted on each engine firewall is incorporated in the fuel system. (**B**/**F**) Two guarded switches on the fuel management panel, placarded L & R FIREWALL FUEL VALVE OPEN — CLOSED, are provided to give the pilot electrical fuel shutoff capability at each engine firewall. Each switch is a two-position unit controlling the corresponding firewall shutoff valve located aft of the firewall. In the CLOSED position, fuel flow to the affected engine is terminated, thereby isolating that engine fuel supply, although the isolated fuel may be supplied to the opposite engine by crossfeed. A hinged red guard engages each firewall valve switch toggle when the switch is in the OPEN position. This guard prevents inadvertent movement of the switch to the CLOSED position. The guard must be manually disengaged from the switch toggle to move the switch to the CLOSED position.

(**M**) The firewall shutoff valves close automatically when the fire extinguisher T-handles on the instrument panel are pulled out. The firewall shutoff valves receive electrical power from the main buses and from the hot battery bus, which is connected directly to the battery.

The valves are protected by 5-ampere circuit breakers placarded FIREWALL VALVE located (**B/F**) on the fuel management panel (**M**) in the FUEL section of the overhead circuit breaker panel.

CAUTION

Do not use the fuel firewall shutoff valve to shut down an engine except in an emergency. The engine-driven (high-pressure) fuel pump obtains essential lubrication from fuel flow. When an engine is operating, this pump may be damaged if the firewall valve is closed before the condition lever is moved to the FUEL CUTOFF position.

Note

A 15 to 45 second delay before engine flameout can be expected when using the firewall shutoff valve to secure an engine.

2.8.5.5 Fuel Quantity Indicators

Two fuel quantity indicators mounted on the fuel management panel (Figures (**B**) 2-10/(**M**) 2-11) indicate AUXILIARY tanks or MAIN tanks fuel quantity in 50 pound increments. A two-position toggle switch placarded (**B/F**) QUANTITY SELECT-MAIN-AUXILIARY/(**M**) FUEL QUANTITY MAIN-AUXILIARY is located between the indicators. It is spring loaded from AUXILIARY to MAIN and can momentarily be positioned in the AUXILIARY position to provide an indication of fuel remaining in the auxiliary system. The MAIN position shows fuel quantity in the main tanks only. In addition to the fuel quantity indicators, caution annunciators placarded (**B/F**) L or R (**M**) #1 or #2 NAC LOW illuminate when there is approximately 247 pounds (30 minutes) of usable fuel at sea level normal cruise power per engine remaining.

2.9 ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

The aircraft employs 28 Vdc and 115 and 26 Vac electrical power. The dc electrical supply (Figures (**B**) 2-12/(**F**) 2-13/(**M**) 2-14) forms the basic power system energizing most aircraft circuits. Ac power for certain engine instruments and for avionics is obtained from dc power through two inverters (Figures (**B**) 2-15/(**F**) 2-16/(**M**) 2-17). Dc power is supplied by a 24 volt, 42 ampere hour valve regulated sealed lead acid battery mounted in the right wing center section and two 250 ampere starter-generators connected in parallel. The generator buses are interconnected by two current limiters. The entire electrical system operates as a single bus, with power being supplied by the battery and both generators. (**B/F**) Four dual fed buses (**M**) six dual fed buses distribute electrical power supplied from either generator main bus through circuit breakers with a diode. The equipment on the dual fed buses is arranged so that all items with duplicate functions (such as left and right landing lights) are connected to different buses (Figures (**B**) 2-12/(**F**) 2-13/(**M**) 2-14).

2.9.1 Battery Bus (Hot)

The hot battery bus is connected directly to the battery and located under the right wing, outboard of the battery. It provides power to various circuits. These circuits are operative regardless of battery master switch position and/or (**M**) key lock switch position. Refer to Figure 2-14**.**

2.9.2 Main Bus

Power to the (**B**) MAIN AIRCRAFT BUS, (**F**) MAIN BUS, (**M**) STARTER BUS from the battery is routed through the battery relay that is controlled by the (**B/F**) BATT switch located on the pedestal extension; (**M**) BATTERY and keylock switches located on the overhead control panel.

Power to the bus system from the generators is routed through reverse-current protection circuitry that prevents the generators from absorbing power from the buses when generator voltage is less than bus voltage.

2.9.3 Gangbar

A one-piece bar on the (**B**/**F**) pedestal extension/(**M**) overhead control panel placarded MASTER SWITCH provides the pilot with the capability to move the battery and both generator switches to the OFF position simultaneously. The gangbar is raised when a battery or generator switch is placed to the ON position. Placed down, the bar forces all switches to the OFF position.

(**M**) The aircraft is equipped with a security keylock switch placarded OFF-ON, located on the left side of the overhead control panel. The switch is connected in series with the battery switch. The keylock switch and battery switch must be ON before battery or dc external power can be utilized. The key cannot be removed from the lock when in the ON position.

2.9.4 External Power Receptacle

An external power receptacle located beneath the wing outboard of the right nacelle (Figure 3-1) permits all dc buses to be powered by an external power source for engine starting and systems operation. A relay in the external power circuit will close to accept external power only if the battery source polarity is correct and the aircraft (**B**/**F**) BATT master switch is ON (**M**) BATTERY and keylock switches are ON. For engine starting, a power unit capable of 1,000 amperes for 0.1 second and 300 amperes minimum continuous power is necessary. An annunciator light placarded EXT PWR and powered from the hot battery bus is provided to alert the crew that an external power source is connected to the aircraft.

Note

With external power supplied to the aircraft, the generators are automatically locked from the aircraft bus.

2.10 STARTER-GENERA TORS

Starter power to each starter-generator is provided from the (**B**) MAIN AIRCRAFT BUS (**F**/**M**) STARTER BUS through a starter relay. It is controlled by a three-position toggle switch for each engine placarded (**B**/**F**) IGNITION AND START-OFF-ST ARTER ONLY (**M**) STARTER ONLY-OFF-ST ART IGNITION. These switches are in a section placarded (**B**/**F**) ENGINE START located on the pedestal extension (**M**) ENG START located on the overhead control panel.

2.10.1 Generators

The dc generators are controlled by individual solid-state regulators that allow a constant voltage to be presented to the buses during variations in engine speed and electrical load requirements. The voltage regulating circuit will automatically disable or enable generator output to the bus. The load on each generator is indicated by the respective left and right volt/loadmeter located in the overhead panel.

2.10.1.1 Generator Switches

The dc generators are manually connected to the voltage regulating circuits by two switches placarded (**B**/**F**) GEN NO. 1 and GEN NO. 2 (**M**) GENERATOR #1 and GENERATOR #2. These switches, located under the MASTER SWITCH gangbar, (**B**/**F**) on the pedestal extension (**M**) on the overhead control panel are also placarded ON-OFF-RESET . To activate a generator or return a generator to service after it has been removed from the line, the appropriate generator switch must be held in the spring-loaded RESET position for 1 second, then released to the ON (center) position.

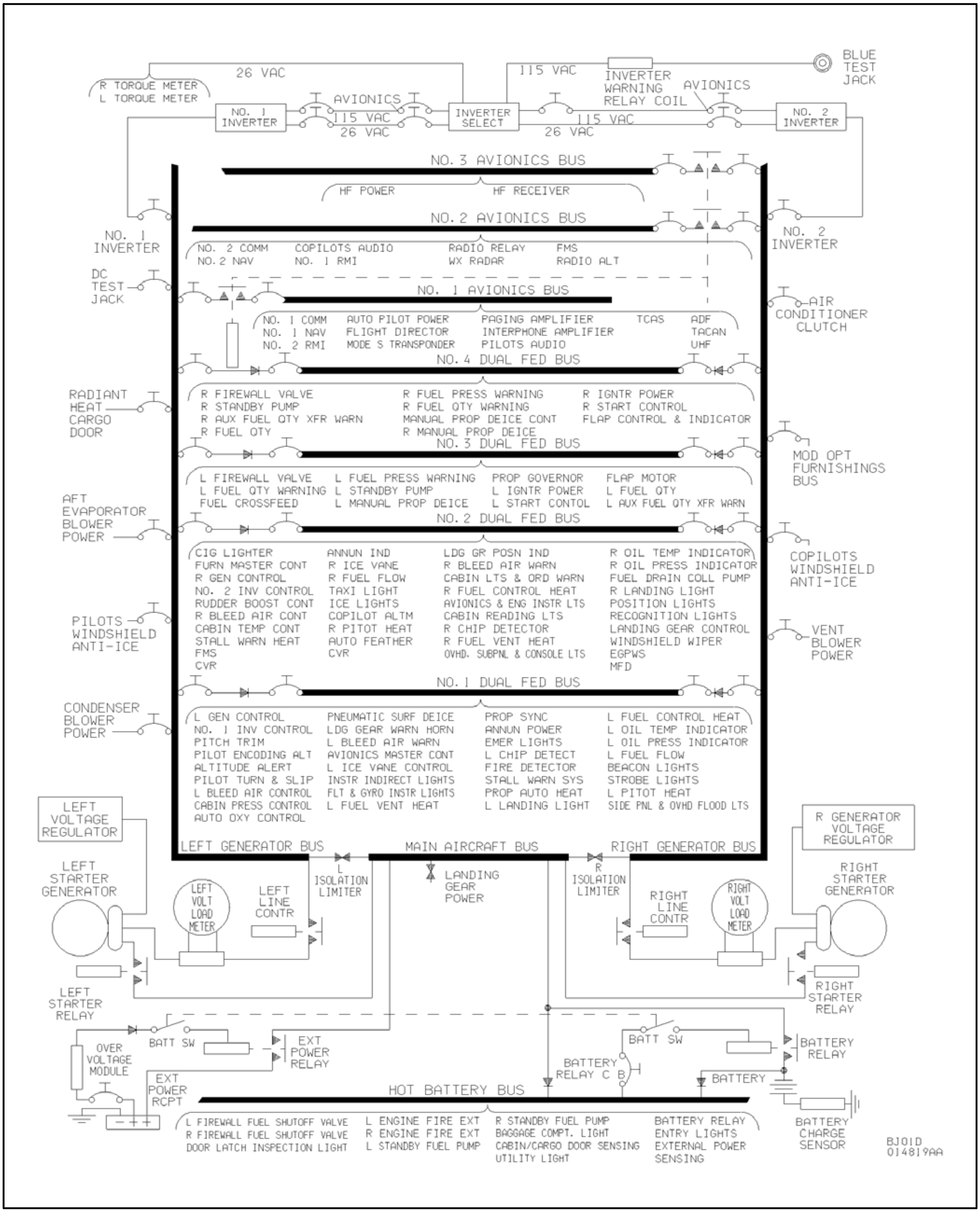


Figure 2-12. (**B**) Dc Electrical System

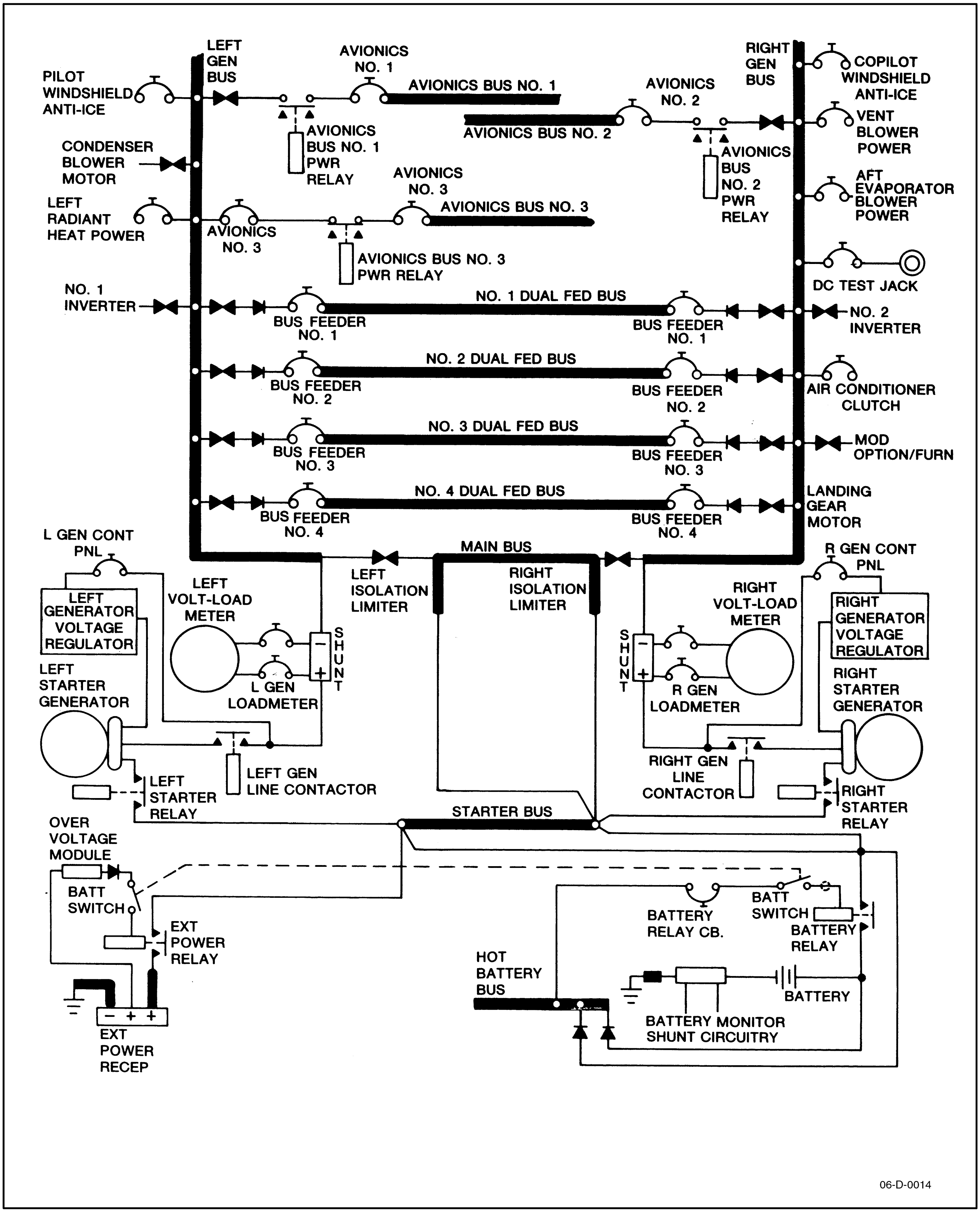


Figure 2-13. (**F**) Dc Electrical System Distribution Schematic (Sheet 1 of 2)

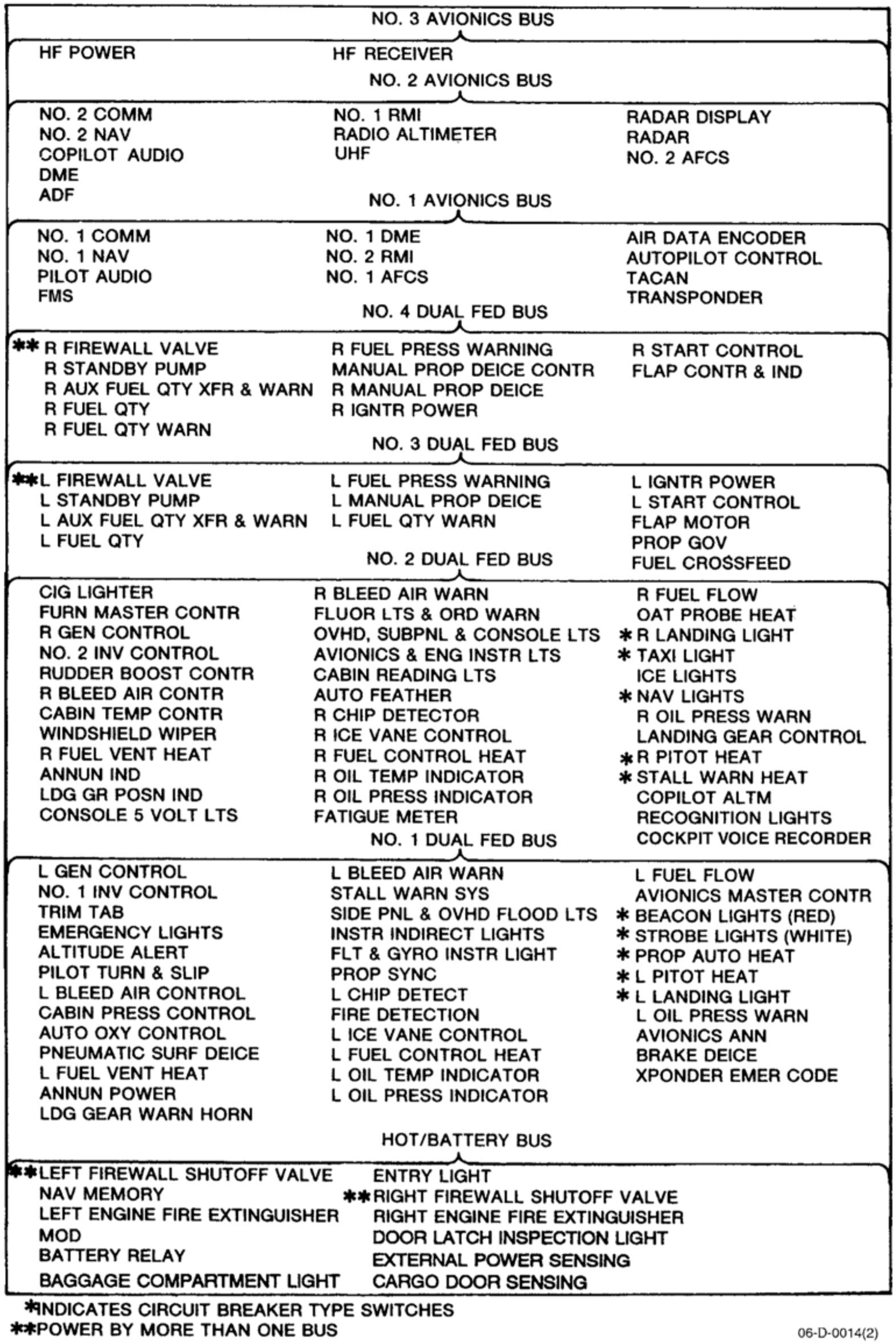


Figure 2-13. (**F**) Dc Electrical System Distribution Schematic (Sheet 2 of 2)

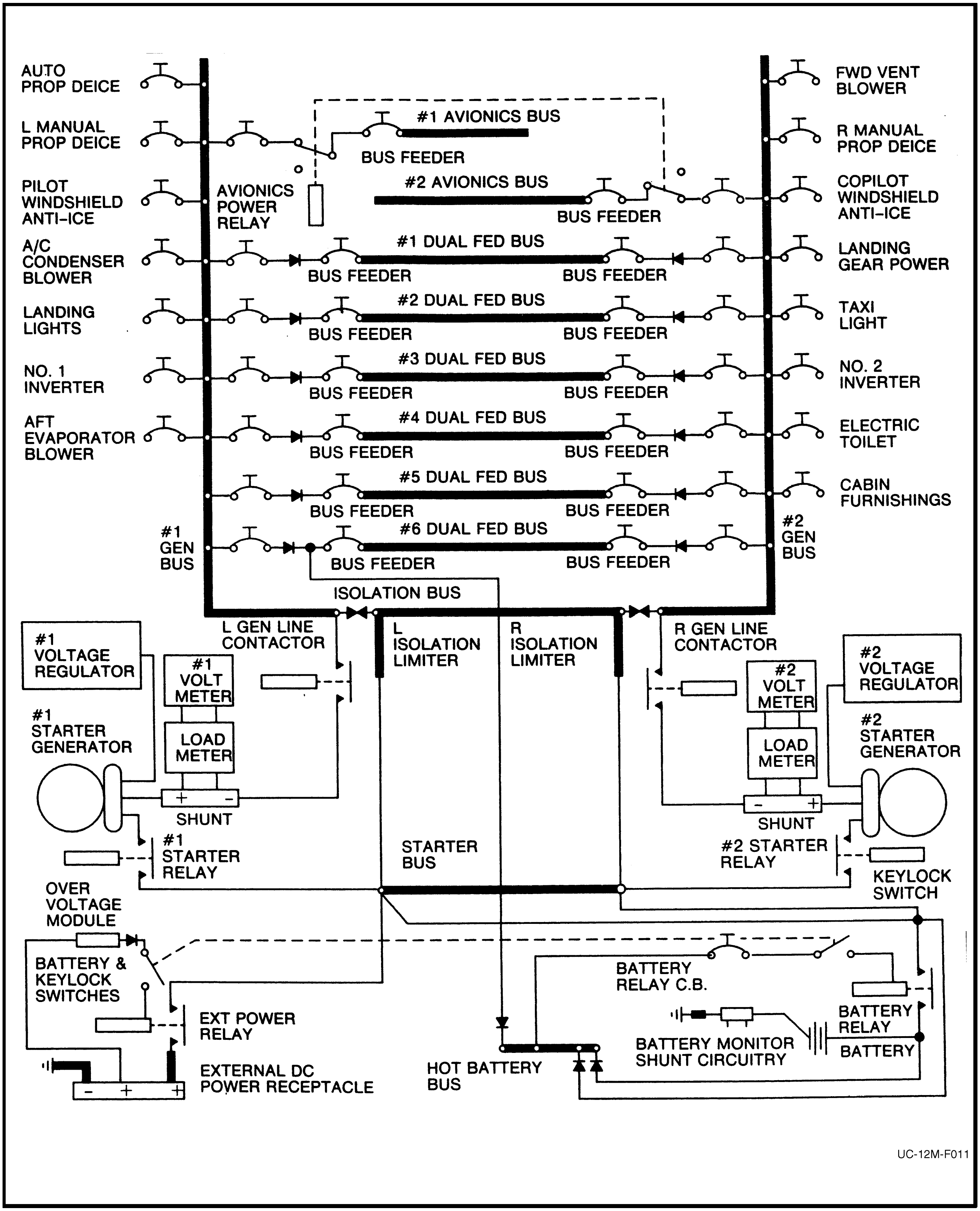


Figure 2-14. (**M**) Dc Electrical System Distribution (Sheet 1 of 2)

IDENTIFIES THE CIRCUIT BREAKERS ON EACH BUS:

#1 AVIONICS BUS

#1 VHF	PAGING	GPS	FMS
#1 NAV	TRANSPONDER	HF RCVR	AP PWR
#1 ADF	UHF	ALT ALERT	#1 AFCS
PILOT AUDIO		AIR DATA ENCDR	#2 RMI
		PILOT ALTM	

#2 AVIONICS BUS

#2 VHF	COPILOT AUDIO	RADIO ALTM	#1 RMI
#2 NAV	INTPH	COPILOT ALTM	GPWS
#2 ADF	RADAR	#2 AFCS	MFD

#1 DUAL FED BUS

#1 VOLT/LOAD IND	BATT TEMP	STALL WARN	#1 CHIP DETR
LEFT BLEED AIR WARNING	LANDING GEAR IND	ACFT ANN IND	#1 FUEL QTY IND
#1 FUEL STANDBY PUMP	#1 FUEL QTY WARN	#1 ENG OIL TEMP	#1 ENG OIL PRESS

#2 DUAL FED BUS

#2 VOLT/LOAD IND	ACFT ANN PWR	BATT CHARGE	#2 FUEL QTY IND
FIRE DETECTOR	#2 FUEL STANDBY PUMP	#2 CHIP DETR	#2 FUEL QTY WARN
RIGHT BLEED AIR WARNING	#2 ENG OIL TEMP	LANDING GEAR WARN	#2 ENG OIL PRESS

#3 DUAL FED BUS

WSHLD WIPER	#1 FUEL FIREWALL VALVE	SURF DE-ICE	#1 FUEL PRESS WARN
AUTO PROP ANTI-ICE	FUEL CROSSFEED	LEFT FUEL VENT HEAT	PROP SYNC
LEFT FUEL CONT HEAT	#1 ENGINE ICE VANE CONTR	LEFT PITOT HEAT	#1 ENGINE START CONTR
#1 AUXILIARY TRANSFER	#1 ENGINE IGNITOR CONTR	TACAN	

#4 DUAL FED BUS

BRAKE DE-ICE	#2 FUEL FIREWALL VALVE	STALL WARN HEAT	#2 FUEL PRESS WARN
MANUAL PROP ANTI-ICE	AUTOFEATHER	RIGHT FUEL VENT HEAT	PROP GOV
RIGHT FUEL CONTR HEAT	#2 ICE VANE CONTR	RIGHT PITOT HEAT	#2 ENGINE START CONTR
#2 AUXILIARY TRANSFER	#2 ENGINE IGNITOR CONTR	HF POWER	TCAS

#5 DUAL FED BUS

#1 GEN RESET	FLAP MOTOR	AIR COND CONTR	RADIO PANEL LIGHTS
LEFT BLEED AIR CONTR	RECOG LIGHTS	TEMP CONTR	ICE LIGHTS
LANDING GEAR CONTROL	BCN LIGHTS	PILOT TURN & SLIP	LANDING LIGHTS
ELEC TRIM	SUBPNL & CONSOLE	INST INDIRECT	CABIN FURN

#6 DUAL FED BUS

#2 GEN RESET	EMERG LIGHTS	CIGAR LIGHTER	FLT INST LIGHTS
AUTO OXYGEN	NAV LIGHTS	RIGHT BLEED AIR CONTR	TAXI LIGHTS
DOOR RADIANT HEAT	OVHD & EL PANELS LIGHTS	PRESS CONTR	CABIN LIGHTS
FATIGUE METER	AVIONICS MASTER CONTR	RUDDER BOOST	AVIONICS ANN
FLAP CONTR	COMPASS SWITCH	READING LIGHTS & SIGNS	EMERG TRANSPONDER

HOT BATTERY BUS

#1 ENG FIRE EXT	#2 ENG FIRE EXT	BATTERY RELAY	CABIN DOOR LIGHTS
#1 FUEL FIREWALL VALVE	#2 FUEL FIREWALL VALVE	#1 FUEL STANDBY PUMP	#2 FUEL STANDBY PUMP
PILOT & COPILOT UTILITY LIGHTS	COCKPIT OVERHEAD FLOOD LIGHTS	EXTERNAL POWER SENSING	

Figure 2-14. (**M**) Dc Electrical System Distribution (Sheet 2 of 2)

2.10.2 Generator Caution Lights

Refer to Chapter 12 for illumination of the (**B/F**) L DC GEN or R DC GEN/(**M**) #1 DC GEN or #2 DC GEN annunciators.

2.10.3 Battery Charge Monitor System

The battery charge current monitoring system provides continuous monitoring of the valve regulated lead acid battery charging. The current detector senses an increase in battery charge current and when the charge current is above normal (e.g., following a battery start or when heavy electrical loads switch off), the increased charge current will trigger a signal to illuminate the yellow caution annunciator light placarded BATTERY CHG and flashing MASTER CAUTION light. As the battery approaches a full charge and the charge current decreases to a normal level, the caution annunciator will extinguish. It is not unusual for the BATTERY CHG light to remain on for 10 minutes and even considerably longer due to the charge time associated with valve regulated sealed lead acid batteries. The battery charge monitor system was designed to monitor charging of a nickel cadmium battery. Valve regulated sealed lead acid batteries have a much lower maximum recharge current; therefore, the battery charges at a lower rate and the annunciator remains on longer. If the battery has a low charge state, cell voltage, or battery temperature, the charge time may be significantly longer than usual. For in-flight illumination of the BATTERY CHG light, refer to Chapter 12.

2.10.4 Load-V oltmeters

(**B/F**) Two meters on the overhead panel display voltage readings and show the rate of current usage from left and right generating systems. Each meter is equipped with a spring-loaded pushbutton switch that, when pressed, will cause the meter to indicate generator output voltage. Each meter normally indicates output amperage as a percent of rated capacity from the respective generator, unless the pushbutton switch is pressed to obtain (**B**) generator voltage (**F**) bus voltage. Battery voltage may be read on the voltmeter.

(**M**) Four digital meters, located on the overhead panel, display voltage readings and show the rate of current usage from the left and right generating systems. The two loadmeters indicate output amperage as a percent of rated capacity from the respective generator, and current consumption is indicated as a percentage of total output amperage capacity for the generating system being monitored. The two voltmeters indicate bus voltage for the respective generating system.

2.11 AC ELECTRICAL SYSTEM

Two inverters provide 115 and 26 Vac electrical power for avionics and instruments. The inverters receive operating current from the dc power system and are designated No. 1 and No. 2. Either inverter is capable of supplying all required single-phase ac power. (**M**) In normal operation, the #1 inverter will supply 115 Vac and 26 Vac to the No. 1 avionics and NAV systems and left engine ac instruments; the #2 inverter will supply ac power to the No. 2 avionics and NAV systems and right engine ac instruments.

2.11.1 Ac Volt-Frequency Meter

(**B/F**) A volt-frequency meter is mounted in the overhead control panel (Figures (**B**) 2-24/(**F**) 2-25) to provide monitoring capability for the 115 Vac bus. Normal display on the meter is shown in frequency Hz. To read voltage, press the button located in the lower left corner of the meter. Normal output of the inverter will be indicated by 115 ($\pm$5) Vac and 400 ($\pm$10) Hz on the meter.

(**M**) Two digital volt-frequency meters are mounted in the overhead control panel (Figure 2-26) to provide monitoring capability for the 115 Vac bus. Normal display on the meters is shown in frequency Hz (hertz) and voltage. Normal output of the inverters will be indicated by 115 Vac and 400 FREQ (Hz) on both meters.

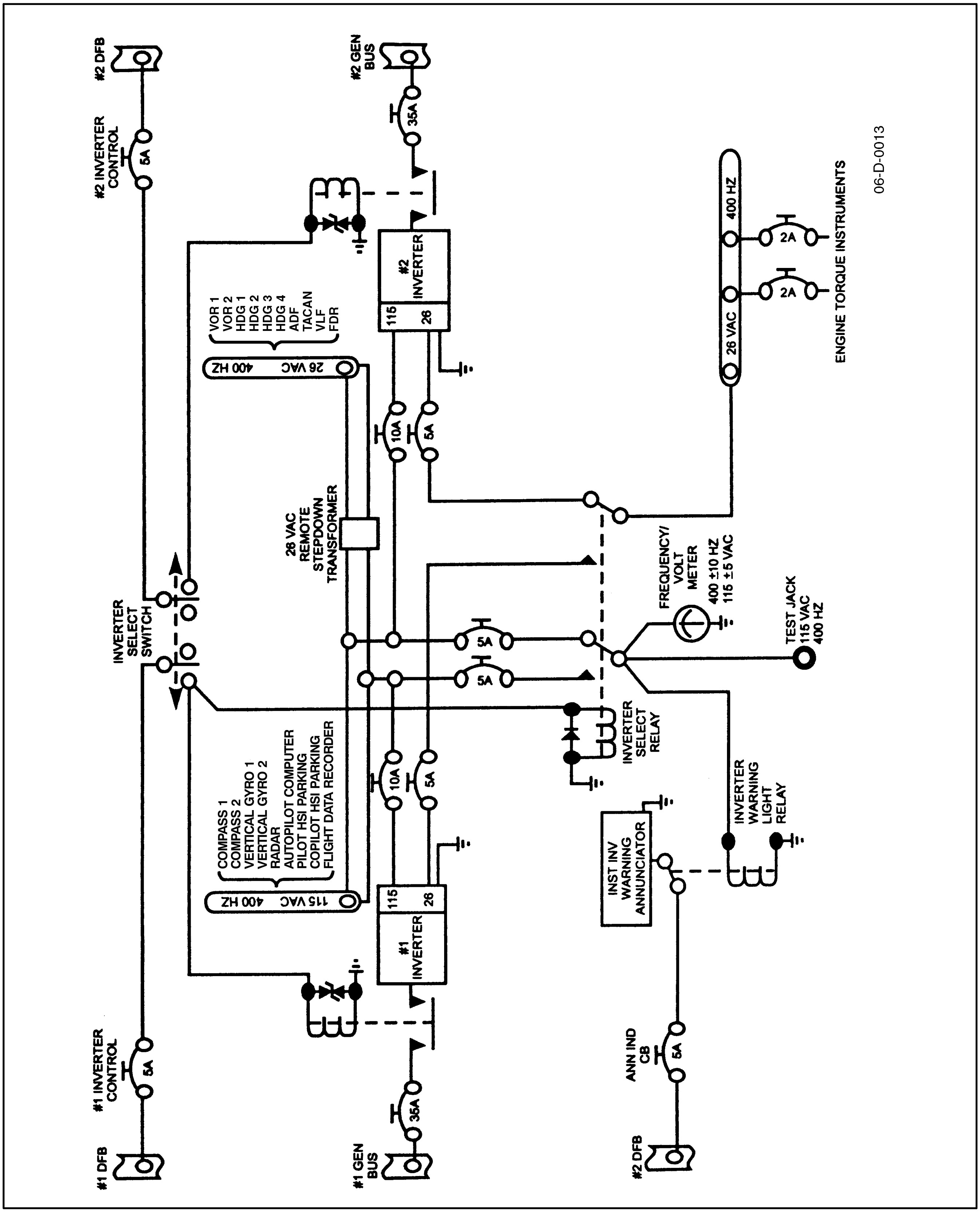


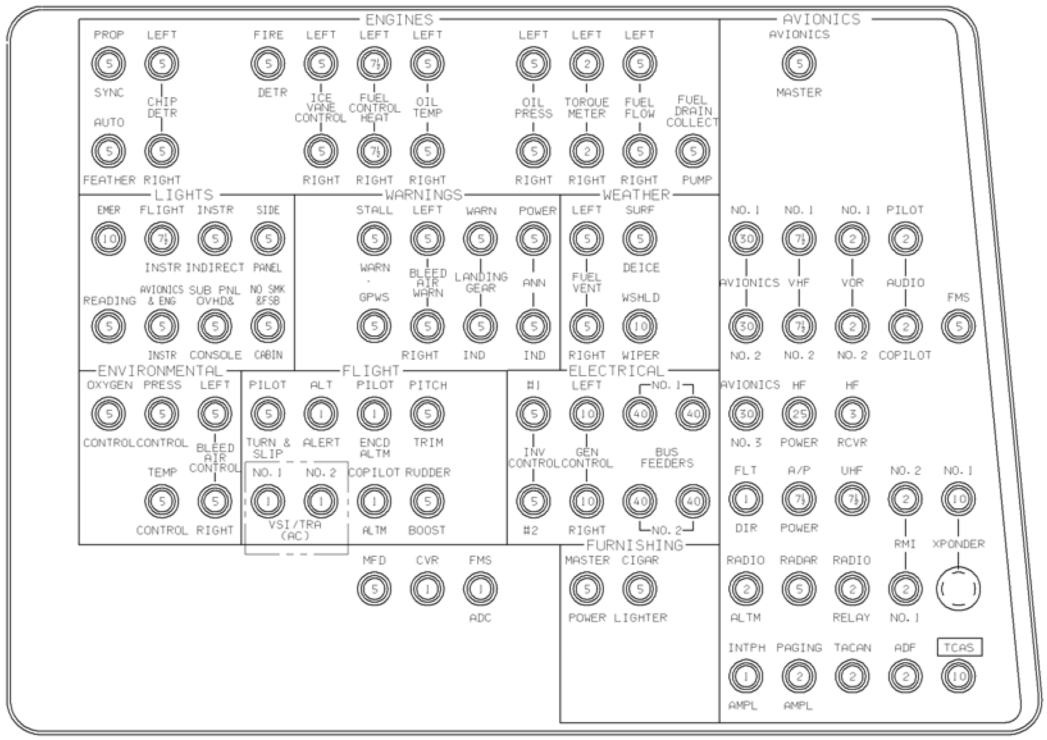
Figure 2-15. (**B**) Ac Electrical System

26 VAC	
NO 1 COMPASS	NO 1 NAV
NO 2 COMPASS	NO 2 NAV
NO 1 RMI	ADF
NO 2 RMI	PILOT ALTIMETER
DATA NAV	GPWS
FDR	AIR DATA COMPUTER
L TORQUEMETER	PILOT HSI
R TORQUEMETER	COPILOT HSI
115 VAC	
WEATHER RADAR	NO 1 COMPASS
PILOT GYRO	NO 2 COMPASS
COPILOT GYRO	IFF
PILOT HSI	GPWS COMPUTER
COPILOT HSI	

Figure 2-16. (**F**) Ac-Powered Instruments

26 VAC	
R TORQUEMETER	NO. 1 COMPASS
L TORQUEMETER	NO. 2 COMPASS
NO. 1 VOR	ADF
NO. 2 VOR	TACAN
AUTOPILOT COMPUTER	
L FUEL FLOW	R FUEL FLOW
PILOT ALTIMETER	
115 VAC	
NO. 1 COMPASS	AUTOPILOT COMPUTER
NO. 2 COMPASS	AUTOPILOT ALTITUDE CONTROLLER
PILOT GYRO	PILOT HSI
COPILOT GYRO	NO. 1 VSI/TRA
COPILOT HSI	NO. 2 VSI/TRA

Figure 2-17. (**M**) Ac Electrical System Distribution



RIGHT SIDEWALL CIRCUIT BREAKER PANEL

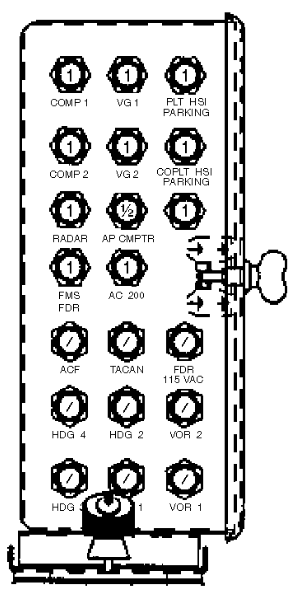


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Figure 2-18. (**B**) Circuit Breaker Panels

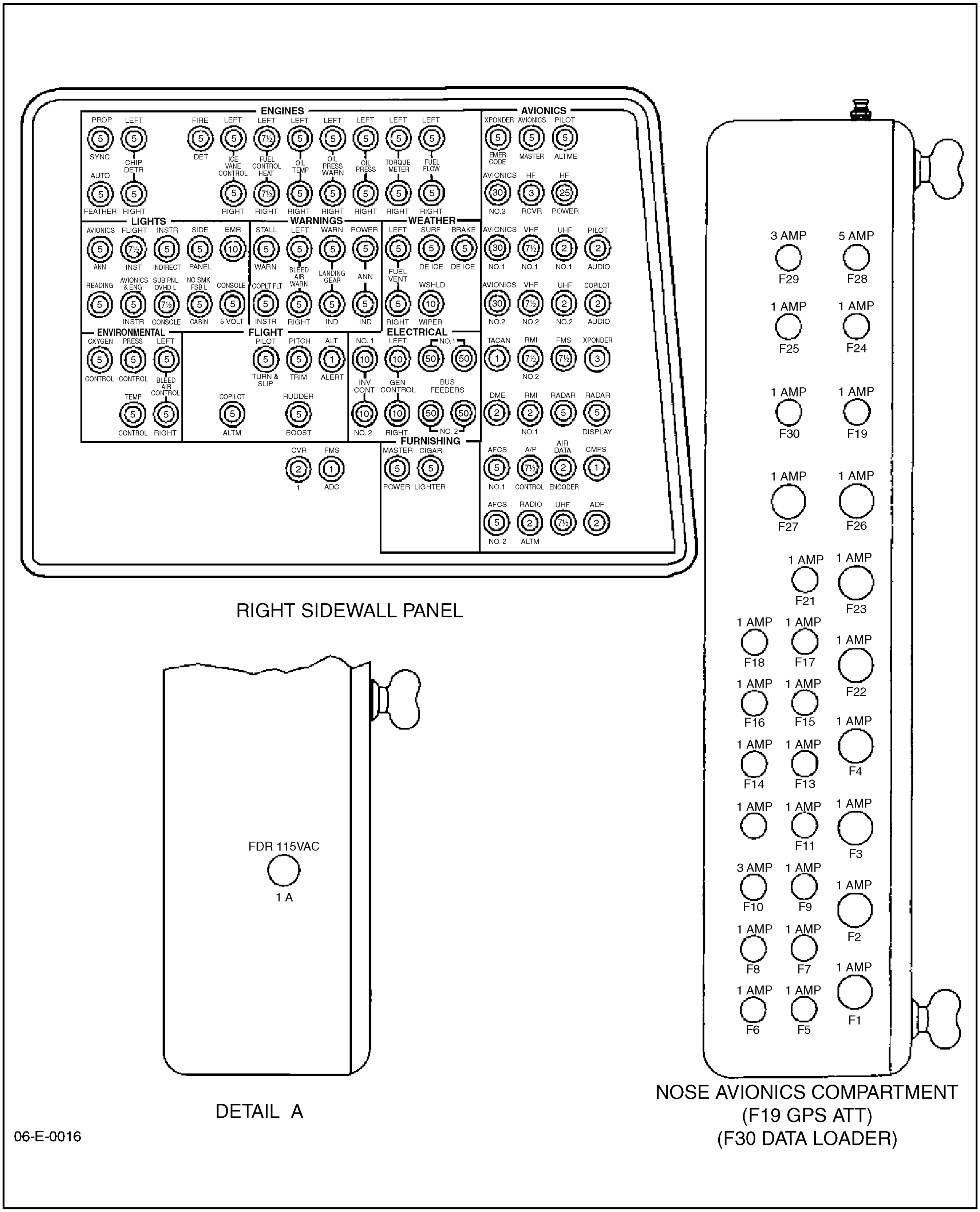


Figure 2-19. (**F**) Circuit Breaker Panels

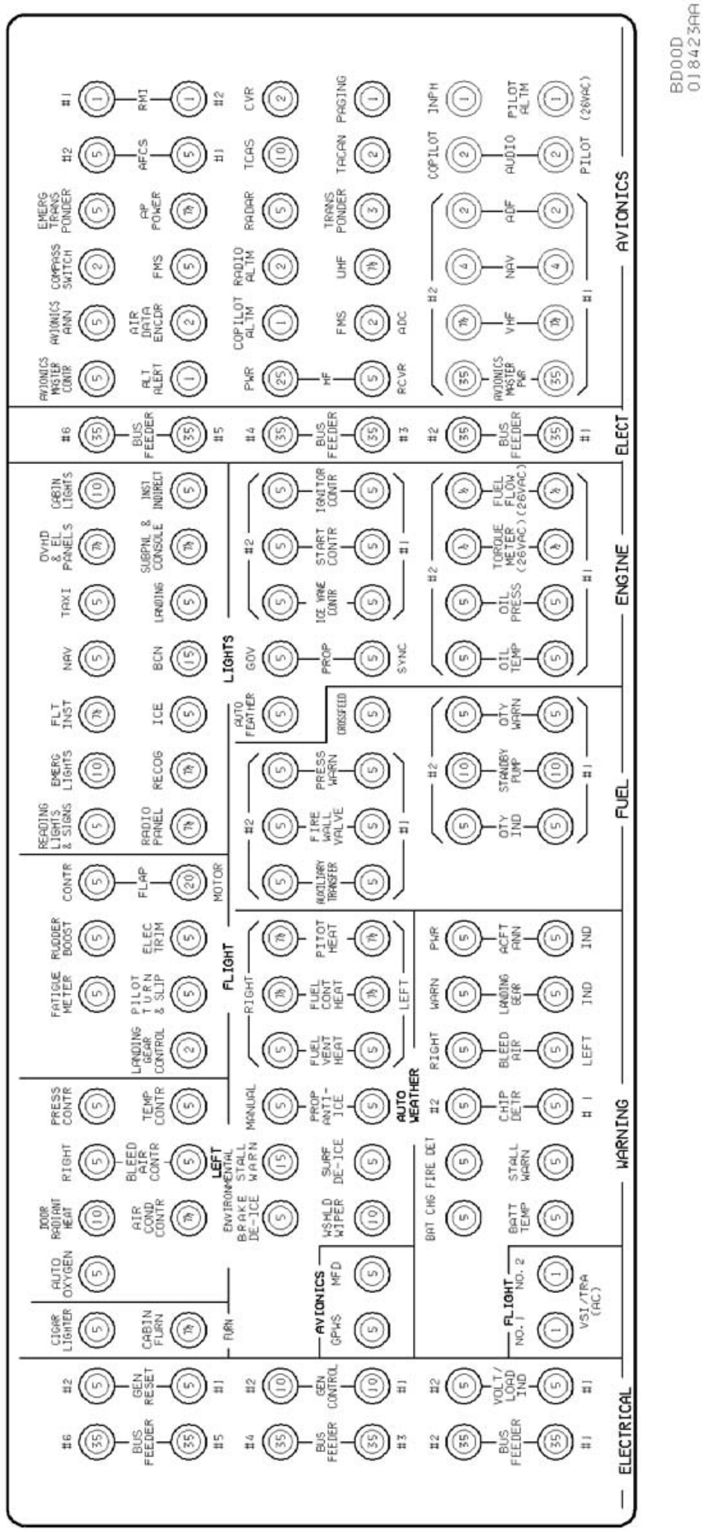


Figure 2-20. (**M**) Circuit Breaker Panels

2.11.2 Inverter Control Switch

(**B/F**) A three-position INVERTER toggle switch is located on the extended pedestal with placarded positions NO. 1 — OFF — NO. 2. Placing the toggle switch to a placarded position activates that inverter: NO. 1 on the left, NO. 2 on the right.

(**M**) Control of the inverters is provided by two switches placarded INVERTER #1-#2-ON and located in the MASTER SWITCH section on the overhead control panel. Placing the toggle switch to ON position activates the selected inverter.

2.11.3 Ac Power Warning Annunciator

Refer to Chapter 12 for illumination of the (**B**) INST INV/(**F**) INVERTER/(**M**) INST AC warning annunciator.

Note

- (**B/F**) Failure of 26 Vac will not illuminate the inverter annunciator.
- (**M**) Failure of the fuse supplying 26 Vac power to the compass, navigation, and engine instruments will not illuminate the INST AC annunciator. Failure of this fuse will prevent 26 Vac power from being supplied to the respective side's instruments by either inverter.

2.11.4 Inverter Circuit Protection

The inverter circuits are protected by the No. 1 and No. 2 inverter power circuit breakers on the dc power distribution panel, located beneath the floor of the flight compartment, (**B/F**) and by circuit breakers in the ELECTRICAL section placarded # 1- # 2 — INV CONTROL, on the right side circuit breaker panel. The inverter select relay circuit breakers are located on a panel assembly mounted behind and above the copilot rudder pedals. Circuit breakers for both the 115 Vac and 26 Vac systems are located in each wing center section, as are the No. 1 (left) and No. 2 (right) inverter power relays.

2.12 LIGHTING SYSTEMS

2.12.1 Interior Lighting

The interior lighting is divided into three sections: flight compartment, cabin, and emergency lighting. The flight compartment lighting is (**M**) Aviation Night Vision (ANVIS) compatible, comprised of an overhead flood light, (**B/M**) one utility light for each of the two crew stations, engine and flight instrument post and indirect lighting, edge lighting of the control pedestal, extended pedestal, overhead panels, subpanels, (**B/F**) side panels, and an emergency light. The cabin lighting is comprised of two continuous rows of (**B/F**) fluorescent/(**M**) ANVIS cold cathode lights on either side of the aisle in the cabin headliner, adjustable eyeball reading lights at the seat positions including the belted lavatory, a NO SMOKING/FASTEN SEAT BELTS cabin sign on both sides of the cabin, an overhead threshold/cargo loading and baggage compartment light, a spar cover light, and lights on the steps of the airstair door. The spar cover, threshold/cargo loading, and airstair doorstep lights are powered by the hot battery bus and may be illuminated from the ramp (airstair door open) by placing a switch located inside on the lower portion of the cargo door to the ON position. All lights controlled by this switch will extinguish when the airstair door is closed. If lighting of the entranceway and/or baggage area is desired with the airstair door closed (loading cargo, etc.), a push ON, push OFF switch for each light is provided on the light assembly. The interior emergency lights are comprised of a light in the flight compartment, a light on the left side of the cabin positioned to illuminate the emergency hatch on the right side of the cabin, and a light collocated with the threshold/cargo loading light, which is directed to illuminate the airstair door assembly. The emergency lights are independent of the aircraft electrical system (battery pack powered) and are automatically actuated by a preset longitudinal shock impulse.

2.12.1.1 (B/M) Flight Compartment Utility Lights

A flight compartment utility light is installed on the left and right side of the flight compartment below the pilot and copilot side windows (Figure 1-3). The light is removable from the utility light mount. The light is attached to a curled extension cord, allowing the light to be used at any location within the flight compartment.

The flight compartment utility light is individually controlled by an OFF/DIM/BRIGHT rheostat, located on the aft end of the light, by rotating the aft section of the light. The utility light lens is adjustable to provide a beam of either spot lighting or flood lighting. A red filter is provided for night vision. Momentary operation is provided by pushing and holding the white momentary switch located in the center of the rheostat. Turning the utility light lens clockwise provides spot lighting. Turning the utility light lens counterclockwise provides flood lighting. Moving the filter switch on the top of the utility light left to red dot will move the red filter across the light beam for night vision. Moving the filter switch right to white dot will remove the red filter for day vision. 28 Vdc to the utility lights is protected by a 5-ampere ENTRY LIGHTS circuit breaker located in the battery power bus box.

Note

The lights are “hot-wired” to the battery. If left on after shutdown, the battery will run down.

2.12.2 Exterior Lighting

The exterior lighting (Figures (**B**) 2-21/(**F**) 2-22/(**M**) 2-23) consists of three conventional navigation (position) lights, two landing lights, one taxi light, two wingtip recognition lights, two nacelle-mounted wing ice check lights, two emergency egress lights, and (**B/F**) two oscillating beacons (**M**) two red/white strobe beacons. The standard navigation lights are located on the tail section and each wingtip. A white recognition light is also installed in each wingtip light assembly. The (**B/F**) oscillating beacons (**M**) strobe beacons are installed on the bottom fuselage and on the upper surface of the horizontal stabilizer. (**B/F**) Strobe lights are installed on each wingtip and tail. Both dual landing lights and single taxi light are located on the nose gear strut assembly. An ice check light located on each outboard nacelle is positioned to illuminate the leading edge of the wings. The two battery pack powered exterior emergency egress lights are provided at the overwing emergency exit hatch and at the airstair door. (**B/F**) A flush-mounted floodlight forward of the flaps in the bottom of the left wing illuminates the surface area around the airstair door. (**B/F**) All exterior lights, except the flush-mounted ramp flood light on the left wing and the emergency egress lights, are controlled from the pilot subpanel by toggle switches placarded with the name of the light(s) they control. (**M**) The exterior lights are controlled from the overhead control panel by toggle switches placarded with the name of the light(s) controlled by the particular switch.

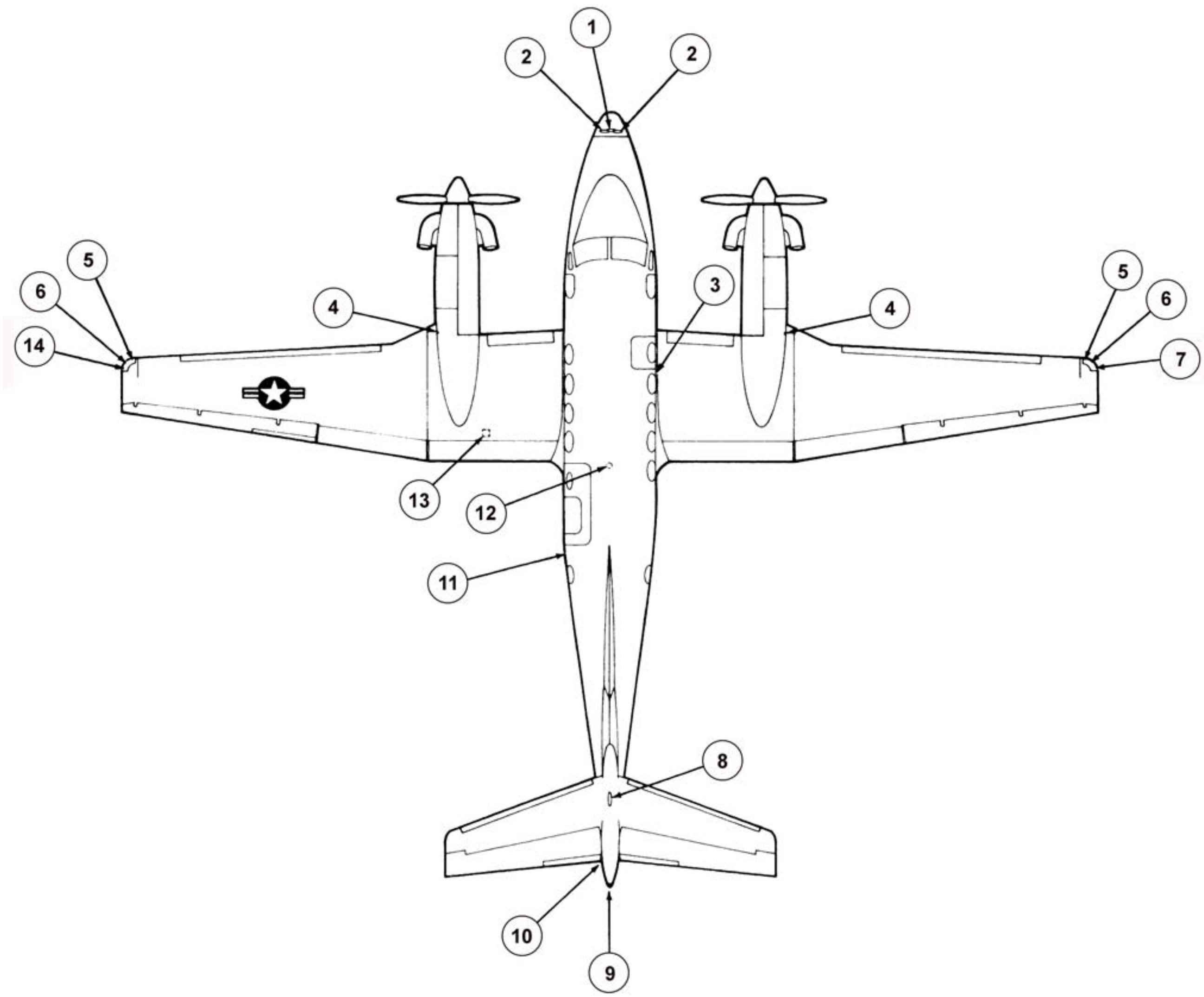
2.12.3 Exterior Lights and Switches

2.12.3.1 Navigation Lights Switch

(**B/F**) A two-position circuit breaker toggle switch located in the pilot subpanel LIGHTS section, placarded NAV, controls the three navigation (position) lights. (**M**) A two-position toggle switch placarded NAV, located in the EXTERIOR LIGHTS section of the overhead control panel, controls the three navigation (position) lights.

2.12.3.2 (B/F) Strobe Lights Switch

In addition to the aircraft navigation light system, three high-intensity, white (strobe) lights are installed. The wing strobes are an integral part of the wingtip light assembly. The tail strobe light is installed in the (**B**) lower (**F**) upper tail cone.



1. TAXI LIGHTS
2. LANDING LIGHTS
3. OVERWING EMERGENCY EGRESS LIGHT
4. WING ICE CHECK LIGHTS
5. RECOGNITION LIGHTS
6. WING STROBE LIGHTS
7. GREEN POSITION LIGHT
8. OSCILLATING (TAIL) BEACON
9. WHITE POSITION LIGHT
10. TAIL STROBE LIGHT
11. RAMP EMERGENCY EGRESS LIGHT
12. ROTATING (LOWER) BEACON
13. RAMP FLOOD LIGHT
14. RED POSITION LIGHT

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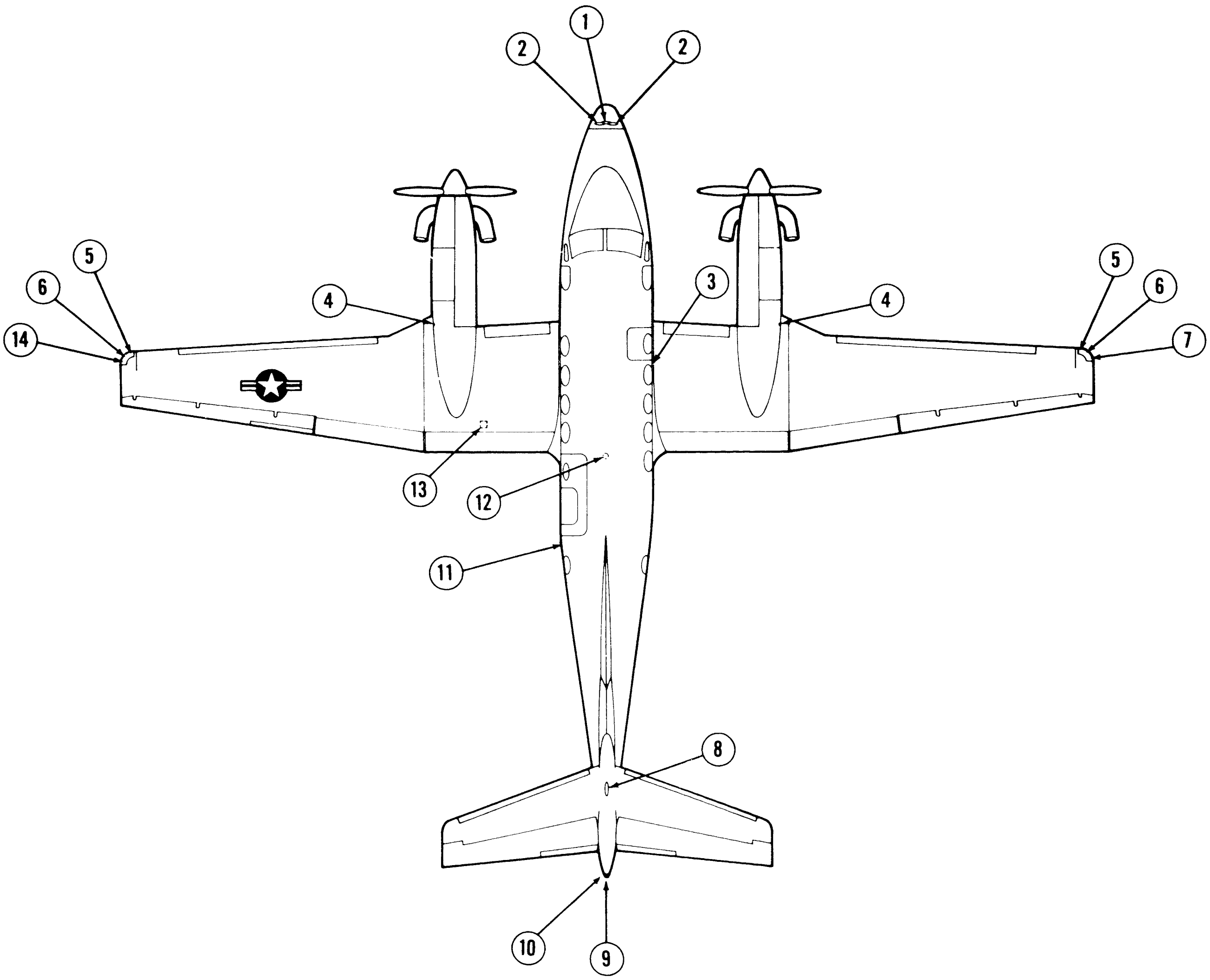
Figure 2-21. (**B**) Exterior Lighting



1. TAXI LIGHTS
2. LANDING LIGHTS
3. OVERWING EMERGENCY EGRESS LIGHT
4. WING ICE CHECK LIGHTS
5. RECOGNITION LIGHTS
6. WING STROBE LIGHTS
7. GREEN POSITION LIGHT
8. OSCILLATING (TAIL) BEACON
9. WHITE POSITION LIGHT
10. TAIL STROBE LIGHT
11. RAMP EMERGENCY EGRESS LIGHT
12. OSCILLATING (LOWER) BEACON
13. RAMP FLOOD LIGHT
14. RED POSITION LIGHT

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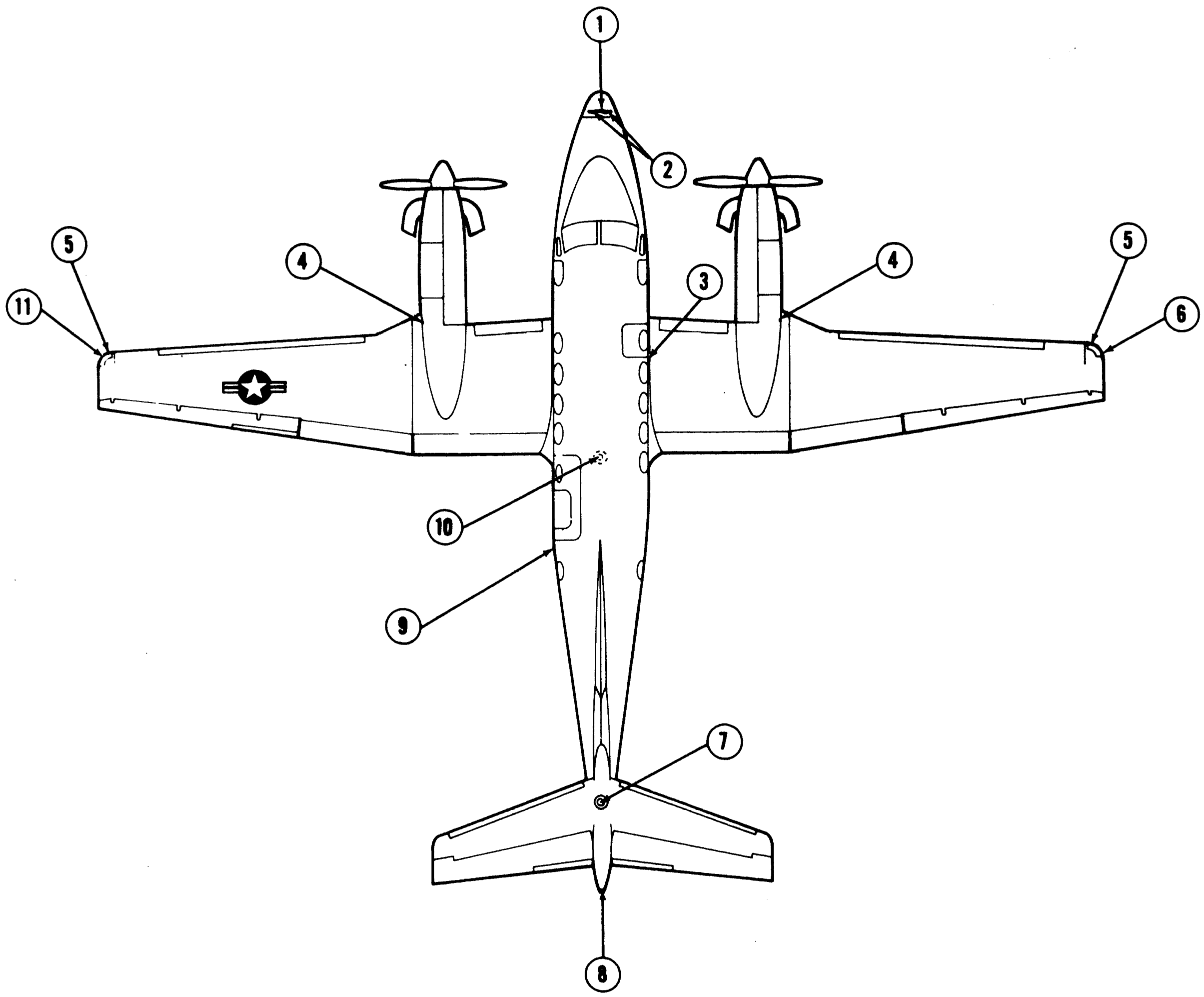
Figure 2-22. (**F**) Exterior Lighting



1. Taxi Light
2. Landing Lights
3. Overwing Emergency Egress Light
4. Wing Ice Check Lights
5. Recognition Lights
6. Green Position Light
7. (Tail) Beacon/Strobe
8. White Position Light
9. Ramp Emergency Egress Light
10. (Lower) Beacon/Strobe
11. Red Position Light

UC-12M-F014

Figure 2-23. (**M**) Exterior Lighting

2.12.3.3 Recognition Lights Switch

A two-position circuit breaker switch in the pilot subpanel LIGHTS section, placarded RECOG, controls the two white recognition lights that are an integral part of the wing tip light assemblies. These lights are used for ready identification of the aircraft if requested, usually while in the traffic pattern. These lights illuminate steady and are bright white.

CAUTION

Prolonged use of the recognition lights during ground operations will generate enough heat to damage the light cover.

2.12.3.4 (B/F) Rotating and Oscillating Beacons Switch

A two- position circuit breaker switch on the inboard pilot subpanel is placarded BEACON and controls both the upper and lower anticollision beacons.

2.12.3.5 (M) Strobe Beacons Switch

A three-position switch, placarded BEACON, DAY-NIGHT located in the LIGHTS section on the overhead control panel, controls the upper and lower strobe beacons. Both beacon lights are powered by the No. 5 dual fed bus. The circuitry is protected by the circuit breaker placarded BCN located in the LIGHTS section of the overhead circuit breaker panel.

2.12.3.6 Ice Lights Switch

(**B/F**) A two-position circuit breaker switch placarded ICE on the pilot subpanel (**M**) a two-position switch, placarded ICE-ON on the overhead control panel, controls the ice lights on the outboard side of each nacelle. The ice lights are positioned to illuminate the wing leading edges.

2.12.3.7 Landing and Taxi Light

(**B/F**) The LANDING and TAXI light switches are located on the pilot subpanel and control illumination of the LEFT and RIGHT LANDING and single TAXI lights. These lights are located on the nose landing gear assembly. The LANDING and TAXI light circuits are protected by the circuit breaker function of the control switches.

(**M**) Two switches located on the pilot subpanel control illumination of the two LANDING and single TAXI lights. The lights are all located on the nose landing gear assembly and receive dc power through the respective (landing, taxi) light power circuit breakers located on the dc power distribution bus. The taxi light power is controlled by landing gear position and TAXI light switch position, through a downlock switch and relay. The landing gear must be extended before the taxi or landing lights can be illuminated.

(**M**) Dc power to the control switches and relays for the landing and taxi lights is through the circuit breakers placarded LANDING and TAXI located in the LIGHTS section of the overhead control panel.

2.12.4 (B/F) Exterior Entry Light

A flush-mounted ramp floodlight located on the underside of the wing and forward of the flaps is provided to illuminate the immediate ramp area surrounding the airstair door. The light is controlled by the same switch that controls the step lights and threshold/cargo loading light. The switch is located on the lower portion of the cargo door just forward of the airstair door.

2.12.5 Flight Compartment Lights and Switches

The flight compartment lighting is controlled from the lighting control panel (Figures (**B**) 2-24/(**F**) 2-25/(**M**) 2-26) located in the flight compartment overhead structure. All switches on this panel with the exception of the MASTER PANEL LIGHTS and (**M**) EMER LIGHTS/OFF RESET switch are rheostat type and control lighting from OFF to BRT (bright). The lighting consists of flood, indirect edge-lighting, and post lights. The lighting rheostats control fuel panel lights, engine instrument lights, avionics panel lights, subpanel and console lights, pilot and copilot instrument lights, gyro instrument lights, instrument indirect lights and overhead flood lights.

2.12.5.1 MASTER PANEL LIGHTS Switch

A two-position switch on the lighting control panel placarded (**B/F**) MASTER PANEL LIGHTS — ON — OFF/(**M**) MASTER PANEL LIGHTS — ON controls dc power to the rheostats on the panel. This switch derives its power from the various lighting circuits associated with the control panel, and those circuits are individually protected by circuit breakers. To operate any of the flight compartment lights (**B/F**) except the overhead flood and instrument indirect, the MASTER PANEL LIGHTS switch must be ON and electrical power applied to the aircraft.

2.12.5.2 OVERHEAD FLOOD Rheostat

The OVERHEAD FLOOD rheostat controls floodlighting of the flight compartment. The rheostat controls the light that is located just aft of the overhead control panel and sweeps from OFF to BRT.

2.12.5.3 INSTRUMENT INDIRECT Rheostat

The INSTRUMENT INDIRECT rheostat controls indirect instrument lighting. The indirect instrument lights are located along the underside of the glareshield.

2.12.5.4 (B) APPROACH PLATE Light Rheostat

Indirect approach plate lighting is controlled by the rheostat placarded APPROACH PLATE located to the left of the warning lights annunciator panel on the instrument glareshield. The blue-white lights are located along the underside of the glareshield and receive electrical power from the MASTER PANEL LIGHTS switch located on the overhead control panel.

2.12.5.5 Flight and Gyro Instrument Rheostats

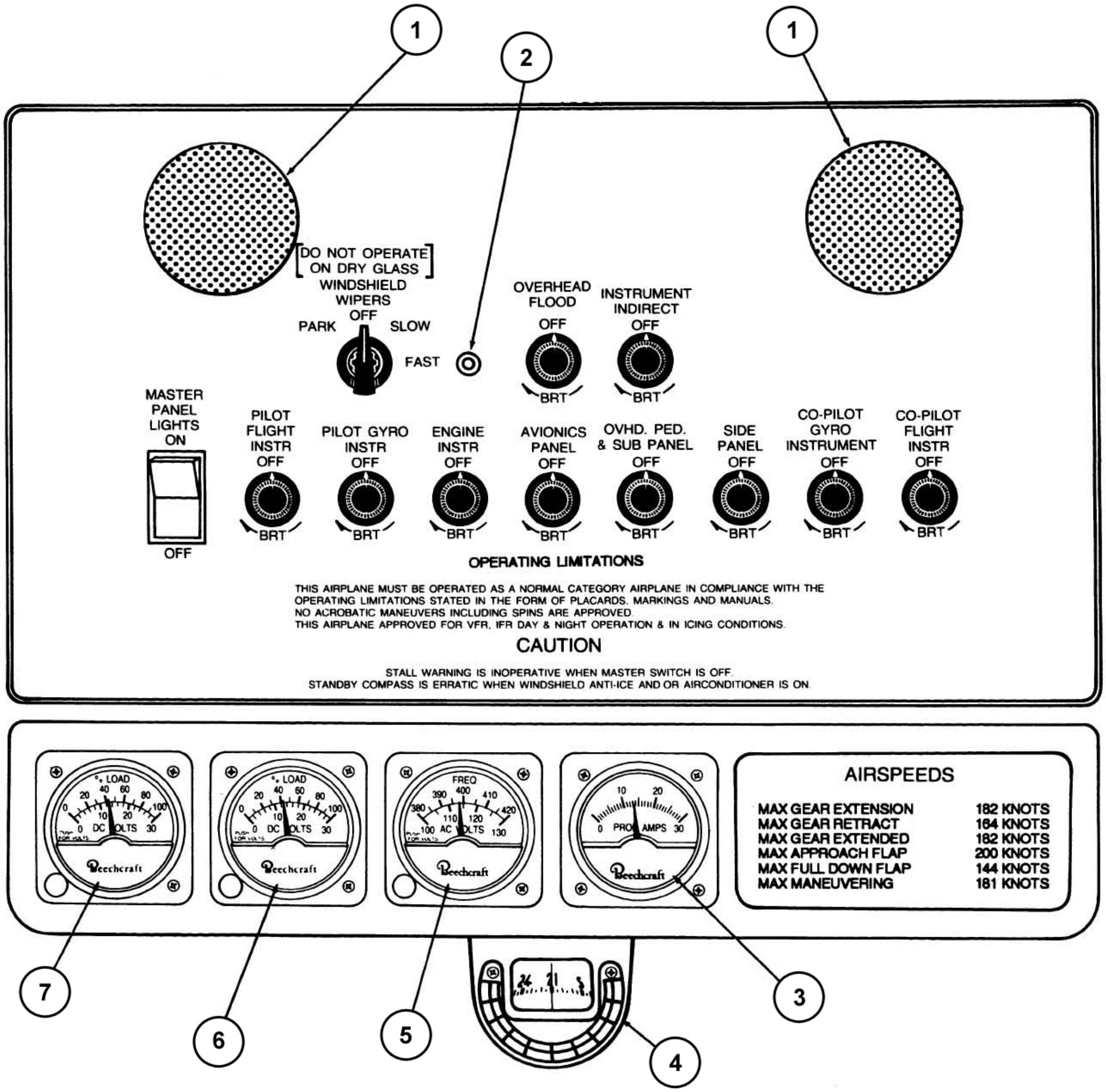
Lighting of the pilot and copilot flight and gyro instruments is controlled by (**B/F**) four rheostats (**M**) two rheostats on the overhead lighting panel placarded (**B/F**) PILOT FLIGHT INSTR, PILOT GYRO INSTR, COPILOT FLIGHT INSTR and COPILOT GYRO INSTR (**M**) PILOT INSTR LIGHTS and COPILOT INSTR LIGHTS. These rheostats control the ON/OFF and brightness of the flight and gyro instrument lights on both sides of the instrument panel.

2.12.5.6 Engine Instrument Rheostat

Engine instrument lighting and brightness is controlled by the rheostat placarded ENGINE INSTR located on the overhead control panel.

2.12.5.7 (M) Radio Panel Rheostat

Radio panel lighting is controlled by the rheostat placarded RADIO PANEL LIGHTS, located on the overhead control panel.



NOTE

AIRCRAFT PRIOR TO BUNO 161318 INDICATE MAXIMUM FULL FLAP AIRSPEED AS 144 KNOTS. CORRECT AIRSPEED LIMITATION IS 155 KIAS.

1. LANDING GEAR AND STALL WARNING HORNS
2. AUTOMATIC LIGHT DIMMING SENSOR
3. PROPELLER AMMETER
4. STANDBY MAGNETIC COMPASS
5. AC VOLT/FREQUENCY METER
6. RIGHT DC VOLT/LOAD METER
7. LEFT DC VOLT/LOAD METER

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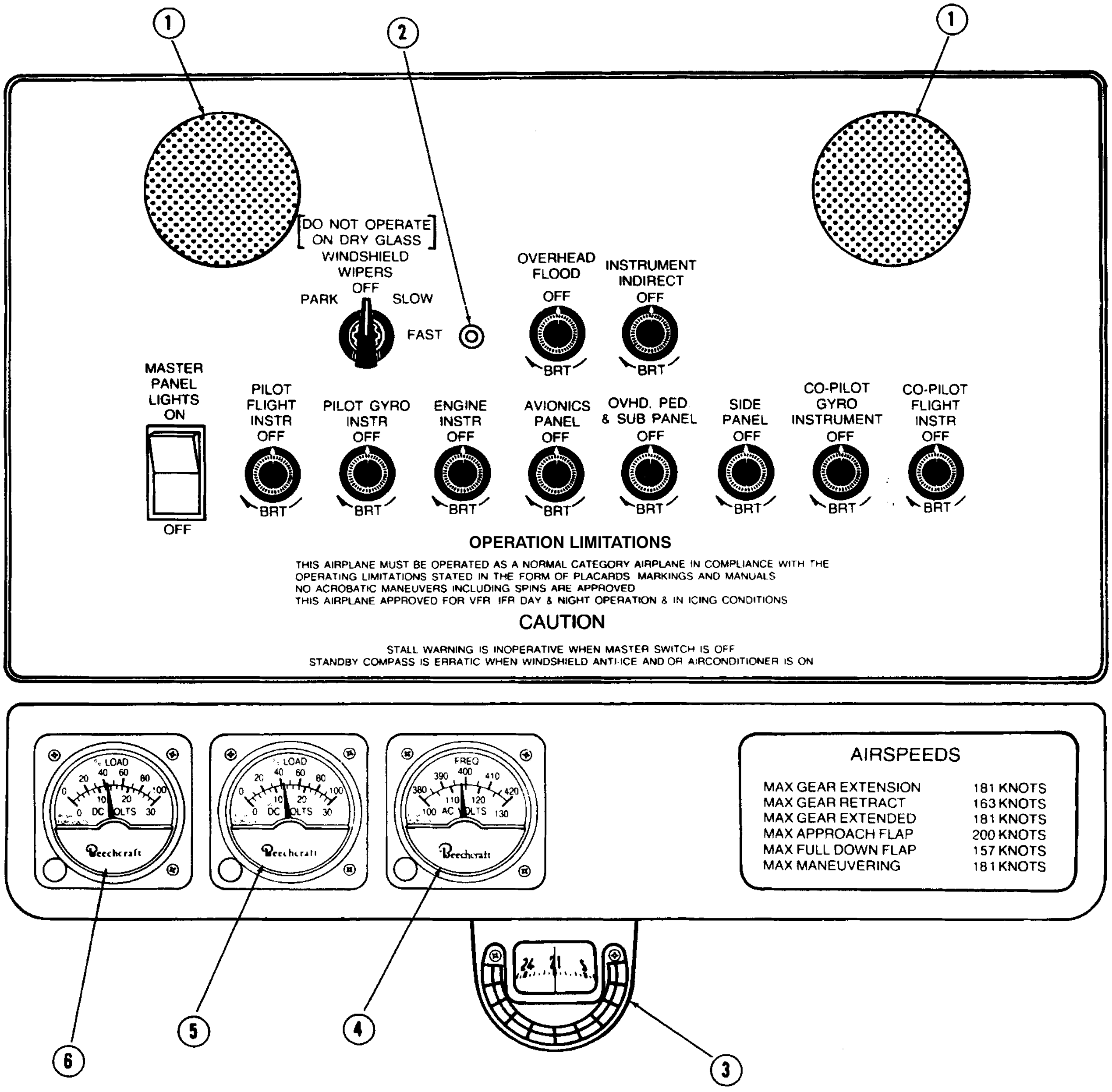
Figure 2-24. (**B**) Overhead Control Panel



1. **LANDING GEAR AND STALL WARNING HORNS**
2. **AUTOMATIC LIGHT DIMMING SENSOR**
3. **STANDBY MAGNETIC COMPASS**
4. **AC VOLT/FREQUENCY METER**
5. **RIGHT DC VOLT/LOAD METER**
6. **LEFT DC VOLT/LOAD METER**

06-E-0017(2)

Figure 2-25. (**F**) Overhead Control Panel

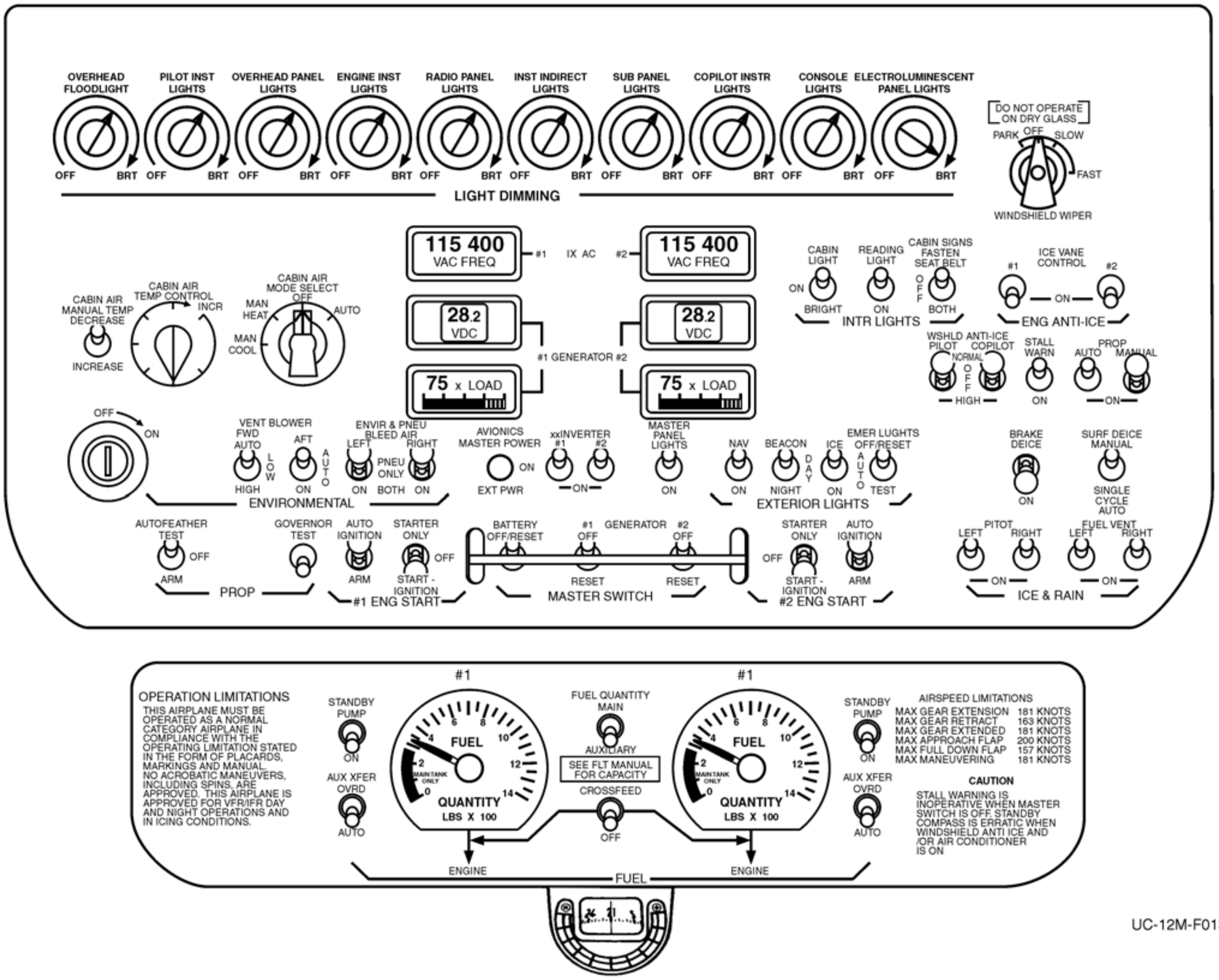


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Figure 2-26. (**M**) Overhead Control Panel

2.12.5.8 (B/F) Avionics Panel Rheostat

The avionics panel lighting is controlled by the rheostat placarded AVIONICS PANEL located on the overhead control panel.

2.12.5.9 (B/F) Overhead, Pedestal, and Subpanel Rheostat

The rheostat placarded OVHD, PED & SUB PANEL controls the edge lighting and/or back lighting of the control pedestal and instruments on the pedestal, extended pedestal, four subpanels, overhead light control panel, and magnetic compass.

2.12.5.9.1 (M) Overhead Panel Rheostat

The rheostat placarded OVERHEAD PANEL LIGHTS controls the lighting for the magnetic compass, #1 and #2 Vac frequency meters, #1 and #2 dc loadmeters, #1 and #2 dc voltmeters, and fuel quantity gauges.

2.12.5.10 (B/F) Side Panel Rheostat

Edge lighting of the upper and lower fuel management panel, fuel quantity gauges, and the circuit breaker panel is controlled by the rheostat placarded SIDE PANEL located on the overhead control panel.

2.12.5.10.1 (M) Electroluminescent Panel Lights Rheostat

Edge lighting of the fuel control panel, overhead lighting panel, circuit breaker panel, oxygen control handles, radio panel, FMS CDU, both pilot and copilot subpanels, and the power control pedestal is controlled by a rheostat placarded ELECTROLUMINESCENT LIGHTS and located in the LIGHT DIMMING section of the overhead control panel.

2.12.5.10.2 (M) Subpanel Lights Rheostat

Postlighting of the gauges located on the pilot and copilot subpanels is controlled by the rheostat placarded SUB PANEL LIGHTS and located in the LIGHT DIMMING section of the overhead control panel.

2.12.5.10.3 (M) Console Lights Rheostat

Edge lighting of the pressurization controller panel located on extended pedestal is controlled by the rheostat placarded CONSOLE LIGHTS.

2.12.5.11 Outside Air Temperature

A press-to-light switch located adjacent to the outside air temperature indicator controls the indicator post lighting.

2.12.6 Cabin Lighting and Switches

(**B/F**) The cabin fluorescent lighting is controlled from the inboard copilot subpanel by a three-position toggle switch in the CABIN LIGHTS section placarded START BRIGHT DIM — OFF. To illuminate the fluorescent lights, the control switch must first be placed in the START BRIGHT position. The lights may be dimmed after initial illumination by placing the control switch in the DIM position.

(**M**) The cabin lighting is controlled by three toggle switches located in the INTR LIGHTS section of the overhead control panel. These lights include the cabin indirect, individual reading, and the CABIN SIGNS (FASTEN SEAT BELT-NO SMOKING).

2.12.6.1 (M) Cabin Indirect Lights Switch

The cabin ANVIS indirect lighting is controlled by a three-position switch placarded CABIN LIGHT-ON-BRIGHT , located in the INTR LIGHTS section of the overhead control panel.

2.12.6.2 No Smoke and Fasten Seatbelt

(**B/F**) A three- position toggle switch located in the CABIN LIGHTS section on the inboard copilot subpanel is placarded NO SMOKE & FSB — OFF — FSB and controls the cabin signs on both sides of the cabin and the electronic alert chime. Placing the toggle switch in the upper NO SMOKE & FSB position will illuminate both the NO SMOKE and FASTEN SEAT BELT lights accompanied by the alert chime. Placing the switch in the lower FSB position will illuminate only the FASTEN SEAT BELT sign accompanied by the alert chime.

(**M**) A three-position toggle switch, located in the INTR LIGHTS section on the overhead control panel, is placarded CABIN SIGNS — FASTEN SEAT BELT — OFF — BOTH, and controls the cabin signs on both sides of the cabin and the electronic alert chime. Placing the toggle switch in the upper FASTEN SEAT BELT position will illuminate both FASTEN SEAT BELT lights accompanied by the alert chime. Placing the switch in the lower BOTH position will illuminate both the FASTEN SEAT BELT and NO SMOKING signs accompanied by the alert chime.

2.12.6.3 Reading Lights

Each seat position is equipped with an adjustable reading light and an ON/OFF switch for control of that light. The switch is a push ON, push OFF type switch.

(**M**) The cabin reading lights are not ANVIS compatible; therefore, the reading lighting circuitry is flight compartment controllable. The two-position reading light control switch, located in the INTR LIGHTS section of the flight compartment overhead control panel, is placarded READING LIGHT ON.

2.12.6.4 Entry and Loading Lights

The entry/cargo loading (threshold) light is located in the center of the headliner at the airstair/cargo door opening. When the airstair door is open, this light, the spar cover, and exterior entry lights are illuminated with a switch located just inside and forward of the airstair door and on the lower position of the cargo door. This placement of the switch allows the entry lights to be actuated from the ramp. When the airstair door is closed, these lights are automatically extinguished. For cargo loading (airstair door closed, cargo door open), or if lighting of the entrance area is desired with the airstair door closed, use the push ON, push OFF switches located adjacent to the threshold light.

2.12.6.5 Baggage Area Lights

The baggage area light assembly is normally controlled by a push ON, push OFF switch. The baggage area light receives power through and is protected by (**B/F**) the entry lights circuit breaker in the right wing center section/(**M**) the CABIN LIGHTS circuit breaker.

2.12.6.6 Airstair Door Lock Mechanism Light

The airstair door lock mechanism light is located inside the airstair door structure. When the door is closed, a placard, LIFT STEP TO INSPECT DOOR LOCK, is visible on the center step. Behind the step is a 2 inch observation window for viewing the locking mechanism. Two lamps illuminate the locking mechanism, one above the lock and one below. The observation lights are actuated by a momentary push ON button located adjacent to the window.

2.12.6.7 Airstair Door Step Lights

The airstair door step lights consist of four lights, one located on the bottom side of each of the top four steps. The threshold light switch controls the step lights; however, before the lights can be turned on, the airstair door must be open.

2.12.7 Emergency Lighting

The emergency lighting system (independent of the aircraft electrical system) comprises three interior lights (one in the flight compartment and two in the cabin) and two exterior lights (one at each aircraft exit). The interior lights provide illumination to permit the occupants to orient themselves, identify the emergency exit hatch and cabin door, and read the instruction placards. The exterior emergency lighting is provided at the overwing exit hatch and cabin door to illuminate the surface and/or aircraft structure. The emergency lighting system is powered by battery pack systems, one for the three forward lights and one for the aft lights. Both systems are automatically recharged from the aircraft 28 volt electrical system. The emergency lighting system is automatically actuated if the aircraft is subjected to a shock impulse along the longitudinal axis of 2 g for a duration of 0.01 second.

(**B**/**F**) A switch located on the pilot subpanel placarded EMERG LIGHTS ORIDE OFF — RESET — AUTO and TEST is provided to override the system or to test the lights system. (**M**) A three-position switch located in the EXTERIOR LIGHTS section of the overhead control panel is placarded EMER LIGHTS — OFF/RESET — AUTO and TEST and is provided to test the emergency lights system.

2.13 FLIGHT CONTROLS

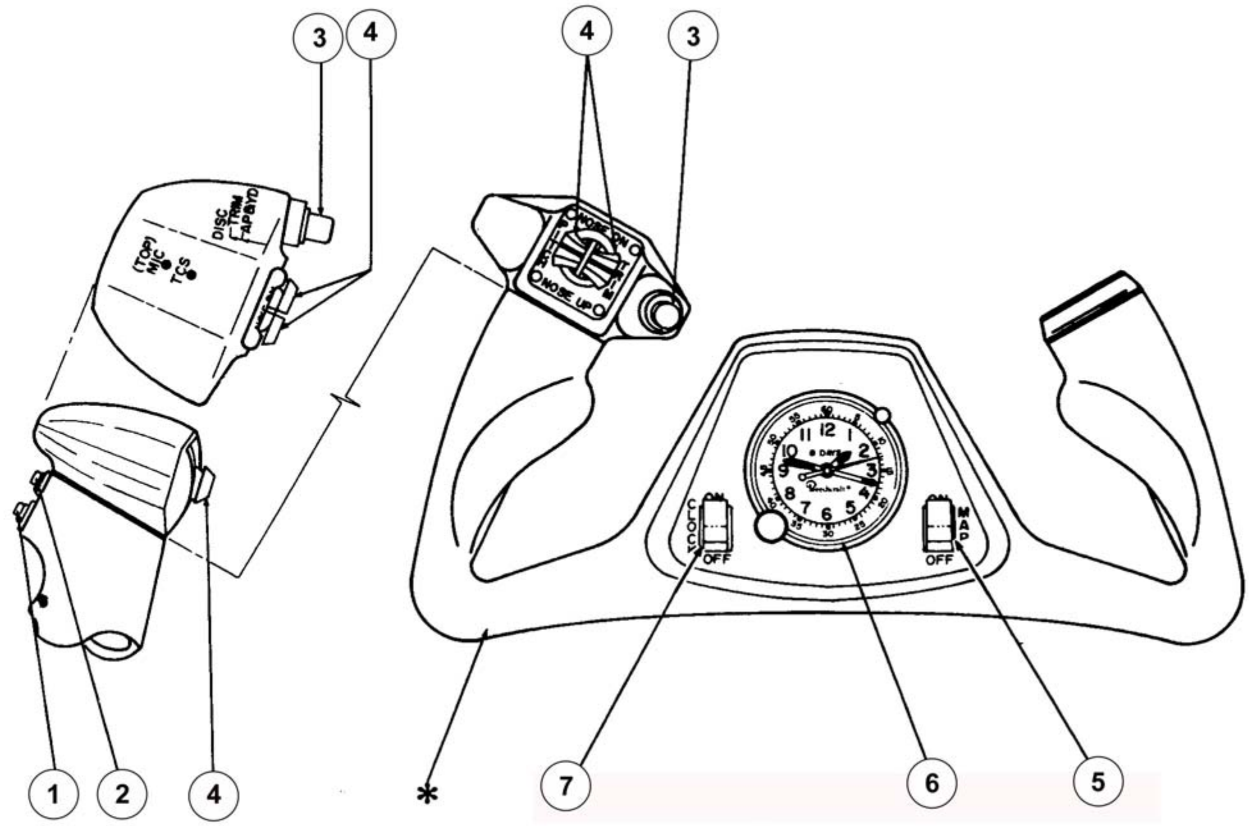
The flight control surfaces (ailerons, rudder, and elevators) are mechanically operated from a conventional set of dual controls. Trim is accomplished through a manually actuated cable-drum system for each set of control surfaces. An electric trim system is incorporated in the elevator trim system and is actuated from either of the control wheels. A rudder boost system is provided to aid the pilot in maintaining directional control in the event of an engine failure or excessive power variations between the engines. A yaw damp system is also provided.

2.13.1 Control Wheels

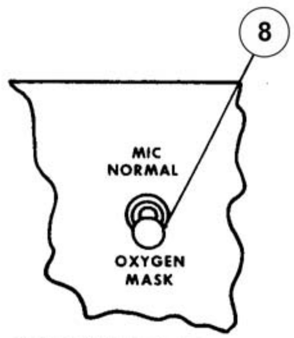
The pilot and copilot control wheels (Figures 2-27, (**B**) 2-28/(**M**) 2-29) are identical except that incorporated switches are in reverse locations.

	B	F	M
Outboard Grip Pilot	TCS Microphone push switch electric elevator trim autopilot-yaw damp/trim disconnect	TCS interphone-microphone electric elevator trim autopilot-yaw damp/trim disconnect	TCS microphone-interphone electric elevator trim autopilot-yaw damp/trim disconnect
Inboard Grip Pilot		map light	ATC ident map light
Outboard Grip Copilot	TCS Microphone push switch electric elevator trim autopilot-yaw damp/trim disconnect	electric elevator trim autopilot-yaw damp/trim disconnect TCS G/A	electric elevator trim autopilot-yaw damp/trim disconnect G/A
Inboard Grip Copilot		map light	TCS map light
Center	clock light map light 8 day clock	quartz chronometer/timer	quartz chronometer/timer

Figure 2-27. Control Wheel Switches



PILOT CONTROL WHEEL



(LOCATION: PILOT, COPILOT SUBPANELS)

1. TOUCH CONTROL STEERING PUSHSWITCH
2. MICROPHONE PUSHSWITCH
3. DISCONNECT PUSHSWITCH:
   (1ST LEVEL) DEPRESSION DISCONNECTS AUTOPILOT AND YAW DAMP SYSTEM.
   (2ND LEVEL) DEPRESSION ALSO DISCONNECTS ELECTRIC TRIM SYSTEM.
4. PITCH TRIM ROCKER SWITCHES
5. MAP LIGHT SWITCH
6. CLOCK
7. CLOCK LIGHT SWITCH
8. MICROPHONE SELECT SWITCH

* **NOTE:** COPILOT CONTROL WHEEL IS IDENTICAL BUT SWITCHES ARE ON RIGHT HAND GRIP.

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Figure 2-28. (**B**) Control Wheels and Microphone Selector Switches

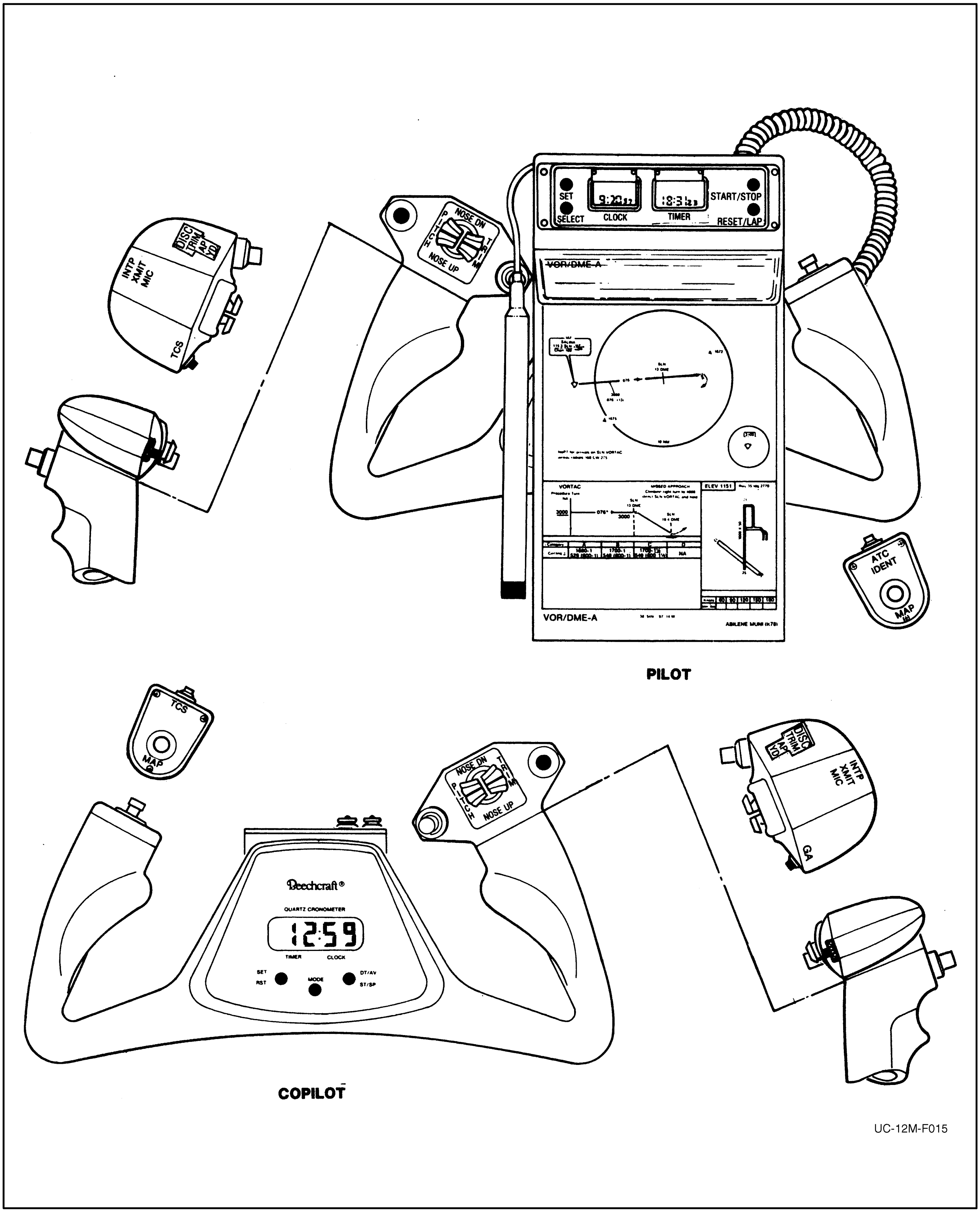


Figure 2-29. (**M**) Control Wheels, Switches, and Chartholder

(**F/M**) The chronometer functions as a clock and as an elapsed time timer. A clock mode switch is used to select the mode desired. Two additional switches are used to start and/or stop the timer function and set and/or reset the clock.

2.13.2 Rudder Pedals

Interconnected rudder pedals are provided for the pilot and copilot that control the rudder action through direct mechanical linkage. The wheelbrakes are actuated by pressure on the top of either set of rudder pedals. Rudder pedals are individually adjustable to either a forward or aft position by depressing a lever on the pedal arm and moving the pedal until the locking pin engages.

2.13.3 Manual Elevator Trim

The elevator (pitch) trim wheel located on the pilot side of the control pedestal affords manual control of and position indication for the elevator trim tab. The tab indicator, which is an integral part of the hand wheel, indicates trim tab position in the units from neutral UP or DN. A white band on the trim wheel extending from 1 unit nosedown to 4 units noseup trim highlights the normal takeoff elevator trim range.

2.13.4 Electric Elevator Trim

The electric elevator trim system is controlled by a toggle switch placarded ELEV TRIM — OFF located on the control pedestal, a dual element thumb switch on the outboard grip of each control wheel, and a trim disconnect switch on each control wheel. The circuitry is protected by a circuit breaker placarded (**B/F**) PITCH TRIM located in the FLIGHT section on the right side circuit breaker panel (**M**) ELEC TRIM located in the FLIGHT section on the overhead circuit breaker panel. Simultaneous movement in the same direction of the dual element thumb switches is required for the electric elevator trim system to operate, and the switches on the pilot control wheel will override the copilot switches.

A bi-level pushbutton, trim disconnect switch is located inboard of the dual element thumb switches on the outboard grip of each control wheel. Depressing the switch to the first level disconnects the autopilot and yaw damp system; depressing the switch to the second level disconnects the autopilot, yaw damp system, and the electric elevator trim system. A green advisory light placarded ELECT TRIM OFF on the caution/advisory panel alerts the pilot that the system has been disconnected and the ELEV TRIM switch is on. Moving the ELEV TRIM switch to OFF, then back ON resets the system.

2.13.5 Manual Rudder Trim

Normal trim of the rudder is provided through the trim knob placarded RUDDER TAB, LEFT — RIGHT located on the control pedestal. A scale that is an integral part of the control knob indicates rudder trim tab position in units from neutral.

2.13.6 Rudder Boost System

Two pneumatic rudder boosting servos are incorporated into the rudder cable system to aid in compensating for asymmetrical thrust during an engine failure, or excessive variations in engine power. The system is comprised of the two pneumatic servos, two solenoid valves, a differential pressure valve, and a differential pressure switch. The system circuit is energized by a two-position toggle switch on the extended pedestal placarded RUDDER BOOST. The differential pressure valve monitors the bleed air pressure of both engines. If the bleed air pressure varies between engines, a shuttle in the differential valve moves toward the low-pressure side. When the pressure differential exceeds approximately 60 psi, a switch on the low-pressure side closes, activating the system, and allowing pressure to actuate the rudder servo. Each rudder servo is attached by cable to the primary rudder control cable. If one or both bleed air valve switches are placed in the (**B/F**) INSTR & ENVIR OFF (**M**) ENVIR & PNEU (off) position, an electrical ground is provided to prevent rudder boost. The system electrical circuitry is protected by a circuit breaker placarded RUDDER BOOST, located (**B/F**) on the right side circuit breaker panel (**M**) in the FLIGHT section of the overhead circuit breaker panel.

2.13.6.1 Yaw Damp

A yaw damping system is provided as a function of the autopilot system to aid in maintaining directional stability. The yaw damp system senses changes in heading (from the compass system) and drives the rudder control cables to deflect the rudder, stabilizing the yaw axis of the aircraft. Yaw damp is automatically engaged when the autopilot is engaged, or it may be engaged independent of the autopilot by pressing the Y/D ENGAGE push switch located on the extended pedestal. Yaw damp may be disengaged by depressing either pilot or copilot red AP/YD disconnect button to first detent (**F/M**) or by depressing the Y/D ENGAGE again.

2.13.7 Aileron Trim

Lateral trim is provided through the control knob on the control pedestal placarded AILERON LEFT — RIGHT that adjusts the left aileron trim tab. A tab indicator that is an integral part of the control knob indicates the tab deflection from a neutral position.

2.13.8 Flight Control Lock

A removable lock assembly provides positive locking of the rudder, elevator, aileron control surfaces, and engine controls (power levers, propeller levers, and condition levers). It consists of two pins and an elongated U-shaped strap that fits around the aligned control levers. The aileron/elevator locking pin is inserted through a guide hole in the top of the pilot control column assembly, thus locking the control wheel 11° forward and rotated approximately 15° left. The rudder is held in a neutral position by an L-shaped pin that is installed through a guide hole in the floor aft of the pilot rudder pedals. The rudder pedals must be centered to align the hole in the rudder bellcrank with the guide hole in the floor.

2.14 STALL WARNING SYSTEM

The stall warning system consists of a lift transducer, a lift computer, a warning horn, and a test switch. The aircraft angle of attack is sensed through aerodynamic pressure exerted on the vane of the lift transducer located on the leading edge of the left wing. When a stall is imminent, signals from the lift transducer and flap position sensor to the lift computer activate the stall warning horns mounted on the overhead control panel. The STALL WARN TEST OFF — LDG GEAR WARN TEST switch on the copilot inboard subpanel is provided for testing the stall warning for proper operation. Placing the switch in the STALL WARN TEST position will activate the stall warning horn. An electromagnetic circuit within the transducer enables the vane to simulate a stall condition for testing purposes. In flight, the lift transducer will provide signals to the lift computer at a margin of approximately 4 to 12 knots above stall. Both the mounting plate and vane of the lift transducer are electrically heated to provide ice protection.

WARNING

The formation of ice on the transducer vane will result in erroneous indications.

2.15 WING FLAPS

The all-metal, slot-type wing flaps are electrically operated and consist of two sections for each wing. These sections extend from the inboard end of each aileron to the junction of the wing and fuselage. During extension or retraction, the flaps are operated as a single unit, each section being actuated by a separate jackscrew actuator. The actuators are driven through flexible shafts by a single, reversible electric motor mounted on the forward side of the rear spar. The motor incorporates a dynamic braking system through the use of two sets of motor windings, which prevents overtravel of the flaps. Wing flap movement is indicated in percent of travel by a flap position indicator on the center of the control pedestal. Limit switches are actuated by the right inboard flap to control flap travel. A safety mechanism is incorporated between the inboard and outboard sections on both wings that disconnects electrical power to the flap motor if the flaps are not moving in synchronization. The flap motor circuit is protected by the FLAP MOTOR circuit breaker in the (**B/F**) ELECTRICAL section on the left side circuit breaker panel (**M**) FLIGHT section on the overhead circuit breaker panel.

2.15.1 Wing Flaps Selector Handle

Flap operation is controlled by a three-position, flap-shaped handle on the pedestal. The handle is placarded FLAP and positions are placarded UP, APPROACH, and DOWN. Flap extension established by position of the flap handle is as follows:

1. UP — 0 percent.
2. APPROACH — 40 percent.
3. DOWN — 100 percent.

Intermediate flap positions between UP and APPROACH cannot be selected; (**M**) however, intermediate positions between APPROACH and DOWN may be selected. (**M**) To raise the flaps from 100 percent (or any setting from approach to full down) to approach, the flap handle must be raised to full up and returned to the approach position when indicator shows approach selected.

2.15.1.1 Wing Flap Position Indicator

Flap position in percent of travel from 0 percent (UP) to 100 percent (DOWN) is shown on an indicator placarded FLAPS on the control pedestal. The flap position indicator circuit receives power through and is protected by the FLAP CONT circuit breaker located on the circuit breaker panel beneath the fuel management panel.

2.16 LANDING GEAR SYSTEM

The main landing gear assemblies and the nose landing gear assembly are air-oil shock struts filled with compressed air and hydraulic fluid.

(**B**) The landing gear is a retractable, tricycle-type system electrically operated by a 28 Vdc motor located below the floor on the forward side of the center section main spar. A dynamic braking system and limit switches prevent coasting and overtravel of the gear. Torque shafts drive the main gear actuators, and duplex chains drive the nosegear actuator. A spring-loaded, friction-type overload clutch is incorporated to prevent damage to the structure and torque shafts in the event of a mechanical malfunction. Spring-loaded locks secure the main gear in the down position, while the jackscrew in the actuator secures the nosegear in an over center down position. The jackscrew in each actuator holds all three gears in the up position. A push-pull type circuit breaker, placarded LANDING GEAR RELAY and located on the pilot inboard subpanel, protects against electrical overload.

(**B**) The nosewheel steering mechanism is automatically centered and the rudder pedals relieved of the steering load when the landing gear is retracted. The gear doors are opened and closed through a mechanical linkage. Gear extension or retraction time is approximately 6 seconds.

(**F/M**) The landing gear assemblies are extended and retracted by a hydraulic power pack located in the left wing center section forward of the main spar (Figures 2-30 and 2-31). The landing gear doors are opened and closed through mechanical linkages connected to the landing gear.

Note

(**F/M**) Rapid cycling of the landing gear may cause the hydraulic power pack to overheat. It is protected from thermal damage by a 1/2 ampere circuit breaker located in front of the main spar below the cabin floorboards.

(**F**/**M**) The power pack consists primarily of a hydraulic pump, a 28 Vdc motor, a gear selector valve and solenoid, a two-section fluid reservoir, filter screens, an uplock pressure switch, and a low fluid level sensor. When the hydraulic fluid level is low, the fluid level sensor circuit will illuminate the HYD FLUID LOW caution annunciator. Engine bleed air, regulated to 18 to 20 psi, is plumbed into the power pack reservoir and the system fill reservoir to prevent cavitation of the pump.

WARNING

- (**F**/**M**) A HYD FLUID LOW caution light indicates the fluid level is critically low. There may not be sufficient fluid in the secondary reservoir to extend the landing gear manually.
- (**M**) If the landing gear control circuit breaker is out, the hydraulic low fluid level sensor and its input to the HYD FLUID LOW caution light are disabled. In this case, the HYD FLUID LOW caution light will not illuminate regardless of the hydraulic fluid level.

Note

(**M**) When electrical power is initially applied to the aircraft, it is normal for the HYD FLUID LOW caution annunciator to illuminate and then extinguish.

(**F**/**M**) Hydraulic system pressure performs the uplock function. The pressure is controlled by the power pack pressure switch and an accumulator that is precharged with nitrogen. When hydraulic pressure approaches an upper preset limit, the pressure switch interrupts the power to the motor-driven pump. This same pressure switch will activate the pump motor if the system pressure falls to the preset low pressure limit. An internal mechanical lock in the nosegear actuator and the overcenter action of the nosegear drag leg assembly lock the nosegear in the extended position. Hook pin attachments fitted to each main gear upper drag leg provide positive down-lock action for the main gear.

(**F**/**M**) The power pack motor is protected by a time-delay module, through a voltage-sensing unit. Both units are located beneath the aisle floorboards forward of the main spar. Landing gear extension or retraction is normally accomplished in 7 seconds. Voltage to the power pack is terminated when the fully extended or retracted position is reached. Approximately 14 seconds after voltage has been applied to the power pack motor, if electrical power has not terminated after the normal extension or retraction time lapse, the time-delay relay will open and electrical power to the system power pack will be interrupted.

2.16.1 Landing Gear Control Handle

The landing gear system operation is controlled by a manually actuated, wheel-shaped switch placarded LDG GEAR CONT UP and DN. The control switch and associated relay circuits are protected by a circuit breaker placarded (**B**/**F**) LANDING GEAR RELAY on the pilot inboard subpanel/(**M**) LANDING GEAR CONTROL located in the FLIGHT section of the overhead circuit breaker panel.

WARNING

Reversal of the landing gear control handle while the gear is in transit can cause major structural damage to gear components, inhibiting proper gear extension and retraction. Aircrews shall report all instances of in transit reversals of the landing gear to ensure system integrity.

2.16.1.1 Landing Gear Down Position — Indicator Lights

Landing gear down position is indicated by three green lights on the pilot inboard subpanel placarded GEAR DOWN. These lights have a press-to-test feature. The circuit is protected by a circuit breaker placarded (**B**/**F**) LANDING GEAR IND in the WARNING section on the right side circuit breaker panel (**M**) IND-LANDING GEAR located in the WARNING section on the overhead circuit breaker panel.

2.16.1.2 Landing Gear Handle Warning Lights

Two (**B**/**F**) red (**M**) ANVIS bulbs, wired in parallel, are positioned inside the plastic grip on the landing gear control handle. These lights illuminate whenever the gear is unlocked, in transit, or the gear warning horn has been activated. Both bulbs will also illuminate should (**B**) both (**F**/**M**) either power lever(s) be retarded below a position corresponding to approximately 79 percent N_1 and the landing gear is not down and locked. To extinguish the handle lights during single-engine operation, the landing gear must be extended or the power lever for the inoperative engine must be advanced to a position higher than the setting of the warning horn microswitch. Both (**B**/**F**) red (**M**) ANVIS lights indicate the same warning conditions, but two lights are provided for a fail-safe indication in the event that one bulb burns out.

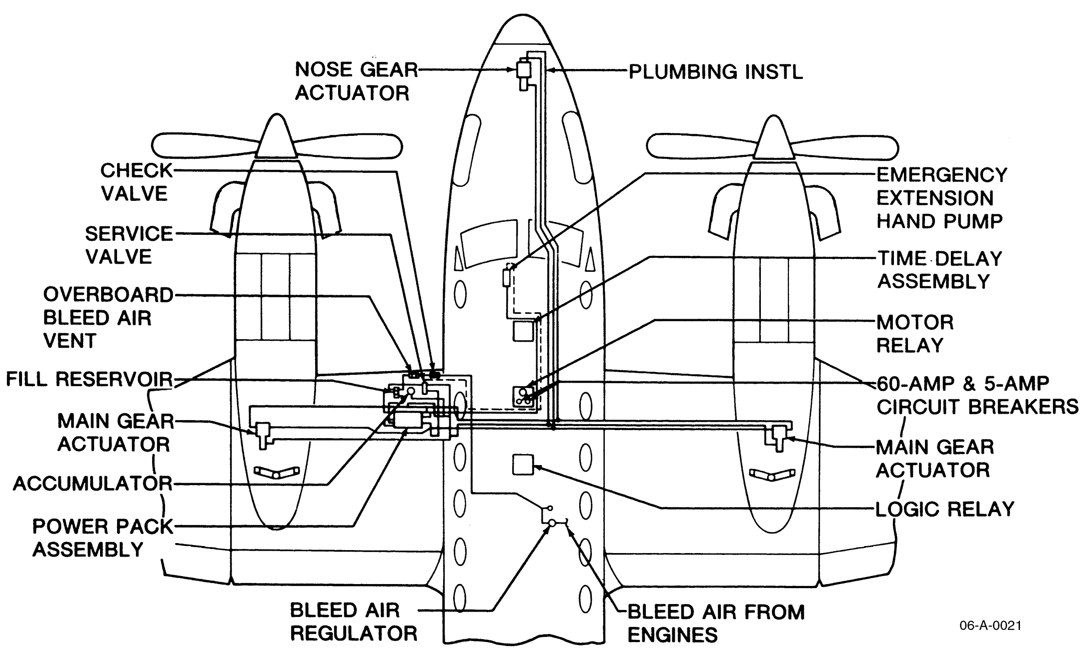


Figure 2-30. (**F**/**M**) Landing Gear System

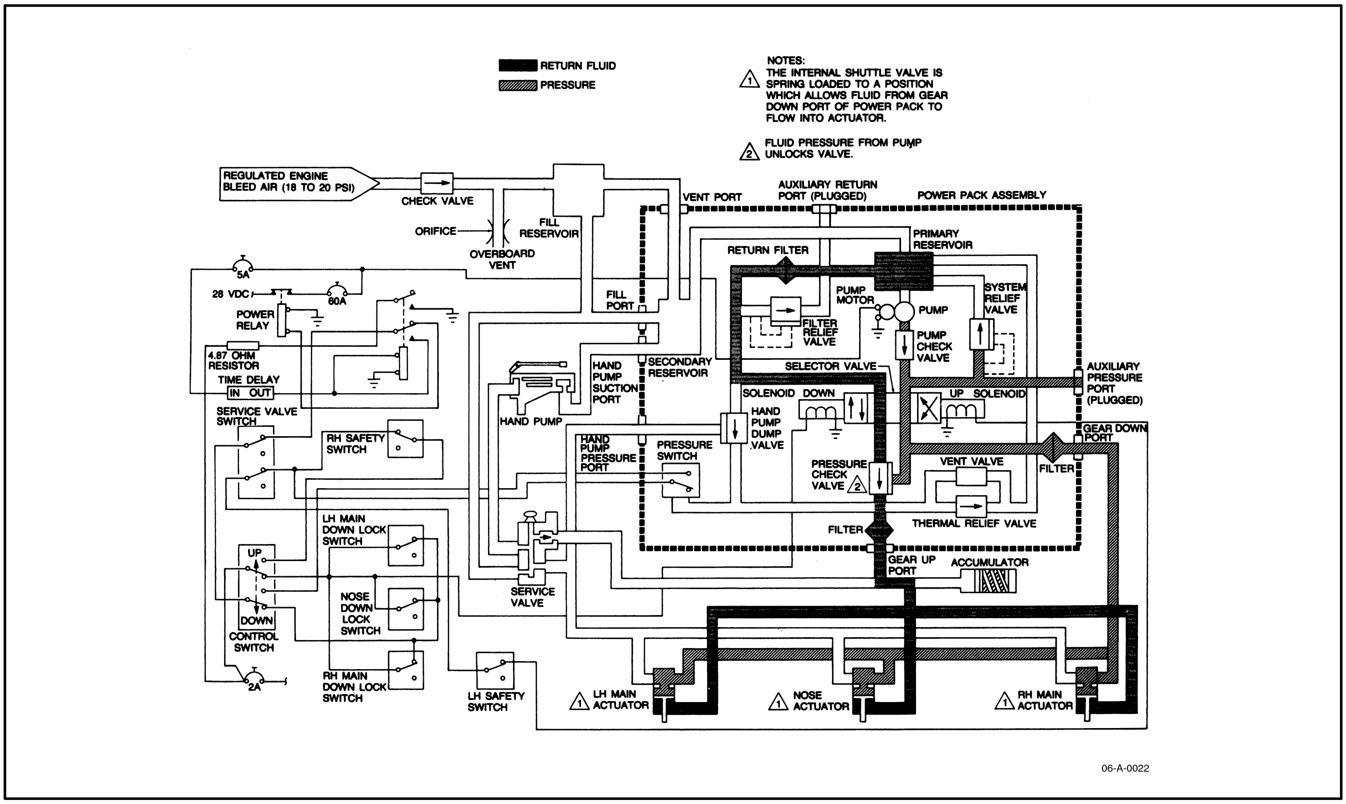


Figure 2-31. (**F/M**) Landing Gear System Normal Extension Schematic

2.16.1.3 Landing Gear Handle Warning Light Test Button

A test button, placarded HD LT TEST, is located adjacent to the gear handle. Failure of the landing gear handle to illuminate red when this test button is pressed indicates two defective bulbs or a circuit fault.

2.16.1.4 Landing Gear Safety Switches

The left and right main landing gear safety (weight-on-wheels) switches are located aft of the respective strut assemblies. When compressed, the switches perform the following functions:

LEFT

1. Closes ambient air solenoid valves.
2. Minimizes heat level to stall warning vane heater.
3. Disables stall warning.
4. Enables loading of the FMS database into memory.
5. (**B/F**) Opens safety valve (DUMP position).
6. (**B/F**) Disables the cabin altitude controller operation.
7. (**F**) Prevents repositioning of the gear selector solenoid.

RIGHT

1. Disables landing gear motor circuit.
2. Disables flight hour (HOBBS) meter.
3. Actuates solenoid-operated downlock hook (J-hook).
4. Enables aircrew to activate the erase feature of the CVR.
5. (**F/M**) Enables ground (and disables flight) mode of the fatigue monitoring system.
6. (**M**) Opens safety valve (DUMP position).
7. (**M**) Disables the cabin altitude controller operation.

2.16.2 Landing Gear Warning Horn

If the landing gear is not fully extended and locked, an intermittent 250 Hz warning signal will sound and the lights in the landing gear handle will illuminate under two conditions:

1. If (**B**) both (**F/M**) either power lever(s) are (is) retarded below a position corresponding to 79 percent N_1 with the flaps at APPROACH or UP, or
2. If flaps are extended beyond approach, regardless of power lever position. The warning horn circuit receives power through and is protected by a circuit breaker placarded (**B/F**) LANDING GEAR WARN, located in the WARNINGS section on the right side circuit breaker panel (**M**) WARN-LANDING GEAR, located in the WARNINGS section on the overhead circuit breaker panel.

2.16.2.1 Landing Gear Warning Test

A three-position toggle switch placarded STALL WARN TEST OFF — LDG WARN TEST and located on the copilot inboard subpanel is provided to test the landing gear and stall warning systems. Placing the switch to the LDG GEAR WARN TEST position will sound the warning horn and illuminate the landing gear handle lights.

2.16.2.2 Landing Gear Warning Horn Silence Button

During flight with reduced power, the landing gear warning horn may be silenced by pressing the button placarded WARN HORN SILENCE located to the right of and below the landing gear control handle on the pilot inboard subpanel; however, the gear warning horn cannot be silenced with full flaps, gear up, and power levers in any position. After silencing, the warning horn will remain silent until either the flaps are extended or the power levers are advanced, then retarded again. Advancing the power levers rearms the system. During single-engine operation with flaps up, the warning horn may be silenced by either pressing the warning horn silence button or advancing the power levers to a position above the microswitch setting (79 percent N_1). The warning horn circuit receives power through and is protected by a circuit breaker placarded LANDING GEAR WARN located in the WARNINGS section on the right side circuit breaker panel.

2.16.3 Landing Gear Handle Down-Lock Release

A safety switch located on the right main mount strut disables the landing gear motor circuit and actuates a solenoid-operated, down-lock hook on the landing gear handle. The down-lock hook prevents the handle from being raised while the aircraft weight is on the gear. The hook unlocks automatically after takeoff. It can be overridden, should a malfunction of the down-lock mechanism preclude raising the gear handle, by pressing down on the red down-lock release switch placarded DN LOCK REL and located to the left of the landing gear control handle. The landing gear cannot be raised on the ground by use of the release unless there is a failure of the right main landing gear safety switch. If the override is used and the landing gear handle is raised, electrical power will be supplied to the landing gear and warning circuits. The down-lock release circuit receives electrical power through and is protected by a circuit breaker placarded LANDING GEAR RELAY located on the pilot inboard subpanel.

2.16.4 Landing Gear Alternate Extension System

In the event the normal actuating switch fails to operate, the landing gear may be extended manually. The manual extension system (Figures (**B**) 2-32/(**F/M**) 2-33) is actuated by (**B**) two (**F/M**) one red handle(s) located to the right of the pilot seat on the flight compartment floor.

2.16.4.1 (B) Landing Gear Disengage Lever

During manual landing gear extension, the manual extension gear and chain mechanism must be locked to the gearbox and motor and the motor electrically disconnected from the system. This is accomplished by lifting the U-shaped engagement lever and turning it 50° clockwise. This positions the landing gear manual extension gear and chain mechanism in the operating position and opens a safety switch mounted on the main landing gear motor gearbox, removing all electrical power from the landing gear circuit.

2.16.4.2 Landing Gear Alternate Extension Handle

The long handle located on the floor to the right of the pilot seat is used to manually extend the landing gear in the event that emergency extension of the gear is required.

2.16.5 Steerable Nosewheel

The aircraft can be maneuvered on the ground by the steerable nosewheel system. Direct linkage from the rudder pedals to the nosewheel steering linkage allows the nosewheel to be turned 14° to the right and left of center. When rudder pedal steering is augmented by the main wheel braking action, the nosewheel can be deflected up to 48° either side of center. Shock forces that would normally be transmitted to the rudder pedals are absorbed by a spring mechanism in the steering linkage. Retraction of the landing gear automatically centers the nosewheel and disengages the steering linkage from the rudder pedals.

2.17 WHEELBRAKE SYSTEM

The main landing wheels are equipped with multi-disc hydraulic brakes actuated by master cylinders attached to the rudder pedals at the pilot and copilot position. Brake fluid is supplied to the system from the reservoir in the nose compartment. The toe brake sections of the rudder pedals are connected to the master cylinders that actuate the system for corresponding wheels. No emergency brake system is provided. Reverse or beta should be used to taxi and to slow the aircraft after landing. The parking brake shall not be set during flight.

2.17.1 Parking Brake

Dual parking brake valves are installed between the master cylinders adjacent to the rudder pedals and the wheelbrakes. Both valves are closed simultaneously by pulling out the handle placarded PARKING BRAKE located under the pilot subpanel. Pulling the handle fully out sets the check valves in the system and any pressure applied by either the pilot or copilot toe brakes is maintained. The parking brakes are released when the parking brake handle is pushed fully in.

Note

Setting the parking brake during low temperatures when an accumulation of moisture is present may cause the brakes to freeze.

2.18 PITOT AND STATIC AIR SYSTEM

The pitot and static air system provides two separate sources of static and ram air for operation of the pilot and copilot flight instruments (airspeed, altimeter, and vertical speed indicators). The system consists of two heated pitot masts mounted externally on either side of the aircraft nose; four static air pressure ports, two in the aircraft exterior skin on each side of the aft fuselage; and the associated plumbing. The pitot masts are protected from ice formation by internal electric heating elements.

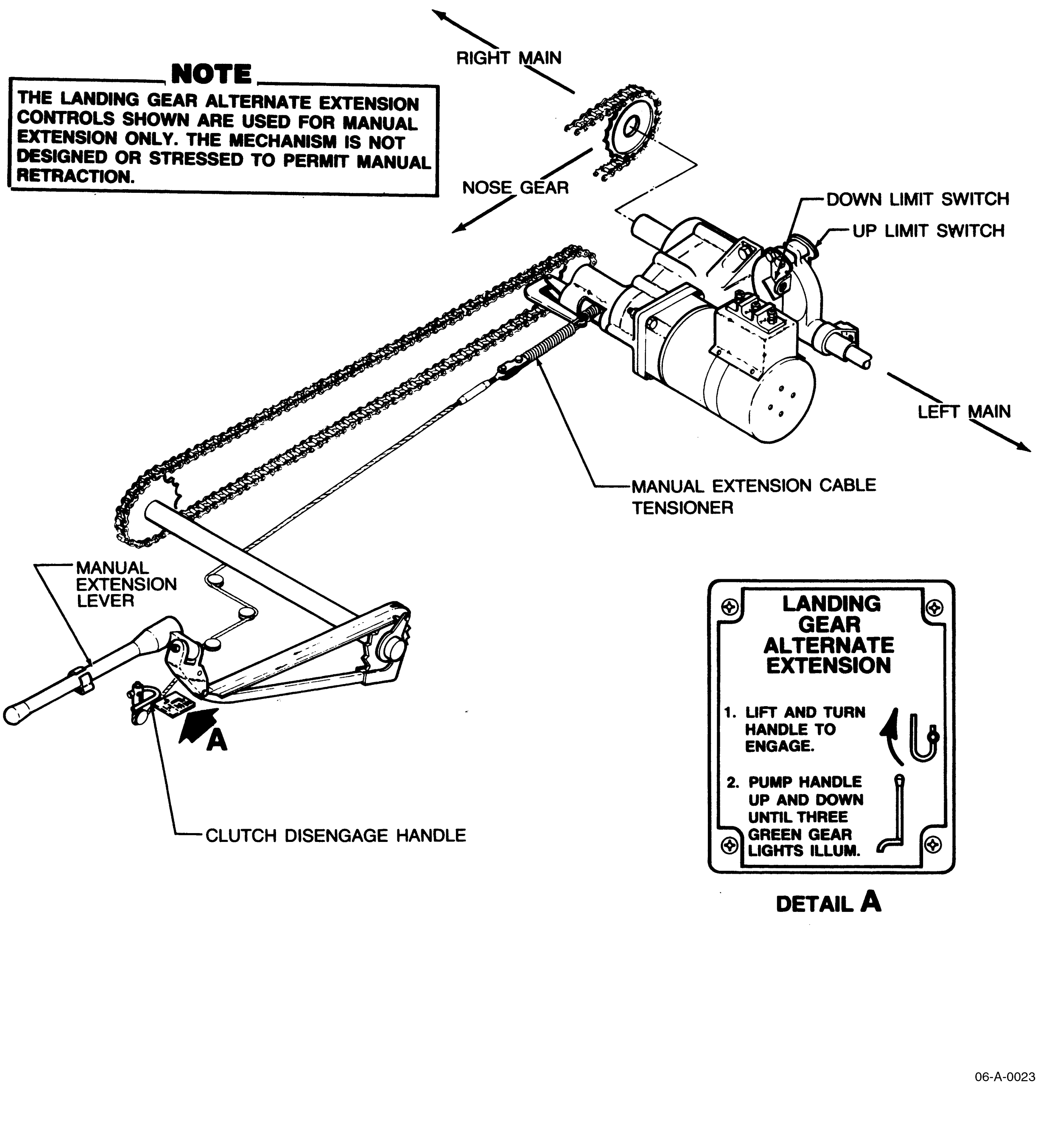


Figure 2-32. (**B**) Landing Gear Emergency Extension Controls

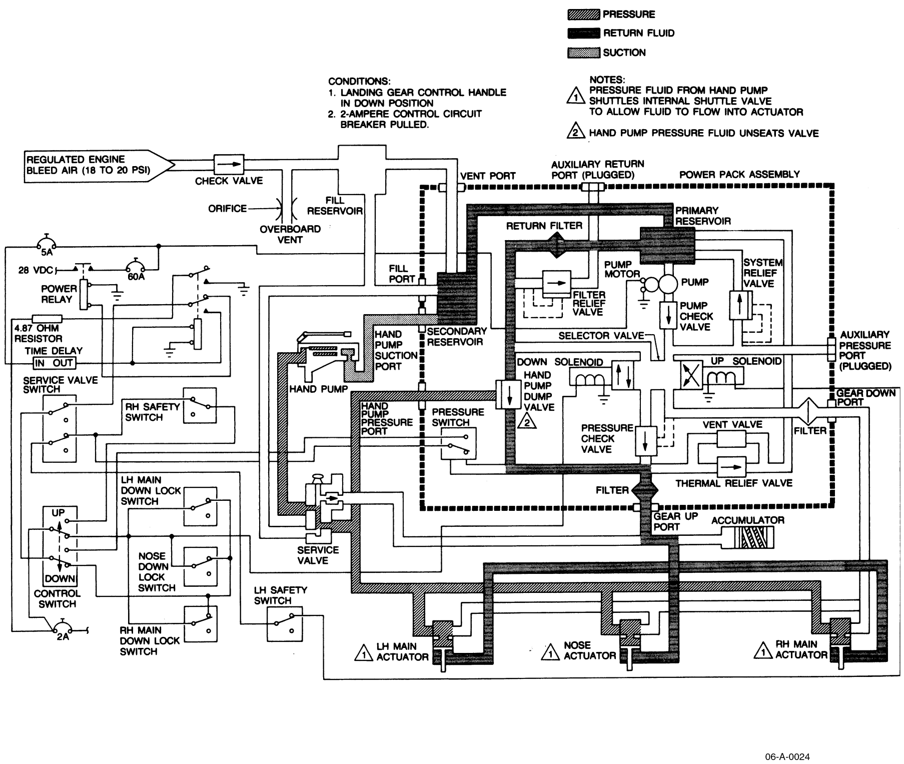


Figure 2-33. **(F/M)** Landing Gear Emergency Extension Controls

(B/F) Circuit breaker switches for the pitot heat are located on the pilot subpanel in the ICE section placarded PITOT LEFT — RIGHT, and circuitry protection is provided through the circuit breaker function of the individual switches.

(M) The heating elements are controlled by two-position toggle switches, placarded PITOT LEFT — RIGHT — ON and located in the ICE & RAIN section on the overhead control panel, and are protected by the circuit breakers located in the WEATHER section on the overhead circuit breaker panel.

The normal static system provides two separate sources of static air for the flight instruments. The static air lines are vented to the atmosphere through two static ports, one on each side of the fuselage. An ALTERNATE static air source for the pilot (left) instruments is provided in the event the NORMAL system becomes unreliable (e.g., ice accumulations obstruct the static ports). The alternate system control valve located on the **(B/F)** right sidewall **(M)** pilot inboard subpanel is placarded PILOTS EMERGENCY STATIC AIR SOURCE NORMAL — ALTERNATE. When alternate static air is required, static pressure may be obtained from inside the unpressurized area of the fuselage aft of the rear pressure bulkhead by releasing the lever guard spring and placing the lever to the ALTERNATE position.

2.18.1 Pilot Encoding Altimeter

(B/F) The pilot encoding altimeter is a self-contained, servo-driven unit that consists of a precision pressure altimeter combined with an altitude encoder. The display indicates corrected pressure altitude and provides encoded altitude data in increments of 100 feet to the Air Traffic Control (ATC) transponder system and input data to the altitude alerter unit. Altitude is displayed on the altimeter by a 10,000 foot counter, a 1,000 foot counter, a 100 foot counter, and a single-needle pointer that indicates hundreds of feet on a circular scale in 20 foot increments. A barometric pressure setting knob is provided to adjust the barometric counters display in inches of mercury (Hg) and millibars (Mb). Should the barometric pressure result in an altitude less than zero feet (sea level), the word NEG will appear on the 10,000 foot counter drum. Below an altitude of 10,000 feet, a diagonal warning symbol will appear on the 10,000 foot counter drum. If dc power to the altimeter is lost, an orange-colored warning flag placarded OFF will appear in place of the "0" at the top of the altimeter dial, indicating that the altimeter is inoperative and the system is not providing encoded data to the transponder.

(**M**) The pilot altimeter provides a servoed (repeats air data computer system) counter drum/pointer display of barometrically corrected pressure altitude. This altimeter is 26 Vac powered and is protected by a 1-ampere circuit breaker placarded PILOT ALTM (26 Vac) and located in the AVIONICS section of the overhead circuit breaker panel.

(**M**) The servoed altimeter provides the following displays: Counter drum display of altitude, in 20-foot increments, and pointer display of altitude between 1,000-foot levels in 20-foot graduations. Altitudes below 10,000 feet are annunciated by a black and white crosshatch on the left digit position of the counter display. A barometric pressure counter, set by means of the BARO knob, displays barometric pressure in inches of mercury (Hg), and millibars (Mb), and provides this information to the air data computer. If the barometric pressure results in an altitude less than sea level "0," the word NEG (indicating negative altitude) will appear on the 10,000-foot counter. A red warning flag in view indicates the altitude information is unreliable; however, the mode C (altitude reporting) information may be valid.

WARNING

(**M**) In the event of a total aircraft ac and dc electrical power loss, the warning flag will be in view, the altimeter will be inoperative, and the indicated altitude will remain as existed at the time of failure. A dc power loss only (retains ac power) usually results in the altimeter spooling down toward a lower altitude instead of retaining the altitude at which the failure occurred.

2.18.2 Copilot Pneumatic Altimeter

The copilot altimeter is an internally lighted pneumatic instrument. It is equipped with a 28 Vdc internal vibrator that is required to overcome friction and ensure accuracy. Altitude is displayed on the altimeter by 10,000-1,000- and 100-foot counter drums and a single-needle pointer that indicates hundreds of feet in 20-foot increments. The barometric pressure setting knob is provided to simultaneously adjust the barometric counters in inches of mercury and millibars. A red and white diagonal symbol will appear in the 10,000-foot counter below an altitude of 10,000 feet. If the barometric pressure results in an altitude less than sea level "0," the word NEG (indicating negative altitude) will appear on the 10,000-foot counter. A circuit breaker placarded COPILOT ALTM on the (**B**/**F**) right side circuit breaker panel in the FLIGHT section (**M**) AVIONICS section on the overhead circuit breaker panel protects the lighting and vibrator circuits.

2.18.3 Airspeed Indicators

The airspeed indicators (Figures (**B**) 4-6/(**F**) 4-7/(**M**) 4-8) are conventional indicators with the addition of an aneroid-operated maximum allowable airspeed pointer that indicates the maximum allowable airspeed at a particular altitude. The dials of the airspeed indicators are calibrated in knots from 40 to 300.

2.18.4 Vertical Speed Indicators

(**B**/**M**) A Vertical Speed Indicator/Traffic Resolution Advisory (VSI/TRA) display is mounted on both the pilot and copilot sides of the instrument panel (Figures (**B**) 2-5/(**M**) 2-7). The VSI/TRA is a color, flat-panel liquid crystal display with two modes of operation: as a normal VSI and as a TRA. As a VSI, the indicator provides a standard display of vertical speed in feet per minute. The range of the instrument is from 0 to 6,000 fpm up or down, with the first 1,000 fpm graduated in 100-fpm increments and the remainder in 500-fpm increments. As a TRA display, an aircraft symbol representing the TCAS 2000 aircraft appears in the lower portion of the display surrounded by 12 dots. The dots are located at the clock positions to assist the crew in visually acquiring the traffic.

(**F**) A vertical speed indicator is mounted on both the pilot and copilot sides of the instrument panel (Figure 2-6). The face is placarded VERTICAL SPEED, UP, and DOWN. It is an Instantaneous Vertical Speed Indicator (IVSI) and it incorporates an accelerometer device to reduce the lag that is present in a standard vertical speed indicator. Changes in altitude are indicated instantly and, because of the accelerometer principle, a slight noseup indication will be noted when entering a level turn and a slight nosedown indication will be noted when rolling out of a turn.

2.18.5 Turn and Slip Indicators

A turn and slip indicator is installed on the pilot and copilot sides of the instrument panel (Figures (**B**) 2-5/(**F**) 2-6, (**M**) 2-7). These indicators are gyroscopically operated. The pilot unit is operated by dc power and is protected by a circuit breaker placarded PILOT TURN AND SLIP on the (**B/F**) right side subpanel (**M**) FLIGHT section on the overhead circuit breaker panel. The copilot indicator is a vacuum instrument operated by reduced pressure engine bleed air.

Note

Depending on the installed instrument, the turn and slip indicator may yield either a standard rate turn or a half standard rate turn at one needle-width deflection.

2.19 VERTICAL GYRO SYSTEM

The pilot and copilot vertical gyro systems are independent and powered by the (**B/F**) ac power bus located in the nose avionics compartment (**M**) No. 1 and No. 2 ac bus. The purpose of the gyro systems is to provide visual indications of aircraft pitch and roll attitudes on the flight director indicators. The gyroscope develops, through synchros, pitch and roll signals representative of the aircraft attitude. Two gravity-sensitive switches that control a torque motor for each gyro axis establish vertical reference. High or low erection rate of the gyro is accomplished by applying high or low voltage to the respective torque motor. Pressing a panel-mounted button placarded FAST ERECT will erect the gyro to within 1° of pitch and roll within 60 seconds of power application and erect to within 0.5° within 2 minutes.

2.19.1 Standby Gyro

The standby gyro (Figure (**B**) 2-5/(**F**) 2-6/(**M**) 2-7) located (**B/F**) on the lower left portion of the instrument panel (**M**) below the pilot vertical speed indicator is operated by vacuum air. This unit functions independently of the flight director attitude indicators and has a self-contained gyro to erect the sphere to provide pitch and roll reference. An indicating plane represents the aircraft, and a horizontal line behind the indicating plane represents the horizon. The movable indicating plane may be adjusted vertically to correct for variations in level flight attitudes by means of a small knob on the front of the indicator.

2.20 HORIZONTAL SITUATION SYSTEM

The horizontal situation system indicators include the pilot and copilot Radio Magnetic Indicator (RMI) and Horizontal Situation Indicator (HSI) located on the respective sides of the instrument panel and the FMS Control Display Unit (CDU) on the extended pedestal. Chapter 24 contains the complete descriptions and operating information for these systems.

2.21 COMPASS SYSTEM

Two identical compass systems provide accurate directional information for the aircraft at all latitudes of the Earth. As a heading reference, two modes of operation are used: directional gyro (FREE) mode or slaved (SLAVE) mode. In polar regions of the Earth where magnetic heading references are not reliable, the system is operated as a free gyro. In this mode, the system furnishes an inertial heading reference, with latitude corrections introduced manually using the INCREASE — DECREASE switches located on both sides of the instrument panel Figures (**B**) (2-5)/(**F**) (2-6/ (**M**) 2-7) for use by the pilot or copilot. In areas where references are reliable, the system is operated in the SLAVE mode. In this mode, the directional gyro is slaved to the magnetic azimuth detector (flux detectors) located (**B**) in each wing tip (**F/M**) in the horizontal stabilizers, which supply long-term magnetic reference for correction of the apparent drift of the gyro. The pilot compass system, COMPASS 1, provides information to the pilot HSI and the copilot RMI. The copilot system COMPASS 2 provides the information to the copilot HSI and the pilot RMI.

2.21.1 Standby Magnetic Compass

A conventional magnetic compass (Figures (**B**) 2-24/(**F**) 2-25/(M) 2-26), located overhead near the windshield divider, is furnished for navigation in case of instrument or electrical failure or for instrument cross-check. Readings should be taken only during level unaccelerated flight since turns, acceleration, or deceleration may introduce errors. A compass correction card indicating deviation with radios and inverter power on is located below the compass face. The standby compass placard on the overhead control panel must be observed.

Note

The standby compass is unreliable when the windshield anti- ice system, and/or windshield wipers, and/or air- conditioner are in use.

2.22 RADIO ALTIMETER

(**B/F**) The radio altimeter is located on the pilot side of the instrument panel (Figures (**B**) 2-5/(**F**) 2-6) and is used to provide the pilot with aircraft AGL information during the critical approach phase of a flight. The indicator displays absolute altitude from –20 to +2,500 feet with 100 foot graduations from 500 to 2,500 feet and 10 foot graduations from –20 to 500 feet. A Decision Height (DH) annunciator light is provided to indicate aircraft arrival at a preselected altitude. The preselected altitude is set by a knob at the lower right corner of the instrument placarded DH SET. The radio altimeter circuit is protected by a circuit breaker placarded RADIO ALTM located in the AVIONICS section on the right sidewall circuit breaker panel. For a complete description and operating instructions, refer to Chapter 24.

(**M**) Refer to Chapter 26 for system description.

2.23 MISCELLANEOUS INSTRUMENTS

Other instruments not previously described include (**B**) an 8-day clock (**F/M**) a digital clock located in the center of each control wheel, an outside air temperature gauge located on the pilot sidewall, flight hour meter, gyro suction gauge, pneumatic pressure gauge, oxygen pressure gauge, and cabin air temperature gauge, (**M**) battery temperature gauge, and (**F/M**) a propeller ampere gauge.

2.24 WARNING, CAUTION, AND ADVISORY LIGHTS

(**B/F**) The annunciator lights (Figures (**B**) 2-34/(**F**) 2-35) consist of a warning lights panel (red lights) mounted in the center of the glareshield with two MASTER WARNING (flashing red) lights on opposite ends of the glareshield and a caution (yellow lights)/advisory (green lights) panel located between the lower subpanels with two MASTER CAUTION (flashing yellow) lights also located on the glareshield. A PRESS TO TEST switch is located adjacent to the warning light panel (**B**) and a CAUTION ON — OFF switch is located on the copilot subpanel. A three-lens light located at each side of the warning light panel is associated with the engine fire detector/extinguisher system.

Figures (**B**) 12-1, 12-2, 12-3/(**F**) 12-4, 12-5, 12-6/(**M**) 12-7, 12-8, 12-9 contain a list of all Warning, Caution, and Advisory (W/C/A) lights and associated procedures.

Note

The MASTER WARNING lights do not have a dim feature.

(**M**) The annunciator light system (Figure 2-36) consists of a warning annunciator panel centrally located in the glareshield and a caution/advisory panel located on the lower center subpanel. The annunciator panels contain rows of small rectangular lenses that illuminate as either (ANVIS) yellow (warning), or (ANVIS) green (caution/advisory) with printing on the face of the lenses identifying the monitored system. A toggle switch placarded ANNUNCIATOR TEST, used to test the entire annunciator light system, is located on the copilot inboard subpanel. The annunciator system should be tested before every flight and/or anytime the integrity of a lamp is in question. Depressing the ANNUNCIATOR TEST switch illuminates all annunciator and MASTER WARNING and MASTER CAUTION lights.

(**M**) An (ANVIS) annunciator, placarded MASTER WARNING, and an (ANVIS) annunciator, placarded MASTER CAUTION, are mounted in the glareshield directly in front of both the pilot and copilot.

(**M**) The advisory of the caution/advisory annunciator panel is an advisory section only; therefore, there are no master warning or master caution lights associated with the annunciators.

(**M**) The annunciators and MASTER WARNING and MASTER CAUTION lights receive electrical signals from the individual systems the circuitry is protected by the ACFT ANN PWR and IND circuit breakers located in the WARNING section on the overhead circuit breaker panel.

(**M**) The annunciator lights system has an automatic bright and dim mode. The dim mode is automatic when all of the following conditions are met at least one generator is on the line, the MASTER PANEL LIGHTS switch is ON, the OVERHEAD FLOOD lights are OFF, and the PILOT FLIGHT INSTR lights are ON. If all the previously mentioned conditions are not met, the bright mode will be automatically selected.

Note

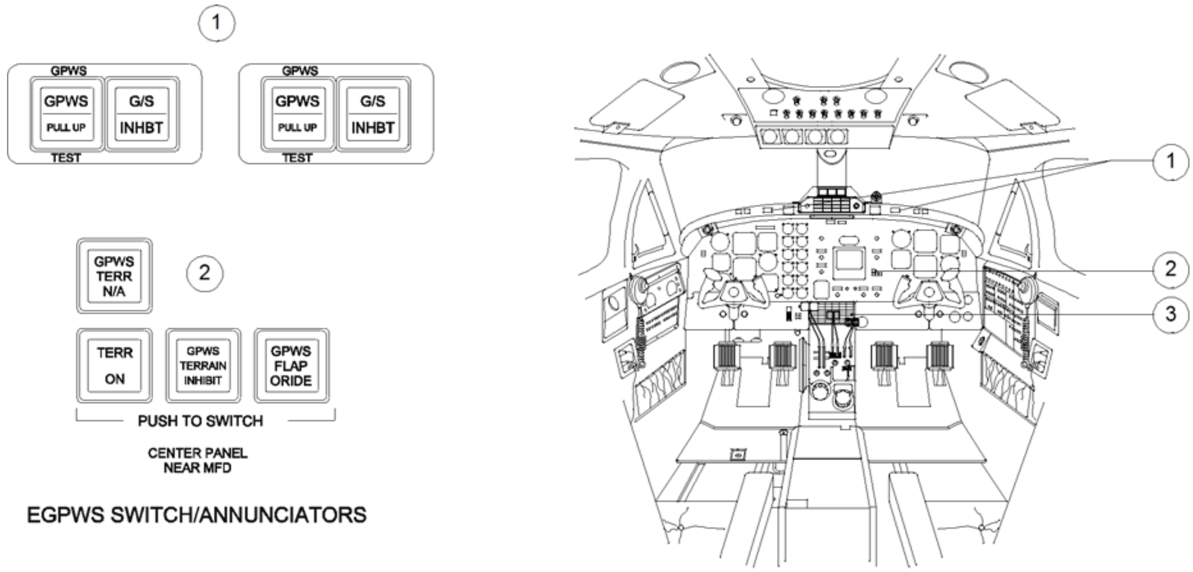
The MASTER WARNING lights are not included in the dim feature.

If a condition exists that requires an immediate corrective action, the flashing MASTER WARNING lights on the glareshield and the applicable warning annunciator panel light will illuminate. The MASTER WARNING lights may be extinguished by pressing on the face of either light to reset the circuit. The illuminated warning annunciator will remain illuminated if the condition is not or cannot be corrected. If an additional fault occurs, the appropriate panel light and flashing MASTER WARNING light will reilluminate.

When a fault occurs that requires the pilot's attention but does not require immediate action, the flashing MASTER CAUTION lights on the glareshield and appropriate caution panel light will illuminate. The MASTER CAUTION lights may be canceled by pressing the face of either light.

(**B**) The caution annunciator may be extinguished by momentarily moving the spring-loaded toggle switch placarded CAUTION ON—OFF on the copilot subpanel to the OFF position. After extinguishing a caution annunciator, a green advisory light placarded CAUT LGND OFF will illuminate as a reminder that a caution still exists. If desired, moving the CAUTION ON—OFF switch momentarily to the ON position may illuminate the existing caution that had been extinguished. Any new fault that illuminates an annunciator will also reilluminate previously canceled lights. The advisory portion (green lights) of the caution/advisory panel is a functional advisory section; therefore, there is no flashing light associated with the annunciators.

(**B/F**) The annunciator lights system has an automatic bright and dim mode. The dim mode is automatic when all of the following conditions are met: at least one generator is on the line, the OVERHEAD FLOOD lights are OFF, the PILOT FLIGHT INSTR lights are ON, and the ambient light level in the flight compartment is low, as sensed by a photoelectric cell. All the previously mentioned conditions must be met, or the bright mode will automatically be selected.



EGPWS SWITCH/ANNUNCIATORS

3

FIRE L ENG	ALT WARN	INST INV	FIRE R ENG
L FUEL PRESS	AP TRIM FAIL	AP DISC	R FUEL PRESS
L BL AIR FAIL	———	———	R BL AIR FAIL
L CHIP DET	———	———	R CHIP DET

WARNING ANNUNCIATORS PANEL

L DC GEN	———	PROP SYNC ON	RVS NOT READY	———	R DC GEN
L NAC LOW	———	CABIN DOOR	DUCT OVERTEMP	FDR FAULT	R NAC LOW
L ICE VANE	———	BATTERY CHG	EXT PWR	GPWS INOP	R ICE VANE
L AUTOFEATHER	———	ELECT TRIM OFF	AIR CND NILOW	———	R AUTOFEATHER
L ICE VANE EXT	———	LDG/TAXI LTS	PASS OXY ON	———	R ICE VANE EXT
L IGNITION ON	L BL AIR OFF	CAUT LGND OFF	FUEL CROSSFEED	R BL AIR OFF	R IGNITION ON

CAUTION AND ADVISORY ANNUNCIATOR PANEL

BB34B
980166AB

Figure 2-34. (**B**) Warning, Caution, and Advisory Lights

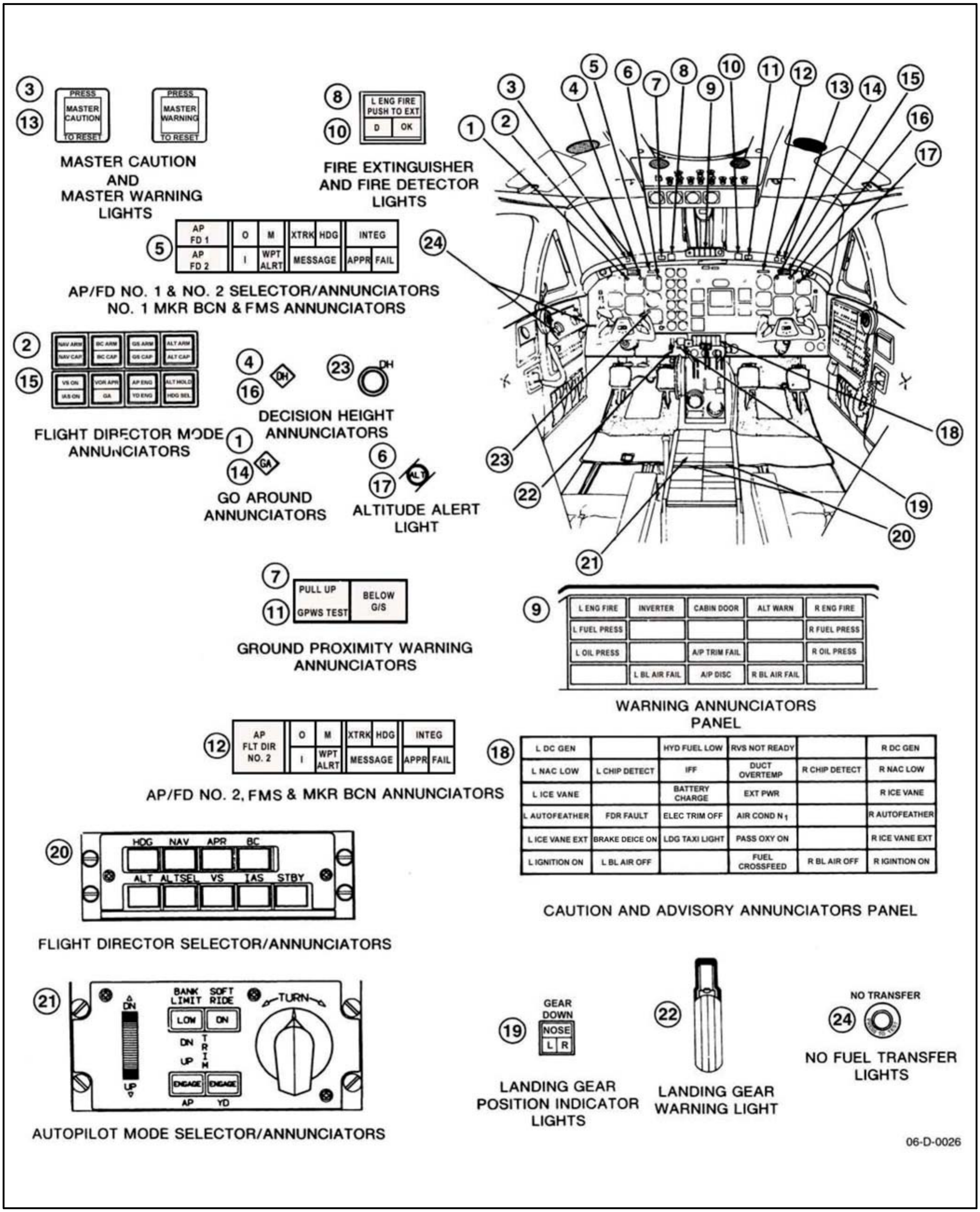


Figure 2-35. (**F**) Warning, Caution, and Advisory Lights

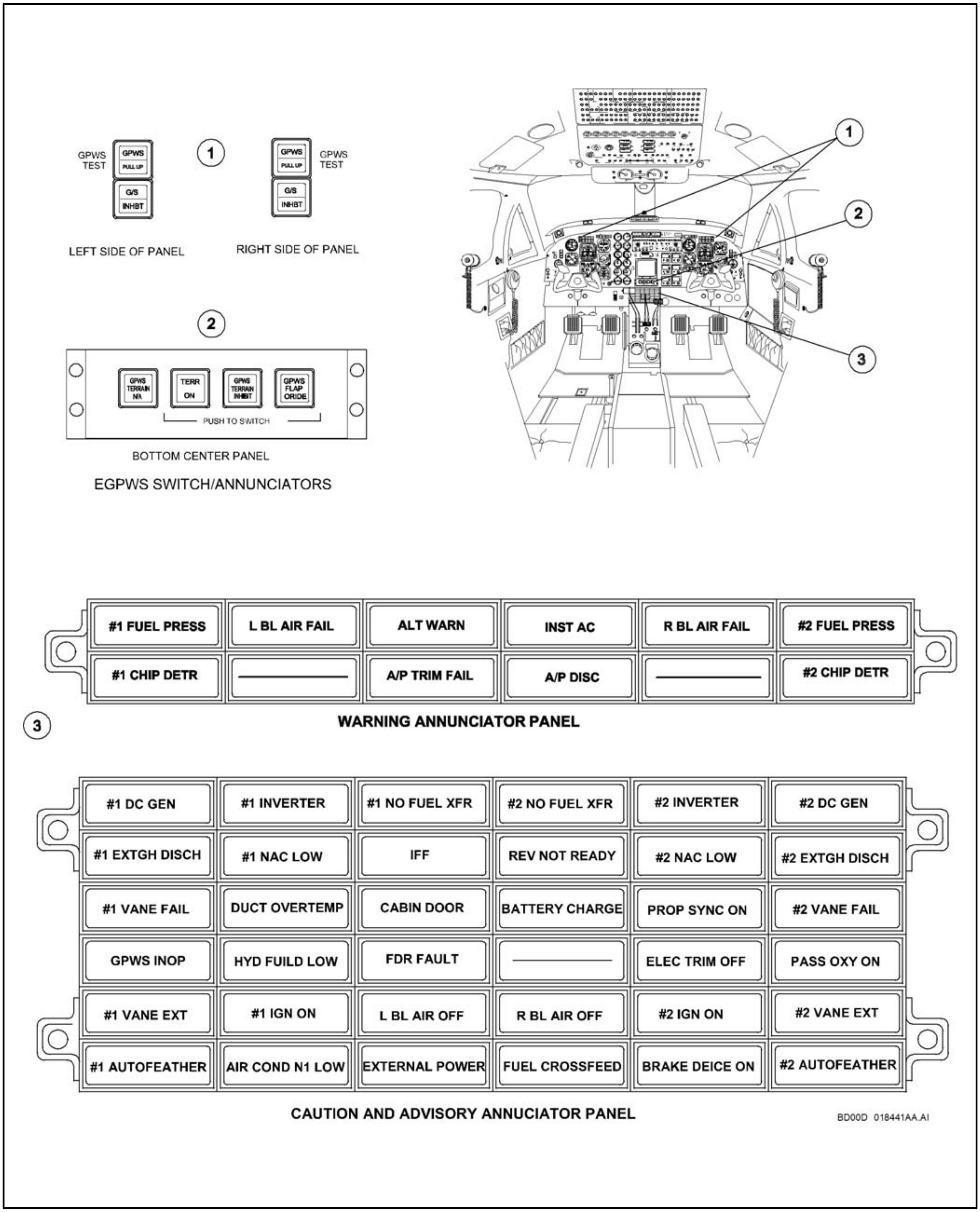


Figure 2-36. (**M**) Warning, Caution, and Advisory Lights

2.25 ENTRANCE AND EGRESS SYSTEM

2.25.1 Airstair Door

A swing-down door (Figure 2-37), hinged at the bottom, provides a stairway for normal and emergency entry and exit. Two of the steps are movable and fold flat against the door in the closed position. A door sill step folds down over the door sill when the door opens to provide a platform (step) for door seal protection. A plastic encased cable provides support for the door in the open position, a handhold, and a convenience for closing the door from inside. A hydraulic damper permits the door to lower gradually during opening. A rubber seal around the door positively seals the pressure vessel while the aircraft is in flight.

The door locking mechanism is operated by either of the two mechanically interconnected handles, one inside and the other outside the door. When either handle is rotated, three rotating cam-type latches on either side of the door capture posts mounted on the cargo door side of the opening. When in the closed position, the airstair door becomes an integral part of the cargo door. A button adjacent to the door handle must be depressed before the handle can be rotated to open the door. A bellows behind the button is inflated when the aircraft is pressurized to prevent accidental unlatching or opening of the door. A small round window just above the second step permits observation of the pressurization safety bellows. A placard adjacent to the window instructs the operator to ensure safe lock/arm is in position around the bellows shaft that indicates a properly locked door. Pushing the red button switch adjacent to the window will illuminate the inside door mechanism. A (**B/M**) caution (**F**) warning panel annunciator light (CABIN DOOR) will be illuminated if the door is not properly closed and securely latched.

CAUTION

- Structural damage may occur if more than one person is on the entrance door at a time.
- The door is weight limited to 300 pounds.

2.25.2 Cargo Door

A swing-up door (Figure 2-37), hinged at the top, provides cabin access for loading cargo or bulky items. After initial opening force is applied, gas springs will completely open the cargo door automatically. The door is counterbalanced and will remain in the open position. A door support assembly (rod) is used to hold the door in the open position and to aid in overcoming the pressure of the gas spring assemblies while closing the door. Once closed, the gas springs apply a closing force to assist in latching the door. A rubber seal around the door seals the pressure vessel while in flight. The door locking mechanism is operated only from inside the aircraft and is operated by two handles, one in the bottom forward portion of the door and the other in the upper aft portion of the door. When the upper aft handle is operated per placard instructions, two rotating cam-type latches on the forward side of the door and two on the aft side rotate, capturing posts mounted on the fuselage side of the door opening. The bottom handle, when operated per placard instructions, actuates four pin lug latches across the bottom of the door. A button on the upper aft handle must be pressed before the handle can be released to open or latch the door. A latching lever on the bottom handle must be lifted to release the handle before the lower latches can be opened. These act as additional aids in preventing accidental opening or unlatching of the door. The airstair and cargo doors are equipped with dual sensing circuits to provide the crew remote indication of airstair/cargo door security. An annunciator light placarded CABIN DOOR will illuminate if the cabin or cargo door is open and the battery switch is ON. If the battery is OFF, the annunciator will illuminate if the cabin or cargo door is closed and not securely latched. The cargo door sensing circuit receives power from the hot battery bus.

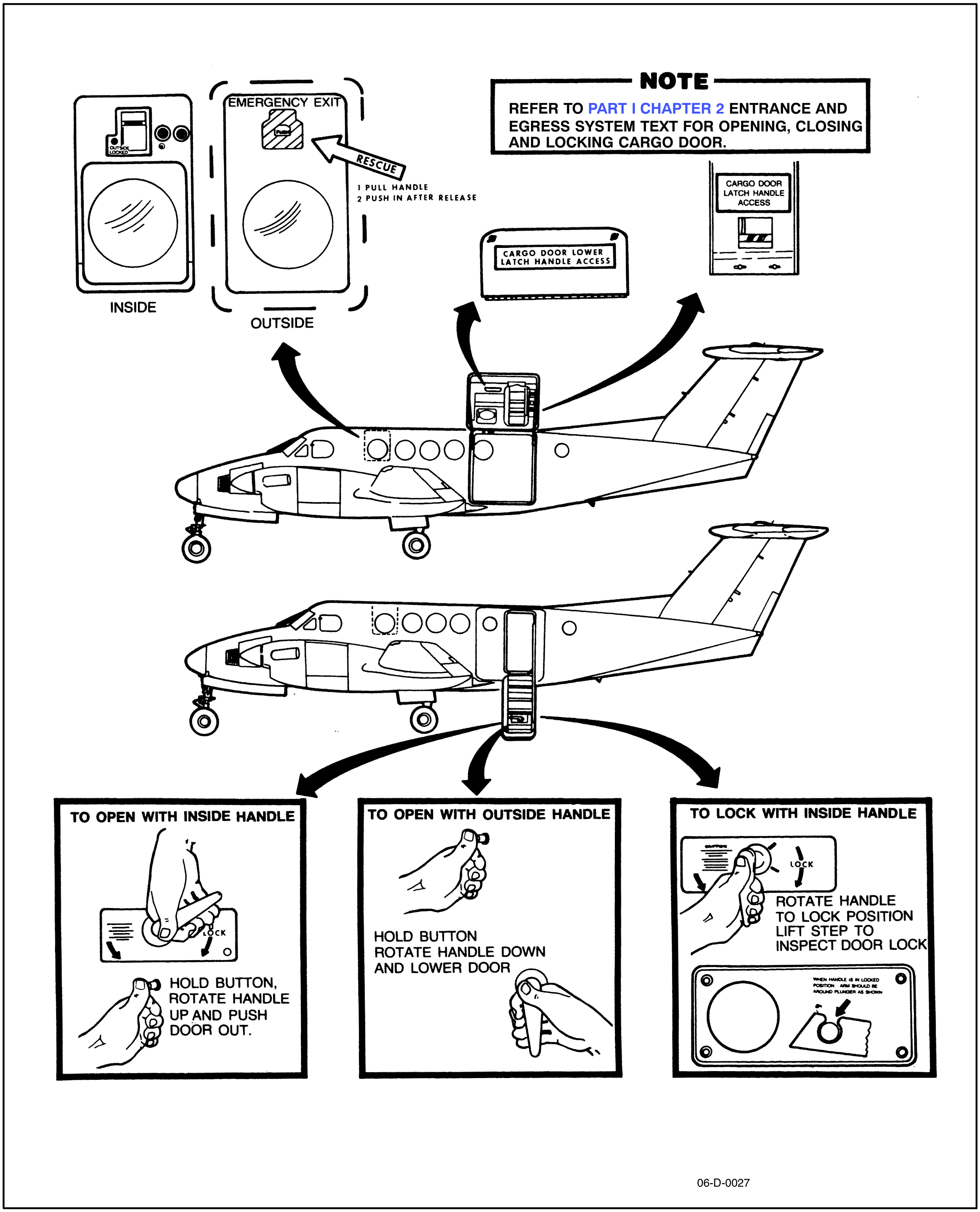


Figure 2-37. Entrance and Exit Provisions

2.25.2.1 Opening the Cargo Door

CAUTION

- Moving the aircraft with the cargo door open may result in aircraft structural damage.

- Ensure the airstair door is closed and locked. Operating the cargo door while the airstair door is open may damage the door hinges and adjacent structure.

Unfasten and open the handle access door at the lower forward corner of the door. Lift the hook and move the handle to the OPEN position. Secure the access door. Unfasten and open the handle access door at the upper aft corner of the door. Depress the button and lift the handle to the OPEN position. Latch the handle in place. Secure the access door.

Attach one end of the door stabilizer assembly to the cargo door ball stud on the forward side of the door. (Ensure the stabilizer rod detent pin is in place.)

Push out on the airstair door sill step and allow the cargo door to swing open. The gas springs will automatically open the door. Attach the free end of the support rod to the ball stud on the forward fuselage doorframe.

2.25.2.2 Closing the Cargo Door

Detach the door support rod from the fuselage door frame ball stud. Firmly grasp the free end of the door support rod while exerting a downward force to overcome the pressure of the gas spring assemblies.

CAUTION

Avoid side loading of the gas springs to prevent damage to the mechanism.

Remove the support rod from the door as the gas spring assemblies pass the overcenter position. The internal pressure of the springs is reversed, forcing the door to the closed position. Using the finger hold cavity in the fixed airstair doorstep, pull the door closed to permit the latching mechanism to engage. Depress the button in the center of the handle at the upper aft corner of the door and pull the handle down until the handle latches into position. Pull up on the handle to ensure it is locked in place. Close and fasten the access door. Move the handle at the bottom forward corner of the door to the full forward position. Ensure the safety hook locks the handle in position by pulling up on the handle.

2.25.3 Emergency Exit Hatch

The plug-type emergency exit hatch (Figure 2-37) is located at the first cabin window on the right side of the aircraft. When released, the hatch completely moves from the frame toward the inside of the cabin. The hatch is released from inside with a pulldown handle placarded EXIT — PULL. From outside, the hatch is released with a flush mounted pullout handle. To provide aircraft security and prevent the hatch from being opened from outside, a key lock is provided on the inside. When the hatch is locked, the key will be in the horizontal position and cannot be removed. The inside release handle will override the key lock assembly when locked; however, the hatch should always be unlocked prior to every flight to allow removal of the hatch from outside in an emergency. A wiper-type disconnect for the air duct that supplies air to the eyeball outlet in the emergency exit hatch is located on the upper aft edge of the hatch. Since it is an integral part of the door, the duct is disconnected as the door is removed. An electrical disconnect for the wiring to the reading light and the fluorescent light in the emergency hatch will unplug as the door is being removed. When reinstalling the hatch, the electrical disconnect should be reconnected before moving the hatch to the fully closed position.

2.26 ENVIRONMENTAL CONTROL SYSTEMS

The pressurization, heating, ventilation, and air-conditioning systems (Figure 2-38) operate in conjunction with each other or as separate systems to maintain the desired cabin pressure altitude and cabin air temperature. The system utilizes a vapor-cycle, refrigerative-type air cooler and engine bleed air heating. Occupied compartments are pressurized, heated, or cooled through a common duct arrangement. Ventilation can be obtained on demand during nonpressurized flight through the condenser air inlet louver on the right side of the nose.

Air pressure for cabin pressurization, cabin and cockpit heating, and surface deicing is obtained by bleeding air from the diffuser section of each engine. Engine bleed air is ducted from the engine to the flow control unit mounted on the firewall. A pressure supply line to operate the surface deice system, rudder boost, and vacuum system ejector tees off the bleed air line just aft of the first fireseal forward of the firewall. The bleed air from either engine will continue to provide adequate air for pressurization and heating and for the deicer system should one engine fail. The bleed air and ambient air from the cowling intake is mixed by the flow control units and is routed aft through the firewall along the inboard side of each nacelle and inboard to the center section forward of the main spar. The heat in the air may either be retained for cabin heating or dissipated for cooling purposes as the air passes through the center section to the fuselage. Air intakes on the inboard wing leading edges bring ram air into heat exchangers to cool the engine bleed air before being ducted into the cabin. This ram air is then ducted overboard through louvers in the lower wing skins. The conditioned bleed air, whether being used for heating or cooling, is then ducted to a mixing plenum located just aft of the forward pressure bulkhead, where it is mixed with cabin recirculated or cooled air. Air is then distributed through various outlets into the cabin and flight compartment of the aircraft. A check valve with two flappers is installed at the juncture of the bleed air lines to prevent loss of pressure should either engine fail.

The air from the mixing plenum is routed through ducts behind the instrument panel to outlets on each side of the flight compartment and to the defroster outlets for the windshield. Valves to each outlet and in the defroster duct control the flow of conditioned air into the flight compartment. These valves are regulated by push-pull controls on the subpanels. A low-pressure duct from the aft side of the mixing plenum extends aft under the right seat deck of the cabin and distributes the heated air through the floor outlets on each side of the cabin.

2.26.1 Bleed Airflow Control Unit

(**B**) Each flow control unit consists of an ejector and an integral bleed air modulating valve, firewall shutoff valve, ambient air modulating valve, and a check valve that prevents the bleed air from escaping through the ambient air intake. The flow of bleed air through the flow control unit is controlled as a function of atmospheric pressure and temperature. Ambient airflow is controlled as a function of temperature only. When the BLEED AIR switches located on the copilot subpanel are in the OPEN position, an electric solenoid valve on each flow control unit opens to allow the bleed air into the unit. As the bleed air enters the flow control unit, it passes through a filter before going to the reference pressure regulator. The regulator will reduce the pressure to a constant value (18 to 20 psi). This reference pressure is then directed to the various components within the flow control unit that regulate the output to the cabin. One reference pressure line is routed to the firewall shutoff valve located downstream of the ejector. An orifice is placed in the line immediately before the shutoff valve to provide a controlled opening rate. At the same time, the reference pressure is directed to the ambient air modulating valve located upstream of the ejector. A pneumatic thermostat with a variable orifice is connected to the modulating valve.

The pneumatic thermostat is located on the lower aft side of the fireseal forward of the firewall. The bimetallic sensing discs of the thermostat are inserted into the cowling intake. These discs sense ambient temperature and regulate the size of the thermostat orifices. Warm air will open the orifice and cold air will restrict it until, at –30 °F, the orifice will completely close. When the variable orifice is closed, the pressure buildup will cause the modulating valve to close off the ambient air source. An electric solenoid valve located in the line to the pneumatic thermostat is wired

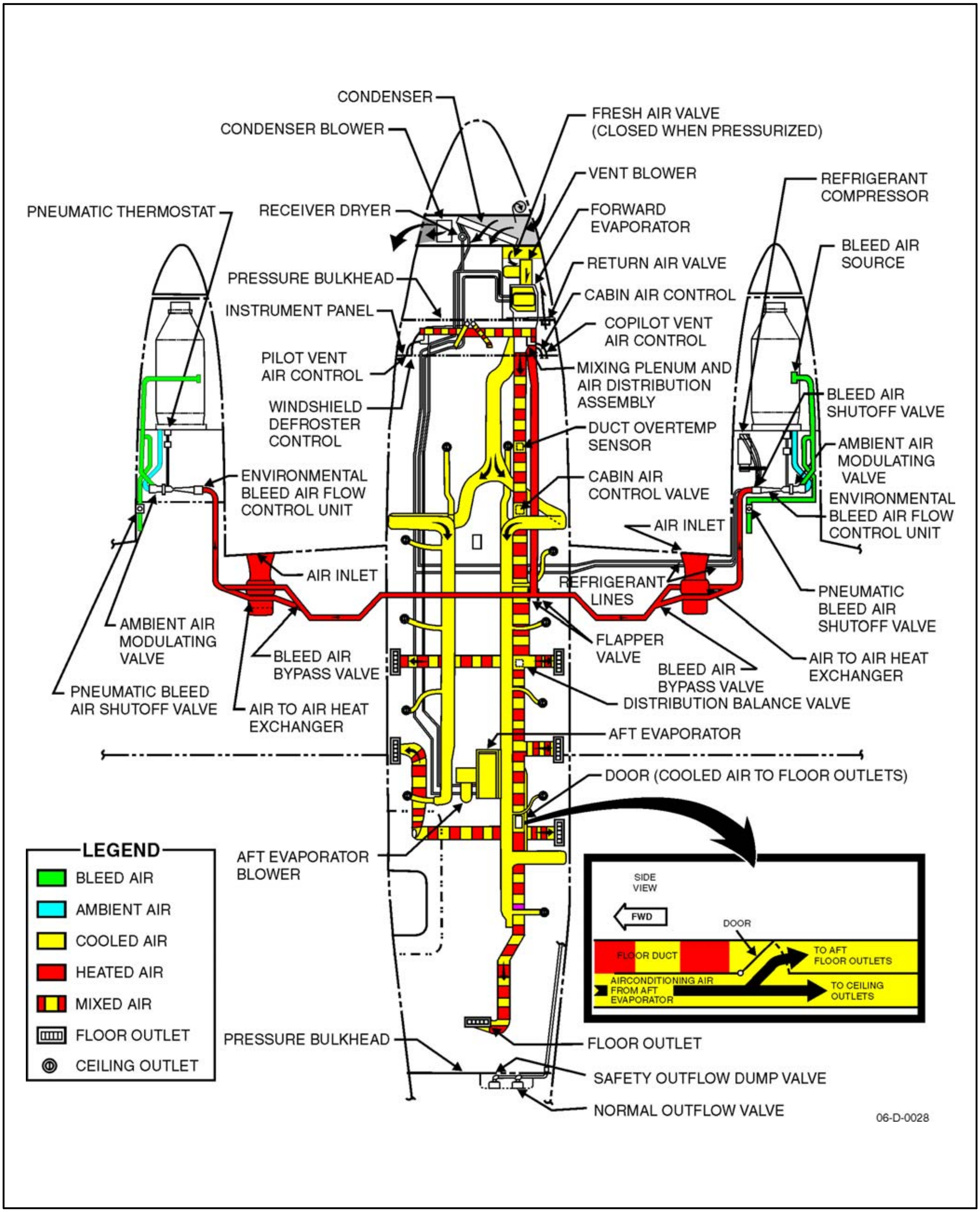


Figure 2-38. Environmental Systems

to the left landing gear safety switch. When the aircraft is on the ground, the solenoid valve is closed, thereby directing the pressure to the modulating valve, causing it to shut off the ambient air source. The exclusion of ambient air allows faster cabin warmup during cold weather operation and prevents induction of contaminants into cabin. An electric circuit containing a time-delay relay is wired to the above mentioned solenoid valves to allow the left valve to open several seconds before the right valve. This precludes the simultaneous opening of the ambient air modulating valves and a sudden pressure surge in the cabin. A check valve located downstream from the modulating valve prevents the loss of bleed air through the ambient air intake. At the same time, reference pressure is directed to the ejector flow control actuator. This actuator is connected to another variable orifice of the pneumatic thermostat and a variable orifice controlled by an isobaric aneroid. The thermostat orifice is restricted by decreasing ambient temperature, and the isobaric aneroid orifice is restricted by decreasing ambient pressure. The restriction of either orifice will cause a pressure buildup on the ejector flow control actuator, permitting more bleed air to enter the ejector.

(**F**/**M**) Each bleed airflow control unit consists of an electronic controller, an ambient temperature sensor, and a pneumatic control valve. The control valve consists of an air ejector, bleed airflow modulating valve with bypass, bleed air valve switch, ambient airflow modulating valve, firewall shutoff solenoid valve, a check valve that prevents the bleed air from escaping through the ambient air intake, a bleed airflow transducer, and an ambient airflow transducer. The electronic flow control and mixing system controls the flow of both ambient and bleed air as a function of atmospheric temperature for cabin heating and pressurization. Input signals to the electronic controller are provided by the ambient temperature sensor, the ambient airflow transducer, and bleed airflow transducer. These input signals are used by the electronic controller to regulate the flow control unit. The ambient temperature sensor, located on the lower aft side of the fireseal forward of the firewall, is inserted into the cowling air intake. The ambient airflow transducer, located on the upstream end of the flow control unit, measures ambient airflow. The bleed flow transducer senses the bleed air valve position (the amount of bleed air). The ambient airflow modulating valve is actuated by the left landing gear squat switch. This valve is actuated (ambient air port closed) during ground operations to prevent the introduction of contaminants into the cabin environment and allow faster cabin warmup. After the engine is started and the flow control unit is energized, the bleed air modulating valve will close, actuating a limit switch. When the switch is actuated, the electronic controller signals the solenoid on the firewall shutoff valve, opening the valve and allowing air to enter the cabin. The bleed air valve continues to open until the desired bleed air flow rate to the cabin is reached. After takeoff, the landing gear squat switch sends signal to the electronic controller that operates the ambient flow modulating valve until the desired ambient flow rate is reached. As the aircraft climbs to higher altitudes and/or enters a cooler environment, the ambient airflow is reduced, allowing bleed airflow gradually increase to maintain sufficient heating of the cabin. At approximately –17 °C temperature, the ambient airflow valve is completely closed and the bleed air valve bypass section opens, allowing more bleed airflow past the fixed flow passage of the air ejector.

2.26.2 Pressurization System

The pressurization system is designed to provide a normal working pressure differential of (**B**) 6.1 psi that will provide cabin pressure altitudes of approximately 9,900 feet at 31,000 feet, (**F**/**M**) 6.6 psi that will provide cabin pressure altitudes of approximately 10,400 feet at 35,000 feet.

Bleed air from the compressor section of each engine is utilized to pressurize the pressure vessel. A flow control unit in the nacelle of each engine controls the pressure of the bleed air and mixes it with ambient air to provide a mixture suitable for the pressurization function. The mixture flows to the environmental bleed air shutoff valve, which is controlled by a switch placarded (**B**/**F**) BLEED AIR VALVE — LEFT (or) RIGHT — OPEN — ENVIR OFF — INSTR & ENVIR OFF on the copilot subpanel. (**M**) ENVIR & PNEU BLEED AIR — LEFT (or) RIGHT — PNEU ONLY — ON located in the overhead control panel. When this switch is in either the (**B**/**F**) ENVIR OFF or the INSTR & ENVIR OFF/(**M**) PNEU ONLY or aft position, the valve is closed. When it is in the OPEN position, the air mixture flows through the valve and to the air-to-air heat exchanger. Depending upon the position of the bypass valves, a greater or lesser volume of the air mixture will be routed through or around the heat exchanger. The temperature of the air flowing through the heat exchanger is lowered as heat is transferred to cooling fins that are in turn cooled by ram airflow through the fins of the heat exchanger. The air leaving the left and right bypass valves is then ducted into a single muffler located under the right floorboard forward of the main spar that helps ensure quiet operation of the environmental bleed air system. The air mixture is then ducted from the muffler into the mixing plenum located under the copilot floorboard.

A partition divides the mixing plenum into two sections. One section supplies the floor outlet duct, and the other supplies the ceiling outlet duct. Both sections receive recirculated cabin air from the forward vent blower. This air passes through the forward evaporator, so it will be cooled if the air-conditioner is operating. Even if the forward vent blower becomes inoperative, some air will still be circulated because of a special nozzle in the discharge side of the mixing plenum.

The environmental bleed air duct is routed into the floor duct section of the mixing plenum, then curves back to discharge the environmental bleed air toward the aft end of the floor duct section of the mixing plenum. Forward of the discharge end of the environmental bleed air duct, warm air is tapped off and ducted up through the top of the mixing plenum and into the crew heat duct, which also receives recirculated cabin air from the mixing plenum. A valve on the forward side of the crew heat duct allows air to be tapped off for delivery to the windshield defroster when the DEFROST AIR knob on the pilot left subpanel is pulled out.

The air from the environmental bleed air duct is mixed with recirculated cabin air (which may or may not be air-conditioned in the mixing plenum) then routed into the floor outlet duct. The pressurized air is then introduced into the cabin through the floor registers. Finally, the air flows out of the pressure vessel through the outflow valve located on the aft pressure bulkhead. A silencer on the outflow and safety dump valves ensures quiet operation.

The mixture from both flow control units is delivered to the pressure vessel at a variable rate depending upon ambient temperature and pressure altitude. Pressure within the cabin and the rate of cabin pressure changes are regulated by pneumatic modulation of the outflow valve, which controls the rate at which air can escape from the pressure vessel.

A vacuum-operated safety valve is mounted adjacent to the outflow valve on the aft pressure bulkhead. It is designed to serve three functions: provide pressure relief in the event of malfunction of the normal outflow valve, allow depressurization of the pressure vessel whenever the cabin pressure switch is moved into the DUMP position, and keep the pressure vessel unpressurized while the aircraft is on the ground with the left landing gear safety switch compressed. A negative pressure relief function is also incorporated into both the outflow and the safety valves that prevents outside atmospheric pressure exceeding cabin pressure by more than 0.1 psi during rapid descents, even if bleed air inflow ceases.

When the BLEED AIR VALVES are OPEN, the air mixture from the flow control units enters the pressure vessel. While the aircraft is on the ground, a left landing gear safety switch-actuated solenoid valve in each flow control unit keeps the ambient air intake port closed, allowing only bleed air to be delivered into the pressure vessel. At lift-off, the safety valve closes and the ambient air shutoff solenoid valve in the left flow control unit opens. Approximately 6 seconds later, the solenoid in the right flow control unit opens. Consequently, by increasing the volume of airflow into the pressure vessel in stages, excessive pressure bumps during takeoff are avoided.

2.26.2.1 Pressurization Control System

The pressurization control system consists of a system mode switch, cabin altitude controller, an outflow valve, and a safety valve. The controller is located on the extended pedestal (Figures (**B**) 2-2/(**F**) 2-3/(**M**) 2-4) along with the system mode switch placarded CABIN PRESS DUMP — PRESS — TEST. The cabin pressure differential indicator, cabin altimeter, and rate-of-climb indicator are located below the caution/advisory annunciator panel. The outflow valve and safety valve are both located in the aft pressure bulkhead. The outflow valve is controlled by the cabin pressure controller to the cabin altitude selected by the pilot, up to the maximum differential of (**B**) 6.1 psi (**F/M**) 6.6 psi. The controller also regulates the rate of cabin pressure change at the value selected by the pilot. The safety valve is set at (**B**) 6.1 psi (**F/M**) 6.6 psi and operates automatically to prevent excessive pressure buildup in the event of a malfunction of the normal control system.

If the cabin altitude should reach 12,500 feet, a pressure-sensing switch mounted on the forward pressure bulkhead will close. This illuminates the red ALT WARN annunciator and flashing MASTER WARNING light, alerting the pilot of operation requiring oxygen. Another pressure-sensing switch mounted on the cabin sidewall forward of the emergency exit will also close, causing the passenger oxygen masks to deploy automatically and cabin lights to go full bright.

The controller provides a display of the selected altitude, an altitude selector, and a rate control. The outer scale of the display indicates the selected cabin altitude; the inner scale indicates the corresponding altitude at which the maximum differential pressure would occur. The rate control regulates the rate at which cabin pressure ascends or descends to the selected altitude. At the 12 o'clock position, the rate of change is approximately 500 feet per minute.

The following description of the system operation assumes that the system is functioning normally, both engines are operating, pneumatic bleed air from the engines is flowing normally, and the aircraft vacuum system is functioning.

Prior to a normal pressurized flight, with the system mode switch placed in the PRESS position, electrical power closes the air-conditioning system evaporator door and, through the left landing gear safety switch, actuates the cabin pressure solenoid and cabin pressure safety valve. When the aircraft leaves the ground, the landing gear safety switch deactivates the vacuum lockout solenoid and the dump solenoid valve. The evaporator door solenoid remains actuated, and the dump solenoid valve closes to remove the safety valve control chamber from the aircraft vacuum system. Cabin air enters the control chamber of the safety valve through a filter and orifice. Simultaneously, the vacuum lockout solenoid valve opens, connecting the cabin altitude controller to the aircraft vacuum system. The controller pre-rates to the selected cabin altitude. If the selected cabin altitude is above the field elevation, the outflow valve will modulate open, preventing pressurization of the aircraft until the selected altitude is reached. As the aircraft reaches the selected cabin altitude, the reference pressure developed within the cabin altitude controller decreases, permitting the outflow valve to modulate toward the closed position, thus restricting the outflow of cabin air. The outflow valve will modulate to restrict the outflow of cabin air required to maintain the selected altitude.

If the flight plan requires an aircraft altitude greater than the altitude indicated on the cabin altitude scale, the cabin will climb at approximately 80 percent of the aircraft rate.

Note

During a rapid rate of aircraft ascent, if the cabin rate selector is set at a low rate, the maximum differential pressure could be achieved prior to reaching the selected aircraft altitude.

Should there be a loss of airflow and the aircraft descends to an altitude where the atmospheric pressure exceeds the cabin pressure, the valves will open, permitting air at atmospheric pressure to flow into the cabin, counteracting the negative pressure differential.

Depressurizing the cabin for emergencies may be accomplished by placing the mode select switch in the DUMP position. The safety valve will open, permitting the cabin airflow to exhaust to the atmosphere without restriction. Upon landing, the DUMP mode is automatically cycled through the landing gear safety switch.

When the mode select switch is in the TEST position, power is removed from the solenoid valves and the aircraft may be pressurized on the ground.

2.26.3 Air- Conditioning System

Air-conditioning is provided by a refrigerant gas vapor cycle system consisting of an engine-mounted, belt-driven compressor installed on the right engine accessory section along with various other plumbing, switches, evaporators, blowers, and coils. Plumbing from the compressor is routed through the right wing and fuselage to the nose, where the vapor cycle system is housed.

High and low pressure limit switches and an N_1 engine speed switch are provided to prevent compressor operation outside of established parameters. The N_1 speed switch will interrupt electrical power to the compressor clutch when the engine speed is below 62 percent N_1. When the N_1 speed switch is open and there is a demand for air conditioning, the green AIR COND N_1 LOW advisory annunciator will illuminate. Protection from refrigerant overpressure or underpressure is provided through a circuit incorporating high- and low-pressure switches in the right wing refrigerant plumbing. On aircraft prior to BuNo 161310, these switches, if activated, will blow a fuse located in the right wing. On aircraft BuNo 161310 and after (includes all **(F)** aircraft), they will trip a circuit breaker in the nose wheelwell to shut down the compressor and the blower. The malfunction should be corrected before returning the system to operation.

The vent blower blows recirculated cabin air (plus outside ambient air if the cabin is unpressurized) through the evaporator, into the mixing plenum, and into the forward floor and ceiling ducts. A rear evaporator and vent blower are located under the center aisle floorboards and supply air to the aft overhead and floor outlets. If the cooling mode is operating, refrigerant will be circulating through the evaporator and the air leaving it will be cool. This cool air is discharged through eyeball outlet nozzles in the cockpit and cabin. Cooled air enters the floor duct, but in order to provide cabin pressurization, warm environmental bleed air will also enter the floor duct anytime either BLEED AIR valve is OPEN; therefore, pressurization air discharged from the floor registers will always be warmer than that discharged at the ceiling outlets, regardless of the temperature mode in use. A vane blower draws ambient air through the condenser located in the nose section when the cooling mode is operating. This blower is not operational when the aircraft is airborne.

2.26.4 Ventilation System

Fresh air ventilation is provided by two sources. One source, which is available during both the pressurized and the unpressurized mode, is the bleed air system. This air mixes with recirculated cabin air and enters the cabin through the floor outlets. Moving a sliding handle at the side of each unit regulates the volume of air from the floor outlets.

The second source of fresh air, which is available during the unpressurized mode only, is ambient air obtained through a check valve from the condenser section in the nose of the aircraft. During pressurized operation, cabin pressure forces the check valve closed. During the unpressurized mode, a spring holds the check valve open, so that the forward blower can draw this air into the cabin. The ambient air then mixes with recirculated cabin air, goes through the forward blower, through the forward evaporator (if it is operating, the air will be cooled), into the mixing plenum, and into the cabin through all the ceiling and floor outlets. Air ducted to each individual ceiling eyeball outlet can be directionally controlled by moving the eyeball in the socket. Twisting the outlet to open or close the damper regulates volume.

2.26.5 Heating System

Cabin heating is accomplished by extracting engine bleed air from both engines and combining it with ambient air through the pressurization and heating flow control unit in each nacelle. A control switch on the copilot subpanel energizes each bleed airflow control valve. The ambient air control solenoid valve is energized to close on the ground by a landing gear safety switch on the left main landing gear to provide only warm bleed air to the cabin. When the aircraft lifts off the ground, the landing gear safety switch immediately deenergizes and opens the ambient air control on one side. The other ambient air control solenoid valve opens later through a time-delay circuit. Air is ducted into the cabin through or around the air-to-air heat exchangers in the inboard wing leading edges. Control of the air being routed through or around the heat exchangers is accomplished by regulating the position of the environmental bleed air bypass valves, either manually or automatically by switch selection on the copilot subpanel.

At the junction of the environmental bleed air lines, a check valve is installed to prevent the loss of pressure should either engine fail. The environmental bleed air line from the tee is routed forward along the right side of the fuselage to a mixing plenum just aft of the forward pressure bulkhead, where it is mixed with cabin recirculated air. The environmental bleed air lines from the engine compartment to the mixing plenum are wrapped with insulation and aluminum tape to reduce heat loss. The air from the mixing plenum is routed through ducts behind the instrument panel to outlets on each side of the cockpit and to the defroster outlets for the windshield. A valve to each outlet and in the defroster duct controls the flow of heated air into the flight compartment. These valves are regulated by push-pull controls on the subpanel placarded PILOT AIR, DEFROST AIR, and COPILOT AIR. A low-pressure duct from the aft side of the mixing plenum extends aft under the right seat deck of the cabin and distributes the heated air through the floor outlets on each side of the cabin.

At cruise power, the heating capacity of the system is sufficient to maintain cabin temperatures in excess of 65 °F at ambient temperatures of -65 °F.

2.26.5.1 Radiant Heating

A radiant heater element installed in the cargo door is controlled by the cabin temperature mode switch and operates in all heating modes. This unit provides supplemental heat to the cabin for additional passenger comfort and heats the dead air space inside the cargo door to aid cabin heating.

2.26.6 Temperature Control

The temperature control system consists of a cabin temperature mode switch, a manual temperature selector switch, a temperature control box, a duct temperature sensor, two heat exchanger bypass valves, electrical relays, and wiring.

The mode switch has four placarded positions: MANUAL HEAT, MANUAL COOL, OFF, and AUTO. The forward evaporator has a two-speed blower for air distribution that is controlled by a three-position VENT BLOWER switch on the copilot subpanel. Positions on the VENT BLOWER switch are AUTO, LO, and HI. The low speed will come on when the mode switch is turned on to AUTO, MANUAL HEAT, or MANUAL COOL.

(**B/F**) The aft vent blower is controlled by a switch placarded AFT VENT BLOWER — OFF — ON. The single-speed blower operates continuously when the switch is placed in the ON position. In the OFF position, the blower will not operate.

(**M**) The aft vent blower is controlled by a switch placarded VENT BLOWER AFT (OFF) — AUTO — ON. This single-speed blower operates automatically through the CABIN TEMP MODE SELECTOR when the AFT BLOWER switch is placed in the AUTO position with the landing gear extended and there is a cool command. This blower is intended for use when maximum cabin cooling is required. When the landing gear is retracted, the blower will automatically shut off. The blower will operate continuously when the switch is in the ON position.

Note

For maximum heating in aft cabin, the aft blower should be secured.

2.26.6.1 Automatic Operation

When the AUTO mode is selected, the heating and air-conditioning system is automatically controlled through a balanced bridge by the temperature control box. An output signal from the temperature control box is transmitted to the environmental bleed air bypass valves in the inboard wings. Here, the bypass valves controlling the amount of air bypassing the air-to-air heat exchangers regulate the inflow air.

When the output signal from the temperature control box drives both bleed air bypass valves to the maximum cool position, the refrigerant compressor clutch and condenser blower will energize. The clutch and fan will remain energized until the left valve rotates 30° back toward the hotter position. At this position, a microswitch on the valve operates to deenergize the clutch and fan.

A thermal switch is wired into the AUTO mode circuit to prevent the clutch and condenser blower from being energized until the ambient temperature is above 50 °F, provided that a heat signal pulse is emitted from the temperature control box. The switch will close at 50 °F as the temperature increases and will open at 30 °F as the temperature decreases. If no heat signal pulse is provided by the temperature control box, the clutch and condenser blower will energize.

2.26.6.2 Manual Heat Operation

When the mode switch is in the MANUAL HEAT position, the compressor clutch and condenser blower cannot be energized. Selecting the position of the bypass valves with the momentary increase/decrease (MANUAL TEMP) control switch controls the temperature. When the MANUAL TEMP selector is switched to INCR, the left bypass valve is driven open to allow the engine bleed air/ambient air mixture to be routed around the heat exchanger for increased heating. The switch must be held in the INCR position to actuate the bypass valves because the action of the valves will stop when the MANUAL TEMP switch is released. If sufficient heating is not obtained by full actuation of the left bypass valve, an integral limit switch in the valve will close and the right bypass valve will energize. Approximately 30 seconds are required for each valve to drive to the full open or full closed position.

When the aircraft is on the ground, the ambient air shutoff valves in the environmental bleed air system are closed by actuation of the landing gear safety switch. This exclusion of ambient air permits all of the heat from the engine bleed air to be retained for cabin heating. When the aircraft lifts off the ground, the safety switch breaks the circuit to the left ambient air valve. In order to prevent a pressure surge in the cabin, the right valve will open a few seconds after the left valve through a time-delay circuit.

2.26.6.3 Manual Cool Operation

With the mode switch in the MANUAL COOL position, the compressor clutch and condenser fan are energized. During the MANUAL COOL mode, the air-conditioner is full on regardless of ambient temperature. Cabin temperature is controlled by actuation of the heat exchanger bypass valves through the MANUAL TEMP switch. The rotation of the valves will stabilize at the relative position at which the MANUAL TEMP switch is released. The bypass valves must be fully closed for air-conditioning.

An automatic bypass valve, located in the refrigerant plumbing in the forward evaporator section, operates to prevent freezeup of the evaporator by routing the hot refrigerant gas around the expansion valve. This maintains a constant low side pressure and a constant evaporator temperature just above freezing. A 33 °F thermal switch is installed in the forward evaporator section to operate the bypass valve. The rear expansion valve automatically shuts off the refrigerant flow when the aft evaporator blower is off.

2.27 OXYGEN SYSTEM

The oxygen system is provided primarily as an emergency use system; however, the system may be used to provide supplemental oxygen for first-aid, etc. Refer to Figure 2-39.

Note

(**B/F**) The passenger manual override is on the right and the system ready knob is on the left.

A 49-cubic-foot oxygen supply cylinder charged with aviators breathing oxygen is installed in the unpressurized portion of the aircraft behind the aft pressure bulkhead. The oxygen pressure gauge on the copilot subpanel gives a direct reading of cylinder pressure. Oxygen duration is based on cylinder pressure, personnel on board, and aircraft altitude. Refer to Figures (**B**) 2-40/(**F/M**) 2-41. The pressure regulator and control valve are located adjacent to the supply cylinder and are actuated by a push-pull control knob placarded PULL ON SYS READY located immediately aft of the overhead control panel. The control knob operates a cable that opens and closes the shutoff valve on the supply cylinder. Opening the shutoff valve charges the primary oxygen supply line that, in turn, delivers oxygen to the pilot, copilot, first-aid oxygen mask outlets, and to the passenger oxygen system control valve. Adjacent to the system control knob is another push-pull knob placarded PASSENGER MANUAL O'RIDE. This actuates the passenger oxygen control valve supplying oxygen to the 10 passenger masks when the PULL ON SYS READY knob is pulled ON. Anytime the primary oxygen supply line is charged, oxygen will be available from the first-aid oxygen outlet by opening the overhead access door placarded FIRST AID OXYGEN — PULL and opening the ON — OFF valve inside. The first-aid oxygen is located in the aft portion of the aircraft containing the liferaft, toilet, etc. A placard inside the door reads NOTE: CREW SYS MUST BE ON as a reminder that the PULL ON SYS READY knob in the flight compartment must be pulled ON before oxygen will be available at the first-aid mask.

2.27.1 Crew Masks

Crew sweep-on full-face oxygen masks are stowed on the partition behind the pilot and copilot seats. Each mask is equipped with an inflatable pneumatic harness, supply indicator, and a mask-mounted automatic diluter-demand regulator with single knob control. Each mask has an automatic microphone cutoff that deactivates the microphone during inhalation, providing clear audio transmissions. The diluter-demand regulator has three mode settings indicated on the mode control knob: NORMAL, 100 percent, and EMERGENCY. In the NORMAL position, the regulator provides supplemental oxygen based on cabin altitude. 100 percent sets the oxygen supply at 100 percent regardless of altitude. The EMERGENCY control setting provides 100 percent oxygen with visor positive pressure to purge and prevent gas contaminates from entering the mask. The inflatable harness expands while the regulator red button is pressed. Each mask oxygen supply line indicator will signal green when armed and red when pressure is low. The crew masks shall be plugged in at all times and normally set in the 100 percent position.

Note

- The quick donning crew masks shall be plugged in and hung on the partition at all times. Diluter demand masks only supply oxygen upon inhalation; therefore, there is no loss of oxygen if the masks are plugged in and the PULL ON SYS READY control knob is pulled ON.
- Moisture that might accumulate in the NORMAL or 100 percent mode can be cleared in 2 to 3 seconds by momentarily selecting EMER mode. In the EMER mode, mask oral-nasal cup vents open to allow 100 percent oxygen to be directed to the visor for defogging.
- Communication may be difficult while on emergency oxygen with HOT MIC selected.

2.27.2 Passenger Oxygen System

The auto-deployment passenger oxygen system is a constant-flow type. The oxygen is delivered to the masks at a 100 percent rate of flow. If, because of a pressurization system failure or malfunction, cabin altitude exceeds approximately 12,500 feet, a barometric pressure switch will energize a solenoid that automatically opens the passenger oxygen system shutoff valve. Oxygen will charge the passenger oxygen system supply line and extend a plunger against each of the passenger mask dispenser doors, forcing the door open. The oxygen masks will then drop down approximately 9 inches below the dispensers. A lanyard pin at the top of the oxygen mask must be pulled for oxygen to flow to the mask and be reinserted to stop oxygen flow when the mask is no longer needed. There are four auto-deployment mask dispensers in the aircraft. Three of the dispensers contain three masks each; the other contains a single unit. Pulling the PASSENGER MANUAL O’RIDE knob located adjacent to the PULL ON SYS READY knob can also open the shutoff valve. After the passenger system has been opened, either automatically or manually, a pressure-sensitive switch in the supply line will activate to illuminate the green PASS OXY ON annunciator legend on the caution/advisory panel. Additionally, all cabin lights will illuminate in the full bright mode, regardless of the CABIN LIGHTS switch position. The passenger oxygen may be shut off and the remaining oxygen isolated to the pilot, copilot, and first-aid masks by pulling the (**B/F**) OXYGEN CONTR circuit breaker in the ENVIRONMENTAL section on the right side (**M**) AUTO OXYGEN circuit breaker in the ENVIRONMENTAL section on the overhead circuit breaker panel, provided the PASSENGER MANUAL O’RIDE knob is in the OFF position.

2.28 RAIN REMOVAL/ANTI-ICE/DEICE SYSTEMS

2.28.1 Windshield Defogging System

Heated air for defogging the windshields is obtained from the environmental air mixing plenum located beneath the floor just aft of the forward pressure bulkhead. The air from the mixing plenum is routed through ducts behind the instrument panel to either the windshield or flight compartment heat outlets. A valve to the windshield outlets is controlled by a push-pull knob placarded DEFROST AIR located on the pilot inboard subpanel.

2.28.2 Windshield Wipers

The dual windshield wiper installation consists of a motor, wiper arm assemblies, drive shafts, and converters, all located forward of the instrument panel, and a control switch located on the overhead lighting control panel. The control switch is placarded WINDSHIELD WIPERS with positions PARK — OFF — SLOW — FAST and includes a bracketed placard (DO NOT OPERATE ON DRY GLASS). The wipers are two-speed units for light or heavy precipitation and may be used for both ground and flight operations. The switch position PARK is a spring-loaded position used to bring both wipers to the inboard position. The wiper electrical components are protected by the circuit breaker placarded WSHLD WIPER in the WEATHER section on the (**B/F**) right side panel (**M**) overhead panel.

2.28.3 Windshield Anti-Ice System

The windshields are protected against icing by electrothermal heating elements incorporated into each windshield. Two levels of heat are provided: NORMAL and HI. In the NORMAL mode, heat is applied to the entire windshield. In the HI mode, heat is applied to a more concentrated but more essential viewing area (outboard two-thirds) at a more rapid rate. When NORMAL or HI is selected, temperature sensing units (thermistors) sense the temperature at the windshield surface and, through a heat controller unit and relay, cycle to maintain the windshield temperature between 90 °F to 100 °F. The windshield heating system is controlled by two individually placarded three-position toggle switches located in the ICE section on the (**B/F**) pilot inboard subpanel (**M**) overhead control panel. The switches are placarded WSHLD ANTI-ICE, PILOT and COPILOT, NORMAL — OFF — HI.

Note

- Unreliable operation of the magnetic compass will occur during use of windshield anti-ice system, and/or windshield wipers, and/or air-conditioner.

- During use of windshield anti-ice, objects viewed through the windshield may appear blurred.

2.28.4 Surface Deice System

The surface deicing systems (Figure 2-42) remove ice from the leading edges of the wings and horizontal stabilizers. Ice removal is accomplished by alternately inflating and deflating the deice boots that are cemented to the leading edges of the wings and stabilizers. Pressure-regulated air from the engines supplies the pressure to inflate the boots, and a Venturi ejector operated by bleed air creates the vacuum to deflate and hold the deice boots down when not in use. To ensure operation of the deice system in the event of an engine failure, a check valve is incorporated in the bleed air line from each engine to prevent the loss of air pressure into the compressor chamber of the inoperative engine. A distributor valve controls the inflation and deflation phases of operation, and the system is actuated by a three-position toggle switch on the (**B/F**) pilot inboard subpanel (**M**) overhead control panel. The switch is placarded (**B/F**) DEICE CYCLE, SINGLE — OFF — MANUAL/(**M**) SURF DEICE MANUAL-SINGLE CYCLE AUTO, and is spring loaded to return to the OFF position from either the SINGLE or MANUAL position. When the switch is placed in the SINGLE position, one complete cycle of the deice operation will automatically follow as the distributor valve opens to inflate the wing boots. After an inflation period of approximately 6 seconds, an electronic timer switches the distributor valve to vacuum to deflate the wing boots and initiates a 4-second inflation period of the horizontal stabilizer boots. When the stabilizer boots have inflated and deflated, the deice cycle is complete. When the switch is placed in the MANUAL position, all the boots will inflate simultaneously and remain inflated as long as the switch is held to the MANUAL position. When the switch is released, the boots will deflate and return to a vacuum hold-down position and remain in this position until the switch is actuated again.

WARNING

Most effective deicing is accomplished by allowing at least 1/2 to 1 inch of ice to form before attempting removal. Very thin ice may only crack and cling to the boots instead of shedding. Subsequent cyclings of the boots will then tend to build a shell of ice outside the leading edge contour, making the ice removal efforts ineffective.

2.28.4.1 Pitot Heater

The dual pitot masts, one on each side of the nose section, are provided with electrical heating elements that prevent the pitot openings from becoming obstructed with ice. The heating elements are controlled by two circuit breaker switches placarded (**B**/**F**) PITOT — LEFT — RIGHT and located in the ICE section on the pilot inboard subpanel/(**M**) PITOT LEFT — RIGHT — ON and located in the ICE & RAIN section on the overhead control panel. Placing the switches to (**B**/**F**) PITOT/(**M**) ON activates the heating elements. (**B**/**F**) The pitot heat system is protected by the circuit breaker function of the switches. (**M**) The left and right pitot mast heaters are protected by the circuit breakers placarded PITOT HEAT and located in the WEATHER section on the overhead circuit breaker panel.

2.28.4.2 Stall Warning Vane Heater

The stall warning vane and mounting plate located on the left wing leading edge are provided with a heating element that prevents ice from impairing or disabling the vane. With weight on wheels, the left main gear safety switch automatically reduces voltage to the heating element to minimize heat to the stall warning vane. (**B**/**F**) The stall warning heat system is controlled by a circuit breaker switch placarded STALL WARN, located in the ICE section on the inboard pilot subpanel. The circuitry is protected by the circuit breaker function of the switch. (**M**) The stall warning heat system is controlled by a toggle switch placarded STALL WARN — ON, located in the ICE & RAIN section of the overhead control panel. Circuitry protection is provided by the circuit breaker placarded STALL WARN, located in the WEATHER section on the overhead circuit breaker panel.

2.28.4.3 Fuel Ram Vent Heater

The fuel systems are vented with two ram vents located beneath each wing adjacent to the nacelle. To prevent icing, one vent is recessed into the wing, and the backup vent protrudes from the wing and contains an electrical heating element. The fuel ram vent heat system is controlled by two switches in the (**B**/**F**) ICE section on the pilot inboard subpanel, placarded FUEL VENT LEFT — RIGHT/(**M**) ICE & RAIN section on the overhead panel, placarded FUEL VENT LEFT-RIGHT. The system circuitry is protected by two circuit breakers in the WEATHER section, placarded LEFT — FUEL VENT — RIGHT on the (**B**/**F**) right side (**M**) overhead circuit breaker panel.

2.28.5 Propeller Electric Deice System

(**B**) The propeller electric deice system consists of an electrically heated boot with two elements (inner and outer) for each propeller blade, brush assemblies, sliprings, a propeller ammeter, timer, override relays, a circuit breaker switch for the automatic cycle, and a switch for the manual (backup) system.

CAUTION

Propeller deice should not be operated when the propellers are not turning. Static operation may damage the brushes and slipring.

(**B**) Current flows from the timer to the brush assembly mounted on the front of the engine case. The brush assembly then conducts the current to the sliprings installed on the propeller spinner bulkhead. The sliprings distribute the current to the deice boots on the propeller blades. Heat from the boot dislodges ice formed on the blade, and it is thrown off by centrifugal force. Power to the inner and outer elements is cycled by the timer in the following sequence: right propeller outer elements, right propeller inner elements, left propeller outer elements, left propeller inner elements. Each phase lasts 30 seconds, and a complete cycle lasts 2 minutes. The automatic propeller deice system is controlled by a two-position circuit breaker toggle switch in the PROP section of the ICE section on the pilot inboard subpanel. The switch has two placarded positions, AUTO and OFF. When the switch is placed in the AUTO position, the propeller ammeter located in the instrument cluster on the overhead panel will register the current (14 to 18 amps) passing through the system. The AUTO mode is protected by the circuit breaker function of the switch.

(**B**) The manual backup deice system is provided. The control switch for the manual system is located in the PROP section of the ICE section on the pilot inboard subpanel and is placarded INNER — OUTER. This switch, which controls the manual deice override relay, is a momentary spring-loaded type, and must be held to the selected position until the ice has been dislodged from the propeller. When the switch is held to either the INNER or OUTER position, the automatic timer is overridden and power is supplied to the selected elements of both propellers simultaneously. After deicing with the outer elements, the switch is held to the INNER position to perform the same function for the inner elements. During use of the manual mode, the aircraft loadmeter will indicate an approximate 5 percent load increase; however, the PROP AMMETER will not indicate any load. The manual deice switch is protected by the circuit breaker placarded PROP DEICE CONTROL located in the circuit breaker section of the fuel management panel. The manual deice circuits are protected by two circuit breakers also located on the fuel management panel placarded LEFT — PROP DEICE — RIGHT.

(**F/M**) The propeller electric deice system consists of electrically heated deice boots, slipring, and brush block assemblies, prop ammeter, a timer for automatic operation, three circuit breakers on the left sidewall circuit breaker panel, and two system switches. The automatic deice system is controlled by a switch placarded (**F**) AUTO — OFF and located in the PROP section of the ICE PROTECTION section on the pilot inboard subpanel/(**M**) PROP AUTO (off) — ON, located in the ICE & RAIN section of the overhead control panel. When the switch is placed in the (**F**) AUTO/(**M**) ON position, the propeller ammeter, located in the instrument cluster on the overhead panel, indicates the current (18 to 24 amperes) passing through the system. The AUTO mode is protected by the circuit breaker function of the switch. The system utilizes a metal foil-type single heating element energized by dc voltage. Heat from the elements dislodges the ice formed on the blades, and the ice is thrown off by centrifugal force.

(**F/M**) Dc current flows from the automatic timer to the brush block assembly mounted on the front of the engine case. The brush assembly conducts the current to the sliprings installed on the prop spinner bulkhead. The sliprings distribute the current to all heating elements on one propeller. The timer then diverts the current to all heating elements on the other propeller for the same length of time. The timer switches every 90 seconds, resulting in a complete cycle of approximately 3 minutes. The cycle will continue as long as the switch is in the AUTO position.

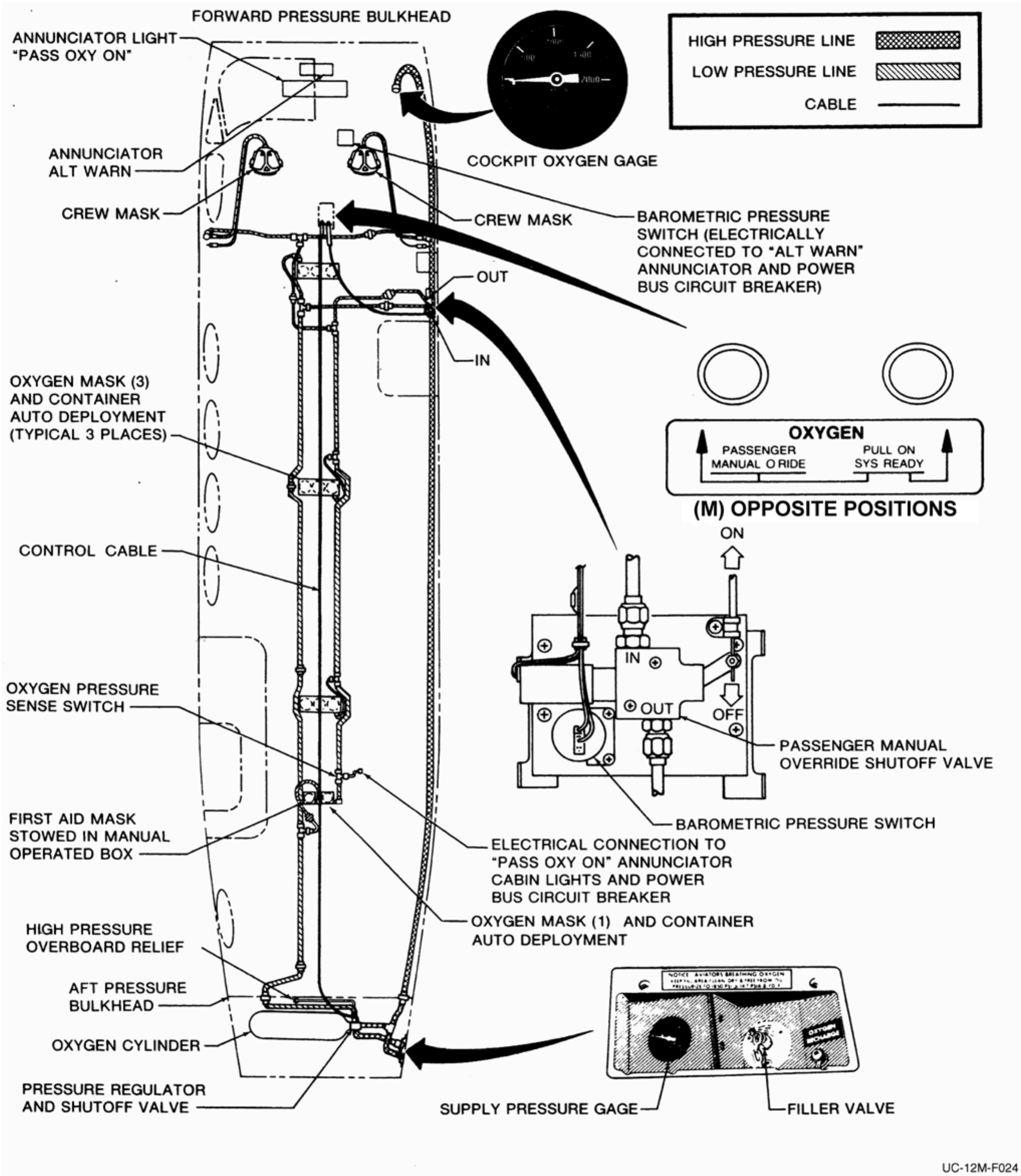


Figure 2-39. Oxygen System Schematic

OXYGEN DURATION IN MINUTES 49-CUBIC-FOOT SYSTEM							
	CABIN ALTITUDE FEET	CREW MASK CONDITION	GAUGE PRESSURE — PSI				200 OR BELOW
			1,850	1,500	1,000	500	
TWO-MAN CREW	31,000	100%	160	129	86	43	
	20,000	100% NORMAL	84 168	68 136	45 90	22 45	
	10,000	100% NORMAL	53 97	42 78	28 52	14 26	
THREE-MAN CREW	31,000	100%	108	87	58	29	
	20,000	100% NORMAL	67 112	54 90	36 60	18 30	
	10,000	100% NORMAL	46 75	39 60	24 40	12 20	
THREE-MAN CREW PLUS ONE PASS	31,000	100%	82	66	44	22	
	20,000	100% NORMAL	56 84	45 68	30 45	15 22	
	10,000	100% NORMAL	40 61	32 49	21 32	10 16	
THREE-MAN CREW PLUS TWO PASS	31,000	100%	66	53	35	17	
	20,000	100% NORMAL	48 67	38 54	25 36	12 18	
	10,000	100% NORMAL	36 54	29 43	19 29	9 14	
THREE-MAN CREW PLUS THREE PASS	31,000	100%	55	45	29	14	
	20,000	100% NORMAL	42 56	34 45	22 30	11 15	
	10,000	100% NORMAL	32 45	29 36	17 24	8 12	
THREE-MAN CREW PLUS FOUR PASS	31,000	100%	47	38	25	12	
	20,000	100% NORMAL	37 48	30 38	20 25	10 12	
	10,000	100% NORMAL	29 39	23 31	15 21	7 10	
THREE-MAN CREW PLUS FIVE PASS	31,000	100%	41	33	22	11	
	20,000	100% NORMAL	33 42	26 34	17 22	8 11	
	10,000	100% NORMAL	27 35	21 28	14 18	7 9	
THREE-MAN CREW PLUS SIX PASS	31,000	100%	37	30	20	10	
	20,000	100% NORMAL	30 37	24 30	16 20	8 10	
	10,000	100% NORMAL	25 32	20 25	13 17	6 8	
THREE-MAN CREW PLUS SEVEN PASS	31,000	100%	33	26	17	8	
	20,000	100% NORMAL	28 33	22 26	15 17	7 8	
	10,000	100% NORMAL	23 39	18 23	12 15	6 7	

Notes:

1. Passenger masks are constant flow at all altitudes.
2. When above 20,000 feet, select “100 percent” oxygen on pilot/copilot mask.
3. Duration data shown assumes pilot/copilot at light work.
4. This data should be used as a general guide only. Respiratory rates vary between individuals and during specific flight circumstances.

Figure 2-40. (**B**) Oxygen Duration Chart

OXYGEN DURATION IN MINUTES 49-CUBIC-FOOT SYSTEM							
	CABIN ALTITUDE (FEET)	CREW MASK POSITION	GAUGE PRESSURE — PSI/LITERS 1850 1238	1500 960	1000 570	500 188	200 OR BELOW
TWO-MAN CREW	35,000	100%	206	160	95	31	EMERGENCY — DESCEND ALTITUDE NOT REQUIRING OXYGEN
	25,000	100%	106	83	49	16	
	15,000	NORMAL	65/124	50/96	30/57	10/19	
	10,000	NORMAL	53/195	41/74	24/44	8/14	
TWO-MAN CREW PLUS ONE PASS	35,000	100%	125	97	57	19	
	25,000	100%	80	52	37	12	
	15,000	NORMAL	54/89	42/69	24/41	8/13	
	10,000	NORMAL	45/73	35/57	21/34	7/11	
THREE-MAN CREW PLUS ONE PASS	35,000	100%	89	69	41	13	
	25,000	100%	64	49	29	9	
	15,000	NORMAL	46/69	35/54	21/32	7/10	
	10,000	NORMAL	40/59	31/46	18/27	6/9	
THREE-MAN CREW PLUS TWO PASS	35,000	100%	70	54	32	10	
	25,000	100%	53	41	24	8	
	15,000	NORMAL	40/57	31/44	18/26	6/8	
	10,000	NORMAL	34/50	27/39	15/23	5/7	
THREE-MAN CREW PLUS THREE PASS	35,000	100%	57	44	26	8	
	25,000	100%	45	35	21	7	
	15,000	NORMAL	36/48	28/37	16/22	5/7	
	10,000	NORMAL	32/43	24/33	14/20	5/6	
THREE-MAN CREW PLUS FOUR PASS	35,000	100%	48	37	22	7	
	25,000	100%	40	31	18	6	
	15,000	NORMAL	32/42	25/32	15/19	5/6	
	10,000	NORMAL	29/38	22/29	13/17	4/6	
THREE-MAN CREW PLUS FIVE PASS	35,000	100%	42	32	19	6	
	25,000	100%	35	27	16	5	
	15,000	NORMAL	29/37	22/29	13/17	4/5	
	10,000	NORMAL	29/37	22/29	13/17	4/5	
THREE-MAN CREW PLUS SIX PASS	35,000	100%	37	29	20	5	
	25,000	100%	32	24	14	5	
	15,000	NORMAL	27/33	21/26	12/15	4/5	
	10,000	NORMAL	24/31	19/24	11/14	4/4	
THREE-MAN CREW PLUS SEVEN PASS	35,000	100%	33	26	15	5	
	25,000	100%	29	22	13	4	
	15,000	NORMAL	24/30	19/23	11/14	4/4	
	10,000	NORMAL	22/38	17/22	10/13	3/4	

Notes:

1. Passenger masks are constant flow at all altitudes.
2. When above 20,000 feet, select “100 percent” oxygen on crew mask (pilot/copilot).
3. Duration data shown is for crew mask with crew at light work (pilot/copilot mask only).
4. This data should be used as a general guide only, since respiratory rates vary between individuals and specific flight circumstances.

Figure 2-41. **(F/M)** Oxygen Duration in Minutes

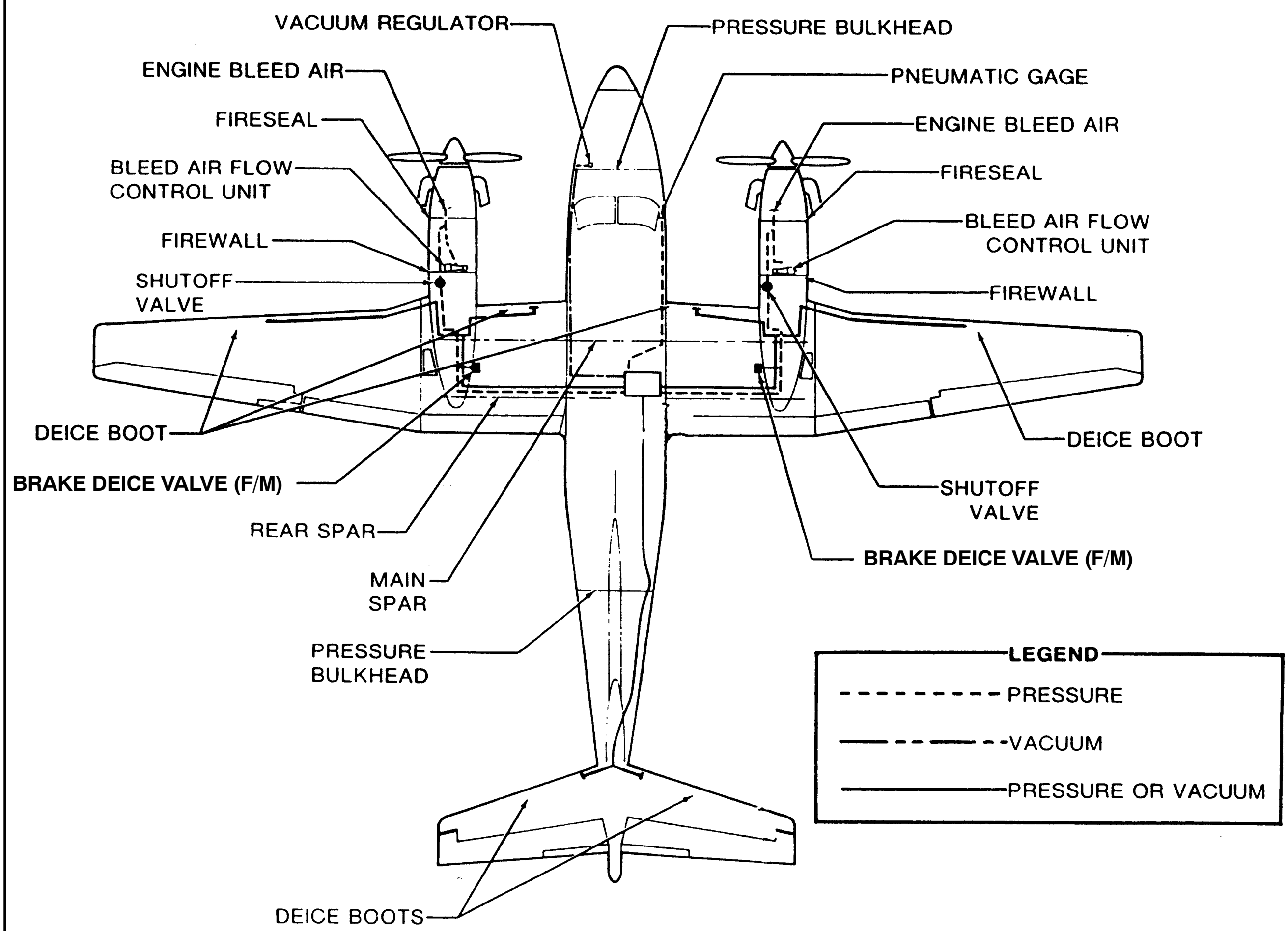


Figure 2-42. Pneumatic/Deice System (Sheet 1 of 2)

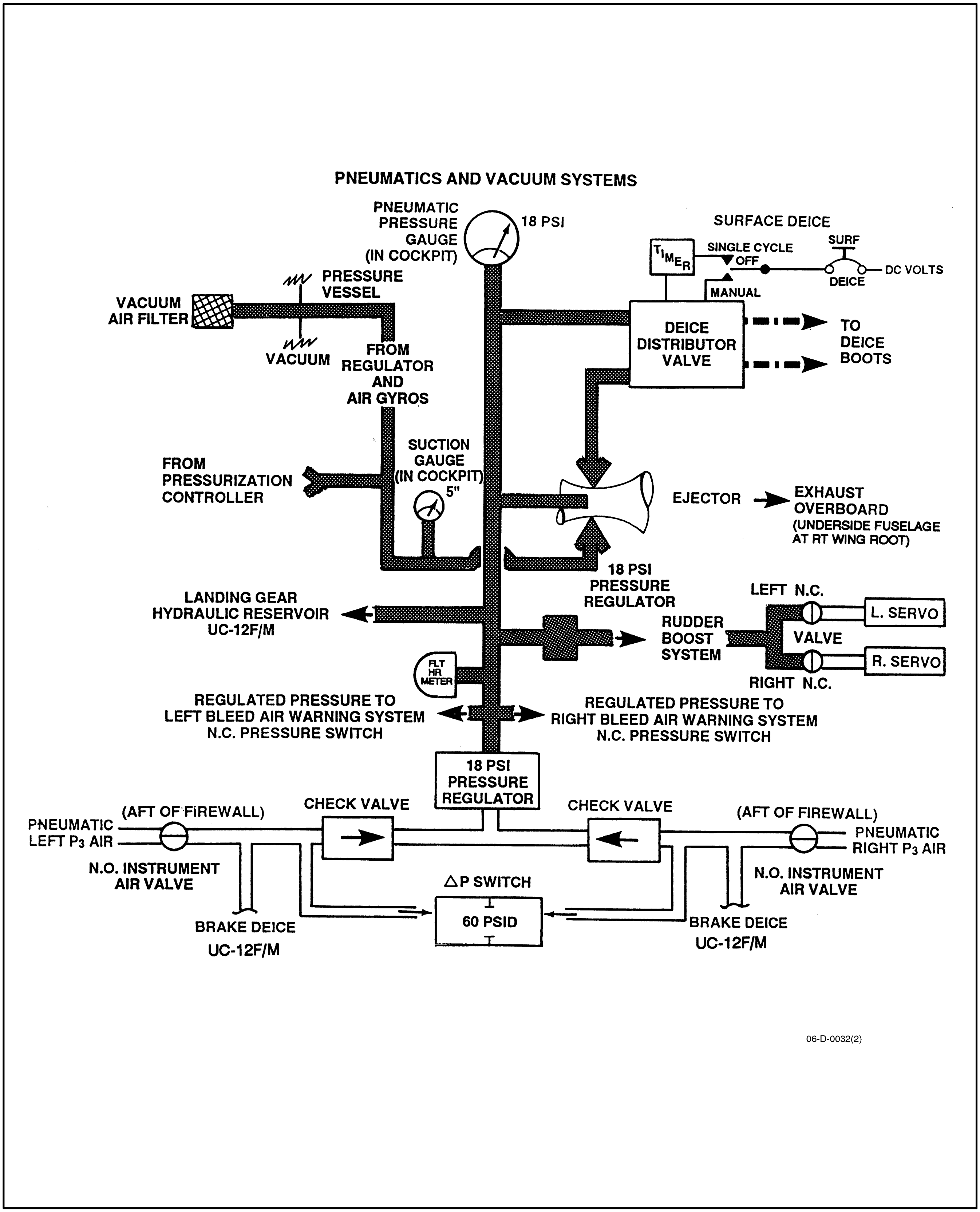


Figure 2-42. Pneumatic/Deice System (Sheet 2 of 2)

(**F**/**M**) The manual deice system is provided as a backup to the automatic system. The control switch for the manual system is located in the (**F**) PROP section of the ICE PROTECTION section on the pilot inboard subpanel and is placarded MANUAL — OFF/(**M**) ICE & RAIN section of the overhead control panel and is placarded PROP MANUAL (OFF) — ON. This switch is a momentary spring-loaded type and must be held to the (**F**) MANUAL/(**M**) ON position until the ice has been dislodged from the propeller. When the switch is held to the (**F**) MANUAL/(**M**) ON position, the automatic timer is overridden and power is supplied to all elements of both propellers simultaneously. During use of the manual mode, the PROP AMMETER will not indicate any load; however, both aircraft loadmeters will indicate an approximate 5 percent load increase. The manual deice switch is protected by a circuit breaker placarded (**F**) PROP DEICE CONTROL and located on the left sidewall circuit breaker panel/(**M**) PROP ANTI ICE — MANUAL located on the overhead circuit breaker panel. The manual deice circuits are protected by two circuit breakers placarded PROP DEICE and located on the left sidewall circuit breaker panel.

2.28.6 Engine Ice Protection

2.28.6.1 Engine Air Inlet

To prevent icing, engine exhaust heat is utilized for heating the engine air inlet lips. The exhaust heat is picked up by a scoop inside the left exhaust stack, plumbed through the engine inlet lip, and exits out of the right exhaust stack. Heating is automatic and requires no pilot action.

2.28.6.2 Inertial Separator System (Ice Vanes)

Each engine is equipped with an ice protection system to prevent moisture and snow from collecting on the engine inlet plenum. This is accomplished within the inlet air duct by introducing a sudden turn to the airflow before it reaches the engine air intake screen covering the N_1 compressor chamber. Airflow deflection is accomplished by lowering a movable anti-ice (inertial separator) vane and bypass door into the airstream when operating in icing or suspected icing conditions. The vane deflects the ram air slightly downward to introduce a sudden turn in the airflow to the engine, causing the moisture/snow particles to continue undeflected by their own momentum. They are discharged through an open bypass duct at the rear of the intake air duct. The extended position of the vane and bypass door is indicated by the annunciator lights placarded (**B**/**F**) L ICE VANE EXT and R ICE VANE EXT/(**M**) #1 VANE EXT and #2 VANE EXT. If for any reason the vane and bypass door do not attain the selected position within 15 seconds, an annunciator light placarded (**B**/**F**) L ICE VANE or R ICE VANE will illuminate on the caution/advisory panel/(**M**) #1 VANE FAIL or #2 VANE FAIL accompanied by the MASTER CAUTION. In this event, a mechanical system is provided and is actuated by pulling the T-handles placarded (**B**/**F**) ICE VANE EMERGENCY MANUAL EXTENSION — PULL — LEFT ENG — RIGHT ENG/(**M**) ICE VANE #1 ENG — ICE VANE #2 ENG located just below the pilot subpanel.

CAUTION

Once the ice vane manual system has been engaged, do not reset circuit breaker or attempt to retract or extend the ice vanes electrically, even if the T-handle has been pushed in, until the override linkage in the engine compartment has been properly reset on the ground. With the ice vane extended, oil temperature may rise to limits with an accompanying drop in oil pressure and/or pressure fluctuations. If approaching temperature limits, reduce power or depart icing conditions. Maintain 140 KIAS minimum.

Note

Decrease airspeed to 160 knots or less to reduce forces for manual extension. Normal airspeed may then be resumed.

When the vane is successfully positioned with the manual system, the yellow annunciator lights will extinguish. The vane may be retracted with the manual system. During manual system use, the electric motor switch position must match the manual handle position for a correct annunciator readout.

2.29 (F/M) BRAKE DEICE SYSTEM

2.29.1 Brake Deice System

When an aircraft is parked outside in a freezing atmosphere, the brake system may become contaminated by freezing rain or snow. The frozen brake assemblies should be deiced before the aircraft is moved or taxied. During flight through icing conditions with the landing gear extended, the wet brake assemblies are assumed to be frozen and should be deiced prior to landing. If pneumatic pressure is being supplied by only one bleed air source or during single-engine operation, the brake deice system must not be operated.

WARNING

If an engine failure should occur during brake deice system operation, the rudder boost system may not operate. Increased rudder pedal forces should be anticipated until the brake deice system is turned off.

Hot air for the brake deice system is supplied by the bleed air pneumatic system that also provides regulated pressure for the surface deice system and vacuum source. High-temperature air from the pneumatic system is routed through a solenoid control valve, located in each main gear wheelwell, through a flexible hose to a distributor manifold around the brake assembly. A two-position switch, placarded BRAKE DEICE and located on the pilot subpanel, and a 10 minute timer control these solenoid valves. Power to the solenoid valves is routed from a 5 ampere circuit breaker to a control module located beneath the aisle floor. The module contains a 10 minute timer, limiting the open period of the solenoid valves to one operating cycle. Timer-limited operation avoids excessive wheelwell temperatures when the landing gear is retracted. The control module also controls a circuit to the BRAKE DEICE ON annunciator and a resetting circuit interlocked with the gear uplock switch. When the system is activated, the BRAKE DEICE ON light should be monitored and the control switch placed to OFF when the light extinguishes. Otherwise, on the next gear extension, the system will restart. If brake deice operation fails to self-terminate (BRAKE DEICE ON annunciator remains illuminated) after approximately 10 minutes, system operation should be terminated manually.

Note

If the automatic timer terminates brake deice operation after retraction of the landing gear, the system cannot be reactivated until the landing gear is extended to reset the timer circuit. Brake deice will not be available until this is completed.

In-flight illumination of either BLEED AIR FAIL light will require closing the respective INSTR & ENVR bleed air valve. Because of uneven brake deicing, the brake deice system must not be used with a bleed air valve closed.

Note

The BLEED AIR FAIL lights may momentarily illuminate during simultaneous operation of the surface deice and brake deice systems at low N_1 speeds. If the lights immediately extinguish, they may be disregarded.

During certain ambient conditions, use of the brake deice system may reduce available engine power. In flight this will result in an ITT/TGT rise of approximately 20 °C. The brake deice system shall not be operated when the ambient temperature is above +15 °C. The appropriate performance charts should be consulted before brake deice system use. If takeoff power cannot be obtained without exceeding limits, the brake deice system must remain OFF until the takeoff is completed. ITT/TGT limitations must also be observed when setting climb and cruise power. During periods of simultaneous brake deice and surface deice operations, 85 percent N_1 or higher should be maintained. If adequate pneumatic pressure cannot be developed for proper surface deice boot inflation, the brake deice system should not be used.

2.30 PERSONNEL EQUIPMENT

2.30.1 Seats

Two under-seat levers may easily adjust the rack-mounted pilot and copilot seats fore and aft or vertically. The inboard under-seat lever releases the seat track lock to permit fore and aft adjustment. When the outboard under-seat lever is pulled and no weight is on the seat, the seat will slowly rise. Adjustments can be made in half-inch increments. Both seats have adjustable headrests and an inboard armrest that folds up to facilitate movement in and out of the seat.

(**B/F**) Five passenger seats are installed in the aircraft, two on the right side of the aisle and three on the left. The passenger seats are fixed-position units with noncaptive feet. Releasing the lever will allow the spring-loaded locks to engage and lock the seat into the tracks. The seats have adjustable headrests and reclining seatbacks. A release lever on the forward side of the seat will allow the passenger to recline the seatback to the desired position. Seatback movement will stop any time the lever is released. Actuating the release lever without any pressure against the seatback will cause the seatback to slowly rise to the fully upright position.

(**B/F**) The seatback can also be folded forward to lay flat on the seat cushion after releasing the lock lever on the lower side of the seatback. The inboard armrest of each passenger seat can be lowered to allow movement in and out of the seat. To lower the armrest, lift the flat rectangular release plate located under the front end of the armrest and move the armrest downward. The armrest can be raised by moving it upward until it locks in place.

(**M**) The cabin (passenger) seating consists of five track-mounted chairs equipped with lap-type seatbelts and inertia shoulder restraints, an inboard facing two-place couch, and belted, inboard facing seat, which also houses the nonflushing lavatory. The track-mounted chairs are placarded on the horizontal leg cross braces as FWD or AFT FACING and MAX 170 LB. AFT FACING. The seats may be rearranged or moved to suit the different leg-room requirements of different passengers by utilizing the quick release fasteners. When the quick release fastener is properly installed, the chair locks will engage and lock the seat into the tracks.

(**M**) The inboard armrest of each passenger seat may be lowered to allow movement into and out of the seat. To lower an armrest, lift the flat rectangular release plate located under the front end of the armrest and move the armrest forward and downward. The armrest can be raised by lifting it upward until it locks in place.

An aisle-facing, two-place couch is located immediately aft of the right side forward partition. The couch contains an ashtray and two 30-pound-capacity storage drawers.

(**B/F**) Two hinged seat cushion halves cover the top of the aisle-facing lavatory to provide an additional passenger seat.

2.30.1.1 Seatbelts/Shoulder Harnesses

All seats, including the toilet and two-place couch, are equipped with a lap-type seatbelt. In addition to the seatbelts, shoulder harness installations are provided for the pilot and copilot/(**M**) each passenger chair and the aft couch occupant. One strap of the harness is worn over each shoulder and fastened by a metal loop into the seatbelt buckle. Spring loading at the inertia reel built into the seatback keeps the harness straps snug and will allow normal movement required during flight operations. The inertia reel incorporates a locking device that will secure the harness under a 2- to 3-g deceleration. The inertial reel lock will automatically release when g loading has ceased.

(**M**) The passenger chair shoulder harnesses are a single strap assembly with an inertia reel. The strap is routed from the inertia reel located between the seatback and headrest diagonally across the torso. The free end of the strap is anchored to the seatbelt by firmly snapping the connecting link onto the seatbelt link retaining stud.

(**M**) The aft couch passenger restraint harness is worn diagonally across the torso after passing the right arm through an integral loop sewn into the single strap. The lower end of the strap is secured at the seatbelt by firmly snapping the link onto the retaining stud. The restraint harness is affixed to the cabin sidewall and is not an inertia type harness.

2.30.2 Headsets/Microphone

Both the pilot and copilot are provided with a headset and a hand-held microphone. The phone and microphone jacks for each pilot are located on the adjacent flight compartment sidewall.

Note

Sound intensity levels of 94 dB have been recorded inside the C-12 cockpit during flight. Pilots should wear hearing protection, as unprotected exposure may result in temporary or permanent hearing loss.

2.31 CARGO PROVISIONS

The cabin area can quickly be converted to a combination passenger/cargo, air ambulance, or all cargo configuration. Refer to Part VIII, Cargo Loading/Weight Balance, for more information.

2.32 EMERGENCY EQUIPMENT

Refer to paragraph 16.6.

2.32.1 (F) Fatigue Monitoring System

A stress monitoring system is installed in the aircraft to measure and record g forces applied to the airframe. The recorded flight and ground vertical acceleration load data are incorporated into an ongoing computer program to help develop structural fatigue life criteria for the UC-12F fleet. The system consists of an accelerometer, a landing gear safety switch, a circuit breaker, and an airborne data recorder. The system is operational whenever aircraft dc electrical power is on. The accelerometer registers the vertical g loads applied to the airframe. Information from the accelerometer is recorded by a solid-state airborne data recorder mounted on the seat tracks immediately aft of the copilot seat. A circuit, wired through the landing gear safety switch, allows the data recorder to differentiate between in-flight and ground operational data. The solid-state memory storage in the airborne data recorder is not affected by the loss of aircraft electrical power; the memory storage life without power is approximately 1 year. The system is powered through a 5-ampere circuit breaker placarded FATIGUE METER and located in the WARNINGS section of the right sidewall circuit breaker panel.

2.33 MISCELLANEOUS EQUIPMENT

2.33.1 Refreshment Cabinet

A hot and cold 1 gallon liquid storage cabinet is installed on the right side of the aircraft between the rear passenger seat and the lavatory privacy curtain. The seat track mounted cabinet may be shifted fore or aft along the seat track or completely removed. Access to the cabinet track release and drain sponge is accomplished by removing the bottom storage drawer.

2.33.2 Lavatory

An aisle-facing, electric flush lavatory is located on the right of the aircraft across from the cabin airstair entrance door. The lavatory is equipped with a lap-type seatbelt and may be removed by quick detach fittings at the seat tracks for conversion to cargo or litter configurations. Tissue paper and an ashtray are located in a small pullout drawer on the front of the wood shell surrounding the lavatory. A privacy curtain is provided. (**B**/**F**) The waste container is adequate for approximately 15 flushings before requiring servicing.

2.33.3 Relief Tube

A relief tube is located behind a door in the right sidewall of the lavatory area.

2.33.4 Cargo Door Stabilizer

An extendible rod shall be used to secure the cargo door in the open position; it is stored in a leather pouch mounted on the aft side of the right rear partition. Use as follows:

1. Attach one end of the door support assembly to the cargo door ball stud on the forward side of the door. (Ensure the support rod detent pin is in place.)

2. Push out on the airstair door sill step and allow the cargo door to swing open. The gas springs will automatically open the door. Attach the free end of the support rod to the ball stud on the forward fuselage door frame.

2.33.5 Sun Visors

Sun visors are provided for the pilot and copilot. Each visor is manually adjustable. When not needed as sun shields, the visors may be rotated to a flush position.

Sun visors are held in position by a mechanical lock that can be released by rotating the knob prior to positioning the sun visor.

CAUTION

When adjusting the sun visors, grasp only by the top metal attachment to avoid damage to the plastic shield.

2.33.6 Partition and Curtains

The flight compartment is separated from the cabin by a fixed partition with sliding doors.

A privacy curtain is provided to close off the lavatory area from the aft cabin. This curtain is attached to the right sidewall and extends across the center aisle.

Each cabin window has a vertical sliding curtain to regulate light through the window.

2.33.7 Cigarette Lighter

(**B**) One electrical push-in type cigarette lighter is located on the pedestal.

(F/M) Two cigarette lighters are provided, and one is located on each flight compartment sidewall.

CHAPTER 3

Servicing and Handling

The following paragraphs include the procedures and precautions necessary to service the aircraft or to lend assistance to maintenance crews unfamiliar with the aircraft. Refer to Figure 3-1 for servicing data.

3.1 SERVICING THE FUEL SYSTEM

Note

- Service fuel tanks after each flight to keep the bladder-type tanks from drying out.
- Do not fill auxiliary tanks unless outboard main tanks are full.

3.1.1 Types of Fuel

Jet A, Jet A1, Jet B, JP-4, JP-5, and JP-8 fuels are approved, in any ratio, for the C-12 aircraft. When commercial jet fuel is used and does not contain anti-ice/fungicide (PFA55MB, MIL-I-27686, or equivalent), it should be added during fueling per approved method to ensure proper anti-icing protection and long-term fungus control. Aviation gasoline (AVGAS) grades 80/87, 91/96, 100/130, and 115/145 are approved emergency fuels.

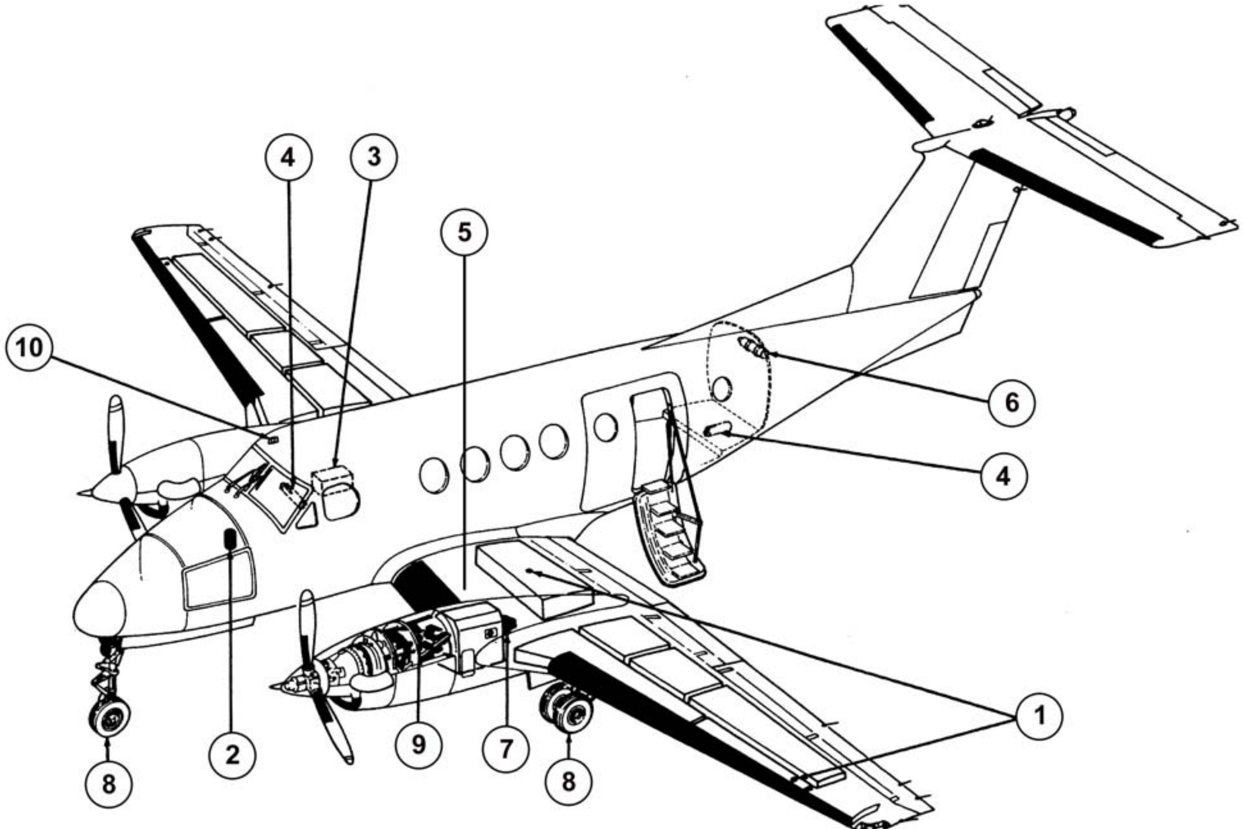
Engine oil is used to heat the fuel on entering the fuel control. Since no temperature measurement is available for the fuel at this point, it must be assumed to be the same as the OAT. Figure 3-2 is supplied for use as a guide in preflight planning. It will indicate operating temperatures where icing at the fuel control could occur if using fuel that does not contain an anti-icing additive. If the plot indicates that oil temperatures versus OAT are such that ice formations could occur during takeoff or in flight, anti-icing additive per MIL-27686 should be mixed with the fuel at refueling to ensure safe operation. JP-4, JP-5, and JP-8 fuels have anti-icing additive blended in the fuel at the refinery, and no further treatment is necessary.

WARNING

If commercial jet fuel is being utilized without anti-ice additive, refer to Figure 3-2 for minimum oil temperature due to the possibility of fuel control icing.

CAUTION

Anti-icing additive must be properly blended with the fuel to avoid deterioration of the fuel cell. The additive concentration by volume shall be a minimum of .060 percent and a maximum of .15 percent.



1. FUEL TANK FILLER CAPS (TYPICAL LEFT & RIGHT)
   FUEL SPECIFICATION: MIL-F-5624

JP-5	F-44 (NATO)	JET A
JP-4	F-40 (NATO)	JET B
JP-8	F-34 (NATO)	JET A1

   AVGAS SPECIFICATION: MIL-F-5572

   AVGAS F-12 (NATO) 80/87 (RED)
   AVGAS F-18 (NATO) 100/130 OR 100LL (LOW LEAD-BLUE)
   AVGAS F-22 (NATO) 115/145 (PURPLE)
   IN SOME FOREIGN COUNTRIES, GRADE 100LL (BLUE) IS COLORED GREEN AND IS DESIGNATED 100L

2. HYDRAULIC FLUID RESERVOIR (BRAKE)
   SPECIFICATION: MIL-H-5606, NATO H-515
   1 US PINT

3. BATTERY
   24 VOLT 42 AMPERE HOUR LEAD ACID

4. FIRE EXTINGUISHERS (HAND TYPE) HALON 1301
   SPECIFICATION: MIL-E-52031

5. (F/M) HYDRAULIC FLUID RESERVOIR (LANDING GEAR) SPECIFICATION: MIL–H–5606, NATO H–515

6. OXYGEN SUPPLY CYLINDER
   OXYGEN SPECIFICATION: MIL-O-27210
   AVIATORS BREATHING OXYGEN
   49 CU FT

7. ENGINE FIRE EXTINGUISHER (TYPICAL LEFT & RIGHT)
   EXTINGUISHING AGENT: MIL-E-52031
   2.5 LBS CF3BR, 450 PSI (DRY NITROGEN)

8. TIRES
   SIZE:
   MAIN WHEELS 6.75-10 (8 PLY TUBELESS)
   NOSE WHEEL 6.75-10 (8 PLY TUBELESS)

   PRESSURE:
   MAIN WHEEL 60-64 PSI
   NOSE WHEEL 55-60 PSI

9. ENGINE OIL FILLER (TYPICAL LEFT & RIGHT)
   OIL SPECIFICATION: MIL-L-23699, NATO 0-156
   14 US QUARTS

10. DC EXTERNAL POWER RECEPTACLE (24 VOLT)

06-A-0034

Figure 3-1. Servicing Data

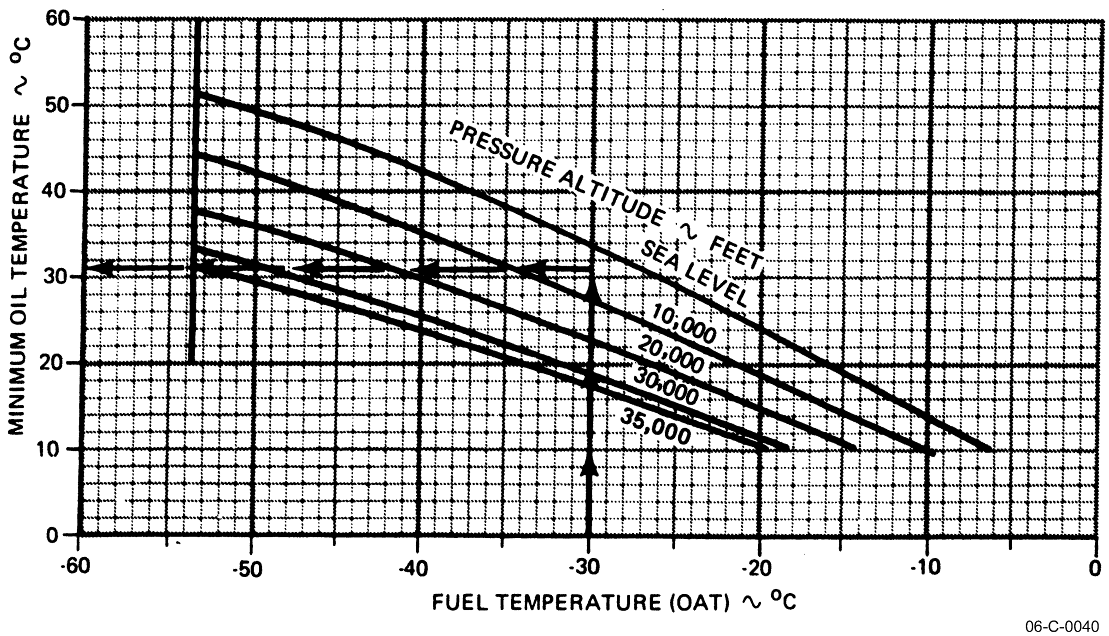


Figure 3-2. Fuel Control Icing

3.1.2 Fuel Handling Precautions

AVGAS is an emergency fuel. When AVGAS is used in a turbine engine, extreme caution should be used when in and around the combustion chamber and exhaust area to avoid cuts or abrasions. The exhaust deposits contain lead oxide, which will cause lead poisoning. Proper procedures for handling fuel cannot be overstressed. Clean, fresh fuel must be used, and the entrance of water into the fuel storage or aircraft fuel system must be avoided.

CAUTION

When conditions permit, the aircraft should be positioned so that the wind will carry fuel vapors away from all possible sources of ignition. The fueling vehicle shall be positioned to maintain a minimum distance of 10 feet from any part of the aircraft and a minimum distance of 20 feet from the fuel filler point.

Note

The use of AVGAS as an emergency fuel is permitted for a period of not more than 150 hours during time between engine overhaul (TBO). Each engine uses approximately 50 gallons of fuel per hour. To determine the number of hours that should be charged against the 150-hour TBO period, divide the number of gallons of gasoline in each side by 50. For example, if 150 gallons of gasoline are pumped into one side, divide by 50 and the total time is 3 hours. The engine should have 3 hours charged against the 150-hour TBO period. The lowest octane AVGAS available is recommended to avoid buildup of deposits on the turbine blades.

Do not allow operation of any electrical tools, such as drills or buffers, in or near the aircraft during fueling.

1. Shut off all electrical equipment on the aircraft, including radar equipment.

2. Refuel aircraft as soon as possible after landing.

3. Keep fuel-servicing nozzles free of snow, water, and mud at all times.

4. Carefully remove snow, water, and ice from the aircraft fuel filler cap area before removing the fuel filler cap. Remove only one tank filler cap at any one time, and replace each one immediately after the servicing is completed.

5. Avoid dragging the fueling hose where it can damage the soft, flexible surface of the deice boots.

6. Ensure the aircraft and components being serviced are securely coupled to a low-resistance ground. Connect the static ground cable and the fueling vehicle to a grounding stake. When engaged in the fueling operation, discharge the static electricity accumulated by the body and clothing by touching the ground cable or stake before each operation.

7. Prior to opening the fuel cap, ensure that the fueling hose is grounded to the aircraft.

8. Wash off spilled fuel immediately.

9. Handle the fuel hose and nozzle cautiously to avoid damaging the wing skin.

10. Do not conduct fueling operations within 100 feet of energized airborne radar equipment or within 300 feet of energized ground radar equipment installations.

11. Wear only nonsparking shoes near aircraft or fueling equipment, as shoes with nailed soles or metal heel plates can be a source of sparks.

3.1.2.1 Fuel Handling Precautions — Extreme Weather Conditions

When fueling is conducted on ice or on sandy or desert terrain, or when a satisfactory ground cannot be secured, additional precautions must be taken to avoid the buildup of static electricity. Since draining the static charges is not possible without an adequate ground, reliance must be placed on equalizing the potentials in order to prevent a dangerous sparking discharge as in the following bonding procedure.

1. Connect bonding cable from aircraft to fuel servicing unit. A conductive type fuel hose is not a satisfactory method of bonding.

2. Connect bonding cable from fuel nozzle to aircraft before fuel tank cover is opened.

3. When disconnecting, reverse the order of steps 1 and 2.

3.1.3 Gravity Fueling

Refer to Figure 3-3.

1. Attach bonding cables to aircraft.

2. Attach bonding cable from hose nozzle to ground.

3. Open applicable fuel tank filler cap.

CAUTION

Do not insert fuel nozzle completely into fuel cell because of possible damage to bottom of fuel cell. Do not rest (lean) the fuel nozzle against the side of the fuel tank opening because it can damage the seal.

4. Fill fuel tank with fuel.

5. Secure applicable fuel tank filler cap.

CAUTION

Ensure latch tab on cap is pointed aft.

6. Disconnect bonding cables from aircraft.

3.1.4 Draining Moisture from Fuel System

Open each fuel drain to check for and remove any water or other contaminants that may have collected in the low points (refer to Figure 7-1). Drains are listed in Figure 3-4.

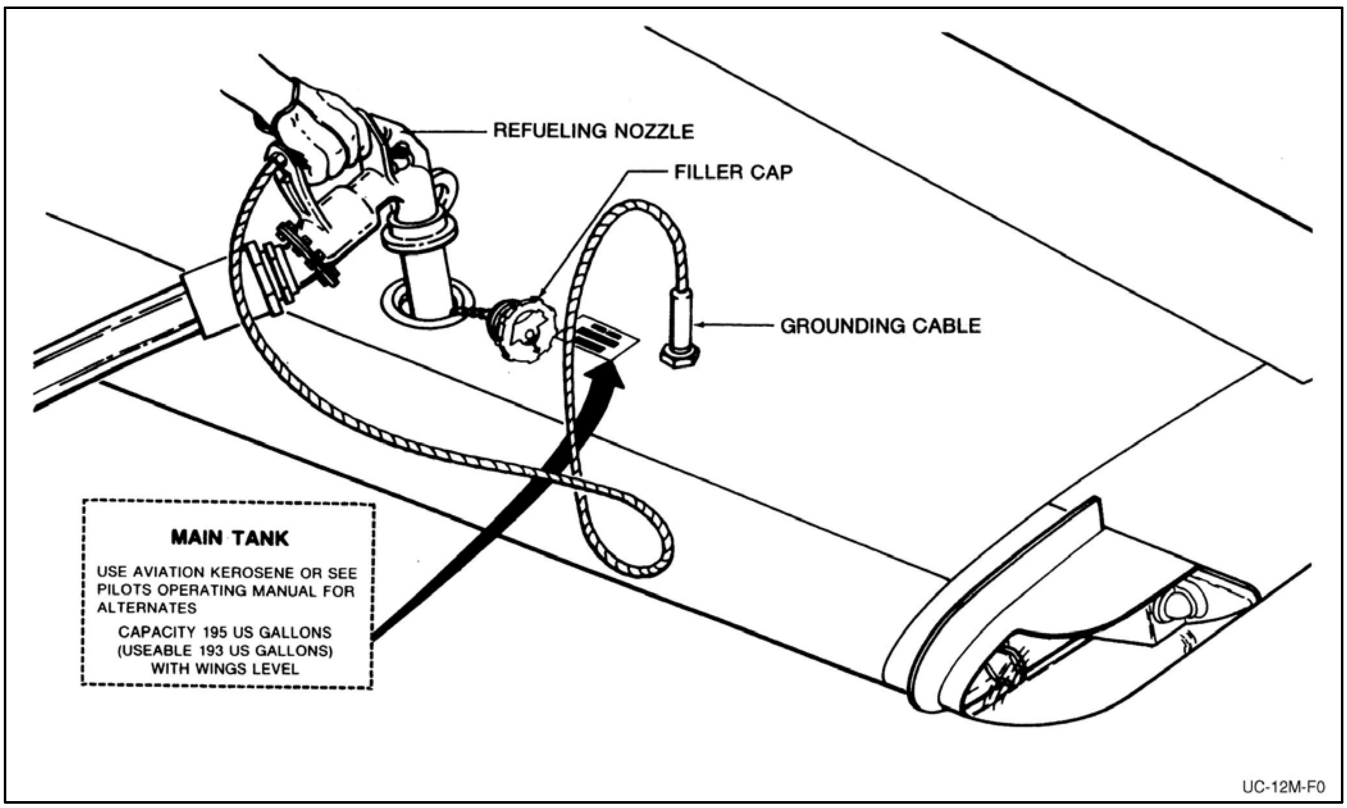


Figure 3-3. Gravity Fueling

Drains	Location
1. Main tanks	Underside of wing, outboard of nacelle
2. Integral tank	Underside of wing, forward of aileron
3. Auxiliary tank	Underside of wing, forward of flap at wing root
4. Gravity	Aft of wheelwell
5. Firewall fuel filter	Underside of nacelle, forward of firewall
6. Sump strainer	Bottom center of nacelle, forward of wheelwell
7. Fuel system (low point in system)	Forward of wheelwell
8. Ferry tanks	Bottom of wing center section, adjacent to fuselage

Figure 3-4. Fuel Drain Locations

The firewall fuel filter drain is accessed through the cowl door.

CAUTION

The firewall shutoff valve must be electrically opened to drain large quantities of fuel from the firewall fuel filter drain.

3.1.5 Use of Fuels

Fuels having the same NATO code numbers (Figure 3-5) are interchangeable. Jet fuels conforming to ASTM D-1655 specification may be used when MIL-T-5624 fuels are not available. This usually occurs during cross-country flights when aircraft using NATO F-44 (JP-5) are refueled with NATO F-40 (JP-4) or commercial ASTM type B fuels.

3.2 SERVICING THE OIL SYSTEM

Servicing the engine oil system is limited to maintaining the engine oil at the proper level. The oil tank is provided with an oil filler neck and quantity dipstick cap, which protrude through the accessory gearcase at the 11 o'clock position. The dipstick is marked in U.S. quarts and indicates the amount of oil required to fill the tank. Access to the dipstick cap is through the aft engine cowling. Oil tank capacity is 2.3 U.S. gallons with 5 quarts measured on the dipstick (for adding purposes). When a dry engine is first serviced, it will require 5 quarts in addition to tank capacity to fill the lines and oil cooler, giving a total system capacity of (**B**) 14 quarts and (**F/M**) 14.2 quarts.

CAUTION

- Spilled oil should be removed immediately to prevent possible tire contamination or damage.
- Use EXXON 2380 or BP2380 only. Do not mix different brands or types of oil when adding oil between changes. Different brands or types may be incompatible because of the differences in chemical structure.

1. Open the aft engine cowling to check the oil system.
2. Remove the oil filler cap.
3. Replenish oil to within 1 quart below the MAX (HOT or COLD as applicable) mark on dipstick.

Note

If a cold oil check indicates more then 3 quarts low, motor engine (starter only) with propeller in the feathered position for 15 to 20 seconds, then recheck and add oil as required. Do not overfill.

4. Check oil filler cap for damage and replace.
5. Check for oil leaks.

3.3 SERVICING HYDRAULICS

3.3.1 Brake System Reservoir

The hydraulic brake system reservoir is located on the bulkhead in the upper left corner of the nose avionics compartment. A dipstick is provided as part of the reservoir lid to measure the fluid level.

1. Remove brake reservoir cap and fill reservoir to washer on dipstick with hydraulic fluid.
2. Install brake reservoir cap.

3.3.2 (F/M) Hydraulic Landing Gear System Reservoir

Service of the reservoir must be accomplished by qualified personnel using MIL-H-5606 hydraulic fluid.

3.4 SERVICING OXYGEN SYSTEM

The oxygen system is serviced through a filler valve that is accessible by removing an access plate on the right side of the aft fuselage. The oxygen system has two pressure gauges, one on the copilot subpanel for in-flight use and one adjacent to the filler valve for checking system pressure during filling. Servicing of the system must be accomplished by qualified personnel only.

3.4.1 Filling the System

Use only aviators breathing oxygen (MIL-O-27210). Fill the oxygen system slowly by adjusting the recharging rate with the pressure regulating valve on the servicing cart. Fill the 49 cubic foot cylinder to a pressure of 1,850 ± 50 psi at a temperature of 70 °F (+21 °C). The pressure may be increased by 3.5 psi for each degree of temperature above 70 °F to a maximum of 2,000 psig and reduced by 3.5 psi for each degree below 70 °F. The oxygen system, after filling, should be allowed to cool and stabilize for a short period before an accurate reading on the pressure gauges can be obtained. When the system is properly charged, disconnect the filler hose from the filler valve and replace the protective cap on the filler valve.

1. Avoid any operation that would create sparks and keep all burning cigarettes or fire away from the vicinity of the aircraft when the outlets are in use.
2. Inspect the filler connection for cleanliness before attaching it to the filler valve.
3. Make sure that your hands, tools, and clothing are clean, particularly of grease or oil stains, because these contaminants will ignite upon contact with pure oxygen.
4. As a further precaution against fire, open and close all oxygen valves slowly during filling.

		FLIP CODE		MIL FUEL GRADE	NATO SYMBOL	COMM ASTM GRADE	UNITED KINGDOM GRADE	FREEZES		AVERAGE LB/GL AT 60° F/15 °C	AVERAGE BTU/LB	AVERAGE BUT/GAL
		MIL	COMM					°F	°C		1000	1000
APPROVED FUELS	PRIMARY	J5		⚠3 JP-5	F-44		AVCAT/48	-51	-46	6.79	18.45	125
		J4		⚠3 JP-4	F-40		AVTAG	-72	-58	6.46	18.60	120
			TA1	JP-8	F-34	JET A-1 JP-1	AVTUR/50	-58	-50	6.79	18.45	125
			TB		F-45	JET B		-58	-50	6.46	18.60	120
	ALTERNATE				F-42		AVCAT/40	-40	-40	6.79	18.45	125
			TA		F-35	JET A		-40	-40	6.79	18.45	125
EMERGENCY FUELS	NO LEAD NO TCP		D			73		-76	-60	5.76	18.90	109
			E			80		-76	-60	5.76	18.90	109
	LEAD NO TCP	C	C1	80/87	F-12	80/87		-76	-60	5.90	18.90	112
		B	B1	91/96	F-15	91/96		-76	-60	5.85	18.90	111
		A	A1	100/130	F-18	100/130		-76	-60	5.82	18.90	111
			G			108/135		-76	-60	5.81	18.90	110
		A +	A + 1	115/145	F-22	115/145		-76	-60	5.80	18.90	110

Notes:

1. Fuels listed from top to bottom in order of preference.
2. Refer to NAVAIRINST 10341.1 series for changes to the aircraft fuels.

⚠3 Contains fuel system icing inhibitor FSII.

Figure 3-5. Fuel Reference Chart

3.5 JACKING POINTS

The aircraft is provided with three jacking points. Two are located on the center section of the rear spar just inboard of the engine nacelles, and one is located near the aft end of the nose wheelwell to the left of the fuselage centerline. All three points are identified by JACK PAD placarding adjacent to the jack points.

3.6 SERVICING TIRES

3.6.1 Tire Sizes

The aircraft is equipped with 22 x 6.75 x 10 inches, 10 ply-rated, tubeless tires on the main and nosegear.

CAUTION

Tires that have picked up a fuel or oil film should be washed down as soon as possible with a detergent solution to prevent contamination of the rubber.

3.6.1.1 Inflation Pressures

Maintaining proper tire inflation will help to avoid damage from landing shock and contact with sharp stones and ruts and will minimize tread wear. When inflating the tires, inspect for cuts, cracks, breaks, and tread wear. The main tires should be inflated between 60 and 64 psi and the nose tire between 55 and 60 psi.

3.7 SERVICING THE FIRE EXTINGUISHER SYSTEM

A fire extinguisher supply cylinder is mounted on brackets at the aft side of the main spar in each wheelwell of the main landing gear. Access to the fire extinguisher cylinder is through the wheelwells of the main landing gear.

3.7.1 Cylinder Pressure

Each cylinder is charged with 2 1/2 pounds of bromotrifluoromethane (CB_rF_3) and pressurized with 0.08 pound of dry nitrogen to 450 psi at 70 °F. Check the pressure gauge on each cylinder prior to flight to ascertain that the cylinders are charged to within the pressure limits for the ambient temperature as noted in Figure 3-6.

TEMP. °F	INDICATED PRESSURE IN PSI
-40	190 to 240
-20	220 to 275
0	250 to 315
20	290 to 365
40	340 to 420
60	390 to 480
80	455 to 550
100	525 to 635
120	605 to 730
140	700 to 840

Figure 3-6. Fire Extinguisher Cylinder Pressure Limits

3.8 EXTERNAL POWER APPLICATION

3.8.1 Safety Precautions

CAUTION

Before connecting the power cables from the external power source to the aircraft, ensure that the Ground Power Unit (GPU) is not touching the aircraft at any point. Due to the voltage drop in the cables, the two ground systems will be of different potentials. Should they come in contact while the GPU is operating, arcing could occur. Turn off all external power while connecting the power cable to or removing it from the external power supply receptacle. Be certain the polarity of the external power source is the same as that of the aircraft before it is connected.

The aircraft electrical system is protected against damage from an external power source with reversed polarity by a relay and diodes in the external power circuit. Observe the following precautions when using an external power source:

1. Use only an auxiliary power source that is negatively grounded. If the polarity of the power source is unknown, determine the polarity with a voltmeter before connecting the unit to the aircraft.
2. Before connecting an external power unit, ensure that a battery capable of 20 volts minimum is installed in the aircraft and the battery switch is OFF. All other electrical and avionics equipment should be turned OFF to prevent damage from transient voltage spikes.

CAUTION

Use of a GPU with an aircraft battery below 20 volts may cause internal damage to the battery.

3. If the unit does not have a standard AN plug, check the polarity and connect the positive lead from the external power unit to the center post and the negative lead to the front post of the aircraft external power receptacle. The small pin of the receptacle must be supplied with +24 Vdc to close the external power relay that provides protection against damage by reversing polarity.

3.8.2 Voltage Requirements

To supply power for ground checks or to assist in starting, a ground power source shall not exceed 30 Vdc and must be capable of delivering a continuous load of 300 amperes and up to 1,000 amperes for 0.1 second if required.

3.8.3 Receptacle Location

The external power receptacle is located just outboard of the nacelle in the right center section. The receptacle is designed for a standard AN type plug.

3.9 SERVICING THE AIR CONDITIONER SYSTEM

Servicing the air conditioner system consists mainly of checking and maintaining the correct refrigerant level, compressor oil level, belt tension and condition, system leak detection, and replacement of the evaporator air filters. It is imperative that the maintenance of the air conditioner system, except for filter replacement, be accomplished only by qualified personnel. The air conditioner filters are flexible, fiberglass type filters that cover the evaporator coils.

3.10 DANGER AREAS

Danger areas to be avoided by personnel while aircraft engines are being operated on the ground are depicted in Figure 3-7. Temperature and velocity of exhaust gases at varying locations aft of the exhaust stacks are shown for maximum and ground idle power. The danger areas extend to 40 feet aft of the exhaust stack outlets. Propeller danger areas are also shown.

3.11 TOWING THE AIRCRAFT

CAUTION

Do not move the aircraft with the cargo door open. Structural damage may result.

Note

When maneuvering the aircraft in constricted areas, allow several inches for clearance of hangar doors or other obstructions. Refer to Figure 3-8.

The tow bar connects to the upper torque knee fitting of the nose strut. Use a tow bar when moving the aircraft by hand or for towing it with a tug.

3.11.1 Towing Procedures

Although the tug will control the steering of the aircraft, a qualified person should be positioned in the pilot seat to operate the brakes in case of an emergency. Always ascertain that the rudder lock is removed before towing the aircraft.

CAUTION

- Serious damage can occur to the steering linkage if the aircraft is towed with the rudder lock installed.
- When ground handling the aircraft, do not use the propeller nosecone or the control surfaces as handholds to push or move the aircraft.

3.11.1.1 Towing Limits

The nosegear strut has turn radius warning marks to warn the tug driver when structure limits of the gear will be exceeded.

CAUTION

Damage will occur to the nosegear and linkage if the turn radius is exceeded.

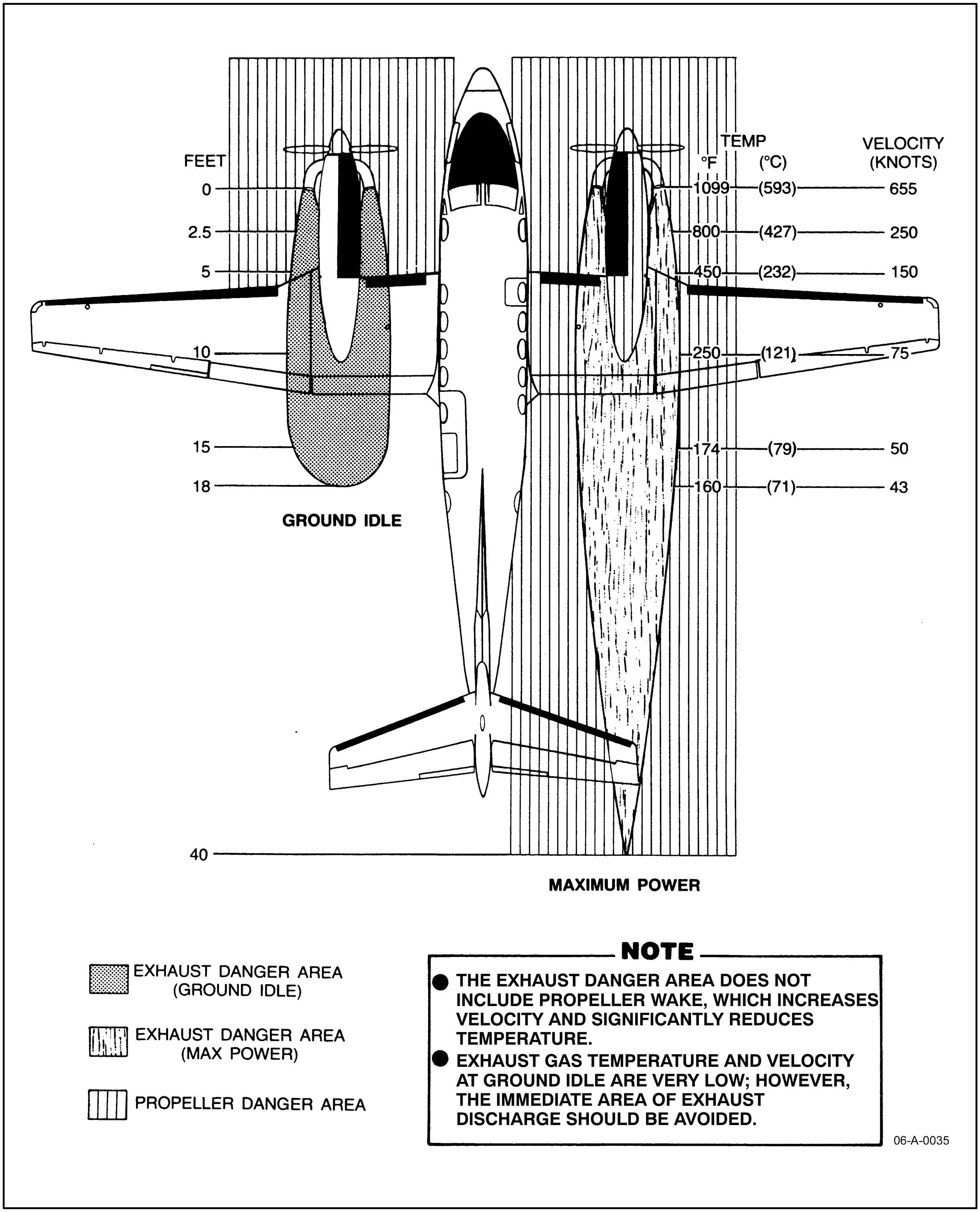
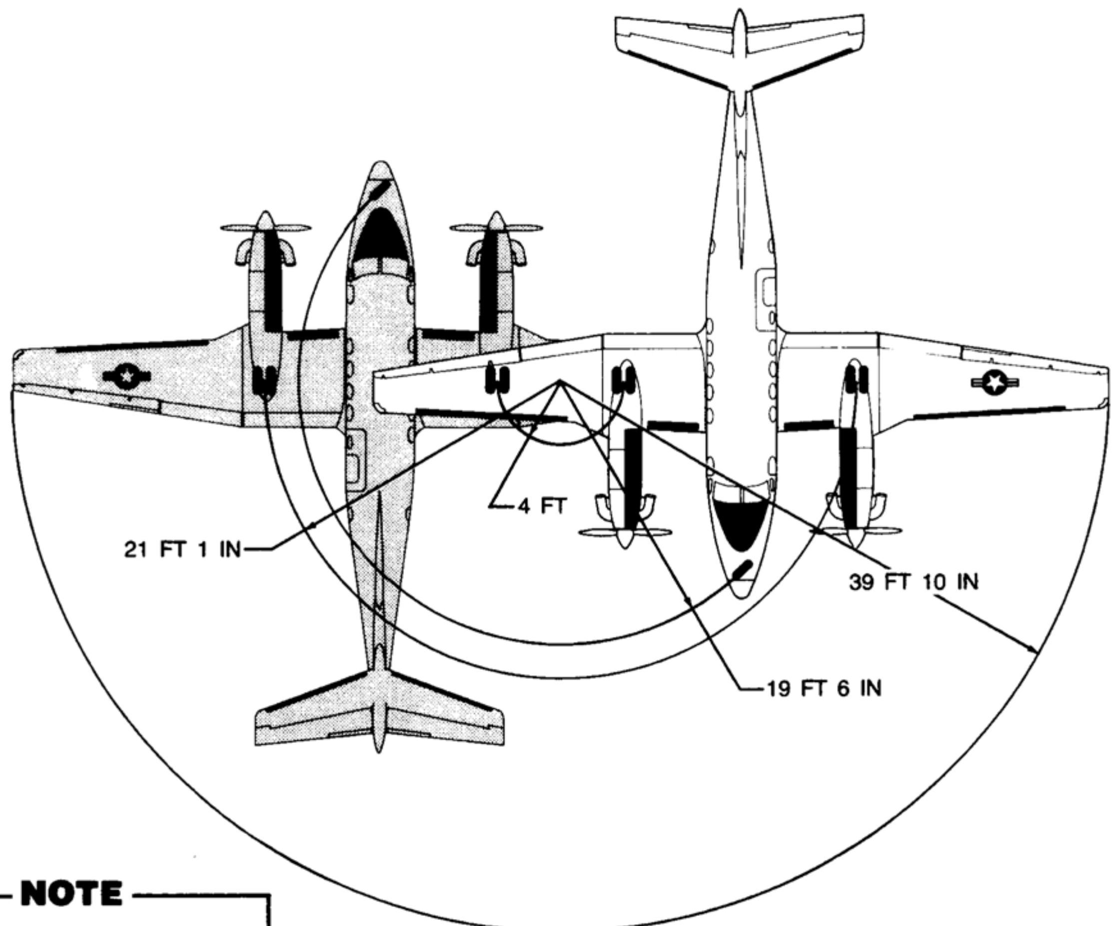


Figure 3-7. Danger Areas



NOTE

TURN RADII DIMENSIONS ARE PREDICATED ON USE OF FULL RUDDER, PARTIAL BRAKING, AND DIFFERENTIAL POWER TO PRODUCE A MAXIMUM RATE TURN WITHOUT NOSE WHEEL SIDESLIP.

Figure 3-8. Turning Radii

3.12 TIEDOWN/SECURING THE AIRCRAFT

The proper steps for securing the aircraft (Figure 3-9) must be based on the time the aircraft will be left unattended, the aircraft weight, the expected wind direction and velocity, and the anticipated availability of ground and aircrews for mooring and/or evacuation. When practical, head the aircraft into the wind, especially if strong winds are forecast or if it will be necessary to leave the aircraft overnight. Set the parking brake and chock the wheels securely. Following engine shutdown, position and engage the control lock.

3.12.1 Tiedown Locations

Mooring points are provided beneath the wing and tail and on each main landing gear.

3.12.1.1 Propeller Restraint, Dust Covers, Wheel Chocks

Propeller restraints, dust covers, and wheel chocks shall be used whenever the aircraft is moored. At the discretion of the pilot, dust covers may be used for the pitot masts, engine intake and exhaust, and the heat exchanger leading edge intake.

3.12.2 Mooring Procedures

1. Use mooring cables of 1/4 inch aircraft cable and clamp (clipwire-rope), chain, or rope 3/8 inch or over. Length of the cable or rope will be dependent upon existing circumstances. All mooring lines are to be installed with no slack.

CAUTION

Do not use slipknots to secure aircraft to mooring stakes.

2. One-piece wheel chocks or wood blocks may be used to chock the main landing gear wheels. Refer to Figure 3-9.

Note

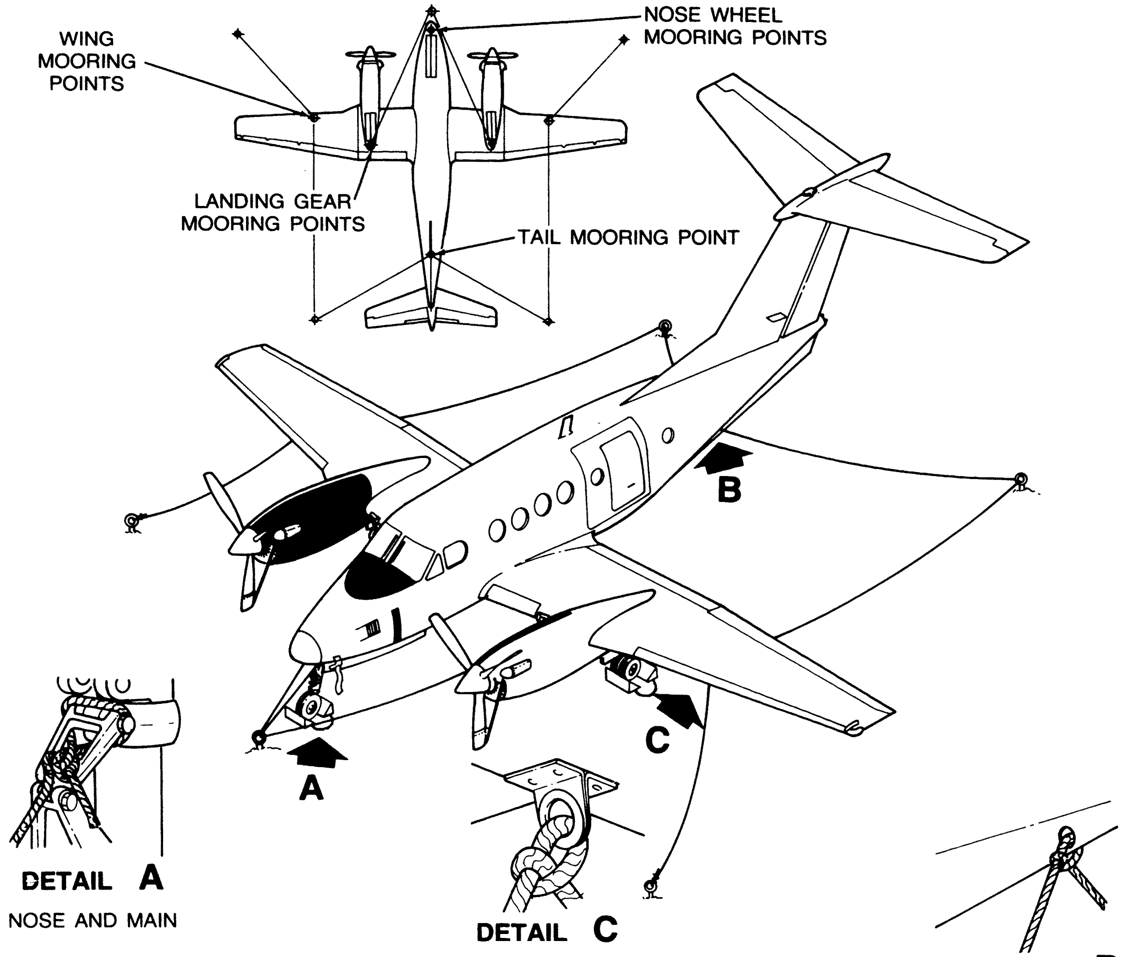
In icy or snowy conditions, collapsible ice grip wheel chocks should be used; however, sandbags may be used if collapsible chocks are not available or if parking or mooring the aircraft on steel mats.

3.12.2.1 High Wind Conditions

If an aircraft is to remain securely moored during high-velocity winds, it is necessary to use the proper size and type of wheel chock. Since the factor of weight is significant in determining adequate mooring provisions, the approximate weight must he known if the aircraft is to be properly secured. During emergencies, knowledge of this information is very useful in selecting the aircraft that should be tied down first, as a heavy aircraft will better withstand high winds then an empty aircraft.

CAUTION

Structural damage can occur from high velocity winds; therefore, if at all possible, the aircraft should be moved to a safe weather area when winds above 75 knots are expected.



NOTE

- IF STRONG WINDS ARE ANTICIPATED, OR AIRCRAFT IS TO BE LEFT UNATTENDED, PROPELLER RESTRAINTS, PITOT MASTS, AND INTAKE COVERS MUST BE INSTALLED, AND THE FLIGHT CONTROLS LOCK ENGAGED.
- THE USE OF DOUBLE OR SINGLE GROUND MOORING POINTS IS DETERMINED BY LOCAL OPTION DEPENDING ON TYPE AND AVAILABILITY OF AIRCRAFT SECURING EQUIPMENT.
- ALL MOORING LINES MUST BE TESTED FOR OR BE CAPABLE OF WITHSTANDING A 3,000 POUND PULL, AND BE INSTALLED WITH NO SLACK. WHEEL CHOCKS SHOULD BE USED.
- IN 65 KNOT OR LESS WINDS, THE AIRCRAFT MAY BE MOORED USING ONLY WING AND TAIL TIEDOWN POINTS. FOR WINDS IN EXCESS OF THIS (HURRICANE FORCE UP TO 100 KNOTS) ALL AIRCRAFT TIEDOWN POINTS, INCLUDING NOSE AND MAIN GEAR, MUST BE USED.

06-A-0037

Figure 3-9. Tiedown/Securing Aircraft

1. After aircraft is properly located, place nosewheel in centered position. Head aircraft into the wind, or as nearly so as possible within limits determined by locations of fixed mooring rings. When necessary, a 45° variation of direction is considered to be satisfactory. Locate each aircraft at slightly more than wingspan distance from all other aircraft. Position nose mooring points approximately 3 to 5 feet downwind from ground mooring anchors.

2. Deflate nosewheel shock strut to within 3/4 inch of its fully deflated position.

3. Fill all fuel tanks to capacity, if time permits.

4. Place wheel chocks fore and aft of main gear wheels and nosewheel. Tie each pair of chocks (wood) together with rope or join together with wooden cleats nailed to chocks on either side of wheels. Tie ice grip chocks together with rope. Use sandbags in lieu of chocks when aircraft is moored on steel mats. Set parking brake as applicable.

5. Accomplish aircraft tiedown by utilizing mooring points shown in Figure 3-9. Make tiedown with one-quarter-inch aircraft cable, using two wire rope clips, or bolts, and a chain tested for a 3,000-pound pull. Attach tiedowns so as to remove all slack. Use a three quarter inch or larger manila rope if cable or chain tiedown is not available. If rope is used for tiedown, use anti-slip knots, such as bowline knot, rather than slip knots. In the event tiedown rings are not available on hard surfaced areas, move aircraft to an area where portable tiedowns can be used. Locate anchor rods at points shown in Figure 3-9. When anchor kits are not available, use metal stakes or dead-man-type anchors, provided they can successfully sustain a minimum pull of 3,000 pounds.

6. In the event nose tiedown is considered to be of doubtful security because of existing soil condition, drive additional anchor rods at nose tiedown position. Place padded work stand or other suitable support under the aft fuselage tiedown position and secure.

7. Place control surfaces in locked position and trim tab controls in neutral position. Place wing flaps in up position.

8. The requirements for dust excluders, protective covers, and taping of openings will be left to the discretion of the responsible maintenance officer or the pilot of the transient aircraft.

9. Secure propellers to prevent windmilling.

10. Disconnect the battery.

11. During typhoon or hurricane wind conditions, mooring security can be further increased by placing sandbags along the wings to break up the aerodynamic flow of air over the wing, thereby reducing the lift being applied against the mooring by the wind.

12. After high winds, inspect aircraft for visible signs of structural damage and for evidence of damage from flying objects. Service nose shock strut and reconnect battery.

CHAPTER 4

Operating Limitations

4.1 INTRODUCTION

This chapter includes all important limits and restrictions that shall be observed during ground and flight operations. The operating limitations set forth are the direct results of design analysis, test, and operating experiences. Compliance with these limits will allow the pilot to safely perform the assigned missions and to derive maximum utility from the aircraft. Limits concerning maneuvers, weight, and cg are also covered.

4.1.1 Exceeding Operational Limits

Anytime an operational limit is exceeded, each occurrence must be properly recorded on the appropriate maintenance forms. Each entry shall state what limit or limits were exceeded, range, time above limits, and any additional data that would aid maintenance personnel in the inspection that may be required.

4.2 SYSTEM LIMITATIONS

4.2.1 Instrument Markings

Instruments that display operating limitations are illustrated in Figures (**B**) 4-6/(**F**) 4-7/(**M**) 4-8. The operating limitations are color coded on the instrument faces; color coding of each instrument is explained in the illustration. RED markings on the dial faces indicate the limit above or below which continued operation is likely to cause damage or shorten life. The GREEN markings indicate the safe or normal range of operation. The YELLOW markings indicate the range where special attention should be given to the operation covered by the instrument. Operation is permissible in the yellow range but should be avoided.

4.2.2 Autopilot Limitations

1. During autopilot operations, a pilot must be seated at the controls with seatbelt fastened.
2. Maximum speed for autopilot operation is V_{MO}: (**B**) 245 knots; (**F/M**) 259 knots.
3. Autopilot or yaw damper shall not be used below 200 feet AGL.
4. Autopilot or yaw damper shall not be used during takeoff or landing.
5. Autopilot disengagement check shall be conducted and found satisfactory prior to each flight on which the autopilot is to be used.

4.2.3 Starter Limitations

The starters in this aircraft are limited to an operating period of 40 seconds on, then 60 seconds off, for two cycles. On the third cycle, after 40 seconds on, the starter shall have a cooling period of 30 minutes off.

4.2.4 Generator Limitations

Maximum sustained generator load is limited as follows:

1. Sea level to FL 310 — 100 percent.
2. Above FL 310 — 88 percent (**F**/**M**).
3. Ground operation — 85 percent.

During ground operation, also observe the limitations in Figure 4-1.

Generator Load (Percent)	Minimum Gas Generator RPM N_1 (Percent)
0 to 70	52 (**B**)
70 to 75	55(**B**)/56(**F**/**M**)
75 to 80	60
80 to 85	65

Figure 4-1. Generator Limitations

Generator output should indicate 27.5 to 29.0 volts and be within 1 volt of each other. The maximum allowable difference between generator loads is 10 percent.

4.2.5 Inverter Limitations

The maximum indicated inverter limits are:

1. Voltage — 115 (±5) Volts.
2. Frequency — 400 (±10) Hz.

4.2.6 Propeller Limitations

Propeller limitations consist of rpm limits. The normal propeller operating range (green arc) extends from 1,600 to 2,000 rpm, with a red line at 2,000 rpm.

WARNING

Do not use propeller in the range of 1,750 to 1,850 rpm during ILS approach due to potential GS signal interference.

4.2.7 Landing Gear Limitations

Landing gear shall not be cycled to exceed 10 complete cycles (extensions and retractions) equally spaced within a 1-hour period and shall not complete a full cycle within a 1-minute period.

CAUTION

- (**B**) Cycling the landing gear in excess of the above limits can cause overheating and failure of the landing gear motor.
- (**F**/**M**) Cycling the landing gear in excess of the above limits can cause the landing gear remote circuit breaker to activate and cause failure of the hydraulic power pack motor.

4.2.8 Fuel Management

1. Takeoff is prohibited if either fuel quantity gauge indicates in the yellow arc or less than 265 pounds of fuel.
2. Operation with the fuel pressure light illuminated is limited to 10 hours between engine driven fuel pump overhaul or replacement periods.
3. Operation on aviation gasoline is limited to 150 hours during any one engine overhaul period.
4. Auxiliary tanks shall not be filled unless the main tanks are full.
5. Maximum fuel imbalance between fuel systems is 1,000 pounds.
6. Crossfeed — Refer to Part V, Emergency Procedures, for crossfeed limitations.

4.2.9 Fuel Capacity

The total fuel system capacity is 549 U.S. gallons, of which 544 U.S. gallons are usable. A 3 percent maximum error may be encountered in the fuel gauging system.

4.2.10 (F/M) Brake Deice Limitations

1. Do not operate longer than 10 minutes (one timer cycle) with the landing gear retracted.
2. A minimum of 85 percent N_1 should be maintained during simultaneous use of surface and brake deice systems. If adequate pneumatic pressure cannot be provided for simultaneous use of both systems, use of the brake deice may be limited.
3. Do not use system during single-engine operation or if pneumatic pressure is being supplied by a single bleed air source.

CAUTION

Use of brake deice during takeoff may render the rudder boost system ineffective with an engine failure after takeoff.

4.3 ENGINE LIMITATIONS

Instruments monitor those conditions that set limits for operation of the PT6A-41/42 engines. Each torquemeter indicates torque applied to the shaft that drives the propeller. Other indicators display Interstage Turbine Temperature (ITT)/Turbine Gas Temperature (TGT), gas generator speed (N_1), and propeller speed (N_2). A dual indication instrument displays both oil pressure and oil temperature. All operating conditions, ranges, and limits for the engine are shown in Figures **(B)** 4-2/**(F/M)** 4-3.

CAUTION

Do not exceed maximum N_1, ITT/TGT, or torque when operating near performance limitations. The power lever stop is not intended to act as a mechanical stop to prevent overspeed, overtemp, or overtorque.

4.3.1 Overtemperature Limitations

Whenever the limiting temperatures listed in Figures (**B**) 4-2/(**F/M**) 4-3 are exceeded and cannot be controlled by retarding the power lever, the engine shall be shut down or a landing shall be made as soon as possible. During engine starting, the temperatures and time limits listed in Figures (**B**) 4-2/(**F/M**) 4-3 must be observed. When these limits are exceeded, the incident shall be entered as an engine discrepancy in the appropriate maintenance forms. It is particularly important to record the amount and duration of overtemperature.

4.3.2 Overspeed Limitations

Whenever the prescribed engine overspeed limit or engine rpm operating limit is exceeded, the incident must be reported as an engine discrepancy in the appropriate maintenance forms. It is particularly important to record the maximum percent of rpm registered by the tachometer and the duration of overspeed.

4.3.3 Power Definitions

The following definitions describe the engine power ratings listed in Figures (**B**) 4-2/(**F/M**) 4-3:

1. Takeoff and maximum continuous power — The maximum power available from the engine for takeoff and for emergency use at pilot discretion.

2. Cruise climb — The maximum power recommended for normal climb.

3. Maximum cruise — The maximum power approved for normal cruise.

4. Performance cruise — The power required from the engines to maintain level flight at a desired altitude while traveling at an airspeed within the normal operating range approved for the aircraft. Cruise power will vary with altitude and airspeed.

4.3.4 Ambient Temperature Limitations

4.3.4.1 Aircraft Operating Temperature Limitation

Refer to Figure 4-4.

4.3.4.2 Surface Deice Boot Temperature Limitation

Operation of the surface deice boots in temperatures below -40 °C (-40 °F) could result in permanent damage to the boots.

4.3.4.3 Brake Deice Limitations

The brake deice system should not be operated at ambient temperatures above +15 °C (59 °F).

4.3.4.4 Ice Vane (Inertial Separator System) Limitations

The ice vanes shall be extended for operations in ambient temperatures of +5 °C (41 °F) or below when flight free of visible moisture cannot be assured. The ice vanes shall be retracted for operations in ambient temperatures of +15 °C (59 °F) or above.

Note

The actual Outside Air Temperature (OAT) may be up to 8 °C less than indicated (IOAT).

OPERATING CONDITION	SHP	TORQUE FT-LB (1)	MAXIMUM OBSERVED ITT °C	GAS GENERATOR RPM N_1%	PROP RPM N_2	OIL PRESS PSI (2)	OIL TEMP °C
Starting	—	—	1,000 (3)	—	—	—	-40 (min)
Low Idle	—	—	660 (4)	52 (min)	—	60 (min)	-40 to 99
High Idle	—	—	—	(5)	—	—	-40 to 99
Takeoff and Max Cont	850	2,230	750 (11)	101.5	2,000	105 to 135	10 to 99
Max Cruise/Climb	—	2,230 (7)	725 (11)	101.5	2,000	105 to 135	0 to 99
Max Reverse (8)	—	—	750	88	1,900	105 to 135	0 to 99
Transient	—	>2,230 (3)	750 (13)	101.6 to 102.6 (9) (12)	2,000 to 2,200 (3) (10)	—	100 to 104 (6)

CAUTION

- Engine torque and temperature limits are determined by ambient temperature. During operations requiring maximum engine performance, be aware of whether torque or temperature limits govern. Remember that cold temperature or low altitude is torque limited, hot temperature or high altitude is temperature limited.
- Each column is a separate limitation. The stated limits do not necessarily occur simultaneously.
- The limit values within the PROP RPM N_2 column are not propeller limitations. These values specify propeller rpms that correspond to stress limits of the engine power section.

1. Torque limit applies within range of 1,600 to 2,000 propeller rpm (N_2). Below 1,600 rpm, torque is limited to 1,100 ft-lb.
2. When gas generator speeds are above 27,000 rpm (72 percent N_1) and oil temperatures are between 60 and 71 °C, normal oil pressures are:

   105 to 135 psi below 21,000 feet; 85 to 135 psi at 21,000 feet and above.

   During extremely cold starts, oil pressure may reach 200 psi. Oil pressure below 85 psi (at and above 21,000 feet) and 105 psi (below 21,000 feet) is undesirable and should be tolerated only for the completion of the flight at reduced power not to exceed 1,100 ft-lb torque. Oil pressure below 60 psi is unsafe — it requires that either the engine be shut down or that a landing be made as soon as possible, using the minimum power required to sustain flight. Fluctuations of ±10 psig are acceptable.
3. These values are time limited to 5 seconds. For values exceeding these, maintenance action may be required - note maximum torque or temperature reached and the number of seconds or minutes at that value. Provide data to maintenance personnel to determine maintenance action requirements.
4. High engine temperature at ground idle may be corrected by reducing accessory load and/or increasing N_1 rpm.
5. At approximately 70 percent N_1.
6. These values are time limited to 5 minutes in any condition.
7. Cruise torque values vary with altitude and temperature.
8. The operation is time limited to 1 minute.
9. These values are time limited to 10 seconds.
10. Propeller speeds above 2,120 rpm indicate failure of both primary and overspeed governors. Torque is limited to 1,800 ft-lb for sustained operation above 2,000 rpm.
11. For increased engine service life, 700 °C ITT is recommended for climb and cruise.
12. Replace engine if limits are exceeded.
13. For temperatures above 750 °C, maintenance action may be required — note maximum temperature reached and number of seconds at that temperature. Provide data to maintenance personnel to determine maintenance action requirements. Temperatures above 850 °C require engine overhaul.

Figure 4-2. (**B**) Engine Operating Limitations

OPERATING CONDITION	SHP	TORQUE FT-LB/% (1)	MAXIMUM OBSERVED ITT °C/TGT °C	GAS GENERATOR RPM N_1%	PROP RPM N_2	OIL PRESS PSI (2)	OIL TEMP °C (3)
Starting	—	—	1,000 (4)	—	—	—	-40 (min)
Low Idle	—	—	750 (5)	56 (min)	—	60 (min)	-40 to 99
High Idle	—	—	—	(6)	—	—	-40 to 99
Takeoff and Max Cont	850	2,230/100	800 (11)	101.5	2,000	100 to 135	0 to 99
Max Cruise	850	2,230/100 (8)	800 (11)	101.5	2,000	100 to 135	0 to 99
Normal Cruise	850	2,230/100 (8)	770	101.5	2,000		0 to 99
Max Reverse (9)	800	—	750 (9)	88	1,900	100 to 135	0 to 99
Transient		>2,230/ >100 (4)	800 (13)	101.6 to 102.6 (10) (12)	2,000 to 2,200 (4) (14)	—	100 to 104 (7)

CAUTION

- Engine torque and temperature limits are determined by ambient temperature. During operations requiring maximum engine performance, be aware of whether torque or temperature limits govern. Remember that cold temperature or low altitude is torque limited, hot temperature or high altitude is temperature limited.
- Each column is a separate limitation. The stated limits do not necessarily occur simultaneously.
- The limit values within the PROP RPM N_2 column are not propeller limitations. These values specify propeller rpms that correspond to stress limits of the engine power section.

1. Torque limit applies within range of 1,600 to 2,000 propeller rpm (N_2). Below 1,600 rpm, torque is limited to (**F**) 1,100 ft-lb/(**M**) 49 percent.
2. When gas generator speeds are above 27,000 rpm (72 percent N_1) and oil temperatures are between 60 and 71 °C, normal oil pressures are:
   100 to 135 psi below 21,000 feet; 85 to 135 psi at 21,000 feet and above.
   During extremely cold starts, oil pressure may reach 200 psi. Oil pressure 60 to 85 psi (at and above 21,000 feet) and 60 to 100 psi (below 21,000 feet) is undesirable and should be tolerated only for the completion of the flight at reduced power not to exceed (**F**) 1,100 ft-lb/(**M**) 49 percent torque. Oil pressure below 60 psi is unsafe — it requires that either the engine be shut down or that a landing be made as soon as possible, using the minimum power required to sustain flight. Fluctuations of ±10 psig are acceptable.
3. An engine oil temperature of 74 to 80 °C is recommended. A minimum oil temperature of 55 °C is recommended for fuel heater operation at takeoff power.
4. These values are time limited to 5 seconds. For values exceeding these, maintenance action may be required - note maximum torque or temperature reached and the number of seconds or minutes at that value. Provide data to maintenance personnel to determine maintenance action requirements.
5. High engine temperature at ground idle may be corrected by reducing accessory load and/or increasing N_1 rpm.
6. At approximately 70 percent N_1.
7. These values are time limited to 5 minutes in any condition.
8. Cruise torque values vary with altitude and temperature.
9. The operation is time limited to 1 minute.
10. These values are time limited to 10 seconds.
11. For increased engine service life, 770 °C is recommended for climb and cruise.
12. Replace engine if limits are exceeded.
13. For temperatures above 800 °C, maintenance action may be required — note maximum temperature reached and number of seconds at that temperature. Provide data to maintenance personnel to determine maintenance action requirements. Temperatures above 850 °C require engine overhaul.
14. Propeller speeds above 2,120 indicate failure of both primary and secondary governors. Torque is limited to (**F**) 1,800 ft-lb/(**M**) 81 percent for sustained operation above (**F**) 2,000/(**M**) 2,080 rpm.

Figure 4-3. (**F/M**) Engine Operating Limitations

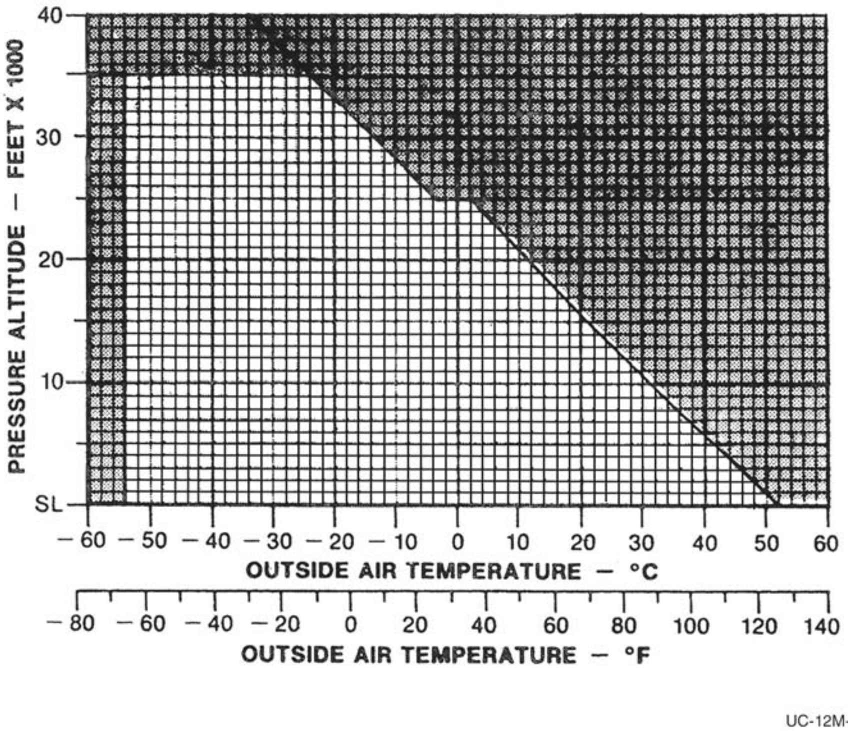


Figure 4-4. Operating Temperature Range

4.4 AIRFRAME LIMITATIONS

4.4.1 Weight Limitations

The aircraft design operating gross weight is 12,500 pounds. The commanding officer may authorize takeoff gross weights of up to 13,500 pounds to meet operational requirements due to long range, poor en route weather, or impractical refueling facilities. This authority may be delegated. The maximum authorized operating weights for the airframe are listed below. Performance considerations may require a reduced weight. Refer to A1-C12BM-NFM-200 Performance Charts.

Maximum Ramp and Taxi Weight:

Max zero fuel weight	— 11,000 lb
Normal Category	— (**B**) 12,590 lb (**F/M**) 12,595 lb
Restricted Category	— (**B**) 13,590 lb (**F/M**) 13,595 lb

Maximum Takeoff Weight:

Normal Category Takeoff	— 12,500 lb
Restricted Category Takeoff	— 13,500 lb

Maximum Landing Weight:

Normal Category	— 12,500 lb
Restricted Category	— 12,500 lb

CAUTION

- Slow taxi speeds, smooth maneuvering, and avoidance of turbulence are essential during operation above 12,500 pounds.
- Landing at weights in excess of 12,500 pounds is authorized in cases of immediate emergency only.
- All takeoffs and landings at weights in excess of 12,500 pounds shall be logged in the aircraft logbook.

4.4.2 Airstair Door Limitations

The door is weight limited to 300 pounds. Structural damage may occur if more than one person is on the entrance door at a time.

4.4.3 Center of Gravity Limitations

The UC-12 is a weight and balance class 2 aircraft; the cg limits and gross weight limits may easily be exceeded. The aircraft commander must ensure that the payload distribution results in flight aircraft cg remaining within the limits throughout the flight. Refer to Figure 4-5.

4.4.4 Airspeed Limitations

The maximum indicated airspeeds and Mach numbers authorized for flight in smooth air are as follows:

1. Maximum operating speed, V_{MO} — (**B**) 245 KIAS; (**F/M**) 259 KIAS.

Note

V_{MO} shall not be deliberately exceeded in any flight regime (climb, cruise, or descent).

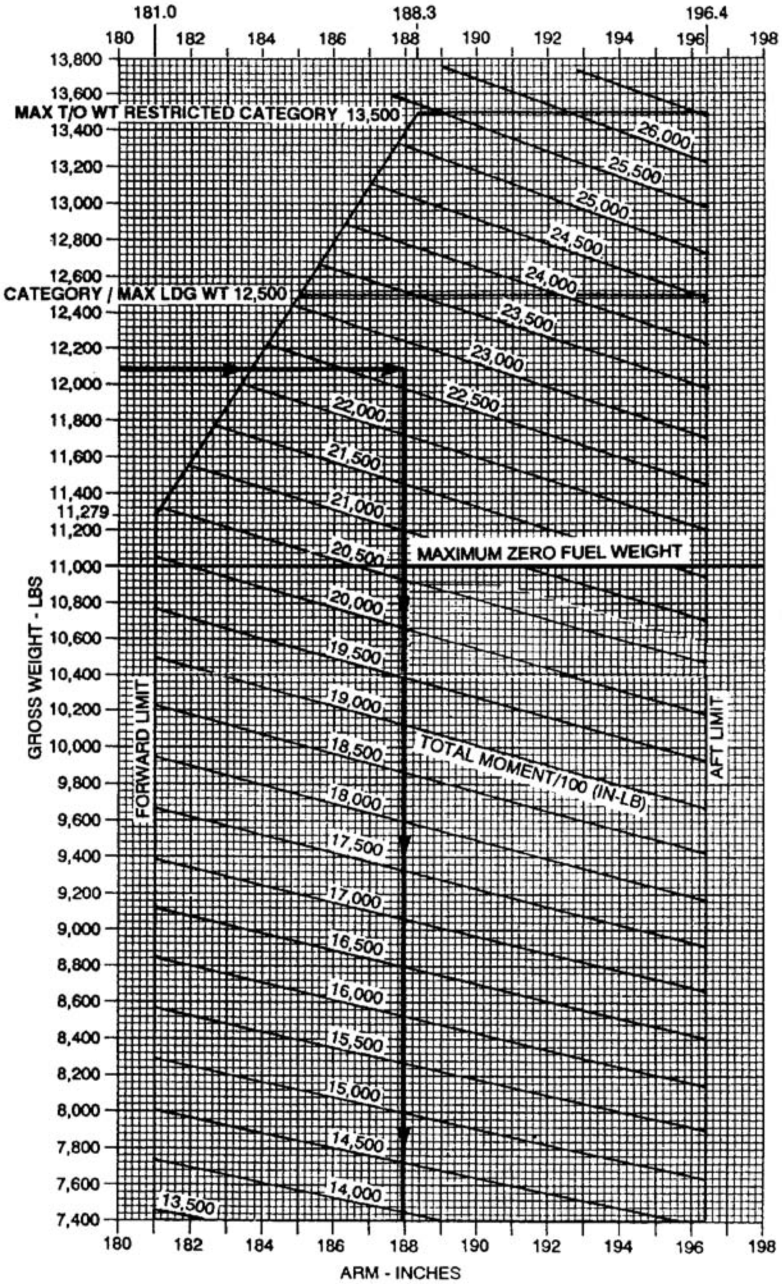
2. Minimum safe single-engine speed, V_{SSE} — 104 KIAS.

4.4.5 Maximum Flap Operating Speeds (V_{FE})

1. Maximum approach flap speed — 200 KIAS.
2. Maximum full flap speed — (**B**) 155 KIAS; (**F/M**) 157 KIAS.

Note

Aircraft prior to BuNo 161318 indicate maximum full flap airspeed as 144 KIAS; correct airspeed limitation is 155 KIAS.



EXAMPLE

WANTED
DETERMINE IF CG LOADING LIMITS ARE EXCEEDED, (1); AND DETERMINE CG POSITION, (2).

KNOWN
GROSS WEIGHT (GW) = 12,085 LB
MOMENT/100 = 22,720 IN-LB

METHOD
ENTER GW AT 12,085 LB
MOVE RIGHT TO TOTAL MOMENT/100 = 22,720 IN-LB
MOMENT LIES WITHIN (BETWEEN FORWARD AND AFT) CG LIMITS, (1).
THEN, MOVE DOWN TO ARM SCALE.
READ CG POSITION ARM = 188.0 IN, (2)
OR
CALCULATE CG MOMENT ARM USING FORMULA:

$$ARM\ (IN) = \frac{MOMENT/100\ (IN\text{-}LB)}{GW\ (LB)}$$

CENTER OF GRAVITY LIMITS (LANDING GEAR DOWN)
NORMAL CATEGORY

WEIGHT CONDITION	FORWARD CG LIMIT	AFT CG LIMIT
12,500 LB (MAXIMUM TAKEOFF OR LANDING)	185.0	196.4
11,279 LB OR LESS	181.0	196.4

RESTRICTED CATEGORY

WEIGHT CONDITION	FORWARD CG LIMIT	AFT CG LIMIT
13,500 LB (MAXIMUM TAKEOFF OR LANDING)	188.3	196.4
11,279 LB OR LESS	181.0	196.4

NOTE: The moment/100 for retraction of the landing gear is 60.4. Loadings based on wheels-down conditions that fall within the limiting moments in the table will be satisfactory for flight with landing gear retracted.

UC-12M-F0106

Figure 4-5. Center of Gravity Limits

4.4.6 Maximum Landing Gear Operating Speeds

1. Maximum gear retraction speed (V_{LO}) — **(B)** 164 KIAS; **(F/M)** 163 KIAS.
2. Maximum gear extension/extended speed (V_{LE}) — **(B)** 182 KIAS; **(F/M)** 181 KIAS.

4.4.6.1 Maximum Design Maneuvering Speed (V_A)

1. Maximum design maneuvering speed flaps up — 181 KIAS.
2. Maximum design maneuvering speed flaps down — 111 KIAS.

4.4.7 Diving Speed V_{MO}

Maximum diving airspeed (red line) is V_{MO}. V_{MO} decreases approximately 5 knots for each 1,000 feet of altitude above **(B)** 13,000 feet/**(F/M)** 15,000 feet. Flight characteristics are conventional with control forces at a comfortable level throughout a dive maneuver. No adverse characteristics prevail.

4.4.8 Turbulent Air Penetration Speed

For turbulent air penetration, use an airspeed of 170 knots. Avoid large power changes. Turn off autopilot altitude hold. Keep wings level, maintain attitude and avoid use of trim. Do not chase airspeed and altitude. Penetration should be at an altitude that provides adequate maneuvering margins when severe turbulence is encountered.

4.4.9 Altitude Limitations

1. Maximum operating altitude — **(B)** 31,000 feet; **(F/M)** 35,000 feet.
2. Emergency operation with aviation gasoline:
   a. Both standby boost pumps operative — 31,000 feet.
   b. Either standby boost pump inoperative — 20,000 feet.
3. Operation with unpressurized cabin — 25,000 feet.
4. Operation with inoperative yaw damp — 17,000 feet.

4.4.10 Pressurization Limitations

1. Maximum cabin pressure differential — **(B)** 6.1 psi; **(F/M)** 6.6 psi.
2. Operation with cracked cabin window (inner or outer) — Unpressurized flight only.
3. Operation with cracked windshield, inner layer — 4.0 psi.
4. Operation with cracked windshield, outer layer — **(B)** 6.1 psi; **(F/M)** 6.6 psi.

4.4.11 Acceleration Limitations

Avoid accelerations greater than those required for level banked turns, maximum 2.0g positive. Accelerations less than 0.5g positive (pushover) may result in loss of engine oil pressure and shall be avoided. Operation within these limitations promotes passenger comfort, assures cargo integrity, and enhances aircraft service life. Aircraft design maneuver loads at design gross weight are:

1. 3.17g positive, 1.27 negative in the clean configuration.
2. 2.0g positive, 1.27 negative with flaps extended.

4.4.12 Prohibited Maneuvers

1. Abrupt control movement.
2. Unusual g loading.
3. Bank angle greater than 50° (normal category).
4. Bank angle greater than 35° (restricted category).
5. Pitch attitude more than 30° above or below the horizon.
6. Intentional spins.

4.4.13 Landing Limitations

1. Rudder pedal inputs should not exceed one half displacement in landing configurations, except as necessary during emergency situations and to maintain balanced flight.
2. Flared landings only.
3. Maximum sink rate at touchdown — 300 fpm.
4. Maximum cross wind component — 25 knots.
   a. Icy runway landing — 10 knots.
   b. Soft field landing — 5 knots.
5. Maximum tailwind component — 10 knots.
6. Damage to the landing gear may result from cable rollover above taxi speed (rigged or lying flat on runway).

CAUTION

Damage to the landing gear may also result from the following:

— Landing on arresting gear cables.

— Braking during cable rollover.

— Wheel contact with cable risers or boots.

— Cable rollover when arresting gear is rigged with tire sections (boots).

4.4.14 Propeller Reversing

Do not move power levers aft of the flight idle position in flight.

WARNING

Moving the power levers into the beta or reverse range in flight will result in an extremely severe nosedown pitch and descent rate.

4.5 MISCELLANEOUS LIMITATIONS

1. Maximum tire speed — 139 KIAS.

4.6 MISSION CAPABILITY

Figure 4-9 provides the mission capability equipment requirements for various types of missions.

> **NOTE**
> ALL ILLUSTRATION NEEDLES MAY NOT REFLECT NORMAL INDICATIONS

INTERSTAGE TURBINE TEMPERATURE

- (Green) 400-750°C NORMAL OPERATING RANGE
- (Red) 750°C MAXIMUM CONTINUOUS
- (Red with white stripes) 1000°C MAXIMUM (STARTING)

TORQUE

- (Green) 400-2230 FT. LB. NORMAL OPERATING RANGE
- (Red) 2230 FT. LB. MAXIMUM

PROPELLER TACHOMETER

- (Green) 1600-2000 RPM NORMAL OPERATING RANGE
- (Red) 2000 RPM MAXIMUM

TURBINE TACHOMETER (N_1 SPEED)

- (Green) 52-101.5% NORMAL OPERATING RANGE
- (Red) 101.5% MAXIMUM

06-E-0038(1)

Figure 4-6. (**B**) Instrument Markings (Sheet 1 of 3)

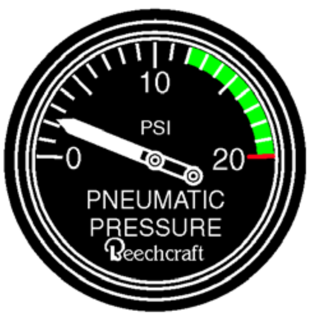
OIL TEMPERATURE AND PRESSURE

OIL TEMPERATURE SCALE

- Green: 10-99°C NORMAL OPERATING RANGE
- Red: 99°C MAXIMUM

OIL PRESSURE SCALE

- Red: 60 PSI MINIMUM
- Yellow/Green: 85-105 PSI CAUTION RANGE BELOW 21,000 FEET; 105-135 PSI NORMAL OPERATING BELOW 21,000 FEET
- Green: 85-135 PSI NORMAL OPERATING ABOVE 21,000 FEET
- Red: 200 PSI MAXIMUM



PNEUMATIC PRESSURE

- Green: 12-20 PSI NORMAL OPERATING RANGE
- Red: 20 PSI MAXIMUM

GYRO SUCTION

- Green: HG 2.8 - 5.9 NORMAL OPERATING RANGE

PROPELLER DEICER AMMETER

- Green: 14-18 AMPERES NORMAL OPERATION

06-E-0038(2)

Figure 4-6. (**B**) Instrument Markings (Sheet 2 of 3)

NOTE
ALL ILLUSTRATION NEEDLES MAY NOT REFLECT NORMAL INDICATIONS

AIRSPEED INDICATOR

- 245 KIAS MAXIMUM (V_{mo}) (.52 MACH)

NOTE
MAXIMUM ALLOWABLE AIRSPEED (RED STRIPPED) POINTER IS SELF ADJUSTING WITH ALTITUDE

- 91 KCAS (86 KIAS) MINIMUM SINGLE-ENGINE CONTROL SPEED (V_{mca})
- 121 KIAS ONE-ENGINE INOPERATIVE BEST RATE OF CLIMB (V_{yse})
- 80-155 KIAS FULL FLAP OPERATING RANGE
- 200 KIAS MAXIMUM FLAPS AT APPROACH SPEED

NOTE
IN AIRCRAFT PRIOR TO BUNO 161318, THE NARROW WHITE ARC IS MARKED 102 TO 144. MAX FLAP LIMITATION AIRSPEED IN THESE AIRCRAFT IS 155 KIAS. THE V_{mo} NEEDLE SHOWS A MAX LIMITATION OF 260 KIAS; CORRECT V_{mo} IS 245 KIAS. AIRCRAFT BUNO 161318 AND AFTER INDICATE AS SHOWN.

MAIN TANKS ONLY

FUEL QUANTITY

- 0-265 LBS NO TAKEOFF RANGE

CABIN ALTIMETER AND PRESSURE DIFFERENTIAL

- 0-6.1 PSI NORMAL RANGE
- 6.1-6.4 PSI MAXIMUM (END OF SCALE)

FLAP POSITION INDICATOR

- 40% TAKEOFF AND APPROACH

06-E-0038(3)

Figure 4-6. (**B**) Instrument Markings (Sheet 3 of 3)

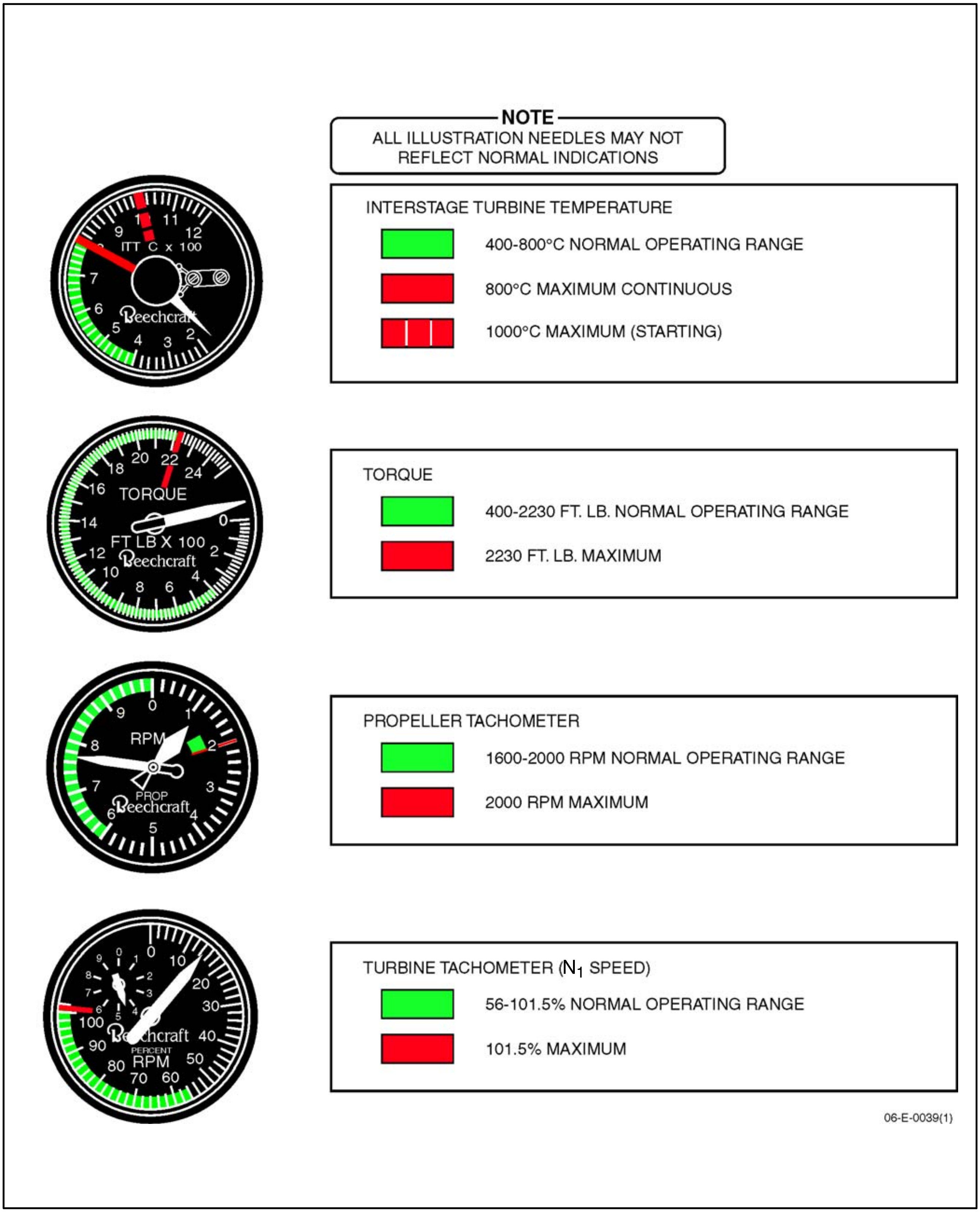


Figure 4-7. (**F**) Instrument Markings (Sheet 1 of 3)

OIL TEMPERATURE AND PRESSURE

OIL TEMPERATURE SCALE

- (Green) 0-99°C NORMAL OPERATING RANGE
- (Red) 99°C MAXIMUM

OIL PRESSURE SCALE

- (Red) 60 PSI MINIMUM
- (Yellow) 85-100 PSI CAUTION RANGE BELOW 21,000 FEET
- (Green) 100-135 PSI NORMAL OPERATING BELOW 21,000 FEET
- (Green) 85-135 PSI NORMAL OPERATING ABOVE 21,000 FEET
- (Red) 200 PSI MAXIMUM

PNEUMATIC PRESSURE

- (Green) 12-20 PSI NORMAL OPERATING RANGE
- (Red) 20 PSI MAXIMUM

GYRO SUCTION

- (Green) HG 2.8 – 5.9 NORMAL OPERATING RANGE

PROPELLER DEICER AMMETER

- (Green) 18-24 AMPERES NORMAL OPERATION

06-E-0039(2)

Figure 4-7. (**F**) Instrument Markings (Sheet 2 of 3)

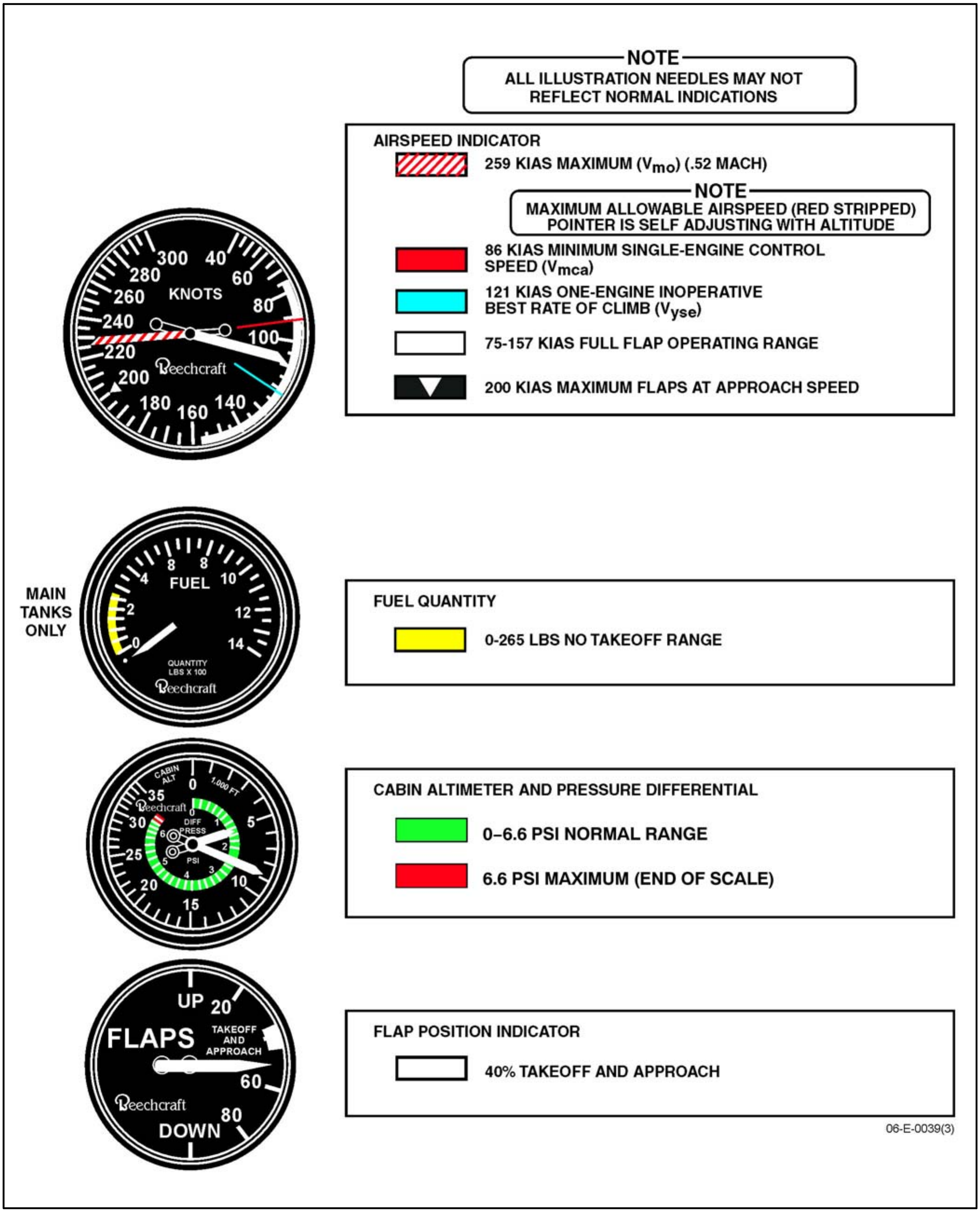


Figure 4-7. (**F**) Instrument Markings (Sheet 3 of 3)

NOTE

ALL ILLUSTRATION NEEDLES MAY NOT REFLECT NORMAL INDICATIONS

TURBINE GAS TEMPERATURE

- Green: 400-800 °C NORMAL OPERATING RANGE
- Red: 800 °C MAXIMUM CONTINUOUS
- Red/white striped: 1000 °C MAXIMUM (STARTING)

TORQUE

- Green: 20-100% NORMAL OPERATING RANGE
- Red: 100% MAXIMUM AT 2000 RPM

PROPELLER TACHOMETER

- Green: 1600-2000 RPM NORMAL OPERATING RANGE
- Red: 2000 RPM MAXIMUM

TURBINE TACHOMETER (N_1 SPEED)

- Red: 101.5% MAXIMUM
- Green: 56-101.5% NORMAL OPERATING RANGE

UC-12M-F032

Figure 4-8. (**M**) Instrument Markings (Sheet 1 of 3)

OIL TEMPERATURE AND PRESSURE

OIL TEMPERATURE SCALE

- (Green) 10-99°C NORMAL OPERATING RANGE
- (Red) 99°C MAXIMUM

OIL PRESSURE SCALE

- (Red) 60 PSI MINIMUM
- (Yellow/Green) 85-100 PSI CAUTION RANGE BELOW 21,000 FEET
  100-135 PSI NORMAL OPERATING BELOW 21,000 FEET
- (Green) 85-135 PSI NORMAL OPERATING ABOVE 21,000 FEET
- (Red) 200 PSI MAXIMUM

PNEUMATIC PRESSURE

- (Green) 12-20 PSI NORMAL OPERATING RANGE
- (Red) 20 PSI MAXIMUM

GYRO SUCTION

- (Green) HG 2.8-5.9 NORMAL OPERATING RANGE

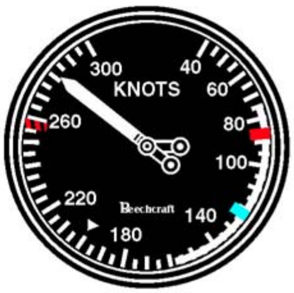
PROPELLER DEICE AMMETER

- (Green) 18-24 AMPERES NORMAL OPERATION

UC-12M-F033

Figure 4-8. (**M**) Instrument Markings (Sheet 2 of 3)

NOTE
ALL ILLUSTRATION NEEDLES MAY NOT REFLECT NORMAL INDICATIONS



AIRSPEED INDICATOR

- 259 KIAS MAXIMUM (V_{mo})(0.52 MACH)

NOTE
MAXIMUM ALLOWABLE AIRSPEED (RED STRIPPED) POINTER IS SELF ADJUSTING WITH ALTITUDE

- 86 KIAS MINIMUM SINGLE ENGINE CONTROL SPEED (V_{mca})
- 121 KIAS ONE-ENGINE INOPERATIVE BEST RATE OF CLIMB (V_{yse})
- 75-175 KIAS FULL FLAP OPERATING RANGE
- 200 KIAS MAXIMUM FLAPS TO AT APPROACH SPEED

FUEL QUANTITY

- 0-265 LBS NO TAKEOFF RANGE

CABIN ALTIMETER AND PRESSURE DIFFERENTIAL

- 0-6.6 PSID NORMAL RANGE
- 6.6-7.0 PSID MAXIMUM (END OF SCALE)

FLAP POSITION INDICATOR

- 40% TAKEOFF AND APPROACH

UC-12M-F034

Figure 4-8. (**M**) Instrument Markings (Sheet 3 of 3)

FULL MISSION CAPABLE
(A) OPTIMUM PERFORMANCE CAPABILITY
(B) EXPANDED MOBILITY
(C) PASSENGERS/MEDEVAC AND/OR CARGO

PARTIAL MISSION CAPABLE
(D) TRAINING FLIGHTS

NOT MISSION CAPABLE
(Y) SAFELY FLYABLE

MISSION DESCRIPTION

(A) OPTIMUM PERFORMANCE CAPABILITY
Maximized capability for successful completion of all applicable missions through availability of all equipment.

(B) EXPANDED MOBILITY
Capable of long-range overwater flight operations.

(C) PASSENGERS/MEDEVAC AND/OR CARGO
Capable of day or night Instrument/Visual Meteorological Condition (IMC/VMC) flights carrying passengers, medical evacuation of litter patients, and/or cargo.

(D) TRAINING FLIGHTS
Capable of day or night IMC/VMC training flights.

(Y) SAFELY FLYABLE
Capable of day, field flight operations under VMC with two-way radio communications and necessary aircraft and crew safety provisions.
Commanding officers may authorize one-time ferry flight.

SYSTEMS AND/OR COMPONENTS	NUMBER OF ITEMS INSTALLED	(A) OPTIMUM PERFORMANCE	(B) EXPANDED MOBILITY	(C) PAX/MEDEVAC AND CARGO	(D) TRAINING FLIGHTS	(Y) SAFELY FLYABLE		REMARKS
ELECTRICAL POWER								
AC Volts/Frequency Meter	1	1	1	1	1	1		
Battery	1	1	1	1	1	1		
Battery Charge Monitor System and Annunciator	1	1	1	1	1	1		
DC Generator	2	2	2	2	2	1		
DC Loadmeter	2	2	2	2	2	1		corresponding to the operable generator
Inverter	2	2	2	2	1	1		
Isolation (Current) Limiter	2	2	2	2	2	1		
ENGINES								
Chip Detector System	2	2	2	2	2	2		
Fire Detection System (**B**/**F**)	6	6	6	6	6	6		
Fire Detection System (**M**)	2	2	2	2	2	2		
Fire Extinguish System	2	2	2	2	2	2		
ITT/TGT Gauge	2	2	2	2	2	2		
N_1 Tach Gauge	2	2	2	2	2	2		
N_2 Tach Gauge	2	2	2	2	2	2		
Oil Pressure Gauge	2	2	2	2	2	2		
Oil Temp Gauge	2	2	2	2	2	2		
Torque Gauge	2	2	2	2	2	2		

Figure 4-9. Minimum Equipment List (Sheet 1 of 5)

SYSTEMS AND/OR COMPONENTS	NUMBER OF ITEMS INSTALLED	(A) OPTIMUM PERFORMANCE	(B) EXPANDED MOBILITY	(C) PAX/MEDEVAC AND CARGO	(D) TRAINING FLIGHTS	(Y) SAFELY FLYABLE	REMARKS
FUEL							
Engine Driven Boost Pump	2	2	2	2	2		
Firewall Fuel Shutoff Valve	2	2	2	2	2	2	
Fuel Crossfeed System	1	1	1	1	1		
Fuel Flow Indicator	2	2	1	1	1	1	both fuel quantity operative
Fuel Quantity Indicating System	2	2	1	1	1	1	both fuel flow/fuel log/visual
Jet Transfer Pump/Motive Flow Valve	2	2	2	2	2		
Low Fuel Quantity Alert System	2	2	2	2	2	2	
Standby Electric Boost Pump	2	2	2	2	2		
PROPELLER							
Autofeather System	1	1					
Prop Overspeed Governor	2	2	2	2	2	2	
Prop Sync	1	1					
NAVIGATION/COMMUNICATION							
ADF (**B**/**F**)	1	1	1				as required/overseas
ADF (**M**)	2	2	1				as required/overseas
Altitude Alerter	1	1					
Clock	2	2	1	1	1		either
Compass System	2	2	2	2	2		
EGPWS (**B**/**M**)	1	1	1	1			Min required for (C) Audio Functions
FMS/GPS	1	1	1	*1			*as required/overseas
GPWS (**F**)	1	1	1	1			
HF	1	1	1				as required/overseas
ICS	1	1					
Magnetic Compass	1	1	1	1	1	1	
Multifunction Display (**B**/**M**)	1	1					
Outside Air Temp Gauge	1	1	1	1	1		
Radio Altimeter	1	1	1				
RMI	2	2	2	1	1		either
TCAS (**B**/**M**)	1	1	1	1			Min required for (C) Traffic Alert (TA) Audio Functions. See Note 1.
Transponder (**F**)	1	1	1	1	1	1	
IFF Transponder (**B**/**M**)	1	1	1	1	1	1	
VHF/UHF	3	3	2	2	2	1	
VOR/TACAN	3	3	2*	2*	1	1	*If the GPS/FMS is operational, and there are GPS approaches at destination facilities, only 1of 3 are required.
PILOT							
Airspeed Indicator	1	1	1	1	1	1	
Altimeter	1	1	1	1	1		
Attitude Indicator	1	1	1	1	1	*	1 of 3 required for safely flyable

Figure 4-9. Minimum Equipment List (Sheet 2 of 5)

SYSTEMS AND/OR COMPONENTS	NUMBER OF ITEMS INSTALLED	(A) OPTIMUM PERFORMANCE	(B) EXPANDED MOBILITY	(C) PAX/MEDEVAC AND CARGO	(D) TRAINING FLIGHTS	(Y) SAFELY FLYABLE	REMARKS
PILOT cont.							
Flight Director	1	1					
HSI	1	1	1	1	1		
IVSI (**F**)	1	1	1	1	1		
Standby Gyro	1	1	1	1			Required night or IMC.
Turn and Bank	1	1	1	1			Required night or IMC.
VSI/TRA (**B**/**M**)	1	1	1	1	1		Not required for (D) if Traffic Alert (TA) Audio Functions are operative. See Notes 1 and 2.
COPILOT							
Airspeed Indicator	1	1	1	1	1		
Altimeter	1	1	1	1	1	1	
Attitude Indicator	1	1	1	1	1	*	1 of 3 required for safely flyable
Flight Director	1	1					
HSI	1	1	1	1	1		
IVSI (**F**)	1	1	1	1			
Turn and Bank	1	1	1	1	1		
VSI/TRA (**B**/**M**)	1	1	1	1			
ENVIRONMENTAL							
Air Conditioner System	1	1					enviro conditions permitting
Cabin Rate of Climb Indicator	1	1	1	1			
Differential Press/Cabin Altitude Indicator	1	1	1	1	1		
Pressurization System	1	1	1	1	1		above 10,000 feet
Pressurization Air Source	2	2	1	1	1		above 10,000 feet
OXYGEN							
Oxygen System — Passenger	1	1	1	1			
Oxygen System — Pilots	1	1	1	1	1	1	
ICE AND RAIN PROTECTION							
Airfoil Deice System	2	2					required in icing
Alternate Static Air Source	1	1	1				required if OAT below 5 °C
Engine Autoignition	2	2	2	2	2		
Engine Inertial Ice Vanes	2	2					required in icing/FOD environment
Heated Fuel Vent	2	2	2	2	2		
Pitot Heat	2	2	2	2	2		
Propeller Deice System	2	2					required in icing
Stall Warning Heat	1	1	1	1	1		
Static Discharge Wicks (**B**/**F**)	22	22	6	6	6		one each control surface/tail cone
Static Discharge Wicks (**M**)	22	22	5	5	5		one each control surface
Windshield Heat	2	2	1	1	1		flying pilot side
Windshield Wiper	2	2	1	1	1		flying pilot side
Weather Radar	1	1					

Figure 4-9. Minimum Equipment List (Sheet 3 of 5)

SYSTEMS AND/OR COMPONENTS	NUMBER OF ITEMS INSTALLED	(A) OPTIMUM PERFORMANCE	(B) EXPANDED MOBILITY	(C) PAX/MEDEVAC AND CARGO	(D) TRAINING FLIGHTS	(Y) SAFELY FLYABLE	REMARKS
LIGHTS							
Cockpit and Instrument Lights	1	1					required night or IMC
Emergency Lighting	5	5	5	5	5		
Landing Lights	2	2					required night (1 min)
Position Lights	3	3					required night or IMC
Recognition Lights	2	2					
Rotating Beacon	2	2	1	1	1	1	
Strobe Lights (**B**/**F**)	3	3					
Strobe/Beacon (**M**)	2	1	1	1	1	1	
Taxi Light	1	1					
Wing Ice Lights	2	2	1	1	1		required for night
FLIGHT CONTROLS							
Autopilot	1	1					
Electric Trim	1	1					
Flap Position Indicator	1	1	1				
Flap System	1	1	1	1	1		
Rudder Boost	1	1					
Stall Warning System	1	1	1	1	1		
Trim Tab System (Manual)	1	1	1	1	1	1	
Yaw Damper	1	1					required above 17,000 feet
LANDING GEAR							
Emergency Landing Gear System	1	1	1	1	1		
Landing Gear Aural Warning	1	1	1	1	1		
Landing Gear Handle Warning Lights	2	2	1	1	1		
Landing Gear Position Indicator Lights	3	3	3	3	3		
EMERGENCY/MISC. EQUIPMENT							
Cabin Seating	8	8					As required
Cockpit Voice Recorder	1	1	1	1			Not required if FDR operative (Note 3)
Emergency Locator	1	1	1	1	1		
Flight Data Recorder	1	1	1	1			Not required if CVR operative (Note 3)
Liferaft	1	1					As required/overwater
Litter Furnishing	2	2	2	2			MEDEVAC missions
Seatbelt and Shoulder Harness (Pilot and Copilot)	2	2	2	2	2	2	

Figure 4-9. Minimum Equipment List (Sheet 4 of 5)

SYSTEMS AND/OR COMPONENTS	NUMBER OF ITEMS INSTALLED	(A) OPTIMUM PERFORMANCE	(B) EXPANDED MOBILITY	(C) PAX/MEDEVAC AND CARGO	(D) TRAINING FLIGHTS	(Y) SAFELY FLYABLE	REMARKS
EMERGENCY/MISC. EQUIPMENT cont.							
Overland Survival Kit	1	1					As required
Survival Radio	1	1	1	1	1	1	
Warning and Caution Lights							ALL

Notes:

1. May be inoperative provided:
   a. Traffic Alert (TA) audio functions are operative.
   b. TA only mode is selected by crew.
2. Required for night or IMC.
3. Either an operable FDR or CVR is required for (B), (C), and (D).

Figure 4-9. Minimum Equipment List (Sheet 5 of 5)

PART II

Indoctrination

CHAPTER 5

Indoctrination

5.1 INDOCTRINATION

The information set forth here is intended as a guide to aircraft indoctrination. The requirements are considered the minimum and in no way are intended to compromise any operational or training standards.

5.2 GROUND TRAINING

The ground training requirements for an activity will vary according to local conditions and requirements and with crewmember experience. At a minimum, all crewmembers shall complete CNO-approved training.

5.2.1 NATOPS Flight Manual Examinations

Open-and closed-book examinations stressing normal/emergency procedures and aircraft limitations are required for all NATOPS evaluations.

5.3 FLIGHT TRAINING

All pilots and NFOs shall complete a CNO-approved simulator flight syllabus prior to initial NATOPS qualification. Aircrewmen shall complete a CNO-approved flight syllabus prior to NATOPS qualification.

5.3.1 Supplemental Aircraft Flight Training Syllabus

The following supplemental flight training syllabus is provided in the event additional post Contracted Aircrew Training (CACT) training is warranted based on experience and/or proficiency. Pilot/NFO training shall be provided by an instructor pilot who shall occupy a pilot seat.

Flight 1:

1. Brief.

    a. SOP/course rules.

    b. JOSAC/NALO mission.

    c. Weight and balance.

    d. Takeoff/Landing Data Card (TOLD).

    e. Takeoff procedures, V_R, V_2, and V_{YSE}.

    f. Touch-and-go procedures.

    g. Nonprecision approach procedures.

    h. Precision approach procedures.

    i. Autopilot/flight director systems.

    j. Coupled approaches.

    k. Crew coordination (CRM).

    l. Stalls.

2. Flight.

   a. Egress.

   b. Preflight procedures.

   c. Engine start — Normal.

   d. Taxiing.

   e. Takeoff.

   f. Climb out.

   g. Turn pattern.

   h. Stalls.

      (1) Clean.

      (2) Approach turn.

      (3) Final.

   i. Landings.

      (1) Full flap.

      (2) Approach flap.

      (3) No flap.

   j. Instrument approaches.

Flight 2:

1. Brief.

   a. GPU start.

   b. Aborts.

   c. Single engine aerodynamics.

   d. Engine failure after takeoff.

   e. Engine failure at altitude.

   f. Engine failure in landing pattern.

   g. Single engine nonprecision approach.

   h. Single engine precision approach.

   i. Single engine landings.

   j. Single engine full stop.

   k. Ditch/forced landing.

2. Flight.

   a. In-flight engine shutdown/airstart.

   b. Engine failure after takeoff at altitude.

   c. Emergency descent.

   d. Ditch.

   e. Normal landings.

   f. Single engine landings.

   g. Single engine waveoff.

   h. Single engine instrument approaches.

   i. Single engine full stop.

Flight 3:

1. Brief.

   a. FMS.

   b. Pressurization system.

   c. Fuel planning.

   d. Right seat responsibilities.

2. Flight.

   a. Right seat FAM.

      (1) Navigation.

      (2) Communication.

      (3) Landings (optional).

      (4) Approaches (optional).

or

   b. Left seat.

      (1) Normal landings.

      (2) Single engine landings.

      (3) Approaches.

      (4) Single engine approaches.

5.4 PILOT QUALIFICATION

The Transport Plane Commander (TPC) and Transport Second Pilot (T2P) pilot qualification will be in accordance with OPNAVINST 3710.7 series with the following exceptions:

5.4.1 Minimum Experience Requirements

	TPC	T2P	TA	NFO
TOTAL PILOT HOURS	700	Note 3		
TOTAL FIXED WING	200	12		12
HOURS IN MODEL (NOTES 2 & 4)	100	12	X	12
GROUND TRAINING SYLLABUS	X	X	X	X
FLIGHT TRAINING SYLLABUS	X	X	X	X
NATOPS EVALUATION	X	X	X	X

Notes:

1. X denotes required item.
2. Cognizant type commanders (commanding officers for TA) may waive, in writing, minimum flight and/or training requirements when experience and proficiency so warrant in accordance with OPNAVINST 3710.7 series.
3. Designated aviator.
4. T-44, Beech King Air series aircraft, and/or approved simulator pilot hours may be substituted for up to, but not to exceed, 50 percent of pilot hours in model requirements.
5. The Naval Flight Officer (NFO) is expected to have the same knowledge of aircraft systems and normal/emergency procedures that is required of a UC-12 designated aviator copilot, except the NFO will not be qualified to physically control the aircraft.
6. The unit providing flight syllabus training for pilot/NFO designation shall administer a NATOPS evaluation at its completion. A new evaluation is not required for change of duty station or upgrade.

5.5 MINIMUM CURRENCY REQUIREMENTS

Currency shall be in accordance with OPNAVINST 3710.7 series for all semi-annual and annual minimum flying hour requirements and with applicable TYCOM/TYPEWING/individual unit directives.

5.5.1 Refresher Requirements

The minimum refresher requirements listed below may be increased at the unit commander's discretion commensurate to individual pilot proficiency.

QUAL	PERIOD	CURRENCY	REFRESHER REQUIREMENT	
TPC	90 Day (rolling)	Current		
	91-180 Days	T2P	1 Flight	w/ TPC (Note 1)
T2P	180 Day (rolling)	Current		
TPC/T2P	181-365 Days	Delinquent	2 Flights	w/ IP (Note 2)
NFO	180 Day (rolling)	Current		
	181-365 Days	Delinquent	1 Flight	w/ IP (Note 1)
TA	180 Day (rolling)	Current		
	181-365 Days	Delinquent	1 Flight	w/TA
All	366+ Days	Delinquent	CACT refresher and NATOPS Evaluation (Note 3)	

Completion of CACT or a NATOPS Evaluation satisfies refresher requirements for 90 to 180 and 181 to 365 day delinquencies.

Notes:

1. Refresher flight may be conducted on either a proficiency flight or operational mission.
2. Refresher flights shall include at a minimum: two landings, two instrument approaches, and SSE maneuvers.
3. CACT does not apply to TA.

5.6 FLIGHTCREW REQUIREMENTS

A TPC, T2P, and TA shall be required for all passenger and cargo missions. Individual Navy NFOs may seek waiver of this requirement through TYCOM/CNATRA. Marine NFOs may seek waiver through COMMARFORPAC, COMMARFORCOM, and COMMARFORRES. At commanding officer discretion, an IP and pilot/NFO under instruction may fly cargo missions.

Note

The requirement for a transport aircrewman may be waived by the commanding officer. This authority may be delegated.

5.6.1 Basic Crew, Transport Mission

1. Aircraft commander.
2. Copilot (T2P or NFO/observer).
3. Transport aircrewman.

5.6.1.1 Functional Checkflight Crew

1. FCF qualified aircraft commander.

2. Copilot (T2P or NFO/observer).

3. Crewman (as appropriate).

5.7 PERSONAL FLYING EQUIPMENT REQUIREMENTS

Personal flying equipment requirements delineated in OPNAVINST 3710.7 series for class aircraft shall be adhered to on each flight. Voice-capable survival radios are not required to be carried by individual crewmembers.

5.8 ANNUAL NATOPS TRAINING

	TPC	T2P	TA	NFO
FLIGHT EVALUATION	X	X	X	X
OPEN BOOK	X	X	X	X
CLOSED BOOK	X	X	X	X
ORAL EXAM	X	X	X	X
INST QUAL	X	X		X

5.8.1 Simulator Training

Pilots/NFOs shall attend a CACT refresher syllabus every 12 months. Commanding Officer/Officer-In-Char ge may authorize an additional 6 months to allow for operational commitments and scheduling conflicts. If a pilot/NFO exceeds the CACT requirement, the pilot/NFO shall not fly.

PART III

Normal Procedures

CHAPTER 6

Flight Preparation

6.1 GENERAL

These procedures are designed to aid the operating crew in the conduct of an efficient and orderly flight.

6.1.1 Mission Planning

Mission planning is the responsibility of the Aircraft Commander and will cover all matters pertinent to the mission to be flown. Every task that can be completed prior to takeoff will contribute to the ease and success with which the actual flight is conducted.

6.1.2 Weather

A complete weather briefing and an understanding of the weather picture are prerequisites for successful mission planning. En route weather will dictate the probable altitude assignments and whether those altitudes assigned will be acceptable. Destination weather will determine expected delays in letdown and landing procedures and whether an alternate is required. This entire weather picture affects fuel planning and flight procedures.

6.1.3 Planning Data

Data and information required for determining the operational parameters and the mission requirements are found in A1-C12BM-NFM-200 Performance Charts.

6.1.4 Weight and Balance

For loading information and weight and balance, refer to Part VIII.

6.1.5 Fuel Planning

A fuel-planning log should be prepared and cross-checked with actual fuel consumption on every flight. Reserve fuel requirements shall be a minimum of 45 minutes (computed at maximum endurance at 10,000 feet) or 10 percent of the fuel required to fly the flight, whichever is greater.

6.1.6 NATOPS Pilot's Card Checklist

The numbered items (line items) in this section correspond to identically numbered items in the NATOPS Pilot's Card Checklist A1-C12BM-NFM-500 . Refer to Figures (**B**) 6-1/(**F**) 6-2/(**M**) 6-3.

6.1.7 Briefing

The success of a flight is a direct measure of the preflight preparation, planning, and briefing. The briefing should include but is not limited to the following guidelines:

6.1.7.1 Communications

1. Frequencies.
2. Radio procedures and discipline.
3. Navigational aids.
4. Identification and Air Defense Identification Zone (ADIZ) procedures.

6.1.7.2 Weather

1. Local area.
2. Local area and destination forecast.
3. Weather at alternate.

6.1.7.3 Navigational and Flight Planning

1. Climbout.
2. Mission planning including fuel/oxygen management.
3. Performance planning.
4. Ground Control Approach (GCA)/instrument approaches.
5. Recovery.

6.1.7.4 Emergencies

1. Aborts.
2. Alternate fields.
3. Minimum and emergency fuel.
4. Waveoff pattern.
5. Radio failure.
6. Aircraft emergencies.
7. System failures.

6.1.7.5 Passenger Briefing

Refer to paragraph 7.2.4.

6.1.8 Debriefing

Each flight shall be followed by a thorough debriefing by the Aircraft Commander as soon as practical. All areas of the flight should be covered, paying particular attention to those areas where difficulty was encountered. The debriefing may be the most beneficial non-flying portion of the flight, for it is here that errors committed are reviewed and the proper techniques discussed.

Note

*Items mandatory on through-flights when no crew change.

BEFORE START

*1. SEATS, PEDALS, HARNESS ... ADJUSTED (BOTH)
*2. PARKING BRAKE ... SET
*3. CHOCKS ... REMOVED
*4. PEDESTAL EXTENSION SWITCHES ... SET
5. POWER QUADRANT ... SET
6. EMERG GEAR CONTROL ... CHECKED
7. MANUAL ICE VANES ... IN
8. GEAR HANDLE/CB ... DOWN/IN
9. SUBPANEL SWITCHES ... SET (BOTH)
*10. BEACON/NAV LIGHTS ... ON
*11. CIRCUIT BREAKERS ... CHECKED (BOTH)
*12. OXYGEN SYSTEM ... CHECKED/SET (RS)
13. OVERHEAD PANEL ... SET (RS)
14. AUDIO PANEL ... SET (RS)
*15. RADAR/TRANSPONDER ... STBY (RS)
16. PITOT STATIC AIR SOURCE ... NORMAL
*17. BATTERY ... ON
*18. FUEL PANEL ... CHECKED/SET
*19. ANNUNCIATOR PANELS ... TESTED (RS)
*20. LANDING GEAR/STALL WARNING ... TESTED (RS)
*21. FIRE DETECTORS AND EXTINGUISHER ... TESTED (RS)
22. COCKPIT VOICE RECORDER ... TESTED (RS)
*23. PROPS ... CLEAR (BOTH)

LEFT ENGINE RESTART

1. ENVIR SWITCHES ... OFF/AUTO/OFF
2. BLEED AIR SWITCHES ... ENVIRO OFF (RS)
3. RADAR ... OFF
4. NA
5. AVIONICS MASTER SWITCH ... OFF
6. INVERTERS ... OFF
7. GENERATORS ... OFF
8. LEFT PROP LEVER ... FULL FORWARD
9. RIGHT CONDITION LEVER ... HIGH IDLE
10. PROPS ... CLEAR (BOTH)

BEFORE TAXI

*1. ELECTRICAL SYSTEM ... CHECKED/SET
*2. AVIONICS MASTER SWITCH ... ON
*3. FMS ANNUNCIATORS ... TESTED (RS)
*4. ENVIRONMENTAL ... SET (RS)
5. NA
6. ELECTRIC ELEVATOR TRIM ... CHECKED (BOTH)
7. ANTI-ICE AND DEICE ... CHECK (AS REQ)
8. NA
9. FLAPS ... CHECKED
10. AUTOPILOT ... CHECKED
*11. FMS ... SET AS REQ
*12. ALTIMETERS ... SET (BOTH)
*13. EGPWS ... TESTED
14. TCAS TRANSPONDER ... CHECKED/SET
*15. CABIN ... READY FOR TAXI (TA)
*16. CABIN SIGNS ... SET

*TAXI

1. BRAKES ... CHECKED (BOTH)
2. FLIGHT INSTRUMENTS ... CHECKED (BOTH)
3. RADAR ... STBY

ENGINE RUNUP

1. OVERSPEED GOV/RUDDER BOOST ... CHECKED
2. PRIMARY GOV ... CHECKED
3. PRESSURIZATION ... CHECKED (RS)
4. AUTOFEATHER/AUTOIGNITION ... CHECKED
5. PROP FEATHER (MANUAL) ... CHECKED

*TAKEOFF

1. AUTOFEATHER ... ARMED (PNF)
2. PRESSURIZATION ... SET (PNF)
3. FLAPS ... STATE SETTING (BOTH)
4. TRIM ... STATE SETTING
5. PROP LEVERS ... FULL FORWARD
6. PROP SYNC ... OFF
7. FLIGHT CONTROLS ... CHECKED
8. FLIGHT INSTRUMENTS ... CHECKED (BOTH)
9. ENGINE INSTRUMENTS ... CHECKED
10. COMM/NAV ... SET (PNF)
11. BLEED AIR VALVES ... OPEN (RS)
12. FUEL PANEL ... CHECKED____ LBS
13. CREW BRIEF ... COMPLETE
14. CABIN ... READY FOR TAKEOFF (PNF)

TAKEOFF DATA

0% FLAPS				GROSS WEIGHT	40% FLAPS			
V_R	V_{LOF}	V_2	V_{YSE}		V_R	V_{LOF}	V_2	V_{YSE}
106	109	125	125	13,500	96	99	106	125
103	106	120	121	12,500	96	99	104	121
102	105	118	118	12,000	95	98	103	118
98	101	116	115	11,000	95	98	102	115
96	99	111	111	10,000	95	98	101	111
96	99	108	109	9,000	95	98	100	109

Figure 6-1. (**B**) Normal Procedures (Sheet 1 of 2)

*LINEUP

1. LIGHTS .... SET
2. ICE PROTECTION .... SET
3. TRANSPONDER .... ON (PNF)
4. RADAR .... AS REQ (PNF)
5. AUTOIGNITION .... ARMED (PNF)
6. GYRO HEADING .... CHECKED (BOTH)
7. CONDITION LEVERS .... SET AND MATCHED

*CLIMB

1. LANDING GEAR .... UP
2. LANDING/TAXI LIGHTS .... OFF
3. FLAPS .... UP
4. CLIMB POWER .... SET
5. PROP SYNC .... ON
6. YAW DAMP .... ON (PNF)
7. AUTOFEATHER .... OFF (PNF)
8. CABIN PRESSURIZATION .... CHECKED
9. WINGS/NACELLES .... CHECKED (BOTH)
10. CABIN SIGNS .... SET (PNF)

*DESCENT

1. CABIN PRESSURIZATION .... SET (PNF)
2. ALTIMETERS .... SET (BOTH)

*APPROACH

1. ALTIMETERS .... SET (BOTH)
2. PRESSURIZATION .... CHECKED (PNF)
3. CABIN SIGNS .... NO SMOKING/FSB (PNF)
4. AUTOFEATHER .... ARMED (PNF)
5. CABIN .... READY (PNF/TA)
6. NAVAIDs/HSIs .... SET (BOTH)
7. CREW BRIEF .... COMPLETE

*LANDING

1. LANDING GEAR .... DOWN AND LOCKED
2. LANDING/TAXI LIGHTS .... ON
3. PROP SYNC .... OFF
4. PROPS .... AS REQ
5. FLAPS .... AS REQ
6. AUTOPILOT/YAW DAMP .... OFF (PNF)

*AFTER LANDING

1. FLAPS .... UP
2. AUTOIGNITION .... OFF (PNF)
3. ICE PROTECTION .... OFF
4. LIGHTS .... SET
5. TRANSPONDER .... STBY (PNF)
6. RADAR .... STBY (PNF)

*ENGINE SHUTDOWN

1. NOSEWHEEL .... CENTER
2. PARKING BRAKE .... SET
3. POWER LEVERS .... IDLE
4. ENVIR SWITCHES .... OFF/AUTO/OFF (RS)
5. BLEED AIR VALVES .... ENVIR OFF (RS)
6. AUTOFEATHER .... OFF (RS)
7. INVERTERS .... OFF (RS)
8. ITT .... STABILIZED
9. PROP LEVERS .... FEATHER
10. CONDITION LEVERS .... FUEL CUTOFF
11. AVIONICS MASTER SWITCH .... OFF (RS)
12. STANDBY PUMPS .... OFF
13. OXYGEN .... OFF (RS)
14. FLIGHT CONTROLS .... SET
15. MASTER PANEL LIGHTS .... OFF (RS)
16. LIGHTS .... OFF
17. GANGBAR (BATTERY & GEN) .... OFF
18. UTILITY LIGHTS .... VERIFY OFF

LANDING DATA (V_{REF})

GROSS WEIGHT	0%	40%	100%
13,500	136	117	106
13,000	134	116	105
12,500	132	115	103
12,000	129	114	102
11,500	128	113	101
11,000	126	112	99
10,500	124	111	98
10,000	122	110	96
9,500	120	109	95
9,000	117	108	93

Figure 6-1. (**B**) Normal Procedures (Sheet 2 of 2)

Note

*Items mandatory on through-flights when no crew change.

BEFORE START

*1. SEATS, PEDALS, HARNESS . . ADJUSTED (BOTH)
*2. PARKING BRAKE . . . . SET
*3. CHOCKS . . . . REMOVED
*4. PEDESTAL EXTENSION SWITCHES . . . . SET
5. POWER QUADRANT . . . . SET
6. EMERG GEAR CONTROL . . . . CHECKED
7. MANUAL ICE VANES . . . . IN
8. GEAR HANDLE/CB . . . . DOWN/IN
9. SUBPANEL SWITCHES . . . . SET (BOTH)
*10. BEACON/NAV LIGHTS . . . . ON
*11. CIRCUIT BREAKERS . . . . CHECKED (BOTH)
*12. OXYGEN SYSTEM . . . . CHECKED/SET (RS)
13. OVERHEAD PANEL . . . . SET (RS)
14. AUDIO PANEL . . . . SET (RS)
*15. RADAR/DATA NAV . . . . OFF (RS)
16. PITOT STATIC AIR SOURCE . . . . NORMAL
*17. BATTERY . . . . ON/CHECKED
*18. FUEL PANEL . . . . CHECKED/SET
*19. ANNUNCIATOR PANELS . . . . TESTED (RS)
*20. LANDING GEAR/STALL WARNING . . . TESTED (RS)
*21. FIRE DETECTORS AND EXTINGUISHER . . . . TESTED (RS)
22. COCKPIT VOICE RECORDER . . . . . . TESTED (RS)
*23. PROPS . . . . CLEAR (BOTH)

LEFT ENGINE RESTART

1. ENVIR SWITCHES . . . . OFF/AUTO/OFF
2. BLEED AIR SWITCHES . . . . ENVIRO OFF (RS)
3. RADAR . . . . OFF
4. DATA NAV . . . . OFF (RS)
5. AVIONICS MASTER SWITCH . . . . OFF
6. INVERTERS . . . . OFF
7. GENERATORS . . . . OFF
8. LEFT PROP LEVER . . . . FULL FORWARD
9. RIGHT CONDITION LEVER . . . . HIGH IDLE
10. PROPS . . . . CLEAR (BOTH)

BEFORE TAXI

*1. ELECTRICAL SYSTEM . . . . CHECKED/SET
*2. AVIONICS MASTER SWITCH . . . . ON
3. NA
*4. ENVIRONMENTAL . . . . SET (RS)
5. DATA NAV . . . . ON
6. ELECTRIC ELEVATOR TRIM . . . CHECKED (BOTH)
7. ANTI-ICE AND DEICE . . . . CHECK (AS REQ)
8. HYD FLUID SENSOR . . . . TESTED
9. FLAPS . . . . CHECKED
10. AUTOPILOT . . . . CHECKED
*11. FMS . . . . SET AS REQ
*12. ALTIMETERS . . . . SET (BOTH)
*13. GPWS . . . . TESTED (RS)
14. NA
*15. CABIN . . . . READY FOR TAXI (TA)
*16. CABIN SIGNS . . . . SET

*TAXI

1. BRAKES . . . . CHECKED (BOTH)
2. FLIGHT INSTRUMENTS . . . . CHECKED (BOTH)
3. RADAR . . . . STBY

ENGINE RUNUP

1. OVERSPEED GOV/RUDDER BOOST . . . . CHECKED
2. PRIMARY GOV . . . . CHECKED
3. PRESSURIZATION . . . . CHECKED (RS)
4. AUTOFEATHER/AUTOIGNITION . . . . CHECKED
5. PROP FEATHER (MANUAL) . . . . CHECKED

*TAKEOFF

1. AUTOFEATHER . . . . ARMED (PNF)
2. PRESSURIZATION . . . . SET (PNF)
3. FLAPS . . . . STATE SETTING (BOTH)
4. TRIM . . . . STATE SETTING
5. PROP LEVERS . . . . FULL FORWARD
6. NA
7. FLIGHT CONTROLS . . . . CHECKED
8. FLIGHT INSTRUMENTS . . . . CHECKED (BOTH)
9. ENGINE INSTRUMENTS . . . . CHECKED
10. COMM/NAV . . . . SET (PNF)
11. BLEED AIR VALVES . . . . OPEN (RS)
12. FUEL PANEL . . . . CHECKED____ LBS
13. CREW BRIEF . . . . COMPLETE
14. CABIN . . . . READY FOR TAKEOFF (PNF)

TAKEOFF DATA

0% FLAPS				GROSS WEIGHT	40% FLAPS			
V_R	V_{LOF}	V_2	V_{YSE}		V_R	V_{LOF}	V_2	V_{YSE}
106	109	125	125	13,500	96	99	106	125
103	106	120	121	12,500	96	99	104	121
102	105	118	118	12,000	95	98	103	118
98	101	116	115	11,000	95	98	102	115
96	99	111	111	10,000	95	98	101	111
96	99	108	109	9,000	95	98	100	109

Figure 6-2. (**F**) Normal Procedures (Sheet 1 of 2)

***LINEUP**

1. LIGHTS .... SET
2. ICE PROTECTION .... SET
3. TRANSPONDER .... ON (PNF)
4. RADAR .... AS REQ (PNF)
5. AUTOIGNITION .... ARMED (PNF)
6. GYRO HEADING .... CHECKED (BOTH)
7. CONDITION LEVERS .... SET AND MATCHED

***CLIMB**

1. LANDING GEAR .... UP
2. LANDING/TAXI LIGHTS .... OFF
3. FLAPS .... UP
4. CLIMB POWER .... SET
5. PROP SYNC .... ON
6. YAW DAMP .... ON (PNF)
7. AUTOFEATHER .... OFF (PNF)
8. CABIN PRESSURIZATION .... CHECKED
9. WINGS/NACELLES .... CHECKED (BOTH)
10. CABIN SIGNS .... SET (PNF)

***DESCENT**

1. CABIN PRESSURIZATION .... SET (PNF)
2. ALTIMETERS .... SET (BOTH)

***APPROACH**

1. ALTIMETERS .... SET (BOTH)
2. PRESSURIZATION .... CHECKED (PNF)
3. CABIN SIGNS .... NO SMOKING/FSB (PNF)
4. AUTOFEATHER .... ARMED (PNF)
5. CABIN .... READY (PNF/TA)
6. NAVAIDs/HSIs .... SET (BOTH)
7. CREW BRIEF .... COMPLETE

***LANDING**

1. LANDING GEAR .... DOWN AND LOCKED
2. LANDING/TAXI LIGHTS .... ON
3. PROP SYNC .... AS REQ
4. PROPS .... AS REQ
5. FLAPS .... AS REQ
6. AUTOPILOT/YAW DAMP .... OFF (PNF)

***AFTER LANDING**

1. FLAPS .... UP
2. AUTOIGNITION .... OFF (PNF)
3. ICE PROTECTION .... OFF
4. LIGHTS .... SET
5. TRANSPONDER .... STBY (PNF)
6. RADAR/DATA NAV .... OFF (PNF)

*** ENGINE SHUTDOWN**

1. NOSEWHEEL .... CENTER
2. PARKING BRAKE .... SET
3. POWER LEVERS .... IDLE
4. ENVIR SWITCHES .... OFF/AUTO/OFF (RS)
5. BLEED AIR VALVES .... ENVIR OFF (RS)
6. AUTOFEATHER .... OFF (RS)
7. INVERTERS .... OFF (RS)
8. ITT .... STABILIZED
9. PROP LEVERS .... FEATHER
10. CONDITION LEVERS .... FUEL CUTOFF
11. AVIONICS MASTER SWITCH .... OFF (RS)
12. STANDBY PUMPS .... OFF
13. OXYGEN .... OFF (RS)
14. FLIGHT CONTROLS .... SET
15. MASTER PANEL LIGHTS .... OFF (RS)
16. LIGHTS .... OFF
17. GANGBAR (BATTERY & GEN) .... OFF
18. UTILITY LIGHTS .... VERIFY OFF

LANDING DATA (V_{REF})

GROSS WEIGHT	0%	40%	100%
13,500	136	117	106
13,000	134	116	105
12,500	132	115	103
12,000	129	114	102
11,500	128	113	101
11,000	126	112	99
10,500	124	111	98
10,000	122	110	96
9,500	120	109	95
9,000	117	108	93

Figure 6-2. (**F**) Normal Procedures (Sheet 2 of 2)

Note

*Items mandatory on through-flights when no crew change.

BEFORE START

*1. SEATS, PEDALS, HARNESS . . ADJUSTED (BOTH)
*2. PARKING BRAKE . . . . SET
*3. CHOCKS . . . . REMOVED
*4. PEDESTAL EXTENSION SWITCHES . . . . SET
5. POWER QUADRANT . . . . SET
6. EMERG GEAR CONTROL . . . . CHECKED
7. MANUAL ICE VANES . . . . IN
8. LANDING GEAR HANDLE . . . . DOWN
9. SUBPANEL SWITCHES . . . . SET (BOTH)
*10. BEACON/NAV LIGHTS . . . . ON
*11. CIRCUIT BREAKERS . . . . CHECKED (BOTH)
*12. OXYGEN SYSTEM . . . . CHECKED/SET (RS)
*13. OVERHEAD PANEL . . . . SET (RS)
14. AUDIO PANEL . . . . SET (RS)
*15. NAVTAC . . . . OFF (RS)
16. PITOT STATIC AIR SOURCE . . . . NORMAL
*17. BATTERY . . . . ON
*18. FUEL PANEL . . . . CHECKED/SET
*19. ANNUNCIATOR PANELS . . . . TESTED (RS)
*20. LANDING GEAR/STALL WARNING . . TESTED (RS)
*21. FIRE DETECTORS AND EXTINGUISHER . . . . TESTED (RS)
22. COCKPIT VOICE RECORDER . . . . . . TESTED (RS)
*23. PROPS . . . . CLEAR (BOTH)

LEFT ENGINE RESTART

1. ENVIR SWITCHES . . . . OFF/AUTO/AUTO
2. BLEED AIR SWITCHES . . . . PNEU ONLY
3. RADAR . . . . OFF
4. NAVTAC . . . . OFF (RS)
5. AVIONICS MASTER SWITCH . . . . OFF
6. INVERTERS . . . . OFF
7. GENERATORS . . . . OFF
8. LEFT PROP LEVER . . . . FULL FORWARD
9. RIGHT CONDITION LEVER . . . . HIGH IDLE
10. PROPS . . . . CLEAR (BOTH)

BEFORE TAXI

*1. ELECTRICAL SYSTEM . . . . CHECKED/SET
*2. AVIONICS MASTER SWITCH . . . . ON
*3. BEACONS . . . . RESET
*4. ENVIRONMENTAL . . . . SET (RS)
5. NAVTAC . . . . ON
6. ELECTRIC ELEVATOR TRIM . . . CHECKED (BOTH)
7. ANTI-ICE AND DEICE . . . . CHECKED (AS REQ)
8. HYD FLUID SENSOR . . . . TESTED
9. FLAPS . . . . CHECKED
10. AUTOPILOT . . . . CHECKED
*11. FMS . . . . SET AS REQ
*12. ALTIMETERS . . . . SET (BOTH)
*13. EGPWS . . . . TESTED
14. TCAS TRANSPONDER . . . . CHECKED/SET
*15. CABIN . . . . READY FOR TAXI (TA)
*16. CABIN SIGNS . . . . SET

***TAXI**

1. BRAKES . . . . CHECKED (BOTH)
2. FLIGHT INSTRUMENTS . . . . CHECKED (BOTH)
3. RADAR . . . . STBY

ENGINE RUNUP

1. OVERSPEED GOV/RUDDER BOOST . . CHECKED
2. PRIMARY GOV . . . . CHECKED
3. PRESSURIZATION . . . . CHECKED (RS)
4. AUTOFEATHER/AUTOIGNITION . . . . CHECKED
5. PROP FEATHER (MANUAL) . . . . CHECKED

***TAKEOFF**

1. AUTOFEATHER . . . . ARMED (PNF)
2. PRESSURIZATION . . . . SET (PNF)
3. FLAPS . . . . STATE SETTING (BOTH)
4. TRIM . . . . STATE SETTING
5. PROP LEVERS . . . . FULL FORWARD
6. NA
7. FLIGHT CONTROLS . . . . CHECKED
8. FLIGHT INSTRUMENTS . . . . CHECKED (BOTH)
9. ENGINE INSTRUMENTS . . . . CHECKED
10. COMM/NAV . . . . SET (PNF)
11. BLEED AIR VALVES . . . . OPEN (RS)
12. FUEL PANEL . . . . CHECKED______LBS
13. CREW BRIEF . . . . COMPLETE
14. CABIN . . . . READY FOR TAKEOFF (PNF)

TAKEOFF DATA

0% FLAPS				GROSS WEIGHT	40% FLAPS			
V_R	V_{LOF}	V_2	V_{YSE}		V_R	V_{LOF}	V_2	V_{YSE}
106	109	125	125	13,500	96	99	106	125
103	104	120	121	12,500	96	99	104	121
102	105	118	118	12,000	95	98	103	118
98	101	115	115	11,000	95	98	102	115
96	99	111	111	10,000	95	98	101	111
96	99	109	108	9,000	95	98	100	109

Figure 6-3. (**M**) Normal Procedures (Sheet 1 of 2)

*LINEUP

1. LIGHTS .... SET
2. ICE PROTECTION .... SET
3. TRANSPONDER .... ON (PNF)
4. RADAR .... AS REQ (PNF)
5. AUTOIGNITION .... ARMED (PNF)
6. GYRO HEADING .... CHECKED (BOTH)
7. CONDITION LEVERS .... SET AND MATCHED

*CLIMB

1. LANDING GEAR .... UP
2. LANDING/TAXI LIGHTS .... OFF
3. FLAPS .... UP
4. CLIMB POWER .... SET
5. PROP SYNC .... ON
6. YAW DAMP .... ON (PNF)
7. AUTOFEATHER .... OFF (PNF)
8. CABIN PRESSURIZATION .... CHECKED
9. WINGS/NACELLES .... CHECKED (BOTH)
10. CABIN SIGNS .... SET (PNF)

*DESCENT

1. CABIN PRESSURIZATION .... SET (PNF)
2. ALTIMETERS .... SET (BOTH)

*APPROACH

1. ALTIMETERS .... SET (BOTH)
2. PRESSURIZATION .... CHECKED (PNF)
3. CABIN SIGNS .... NO SMOKING/FSB (PNF)
4. AUTOFEATHER .... ARMED (PNF)
5. CABIN .... READY (PNF/TA)
6. NAVAIDs/HSIs .... SET (BOTH)
7. CREW BRIEF .... COMPLETE

*LANDING

1. LANDING GEAR .... DOWN AND LOCKED
2. LANDING/TAXI LIGHTS .... ON
3. PROP SYNC .... AS REQ
4. PROPS .... AS REQ
5. FLAPS .... AS REQ
6. AUTOPILOT/YAW DAMP .... OFF (PNF)

*AFTER LANDING

1. FLAPS .... UP
2. AUTOIGNITION .... OFF (PNF)
3. ICE PROTECTION .... OFF
4. LIGHTS .... SET
5. TRANSPONDER .... STBY (PNF)
6. RADAR .... STBY (PNF)

* ENGINE SHUTDOWN

1. NOSEWHEEL .... CENTER
2. PARKING BRAKE .... SET
3. POWER LEVERS .... IDLE
4. ENVIR SWITCHES .... OFF/AUTO/AUTO
5. BLEED AIR VALVES .... PNEU ONLY
6. AUTOFEATHER .... OFF (RS)
7. INVERTERS .... OFF (RS)
8. TGT .... STABILIZED
9. PROP LEVERS .... FEATHER
10. CONDITION LEVERS .... FUEL CUTOFF
11. AVIONICS MASTER SWITCH .... OFF (RS)
12. STANDBY PUMPS .... OFF
13. OXYGEN .... OFF (RS)
14. FLIGHT CONTROLS .... SET
15. MASTER PANEL LIGHTS .... OFF (RS)
16. LIGHTS .... OFF
17. GANGBAR (BATTERY & GEN) .... OFF
18. UTILITY LIGHTS .... VERIFY OFF

APPROACH DATA (V_{REF})

GROSS WEIGHT	0% FLAPS	40% FLAPS	100% FLAPS
13,500	136	117	106
13,000	134	116	105
12,500	132	115	103
12,000	129	114	102
11,500	128	113	101
11,000	128	112	99
10,500	124	111	98
10,000	122	110	96
9,500	120	109	95
9,000	117	108	93

Figure 6-3. (**M**) Normal Procedures (Sheet 2 of 2)

CHAPTER 7

Shore-Based Procedures

7.1 LINE OPERATIONS

7.1.1 Aircraft Acceptance

The discrepancy records of at least the last 10 flights will be made available to the pilot for his examination. The aircraft commander will ensure that all servicing entries have been made. When satisfied that all required information has been stated, the aircraft commander will sign for the aircraft.

7.2 PREFLIGHT INSPECTION

The Aircraft Commander will ensure a proper preflight inspection is accomplished. A satisfactory preflight will consist of both the interior and exterior inspection. As the aircraft is approached, observe wheel chocks in place, tiedowns removed, and no obvious aircraft discrepancies exist. Drains and vents are shown in Figure 7-1.

7.2.1 Interior Inspection

7.2.1.1 Cockpit

Note

- If night flight is anticipated, all lights should be checked for operation.
- Emergency lights should not be used routinely for lighting the interior of the aircraft.
- Procedural steps identified by an asterisk (*) constitute the minimum required checks for subsequent flights after the first flight of the day provided no maintenance had been performed. Any change in the Aircraft Commander that day shall require performing all checklist items.

1. Flight controls — Remove control locks and check for free movement.

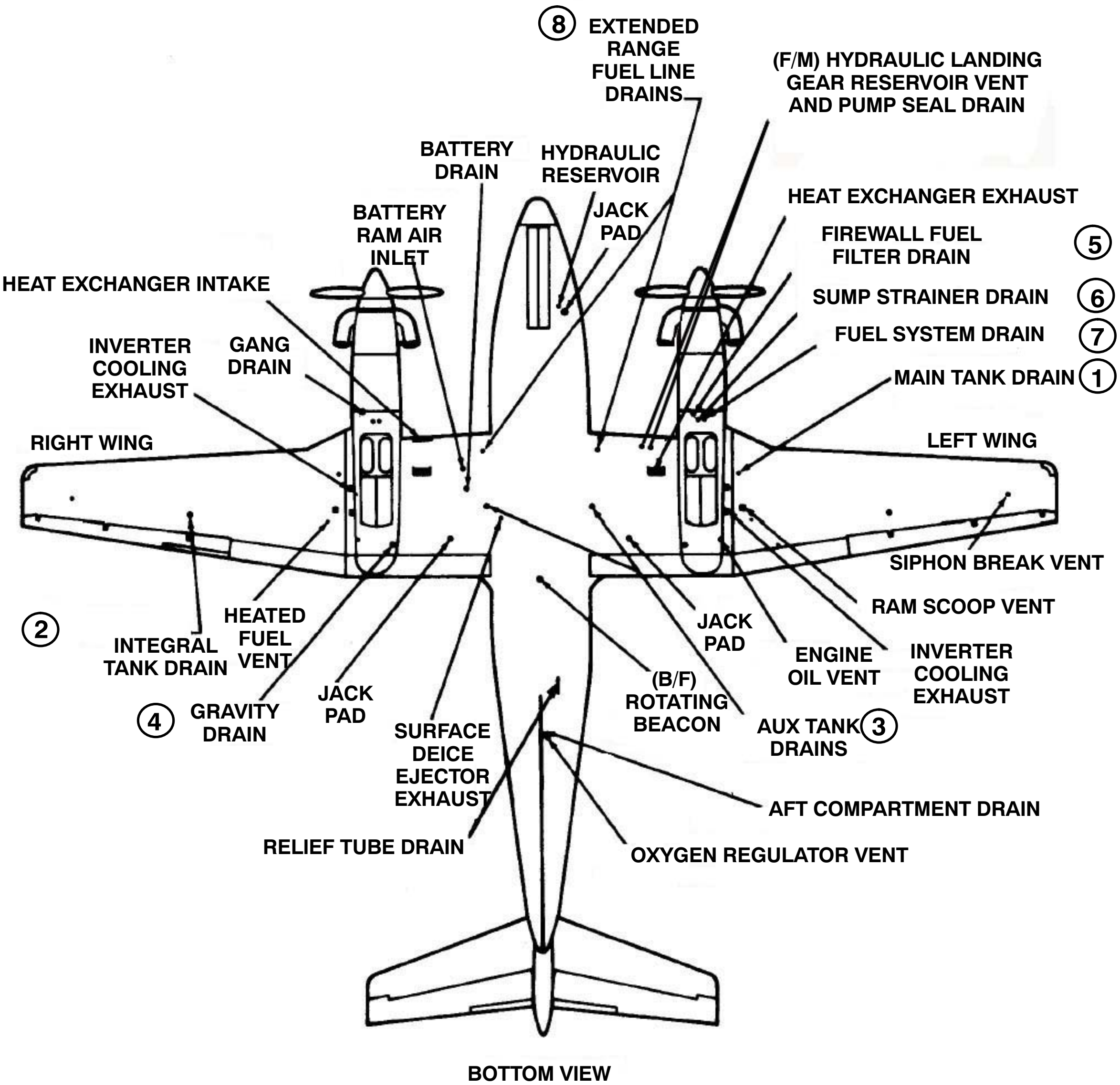
CAUTION

Consideration should be given to wind conditions before removing control locks.

2. Manual trim — Checked and set to “0”. Check rudder, aileron, and manual elevator trim for free movement and then return to “0” (neutral).

Note

The elevator trim system must not be forced past the limits that are marked in red on the elevator trim indicator scale either manually, electrically, or by action of the autopilot.



Note

THE FUEL DRAIN NUMBERS CORRESPOND TO THE NUMBERS SHOWN IN THE FUEL DRAINS DESCRIPTION IN FIGURE 3-4.

Figure 7-1. Drains/Vents

3. Circuit breakers — In.

4. Electrical switches — Set. Ensure that all switches on the fuel control panel, pilot and copilot subpanel, overhead circuit breaker panel, and pedestal are OFF or AUTO, and landing gear handle is down (DN).

5. Oxygen system — Check.

   a. Oxygen pressure — As required.

   b. Passenger manual override — In.

   c. System ready — Pull on.

   d. Check mask hose and communication connection secure.

   e. Diluter lever — 100 percent (both).

   f. Pressure indicator — Check green.

   g. Check for proper mask orientation in storage bag — Oxygen hose connection to mask regulator should be facing forward.

   h. Momentarily select EMER to verify oxygen flow then back to 100 percent.

CAUTION

Maintaining the regulator in the EMER position when not in use will deplete the oxygen system. Return to the 100 percent or NORM position immediately upon verification.

Note

Proper functioning of the regulator can be verified without removing mask from stowage bag by momentarily switching the control knob to the EMER position, allowing oxygen to flow through the regulator.

6. Hot battery bus/fuel quantity/flaps/CVR.

Note

If unable to determine if firewall fuel valves operate on hot battery bus, perform noisy ramp substeps.

   a. Firewall valve circuit breakers — Pull (noisy ramp).

   b. (**BM**) STBY pump circuit breakers — Pull (noisy ramp).

   c. (**B/F**) Firewall fuel valves — CLOSED.

      (**M**) Fire handles — PULL.

   d. Standby pumps — ON.

e. (**M**) Keylock switch — ON.

f. Emergency lights — ON.

g. Battery — ON (FUEL PRESS lights illuminate).

h. (**F**) Battery voltage — Checked (20 volt minimum). Volt/loadmeter — Push to check voltage. No voltage on one dc voltmeter indicates either a current limiter is out or an inoperative meter.

i. Emergency lights — Reset.

j. (**B**/**F**) Firewall fuel valves — OPEN (FUEL PRESS lights extinguish).

(**M**) FIRE PULL handles — IN (FUEL PRESS lights extinguish).

k. Standby pumps — OFF (FUEL PRESS lights illuminate).

l. (**B**/**M**) Standby pump circuit breakers — Reset (noisy ramp).

m. Firewall valve circuit breakers — Reset (noisy ramp).

n. Crossfeed — Left, right, OFF (crossfeed light illuminates, FUEL PRESS lights extinguish).

o. Auxiliary transfer switches — AUTO.

p. No fuel transfer lights — Check.

q. Fuel quantity — ____________ pounds.

r. Flaps — DOWN (100 percent).

s. CVR — Test.

(1) CVR test button — Depress (5 seconds minimum). Note green light illuminated.

(2) Erase button — Depress (2 seconds) if desired.

Prior to first flight of the day:

(3) Headset — Plug headphones into CVR control unit. Speak into area microphone noting voice playback with no delay.

t. Battery — OFF.

7. Emergency locator transmitter — Check ARMED.
8. Windows — Check for scratches, cracks, cleanliness, and delamination.
9. Emergency equipment — Check for lifevests, fire extinguisher, NATOPS manual, and Normal/Emergency checklists.

7.2.1.2 Cabin

1. Windows — Check.
2. Emergency exit — Unlocked, latched, and flush with interior.

3. Emergency equipment.

   a. Passenger oxygen masks and lifevests.

   b. Fire extinguisher.

   c. Raft.

   d. Survival kit.

4. Lavatory knife valve — Slightly open.

5. Cargo — Secured.

6. Airstair door — Check.

7.2.2 Exterior Inspection

1. Fuel sample — Check collective fuel sample.

Note

It is the responsibility of the aircraft commander to ensure that fuel samples have been taken prior to flight. If samples have not been taken by qualified maintenance personnel, drain fuel from all drains and check for evidence of water or sediment as necessary.

7.2.2.1 Left Wing

1. Flaps — Check.

2. Fire extinguisher pressure — Check.

3. Aileron and trim tab — Check.

*4. Wingtip(s) — Check static wicks, condition of navigation/recognition/(**B**/**F**) strobe lights, glareshield condition and security, access panels secure, siphon break vent clear of obstructions.

Note

At least one static wick is required on the rudder, and outboard ends of each elevator, aileron, and (**B**/**F**) top tail cone for IMC flight (minimum of (**B**/**F**) six; (**M**) five).

*5. Main fuel cap — Check secure.

6. Outboard deice boot — Check.

7. Stall warning vane — Visually check.

*8. Tiedown — Released.

9. Fuel vents — Check.

10. Engine compartment — Check engine oil quantity as required and cap secure. Drain firewall fuel filter and sump strainer drains as required. Check general condition of all components and engine cowling secure.

Note

If cold oil check indicates more than 3 quarts low, motor engine (STARTER ONLY) with the propeller in the feathered position for 15 to 20 seconds then recheck and add oil as required. Do not overfill.

11. Outboard cowls and exhaust — Check. Ensure both latches and alignment pins/cam locks are secure.

*12. Gear and well — Check for signs of leaks, damage, and tire wear; brake assembly, safety switch, torque knee, doors and strut, strut extension of (**B**) 5.50/(**F/M**) 5.56 inches minimum.

*13. Chocks — As required.

14. Propeller — Check.

15. Air inlet and ice vane — Check clear and retracted.

16. Inboard cowls and exhaust — Check. Ensure both latches and alignment pins/cam locks are secure.

17. Heat exchanger inlet — Check.

18. Inboard deice boot — Check.

*19. Auxiliary fuel cap — Check secure.

20. (**F/M**) Hydraulic reservoir and pump seal drain — Check vent clear of obstructions and no excessive fluid is present.

7.2.2.2 Nose Section

1. Lower antennas and beacon — Check.
2. Outside air temperature probe — Check.
3. Avionics door left side — Secure.
4. Air-conditioner exhaust — Check.

*5. Gear and well — Check for signs of leaks, damage, and tire wear; gear doors, gear actuator, torque knee, shimmy damper, turn stops, and strut. Strut extension of (**B**) 3.00/(**F/M**) 3.77 inches minimum.

6. Landing and taxi lights — Check.

*7. Chocks — As required.

8. Pitot tubes (2) — Check clear.
9. Windshield and wipers — Check.
10. Air-conditioner inlet — Check.
11. Avionics door right side — Secure.

7.2.2.3 Right Wing

*1. Auxiliary fuel cap — Check secure.

2. Battery ram air inlet — Check clear and that the thermostatic control valve moves freely.

3. Inboard deice boot — Check.
4. Heat exchanger inlet — Check.
5. Engine compartment — Check (same as left side).
6. Inboard cowls and exhaust — Check (same as left side).
7. Propeller — Check.
8. Air inlet and ice vane — Check (same as left side).
9. Outboard cowls and exhaust — Check (same as left side).

*10. Gear and well — Check (same as left side).

11. Fire extinguisher pressure — Check.
12. Fuel vents — Check.

*13. Tiedown — Removed.

14. Outboard deice boot — Check.

*15. Main fuel cap — Check secure.

*16. Wing tip — Check (same as left side).

17. Aileron and fixed trim tab — Check.
18. Flaps — Check.

*19. Chocks — As required.

7.2.2.4 Empennage Section

1. Lower antennas — Check.
2. Oxygen access panel — Secure.
3. Static ports (right side) — Clear.

*4. Tiedown — Released.

5. Access panels — Secure.
6. Deice boot (right side) — Check.

*7. Control surfaces and trim tabs — Check.

8. Elevator/rudder trim tabs — Verify “0” (neutral) position.

Note

- The elevator trim tabs “0” (neutral) position is determined by observing that the trailing edge of the elevator trim tabs align with the trailing edge of the elevator.
- At least one static wick is required on the rudder and outboard ends of each elevator surface and (**B/F**) top tail cone for IMC flight.

9. Navigation/strobe lights — Check.
10. Deice boot (left side) — Check.
11. Static port (left side) — Clear.
12. Top antennas — Check.
13. Top beacon — Check.

*7.2.3 Interior Check

1. Cargo/loose equipment — Secured.
2. Cabin/cargo door — Locked and checked.

CAUTION

When closing the airstair door, avoid pinching the door support cable between the door and the fuselage to prevent cable damage.

3. Emergency exit — Secure and unlocked.

7.2.4 Passenger Briefing

1. Mission.
   a. Estimated time en route.
   b. Destination.
   c. Weather.
2. Exits (location and use).
3. Oxygen (location, demonstration, aural/visual warning signals).
4. Emergency survival equipment.
   a. Lifevests (location and use).
   b. Liferaft/survival kit — Location.
5. Forced landing/ditching positions — As required.
6. Takeoff/landing.
   a. Seats upright.
   b. Seatbelts fastened/adjusted.
   c. Armrests down.

7. Environmental/pressurization (lights and air outlets).

8. Comfort station.

9. Prohibited items.

7.3 BEFORE START CHECKLIST

*1. Seats, pedals, harness — Adjusted (both).

Note

Do not use the glareshield as a support point when adjusting the cockpit seats. This may loosen and/or damage the glareshield.

*2. Parking brake — Set.

*3. Chocks — Removed.

*4. (**B/F**) Pedestal extension switches — Set.

a. Ice vanes — Retracted.

b. Autofeather — OFF.

c. Avionics master — OFF.

d. Inverters — OFF.

e. Elevator trim — ON.

f. Rudder boost — ON.

g. Engine start switches — OFF.

h. Autoignition switches — OFF.

i. Master switch (battery and generators) — OFF.

j. Pressurization controller — Set.

k. (**B**) Transponder — STBY.

l. (**B**) Weather radar — STBY.

*4. (**M**) Pedestal extension switches — Set.

a. Electric ELEV TRIM switch — ON.

b. RUDDER BOOST switch — ON.

c. Pressurization controller — Set.

d. Transponder — STBY.

e. Weather radar — STBY.

5. Power quadrant — Set.

   a. Power levers — IDLE.

CAUTION

Do not position power levers aft of IDLE while the engines are shut down. Damage to the reversing linkage will result.

   b. Propeller levers — Full forward.

   c. Condition levers — FUEL CUTOFF.

   d. Flaps — Corresponding.

   e. Trim — Set.

6. Emergency gear control — Checked.

7. Manual ice vanes — In.

8. (**B**/**F**) Gear handle/circuit breaker — Down/in.

   (**M**) Landing gear handle — DOWN.

9. (**B**/**F**) Subpanel switches — Set (both).

   a. LEFT SEAT.

      (1) Exterior lights section — OFF.

      (2) Ice and rain section — OFF.

      (3) Pilot oxygen microphone switch — NORMAL.

      (4) No. 1 compass gyro — SLAVE.

      (5) (**B**) Prop sync — OFF.

      (6) (**F**) Prop sync — As desired.

   b. RIGHT SEAT.

      (1) Copilot oxygen microphone switch — NORMAL.

      (2) No. 2 compass gyro — SLAVE.

      (3) Environmental switches.

         (a) CABIN TEMP MODE — OFF.

         (b) Vent blower — AUTO.

         (c) Aft blower — OFF.

         (d) Bleed air valve switches — ENVIRO OFF.

      (4) Cabin lights — OFF.

9. (**M**) Subpanel switches — Set (both).

   a. LEFT SEAT.

      (1) Landing, taxi, recognition lights — OFF.

      (2) Prop sync — As desired.

      (3) No. 1 compass gyro — Slaved.

      (4) Pilot oxygen microphone switch — Headset.

   b. RIGHT SEAT.

      (1) No. 2 compass gyro — Slaved.

      (2) Copilot oxygen microphone switch — Headset.

*10. Beacon/NAV lights — ON.

*11. Circuit breakers — Checked (both).

*12. Oxygen system — Checked/set (RS).

   a. Oxygen pressure — Checked.

   b. Oxygen supply control lever — Pull ON, SYS READY.

   c. Crew oxygen masks — Check 100 percent.

13. (**B**/**F**) Overhead panel — Set (RS).

   a. Master panel lights — As required.

   b. Overhead flood — OFF.

   c. Instrument indirect — OFF.

13. (**M**) Overhead panel — Set (RS).

   a. AUTOFEATHER switch — OFF.

   b. Keylock switch — ON.

   c. Environmental switches — Set.

      (1) Cabin air mode control — OFF.

      (2) Vent blowers — AUTO/AUTO.

      (3) Bleed air switches — PNEU ONLY.

   d. AVIONICS MASTER PWR switch — OFF.

   e. Inverters No. 1 and No. 2 — OFF.

f. MASTER PANEL LIGHTS — Set.

(1) Master panel lights switch — As required.

(2) Overhead flood light — As required.

(3) Instrument indirect — As required.

(4) Utility lights — As required (both).

g. Exterior lights section — OFF.

h. Instrument lights — OFF/OFF (both) (RS).

i. Ice vane control — OFF (RS).

j. Ice and rain section — OFF (RS).

k. Nos. 1 and 2 ENGINE START switches — OFF (RS).

14. Audio panel — Set (RS).

*15. (**B**) RADAR/TRANSPONDER — STBY (RS).

(**F**) RADAR/DATA NAV — OFF (RS).

(**M**) NAVTAC — OFF (RS).

16. Pitot static air source — NORMAL.

*17. Battery — ON/(**F**) Checked.

*18. Fuel panel — Checked/set.

a. Standby pumps — OFF.

b. AUX TRANSFER — AUTO.

c. No transfer lights — Checked.

d. Fuel quantity — ____________ pounds.

e. (**B/F**) Firewall fuel valves — OPEN.

(**M**) Fire pull handles — IN.

*19. Annunciator panels — Tested (RS).

*20. Landing gear/stall warning — Tested (RS).

a. Landing gear handle lights illuminate and gear horn sounds.

b. Stall warning horn sounds and vane moves.

*21. (**B/F**) Fire detectors and extinguisher — Tested (RS).

a. Fire detectors — Rotate the test switch to check that the FIRE L ENG and FIRE R ENG warning lights illuminate in all three positions. If MASTER WARNING is canceled between selections, it may not reilluminate.

b. Fire extinguishers — Rotate the test switch to LEFT EXT and RIGHT EXT positions and verify illumination of amber D and green OK light in each position.

*21. (**M**) Fire detectors and extinguisher — Tested (RS).

a. Fire detectors —Hold TEST switches to DET position. Check that the FIRE PULL handle warning lights and MASTER WARNING annunciators illuminate.

b. Fire extinguishers — Hold TEST switches to EXT position and verify illumination of SQUIB OK and No. 1 and No. 2 EXTINGH DISCH and MASTER CAUTION annunciators.

22. Cockpit Voice Recorder — Tested (RS).

*23. Propeller — Clear (both).

7.4 LEFT ENGINE RESTART CHECKLIST

On those occasions when only the left engine is secured for embarking/debarking passengers, the following checklist ensures a safe procedure for preparing to start the left engine.

1. Environmental switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AUTO.
2. Bleed air switches — (**B**/**F**) ENVIRO OFF (RS)/(**M**) PNEU ONLY.
3. Radar — OFF.
4. (**B**) Not applicable.

   (**F**) DATA NAV — OFF (RS).

   (**M**) NAVTAC — OFF (RS).
5. AVIONICS MASTER switch — OFF.
6. Inverters — OFF.
7. Generators — OFF.
8. Left propeller lever — Full forward.
9. Right condition lever — HIGH IDLE.
10. Propellers — Clear (both).

    a. Proceed with Battery Start procedure.

7.5 ENGINE STARTING PROCEDURES

7.5.1 Battery Start

1. Propellers — Clear.
2. Engine — Start.

   a. Right IGNITION & START switch — ON. Note R FUEL PRESS light OFF, R IGNITION light ON, and oil pressure movement.

CAUTION

If N_1 stabilizes less than 17 percent, anticipate a hotter than normal engine start. If N_1 stabilizes below 15 percent, consider using a GPU to prevent excessive start temperature.

b. Right condition lever — LOW IDLE (after N_1 stabilizes; 12 percent minimum).

CAUTION

If no ITT/TGT rise is observed within 10 seconds after moving the condition lever to LOW IDLE, complete Abnormal Start procedures (paragraph 13.1).

c. ITT/TGT and N_1 — Monitor (1,000 °C maximum).

d. Right oil pressure — Check.

e. Right condition lever — HIGH IDLE.

Note

Any time the condition lever is moved, the pilot should monitor ITT/TGT.

f. Right IGNITION & START switch — OFF (N_1, 50 percent minimum).

g. Left IGNITION & START switch — ON. Note L FUEL PRESS light OFF, L IGNITION light ON, and oil pressure movement.

h. Right generator — RESET, then ON (after N_1 passes 12 percent).

i. Left condition lever — LOW IDLE (after N_1 stabilized).

CAUTION

If no ITT/TGT rise is observed within 10 seconds after moving the condition lever to LOW IDLE, complete Abnormal Start procedures (paragraph 13.1).

j. ITT/TGT and N_1 — Monitor (1,000 °C maximum).

k. Left oil pressure — Check.

l. Left IGNITION & START switch — OFF (N_1, 50 percent minimum).

3. Condition levers — As required.

7.5.2 GPU Start

WARNING

Conducting right engine GPU starts will place ground personnel within engine exhaust and propeller danger areas during GPU disconnect.

1. Left — Engine start.

a. Battery — OFF.

b. GPU — Connected.

c. Battery — ON.

d. GPU — ON.

2. Left propeller — Clear.
3. Left IGNITION & START switch — ON. Note L FUEL PRESS light OFF, L IGNITION light ON, and oil pressure movement.
4. Left condition lever — LOW IDLE (after N_1 stabilizes; 12 percent minimum).
5. Left ITT/TGT and N_1 — Monitor (1,000 °C maximum).

CAUTION

If no ITT/TGT rise is observed within 10 seconds after moving the condition lever to LOW IDLE, complete Abnormal Start procedures in paragraph 13.1.

6. Left oil pressure — Check.
7. Left IGNITION & START switch — OFF (N_1, 50 percent minimum).

CAUTION

Do not turn on generators with GPU connected.

8. Left condition lever — HIGH IDLE.
9. GPU — Disconnect.
10. Right propeller — Clear.
11. Right IGNITION & START switch — ON. Note R FUEL PRESS light off, R IGNITION ON light on, and oil pressure movement.
12. Left generator — RESET then ON (after N_1 passes 12 percent).
13. Right condition lever — LOW IDLE (after N_1 stabilizes).

CAUTION

If no ITT/TGT rise is observed within 10 seconds after moving the condition lever to LOW IDLE, complete Abnormal Start procedures (paragraph 13.1).

14. Right ITT/TGT and N_1 — Monitor (1,000 °C maximum).
15. Right oil pressure — Check.
16. Right IGNITION & START switch — OFF (N_1, 50 percent minimum).
17. Condition levers — As required.

7.6 BEFORE TAXI CHECKLIST

*1. (**B**) Electrical system — Checked/SET.

   a. Battery — OFF.

b. Inverter No. 1 — ON.

c. Note torquemeters are operational.

d. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

e. Inverter No. 2 — ON.

f. Note torquemeters are operational.

g. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

h. Desired inverter — Select.

i. Battery — ON.

j. Generator — RESET, then ON.

k. Voltmeter pushbuttons — Depress and hold, note voltage.

Note

Voltage should be 27.5 to 29 volts and within 1 volt of each other.

*1. (**F**) Electrical system — Checked/SET.

a. Voltmeter pushbuttons — Depress and hold, note voltage.

b. Left generator — RESET, then ON (right GEN if GPU start).

c. Right generator — OFF (left GEN if GPU start).

CAUTION

Generator voltage should be indicated on both buses. If this is not the case, then a current limiter may have failed.

Note

Voltage should be 27.5 to 29 volts and should not change more than 1 volt when one generator is turned ON and the other generator is turned OFF.

d. Right generator — RESET, then ON (left GEN if GPU start).

e. Voltmeter pushbuttons — Release; check generator loads within 10 percent of each other.

f. Inverter No. 1 — ON.

g. Torquemeters — Check.

h. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

i. Inverter No. 2 — ON.

j. Torquemeters — Check.

k. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

l. Desired inverter — Select.

*1. (**M**) Electrical system — Checked/SET.

a. Battery — OFF.

b. No. 1 inverter — ON.

c. Torquemeters/fuel flow meters — Check.

d. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

e. No. 1 inverter — OFF.

f. No. 2 inverter — ON.

g. Torquemeters/fuel flow meters — Check.

h. Ac voltage and frequency — Check (110 to 120 volts; 390 to 410 Hz).

i. No. 1 inverter — ON.

j. Battery — ON.

k. Generators — RESET, then ON.

*2. AVIONICS MASTER switch — ON.

*3. (**B**) FMS annunciators — Tested (RS). (FMS annunciator lights are powered after AVIONICS MASTER switch is on.)

(**F**) Not applicable.

(**M**) Beacons — Reset.

*4. Environmental — Set (RS).

5. (**B**) Not applicable.

(**F**) DATA NAV — ON.

(**M**) NAVTAC — ON.

6. Electric elevator trim — Checked (both).

Note

Any movement of the elevator trim wheel while depressing only one switch element indicates a system malfunction. The electric elevator trim switch must then be turned off and flight conducted by operating the elevator trim wheel manually. Do not use autopilot.

a. ELEV TRIM switch — ON.

b. Left and right pitch trim rocker switches — Check operation.

7. Anti-ice and deice — Check (as required).

a. Either generator — OFF.

b. Windshield heat — Checked. Place pilot WINDSHIELD ANTI-ICE switch in NORMAL, note loadmeter increase. Repeat for HI. Check copilot WINDSHIELD ANTI-ICE switch in NORMAL and HI.

Note

If windshield temperature is greater than 32 °C (90 °F), windshield anti-ice may not operate.

c. Propeller deice — Checked.

CAUTION

Propeller deice should not be operated when propellers are stationary. Static operation may damage the brushes and slipring.

(1) (**B**) Auto — Place AUTO switch in the ON position. Confirm propeller ammeter 14 to 18 amps and momentary deflection every 30 seconds for the full 2-minute cycle. Check switch off.

(**F/M**) Auto — Place AUTO switch in the ON position. Confirm propeller ammeter 18 to 24 amps and momentary deflection every 90 seconds for the full 3-minute cycle. Check switch off.

(2) (**B**) Manual — Hold MANUAL switch to outer, then inner position. Confirm approximately 5 percent load increase for each propeller (10 percent increase on one loadmeter). Prop ammeter should read zero.

(**F/M**) Manual — Hold MANUAL switch to ON manual position. Confirm approximately 5 percent load increase (10 percent increase on one loadmeter). Prop ammeter should read zero.

d. Pitot(s), stall vane, fuel vents heat — Checked. Turn on all five switches. Turn off individually and note loadmeter decrease. Utilizing one generator during this check enhances loadmeter deflection.

e. Surface deice — Checked.

(1) Single — Select single cycle. Pneumatic and vacuum pressures fluctuate, wing boots inflate for 6 to 9 seconds. Pneumatic and vacuum pressures fluctuate, wings deflate/tail boots inflate for 4 to 6 seconds. Pneumatic and vacuum pressures fluctuate, tail boots deflate.

(2) Manual — Wing and tail boots inflate as long as the switch is held in MANUAL. Pressure and vacuum return to normal when released.

f. (**F/M**) Brake deice — Checked.

(1) Turn the BRAKE DEICE switch on. Observe a rise in ITT/TGT, decrease in torque, fluctuation in bleed air pressure, and the illumination of the BRAKE DEICE advisory light.

(2) Turn the BRAKE DEICE switch OFF. Observe a drop in ITT/TGT, increase in torque, fluctuation in bleed air pressure, and the BRAKE DEICE annunciator light goes out.

g. Ice vanes — Check. At 1,800 rpm, extend ice vanes electrically and check for torque drop. Retract the vanes and check for return to original value. Ensure both ICE VANE EXT lights illuminate during check.

h. Generator — Reset, ON.

8. **(B)** Not applicable.

(**F/M**) Hydraulic fluid sensor — Tested.

9. Flaps — Checked (100 percent, 40 percent, UP).

10. **(B)** Autopilot — Checked.

a. Engage autopilot with AP ENGAGE switch.

b. Pilot AP/YD TRIM DISC switch — Depress through second level. Autopilot disengages and ELECT TRIM OFF annunciator illuminates.

c. Engage autopilot with AP ENGAGE switch.

d. Autopilot TEST button — Depress. Autopilot disengages and AP DISC and MASTER WARNING annunciators illuminate.

CAUTION

If autopilot does not disengage when the TEST button is depressed, it indicates autopilot torque monitors are not functioning properly. Do not use autopilot in flight until corrective action has been taken.

e. Engage autopilot with AP ENGAGE switch.

f. Copilot AP/YD TRIM DISC switch — Depress through first level. Autopilot disengages and ELECT TRIM OFF annunciators illuminate.

g. Pilot AP/YD TRIM DISC switch — Depress through first level to clear AP DISC annunciator.

h. Electric ELEV TRIM switch — OFF, then ON (resets electric trim and ELEC TRIM OFF annunciator extinguishes).

10. (**F/M**) Autopilot — Checked.

a. AP engage switch/annunciator — Depress. AP ENGAGE and YD ENGAGE annunciators on autopilot controller flash. Servo clutches engage. FD flag on ADI in view.

b. Rudder pedals — Overpower slowly. YD ENGAGE annunciator stops flashing.

c. Control wheel — Overpower slowly in both pitch and roll axis. AP ENGAGE annunciator stops flashing. FD flag retracts.

CAUTION

If autopilot or yaw damper disengages during overpower test, do not use. If AP ENGAGE or YD ENGAGE annunciator continues to flash, do not use.

d. Pilot AP/YD & TRIM DISC button — Depress through second level. Autopilot and yaw damper disengages and ELEC TRIM OFF annunciator illuminates. AP ENG and YD ENG annunciators on instrument panel flash five times and autopilot off aural alert sounds for 1 second.

Note

Autopilot preflight check is disabled during in-flight operations.

e. Repeat steps a, b, and c.

f. Copilot AP/YD & TRIM DISC button — Depress through second level. Autopilot and yaw damper disengages and ELEC TRIM OFF annunciator illuminates. AP ENG and YD ENG annunciators on instrument panel flash five times and autopilot off aural alert sounds for 1 second.

g. Electric ELEV TRIM switch — OFF, then ON (ELEC TRIM OFF annunciator extinguishes).

*11. FMS — Set, as required.

*12. Altimeters — Set (both).

*13. (**B/M**) EGPWS — Tested.

a. Ensure the G/S INHBT and TERR INHBT functions are not engaged.

b. Select the MFD to MAP mode.

c. Momentarily push (less than 2 seconds) the GPWS TEST switch and verify the following:

(1) The amber GPWS INOP and the GPWS TERR N/A annunciators illuminate then extinguish.

(2) The amber GPWS annunciators illuminate.

(3) The aural GLIDESLOPE message is announced.

(4) The amber GPWS annunciators extinguish.

(5) The red PULL UP annunciators illuminate.

(6) The aural PULL UP message is announced.

(7) The red PULL UP annunciators extinguish.

(8) The MFD “pops up” the ARC Map mode and the Terrain Display test pattern is displayed.

(9) The red PULL UP annunciators illuminate.

(10) The aural TERRAIN, TERRAIN, PULL UP message is announced.

(11) The red PULL UP annunciators extinguish.

(12) The amber GPWS annunciators momentarily illuminate.

(13) The Terrain Display test pattern is removed from the MFD after several sweeps.

*13. (**F**) GPWS — Tested (RS).

a. Press and hold the pilot PULL UP warning light.

(1) The BELOW G/S light should illuminate.

(2) The glideslope warning voice will say GLIDESLOPE.

(3) Approximately 1 second after pressing the PULL UP light, both the pilot and copilot PULL UP warning light will start flashing on and off. A WHOOP WHOOP tone warning followed by a PULL UP voice warning will be heard.

b. Release the light as soon as flashing begins. At the completion of the PULL UP voice warning, all aural warnings and warning lights will extinguish.

14. (**F**) Not applicable.

(**B/M**) TCAS transponder — Checked/set.

a. Select TCAS only on the MFD control panel.

b. Set TCAS/XPDR mode selector switch to STBY.

c. The VSI/TRA displays annunciate white TCAS OFF message in the right center of the display.

d. The MFD annunciates cyan TCAS STBY message in the lower right corner of the display.

e. Momentarily depress the system TEST pushbutton on the TCAS control panel and verify the following:

(1) Aural TCAS TEST message is heard over the cockpit speakers or headsets indicating the start of the self-test.

(2) XPDR FAIL indicator illuminates momentarily and PASS is displayed on TCAS/transponder control panel.

(3) VSI/TRA displays depict the standard pattern of intruders and RA arcs along with the white TEST annunciation in the right center of the display.

(4) MFD display depicts the standard pattern of intruders and cyan TCAS TEST annunciation in the lower right corner of the display. The MFD does not present RA information.

(5) After approximately 8 seconds, the aural TCAS TEST PASS message is heard over the cockpit speakers or headsets, indicating the successful completion of the self-test. The VSI/TRA and MFD annunciations revert to previous messages.

*15. Cabin — Ready for taxi (TA).

*16. Cabin signs — Set.

7.7 TAXI

Normal taxi operations are started from a slow, straight-ahead roll using engine power as required to initiate movement. Taxi speed can be effectively controlled by the use of power application and the use of the variable pitch propellers in the beta range. Normal turns must be made with the steerable nosewheel; however, a turn may be tightened using full rudder and inside brake as necessary. Turns should not be initiated with brakes alone, nor should the aircraft be pivoted sharply on one main gear. Observe gyro instruments during turns for proper response.

CAUTION

- Use of reverse range in surface areas containing loose sand or small stones may cause propeller blade erosion.
- Do not taxi aircraft until attitude and heading flags are out of view.

1. Brakes — Checked (both).
2. Flight instruments — Checked (both). Check for proper indications of HSI, RMI, turn and slip, standby attitude gyro, magnetic compass, and pitot static instruments.
3. RADAR — STBY.

7.8 ENGINE RUNUP

Note

Completion of the Engine Runup checks is at the discretion of the Aircraft Commander. If maintenance has been performed on any of the systems affected by the Engine Runup checklist, these checks shall be completed before the first flight following maintenance action.

1. Nosewheel — Centered.
2. Brakes — Set.
3. Condition levers — LOW IDLE.
4. Engine instruments — Checked.
5. Overspeed governors and rudder boost — Checked.
   a. Rudder boost — ON.
   b. Propeller levers — Full forward.
   c. Propeller governor test switch — Hold in PROP GOV TEST position.
   d. Left power lever — Increase until propeller is stabilized at 1,830 to 1,910 rpm to check overspeed governor. Then continue to increase power until rudder movement is noted. Observe ITT/TGT and torque limits.
   e. Left power lever — IDLE.

f. Right power lever — Increase until propeller is stabilized at 1,830 to 1,910 rpm to check overspeed governor. Then continue to increase power until rudder movement is noted. Observe ITT/TGT and torque limits.

g. Right power lever — IDLE.

h. Propeller governor test switch — Released.

6. Primary governors — Checked.

   a. Propeller levers — Full forward.

   b. Propeller rpm — Set 1,800 using power levers.

   c. Propeller levers — Pull propeller levers until friction of feather detent is felt. Propeller rpm should follow lever movement.

   d. Check rpm — 1,600 to 1,640 rpm.

   e. Propeller levers — Full forward.

7. Pressurization/pneumatics/vacuum systems — Checked (at 70 percent N_1) (RS).

   a. At 70 percent N_1, turn both bleed air valves to (**B/F**) INST & ENVIR OFF (**M**) ENVIR & PNEU OFF and note the pneumatic pressure and gyro suction gauges go to zero and BL AIR FAIL warning lights illuminate. Set pressurization controller to 500 feet below field elevation and rate knob to maximum. Actuate CABIN PRESS switch to TEST and open the left bleed valve. Note an indication of pressurization after 30 to 45 seconds and pneumatic pressure and gyro suction gauges are in the green arc. Close the left bleed air valve and check cabin pressurization returns to field elevation and pneumatic pressure/gyro suction gauges return to zero. Repeat the above sequence for the right bleed air valve. Open both bleed air valves, set controller to 500 feet above field elevation, and set cabin pressure switch to PRESS position.

Note

If the airfield elevation is near sea level and the current pressure altitude is 30.42 or greater, an accurate pressurization check may not be possible.

8. Autofeather/autoignition — Check.

   a. AUTOIGNITION switch — ON.

   b. Power levers — Approximately (**B/F**) 500 foot-pounds (**M**) 25 percent torque.

   c. AUTOFEATHER switch — Hold to TEST. Observe both AUTOFEATHER annunciator lights illuminated.

   d. Power levers — Retard (individually):

      (1) At (**B/F**) 410 ± 50 foot-pounds/(**M**) 18 ± 2 percent torque — Opposite AUTOFEATHER annunciator light extinguished; corresponding side AUTOIGNITION annunciator light illuminated.

      (2) At (**B/F**) 260 ± 50 foot-pounds/(**M**) 11 ± 2 percent torque — Both AUTOFEATHER annunciator lights extinguished (propeller starts to feather).

Note

The AUTOFEATHER annunciator light on the side being tested will cycle on and off with each fluctuation of torque as the propeller tries to feather.

(3) Repeat items (1) and (2) with the opposite power lever.

e. Power levers — Approximately (**B**/**F**) 500 foot-pounds/(**M**) 25 percent torque, then both IDLE (both AUTOFEATHER annunciator lights extinguished, both AUTOIGNITION annunciator lights illuminated, neither propeller in feather).

f. AUTOFEATHER switch — Release.

g. Autoignition — OFF.

9. Propeller feather (manual) — Check for an increase in torque, a decrease in propeller rpm, and that N_1 does not decrease more than 1 percent.

7.9 ENGINE RUNUP CHECKLIST

1. Overspeed governors/rudder boost — Checked.
2. Primary governors — Checked.
3. Pressurization — Checked (RS).
4. Autofeather/autoignition — Checked.
5. Propeller feather (manual) — Checked.

*7.10 TAKEOFF CHECKLIST

1. Autofeather — ARMED (PNF).
2. Pressurization — Set (PNF).

   a. Cabin altitude selector knob — Adjust so that inner scale (ACFT ALT) indicates planned cruise altitude plus 1,000 feet. If this setting does not result in an outer scale (CABIN ALT) indication of at least 500 feet above takeoff field pressure altitude, adjust as required.

   b. Rate control selector knob — Set index between 9 and 12 o’clock positions.

3. Flaps — State setting (both).
4. Trim — State setting.
5. Propeller levers — Full forward.
6. (**B**) Propeller sync — OFF.

   (**F**/**M**) Not applicable.

7. Flight controls — Checked.
8. Flight instruments — Checked (both).
9. Engine instruments — Checked.
10. COMM/NAV — Set (PNF).

11. Bleed air valves — OPEN (RS).

Note

Under hot and humid conditions (i.e., maximum air-conditioning required), bleed air valves should be left closed (ENVIR OFF) until airborne and sufficient altitude is gained.

12. Fuel panel — Checked ______ pounds.

13. Crew brief — Complete.

14. Cabin — Ready for takeoff (PNF).

*7.11 LINEUP CHECKLIST

1. Lights — Set (turn on landing/taxi, strobe, and recognition lights).

Note

Prolonged use of the recognition lights during ground operations will generate enough heat to damage the light cover. Strobe beacons may be turned off at pilot discretion when encountering conditions of haze, fog, or clouds.

2. Ice protection — Set (minimum of pitot, stall vane, fuel vent).

3. Transponder — ON (PNF).

4. Radar — As required (PNF).

5. Autoignition — ARMED (PNF).

CAUTION

Prolonged ground operation with autoignition armed will reduce igniter life.

6. Gyro heading — Checked (both).

7. Condition levers — Set and matched.

7.12 TAKEOFF

7.12.1 Normal Takeoff

Takeoff roll may begin at idle power or the brakes may be held while the power levers are advanced to 70 to 80 percent N_1. Release brakes and apply power smoothly. Refer to A1-C12BM-NFM-200 — Performance Charts for correct rotation and lift-off speeds. Monitor ITT/TGT and torque. At "rotate," smoothly raise the aircraft pitch to 7 to 10° nose up. Retract the landing gear when airborne with a positive rate of climb, and accelerate to the appropriate climb speed. Takeoff power must be applied prior to releasing brakes to obtain the normal takeoff distances in A1-C12BM-NFM-200 — Performance Charts.

Note

- Rapid advancement of the power levers may result in propeller surge and asymmetric power application that could result in directional control problems.
- All reclining seats must be in the upright position with armrests down during takeoff.
- To achieve precomputed performance data, at least minimum power for takeoff must be set.
- Maximum weight for takeoff may be restricted by the requirement to:

  — Accelerate to V_1 and stop on the runway (accelerate-stop);

  — Climb at 100 fpm with gear down and a failed engine;

  — Climb at a gradient steep enough to clear obstacles if an engine fails.

  Refer to the appropriate charts in A1-C12BM-NFM-200 — Performance Charts. The highest weight to meet all those criteria establishes maximum takeoff weight. If any of these criteria are not met (because of runway length, elevation, ambient temperature, or gross weight), reduce gross weight or wait for a lower temperature prior to takeoff.

7.12.2 Crosswind Takeoff

In accomplishing a crosswind takeoff, directional control may be more difficult to maintain. Leading with upwind power at the beginning of the takeoff roll will assist in maintaining directional control. Keep the nosewheel on the surface and apply aileron into the wind to maintain a wings-level attitude. Rotate firmly at V_R, making the lift-off positive to prevent side skipping as weight is lifted from the shock struts. Initial drift correction is made by turning into the wind with a shallow bank to counteract drift, then rolling the wings level. Continue to climb straight ahead maintaining drift correction. Refer to A1-C12BM-NFM-200 — Performance Charts for takeoff/landing crosswind chart.

7.12.3 Obstruction Clearance Takeoff

If performance charts (A1-C12BM-NFM-200 — Performance Charts) dictate the need for a maximum performance takeoff for obstruction clearance, the following procedure should be used. When aligned on the runway with approach flaps set, apply maximum power and release the brakes. Accelerate to V_R, then rotate and maintain V_X until the obstacle is cleared. Raise the landing gear as soon as safely airborne. Once clear of the obstacle, accelerate to at least V_Y (V_{YSE}) and raise flaps.

7.12.4 Soft-Field Takeoff

If a takeoff must be made in mud, snow, tall grass, or other conditions of high surface friction, the following procedure should be used. Taxi at a steady speed using power as necessary and minimum braking. Hold the yoke full aft to reduce pressure on the nosewheel. Use approach flaps (40 percent) for takeoff. Begin a steady acceleration to maximum power. Continue to hold full aft yoke and raise the nosewheel as soon as possible. When the aircraft rotates, control attitude by reducing aft yoke pressure until completely airborne. Once clear of the soft surface, level off in ground effect and accelerate to normal climb airspeed. Keeping the aircraft in ground effect without touching down again after lift-off requires numerous, rapid fore and aft inputs. Consider the effects of snow or mud on gear retraction as applicable.

WARNING

- Soft-field takeoffs with a crosswind component in excess of 5 knots are prohibited.
- Accelerate at an altitude low enough to allow a safe power-off landing from a speed below stall speed. The soft-field takeoff procedure will result in lift-off airspeeds below power-off stall speed and below V_{MC}. If an engine fails below V_{MC}, power must be reduced to maintain directional control.

7.12.5 Short-Field Takeoff

If a short-field takeoff is necessary on a hard surface, use approach flaps and set maximum power prior to brake release. Accelerate to V_R then rotate and maintain V_2 until safely airborne. Raise the landing gear as soon as safely airborne. Accelerate to at least V_Y and raise the flaps. Accelerate to normal climb airspeed. Raise the flaps after accelerating to normal climb speed.

*7.13 CLIMB CHECKLIST

The Climb Checklist must be completed after each takeoff except when staying in the pattern or when conducting multiple instrument approaches. Pilots should avoid adjusting avionics controls located on the aft portion of the extended pedestal while the aircraft is in a turn to reduce the chance of introducing spatial disorientation (vertigo).

1. Landing gear — UP.
2. Landing/taxi lights — OFF.
3. Flaps — UP.
4. Climb power — Set. Observe maximum ITT/TGT, torque, and N_1 limits.
5. Propeller sync — ON.
6. Yaw damp — ON (200-foot AGL minimum) (PNF).
7. Autofeather — OFF (PNF).
8. Cabin pressurization — Checked.
9. Wings/nacelles — Checked (both).
10. Cabin signs — Set (PNF).

7.14 CRUISE CLIMB

1. Propeller speed — 1,900 rpm.
2. ITT/TGT — Not to exceed (**B**) 725 °C; (**F/M**) 770 °C.

Note

- To prolong engine life, recommended cruise climb ITT/TGT should not exceed (**B**) 700 °C; (**F/M**) 770 °C.
- When becoming temperature-limited in the climb, propeller rpm may be reduced to 1,700 to reduce noise and vibration. Climb rate will be reduced by 100 to 200 fpm.

3. Torque — (**B/F**) 2,230 foot-pounds; (**M**) 100 percent.
4. Airspeed:
   a. Sea level to 10,000 feet — (**B**) 155/(**F/M**) 160 KIAS.
   b. 10,000 to 20,000 feet — (**B**) 135/(**F/M**) 140 KIAS.
   c. 20,000 to 25,000 feet — (**B**) 125/(**F/M**) 130 KIAS.
   d. (**B**) 25,000 to 31,000 feet — 115 KIAS.
   (**F/M**) 25,000 to 35,000 feet — 120 KIAS.

7.15 DESCENT

Descent from cruising altitude may be made at any airspeed and power combination within the aircraft operating envelope. Maximum rate of descent may be obtained in either the clean or dirty configuration; however, the descent gradient of a dirty descent is considerably greater than that of a clean descent at a given power setting.

Note

Approximately 75 percent N_1 (85 percent N_1 with one engine inoperative) is required to maintain the pressurization schedule during descent.

*7.16 DESCENT CHECKLIST

1. Cabin pressurization — Set (PNF).
   a. Cabin altitude selection knob — Set 500 feet above field elevation.

Note

When descending into areas of abnormally high or low barometric pressure, consult A1-C12BM-NFM-200 — Performance Charts.

   b. Rate control selector knob — Set index at 12 o’clock position (300 to 500 fpm rate of descent).

Note

High-speed minimum power descents will result in possible sudden cabin depressurization unless the cabin pressurization rate control selector knob is increased. Failure to maintain 85 percent N_1 (single engine) or 75 percent N_1 (two engines) will render the rate control knob useless.

2. Altimeters — Set (both).

*7.17 APPROACH CHECKLIST

WARNING

Do not use propeller in the range of 1,750 to 1,850 rpm during ILS approach due to potential GS signal interference.

Note

- In low visibility conditions, landing and taxi lights should not be used due to light reflections.
- If a crosswind landing is anticipated, determine crosswind component from A1-C12BM-NFM-200 — Performance Charts for takeoff/landing crosswind chart.

1. Altimeters — Set (both).
2. Pressurization — Checked (PNF).
3. Cabin signs — NO SMOKING/FSB (PNF).
4. Autofeather — ARMED (PNF).
5. Cabin — Ready for approach (PNF/TA).
   a. Seatbacks — Upright.
   b. Seatbelts — Fastened.
   c. Armrests — Down.
   d. Loose gear and cargo — Stowed/secured.
   e. Passengers — Awake.
   f. Report — CABIN READY.
6. NAVAIDs/HSIs — Set (both).
7. Crew brief — Complete.

7.18 LANDING CHECKLIST

1. Landing gear — Down and locked.
2. Landing/taxi lights — ON.
3. Propeller sync — (**B**) OFF; (**F/M**) as required.
4. Propellers — As required.
5. Flaps — As required.
6. Autopilot/yaw damp — OFF (PNF).

7.19 INSTRUMENT APPROACHES

Refer to instrument procedures in Chapter 18.

7.20 LANDING

Normal and no-flap landing patterns are depicted in Figures 7-2 and 7-3.

7.21 NORMAL LANDING

Fly a smooth power-on approach with a descent rate of 500 to 1,000 fpm. Use an approach speed of 120 KIAS or V_{REF}, whichever is higher. Once landing is assured and the final flap selection is made, slow to cross the threshold at V_{REF}.

WARNING

Lifting the power levers in flight or moving the power levers in flight below the FLIGHT IDLE position could result in nosedown pitch and a descent rate leading to aircraft damage and injury to personnel.

CAUTION

If possible, propellers should be moved out of REVERSE above 40 knots to minimize propeller blade erosion. Care must be exercised when reversing on runways with loose sand or dust on the surface. Flying gravel will damage propeller blades, and dust may impair pilot forward visibility at low aircraft speeds.

Note

- The propeller levers must be placed full forward to ensure proper reversing characteristics.
- Full flaps (100 percent) is the normal landing flap setting; however, any flap setting appropriate for existing conditions may be used.

Make a smooth flare, touching down on the main gear first. After touchdown, the PNF ensures the propeller levers are full forward. Stop the aircraft by placing the propellers in BETA or REVERSE (as required) and applying wheelbrakes. Maintain directional control with rudder, nosewheel steering, and brakes.

The aircraft has demonstrated landings on hard, smooth surfaces and dry sod runways. When landing on these surfaces, the pilot should use discretionary propeller reverse and minimum wheelbraking necessary to stop the aircraft on the available runway.

The following precautions should be observed immediately after landing or at any time there is considerable lift on the wings. Extreme care should be used during any braking to prevent skidding the tires and causing flat spots. Proper traction cannot be expected until the tires are carrying the aircraft weight. In the event that maximum braking is required after touchdown, the propellers should be reversed immediately and the brakes applied smoothly and evenly to the end of the ground roll.

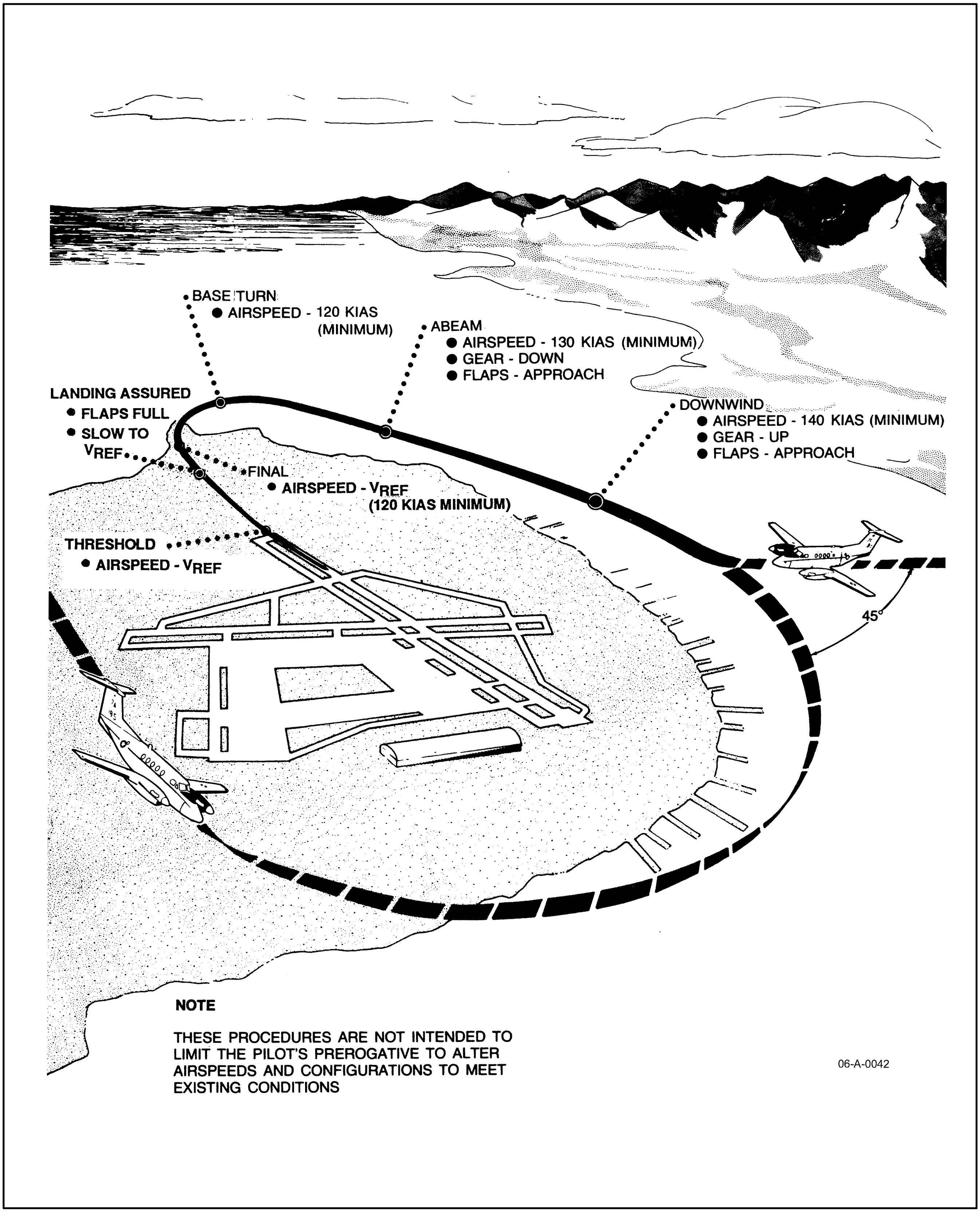


Figure 7-2. Normal Landing Pattern

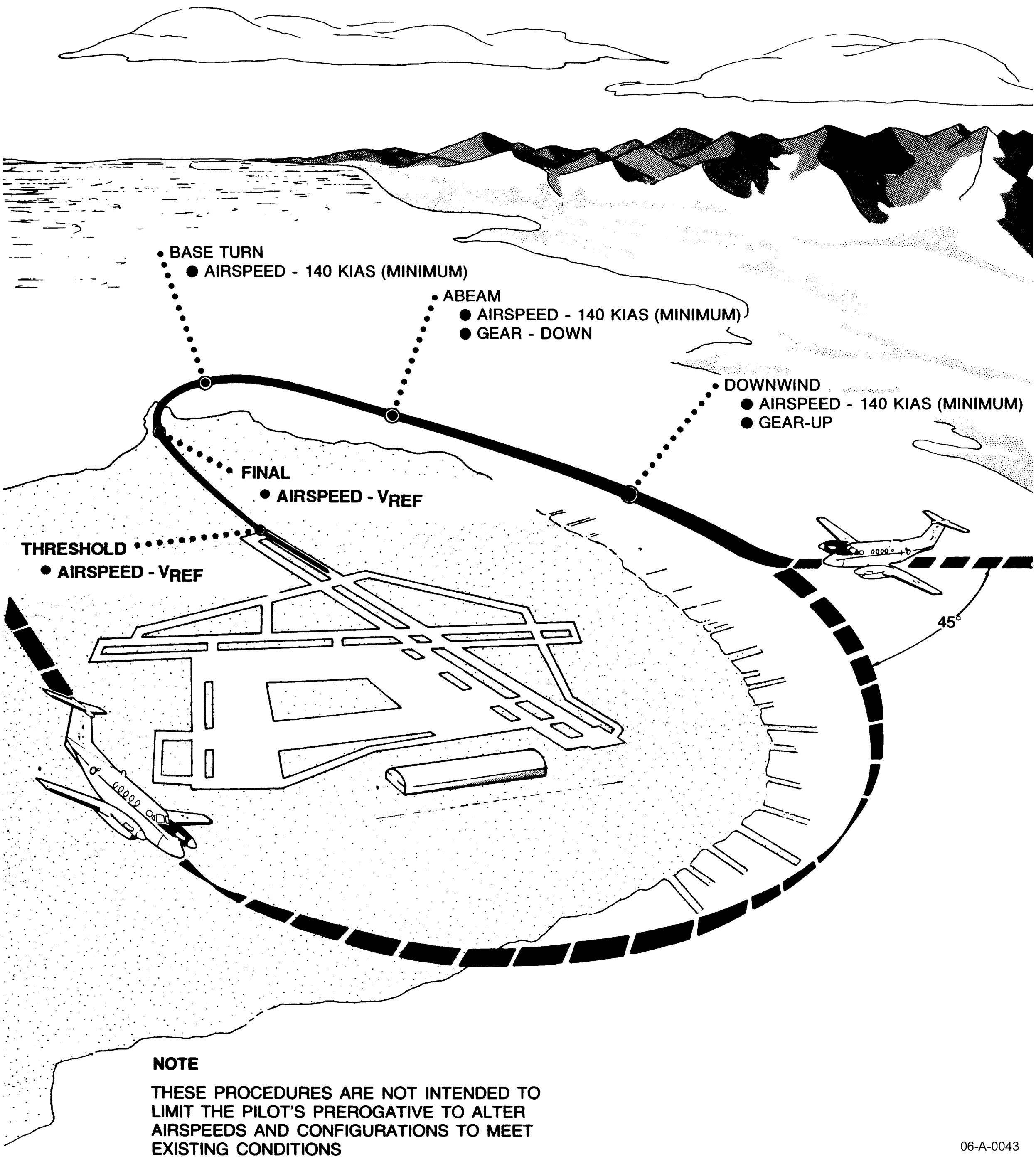


Figure 7-3. No-Flap Landing Pattern

7.21.1 Touch and Go Landing

7.21.1.1 After Touchdown

1. Propeller levers — Full forward.
2. Flaps — As required.
3. Trim — As required.
4. Power — Set, as required.

Note

Electric trim may not be adequate to relieve the high longitudinal control forces associated with the landing transitions.

7.21.2 Crosswind Landing

No unusual technique is required in a crosswind landing. Use the wing-low method. Allow for drift while turning on final approach so that you will not overshoot or undershoot the approach leg. Establish drift correction as soon as drift is detected. Use ailerons and top rudder as necessary to counteract drift during flare and touchdown. Crosswind correction (ailerons) should be maintained throughout the landing ground roll.

Note

With landing gear extended, nosewheel steering is engaged. Nosewheel may be cocked on touchdown depending on rudder input.

7.21.3 Night Landing

Night landing procedures are the same as procedures used during a day landing. Instrument and interior light intensity should be kept as low as possible to aid night vision. Avoid using landing/taxi, beacon, or strobe lights in thick haze, smoke, or fog, as reflected light from the particles in the air may reduce visibility.

7.21.4 Soft-Field Landing

If a landing is to be made on soft or unprepared surface, such as mud, tall grass, or snow, plan a normal full flap power approach until entering the flare. Decelerate to the slowest possible airspeed just prior to touchdown, using power to control the final rate of descent to as slow as possible. Do not stall prior to touchdown as the nose attitude and rate of descent will become unacceptable. On touchdown, apply full aft yoke and leave power on. Reduce power slowly. Do not use brakes unless absolutely necessary. Every precaution must be taken to prevent the nosewheel from digging into the surface.

CAUTION

- Do not reverse with nosewheel off the ground.
- Use of reverse in surface areas containing loose sod or small stones may cause propeller blade erosion or engine foreign object damage.

Note

- Extending the ice vanes will reduce the amount of loose particles ingested by the engine when landing on an unprepared surface.
- Use of the ice vanes above +15 °C is not recommended.

7.21.5 Short-Field Landing

If a landing must be made on a runway where the usable surface is equal to or less than 150 percent of the minimum run required based on the landing distance information in A1-C12BM-NFM-200 — Performance Charts, the following procedure should be used. Make a normal full-flap power approach, decelerating to not less than V_{REF} on final. If no obstacle is to be considered, plan a slightly shallower approach than for a normal landing. Plan to touch down as near the end of the runway as is commensurate with safety. After touchdown, apply maximum braking and maximum reverse thrust. If an obstacle dictates the use of a steeper angle of descent, plan the descent to clear the obstacle and continue the approach. If an obstacle is adjacent to the approach end of the runway, the landing point should be placed further down the runway surface to allow a safe angle of descent once clear of the obstacle. A partial power reduction over the obstacle will allow a continuous angle of descent to the flare. Plan to touch down as slow as possible, keeping in mind that better deceleration can be obtained on the ground than in the air. Raise flaps on touchdown. Complete the following procedures:

1. Landing checklist — Complete.
2. Condition levers — HIGH IDLE.
3. Propeller levers — Full forward.
4. Flaps — DOWN (100 percent).
5. Power levers — LIFT and REVERSE after touchdown.
6. Flaps — UP after touchdown.
7. Brakes — Maximum.
8. Condition levers — LOW IDLE.

7.21.6 Waveoff

Pilots should initiate their own waveoff any time a safe landing is not possible. The decision should be made as soon as possible during the approach and prior to flare to provide a safe margin of airspeed and altitude. Complete the following procedures as applicable:

1. Power — Maximum (ensure propeller levers are full forward).
2. Attitude — Sufficient to stop rate of descent.

Note

Electric trim may not be adequate to relieve the high longitudinal control forces associated with the transition from landing attitude to climb attitude.

3. Airspeed — As required (V_Y, V_X).
4. Flaps — Approach (if 100 percent [Full]).

Positive climb, then:

5. Gear — UP.
6. Flaps — UP.

Note

Steps 1, 2, 3, and 4 are to be accomplished simultaneously in order to ensure a positive rate of climb is established at the required airspeed. If maximum rate or maximum angle of climb is not required, allow the aircraft to accelerate to normal climb airspeed.

7.22 AFTER LANDING

7.22.1 After Landing Checklist

The After Landing checklist must be completed after each full stop landing.

1. Flaps — UP.
2. Autoignition — OFF (PNF).
3. Ice protection — OFF.
4. Lights — Set.
5. Transponder — STBY (PNF).
6. (**B**/**M**) RADAR — STBY (PNF).

   (**F**) RADAR/DATA NAV — OFF (PNF).

7.22.2 Engine Shutdown

1. Nosewheel — Center.
2. Parking brake — Set.
3. Power levers — IDLE.
4. Environmental switches — OFF/AUTO/(**B**/**F**) OFF (RS)/(**M**) AUTO.
5. Bleed air valves — (**B**/**F**) ENVIR OFF (RS)/(**M**) PNEU ONLY.
6. Autofeather — OFF (RS).
7. Inverters — OFF (RS).
8. ITT/TGT — Stabilized at minimum temperature for 1 minute.

CAUTION

Monitor ITT/TGT during shutdown. If sustained combustion is observed, proceed immediately to Engine Clearing procedures in paragraph 13.1 (Abnormal Start). During shutdown, ensure that the compressors decelerate freely. Do not close the fuel firewall shutoff valves for normal engine shutdown.

9. Propeller levers — FEATHER.
10. Condition levers — FUEL CUTOFF.
11. AVIONICS MASTER switch — OFF (RS).
12. Standby pumps — OFF.

CAUTION

The standby boost pumps and cabin entry lights are connected to the battery bus. Failure to turn these switches OFF will discharge the battery.

13. Oxygen — OFF (RS).
14. Flight controls — Set.
15. Master panel lights — OFF (RS).
16. Lights — OFF.
17. Gangbar (battery and generator) — OFF.
18. Utility lights — Verify OFF.

7.23 POSTFLIGHT

Check aircraft integrity following each flight.

7.24 TERMINAL OPERATIONS

Every attention should be paid to the conduct and safety of passengers during loading and unloading. As a minimum, the port engine should be shut down during loading and unloading operations, even on short turnaround.

CHAPTER 8

Ship-Based Procedures

Not applicable to UC-12 aircraft.

CHAPTER 9

Overwater Operations

9.1 OVERWATER OPERATIONS

To conduct extended overwater operations, the following considerations must be carefully evaluated and all planning factors strictly adhered to. All flights over water in excess of 1,000 nm shall be planned in accordance with this chapter.

9.1.1 Payload

Because of constraints of maximum allowable takeoff weight and fuel requirements, cabin load/payload must always remain secondary as a mission consideration. The aircraft commander must be prepared to reduce cabin load (i.e., refuse passengers or cargo based on his evaluation of all factors). In some cases, delay or cancellation to await more favorable conditions will be indicated.

9.1.2 General Procedure

When involved in overwater flying, the requirement for fuel planning becomes more complex. Because of the lack of available alternates, possible significant en route wind changes, and rapidly changing weather, the fuel planning delineated in this chapter shall be completed for extended overwater flight.

9.2 OVERWATER FUEL PLANNING TERMINOLOGY

9.2.1 Reserve Fuel

Reserve fuel is additional fuel taken on at the departure point for enroute contingencies such as wind variations, temperature deviations, and flight at less-than-optimal altitudes. It is the fuel that can be burned en route in addition to the planned burnoff and still have the required holding fuel at destination, plus alternate fuel if required. Minimum reserve fuel is 10 percent of the planned fuel burn from departure point to destination and then on to the alternate if an alternate is required.

9.2.2 Holding Fuel

Holding fuel is planned fuel for holding at destination or alternate if required. This is the fuel required for holding in cases I, II, and III as defined in paragraphs 9.3.3.1, 9.3.3.2, and 9.3.3.3 respectively. Holding fuel does not include fuel for anticipated Air Traffic Control (ATC) holding, approach procedures, or alternate requirements at the departure or destination airports.

9.2.3 Equal Time Point

The Equal Time Point (ETP) is a point expressed in miles along the track from which the same amount of time will be required to either return to the takeoff point or continue to destination. It is calculated assuming an emergency requiring a descent to 10,000 feet at that point and either continuing to the destination or returning to the departure point with one engine inoperative or at 10,000 feet. It is the most critical point along the route of flight and is used for turnaround decision-making purposes.

$$\text{ETP (in miles)} = \text{Total Distance} \times \frac{GS_R}{GS_R + GS_C}$$

Where:

Distance = Total distance from takeoff to destination.

GS_R = Groundspeed to return, based on wind average from the takeoff point to midpoint of flight.

GS_C = Groundspeed to continue, based on wind average from midpoint to destination.

Example:

Takeoff Point	Wind A	+	Wind B	Destination
	GS_R	Midpoint	GS_C	

GS_R = True Airspeed (TAS) ± Wind A.

GS_C = Point of No Return (PNR) ± Wind B.

9.2.4 Emergency on Deck Fuel

Emergency on Deck Fuel (EODF) is the absolute minimum planned fuel required upon landing after experiencing a rapid decompression or engine failure at the most critical point along the route of flight ETP. Minimum EODF is 500 pounds. Minimum fuel required at ETP is fuel to continue to destination (or divert) plus 500 pounds.

9.2.5 Point of Safe Return

The Point of Safe Return (PSR) is the farthest point along the route to which the aircraft can fly and still return safely to the point of departure. It is predicated on two-engine operation.

$$\text{PSR (time)} = ts = GS_2 \times \frac{T_1}{GS_1 + GS_2}$$

$$\text{PSR (distance)} = ds = ts(GS_1)$$

Where:

T_1 = All fuel on board (in hours) at takeoff except fuel for holding and flying to departure alternate.

GS_1 = Groundspeed from takeoff to midpoint in flight.

GS_2 = Groundspeed from midpoint to departure point.

9.2.6 Point of No Return

The PNR is the farthest point along the route to which the aircraft can fly and still return to the point of departure and land with no fuel remaining (predicated on two engines).

$$\text{PNR (time)} = tn = GS_2 \times \frac{T_2}{GS_1 + GS_2}$$

$$\text{PNR (distance)} = dn = tn(GS_1)$$

Where:

T_2 = All fuel aboard (in hours) at takeoff.

GS_1 = Groundspeed from takeoff to midpoint in flight.

GS_2 = Groundspeed from the midpoint of the route of flight to the departure point.

9.3 FLIGHT PLAN FUEL LOADS

9.3.1 General Procedure

The appropriate charts in A1-C12BM-NFM-200 Performance Charts will be utilized for preflight planning, as applicable to the mission profile. When true airspeeds other than maximum range are to be adhered to, the specific range charts shall be considered the primary reference for en route fuel planning.

9.3.2 Computer Flight Plan

A computer flight plan Optimum Path Aircraft Routing System (OPARS) may be utilized for basic fuel/flight planning information. It is, nonetheless, a pilot responsibility to ensure that reserve and alternate fuel are provided as outlined in current instructions.

9.3.3 Normal Two-Engine Operation

After consideration of destination weather, one of the following formulas shall apply in calculating minimum takeoff fuel:

9.3.3.1 Case I

Destination forecast Visual Flight Rules (VFR) ±1 hour:

Fuel to destination +
10 percent of fuel to destination +
45 minutes holding at maximum endurance and 10,000 feet.

9.3.3.2 Case II

Alternate required:

Fuel to destination +
Fuel to alternate at 10,000 feet +
10 percent of (fuel to destination + fuel to alternate) +
45 minutes holding at maximum endurance and 10,000 feet.

9.3.3.3 Case III

Island holding (no alternate available):

Fuel to destination +
10 percent of fuel to destination +
1 hour 15 minutes holding at maximum endurance at 20,000 feet.

9.3.4 Single-Engine Fuel Planning or Unpressurized Flight Fuel Planning

In the event of an engine failure, a precise estimate of fuel required from the ETP should be considered for the emergency. Variables such as icing, wind changes, or nonstandard temperatures will affect cruise ceilings and fuel usage considerably. With all variables considered, the aircraft must be able to either continue to destination or return to takeoff point on fuel available from single-engine ETP. Methodology and charts for determining single-engine range are contained in A1-C12BM-NFM-200 Performance Charts.

Note

On some overwater legs, a suitable divert field is available near the midpoint. In these cases, although fuel planning shall be in accordance with the above, construction of range control charts and computation of ETP and PSR shall be at the discretion of the aircraft commander.

9.3.5 Fuel Computation

9.3.5.1 ETP

ETP should be computed prior to takeoff and verified enroute. An aircraft shall depart with sufficient fuel to proceed to the ETP, experience an engine failure or require depressurized flight, and then continue to either the destination or divert and land with minimum EODF (500 pounds).

9.3.5.2 Depressurization

Fuel planning shall be done assuming an emergency descent to 10,000 feet at the ETP. If there is sufficient oxygen aboard for all passengers and crew, an altitude up to 25,000 feet may be used.

9.3.5.3 Fuel Calculation

1. Compute fuel to destination and, if required, to alternate.
2. Add a minimum 10 percent and any known additional fuel required (e.g., known ATC delays).
3. Compute holding fuel (case I, II, or III).
4. Compute preliminary fuel load by totaling items 1 to 3.
5. Compute single-engine and depressurized ETP. If using altitudes other than OPARS, use the most adverse altitudes.
6. Compute emergency fuel requirements. This is the fuel burn computed from departure point to ETP using normal two-engine figures, plus fuel burn from ETP to destination or departure point after an engine failure or depressurization at ETP plus 500 pounds.
7. Compare emergency fuel requirements with preliminary fuel load determined in step 4. The greater will become the minimum departure fuel. Recompute enroute burn as required by new aircraft takeoff gross weight.

Note

- If at any point prior to ETP it is determined that fuel at ETP will be less than that required to experience an engine failure or depressurization and land with minimum EODF, the aircraft shall return to the departure point or a suitable divert field.
- OPARS estimates may contain errors.

9.3.5.4 Fuel Evaluation

1. A locally prepared fuel range control chart or an OPARS howgozit shall be completed.
2. All checkpoints on the flight plan will be clearly depicted on the fuel evaluation chart corresponding to planned fuel consumption.
3. A 10 percent overage will be calculated for total fuel burn at each point and plotted on the chart. Once plotted, a dark line shall be drawn through the estimated burn points on the chart. A red line shall be drawn through the 10 percent above points to indicate the excessive burn acceptability line. All ETPs, PSRs, and PNRs will be plotted on the chart to provide an immediate reference to all points.

Note

Preliminary ETP, etc. may be plotted based on forecast winds but shall be updated based on actual conditions.

CHAPTER 10

Functional Checkflight Procedures

10.1 GENERAL

10.1.1 Checkpilots

Functional check pilots shall be fully qualified in accordance with this manual and OPNAVINST 3710.7. Commanding officers will designate in writing those pilots within their command who are currently qualified to perform this duty.

10.1.2 Crewmembers

Crewmembers of checkflights shall be qualified to conduct such tests as may be required.

10.1.3 Safety

Safety shall be the governing factor on all post-maintenance checkflights. The following general rules shall apply:

1. The flight shall be governed by the requirements of this manual and OPNAVINST 3710.7.

2. Radio communications shall be maintained with the control tower or another appropriate agency at all times.

3. Checkflights should be flown in a designated area, and those portions of the checkflight that are considered critical shall be conducted in the vicinity of a suitable landing area.

10.1.4 Forms

Functional Checkflight Checklists are published separately. The results of the checks shall be entered on the checklists with appropriate remarks if necessary and returned to maintenance at the completion of the checkflight.

10.1.5 Checkflights

Checkflights are required to determine whether the airframe, powerplant, accessories, and items of equipment are functioning in accordance with predetermined requirements while subjected to the intended operating environment. Checkflights shall be flown as required by OPNAVINST 4790.2 series maintenance directives, or at such other times as may be directed by the commanding officer or other competent authority.

10.2 CONDITIONS REQUIRING CHECKFLIGHT

Perform applicable flight profile and associated checks in accordance with the following checkflight conditions (after the necessary ground checks and prior to release of aircraft for operational use):

A. At the completion of aircraft rework and transfer of aircraft custody. Minimum checks required are prefixed by letter A.

B. After the installation of an engine, propeller, engine fuel control, or any components that cannot be checked on the ground. Minimum checks required are prefixed by letter B.

C. When fixed or movable flight surfaces or flight control system components have been installed, reinstalled, adjusted, or rerigged and improper adjustment or replacement of such components could cause an unsafe operating condition. Minimum checks required are prefixed by letter C.

10.3 PROCEDURES

10.3.1 Briefing

Prior to the checkflight, maintenance personnel shall brief pilots on the maintenance performed on the aircraft, pertinent aircraft history, and the checkflight requirements for the particular flight. The briefing should include the expected results, troubleshooting recommendations, and when appropriate, corrective or emergency action to be taken if required.

10.3.2 Functional Checkflight

NATOPS procedures shall apply during the entire checkflight unless specific deviation is required by the functional check to record data or ensure proper operation within the approved aircraft envelope. The following items provide a detailed description of the functional checks, sequenced in the order in which they should be performed. In order to complete the checks in the most efficient and logical order, a flight profile (Figure 10-1) has been established for each checkflight condition and identified by the letter corresponding to the purpose for which the checkflight is being flown. The applicable letter identifying the profile prefixes each check, both in the following text and in the Functional Checkflight Checklist. Checkflight personnel shall familiarize themselves with these requirements prior to the flight.

Prior to a functional checkflight requiring maximum cruise power, speed checks, and/or stall checks, the aircraft shall be loaded with full oil, full main tanks, full auxiliary tanks, pilot, copilot, optional equipment, and ballast if required to remain within cg limits. The takeoff weight shall be 12,500 ±200 pounds with the cg between F.S. 184.7 and 187.0. All other checks shall be conducted within normal weight limits.

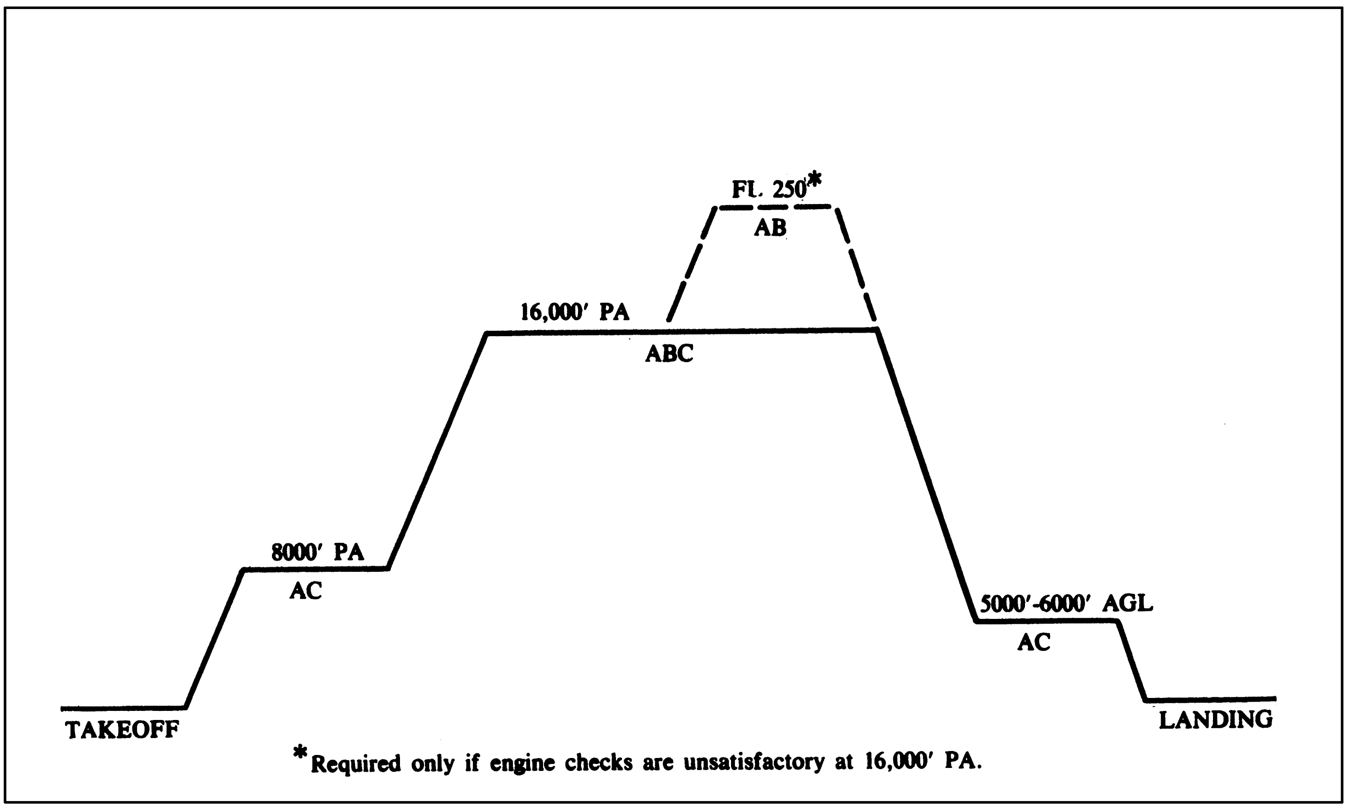


Figure 10-1. Functional Checkflight Profile

PROFILE

10.4 PREFLIGHT

The exterior and interior inspections shall be conducted with special attention directed to all areas where maintenance was performed. If a downing discrepancy is discovered during the preflight, the complete exterior and interior inspections should be completed and all discrepancies recorded on the checklist and Aircraft Maintenance Discrepancy Form.

A B C

1. Exterior Inspection.

   a. Considering the nature of the maintenance performed on the aircraft, appropriate access panel/cowling doors should be opened, and the areas that were worked on should be scrutinized closely for proper assembly, leaks, correct rigging, tools, rags, and other foreign objects.

   b. Check the powerplants for security, fuel, and oil leaks.

   c. Check the landing gear, wheels, tires, struts, brakes, and fire extinguisher bottles for condition and leaks.

   d. Check the wings, control surfaces, and tabs for general condition and verify that when the control tabs are neutral, the cockpit indications correspond.

   e. Check the pitot tubes, static ports, and antennas for general condition; also inspect for missing/worn fasteners, the security of access panels, popped/loose rivets, skin irregularities, and general aircraft condition.

A

2. Interior Inspection.

   a. Check cabin entrance door. Door must lock easily. When closed, lines on door cams should line up with notches on the adjacent door frame brackets and safety lock arm should be in position around the plunger. Check adjustment of door open annunciator light. Check operation of door lowering cylinder; door must lower slowly and smoothly. Check for correct illumination of the CABIN DOOR annunciator light.

   b. Check cargo door. When closed, visually check that both (upper aft and lower forward) door latching handles are secured by the latch locks and that the lines on the four rotary cam locks align with the notches on the adjacent door frame brackets. Check operation of the door raising cylinders; they must raise the door smoothly and slowly.

   c. Check escape hatch security and keylock/hatch operation.

   d. Passenger/cargo compartment check.

      (1) Check webbing installation and baggage compartment placard.

      (2) Check window guards in place (if installed).

      (3) Check toilet and passenger seats for secure installation.

      (4) Check seatbelt installation for security to each seat.

      (5) Check fire extinguisher stowed.

PROFILE

e. Cockpit check.

(1) Check fire extinguisher stowed.

(2) Normal and emergency checklists.

(3) NATOPS manual.

10.5 PRESTART

A B C

3. Flight Station Checks.

a. Check operation of switches, rheostats, cockpit and instrument lights. Check for missing hardware, decals, instruction plates, and frequency and compass cards. Note condition of windshield and all windows. Check rudder pedals, seats, and restraint harness adjustments. Check all circuit breakers.

b. Check propeller levers and condition levers for freedom of movement through full range of travel. Check power levers for freedom of movement and smoothness through idle to full power range only. Check all control lever friction locks.

CAUTION

Do not move power levers aft of idle when engines are not running.

c. Ensure instruments that are required to have limit decals are properly marked (i.e., ITT/TGT, torque, propeller tachometer [N_2], turbine tachometer [N_1], oil temperature, oil pressure, and airspeed).

d. Check parking brake operation.

e. Trim tabs check.

CAUTION

The elevator trim must not be forced past the limits that are marked in red on the elevator trim indicator scale either manually, electrically, or by action of the autopilot.

(1) Operate tabs through full travel range, noting excessive friction or binding.

(2) In the cockpit and at control surface, simultaneously check tab direction and neutral position.

f. Flight controls check.

(1) Disengage gust lock and check yoke movement for full aileron and elevator deflection. Visually confirm proper deflection and displacement.

(2) Check rudder pedals for freedom of movement and full travel. Visually confirm rudder surface movement with pedal movement.

PROFILE

(3) Confirm that when elevator control is pulled fully aft, there is no tendency for the control wheels to swing to either side.

(4) Check for any excess friction or obstructions through full range of travel.

g. Clocks check.

(1) Check pilot and copilot clock (respective control wheels) for normal operation.

h. Fuel panel check. The standby pumps, firewall shutoff valves, and crossfeed shall be checked by the following procedure to ensure they are powered (**B**/**M**) through the hot battery bus:

(1) Firewall shutoff valve circuit breakers — Pull.

(2) (**B**/**M**) Standby pump circuit breakers — Pull.

(3) Firewall shutoff valve switches — Close and listen for operation.

(4) (**M**) Fire pull handles — Pull.

Note

Fuel pressure lights may not illuminate if residual pressure is in the line. Allow sufficient time (up to 5 seconds) for valves to fully close before proceeding to the next step.

(5) Standby pumps — ON.

(6) Battery switch — ON (fuel pressure lights on).

(7) (**B**/**F**) Firewall shutoff valve switches — Open (fuel pressure lights out).

(8) (**M**) Fire pull handles — IN.

(9) Standby pumps — OFF (fuel pressure lights on).

(10) Circuit breakers — IN.

(11) Crossfeed — Check left and right (crossfeed light on, fuel pressure lights out).

(12) Crossfeed — OFF.

(13) No fuel transfer lights — (**B**/**F**) Press to test/(**M**) Check.

i. (**B**/**M**) Battery master switch and current limiter check.

(1) Turn battery switch ON.

(2) Turn one inverter ON; if INST INV light goes out, that limiter is good.

(3) Repeat with other inverter.

j. (**F**) Battery master switch and current limiter check.

(1) Turn battery switch ON.

(2) Press-to-test volt load button.

(3) Repeat for the other side.

PROFILE

k. Fuel quantity indications check.

(1) With full fuel load, main tank quantities must indicate within 82 pounds of each other and auxiliary tanks within 35 pounds of each other.

l. Landing gear/stall warning check.

(1) Lift up stall warning test switch, note aural warning, and visually check for movement of stall vane. Push down landing gear warning test switch and note warning horn and two lights in the landing gear handle.

m. Annunciator panels check.

(1) Push annunciator panel test switch and verify that all bulbs illuminate and correct lenses are installed. Check for illumination of MASTER WARNING and MASTER CAUTION lights.

n. (**B**/**F**) Fire detector and extinguisher checks.

(1) Rotate test switch and monitor indicator lights for three fire detection circuits (each nacelle) and both fire extinguisher pyrotechnic cartridges.

o. (**M**) Fire detectors and extinguisher — Tested (RS).

(1) Fire detectors —Hold TEST switches to DET position. Check that the FIRE PULL handle warning lights and MASTER WARNING annunciators illuminate.

(2) Fire extinguishers — Hold TEST switches to EXT position and verify illumination of SQUIB OK and No. 1 and No. 2 EXTINGH DISCH and MASTER CAUTION annunciators.

p. External power check.

(1) With the battery switch OFF, connect external power cart (300 amperes continuous, 1,000 amperes for 0.1 second if start is to be performed). EXT PWR annunciator light shall illuminate. Turn the battery ON to absorb voltage transients, then turn the external power cart ON.

10.6 START

A B

4. Starter Checks.

a. Starts shall be made using the aircraft battery or the aircraft battery in parallel with external power. (Start left engine on GPU and aircraft battery, right engine on battery only.)

b. Starter should operate normally. N_1 should stabilize at or above 12 percent (battery start). Note maximum stabilized N_1 on both engines.

Note

(**B**/**F**) No transfer lights/(**M**) NO FUEL XFR Advisory lights should extinguish within 30 to 50 seconds of engine start.

PROFILE

A B

5. Maximum Allowable ITT/TGT Check.

   a. Monitor ITT/TGT during all engine starts. ITT/TGT must peak. Observe 5-second time limit if peak is 1,000 °C (maximum). Below 1,000 °C, there is no time limit. Normal ITT/TGT peak is approximately 700 °C to 800 °C.

A B

6. Acceleration to Low Idle Check.

   a. Engine should accelerate to (**B**) 52 to 55 percent and (**F/M**) 56 to 58 percent.

Note

Observe starter limitations.

A B

7. Oil Pressure Check.

   a. Confirm 60 psi minimum each engine (low idle).

A B

8. Acceleration to High Idle Check.

   a. Engine should accelerate to 70 to 73 percent within approximately 4 seconds.

A B

9. Battery Charge Light Check.

   a. Monitor battery charge annunciator light after engine start. This light shall illuminate within 6 seconds after a generator is brought on the line. Light should extinguish within 5 minutes following a normal engine start on battery.

A B

10. Generator and Regulator Check.

   a. Turn both generators ON (one at a time). Both generators should come on the line. Check loadmeters for balancing of load. Observe each generator for the following positive charging rate:

      (1) Aircraft voltmeter — 27.5 to 29.0 volts (within 1.0 volt of each other).

      (2) Precision voltmeter — 28.0 to 28.5 volts (within 0.5 volt of each other).

      (3) Load — Shall not exceed 85 percent (10 percent maximum difference between generators).

A

11. Inverter Check.

   a. Each inverter shall be checked for operation, appropriate voltage (110 to 120 volts), and frequency (390 to 410 Hz).

10.7 PRETAXI

A B

12. Environmental Control and Air-Conditioning N_1 Speed Switch Check.

   a. Set CABIN TEMP MODE switch to MAN COOL with right engine operating at low idle. The AIR CND N_1 LOW light will illuminate on the lower annunciator panel. Advance condition lever to increase N_1 between 57 to 63 percent. The AIR CND N_1 LOW light will extinguish, and in approximately 8 to 12 seconds the compressor will turn on as evidenced by sustained increase in ITT/TGT on right engine and a load increase on the operating generator(s).

   b. Set controls as desired for operation.

PROFILE

A

13. Light Check.

a. Verify that light switches function by noting a loadmeter deflection as each is turned on. Utilizing only one generator during this check enhances the loadmeter deflection. Have a lineman verify all external lights are in working order.

A C

14. Electric Elevator Trim Check.

a. Operate trim with both pilot and copilot switches. Check for proper direction of trim movement and that pilot switches override copilot switches. Trim operation should occur only by movement of pairs of switches. Determine that quick disconnect switches on each control wheel deactivate system and that the ELEC TRIM OFF annunciator illuminates properly. Check trim reset with pedestal switch.

A B C

15. Anti-Ice/Deice Checks.

a. Windshield anti-ice check. On hot days (over 24°C/75 °F), this check shall be performed in flight.

(1) Pilot windshield anti-ice control switch to HI. Monitor load increase. Pilot windshield anti-ice control switch to NORMAL. Monitor load for slight decrease from above reading. Turn switch OFF.

(2) Copilot windshield anti-ice control switch to HI. Monitor load increase. Copilot windshield anti-ice control switch to NORMAL. Monitor load for slight decrease from above reading. Turn switch OFF.

b. Electrothermal propeller deice check.

(1) Automatic. Place the AUTO propeller deice switch in the AUTO position and check for a reading of:

(**B**) 14 to 18 amperes on the propeller deice ammeter. Watch the propeller ammeter for 2 minutes. A small momentary needle deflection approximately every 30 seconds shows that the timer is functioning normally.

(**F/M**) 18 to 24 amperes on the propeller deice ammeter. Watch the propeller ammeter for 3 minutes. A small momentary needle deflection approximately every 90 seconds shows that the timer is functioning normally.

(2) Manual. Repeat procedure using the manual propeller deice system. Hold the switch in the INNER and OUTER positions and check for approximately a 5 percent increase on each loadmeter indication.

c. Pitot and stall vane heat check.

(1) Individually select switches to ON position. Monitor electrical load increases. Utilizing only one generator during this check enhances loadmeter deflection.

d. Fuel vent heat check.

(1) Individually select switches to ON position. Monitor electrical load increases. Utilizing only one generator during this check enhances loadmeter deflection.

PROFILE

e. Surface deice system check. Check pneumatic pressure gauge during the following operations. Readings should be within the green arc and preferably toward the higher end with the engines in high idle. Ensure lineman is aware of check in order to monitor elevator boot inflation because of difficulty seeing this from the cockpit.

(1) Select switch to SINGLE CYCLE position. Boots will inflate and automatically deflate for one cycle. Cycle time should be from 6 to 9 seconds for leading edge boots and 4 to 6 seconds for elevator boots. The timer actuates the leading edge boots first and then the elevator boots.

(2) Switch to MANUAL position. All boots (leading edge and elevator) will stay inflated as long as switch is held in the MANUAL position.

f. Fuel control heat check.

(1) Pull both left and right fuel control heat circuit breakers.

(2) Monitor loadmeter for increase while setting circuit breakers one at a time. Utilizing only one generator during this check enhances loadmeter deflection.

g. (**F/M**) Brake deice check — Check at 1,800 rpm.

(1) Turn BRAKE DEICE switch ON. Observe a rise in ITT/TGT, decrease in torque, fluctuation in bleed air pressure, and the illumination of the BRAKE DEICE advisory light.

(2) Turn BRAKE DEICE switch OFF. Observe a drop in ITT/TGT, increase in torque, fluctuation in bleed air pressure, and the BRAKE DEICE annunciator light goes out.

A C 16. Wing Flaps Check

a. Operate flaps through a full cycle and check for proper operation. Movement should be free. Compare actual position of flaps with flap position instrument panel indicator.

A C 17. (**B**) Autopilot/flight director — Checked (BOTH).

a. Elevator trim indicator — Check. Observe that autopilot trim indicator on autopilot controller shows an average signal of zero with only short period deviations from zero. A steady full scale deflection on the elevator trim indicator denotes automatic synchronization is not functioning and the autopilot should not be engaged.

b. Turn knob — In center detent position.

c. Autopilot — Test.

(1) Control wheel to midtravel — Depress AP ENGAGE switch.

(2) Control movement — Check that the system can be overpowered by slowly moving controls through all three axes.

PROFILE

CAUTION

- The elevator trim system must not be forced beyond the limits that are marked in red on the elevator trim tab indicator either manually, electrically, or by action of the autopilot.
- If autopilot disengages, do not use.
- Overpowering the rudders to the point of audible ratcheting may cause damage to the equipment.

(3) Elevator trim follow-up — Check. Hold control wheel forward of midtravel. Trim wheel will run noseup after 3 to 5 seconds. Hold control wheel aft of midtravel. Trim wheel will run nosedown after 3 to 5 seconds.

(4) Pilot AP/YD TRIM DISC switch — Depress through second level. Autopilot will disengage and ELECT TRIM OFF annunciator will illuminate.

(5) Autopilot — Reengage with control wheel at midtravel. Hold control wheel forward of midtravel. Trim wheel will not operate and AP TRIM FAIL annunciator will illuminate after 3 to 5 seconds. Hold control wheel aft of midtravel. Trim wheel will not operate and AP TRIM FAIL annunciator will illuminate after 3 to 5 seconds.

(6) Autopilot TEST button — Depress. Autopilot will disengage and AP DISC and MASTER WARNING annunciators will illuminate.

CAUTION

If autopilot does not disengage when the TEST button is depressed, it indicates autopilot torque monitors are not functioning properly. DO NOT USE AUTOPILOT IN FLIGHT UNTIL CORRECTIVE ACTION HAS BEEN TAKEN.

(7) Press AP ENGAGE switch.

(8) Copilot TRIM DISC switch — Depress. Autopilot will disengage; master warnings and AP DISC annunciators will illuminate.

(9) Control wheel may remain forward — Depress AP ENGAGE switch.

(10) Press ALT with AP engaged. The horizontal flight director bars come into view and PITCH COUPLE light illuminates.

(11) Press SBY. All lights should illuminate and flight director bars should be biased out of view.

(12) Press HDG with the AP engaged. Both the vertical and horizontal command bars will come into view on the FD indicator, and the ROLL COUPLE and PITCH COUPLE lights will illuminate on the engage controller. Rotate the heading bug on the HSI. The vertical FD bar and control wheel should respond to these inputs.

PROFILE

(13) Press GO AROUND. Check that autopilot and yaw damp disengage and flight director commands approximately 7° noseup wings-level attitude.

(14) Clear all warning and go around indications. AP/YD DISC annunciator will extinguish by depressing the pilot control wheel AP/YD DISC button and the MASTER WARNING annunciator by depressing its face.

(15) Electric ELEV TRIM switch — OFF, then ON (resets electric trim and ELECT TRIM OFF annunciator will extinguish).

18. (**F**/**M**) Altitude alert — Checked.

Note

Pause 8 to 10 seconds between each step to allow time for the proper indications.

a Set alert controller more than 1,000 feet above altitude indicated on pilot altimeter. The pilot altimeter alert light should extinguish.

(1) Decrease the alert controller to within 1,000 feet of the pilot altimeter setting. The alert light and the aural tone should activate.

(2) Decrease the controller to within 300 ±50 feet of the pilot altimeter indication. The alert light should extinguish.

(3) Increase the controller to 300 ±50 feet above pilot altimeter indication and check that the alert light illuminates and the aural alert sounds.

(4) Set the desired altitude.

19. Autopilot/Flight Director — Check.

a Autopilot controller TRIM UP, TRIM DN annunciators — CHECK not illuminated.

CAUTION

A steady illumination of TRIM UP or TRIM DN annunciator indicates the automatic synchronization is not functioning and the autopilot should not be engaged.

(1) Turn knob — Center.

(2) Elevator trim control switch — ON.

(3) Control wheel — Hold to midtravel.

(4) AP button — PRESS. AP ENGAGE and YD ENGAGE annunciators on autopilot controller will flash. Servo clutches will engage. FD flag on ADI in view.

b. Control movement — Check.

(1) Rudder pedals — Overpower slowly. YD ENGAGE annunciator stops flashing.

(2) Control wheel — Overpower slowly in both pitch and roll axis. AP ENGAGE annunciator stops flashing. FD flag retracts.

PROFILE

WARNING

If autopilot or yaw damper disengages during overpower test, DO NOT USE. If AP ENGAGE or YD ENGAGE annunciator continues to flash, DO NOT USE.

CAUTION

The elevator trim system must not be forced beyond the limits that are marked in red on the elevator trim indicator scale either manually, electrically, or by action of the autopilot.

c. Elevator trim follow-up — Check.

(1) Control wheel — Hold aft of midtravel. Trim wheel should run nosedown after approximately 3 seconds. TRIM DN annunciator should illuminate after approximately 8 seconds.

(2) Control wheel — Hold forward of midtravel. Trim wheel should run noseup after approximately 3 seconds, TRIM UP annunciator should illuminate after approximately 8 seconds, and AP TRIM FAIL annunciator and MASTER WARNING annunciator should illuminate after approximately 15 seconds.

d. AP/YD & TRIM DISC button — Depress through second level. Autopilot and yaw damper should disengage and ELEC TRIM OFF annunciator should illuminate. AP ENG and YD ENG annunciators on instrument panel should flash 5 times and autopilot off aural alert should sound for 1 second.

Note

Autopilot preflight check is disabled during in-flight operations.

e. Elevator trim control switch — OFF, then ON (ELEC TRIM OFF annunciator should extinguish).

f. AP reengage and overpower another time.

g. Turn controller — Check that control wheel follows in each direction.

h. Pitch wheel — Check that trim responds to pitch wheel movement (TRIM UP and TRIM DN annunciators may illuminate).

i. Heading bug — Center and engage HDG. Check that controls follow a turn in each direction.

j. AP disengage by selecting GA. Check that AP disengages FD commands approximately 7° nose up, wings-level altitude.

PROFILE

k. AP/FD transfer switch — Select AP/FD2. Engage copilot AP and actuate AP/YD and trim disconnect switches located on the copilot control wheel. Repeat steps i. and j.

l. Select desired AP/FD.

A 20. Altimeter and Clock Checks.

a. Check both to a tolerance of within 75 feet of field elevation and within 40 feet of each other. Check radio altimeter and ensure DH light operates. Check both clocks for proper operation.

21. (**B**/**M**) Flight Data Recorder (FDR) — Check FAULT annunciator extinguished.

22. (**B**/**M**) Cockpit Voice Recorder (CVR) — Check TEST and ERASE buttons.

23. (**B**/**M**) Enhanced Ground Proximity Warning System (EGPWS) — Self-test — Check.

24. (**B**/**M**) TCAS — Check.

10.8 TAXI

A C 25. Steering Check.

a. No turning tendency shall exist while taxing straight ahead with no braking and no rudder applied to either side. This check shall be made with minimum crosswind. Check freedom of movement and ability to turn with rudder pedals and brakes. Note any excess vibration or shimmy during takeoff or landing.

A 26. Brakes Check.

a. New brakes shall be “burned in” by applying near maximum braking (short of locking) for one or two landings or high-speed taxi runs.

b. Brakes should be checked from both pilot and copilot sides for proper operation and no tendency to drag.

A 27. Flight Instruments Check.

a. Check all gyros, turn needles, balance balls, and pitot static instruments for proper indications during taxi.

10.9 RUNUP

A 28. Parking Brake Check.

a. After two or more landings where maximum braking has been applied, confirm that the parking brake:

(1) Locks without undue tension on the control.

(2) Holds aircraft still with power levers at 2,000 rpm.

(3) Unlocks when control is pushed in.

PROFILE

A B

29. Engine Instruments Check.

a. Ensure all instruments are within limits and indicating proper operation of the engine.

A B

30. Propeller Overspeed Governor and Rudder Boost Check.

a. RUDDER BOOST control switch — ON.

b. Propeller levers — Full forward.

c. Condition levers — LOW IDLE.

Note

Remaining steps of this check are performed on engines individually.

d. PROP GOV TEST switch — Hold to TEST.

e. Power lever — Increase until propeller is stabilized at 1,830 to 1,910 rpm. Continue to increase until rudder movement is noted. Observe ITT/TGT and torque limits. The rudder boost should actuate within the following values of engine N_1 speed and OAT:

(B)

OAT	**Engine Speed % N_1**	
	Minimum	**Maximum**
More than 35 °C	92	95
10 °C to 35 °C	89	94
Less than 10 °C	86	91

(F/M)

OAT	**Engine Speed % N_1**	
	Minimum	**Maximum**
More than 35 °C	93	96
10 °C to 35 °C	90	95
Less than 10 °C	87	92

f. Select RUDDER BOOST switch OFF (system deactivated), then on.

g. Power lever — Approximately (**B**) 1,200 foot-pounds (**F**) 2,000 foot-pounds (**M**) 90 percent torque.

h. Release PROP GOV TEST switch and observe rpm increase.

PROFILE

i. Power lever — IDLE.

j. Repeat steps d. to i. on the opposite engine.

A B

31. Low Pitch Torque Check.

a. Park crosswind or perpendicular to prevailing wind. Obtain correct OAT and read corrected torque at 1,800 rpm from Figures **(B/F)** 10-2/**(M)** 10-3. Place the propeller controls to high rpm and increase power to obtain 1,800 rpm. Record torque and compare value obtained from the graph. The torque for each engine must be within **(B/F)** ±40 foot- pounds/**(M)** ±2 percent of graph value. The difference between the left and right engine torque shall not be greater than **(B/F)** ±20 foot- pounds/**(M)** ±1 percent.

A B

32. Primary Governor Check.

a. With power levers set at 1,800 rpm, bring propeller controls back to detent. Rpm should decrease together to 1,600 to 1,640 rpm. Reset propeller levers to full forward.

A B

33. Ice Vane Check.

a. With the power levers set at 1,800 rpm, electrically extend the ice vanes one at a time; check for torque drop of **(B/F)** 20 to 40 foot-pounds/**(M)** 1 to 2 percent and visually check for bypass door extension and ICE VANE EXT annunciator lights within 15 seconds. Retract and check that torque returns to original value and for retraction of the bypass doors. Monitor ICE VANE annunciator lights during check.

A B

34. Pressurization Test.

a. At 70 percent N_1, turn both bleed air valves to **(B/F)** INST & ENVIR OFF/**(M)** ENVIR & PNEU and note pneumatic pressure and gyro suction gauges go to zero and BL AIR FAIL warning lights illuminate. Opening either valve will extinguish the lights. Set pressurization controller to 500 feet below field elevation and rate knob to maximum. Actuate CABIN PRESS switch to TEST and OPEN left bleed valve. Note an indication of pressurization within 30 to 45 seconds and pneumatic pressure and gyro suction gauges are in the green arc. Turn OFF the left bleed air valve and check cabin pressurization returns to field elevation, and pneumatic pressure/gyro suction gauges return to zero. Repeat the above sequence for the right bleed air valve. OPEN both bleed air valves, set controller to 500 feet above field elevation, and set cabin pressure switch to PRESS position.

Note

If the airfield elevation is near sea level and the current pressure altitude is 30.42 or greater, an accurate pressurization check may not be possible.

A B

35. Autoignition and Purge Valve Check.

a. Autoignition — Arm both autoignition switches and check for ignition lights. Ignition lights shall come on if engine torque falls below **(B/F)** 410 ±50 foot- pounds/**(M)** 18 ±2 percent. This check may be done simultaneously with the autofeather check.

b. Purge valve — Each purge valve of the engine will open and return fuel to the nacelle tank if the ignition is on or the starter is engaged. Note fuel flow increases by approximately 20 pounds per hour (pph) on each engine when ignition lights come on.

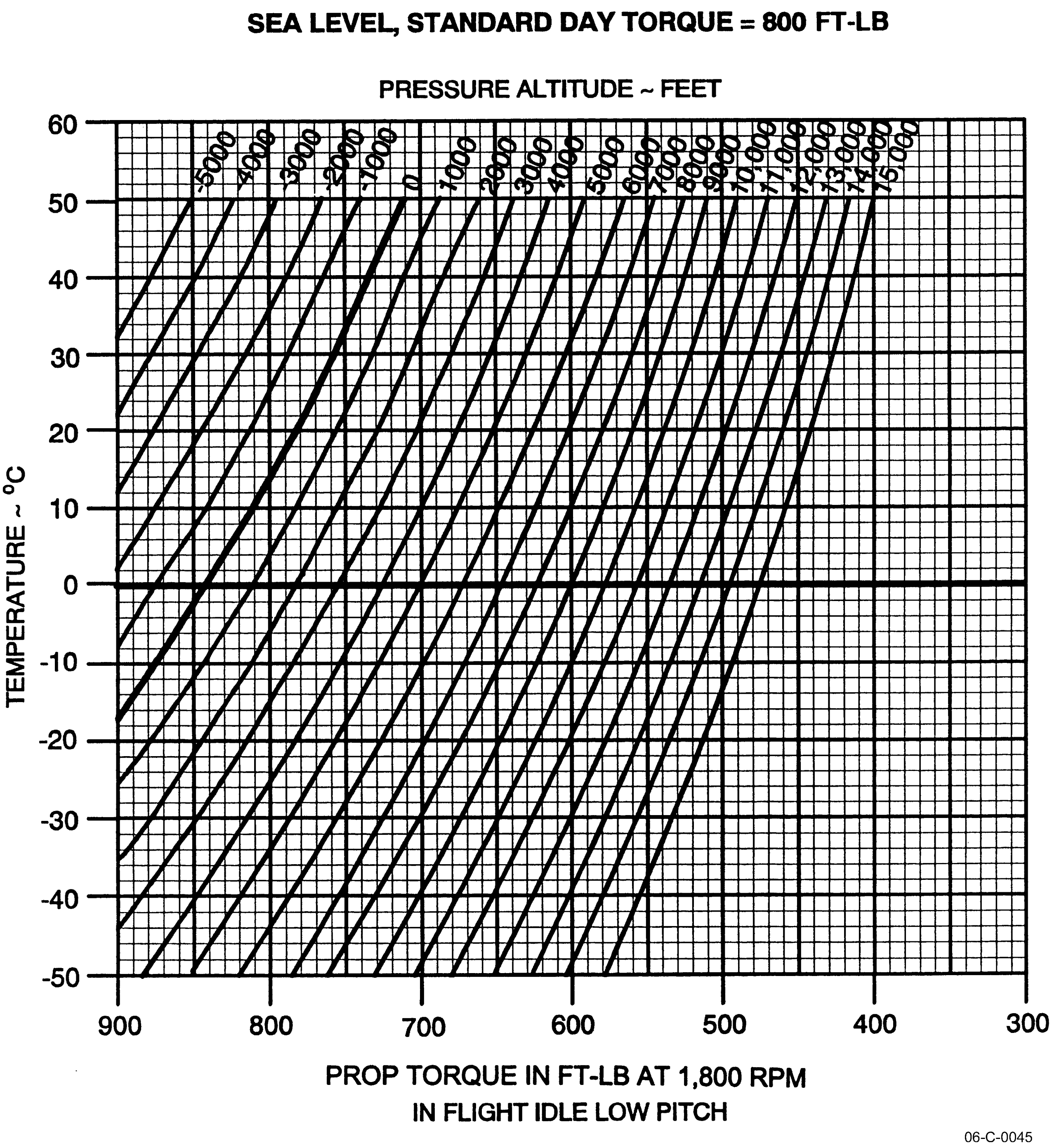
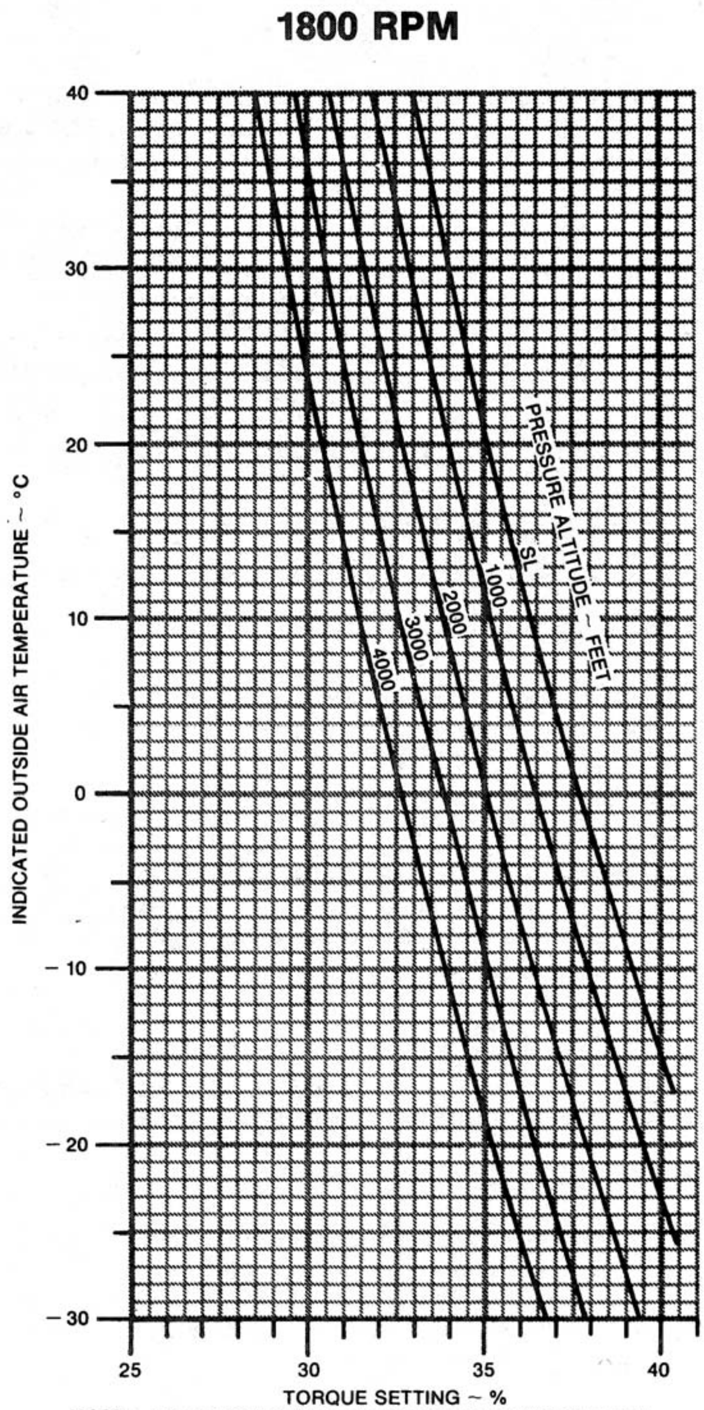


Figure 10-2. (**B**/**F**) Low Pitch Torque Check



NOTE: FOR MCCAULEY PROPELLERS SUBTRACT 2.2 PERCENTAGE POINTS FROM TARGET TORQUE (EXAMPLE: 35.6% − 2.2% = 33.4%).

UC-12M-F042

Figure 10-3. (**M**) Flight Idle Low Pitch Stop

PROFILE

A B

36. Autofeather Check.

a. Check condition levers in LOW IDLE. Set both engines to approximately (**B/F**) 500 foot-pounds/(**M**) 25 percent torque. Move the AUTOFEATHER switch to the TEST position. Both AUTOFEATHER lights should come on.

b. Slowly retard the left power lever to IDLE with the switch in the TEST mode. At (**B/F**) 410 ±50 foot-pounds/(**M**) 18 ±2 percent, the right AUTOFEATHER light should extinguish. At (**B/F**) 260 ±50 foot-pounds/(**M**) 11 ±2 percent, the left AUTOFEATHER light should flash on and off and the left propeller should start into feather. Allow rpm to decay below 800 and reset left engine to (**B/F**) 500 foot-pounds/(**M**) 25 percent torque.

c. Repeat above procedure by retarding right power lever with left engine at approximately (**B/F**) 500 foot-pounds/(**M**) 25 percent torque.

d. Reset right engine to (**B/F**) 500 foot-pounds/(**M**) 25 percent torque, then retard both power levers to IDLE. Both AUTOFEATHER lights should go out and neither propeller should attempt to feather, indicating the system is dearmed.

e. Individually advance each power lever above 85 to 90 percent N_1 with the AUTOFEATHER switch in the armed and the other power lever at IDLE. The AUTOFEATHER lights should not illuminate. Advance both power levers above 85 to 90 percent N_1 simultaneously; both AUTOFEATHER lights should illuminate. Moving the left power lever below 85 percent N_1, both AUTOFEATHER lights should extinguish. Returning the left power lever to above 85 to 90 percent N_1 and retarding the right power lever below 85 percent N_1 should cause both AUTOFEATHER lights to extinguish. Retard both power levers to IDLE.

A B

37. Propeller Manual Feathering Check.

a. With the power levers at IDLE position and the condition levers at low idle, bring the propeller levers into the FEATHER detent. Both propellers should immediately start to feather. Engine N_1 should not drop more the 1 percent. Check for proper pedestal control detent.

10.10 TAKEOFF

A B

38. Takeoff Check.

a. During takeoff, the propeller tachometers should indicate 2,000 rpm and the propellers should be in sync (propeller sync off). If propellers are in sync (confirmed audibly and on the sync wheel) and indicator tolerances result in a difference in indicated rpm between left and right, the lower of the two values shall be considered 2,000 rpm. The maximum indicator difference is 20 rpm.

b. Check all other engine instruments for proper indication.

c. Landing gear should retract normally. (**B**) Nosegear drive chain should not rattle in its tracks.

10.11 CLIMB

A B

39. Engine Instruments Check.

a. All instruments shall give proper indication with minimum fluctuation. Maximum allowable oil pressure fluctuation is ±10 psi in the normal operating range of 105 to 135 psi (green arc).

PROFILE

A

40. Vertical Speed Check.

a. Check normal operation of both pilot and copilot IVSIs against the sensitive altimeter (tolerance ±200 feet at indicated 1,000 fpm).

A B

41. Pressurization Check.

a. After takeoff, ensure both bleed air valves are OPEN. Set the pressurization controller to sea level and place the cabin pressurization switch to PRESS. The cabin altitude should climb or descend as necessary and stabilize at sea level, and the differential pressure should increase. The cabin altitude should remain at the selected altitude until the maximum differential pressure of (**B**) 6.0 ±0.1 psi and (**F/M**) 6.5 ±0.1 psi is reached. At this point, the cabin altitude should start to increase with the maximum differential pressure being maintained.

A B

42. Propeller Synchrophaser Check.

a. (**B**) Synchronize propellers manually at a midrange rpm (1,700 to 1,900) and turn propeller synchrophaser switch ON. Decrease left propeller rpm in small increments. Both propellers should decrease together until the actuator reaches the end of its travel (approximately 30 rpm), then the right propeller should stabilize its rpm while the left continues to decrease. Repeat process to check the increase range of synchronization.

b. (**B**) With the synchrophaser ON and propellers in sync, adjust the left propeller control to a point close to the end of actuator travel but still in sync. Turn the synchrophaser OFF and an unsynchronized condition should result as the actuator moves to its midposition. Turn the synchrophaser switch ON again and synchronization should be regained.

c. (**F/M**) Establish a small out-of-sync (less than 20 rpm) condition. Turn the propeller synchrophaser on. Synchronization and synchrophasing should be established and held in a few seconds.

A

43. Airspeed and Altimeter Indicating System Check (Alternate System).

a. Establish an airspeed in level flight between 130 and 150 KIAS with the Pilot's Static Air Source switch in the NORMAL position. Place the switch in the ALTERNATE position. Airspeed and altimeter should increase (refer to A1-C12BM-NFM-200 Performance Charts). Reselect NORMAL position. Altimeter and airspeed indicators should return to original values.

A B

44. Generators Check.

a. Check both generators ON and the load balanced between them by observing loadmeters.

b. Observe each generator for the following:

(1) Positive load indication. Voltage — 27.5 to 29.0 volts.

(2) Load — Shall not exceed 100 percent (10 percent maximum difference between generators).

c. Balance — Check for proper balanced operation. Generator outputs must indicate within 10 percent of each other.

PROFILE

d. Check all electrical systems for proper operation.

e. If the voltage on both generators exceeds 30 volts, turn off both generators and all electrical equipment to conserve battery power for lowering gear and flaps. When approaching the landing field, minimum radio equipment may be turned on in order to make contact with the tower for traffic instructions and to lower the landing gear and flaps.

A 45. Outside Air Temperature Gauge Check.

a. Check for normal operation and readings.

10.12 LEVEL 8,000-FOOT PRESSURE ALTITUDE (5,000 FEET AGL MINIMUM)

Note

Check normal operation of landing gear and flap systems (if maintenance has been performed) prior to stalls to preclude malfunctions during stall recovery.

A 46. Altimeters Check.

a. Verify altimeters are within 120 feet of each other. Set 29.92 in copilot altimeter to obtain pressure altitude.

A C 47. Stalls and Stall Warning Check.

a. Conduct stalls, power idle, and power on in the following configuration with the aircraft trimmed to appropriate speed:

(1) Landing gear and flaps fully retracted.

(2) Landing gear and flaps fully extended.

b. Power-on stalls will be made with a power setting of 2,000 rpm and (**B**/**F**) 1,675 foot-pounds/(**M**) 75 percent torque. Approaches to stall shall be made by reducing the airspeed at a rate as close as possible to 1 knot per second or less. In all stalls, the roll and yaw shall be controllable up to the time the aircraft buffets, and the stall warning horn will come on at no more than 12 and no less than 4 knots above the initial stall buffet. The stall speed shall not exceed the appropriate value listed below, and roll will be controllable within 15° of wings level during recovery from the stall. In all cases, recovery will be straight ahead and initiated by relaxing back pressure to a nosedown attitude. The appropriate buffet speeds, based on 11,300 pounds, are:

Configuration	Power	Trim Speed	Initial Buffet Speed
Gear & Flaps Up	Idle	145 KIAS	90 to 98 KIAS
Gear & Flaps Up	On	145 KIAS	
Gear & Flaps Down	Idle	114 KIAS	65 to 73 KIAS
Gear & Flaps Down	On	114 KIAS	

Note

The stall warning horn should activate 4 to 12 KIAS above initial buffet.

PROFILE

A C

48. Minimum Trim Check.

a. Condition levers — LOW IDLE.

b. Power levers — IDLE.

c. Propeller levers — Full forward.

d. Landing gear — DOWN.

e. Flaps — Full DOWN.

f. Trim aircraft full nose up. Glide airspeed shall be 82 to 92 KIAS.

g. Annotate airspeed and elevator trim units.

Note

Glide airspeed outside the specified range requires maintenance action.

10.13 LEVEL 16,000-FOOT PRESSURE ALTITUDE

A

49. Altimeters Check.

a. Verify that altimeters are within 220 feet of each other. Set 29.92 in copilot altimeter to obtain pressure altitude.

A B

50. Airspeed Check.

a. Compare pilot and copilot airspeed indicators at 20-knot increments from 80 to 220 KIAS. The maximum allowable difference is 4 KIAS.

A B

51. Engine Acceptance and Speed Check.

CAUTION

- Do not exceed maximum N_1, ITT, or torque when operating near performance limits. The power lever stop is not intended to act as a mechanical stop to prevent overspeed, overtemp, or overtorque.
- If the maximum N_1 transient limit of 102.6 percent is exceeded, the engine must be replaced.

a. Maximum Cruise Power. Set charted maximum cruise power torque (A1-C12BM-NFM-200 Performance Charts). Compare actual torque attained with predicted torque without exceeding (**B**) PT6A-41 engine ITT acceptance limit (Figure 10-4) (**F/M**) 800 °C ITT/TGT. Compare actual True Airspeed (TAS) attained with predicted TAS (A1-C12BM-NFM-200, Performance Charts, Chapter 5 and/or the FMS can be used in determining actual TAS). After 1 minute of stabilized flight in smooth air, record all values on first column of engine acceptance checklist (Figure 10-5). The check is successful if the engines are able to operate at maximum cruise power torque without exceeding (**B**) PT6A-41 engine ITT acceptance limit (Figure 10-4) (**F/M**) 800 °C ITT/TGT. Conduct the check at FL 250 using steps 52 and 53 if the check is unsuccessful.

PROFILE

Note

Performance checks shall be accomplished with ice vanes retracted.

b. Maximum power check. With propeller speed set at 2,000 rpm, engines shall be able to operate within one of the following N_1 or ITT/TGT values (without exceeding limits). It is only necessary to reach one of the below limits, not both. If the torque limit (2,230 foot-pounds/100 percent) is reached prior to reaching either of the below values, conduct the check at FL 250.

(1) N_1 — 101.2 to 101.5 percent.

(2) ITT/TGT — (**B**) 745 °C to 750 °C, (**F/M**) 780 °C to 800 °C.

Note

The intent of this check is to ensure the engine is not being mechanically restricted by an out-of-rig condition. The engine should be capable of operating at either the maximum N_1 or ITT/TGT limit.

10.14 LEVEL FL 250 (IF REQUIRED)

Note

The checks in 52 and 53 are required only if the checks in 51 a. and 3 b. at 16,000 feet were unacceptable.

A 52. Altimeter Check.

a. Verify that altimeters are within 310 feet of each other. Set 29.92 in copilot altimeter to obtain pressure altitude. The pilot and copilot altimeters should read a maximum difference of 310 feet when set to identical pressure settings.

A B 53. Engine Acceptance Check at Maximum Cruise Power.

a. Engine performance shall be determined by comparing engine torque available with that computed refer to A1-C12BM-NFM-200 Performance Charts. This graph shows the minimum power to be achieved at maximum cruise power rating at an indicated airspeed of 175 KIAS at 25,000 feet. The graph establishes the torque setting for maximum cruise power rating at (**B**) 1,900 rpm and (**F/M**) 1,800 rpm. In addition, the following parameters must be observed:

(1) Ice vanes retracted.

(2) Bleed air valves open.

(3) Electrical load 50 percent or less per engine.

b. After 1 minute of stabilized flight in smooth air, record all values on second column of engine acceptance checklist (Figure 10-5). The check is successful if the engines are able to operate at charted maximum cruise power torque without exceeding (**B**) PT6A-41 engine ITT/TGT acceptance limit (Figure 10-4) (**F/M**) 800 °C ITT/TGT at FL 250.

PROFILE

10.15 LEVEL 16,000-FOOT PRESSURE ALTITUDE

A B 54. Cruise Engine Rigging Check.

a. Establish NATOPS normal cruise engine power. After speed has stabilized, check engine control levers and instruments for proper alignment and match (left to right).

A B 55. Fuel Systems Check.

a. Determine that auxiliary fuel transfer is operating correctly by monitoring auxiliary fuel level.

b. Select OVERRIDE and check that fuel continues to transfer from the auxiliary tanks after 10 minutes. Reselect AUTO.

A B 56. Vacuum System Check.

a. Vacuum pressure should be 2.8 to 5.9 inches Hg. At low altitudes, the reading should be at the upper end of the green arc.

A C 57. Trim Tabs Check.

a. In smooth air, determine the lateral and directional trim at cruise power.

b. The aircraft will fly or be rigged to fly straight and level at these settings.

c. Ailerons will be trimmed in level flight evenly aligned with the flaps at the trailing edge.

A B 58. Autoignition Check.

a. Arm autoignition system. Slowly retard each power lever. Ignition lights should illuminate at (**B**/**F**) 410 ±50 foot- pounds/(**M**)18 ± 2 percent torque. If the system appears normal, establish cruise power and a minimum of 180 KIAS. Rapidly retard the left condition lever to FUEL CUTOFF for 3 seconds and return to LOW IDLE. Engine relight should occur within 3 to 5 seconds. Monitor engine acceleration and ITT/TGT rise. If relight does not occur within the prescribed time or acceleration and ITT/TGT indications do not appear normal, immediately abort the start. Restart the engine using normal procedures.

b. Complete step a. on the right engine.

A B 59. Propeller Feather/Unfeather Check (Manual).

a. At 120 KIAS, check feathering on each propeller as follows: With the appropriate engine indicating 2,000 rpm, move the power lever to IDLE and place the condition lever to FUEL CUTOFF. Pull the propeller lever to the FEATHER position. The propeller rotation should stop completely in less than 10 seconds.

b. Restart the engine with the propeller in feathered position using the starter-assisted airstart checklist. With the gas generator running in LOW IDLE on the condition lever and IDLE on the power lever, move the propeller lever out of the FEATHER detent. The propeller should unfeather smoothly and reach 1,000 rpm in 30 seconds or less.

c. After restart, repeat steps a. and b. on the other engine.

PROFILE

A B

60. Propeller Autofeather Check.

a. Check autofeather ARMED. At 104 KIAS with takeoff power set (2,000 rpm, maximum torque) place a condition lever to FUEL CUTOFF. Time from fuel cutoff to visual feather is approximately 10 seconds. Visual feather is when the blades are individually visible with the propeller still rotating. Check time in Figure 10-6.

b. Restart engine using starter-assisted airstart checklist.

c. Repeat steps a. and b. on other engine.

d. Autofeather — OFF.

A B

61. Engine Anti-Ice Systems Check.

a. Actuate engine ice vane switches to the extended position and monitor engine torque. There should be a (**B/F**) 150 to 350 foot-pounds/(**M**) 7 to 15 percent torque loss with the vanes extended. Both green ICE VANE EXT annunciator lights should illuminate. Retract the ice vanes and note annunciator lights extinguish and torque increases.

b. Pull both ice vane control circuit breakers on the copilot right side panel. Slow to 160 KIAS and place the ice vane switches to extended position. The yellow ICE VANE caution annunciator lights should illuminate within 15 to 20 seconds after the switches are actuated. Manually extend the vanes and note yellow caution lights extinguish and green ICE VANE EXT lights illuminate. Pull force should not be excessive. Increase airspeed to 200 KIAS to ensure the ice vanes do not retract due to aerodynamic blowback. Reposition ice vane switches to retract position. The ICE VANE yellow caution lights should again illuminate within 15 to 20 seconds. Retract the ice vanes manually and annunciator lights should extinguish.

CAUTION

Do not reset the ice vane control circuit breakers in flight. The ice vane actuators must be reset on the ground before electrical actuation is attempted or damage will occur to the actuators. If ice vanes are required during the remainder of the functional checkflight, they must be extended and retracted manually.

A

62. Cabin Noise Level Check.

a. There will be no undue air noise in the cabin from around the perimeter of the doors, nor between the window frames and the door frame. There will be no undue noise in the cabin due to vibrating and rattling articles. The copilot or aircrewman can do this check to coincide with cabin ventilation and temperature control checks.

PROFILE

A 63. Cabin Ventilation Check.

a. There shall be unrestricted airflow through all of the following:

(1) Eyeball cool air vents in the flight station and passenger compartment.

(2) Pilot and copilot vents.

(3) Windshield defroster ducts.

(4) Main cabin air ducts (floor vents).

b. Check all of the controls to the above items for any binding. Ensure air can be shut off with these controls.

A 64. MAN TEMP Control Check.

a. Place CABIN TEMP MODE control in MANUAL HEAT or COOL position.

b. Hold manual temperature switch in INCR position for 1 minute. Note an increase in cabin temperature.

c. Hold MANUAL TEMP switch in DECR position for 1 minute. Note a decrease in temperature.

A 65. Automatic Temperature Control Check.

a. Place CABIN TEMP MODE control in AUTO position.

b. Rotate CABIN TEMP control full clockwise. Note an increase in cabin temperature.

c. Rotate CABIN TEMP control full counterclockwise. Note a decrease in cabin temperature. Air-conditioning should come on if cabin temperature is above 60 to 65 °F and the OAT is above 50 °F (10 °C).

Note

The temperature control rheostat should be in midposition at approximately 75 °F cabin temperature.

A B 66. Pressurization Check.

a. After takeoff, the cabin altitude needle should stabilize at sea level and the differential pressure needle should continue climbing. The cabin altitude needle should remain at sea level until maximum differential of (**B**) 6.0 ±0.1 psi and (**F/M**) 6.5 ±0.1 psi is reached. At this point (approximately (**B**) 13,900, (**F/M**) 15,400 foot pressure altitude), cabin altitude should increase and the differential pressure should remain constant.

b. Set N_1 above 90 percent. Close the left bleed air valve (select (**B/F**) ENVIR OFF/(**M**) PNEU ONLY). Cabin pressurization should remain steady. Slowly reduce power on the operating flow control package toward 85 percent N_1. At an N_1 less than 85 percent, the operating flow control package should discontinue holding maximum differential (indicated by a stabilized increase in the cabin rate of climb and cabin altitude). This procedure requires a slow power reduction for accurate indications.

PROFILE

c. Repeat for the left engine by opening the left bleed air valve and closing the right bleed air valve.

d. Starting at maximum cabin differential pressure, close both bleed air control valves (select (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY). When the cabin differential pressure reaches approximately 5.7 psi, note the cabin rate of climb. It should not exceed 2,500 fpm (maximum leak rate).

e. Open both bleed air valves, set the cabin pressurization rate knob to maximum, and the cabin control to 10,000-foot pressure altitude. The cabin ascent should be between 2,000 and 3,000 fpm. Reset cabin pressurization rate knob to midrange, and the cabin ascent range should be 350 to 650 fpm. Reset the cabin pressurization rate knob to minimum, and the cabin ascent rate should be between 50 and 300 fpm.

f. Reset the cabin altitude control to sea level. The cabin descent rate should be between 50 and 300 fpm. Reset cabin pressurization rate knob to maximum, and the cabin descent rate should be between 2,000 and 3,000 fpm. Reset cabin pressurization rate knob to midposition, and the cabin descent rate should be 350 to 650 fpm.

g. Set cabin altitude control to 10,000 feet and cabin pressurization rate control to a comfortable rate of ascent. Cabin altitude should reach a 9,750- to 10,250-foot pressure altitude.

10.16 DESCENT

A C

67. Dive to V_{MO} Check.

a. If the pilot is satisfied that the entire aircraft is functioning properly, a dive to the V_{MO} limit shall be conducted commencing at no less than 16,000 feet and terminating at no less than 10,000 feet.

PRESSURE ALTITUDE KIAS

(B) PRESSURE	**KIAS**
18,000	221
17,000	226
16,000	230
15,000	235
14,000	239
13,000 and below	245
(F/M)	
18,000	247
17,000	251
16,000	(**F**) 251/(**M**) 257
15,000 and below	259

b. Controls shall be checked during the dive for any flutter or oscillation. Any sign of undue vibration or other malfunction shall be noted.

c. Trim aircraft to V_{MO} with maximum continuous power, landing gear and flaps up. Excess nosedown trim should be at least 0.9 but not exceed 1.4 trim wheel indicator units. Annotate trim excess (difference between full trim and trim required for V_{MO}).

PROFILE

A

68. Oxygen System Check.

a. Descend aircraft to 11,000 feet.

b. With the cabin altitude stabilized at 10,000 feet, don oxygen masks and place the CABIN PRESS switch to DUMP position. Slowly climb aircraft back toward 12,500 feet with the cabin dumped. At 12,000 to 12,500 feet cabin altitude, the CABIN ALT red warning annunciator light should illuminate, the automatic deployment of oxygen equipment should occur, and the cabin lights/PASS OXY ON green annunciator light should illuminate.

c. Test at least one passenger oxygen mask from each of three dispensers by pulling the appropriate lanyard and breathing through the mask.

d. Place the CABIN PRESS switch back to PRESS (center) position and observe the cabin descend within 20 seconds. Reset the cabin altitude control for destination.

e. As the cabin altitude descends through 11,000 feet, the PASS OXY ON annunciator light extinguishes and oxygen flow to the passenger masks terminates.

f. Ensure the actuation pins for all passenger masks are reset, then pull the manual override handle in the cockpit and the PASS OXY ON annunciator light should again illuminate. Push in the manual override handle. Provided all the pins are reset properly, the PASS OXY ON annunciator light should stay illuminated until after landing, as pressure is locked in the system. Do not pull a passenger mask lanyard or this pressure will escape.

A B

69. Pressurization Check.

a. Cabin altitude should remain steady during descent, and the descent rate should be adjusted to remain steady at 500 fpm.

A

70. Vertical Speed Check.

a. Check normal operation of both pilot and copilot IVSIs against the sensitive altimeter (tolerance ±200 feet at indicated 1,000 fpm).

10.17 LEVEL 5,000 TO 6,000 FEET AGL

A

71. Slaved Compass Systems Check.

a. The HSIs and RMIs will indicate within ±2° of several known magnetic headings and within 3° of each other (use known magnetic variation and available section lines or other geographic points).

A

72. Magnetic Compass Check.

a. Verify completed calibration card is installed. Compare with slaved compasses (tolerance ±8°).

Note

Windshield heat, windshield wipers, and air-conditioner should be off. All normally used electronic equipment and vent blower should be on.

PROFILE

A

73. Turn and Bank Indicators Check.

a. Make timed turns both left and right for 180° (tolerance ±25°). The difference between left and right turns should not exceed 20°.

b. In straight-and-level flight, the turn needle will be centered within a tolerance of one-sixteenth needle width.

A

74. Attitude Indicators Check.

a. The horizon reference line should immediately indicate changes in aircraft attitude. Sluggishness is an indication of faulty instruments or leaks in the vacuum system. Indicators should be within 3° in level flight.

A

75. Radio Equipment Check.

a. Radio installations shall be completely checked for proper operation and excessive noise. Radio equipment shall be checked for proper calibrations and markings. Radio transmitters and receivers shall be checked with local control tower and other facilities at a distance of not less than 20 miles for clarity and normal operation. VHF Omnidirectional Range (VOR) and TACAN shall be checked on at least three frequencies, each at a distance of at least 50 nm. Check each station on various relative bearings from the aircraft.

Note

The various navigation systems in the aircraft can best be checked during a series of precision and nonprecision approaches. Utilizing the autopilot/flight director will allow a simultaneous check of those systems.

b. VOR systems will indicate within ±2° of several known magnetic bearings.

c. The ADF pointer will indicate a known bearing to within ±4° tolerance. The needle oscillation on either single or dual selection will not exceed ±5°.

d. Marker beacon receivers reception will be clearly audible at 2,500 feet above the station and will indicate a 2- to 3- mile width in HI sense.

e. ILS equipment will give position indications with no glidepath or localizer needle oscillation from the outer marker to the approach end of the runway.

f. TACAN/Distance Measuring Equipment (DME) will indicate known distances to within 0.5 mile or ±5 percent of range, whichever is greater. Check groundspeed to and from station. Bearing tolerances shall be the same as step b.

g. (**B**/**M**) Check the FMS/GPS as required. (**F**) Check FMS for proper operation. The FMS will be set up as prescribed in Chapter 7. The operational accuracy of the system shall be checked using known checkpoints (NAVAIDs or airfields). There should be no position error.

h. Weather radar will be checked for returns and noise on scope. Gyro stabilization shall be checked. Refer to Chapter 27 for test and operation procedures.

PROFILE

i. (**B/F**) Check transponder(s) for proper operation. ATC altitude reporting shall be within ±200 feet of indicated altitude.

j. (**B/M**) Enhanced Ground Proximity Warning (EGPWS) — Check that all Modes 1 through 6 are operating properly. Refer to paragraph 24.9 for Mode and Flight Envelope (profile) description.

k. The audio system in general (speakers, headphones, cabin speakers, intercom, oxygen mask microphones, etc.) will be checked for proper operation without excessive noise or feedback.

l. Conduct the full CVR check found in Chapter 20.

A C 76. Autopilot/Flight Director(s) Check.

a. All channels of the autopilot shall operate positively and smoothly with no oscillations in any flight control. Control buttons shall be checked for proper lighting.

b. Flight director functions shall be checked for proper indications. It shall operate positively, smoothly, and with no oscillations in both the coupled and uncoupled modes.

A C 77. Flap Operation Check.

a. Flap operation will be free and smooth throughout while extending at maximum speeds. Extend flaps from UP to APPROACH (40 percent) position at a speed of 200 KIAS. Extend flaps from UP to DOWN (100 percent) at a speed of (**B**) 155/(**F/M**) 157 KIAS. Aircraft rolling tendency with flap extension should be minimal. Flaps should extend from up to full down within 13 seconds and retract within 9 seconds.

A 78. Landing Gear Check.

a. Gear indicators — Check for proper operation of the gear down indicators and warning lights in handle.

b. Gear extension — Check that the gear extends properly and that the extension time is approximately (**B**) 4 to 6 seconds at 182 KIAS and (**F/M**) 5 to 7 seconds at 181 KIAS.

c. Gear retraction — Check that the gear retracts properly and that the retraction time is approximately 5 to 7 seconds at (**B**) 164 KIAS or (**F/M**) 163 KIAS.

A 79. Alternate Landing Gear Extension Check.

Note

The landing gear may be extended manually by operating a lever on the floor to the right of the pilot seat; however, it cannot be retracted manually.

a. Maintain no more than (**B**) 130 KIAS or (**F/M**) 181 KIAS.

b. Pull the landing gear relay circuit breaker next to the landing gear handle.

c. Place the landing gear handle in the DOWN position.

PROFILE

Note

The autopilot may be used as an aid in maintaining stabilized flight.

d. (**B**) Disengage landing gear motor and gearbox by pulling up the U-shaped control and turning clockwise (approximately 45°) to lock in the stop position.

e. (**B**) Lower landing gear by pumping the ratchet lever up and down. The lever actuates a double-acting ratchet and should require little effort to operate. Approximately 70 complete strokes of the ratchet will be required to lower and lock the gear. As full extension is approached, proceed cautiously and stop when the three green landing gear down lights illuminate, or resistance is felt in the handle, whichever comes first. Further movement of the handle could damage the driving mechanism and impair subsequent retraction.

f. (**B**) To retract the landing gear after the manual extension check, rotate the U-shaped alternate handle counterclockwise and push it down. Stow the ratchet handle, reset the landing gear relay circuit breaker, and retract in the normal manner with the landing gear handle.

g. (**F/M**) Pump the extension lever until three green GEAR DOWN indicator lights illuminate or resistance to pumping is felt. It may require up to 80 strokes to achieve full gear extension.

h. (**F/M**) To retract the landing gear after manual extension check, stow the extension lever, reset the landing gear relay circuit breaker, and retract in the normal manner with the landing gear handle.

A B

80. Landing Gear Warning Horn Check.

a. The landing gear warning horn and the warning lights in the landing gear handle must activate any time the landing gear is not fully extended and locked and:

(1) (**B**) Both/(**F/M**) either power lever(s) is retarded below 79 to 81 percent N_1.

(2) The wing flaps are extended beyond the approach position (40 percent) regardless of power lever position.

Note

If warnings occur outside the above limits, mark the power lever quadrant where the warnings activate and the 79/81 percent settings.

b. Check proper function of the silence button to ensure it will cancel the warning horn but not the illuminated handle light when the flaps are either retracted or in the approach position (40 percent). The silence button should not cancel either the warning horn or the illuminated handle light at flap settings beyond the approach position (40 percent).

PROFILE

10.18 LANDING

A B

81. Reversing System Check

    a. Make landing using normal reverse. Check for smoothness of operation and equal thrust from engines. Maximum reverse power should be 85 ±3 percent N_1; maximum difference between engines should be 2 percent N_1.

10.19 POSTLANDING

A

82. Brake Operation Check.

    a. During the landing rollout with nosewheel on the ground, apply moderate braking. Note any tendency for brakes to bleed down, to drag after being released, or to indicate more braking power on one side than the other.

A B

83. Oil Pressure Temperature Check.

    a. The oil pressure and temperature at ground idle should be a minimum of 60 psi and (**B**) 10 to 99 °C (**F/M**) 0 to 99 °C.

A

84. Clock.

    a. Check for normal operation.

A

85. Cargo Door Check.

    a. After flight, a cargo door check should be completed using step 2.b. of the interior inspection as a guide.

A B C

86. Walkaround Check.

    a. A walkaround postflight check should be accomplished. Discrepancies that developed should be recorded on the Aircraft Maintenance Discrepancy Form. Particular attention should be given to oil, fuel, or hydraulic leaks.

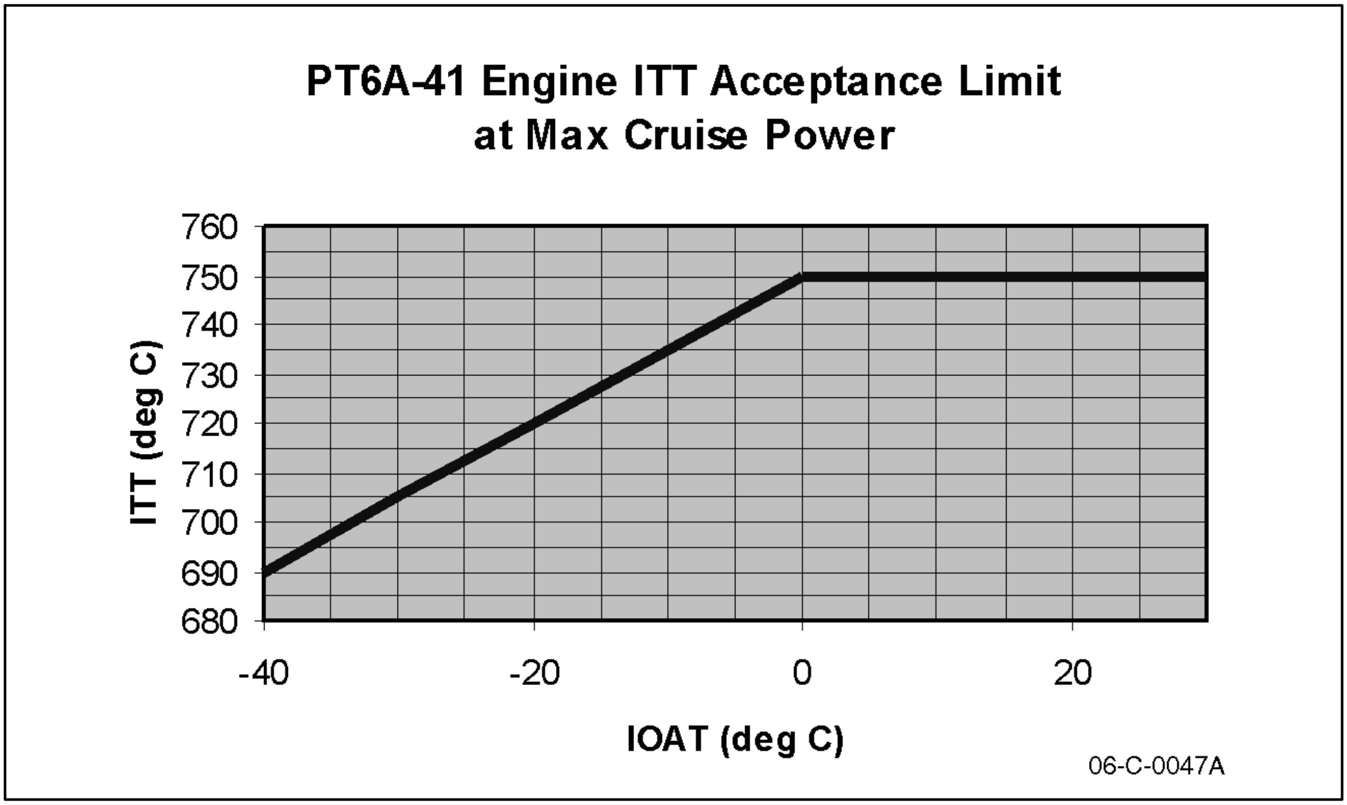


Figure 10-4. PT6A-41 Engine ITT Acceptance Limit

	MAXIMUM CRUISE POWER — SPEED (B) @ 1,900 RPM (F/M) @ 1,800 RPM		MAXIMUM CRUISE OR ENGINE ACCEPT (B) @ 1,900 RPM (F/M) @ 1,800 RPM		MAX. PWR LEVER N_1/TEMP LIMIT 2,000 RPM	
FLIGHT DATE						
PRESSURE ALTITUDE			25,000			
OAT						
SPEED CHARTS			175 KIAS			
SPEED ACT						
ENGINE	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT
ITT/TGT — VANES/JC*						
ITT/TGT — INDICATED						
TORQUE — VANES						
TORQUE — ACT						
TORQUE — CHART						
N_1 JC*						
N_1 — INDICATED						
F/F — VANES						
F/F — INDICATED						
OIL TEMP						
OIL PRESSURE						
THROTTLE POS						

*JC = Jet Cal Instrumentation

Figure 10-5. Engine Acceptance and Speed Checks

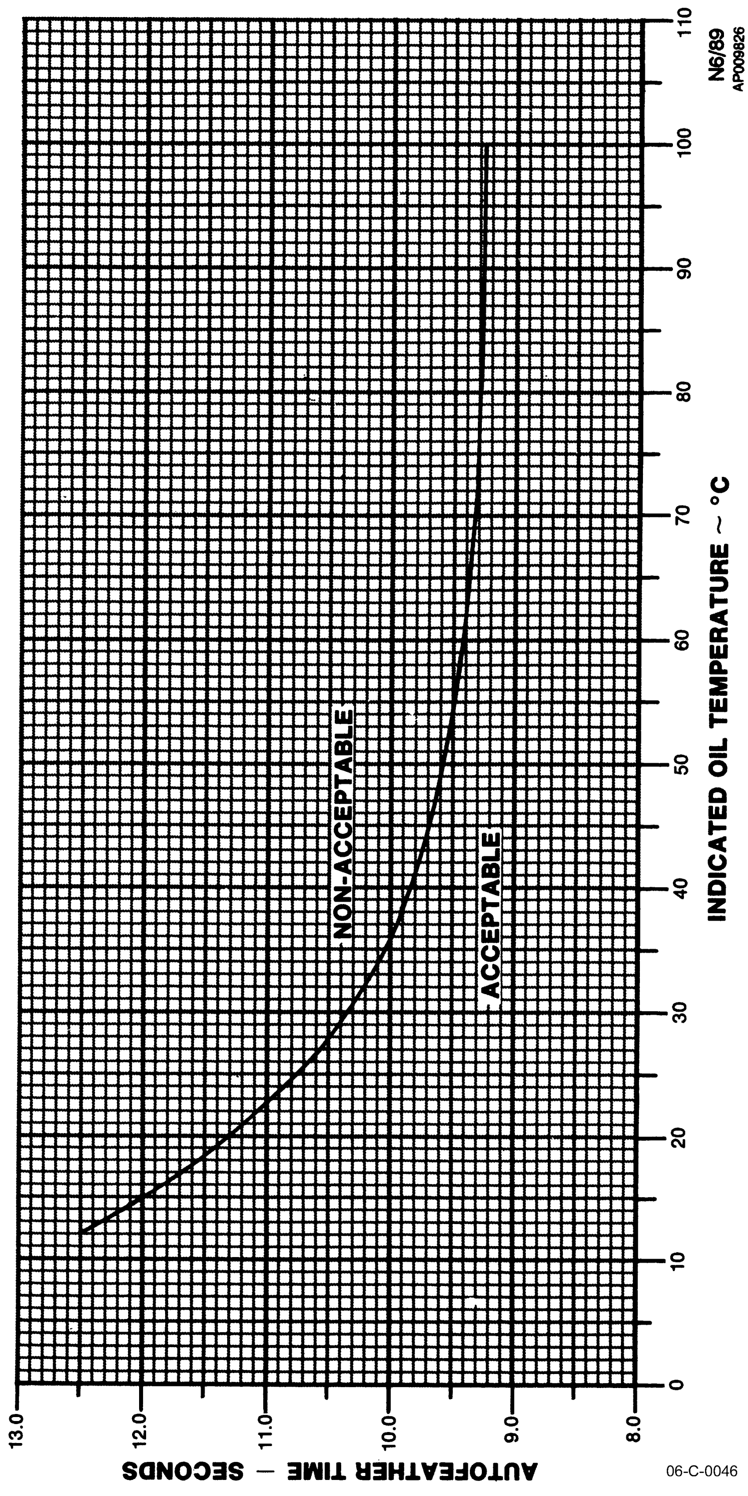


Figure 10-6. Autofeather Time Requirement

PART IV

Flight Characteristics

CHAPTER 11

Flight Characteristics

11.1 GENERAL CHARACTERISTICS

The characteristics described in this section are based on actual flight test data. The general flight characteristics of the aircraft are satisfactory for normal maneuvering in all flight configurations throughout the design speed and altitude range. When correctly trimmed, the aircraft tends to remain in straight-and-level flight. Extending and retracting the landing gear and wing flaps or changing power settings cause changes in control pressure that can be removed by retrimming.

11.2 FLIGHT CONTROLS

Aileron, elevator, rudder, and trim tab controls function effectively throughout slow, cruising, and high-speed flight. Controls become more sensitive as speed increases; likewise, control forces become progressively greater. Elevator control feel at low airspeed is enhanced by the use of antiservo trim tabs, which also serve to increase effectiveness at extreme positions.

11.3 AUTOMATIC FLIGHT CONTROL SYSTEM

All modes of normal and emergency operating procedures for the AFCS are presented in Part VII.

11.4 CLIMB CHARACTERISTICS

After normal takeoff and completion of the climb checklist, accelerate to the appropriate enroute climb speed. Refer to A1-C12BM-NFM-200 Performance Charts to determine aircraft rate of climb. Control forces resulting from climb attitudes and power settings may be completely trimmed out. Excellent longitudinal, lateral, and directional control effectiveness characterize the approach to a stall during climb. Ample stall warning is given in the form of a mechanical warning horn.

11.5 LEVEL FLIGHT CHARACTERISTICS

All flight characteristics are conventional throughout the level flight speed range. Controls are sensitive with very little effort required to change aircraft attitude.

11.6 MANEUVERING FLIGHT

Maneuvering speed (V_A) or the maximum speed at which abrupt full control travel may be applied without exceeding the design load factor of the aircraft is 181 KIAS with flaps up and 111 KIAS with flaps down. There are no conditions of normal maneuvering flight that will produce a reversal of control pressures.

11.7 STALL CHARACTERISTICS

Stalls are characterized by adequate control effectiveness and stability with an almost complete lack of aerodynamic stall warning. Adequate stall warning occurs 4 to 12 knots above stall speed in the form of an artificial stall warning horn in all configurations. The term “power-on stall” means that both engines and propellers are operating at approximately 75 percent of maximum continuous power. The term “power-idle stall” means that both engines are operating at idle power.

11.7.1 Center of Gravity Effects

Stalls in all cg configurations (Figure 11-1) are characterized by wing stall prior to reaching full control travel. Stalls in the most aft cg configuration have more shallow control force gradients in all configurations, but stall warning, actual stall speeds, and general handling characteristics are the same as those for normal cg.

11.7.2 Power Effects

Power-idle stalls in all configurations are characterized by steep control force gradients. At midpower settings, control forces are lighter about all axes and stall characteristics are more abrupt. Power-on stalls are typified by high pitch attitudes, shallow force gradients, a significant increase in artificial stall warning margins, and a decrease in stall speeds.

11.8 STALLS

11.8.1 Approach to Stall

Aircraft response to all control force inputs during approach to stall is normal. The aural stall warning system will provide 4 to 12 knots of stall warning in all configurations with increasing frequency tone with increasing angle of attack as an effective pilot alert to an impending stall. Light airframe buffet will occur 3 to 4 knots prior to stall in power-on configurations combined with very high pitch attitudes and low stall speeds, which provide good stall warning in high power configurations. At midpower settings, the stall margins are 3 to 4 knots prior to stall and are combined with steep control force gradients that provide satisfactory stall warning. In landing configuration, aerodynamic airframe buffet stall warning may not be easily perceptible to the pilot. This presents the possibility of a high sink rate landing following a high landing flare, unless the pilot is completely aware of existing conditions.

11.8.2 Power-On Stalls

The power-on stall attitude is very steep, and the first indication of an approaching stall is a slight decrease in control effectiveness. The stall is defined by a sudden onset of mild to heavy buffet followed by a rolling tendency if the aircraft is allowed to yaw. The use of rudder to prevent yaw will also prevent the tendency to roll. Slight pitching oscillations will develop if the aircraft is held in the stall, resulting in the nose dropping sharply, then pitching toward the horizon. This cycle will be repeated until recovery is made. Recovery from the stall with little loss in altitude is immediate upon relaxation of aft elevator control forces. Power-on stall characteristics are not greatly affected by landing gear and wing flap position, except that stall speed is reduced in proportion to the degree of flap extension. All flight controls remain effective throughout the stall.

11.8.3 Power-Idle Stalls

The power-idle stall is characterized by high control force, pitch change of 2° to 3°, slight wing rock, and an increasing rate of descent of 1,800 to 2,000 fpm in all flaps-up configurations. The roll tendency is considerably less pronounced in power-off stalls in takeoff, landing, or clean configurations, and it is more easily prevented or corrected by adequate rudder and/or aileron. The nose will generally drop straight through, with some tendency to pitch up again if recovery is not made immediately. With wing flaps down, there is little or no roll tendency and stalling speed is 7 to 8 knots slower than with wing flaps up. Stall recovery is immediate upon relaxation of aft elevator control forces and addition of power. Flight controls remain effective throughout the stall in all configurations.

11.8.4 Accelerated Stalls

Accelerated stalls are caused by increasing aircraft weight resulting from centrifugal force in a turn or an abrupt pullout from a dive. Stall speed is increased by the square root of the g load factor multiplied by normal stall speed. Approaches to accelerated stalls are characterized by rapid onset of moderate buffet followed by g break. Steep maneuvering force gradients and heavy buffet levels provide noticeable stall warning. A rapid roll typifies the stall, generally to the left, immediately following g break. Stall recovery is immediate upon relaxation of aft elevator control force. High control wheel forces during accelerated stalls minimize unintentional stalls.

MODEL: UC-12B/M
DATE: 14 MAY 1979
DATA BASIS: FLIGHT TEST

ENGINE: PT6A-41/42
PROPELLER: T10178B-3R/
P7025423-0152
FUEL GRADE: JP-5
FUEL DENSITY: 6.8 LB/GAL

TAKEOFF/CRUISE

POWER: IDLE
FLAPS: UP
LANDING GEAR: UP OR DOWN

GROSS WEIGHT	STALL SPEEDS — KNOTS IAS ANGLE OF BANK				
	0°	15°	30°	45°	60°
10,500	92	94	99	110	129
11,500	96	98	104	115	136
12,500	99	101	107	118	140
13,500	103	105	111	122	146

APPROACH

POWER: IDLE
FLAPS: APPROACH
LANDING GEAR: DOWN

GROSS WEIGHT	STALL SPEEDS — KNOTS IAS ANGLE OF BANK				
	0°	15°	30°	45°	60°
10,500	82	83	87	98	115
11,500	84	86	91	100	118
12,500	85	87	92	101	120
13,500	87	89	94	104	122

LANDING

POWER: IDLE
FLAPS: FULL DOWN
LANDING GEAR: DOWN

GROSS WEIGHT	STALL SPEEDS — KNOTS IAS ANGLE OF BANK				
	0°	15°	30°	45°	60°
10,500	71	72	76	85	101
11,500	73	75	78	87	103
12,500	75	77	81	89	106
13,500	77	79	83	92	109

Figure 11-1. Stall Speeds Versus Configuration

11.8.5 Practice Stalls

Practice stalls should be conducted at a moderate aircraft weight and at an altitude of at least 5,000 feet AGL with the Stall checklist completed. The recommended procedure for practice stalls is to trim the aircraft in a particular configuration approximately 20 knots above the stall speed. Without retrimming or changing configuration, gradually decrease airspeed until the desired degree of stall is attained.

CAUTION

- During practice stalls, monitor power addition closely to avoid overtorque/overtemperature.
- Rapid power application during recovery may result in uneven engine acceleration with accompanying roll and yaw. With airspeed below V_{MCA}, this could result in the aircraft departing controlled flight.

11.8.5.1 Stall Checklist

1. Loose gear — Stowed.
2. Altitude — Minimum 5,000 feet AGL.
3. Cabin sign — NO SMOKING FASTEN SEAT BELTS.
4. Spin recovery — Brief.
5. Yaw damp — OFF.
6. Propellers — 1,700 rpm.
7. Clearing turn — Minimum of 180° (one 180° turn or two 90° turns). During each clearing turn, reduce power to 500 foot-pounds torque and adjust the aircraft configuration so as to be ready for stall entry when straight and level on assigned heading.

11.8.5.2 Stall Recovery

1. Simultaneously:
   a. Power — Maximum allowable. Ensure props FULL FORWARD.
   b. Nose attitude — Adjust to break stall.
   c. Level wings.
2. Flaps — Approach (if full).
3. Gear — UP.
4. Establish positive rate of climb.
5. Flaps — UP (at V_Y).

11.9 SINGLE-ENGINE FLIGHT CHARACTERISTICS

Single-engine characteristics were determined with the inoperative engine at idle, shut down, propeller windmilling and feathered and following sudden engine failure. All single-engine configurations produce stable flight characteristics through the aircraft designed speed and altitude range when it is properly trimmed and established NATOPS procedures are adhered to.

11.9.1 Single-Engine Approach to Stall

Single-engine approach to stall in midpower configurations is characterized by light aerodynamic buffet that occurs 4 to 6 knots above V_{MC}. At maximum power settings, buffet onset and aural stall warning occur simultaneously with loss of directional control (V_{MC}) and a slight tendency to roll to the left. In landing configuration, the aural stall warning provides 4 to 12 knots of stall warning depending on power setting. With power idle, light buffet occurs 1 knot prior to V_{MC}. Flight controls are effective throughout stall approach with recovery being immediate upon relaxation of aft elevator control force and/or addition of power on the operating engine. There is no tendency to depart from controlled flight or spin. Intentional spins are not permitted. If a spin is inadvertently entered, use the recovery procedures in paragraph 15.8.7, accomplishing steps 1 through 3 as simultaneously as possible.

11.9.2 Single-Engine Approach and Landing

All control forces can be trimmed to zero for single-engine approach. No unusual control problems are posed if airspeed is maintained at or above the established NATOPS speeds presented in Figure 16-1. After landing, propeller reversing may be utilized on the operative engine to assist in stopping, while directional swerve may be minimized with rudder and light braking until nosewheel steering becomes effective during rollout. Plan to touch down on runway centerline.

PART V

Emergency Procedures

CHAPTER 12

Emergency Procedure Introduction

12.1 SCOPE

The procedures contained in this section are considered the best for coping with the various emergencies that may be encountered during operation of the aircraft. Only single failures are considered; however, each failure presents a different problem. Certain line items within a procedure are asterisked (*). These asterisked items are those requiring emphasis that shall be committed to memory as time in an emergency may not permit referral to the checklist. Daggered (†) items require concurrence of both pilots. Even though the procedures are considered the best possible, sound judgment must be used when multiple emergencies, adverse weather, terrain clearance, etc. are encountered.

12.1.1 Explanation of Terms

The term “land immediately” is defined as executing a landing without delay. (The primary consideration is to ensure the survival of aircraft occupants.)

The term “land as soon as possible” is defined as executing a landing at the nearest suitable airport, in terms of time, provided weather conditions, terrain, and facilities available indicate a safe landing can be accomplished.

The term “land as soon as practical” means extended flight is not recommended. The landing site and duration of flight is at the discretion of the Aircraft Commander.

12.1.2 Simulated Emergency Training

Simulated emergency training is necessary to develop fully qualified flightcrews. The simulated emergencies must be reasonable, applicable, and must not create a condition hazardous to flight safety not normally encountered in an actual emergency; therefore, emergencies shall be practiced in such a manner as to allow sufficient latitude to ensure safe recovery. The rules set forth below shall be adhered to when practicing emergencies.

1. During familiarization or transition flights involving scheduled in-flight emergency training that might affect control of the aircraft, no person shall be embarked in the aircraft other than the pilot(s) under instruction, qualified instructor pilot, transport aircrewmen, and transport aircrewmen under instruction. Stalls and simulated single-engine landings are included.

2. Simulated systems failures shall not be unreasonably compounded. System failures will not be simulated in conjunction with simulated engine failure training, unless such system failure is normally associated with engine failure.

3. An instructor pilot shall introduce all emergency training maneuvers to a pilot under instruction and ensure the pilot’s knowledge of these maneuvers.

4. An instructor pilot shall occupy one of the pilot seats for all stalls, dynamic engine cuts, practice emergency engine shutdowns, and simulated engine failures.

5. Simulated engine failure shall not be initiated below either V_{SSE} or 200 feet AGL.

6. Simulating a failed engine by moving the condition lever to FUEL CUTOFF or feathering a propeller for emergency training shall not be practiced below 4,000 feet AGL.

7. An engine failure for training purposes shall be initiated only by moving a condition lever to FUEL CUTOFF or by retarding a power lever to IDLE.

8. Under no circumstances shall an engine be secured or a propeller feathered during a simulated single-engine landing practice.

9. A propeller-feathered condition can be simulated by reducing the power on either engine to zero thrust. The following conditions will approximate zero thrust at low altitudes at speeds between 105 and 120 knots:

   a. Propeller — 1,600 rpm.

   b. Power lever — Set 120 foot-pounds/5 percent torque.

10. During simulated single-engine approaches, as described above, practice single-engine waveoffs may be practiced only if executed prior to descending below 200 feet AGL. Any waveoff from a lower altitude during such practice approaches shall be made utilizing both engines. Any time during a simulated single-engine approach that the pilot feels the safety of the aircraft is being jeopardized or is becoming marginal, the pilot shall execute a normal waveoff using both engines and proceed in the safest manner available at that time.

11. Simulated single-engine training shall not be practiced:

    a. Under other than visual meteorological conditions.

    b. When any actual flight emergency exists.

    c. During touch-and-go landings, except when both engines are available and utilized normally for succeeding takeoff.

12. During maneuvers requiring large rudder inputs (e.g., V_{SSE} dynamic engine cut), ensure yaw damper is not engaged.

12.2 WARNINGS/CAUTION/ADVISORIES DISPLAYS

Refer to Figures 12-1, 12-2, 12-3, 12-4, 12-5, 12-6, 12-7, 12-8, 12-9, 12-10, and 12-11.

<table>
<tr><th>INDICATION</th><th>CAUSE/REMARKS</th><th>CORRECTIVE ACTION</th></tr>
<tr><td>ALT WARN</td><td>Cabin altitude exceeds 12,500 feet.</td><td>1. Don/deploy oxygen masks and/or descend to a lower altitude.</td></tr>
<tr><td>AP DISC</td><td>Autopilot has been disconnected by means other than depressing pilot AP/YD DISC switch.</td><td>1. AP/YD disconnect — Depress (first detent). (PF)
2. Retrim aircraft.
3. Reengage autopilot (as required).</td></tr>
<tr><td>AP TRIM FAIL</td><td>Trim will not run or running opposite direction from commanded.</td><td>1. AP/YD disconnect — Depress fully (second detent). (PF)
2. Use manual trim wheel for trim changes.
CAUTION
Do not reactivate electric trim system until cause of malfunction is corrected.</td></tr>
<tr><td>BL AIR FAIL L/R</td><td>Indicates a possible rupture of bleed air line downstream of the engine firewall. Affected bleed air warning line has melted or failed, indicating possible loss of engine bleed air. Closing the affected bleed air valve removes bleed air from the affected system.
CAUTION
The first indication of a ruptured bleed air line inside the engine compartment will be a reduction in engine power possibly followed by fire. Depending upon the exact location of the rupture within the engine compartment, the problem might not be remedied by securing the bleed air valve switch on the side associated with the power reduction. Consideration should be given to further reducing engine power or securing the engine if closing the bleed air valve had no discernable effect on the power loss. This type of failure will not cause the BL AIR FAIL light to illuminate.</td><td>1. Engine instruments — Monitor.
Note
When the bleed air valve closes after the switch is secured, ITT may drop, torque may rise, and cabin pressure may fluctuate momentarily.
2. (B/F) BLEED AIR switch (affected engine) — INSTR/ENVIR OFF (PNF).
(M) BLEED AIR switch (affected engine) — OFF (PNF).
3. Cabin pressurization — Check (PNF).
Note
• Approximately 75 percent N_1 (85 percent N_1 with one engine inoperative) is required to maintain the pressurization schedule during descent.
• Rudder boost will be lost if either bleed air valve switch is placed in the INSTR & ENVIR OFF position.
• The BL AIR FAIL light will not extinguish, regardless of the position of the BLEED AIR valve switch, until the plastic failure sensing tubing is repaired.
• Bleed air failure lights may momentarily illuminate during surface deice operation at low N_1 speeds. If lights immediately extinguish, they may be disregarded.</td></tr>
</table>

Figure 12-1. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Warning Lights (Red) (Sheet 1 of 2)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
CHIP DET L/R	Illumination (or flicker) of either CHIP DET light indicates that metal particles may be present in the engine oil system.	*1. Emergency Engine Shutdown Checklist — Perform. **Note** Consideration may be given to leaving engine running if a situation requiring power exists.
FIRE L/R ENG	Illumination of the FIRE warning light is usually the first indication of engine compartment fire.	*1. Confirm fire. If fire exists: *2. Emergency Engine Shutdown Checklist — Perform. **Note** Sunlight or moisture can cause illumination of warning light. Even if no secondary indications are noted, consideration should be given to shutdown of the affected engine.
FUEL PRESS L/R	Affected engine fuel boost pressure has dropped.	1. Check corresponding engine nacelle for fuel leak. If fuel is leaking: 2. Emergency Engine Shutdown Checklist — Perform. If no leak is evident: 3. Standby boost pump — ON. If FUEL PRESS light extinguishes: 4. Monitor oil system instruments for secondary indications. If FUEL PRESS light remains on: 5. Standby boost pump — OFF. 6. Start recording time. **CAUTION** • Engine-driven fuel pump operations without boost pump fuel pressure are limited to 10 hours. • Operation is limited to 20,000-foot altitude when operating on aviation gasoline with one standby boost pump inoperative.
INST INV	Loss of 115 Vac power supply. Either inverter is capable of supplying the full amount of normally required single-phase ac power.	1. Switch to opposite inverter and check for switchover.

Figure 12-1. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Warning Lights (Red) (Sheet 2 of 2)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
BATTERY CHG	Indicates the battery is receiving a charge from the aircraft electrical system. This is a normal function on deck after battery start for an extended period with the valve regulated sealed lead acid battery. The light may also illuminate in flight with airstarts and multiple gear or flap actuations; however, unexplained illumination in flight under normal circumstances could indicate a malfunction of the battery charge sensor or an internal short.	Perform a battery condition check as listed in paragraph 15.1.1.
CABIN DOOR	Cabin/cargo door open or not secure. **WARNING** Do not attempt to close door or check for security until the cabin is depressurized and the aircraft is on the ground.	1. All aircraft occupants — Seated, seatbelts fastened. 2. Descend — As required. 3. Pressurization controller — INCREASE CABIN ALTITUDE (reduce cabin pressure differential). 4. Land as soon as practical.
DC GEN L/R	Affected engine generator off the line. If a generator fails, all nonessential electrical equipment should be used with caution to avoid overloading the remaining generator. Load in excess of single-generator output will drain the battery. **WARNING** • A loss of electrical power (e.g., gangbar OFF) will cause the environmental bleed air valves to close with a subsequent loss of pressurization. • Continued flight under these conditions may be hazardous because of concurrent loss of the pressurization, anti-icing, communication, navigation, and rudder boost systems as well as limited emergency lighting. (Refer to Figure 2-12.)	1. Starter switch — Check OFF. 2. Generator — OFF, RESET, then ON. **Note** Normal voltage in the RESET position indicates a failure of the generator control rather than the generator. If generator will not reset: 3. Generator — OFF. 4. Inverter — Select to match operating generator. 5. Current limiter — Check. 6. Operating generator — Do not exceed 100 percent load. 7. Land as soon as practical. **Note** If both generators are inoperative because of generator or engine failure, all unnecessary equipment should be turned off by the gangbar. This will preserve battery power for extending the landing gear and flaps prior to landing.

Figure 12-2. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow) (Sheet 1 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
DC GEN L/R (cont)	**WARNING** After activating the gangbar, only the pilot vacuum-driven gyro, copilot altimeter, pitot static instruments, engine N_1, ITT, propeller rpm, clocks, copilot turn and bank indicator, and standby compass are available for instrument flight conditions.	
DUCT OVERTEMP	Excessive bleed air temperature in cabin heating duct system. **Note** Allow approximately 30 seconds after each adjustment for the system temperature to stabilize. The overtemperature condition is considered corrected at any point during the procedure that the light extinguishes.	1. Check floor/baggage compartment outlet vents open, not obstructed — (TA). 2. Cabin air control knob — IN. 3. Defrost/Pilot/Copilot air — Pull ON. 4. CABIN TEMP MODE — AUTO. 5. CABIN TEMP control — Decrease. 6. Vent blower — HI. 7. Aft blower — OFF. 8. CABIN TEMP MODE — MAN COOL. 9. MANUAL TEMP — DECR. 10. Left bleed air valve — ENVIR OFF. If light is still on: 11. Left bleed air valve — OPEN. 12. Right bleed air valve — ENVIR OFF. If light is still on: 13. Right bleed air valve — OPEN. If vent air is still hot: 14. Both bleed air valves — ENVIR OFF. **Note** Both bleed air valves in ENVIR OFF will result in a loss of cabin pressurization. 15. LAND AS SOON AS POSSIBLE.
EXT PWR	An external power source is connected at the external receptacle. Light will extinguish when external power source is disconnected.	N/A
FDR FAULT	Recorder or data input faulty.	N/A
GPWS INOP	Radio altimeter, altimeter adapter, or air data computer faulty. GPWS inoperative.	N/A

Figure 12-2. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow)
(Sheet 2 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
ICE VANE L/R	Affected engine ice vane has not attained proper position.	1. Visually check bypass door and proper ITT/torque indications. If vane failure confirmed: 2. Airspeed — 160 KIAS or less. 3. Ice vane circuit breaker — Pull. 4. ICE VANE CONTROL switch — Extend. 5. Manual ice vane — Pull. 6. Airspeed — Resume. **CAUTION** Once the manual ice vane system has been engaged, do not reset the circuit breaker or attempt to retract or extend the ice vanes electrically, even if the T-handle has been pushed in, until the override linkage in the engine compartment has been properly reset on the ground.
NAC LOW L/R	Affected engine nacelle tank has 30 minutes usable fuel remaining at sea level (approximately 240 pounds) normal cruise power consumption rate. A highly probable cause for this condition is that the gravity flow check (anti-surge) valve between the main tank and nacelle tank has frozen.	*1. LAND AS SOON AS POSSIBLE. **Note** If suitable airfield is not available (e.g., overwater flights), consideration should be given to rocking the wings and/or descending to warmer temperature in an attempt to free valve. Additionally, crossfeed to affected engine may be performed to prolong engine operation.
RVS NOT READY	Propellers not at HIGH RPM with landing gear extended.	Prop levers — Full forward (as required).

Figure 12-2. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow) (Sheet 3 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
AIR CND N_1 LOW	Right (#2) engine rpm is too low for air conditioner compressor to operate.	1. Advance N_1 on right (#2) engine to a minimum of 61 percent.
AUTO FEATHER L/R	Autofeather armed with power levers advanced above 85 to 90 percent N_1. Light extinguishes if either propeller autofeathers, or if system is disarmed by retarding one power lever, or if AUTOFEATHER switch is placed in the OFF position.	Advisory only.
BL AIR OFF L/R	Affected environmental bleed air valve is closed.	Advisory only.
CAUT LGND OFF	Caution annunciator is turned off.	Advisory only.
ELECT TRIM OFF	Electric trim deenergized by a trim disconnect switch on the control wheel with the ELEV TRIM switch in the ON position.	Advisory only.
FUEL CROSSFEED	Crossfeed switch is selected.	Advisory only.
ICE VANE EXT L/R	Ice vane extended.	Advisory only.
IGNITION ON L/R	Affected starter/ignition switch is in the engine/ignition mode or autoignition system is armed and engine torque is below 410 (±50) ft-lb.	1. In autoignition mode, extinguishes when torque reaches or exceeds 410 (±50) ft-lb.
LDG/TAXI LTS	Lights are on with landing gear retracted.	1. LDG/TAXI light switches — OFF.
PASS OXY ON	Passenger oxygen system charged.	1. PASSENGER MANUAL O'RIDE knob — OFF (as required). 2. OXYGEN CONTROL C/B — PULL (as required).

Figure 12-3. (**B**) UC-12B WARNING/CAUTION/ADVISORY DISPLAYS Advisory Lights (Green)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
ALT WARN	Cabin altitude exceeds 12,500 feet.	1. Don/deploy oxygen masks and/or descend to a lower altitude.
AP DISC	Autopilot has been disconnected by means other than depressing pilot AP/YD DISC switch. **WARNING** Failure of the AP PWR circuit breaker in flight will cause the autopilot to disengage with no annunciator indications.	1. AP/YD disconnect — Depress (first detent) (PF). 2. Retrim aircraft. 3. Reengage autopilot (as required).
AP TRIM FAIL	Trim will not run or running opposite direction from commanded.	1. AP/YD disconnect — Depress fully (second detent) (PF). 2. Use manual trim wheel for trim changes. **CAUTION** Do not reactivate electric trim system until cause of malfunction is corrected.
BL AIR FAIL L/R	Indicates a possible rupture of bleed air line downstream of the engine firewall. Affected bleed air warning line has melted or failed, indicating possible loss of engine bleed air. Closing the affected bleed air valve removes bleed air from the affected system. **CAUTION** The first indication of a ruptured bleed air line in the engine compartment will be a reduction of engine power possibly followed by fire. This cannot be remedied by securing the BLEED AIR valve switch. Consideration should be given to reducing engine power or securing the engine if it cannot be determined that the bleed air valve closed. This type of failure will not cause the BL AIR FAIL light to illuminate.	1. Engine instruments — Monitor. **Note** When the bleed air valve closes after the switch is secured, ITT may drop, torque may rise, and cabin pressure may fluctuate momentarily. 2. BLEED AIR Switch (affected engine) — INSTR/ENVIR OFF (PNF). 3. Cabin pressurization — Check (PNF). **Note** • Rudder boost will be lost if either BLEED AIR VALVE switch is placed in the INSTR & ENVIR OFF position. • The BL AIR FAIL light will not extinguish, regardless of the position of the BLEED AIR valve switch, until the plastic failure sensing tubing is repaired. • Bleed air failure lights may momentarily illuminate during surface deice operation at low N_1 speeds. If lights immediately extinguish, they may be disregarded.

Figure 12-4. (F) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Warning Lights (Red) (Sheet 1 of 2)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
CABIN DOOR	Cabin/cargo door open or not secure. **WARNING** Do not attempt to close door or check for security until the cabin is depressurized and the aircraft is on the ground.	1. All aircraft occupants — Seated, seatbelts fastened. 2. Descend — As required. 3. Pressurization controller — Increase cabin altitude (reduce cabin pressure differential). 4. Land as soon as practical.
FIRE L/R ENG	Illumination of the FIRE warning light is usually the first indication of engine compartment fire.	*1. Confirm fire. If fire exists: *2. Emergency Engine Shutdown Checklist — Perform. **Note** Sunlight or moisture can cause illumination of warning light. Even if no secondary indications are noted, consideration should be given to shutdown of the affected engine.
FUEL PRESS L/R	Affected engine fuel boost pressure has dropped.	1. Check corresponding engine nacelle for fuel leak. If fuel is leaking: 2. Emergency Engine Shutdown Checklist — Perform. If no leak is evident: 3. Standby boost pump — ON. If FUEL PRESS light extinguishes: 4. Monitor oil system instruments for secondary indications. If FUEL PRESS light remains on: 5. Standby boost pump — OFF. 6. Start recording time. **CAUTION** • Engine-driven fuel pump operations without boost pump fuel pressure are limited to 10 hours. • Operation is limited to 20,000-foot altitude when operating on aviation gasoline with one standby boost pump inoperative.
INVERTER	Loss of 115 Vac power supply. Either inverter is capable of supplying the full amount of normally required single-phase ac power.	1. Switch to opposite inverter and check for switchover.
OIL PRESS	Low oil pressure affected engine.	Check oil pressure and temperature. If out of oil limits, Emergency Engine Shutdown Checklist — Perform.

Figure 12-4.(**F**) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Warning Lights (Red) (Sheet 2 of 2)

<table>
<tr><th>INDICATION</th><th>CAUSE/REMARKS</th><th>CORRECTIVE ACTION</th></tr>
<tr><td>BATTERY CHG</td><td>Indicates the battery is receiving a charge from the aircraft electrical system. This is a normal function on deck after battery start for an extended period with the valve regulated sealed lead acid battery. The light may also illuminate in flight with airstarts and multiple gear or flap actuations; however, unexplained illumination in flight under normal circumstances could indicate a malfunction of the battery charge sensor or an internal short.</td><td>Perform a battery condition check as listed in paragraph 15.1.1.</td></tr>
<tr><td>CHIP DET L/R</td><td>Illumination (or flicker) of either CHIP DET light indicates that metal particles may be present in the engine oil system.</td><td>*1. Emergency Engine Shutdown Checklist — Perform.
Note
Consideration may be given to leaving engine running if a situation requiring power exists.</td></tr>
<tr><td>DC GEN L/R</td><td>Affected engine generator off the line.
If a generator fails, all nonessential electrical equipment should be used with caution to avoid overloading the remaining generator. Load in excess of single-generator output will drain the battery.
WARNING
• A loss of electrical power (e.g., gangbar OFF) will cause the environmental bleed air valves to close with a subsequent loss of pressurization.
• Continued flight under these conditions may be hazardous because of concurrent loss of the pressurization, anti-icing, communication, navigation, and rudder boost systems as well as limited emergency lighting. (Refer to Figures 2-16 and 2-18.)</td><td>1. Starter switch — Check OFF.
2. Generator — OFF, RESET, then ON.
Note
Normal voltage in the RESET position indicates a failure of the generator control rather than the generator.
If generator will not reset:
3. Generator — OFF.
4. Inverter — Select to match operating generator.
5. Current limiter — Check.
6. Operating generator — Do not exceed 100 percent load (88 percent above FL 310).
7. Land as soon as practical.</td></tr>
</table>

Figure 12-5. (F) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow) (Sheet 1 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
DC GEN L/R (cont)	**WARNING** After activating the gangbar, only the pilot vacuum-driven gyro, copilot turn and bank indicator, copilot altimeter, pitot static instruments, engine N_1, ITT, propeller rpm, clocks, and standby compass are available for instrument flight conditions.	**Note** If both generators are inoperative because of generator or engine failure, all unnecessary equipment should be turned off by the MASTER SWITCH (gangbar). This will preserve battery power for extending the landing gear and flaps prior to landing.
DUCT OVERTEMP	Excessive bleed air temperature in cabin heating duct system. **Note** Allow approximately 30 seconds after each adjustment for the system temperature to stabilize. The overtemperature condition is considered corrected at any point during the procedure that the light extinguishes. **WARNING** ● A loss of electrical power (e.g., gangbar OFF) will cause the environmental bleed air valves to close with a subsequent loss of pressurization. ● Continued flight under these conditions may be hazardous because of concurrent loss of the pressurization, anti-icing, communication, navigation, and rudder boost systems as well as limited emergency lighting. (Refer to Figures 2-15 and 2-13.)	1. Check floor/baggage compartment outlet vents — Open, not obstructed (TA). 2. Cabin air control knob — IN. 3. Defrost/Pilot/Copilot air — Pull ON. 4. CABIN TEMP MODE — AUTO. 5. CABIN TEMP control — Decrease. 6. Vent blower — HI. 7. Aft blower — OFF. 8. CABIN TEMP MODE — MAN COOL. 9. MANUAL TEMP — DECR. 10. Left bleed air valve — ENVIR OFF. If light is still on: 11. Left bleed air valve — OPEN. 12. Right bleed air valve — ENVIR OFF. If light is still on: 13. Right bleed air valve — OPEN. If vent air is still hot: 14. Both bleed air valves — ENVIR OFF. **Note** Both bleed air valves in ENVIR OFF will result in a loss of cabin pressurization. 15. LAND AS SOON AS POSSIBLE.

Figure 12-5. (**F**) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow) (Sheet 2 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
EXT PWR	An external power source is connected at the external receptacle. Light will extinguish when external power source is disconnected.	N/A
FDR	Recorder or data input faulty.	N/A
HYD FLUID LOW	Hydraulic fluid low in power pack.	Manual extension of gear may be required.
ICE VANE L/R	Affected engine ice vane has not attained proper position.	1. Visually check — Bypass door and proper ITT/torque indications. If vane failure confirmed: 2. Airspeed — 160 KIAS or less. 3. Ice vane circuit breaker — Pull. 4. ICE VANE CONTROL switch — Extend. 5. Manual Ice vane — Pull. 6. Airspeed — Resume. **CAUTION** Once the manual ice vane system has been engaged, do not reset the circuit breaker or attempt to retract or extend the ice vanes electrically even if the T-handle has been pushed in until the override linkage in the engine compartment has been properly reset on the ground.
IFF	Aircraft Mode 4 Transponder code and ground interrogation codes do not agree.	Advisory only.
NAC LOW L/R	Affected engine nacelle tank has 30 minutes usable fuel remaining at sea level (approximately 240 pounds) normal cruise power consumption rate. A highly probable cause for this condition is that the gravity flow check (anti-surge) valve between the main tank and nacelle tank has frozen.	*1. LAND AS SOON AS POSSIBLE. **Note** If suitable airfield is not available (e.g., overwater flights), consideration should be given to rocking the wings and/or descending to warmer temperature in an attempt to free valve. Additionally, crossfeed to affected engine may be performed to prolong engine operation.
OIL PRESS	Low oil pressure affected engine.	Check oil pressure and temperature. If out of limits, Emergency Engine Shutdown Checklist — Perform.
RVS NOT READY	Propellers not at HIGH RPM with landing gear extended.	1. Prop levers — HIGH RPM (as required).

Figure 12-5. (**F**) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Caution Lights (Yellow) (Sheet 3 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
AIR CND N_1 LOW	Right (#2) engine rpm is too low for air conditioner compressor to operate.	1. Advance N_1 on right (#2) engine to a minimum of 63 percent.
AUTO FEATHER L/R	Autofeather armed with power levers advanced above 85 to 90 percent N_1. Light extinguishes if either propeller autofeathers, or if system is disarmed by retarding one power lever, or if AUTOFEATHER switch is placed in the OFF position.	Advisory only.
BL AIR OFF L/R	Affected environmental bleed air valve is closed.	Advisory only.
BRAKE DEICE ON	Brake deice system activated.	Advisory only.
ELECT TRIM OFF	Electric trim deenergized by a trim disconnect switch on the control wheel with the ELEV TRIM switch in the ON position.	Advisory only.
FUEL CROSSFEED	CROSSFEED switch is selected.	Advisory only.
ICE VANE EXT L/R	Ice vane extended.	Advisory only.
IGNITION ON L/R	Affected starter/ignition switch is in the engine/ignition mode or autoignition system is armed and engine torque is below 410 (±50) ft-lb.	1. In autoignition mode, extinguishes when torque reaches or exceeds 410 (±50) ft-lb.
LDG/TAXI LTS	Lights are on with landing gear retracted.	1. LDG/TAXI light switches — OFF.
PASS OXY ON	Passenger oxygen system charged.	1. PASSENGER MANUAL O'RIDE knob — OFF (as required). 2. OXYGEN CONTROL C/B — Pull (as required).

Figure 12-6. (F) UC-12F WARNING/CAUTION/ADVISORY DISPLAYS Advisory Lights (Green)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
ALT WARN	Cabin altitude exceeds 12,500 feet.	Don oxygen masks and/or descend to lower altitude.
A/P DISC	Autopilot has disconnected by means other than depressing pilot AP/YD DISC switch. **WARNING** In-flight failure of the AP POWER circuit breaker will cause autopilot disengagement with no annunciated indication.	1. AP/YD disconnect — Depress (first detent) (PF). 2. Retrim aircraft. 3. Reengage autopilot (as required).
A/P TRIM FAIL	Trim won't run or running opposite direction commanded.	1. AP/YD disconnect switch — Depress fully (second detent). 2. Use manual trim wheel for trim changes. **CAUTION** Do not reactivate electric trim system until cause of malfunction is corrected.
BL AIR FAIL L/R		1. Engine instruments — Monitor. **Note** When the bleed air valve closes after the switch is secured, TGT may drop, torque may rise, and cabin pressure may fluctuate momentarily. 2. ENVIR & PNEU BLEED AIR switch (affected engine) — OFF (PNF). 3. Cabin pressurization — Check (PNF). **Note** • Rudder boost will be lost if either bleed air valve switch is placed in the ENVIR & PNEU OFF position. • The BL AIR FAIL light will not extinguish, regardless of the position of the bleed air valve switch, until the plastic failure sensing tubing is repaired. • Bleed air failure lights may momentarily illuminate during surface deice operation at low N_1 speeds. If lights immediately extinguish, they may be disregarded.

Figure 12-7. (**M**) Warning Light Panel (Sheet 1 of 2)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
CHIP DETR #1/#2	Illumination (or flicker) of either CHIP DETECT annunciator indicates that metal particles may be present in the engine oil system.	*1. Emergency Engine Shutdown Checklist — Perform. **Note** Consideration may be given to leaving engine running if a situation requiring power exists.
FIRE PULL #1/#2	Illumination of the FIRE warning light is usually the first indication of engine compartment fire.	*1. Confirm fire. If fire exists: *2. Emergency Engine Shutdown Checklist — Perform.
FUEL PRESS #1/#2	Affected engine fuel boost pressure has dropped.	1. Check corresponding engine nacelle for fuel leak. If fuel is leaking: 2. Emergency Engine Shutdown Checklist — Perform. If no leak is evident: 3. Standby pump switch — ON. If FUEL PRESS light extinguishes: 4. Monitor the oil system instruments for secondary indications. If FUEL PRESS light remains on: 5. Standby pump switch — OFF. 6. Start recording time. **CAUTION** • Engine-driven fuel pump operation without boost pump fuel pressure is limited to 10 hours. This time shall be recorded. • Operation with a boost pump inoperative is limited to 20,000 feet when operating on aviation gasoline.
INST AC	Loss of 115 Vac power.	Check for inoperative inverter (Inverter fail annunciator), and switch Off.

Figure 12-7 (**M**) Warning Light Panel (Sheet 2 of 2)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
BATTERY CHARGE	Indicates the battery is receiving a charge from the aircraft electrical system. This is a normal function on deck after battery start for an extended period with the valve regulated sealed lead acid battery. The light may also illuminate in flight with airstarts and multiple gear or flap actuations. However, unexplained illumination in flight under normal circumstances could indicate a malfunction of the battery charge sensor or an internal short.	Perform a battery condition check as listed in paragraph 15.1.1.
CABIN DOOR	Cabin/cargo door open or not secure. **WARNING** Do not attempt to close door or check for security until the cabin is depressurized and the aircraft is on the ground.	1. All aircraft occupants — Seated, seat belts fastened. 2. Descend — As required. 3. Pressurization Controller — increase cabin altitude (reduce cabin pressure differential). 4. Land as soon as practical.
DC GEN #1 /#2	Affected engine generator off the line. If a generator fails, all nonessential electrical equipment should be used with caution to avoid overloading the remaining generator. Load in excess of single-generator output will drain the battery. **WARNING** • A loss of electrical power (e.g., gangbar OFF) will cause the environmental bleed air valves to close with a subsequent loss of pressurization. • Continued flight under these conditions may be hazardous because of concurrent loss of the pressurization, anti-icing, communication, navigation, and rudder boost systems as well as limited emergency lighting. Refer to Figure 2-14.	1. ENG start switch — Check OFF. 2. Generator — OFF, RESET, then ON. **Note** Normal voltage in the RESET position indicates a failure of the generator control rather than the generator. If generator will not reset: 3. Generator — OFF. 4. Current limiter — Check. 5. Operating generator — Do not exceed 100 percent load (88 percent above FL 310). 6. Land as soon as practical. **Note** If both generators are inoperative because of generator or engine failure, all unnecessary equipment should be turned off by the MASTER SWITCH (gangbar). This will preserve battery power for extending the landing gear and flaps prior to landing. 1. ENG start switch — Check OFF. 2. Generator — OFF, RESET, then ON.

Figure 12-8. (**M**) Caution Light Panel (Sheet 1 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
DC GEN #1 /#2 (cont.)	**WARNING** After activating the gangbar, only the pilot vacuum-driven gyro, copilot turn and bank indicator, copilot altimeter, pitot static instruments, engine N_1, TGT, propeller rpm, clocks, and standby compass are available for instrument flight conditions.	**Note** Normal voltage in the RESET position indicates a failure of the generator control rather than the generator.
DUCT OVERTEMP	Excessive bleed air temperature in cabin heating duct system. **Note** Allow approximately 30 seconds after each adjustment for the system temperature to stabilize. The overtemperature condition is considered corrected at any point during the procedure that the light extinguishes.	1. Check floor/baggage compartment outlet vents open, not obstructed — (TA). 2. Cabin air control knob — IN. 3. Defrost/Pilot/Copilot air — Pull ON. 4. CABIN AIR MODE SELECT — AUTO. 5. CABIN AIR TEMP control — Decrease. 6. Fwd Vent blower — HI. 7. Aft Vent blower — OFF. 8. CABIN AIR MODE SELECT — MAN COOL. 9. CABIN AIR MANUAL TEMP SWITCH — DECREASE. 10. Left ENVIR & PNEU BLEED AIR switch — PNEU ONLY. If light is still on: 11. Left ENVIR & PNEU BLEED AIR switch — ON. 12. Right ENVIR & PNEU BLEED AIR switch — PNEU ONLY. If light is still on: 13. Right ENVIR & PNEU BLEED AIR switch — ON. If vent air is still hot: 14. Both ENVIR & PNEU BLEED AIR switches — PNEU ONLY. **Note** Both bleed air valves in ENVIR OFF will result in a loss of cabin pressurization. 15. LAND AS SOON AS POSSIBLE.
EXTGH DISCH #1/#2	Indicated engine fire extinguisher discharged.	Extinguishes when extinguisher system is serviced.

Figure 12-8 (**M**) Caution Light Panel (Sheet 2 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
HYD FLUID LOW	Hydraulic fluid low in power pack.	Manual extension of gear may be required. Paragraph 16.3.3.
IFF	Aircraft Mode 4 Transponder code and ground interrogation codes do not agree.	Check codes.
INVERTER #1/#2	Indicated inverter inoperative. Either inverter is capable of supplying the full amount of normally required single-phase AC power.	1. Failed inverter — OFF. Observe remaining operative inverter has assumed load. 2. Current limiter — Check.
NAC LOW #1/#2	Affected nacelle tank has approximately 30 minutes fuel remaining at sea level (approx. 247 lb) normal cruise power consumption rate. This could also indicate a stuck check valve between the main tank and nacelle tank.	Land as soon as possible at nearest suitable airfield. **Note** If a suitable airfield is not available (i.e., overwater flights), crossfeed to the affected engine should be considered to prolong engine operation.
NO FUEL XFR #1/#2	Affected auxiliary tank has lost motive flow pressure. May be result of motive flow valve or circuitry failure. **Note** ● In turbulence or during maneuvers, the NO FUEL XFR annunciator may momentarily illuminate after the auxiliary fuel has completed transfer. ● The motive flow transfer valve and the NO FUEL XFR caution annunciators share a common circuit. It is possible for the auxiliary fuel transfer to fail without illumination of the associated #1 and #2 NO FUEL XFR lights.	1. AUX XFER switch — OVRD. 2. Auxiliary fuel quantity — Monitor.
PROP SYNC ON	Propeller synchrophaser switch on with landing gear extended.	Turn synchrophaser switch Off.
REV NOT READY	Propellers not in HIGH RPM with landing gear extended.	Place prop controls in HIGH RPM.
VANE FAIL #1/#2	Affected engine ice vane has not attained proper position.	1. Visually check for bypass door and proper TGT/torque indications. If vane failure confirmed: 2. Airspeed — 160 KIAS or less. 3. Ice vane control circuit breaker — Pull. 4. ICE VANE control switches — ON. 5. Ice vane handle — Manually pull. 6. Airspeed — Resume.

Figure 12-8 (**M**) Caution Light Panel (Sheet 3 of 3)

INDICATION	CAUSE/REMARKS	CORRECTIVE ACTION
AIR COND N_1 LOW	Right engine rpm too low for air conditioning load.	Advance N_1 on right (#2) engine to minimum of 63 percent.
AUTOFEATHER #1/#2	Autofeather armed with power levers advanced above 90 percent N_1. Light extinguishes if either propeller autofeathers or if system is disarmed by retarding one power lever or AUTOFEATHER switch is placed OFF.	Advisory only.
BL AIR OFF L/R	Affected environmental bleed air valve is closed.	Place ENVIR & PNEU BLEED AIR switch(es) in BOTH position.
BRAKE DEICE ON	Brake deice system activated.	Advisory only.
ELEC TRIM OFF	Electric trim de-energized by a trim disconnect switch on the control wheel with the system power switch on the pedestal turned on.	Reset by moving ELEV TRIM switch on pedestal to OFF then back to ELEV TRIM.
EXTERNAL POWER	An external power source is connected at the external receptacle.	Light will extinguish when external power source is disconnected.
FUEL CROSSFEED	Electrically operated crossfeed valve is energized.	Place the switch placarded CROSSFEED to center OFF position.
IGN ON #1/#2 IGN ON	Affected starter/ignition switch is in the engine/ignition mode or autoignition system is armed and engine torque is below 18 ±2 percent.	In Autoignition mode, extinguished when torque reaches or exceeds 18 ±2 percent or autoignition switch is placed Off. In normal start mode, extinguishes only when START — IGNITION switch is placed OFF.
PASS OXY ON	Passenger oxygen system charged.	Place PASSENGER MANUAL O'RIDE knob in off position. Pull AUTO OXYGEN circuit breaker on overhead circuit breaker panel.
VANE EXT #1/#2	Affected ice vane extended.	Advisory only.

Figure 12-9. (**M**) Advisory Light Panel

EMERGENCY ENGINE SHUTDOWN

† 1. CONDITION LEVER . . . . FUEL CUTOFF (PNF)
† 2. PROPELLER LEVER . . . . FEATHER (PNF)
† 3. (**B**/**F**) FIREWALL VALVE . . . . CLOSED (PNF)
(**M**) FIRE PULL HANDLE . . . . PULLED (PNF)
† 4. FIRE EXTINGUISHER . . . . AS REQUIRED (PNF)
5. PROP SYNC . . . . OFF
6. AUTOIGNITION . . . . OFF (PNF)
† 7. GENERATOR . . . . OFF (PNF)
8. (**B**/**F**) INVERTER . . . . MATCH OPERATING GENERATOR (PNF)
9. ELECTRICAL LOAD . . . . CHECK (PNF)
10. CURRENT LIMITER . . . . CHECK (PNF)

ENGINE FLAMEOUT (SECOND ENGINE)

1. AIRSTART . . . . AS REQUIRED

AIRSTART STARTER—ASSISTED

1. (**B**/**F**) ENVIRONMENTAL SWITCHES . . . . OFF/AUTO/OFF (PNF)
(**M**) ENVIRONMENTAL SWITCHES . . . . OFF/AUTO/AFT (PNF)
2. RADAR . . . . STBY
3. ANTI-ICE/DEICE . . . AS REQUIRED/REDUCE LOAD
† 4. POWER LEVER . . . . IDLE
† 5. CONDITION LEVER . . . . FUEL CUTOFF (PNF)
† 6. (**B**/**F**) FIREWALL FUEL VALVE . . . . OPEN
(**M**) FIRE PULL HANDLE . . . . IN (PNF)
7. ENG START SWITCH . . . . . . START/IGNITION (PNF)
8. IGNITION/FUEL/(**F**)/OIL PRESS LIGHTS . . . . ON/OFF/(**F**)/OFF (STANDBY BOOST PUMP AS REQUIRED) (PNF)
9. CONDITION LEVER . . . . LOW IDLE (STABILIZED ABOVE 12% N_1) (PNF)
10. OIL PRESSURE . . . . CHECK
11. ENG START SWITCH . . . . OFF (ABOVE 50% N_1) (PNF)
12. PROPELLER LEVER . . . . UNFEATHER (PNF)
13. POWER . . . . AS REQUIRED
14. CURRENT LIMITERS . . . . CHECK (PNF)
15. GENERATORS . . . . RESET/ON (PNF)
16. AUTOIGNITION . . . . ARM (PNF)
17. ELECTRICAL EQUIPMENT . . . AS REQUIRED (PNF)
18. ENVIRONMENTAL SWITCHES . . . . AS REQUIRED (RS)

Boxed items are memory items.
† Concurrence of both pilots required

AIRSTART—WINDMILLING (NO STARTER, PROPELLER WINDMILLING)

1. (**B**/**F**) ENVIRONMENTAL SWITCHES . . . . OFF/AUTO/OFF (PNF)
(**M**) ENVIRONMENTAL SWITCHES . . . . OFF/AUTO/AFT (PNF)
2. RADAR . . . . STBY
3. ANTI-ICE/DEICE . . . AS REQUIRED/REDUCE LOAD
† 4. POWER LEVER . . . . IDLE
† 5. PROPELLER LEVER . . . . DO NOT FEATHER (PNF)
† 6. CONDITION LEVER . . . . FUEL CUTOFF (PNF)
† 7. (**B**/**F**) FIREWALL FUEL VALVE . . . . OPEN
(**M**) FIRE PULL HANDLE . . . . IN (PNF)
† 8. GENERATOR (INOPERATIVE ENGINE) . . . . OFF (PNF)
9. AIRSPEED/ALTITUDE . . . . MINIMUM 140 KIAS/ BELOW 20,000 FEET
10. AUTOIGNITION . . . . ARM (IGNITION LIGHT ON) (PNF)
11. FUEL PRESS LIGHTS (**F**) OIL PRESSURE LIGHTS . . . . OUT (STANDBY BOOST PUMPS AS REQUIRED)
12. CONDITION LEVER . . . . LOW IDLE (PNF)
13. POWER . . . . AS REQUIRED
14. CURRENT LIMITERS . . . . CHECK
15. GENERATOR . . . . RESET/ON (PNF)
16. ELECTRICAL EQUIPMENT . . . . AS REQUIRED
17. ENVIRONMENTAL SWITCHES . . . . . . AS REQUIRED

PROPELLER FAILURE OR OVERSPEED

TORQUE IS LIMITED TO (**B**/**F**) 1,800 FT-LBS (**M**) 81% FOR SUSTAINED OPERATION ABOVE 2,000 RPM. IF AN OVERSPEED CONDITION OCCURS THAT IS NOT CONTROLLED BY THE GOVERNORS, POWER LEVER, OR PROP LEVER, PROCEED AS FOLLOWS:

1. POWER LEVER (AFFECTED ENGINE) . . . . REDUCE
2. AIRSPEED . . . . REDUCE
† 3. PROPELLER LEVER . . . . FEATHER (PNF)
† 4. CONDITION LEVER . . . . AS REQUIRED (PNF)

IF PROPELLER FAILS TO FEATHER:

† 5. CONDITION LEVER . . . . FUEL CUTOFF (PNF)
6. AUTOFEATHER . . . . HOLD TO TEST UNTIL PROP FEATHERS (PNF)
7. EMERGENCY SHUTDOWN CHECKLIST . . . . COMPLETE AS REQUIRED

Figure 12-10. Emergency Procedures (Sheet 1 of 3)

COCKPIT/CABIN FIRE/SMOKE/FUMES (ELECTRICAL SOURCE SUSPECTED)

1. OXYGEN MASK .... DON/DEPLOY (CREW 100%) (BOTH/TA)
2. (**B**/**F**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/OFF (PNF)
   (**M**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/AFT (PNF)
3. MIC SWITCHES .... OXYGEN MASK (BOTH)
4. HEADSET .... ON (BOTH)
5. (**B**) SPEAKER/PHONE SWITCH .... PHONE (BOTH)
   (**F**) AUDIO SPEAKER SWITCH .... OFF (BOTH)
   (**M**) INTERPHONE SWITCH .... INTERPHONE (BOTH)

IF SOURCE IS KNOWN:

6. AFFECTED POWER SWITCH(ES) ...... OFF (PNF)
7. AFFECTED CB(S) .... PULL (PNF)
8. FIRE EXTINGUISHER .... AS REQUIRED (PNF/TA)

IF SOURCE UNKNOWN:

9. AVIONICS MASTER SWITCH .... OFF (PNF)
10. VOLT/LOADMETERS .... CHECK (PNF)
11. NONESSENTIAL ELECTRICAL EQUIPMENT .... OFF (BOTH)
12. FIRE EXTINGUISHER .... AS REQUIRED (PNF/TA)

IF FIRE OR SMOKE CEASES:

13. INDIVIDUALLY RESTORE AVIONICS AND EQUIPMENT .... AS REQUIRED (BOTH)
14. ISOLATE DEFECTIVE EQUIPMENT .... AS REQUIRED (BOTH)
15. CABIN PRESSURE SWITCH .... DUMP (PNF) (VENTILATE CABIN)
16. LAND AS SOON AS PRACTICAL.

IF FIRE OR SMOKE PERSISTS:

17. LAND AS SOON AS POSSIBLE.
18. (**B**/**F**) BOTH BLEED AIR VALVES .... ENVIR OFF (PNF)
    (**M**) BOTH BLEED AIR VALVES .... PNEU ONLY (PNF)
19. GANGBAR .... OFF

COCKPIT/CABIN FIRE/SMOKE/FUMES (ENVIRONMENTAL SOURCE SUSPECTED)

1. OXYGEN MASK .... DON/DEPLOY (CREW 100%) (BOTH/TA)
2. (**B**/**F**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/OFF (PNF)
   (**M**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/AFT (PNF)
3. MIC SWITCHES .... OXYGEN MASK (BOTH)
4. HEADSET .... ON (BOTH)
5. INTPH SWITCH .... HOT MIC (BOTH)
6. (**B**) SPKR/PHONE SWITCH .... PHONE (BOTH)
   (**F**) AUDIO SPKR SWITCH .... OFF (BOTH)
   (**M**) INTPH SWITCH .... INTERPHONE (BOTH)
7. (**B**/**F**) VENT BLOWER .... HIGH (PNF)
   (**M**) FWD VENT BLOWER .... HIGH (PNF)
8. (**B**/**F**) LEFT BLEED AIR VALVE ... ENVIR OFF (PNF)
   (**M**) LEFT BLEED AIR VALVE ... PNEU ONLY (PNF)

IF SMOKE DOES NOT DECREASE:

9. (**B**/**F**) LEFT BLEED AIR VALVE .... OPEN (PNF)
   (**M**) LEFT BLEED AIR VALVE .... ON (PNF)
10. (**B**/**F**) RIGHT BLEED AIR VALVE .... ENVIR OFF (PNF)
    (**M**) RIGHT BLEED AIR VALVE .... PNEU ONLY (PNF)

IF SMOKE DOES NOT DECREASE:

11. (**B**/**F**) BOTH BLEED AIR VALVES .... ENVIR OFF (PNF)
    (**M**) BOTH BLEED AIR VALVES .... ON (PNF)
12. (**B**/**F**) VENT BLOWER .... AUTO (PNF)
    (**M**) FWD VENT BLOWER .... AUTO (PNF)
13. DESCEND .... AS REQUIRED
14. CABIN PRESSURIZATION SWITCH .... DUMP AS REQUIRED (PNF)
15. LAND AS SOON AS POSSIBLE.

FUSELAGE FIRE

1. OXYGEN MASK .... DON/DEPLOY (CREW 100%) (BOTH/TA)
2. (**B**/**F**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/OFF (PNF)
   (**M**) ENVIRONMENTAL SWITCHES .... OFF/AUTO/AFT (PNF)
3. MIC SWITCH .... OXYGEN MASK (BOTH)
4. HEADSET .... ON (BOTH)
5. (**B**/**F**) INTPH SWITCH .... HOT MIC (BOTH)
   (**M**) INTPH SWITCH .... INTERPHONE (BOTH)
6. (**B**/**F**) SPKR/PHONE SWITCH ...... PHONE (BOTH)
   (**M**) AUDIO SPEAKER .... OFF (BOTH)
7. CABIN PRESSURE SWITCH .... DUMP (PNF)
8. FIRE EXTINGUISHERS ...... DEPLOY/FIGHT FIRE

IF FIRE CANNOT BE EXTINGUISHED:

9. EMERGENCY DESCENT .... ACCOMPLISH
10. LAND OR DITCH .... AS SOON AS POSSIBLE

Boxed items are memory items.
† Concurrence of both pilots required

Figure 12-10. Emergency Procedures (Sheet 2 of 3)

WING FIRE

1. EXTERIOR LIGHTS .... OFF (PNF)
2. FUEL VENT HEAT .... OFF (PNF)
3. STALL VANE HEAT .... OFF (PNF)
4. (**B**/**F**) INVERTER .... SWITCH TO OPPOSITE SIDE (PNF)
   (**M**) INVERTER (AFFECTED SIDE) ..... OFF (PNF)
5. † GENERATOR .... OFF (AFFECTED SIDE) (PNF)
6. (**B**/**F**) BLEED AIR VALVE .... INST & ENVIR OFF (PNF)
   (**M**) BLEED AIR VALVE .... OFF (PNF)

IF THE FIRE IS FUEL FED:

7. EMERGENCY ENGINE SHUTDOWN CHECKLIST .... PERFORM
8. SLIP AIRCRAFT AWAY FROM BURNING WING

IF FIRE DOES NOT GO OUT:

9. LAND OR DITCH IMMEDIATELY

PRESSURIZATION FAILURE

IF THE AIRCRAFT FAILS TO PRESSURIZE OR GRADUAL PRESSURIZATION LOSS IS EXPERIENCED:

1. CABIN ALTITUDE .... CHECK
2. PRESSURIZATION CONTROLLER .... CHECK IN PRESS POSITION
3. BLEED AIR VALVES .... CHECK OPEN
4. CABIN PRESSURIZATION SWITCH .... TEST (PNF)

IF PRESSURIZATION RETURNS:

5. PRESSURIZATION CONTROL CB ...... PULL (PNF)
6. PRESSURIZATION CONTROL CB .... RESET AFTER LANDING

IF UNABLE TO RESTORE PRESSURIZATION:

7. OXYGEN MASK ..... DON/DEPLOY AS REQUIRED (ON ABOVE 10,000 FEET) (BOTH/TA)
8. DESCEND .... AS REQUIRED
9. ASSIST PASSENGERS .... AS REQUIRED (TA)

BLEED AIR FAILURE LIGHT

1. ENGINE INSTRUMENTS .... MONITOR
2. (**B**/**F**) BLEED AIR SWITCH (AFFECTED ENGINE) .... INSTR/ENVIR OFF (PNF)
   (**M**) BLEED AIR VALVE (AFFECTED ENGINE) .... OFF (PNF)
3. CABIN PRESSURIZATION .... CHECK (PNF)

DUCT OVERTEMPERATURE LIGHT

1. CHECK FLOOR/BAGGAGE COMPARTMENT OUTLET VENTS .... OPEN, NOT OBSTRUCTED (TA)
2. CABIN AIR CONTROL KNOB .... IN
3. DEFROST/PILOT/COPILOTAIR .... PULL ON
4. CABIN TEMP MODE .... AUTO
5. CABIN TEMP CONTROL .... DECREASE
6. (**B**/**F**) VENT BLOWER .... HI
   (**M**) FWD VENT BLOWER .... HI
7. AFT BLOWER .... OFF
8. CABIN TEMP MODE .... MAN COOL
9. MANUAL TEMP .... DECR
10. LEFT BLEED AIR VALVE .... (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY

IF LIGHT IS STILL ON:

11. LEFT BLEED AIR VALVE .... OPEN
12. RIGHT BLEED AIR VALVE .... (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY

IF LIGHT IS STILL ON:

13. RIGHT BLEED AIR VALVE .... OPEN

IF VENT AIR IS STILL HOT:

14. BOTH BLEED AIR VALVES .... (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY
15. LAND AS SOON AS POSSIBLE.

DITCH/FORCED LANDING

1. ANNOUNCE INTENTION AND TIME TO DITCH .... (PNF)
2. MAYDAY MESSAGE .... TRANSMIT (PNF)
3. TRANSPONDER .... EMERGENCY (PNF)
4. CABIN PRESSURIZATION .... DUMP (PNF)
5. LIFEVEST .... ON AND ADJUSTED (DO NOT INFLATE)
6. CABIN EMERGENCY HATCH .... REMOVE AND JETTISON (TA)
7. SEATBELTS/HARNESSES............... SECURE (PASSENGERS - BRACE POSITION)
8. EMERGENCY LIGHTS .... ON
9. LANDING GEAR .... AS REQUIRED
10. FLAPS .... AS REQUIRED
11. AIRSPEED .... AS REQUIRED

Boxed items are memory items.
† Concurrence of both pilots required

Figure 12-10. Emergency Procedures (Sheet 3 of 3)

AIRCREW EMERGENCY PROCEDURES

CABIN SMOKE OR FIRE

1. PILOTS . . . . NOTIFY
2. DON OXYGEN . . . . AS REQUIRED
3. EXTINGUISH FIRE . . . . AS REQUIRED
4. PREPARE FOR DESCENT/FORCED LANDING/DITCH . . . . AS REQUIRED

LOSS OF PRESSURIZATION

1. DON OXYGEN . . . . AS REQUIRED
2. ASSIST CREW AND PASSENGERS . . . COMPLETE

DUCT OVERTEMPERATURE LIGHT

1. FLOOR OUTLET VENTS OPEN, NOT OBSTRUCTED, OR BLOCKED . . . . COMPLETED
2. BRIEF PILOTS . . . . COMPLETE

CABIN DOOR OPEN LIGHT ILLUMINATED

1. SEATBELTS . . . . FASTENED

Boxed items are memory items.

DITCH/FORCED LANDING

1. PASSENGERS . . . . BRIEFED
   - A. REMOVE ALL SHARP OBJECTS
   - B. OPERATION OF EMERGENCY EXITS
   - C. ASSIGNMENT OF AFTER DITCH DUTIES
   - D. PROPER BRACE POSITION
2. DON LIFEVEST . . . . AS REQUIRED
   - A. SURVIVAL RADIO . . . . RETRIEVED AND STOW IN POCKET
3. ESCAPE HATCH . . . . JETTISON AS DIRECTED
4. BAGS/CARGO . . . . JETTISON AS REQUIRED
   - A. PILOTS . . . . NOTIFIED
5. BRACE POSITION . . . . ASSUME
6. AFTER ALL VIOLENT MOTION STOPS . . . . EVACUATE AIRCRAFT
7. RAFT/SURVIVAL EQUIPMENT . . . . . AS REQUIRED

CRACKED CABIN WINDOW

1. PILOTS . . . . NOTIFIED
2. SEATBELTS . . . . FASTENED
3. DON OXYGEN . . . . AS REQUIRED

Figure 12-11. Aircrew Emergency Procedures

CHAPTER 13

Ground Emergencies

13.1 ABNORMAL START

Monitor ITT/TGT during normal start. If the ITT/TGT rate of increase appears likely to exceed 1,000 °C, no rise in ITT/TGT is evident within 10 seconds after selecting LOW IDLE with the condition lever, CHIP DET light illuminates, or N_1 does not accelerate normally to low idle, proceed as follows:

*1. Condition lever — Fuel cutoff (note ITT/TGT decrease).

*2. ENG START switch — OFF.

In the event of a hot start:

*3. ENG START switch — STARTER only (until reaching an ITT/TGT of 300 °C or lower).

For clearing engine, wait 60 seconds then:

4. ENG START switch — STARTER only (minimum 15 seconds, maximum 40 seconds).

CAUTION

Starter is limited to 40 seconds on, 60 seconds off, 40 seconds on, 60 seconds off, 40 seconds on, then 30 minutes off.

13.2 HOT BRAKES

Hot brakes usually are caused by excessive or heavy braking action. If hot brakes are suspected, stop the aircraft and allow the brakes to cool.

CAUTION

Do not set parking brake if hot brakes are known or suspected.

13.3 LOSS OF BRAKES

In the event of wheelbrake failure, maintain directional control with rudder, nosewheel steering, or differential power. Use propeller reversing or beta range as required to stop the aircraft. Do not attempt to taxi the aircraft. Both pilots should check their individual brakes.

13.4 FIRE ON GROUND

In the event of fire:

*1. Aircraft — Stop.

*2. Parking brake — On.

*3. Condition levers — FUEL CUTOFF (PNF).

*4. Propeller levers — FEATHER (PNF).

*5. (**B**/**F**) Firewall valves — CLOSED.

(**M**) FIRE PULL handle (affected engine) — Pulled (PNF).

Note

(**M**) If both FIRE PULL handles are pulled, both fire extinguishers will fire when the PUSH-TO-EXTINGUISH button is pressed.

*6. Fire extinguisher — As required (PNF).

*7. (**M**) FIRE PULL handle (remaining engine) — Pulled (PNF).

*8. Gangbar — OFF (PNF).

13.5 JAMMED CONTROLS ON DECK

In the event that any jamming or binding of flight or engine controls is experienced on the ground, check yaw damp and autopilot OFF, maintain the controls in the jammed or binding condition, and call for immediate inspection.

13.6 SINGLE-ENGINE TAXI

Taxiing the aircraft with one engine inoperative is not recommended if ground towing equipment is available. Taxiing can be accomplished by careful use of nosewheel steering, brake, and power. To start the aircraft taxiing from a static condition, it may be necessary to allow the aircraft to turn into the inoperative engine (perhaps a complete 360° turn) until enough speed is obtained to allow use of braking for steering without stopping the aircraft. The nosegear can be centered after speed is attained by tapping the brake on the operative engine side with full rudder in the desired direction while adjusting power as required to control speed. All turns thereafter should be made toward the inoperative engine because of the lower turning radius required. Turning into the operating engine at slow taxi speeds requires the use of the inside brake, which may cause the aircraft to stop if a low radius turn is attempted.

CHAPTER 14

Takeoff Emergencies

14.1 ABORT

The decision to abort or take off is based on V_R. A critical malfunction before V_R requires an abort. After V_R, treat the emergency as an airborne emergency. When aborting a takeoff, proceed as follows:

*1. Power levers — IDLE/REVERSE as required.

WARNING

In the event of a malfunction affecting directional control, bringing the power levers to IDLE prior to cutting off fuel may accentuate yaw and result in departure from the runway. In this case, consideration should be given to moving both condition levers to FUEL CUTOFF prior to reducing power levers.

*2. Brakes — As required.

CAUTION

Single-engine reversing, if used, must be applied cautiously or loss of directional control may result. Use extreme caution if takeoff surface is not hard and dry.

Note

The recommended technique for single-engine reversing is to hold the yoke full forward, apply aileron into the dead engine, and use rudder as required.

If anticipating leaving prepared surface:

*3. Condition levers — FUEL CUTOFF prior to leaving prepared surface (PNF).

After aircraft stops:

*4. (**B/F**) Firewall valves — Close.

(**M**) Fire pull handles — Pull (PNF).

*5. Gangbar — OFF.

14.1.1 Critical Malfunction During Takeoff

A takeoff will normally be aborted for any critical malfunctions prior to V_R, to include engine fire light, engine chip light, or other malfunctions as briefed. Refer to Figure 15-1.

Note

The decision to abort or to continue the takeoff rests with the Aircraft Commander. The takeoff abort maneuver is made by the pilot flying, who announces "ABORT," and executes the abort procedure.

CHAPTER 15

In-Flight Emergencies

15.1 ELECTRICAL SYSTEM EMERGENCIES

15.1.1 BATTERY CHARGE Light Illuminated

The BATTERY CHARGE light was originally designed to warn of a possible dangerous thermal runaway of the NiCad battery. With the valve regulated sealed lead acid battery now incorporated into the UC-12, the BATTERY CHARGE light, though deprived of most of its practical significance, remained installed as an indicator to the crew of possible battery performance problems (such as an internal short) or a malfunction of the battery charge sensor. Illumination of the BATTERY CHARGE light is expected after large loads are drawn from the aircraft electrical system, such as initial ground starts, airstarts, and multiple gear or flap actuations, but should not be expected to illuminate during normal cruise flight conditions.

If the BATTERY CHARGE light illuminates unexpectedly in flight, or does not extinguish on deck after such time as to indicate that there could be such a problem, proceed with a battery condition check as follows:

1. Turn off one generator.

Note

If BATTERY CHARGE light extinguishes after securing one generator and does not reilluminate, the cause of the BATTERY CHARGE light is most likely the paralleling circuit and not the battery. Reset the generator and note if there is a difference in generator load to verify a paralleling problem. Further battery condition checks are not warranted. Continue flight and write up problem with maintenance upon completion.

2. Note percentage load on remaining generator.

3. Turn off battery and note change in percentage generator load.

CAUTION

With battery switch secured, BATTERY CHARGE light should extinguish. If still illuminated, a malfunction with the battery charge sensor is indicated or the battery relay has fused in the closed position, resulting in an excessive amperage draw from the battery. Battery power cannot be monitored and could be lost at any time. Land as soon as practical.

Note

- This change in generator load percentage is the amount of charge the battery is drawing from the generator.
- Unlike the NiCad battery, a thermal runaway of the valve regulated sealed lead acid battery will only result in a moderate temperature peak (approximately 260 °F) at which point the water in the electrolyte vaporizes and is vented. The loss of water reduces the conductivity between battery plates and the battery ceases to accept further charge. The battery slowly cools.

4. Reset the secured generator and turn the battery back on.
5. Repeat steps 1 through 4 after waiting 90 seconds.

A successful battery condition check is indicated if observed change in generator load when securing the battery decreases during subsequent checks.

If battery fails condition check:

6. The battery is not accepting charge from the generators.
7. Battery power cannot be monitored and could be lost at any time.
8. Land as soon as practical.

If battery passes condition check:

9. The battery is accepting charge, indicating the battery and charge sensor are working properly and the BATTERY CHARGE light will soon extinguish.
10. Continued operation is permissible.
11. Continue battery condition checks until light extinguishes.

15.1.2 Bus Feeder Circuit Breaker Tripped

A short is indicated; DO NOT RESET.

15.1.3 Circuit Breaker Tripped

WARNING

A tripped standby fuel pump or fuel quantity indicator circuit breaker should not be reset.

Note

This procedure applies to both normal circuit breakers and circuit breaker-type switches.

1. Circuit breaker — Reset.

If circuit breaker trips again:

2. Do not reset.

15.1.4 (B/M) Current Limiter Check (In Flight)

1. Either generator — OFF.

2. Check for avionics off flags.

Note

- If flags are in view, then the current limiter on the side of the inoperative generator has failed. Refer to Figures (**B**) 2-12/(**F**) 2-13/(**M**) 2-14 to determine other inoperative equipment.

- If no off flags are in view, then the current limiter on the side of the inoperative generator is functioning. Complete step 3 to determine status of opposite side current limiter.

3. Actuate the windshield heat on the side of the inoperative generator. Check for the following indications.

   a. If functioning loadmeter increases and compass swings, then both current limiters are functioning.

   b. If functioning loadmeter does not increase and the compass swings, then the current limiter on the side of the operating generator has failed.

   c. If functioning loadmeter does not increase, then check a second item on affected generator bus. If the second item does not produce a loadmeter increase, then the current limiter on the side of the inoperative generator has failed.

CAUTION

If current limiter has failed simultaneously with opposite generator failure, the battery cannot be charged and should be conserved for necessary operations.

If current limiters are good:

4. Generator — ON.

15.1.5 (F) Current Limiter Check (In Flight)

1. Either generator — OFF.

2. Bus voltage — Check.

Note

- The presence of battery voltage on one bus indicates that the current limiter between the main aircraft bus and the operating generator has failed. Turn off unnecessary equipment receiving power from the battery. The operating generator will not be able to recharge the battery.

- A reading of zero volts on one of the generator buses indicates that the current limiter between the main aircraft bus and the generator indicating zero voltage has failed. In either case, leave the battery on to provide power to the main aircraft bus should the operating generator quit.

3. Generator — RESET/ON (if applicable).

CAUTION

If the current limiter has failed simultaneously with opposite generator failure, the battery cannot be charged and should be conserved for necessary operation.

15.1.6 Excessive Loadmeter Indications (Over 100 Percent)

Excessive loadmeter indications are generally caused by excessive battery charge rates or electrical system ground fault.

1. Volt/loadmeter — Note.

If an excessive charge rate is indicated:

2. Battery — OFF.

Note

Prior to landing, consideration should be given to turning on the battery for gear and flap extension or manually extending the gear and using no flaps to protect avionics equipment from power surges.

If loadmeter still indicates over 100 percent:

3. Nonessential loads — OFF.

If loadmeter still indicates over 100 percent:

4. Both generators — OFF (flight conditions permitting).

5. Land as soon as possible.

If loadmeter indicates 100 percent or below:

6. Battery — ON.

15.2 ENGINE SYSTEM EMERGENCIES

15.2.1 Engine Failure

The UC-12 exhibits no unusual handling characteristics at speeds above V_{MC}. Refer to A1-C12BM-NFM-200 Performance Charts for the climb or cruise performance that can be expected in an engine-out situation. Directional control (Figure 15-1) is a function of airspeed and power, varying directly with airspeed and inversely with power. An increase in asymmetrical power at any given airspeed results in mild yaw, accompanied by a more pronounced proverse roll into the dead engine. The rate of roll and yaw varies directly with the rate of power increase on the operative engine. These can be easily controlled with aileron and rudder. Rudder trim is sufficient to maintain balanced flight at airspeeds above approximately 100 KIAS. At speeds below 100 KIAS, full rudder trim must be supplemented by constant rudder pressure. At full rudder trim, only a few inches of rudder travel remain. The use of flaps will not significantly affect directional control, but will adversely affect performance. If full flaps are used during a single-engine approach, the waveoff procedure will result in a loss of approximately 200 feet before a positive rate of climb can be established.

An indication of impending engine failure or flameout usually is preceded by unstable engine operation. One or a combination of symptoms may prevail, such as fluctuating turbine rpm, torque, and ITT/TGT; illumination of fuel system warning lights; dropping oil pressure; and loss of thrust. In the event engine failure or unexpected flameout occurs, an airstart should be accomplished, provided time and altitude permit, unless the engine failure can be attributed to a mechanical malfunction or was accompanied by an explosion, overheating, vibration, strong fuel fumes, fire, or the N_1 tachometer indicating zero rpm. A drop in ITT/TGT, torque, and turbine rpm indicates a flameout condition. In the event of engine failure (no restart attempt), perform the Emergency Engine Shutdown checklist.

15.2.2 Engine Failure After Takeoff

*1. Power — Maximum allowable.

*2. Airspeed — V_{LOF} or greater.

*3. Gear — UP.

*†4. Propeller — Confirm autofeather or feather inoperative engine propeller (PNF).

*5. Airspeed — V_2 (until clearing obstacles, then V_{YSE}).

*6. Flaps — UP (at V_{YSE}).

*7. Emergency Engine Shutdown checklist — Perform.

Note

- Maximum climb performance can be achieved by raising the failed engine 3 to 5° up and displacing the balance ball one-half to three-quarters of a ball width toward the good engine.
- If the autofeather system is being used, retarding the power lever below approximately 90 percent N_1 before the feathering sequence is complete will deactivate the autofeather circuit and prevent automatic feathering.

15.2.3 Emergency Engine Shutdown

The Emergency Engine Shutdown checklist should be completed when:

Chip detector light.

Runaway torque increase in flight (not responsive to power lever movement).

Engine fire in flight.

Oil pressure low.

Leaking oil/fuel.

Engine failure in flight.

*†1. Condition lever — FUEL CUTOFF (PNF).

*†2. Propeller lever — FEATHER (PNF).

DIRECTIONAL CONTROL

VMCA

MINIMUM CONTROL SPEED

86 KIAS

CONFIGURATION:

- GEAR UP
- FLAPS UP
- PROPELLER WINDMILLING (DEAD ENG.)
- LIVE ENGINE TAKEOFF POWER
- 5° BANK ANGLE INTO LIVE ENGINE
- SUFFICIENT RUDDER TO MAINTAIN HEADING (SLIP BALL WILL DEFLECT TOWARD GOOD ENGINE)

VSSE

MINIMUM SAFE ONE-ENGINE INOPERATIVE SPEED

104 KIAS

CONFIGURATION:

- GEAR UP
- FLAPS UP
- PROPELLER WINDMILLING (DEAD ENG.)

NOTE:

ENGINES SHOULD NOT BE INTENTIONALLY RENDERED INOPERATIVE BELOW THIS SPEED.

PERFORMANCE

VXSE

BEST SINGLE-ENGINE ANGLE OF CLIMB SPEED

115 KIAS

CONFIGURATION:

- GEAR UP
- FLAPS UP
- PROPELLER FEATHERED (DEAD ENG.)
- LIVE ENGINE MAXIMUM CONTINUOUS POWER (2,000 RPM)

VYSE

BEST SINGLE-ENGINE RATE OF CLIMB SPEED

121 KIAS

CONFIGURATION:

- GEAR UP
- FLAPS UP
- PROPELLER FEATHERED (DEAD ENG.)
- LIVE ENGINE MAXIMUM CONTINUOUS POWER (2000 RPM)

06-E-0088

Figure 15-1. Minimum Single-Engine Airspeeds at 12,500 Pounds

Note

- Full thrust on operating engine is not available without setting operating propeller to 2,000 rpm.

- (**B**) If the starboard propeller is manually feathered with the PROP SYNC on, the propeller may not go completely into full feather but may rotate at low rpm.

†3. (**B**/**F**) Firewall valve — Closed (PNF).

(**M**) Fire pull handle — Pulled (PNF).

†4. Fire extinguisher — As required (PNF).

5. PROP SYNC — OFF.

6. AUTOIGNITION — OFF (PNF).

†7. Generator — OFF (PNF).

8. (**B**/**F**) Inverter — Match operating generator (PNF).

9. Electrical load — Check (PNF).

10. Current limiter — Check (PNF).

15.2.4 Airstarts

A starter-assisted airstart (paragraph 15.2.4.1) accomplished with the assistance of an operating generator (cross-generator start) or with the battery only is the preferred restart method and should be successful at all altitudes and airspeeds whether the propeller on the dead engine is feathered or not. A windmilling airstart (paragraph 15.2.4.2) is considered to be an alternate airstart method to be used in the event the dead engine starter is inoperative or insufficient battery power exists to successfully accomplish a starter-assisted airstart. If a windmilling airstart is to be made, the propeller must be windmilling, altitude should be below 20,000 feet, and airspeed should be above 140 KIAS prior to start.

CAUTION

- The cause for engine failure should be determined before attempting an airstart.

- Above 20,000 feet, starts tend to be hotter. During engine acceleration to idle speed, it may be necessary to periodically move the condition lever to FUEL CUTOFF to avoid an overtemperature.

- Electrical loads not required for current flight conditions should be reduced.

15.2.4.1 Airstart — Starter-Assisted

Starter-assisted airstarts may be achieved at all altitudes and airspeeds, precluding mechanical malfunctions. Restart procedures should be initiated as soon as possible after flameout while N_1 rpm is available to assist the restart.

CAUTION

Cross-generator starts generally increase ITT/TGT approximately 50 °C. If conditions permit, retard operative engine power lever to reduce the possibility of exceeding ITT/TGT limits.

1. ENVIRONMENTAL switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AFT (PNF).
2. Radar — STBY.
3. ANTI-ICE/DEICE — As required/reduce load.

†4. Power lever — IDLE.

†5. Condition lever — FUEL CUTOFF (PNF).

†6. (**B**/**F**) Firewall fuel valve — OPEN.

(**M**) Fire pull handle — In (PNF).

7. ENG START switch — START/IGNITION (PNF).
8. Ignition/fuel/(**F**)Oil pressure lights — ON/OFF/(**F**)OFF (standby boost pump as required) (PNF).
9. Condition lever — LOW IDLE (stabilized above 12 percent N_1) (PNF).
10. Oil pressure — Check.
11. ENG START switch — OFF (above 50 percent N_1) (PNF).
12. Propeller lever — Unfeather (PNF).
13. Power — As required.
14. Current limiters — Check (PNF).
15. Generators — RESET/ON (PNF).
16. AUTOIGNITION — ARM (PNF).
17. Electrical equipment — As required (PROP SYNC, ENVIRONMENTAL switches, radar, ANTI-ICE/DEICE) (PNF).
18. Environmental switches — As required (RS).

15.2.4.2 Airstart — Windmilling (No Starter, Propeller Windmilling)

CAUTION

- Windmilling airstarts should not be attempted above 20,000 feet or below 140 KIAS. Higher airspeed and lower altitude will reduce ITT/TGT on start.
- In order to conduct a windmilling airstart, the propeller must be rotating (windmilling) to ensure sufficient N_1 is available prior to ignition and fuel introduction. If the windmilling airstart procedure is conducted with a feathered propeller (regardless of propeller lever position), overtemperature could occur, causing damage to the engine.

1. ENVIRONMENTAL switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AFT (PNF).
2. Radar — STBY.
3. ANTI-ICE/DEICE — As required/reduce load.

†4. Power lever — IDLE.

†5. Propeller lever — Do not feather (PNF).

†6. Condition lever — FUEL CUTOFF (PNF).

†7. (**B**/**F**) Firewall fuel valve — OPEN.

(**M**) Fire pull handle — In (PNF).

†8. Generator (inoperative engine) — OFF (PNF).

9. Airspeed/altitude — Minimum 140 KIAS/below 20,000 feet.
10. AUTOIGNITION — ARM (ignition light ON) (PNF).
11. Fuel pressure lights/(**F**) Oil pressure lights — Out/(**F**) Out (standby boost pumps as required).
12. Condition lever — LOW IDLE (PNF).
13. Power — As required.
14. Current limiters — Check.
15. Generator — RESET/ON (PNF).
16. Electrical equipment — As required.
17. ENVIRONMENTAL switches — As required.

15.2.5 Engine Flameout (Second Engine)

*1. Airstart — As required.

The zero-wind glide distance with both propellers feathered is approximately 2 nm per 1,000 feet. In the event of a dual engine failure, proceed to the appropriate Airstart checklist. Should all attempts to restart either engine fail, establish maximum glide profile (140 KIAS, gear up, flaps up, and propellers feathered).

CAUTION

If airstart is to be conducted on second failed engine, anticipate minimum altitude loss of 2,000 to 3,000 feet before power is again available to maintain flying speed. If second engine has flamed out below 3,000 feet AGL, there may not be enough time for a restart prior to forced landing or ditch, and consideration should be given to feathering both propellers and preparing the aircraft for maximum glide.

Note

A feathered propeller will not unfeather unless the engine compressor section is operating at low idle or above.

15.2.6 Oil System Failure

15.2.6.1 Oil Pressure/Temperature

Oil pressure below 85 psi (above 21,000 feet) and (**B**) 105 psi (**F/M**) 100 psi below (21,000) is undesirable and should be tolerated only for the completion of the flight at a reduced power not to exceed (**B/F**) 1,100 foot-pounds (**M**) 49 percent torque. Oil pressure below 60 psi and/or oil temperature that exceeds 99 °C is unsafe and requires that either the engine should be shut down or a landing be made as soon as possible using minimum power to sustain flight.

15.2.7 Propeller Failure or Overspeed

Normally, the primary governor controls the speed of the propeller within the range of 1,600 to 2,000 rpm. If the primary governor fails, the propeller will either feather or overspeed. An additional governor should control an overspeed condition. Torque is limited to (**B/F**) 1,800 foot-pounds (**M**) 81 percent for sustained operation above 2,000 rpm. If a propeller should stick or move too slowly during a transient condition, the pneumatic section of the primary governor acts as a fuel topping governor when the rpm exceeds 106 percent of the selected rpm. This limits the fuel flow, thereby reducing the power driving the propeller.

If an overspeed condition occurs that is not controlled by the governors, power lever, or prop lever, proceed as follows:

*1. Power lever (affected engine) — Reduce.

2. Airspeed — Reduce.

†3. Propeller lever — Feather (PNF).

†4. Condition lever — As required (PNF).

Note

If the propeller feathers, consider leaving engine running to provide generator power.

If propeller fails to feather:

†5. Condition lever — FUEL CUTOFF (PNF).

6. AUTOFEATHER — Hold to TEST until prop feathers (PNF).

7. Emergency shutdown checklist — COMPLETE as required.

15.3 FIRE

15.3.1 In-Flight Fire

Fire in flight is a critical emergency requiring the pilot to assess, diagnose, and take prompt corrective action. Depending on the circumstances and seriousness of the fire, consideration should be given to making an immediate descent and landing. Do not unnecessarily delay the decision to land while executing emergency procedures. If conditions warrant, every attempt should be made to locate the source of any smoke prior to initiating an emergency procedure. Smoke or fumes originating from the bleed air/environmental system differ from those caused by electrical malfunctions in odor and color. Normally, electrical fumes are acrid and burn the eyes whereas bleed air related smoke and fumes are darker in color and smell like burning oil or overheating ducting. If the source of fumes cannot be determined, perform Cockpit/Cabin Fire/Smoke/Fumes (Electrical Source Suspected) procedure in paragraph 15.3.2. If smoke or fumes are related to a bleed air/environmental malfunction, perform the Cockpit/Cabin Fire/Smoke/Fumes (Environmental Source Suspected) procedure in paragraph 15.3.3.

15.3.2 Cockpit/Cabin Fire/Smoke/Fumes (Electrical Source Suspected)

*1. Oxygen mask — Don/deploy (crew 100 percent) (both/TA).

2. Environmental switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AFT (PNF).

3. MIC switches — Oxygen mask (both).

4. Headset — ON (both).

5. (**B**) Speaker/phone switch — PHONE (both).

   (**F**) Audio speaker switch — OFF (both).

   (**M**) Interphone switch — INTERPHONE (both).

Note

Use of intercom requires headset on.

If source is known:

6. Affected power switch(es) — Off (PNF).

7. Affected circuit breaker(s) — Pull (PNF).

8. Fire extinguisher — As required (PNF/TA).

WARNING

Vapors from the portable fire extinguisher agent, while not poisonous, can cause asphyxiation by displacement of oxygen in confined space. The cabin should be ventilated as soon as possible.

If source is unknown:

9. AVIONICS MASTER switch — OFF (PNF).

10. Volt/loadmeters — Check (PNF).
11. Nonessential electrical equipment — Off (both).
12. Fire extinguisher — As required (PNF/TA).

If fire or smoke ceases:

13. Individually restore avionics and equipment — As required (both).
14. Isolate defective equipment — As required (both).
15. Cabin pressure switch — DUMP (PNF) (ventilate cabin).

Note

Battery or generator power is required to dump cabin pressure.

16. Land as soon as practical.

Note

After the cabin is depressurized, the pilot or copilot storm window may be opened.

If fire or smoke persists:

17. Land as soon as possible.

WARNING

Severity of the fire and conditions present will dictate whether an emergency descent and immediate landing/ditch is required.

18. Both bleed air valves — (**B**/**F**) ENVIR OFF (**M**) PNEU ONLY (PNF).
19. Gangbar — OFF.

Note

- After securing all electrical power, the following instruments are still available: pilot standby gyro, copilot altimeter and turn and bank, pitot static instrument, N_1, ITT/TGT, propeller rpm, clocks, and standby compass. Instruments lost are the pilot altimeter and radar altimeter. The aural stall warning system is also inoperative.
- A loss of power (i.e., gangbar OFF) will cause the bleed air valves to close with a subsequent loss of pressurization.

15.3.3 Cockpit/Cabin Fire/Smoke/Fumes (Environmental Source Suspected)

Note

This checklist is designed to troubleshoot the origin of the malfunction and requires that steps 10 to 14 be accomplished slowly enough to allow the system to react and determine whether the smoke is decreasing.

*1. Oxygen mask — Don/deploy (crew 100 percent) (both/TA).

2. ENVIRONMENTAL switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AFT (PNF).

3. MIC switches — OXYGEN MASK (both).

4. Headset — ON (both).

5. INTPH switch — HOT MIC (both).

6. (**B**) SPKR/PHONE switch — PHONE (both).

   (**F**) AUDIO SPKR switch — OFF (both).

   (**M**) INTPH switch — INTERPHONE (both).

7. (**B**/**F**) Vent blower — HIGH (PNF).

   (**M**) Fwd vent blower — HIGH (PNF).

8. Left bleed air valve — (**B**/**F**) ENVIR OFF (**M**) PNEU ONLY (PNF).

If smoke does not decrease:

9. Left bleed air valve — (**B**/**F**) OPEN (**M**) ON (PNF).

10. Right bleed air valve — (**B**/**F**) ENVIR OFF (**M**) PNEU ONLY (PNF).

If smoke does not decrease:

11. Both bleed air valves — (**B**/**F**) ENVIR OFF (**M**) ON (PNF).

12. (**B**/**F**) Vent blower — AUTO (PNF).

    (**M**) Fwd vent blower — AUTO (PNF).

13. Descend — As required.

14. Cabin pressurization switch — DUMP as required (PNF).

15. Land as soon as possible.

WARNING

Severity of the fire/smoke and conditions present will dictate whether an emergency descent and immediate landing/ditch is required.

Note

After the aircraft is depressurized, the pilot or copilot storm window may be opened.

15.3.4 Wing Fire

There is little that can be done to control a wing fire except to shut off fuel and electrical systems that may be contributing to the fire or could aggravate it. Slipping the aircraft away from the burning wing may help.

1. Exterior lights — OFF (PNF).

2. Fuel vent heat — OFF (PNF).

3. Stall vane heat — OFF (PNF).

4. (**B**/**F**) Inverter — Switch to opposite side (PNF).

   (**M**) Inverter (affected side) — OFF (PNF).

†5. Generator — OFF (affected side) (PNF).

6. Bleed air valve — (**B**/**F**) INST & ENVIR OFF (**M**) OFF (PNF).

If the fire is fuel fed:

7. Emergency Engine Shutdown checklist — Perform.

8. Slip aircraft away from burning wing.

If fire does not go out:

9. LAND OR DITCH **IMMEDIATELY.**

15.3.5 Fuselage Fire

*1. Oxygen mask — Don/deploy (crew 100 percent) (both/TA).

2. ENVIRONMENTAL switches — OFF/AUTO/(**B**/**F**) OFF (**M**) AFT (PNF).

3. MIC switch — Oxygen mask (both).

4. Headset — On (both).

5. INTPH switch — (**B**/**F**) HOT MIC (**M**) INTERPHONE (both).

6. (**B**/**F**) SPKR/PHONE switch — PHONE (both).

   (**M**) AUDIO SPEAKER — OFF (both).

7. CABIN PRESSURE switch — DUMP (PNF).

8. Fire extinguishers — Deploy/fight fire.

If fire cannot be extinguished:

9. Emergency descent — Accomplish.

10. Land or ditch — As soon as possible.

15.3.6 Cabin Smoke or Fire (Aircrew)

Fires are a critical emergency requiring the pilot and aircrewman to assess, diagnose, and take prompt corrective action.

*1. Pilots — Notify.

*2. Don oxygen — As required.

*3. Extinguish fire — As required.

*4. Prepare for descent/forced landing/ditch — As required.

15.4 FLIGHT CONTROL SYSTEM EMERGENCIES

15.4.1 Elevator Trim Controls Frozen in Flight

Moisture entering or condensing in the elevator trim control clutch assembly can freeze in flight, locking the trim in a cruise position. The condition is first noticed when preparing for descent or retrimming at altitude. The autopilot provides some trim control; however, the (**B**) elevator trim meter shows a constant deflection, indicating that a sustained signal is applied to the elevator servo, (**F**/**M**) elevator trim annunciator indicates UP or DN when a sustained signal is applied to the elevator servo. Flight in above-freezing temperatures will normally clear the problem before landing. If the elevator control is still frozen during approach, control forces must be overcome physically. Descent should be made using power reduction to keep heavy control forces caused by airspeed increases to a minimum. Consideration should be given to using a no-flap approach and landing to ease control back pressure if trim has not freed prior to landing.

15.4.2 Autopilot Emergency Disengagement

WARNING

Failure of the autopilot circuit breaker in flight will cause the autopilot to disengage with no annunciator indications.

The following conditions will cause the autopilot to disengage automatically: any interruption or failure of power, vertical gyro failure, activation of vertical gyro fast erect, compass INCREASE-DECREASE switch, a flight control system power failure or circuit failure, directional gyro failure, or torque limiter failure. The autopilot may be intentionally disengaged by any of the following methods:

1. Pushing AP/YD disconnect switch (either control wheel).
2. Pushing (**B**) AUTOPILOT TEST/(**F**/**M**) AP ENGAGE button on AFCS control panel.
3. Actuation of GO-AROUND button.
4. Pulling (**B**) FLT DIR/AP POWER (**F**) AP CONTROL (**M**) AFCS/AP POWER circuit breaker.
5. Turning OFF BATT/GENS (gangbar) or AVIONICS MASTER switch.
6. Turning off inverter.
7. Activation of respective vertical gyro FAST ERECT button.
8. Actuation of pilot compass INC — DEC switch.
9. Actuating electric elevator trim.

15.4.3 Electric Elevator Trim Failure

1. Attitude — Maintain.
2. TRIM DISC switch — Depress.
3. Retrim — Manually.
4. ELEVATOR TRIM switch — OFF.

CAUTION

Do not reactivate electric trim system until cause of malfunction has been determined.

15.4.4 In-Flight Damage/Binding Controls

If the aircraft should sustain damage because of a midair collision, bird strike, or overstress, the single most important concern is maintaining or regaining control of the aircraft. Monitor engine instruments for unusual indications and flight control for free and correct response. Existing conditions may warrant consideration of airborne visual check. Proceed as follows:

1. Climb to at least 5,000 feet AGL. If possible, climb at or above airspeed at which damage occurred.
2. Check flight characteristics in landing configuration, decreasing airspeed in increments of 10 knots to an airspeed at which a safe landing can be made (no slower that 104 KIAS), one-half control yoke or one-half rudder deflection.
3. If flap damage is suspected, make a no-flap approach.

WARNING

Due to unknown flight characteristics of damaged aircraft, a stall may result in uncontrolled flight. If a stall or spin occurs, execute recovery in accordance with paragraphs 11.8.5.2 or 15.8.7.

4. Land as soon as possible (fly a wide straight-in approach to a shallow, minimum sink rate landing at or above target airspeed).

15.4.5 Rudder Boost Failure

Rudder boost operation without a large variation in power between engines indicates a failure of the rudder boost system. For any unscheduled rudder boost activation, proceed as follows:

1. Rudder boost — OFF.

If condition persists:

2. Rudder trim — Adjust.

If condition persists:

3. RUDDER BOOST circuit breaker — Pull.

If conditions persists, prior to approach landing:

4. Both bleed air valves — OFF.

15.4.6 CABIN DOOR OPEN Light Illuminated (Aircrew)

*1. Seatbelts — Fastened.

The aircrewman is responsible for verifying that all passengers and crewmembers are fastened and secure.

15.5 FUEL SYSTEM EMERGENCIES

15.5.1 Auxiliary Fuel Transfer Failure

1. Auxiliary transfer — Override.
2. Auxiliary fuel gauge — Monitor.

Note

- In turbulence or during maneuvers, the NO TRANSFER light may momentarily illuminate after the auxiliary fuel has completed transfer.
- (**M**) The motive flow transfer valve and NO FUEL XFR caution annunciators share a common circuit. It is possible for the auxiliary fuel transfer to fail without illumination of the associated #1 and #2 NO FUEL XFR lights.

15.5.2 Crossfeed

Crossfeed is primarily intended to allow continued single-engine operation, not to correct minor fuel imbalance in flight. Crossfeed to support dual-engine is not recommended or normally required; however, it is not prohibited if deemed necessary by the aircraft commander. If crossfeed is deemed necessary, proceed as follows:

WARNING

When crossfeeding, if the tank is run dry, the feeding side will flame out.

1. Auxiliary transfer switches — AUTO.
2. Standby boost pumps — OFF.
3. CROSSFEED switch — Select (L) or (R) as required.
4. FUEL CROSSFEED light — Check ON.

To discontinue crossfeed:

5. CROSSFEED switch — OFF.

Note

- (**B/F**) If it is necessary to crossfeed auxiliary tank fuel, the firewall valve in the supplying side must be opened. If the firewall valve is closed, the auxiliary fuel supply will not be available and the FUEL PRESS light will remain illuminated on the side supplying fuel.
- (**M**) The AUX XFER switch must be in AUTO position on side receiving fuel. If the FIRE PULL handle on the supporting side is pulled, auxiliary fuel supply will not be available, and the FUEL PRESS annunciator will remain illuminated.

15.5.3 Fuel Leak

A fuel leak may be evidenced by the smell of fuel in the cockpit, a rapid drop in fuel quantity, or sighted visually. The first concern of the crew must be to guard against the outbreak of fire. Consideration should be given to securing electrical systems. Electrical systems that may be individually secured from the cockpit are the navigation and strobe lights, fuel vent heaters, and the stall warning sensor heater. If a wing or nacelle fuel leak is evident and a single-engine power would be sufficient to sustain flight or reach a safe destination, consideration should be given to securing the engine as follows:

1. Emergency Engine Shutdown checklist — Perform.

15.5.4 Fuel Siphoning

If fuel filler cap or fuel vent siphoning occurs, proceed as follows:

1. Airspeed — 140 KIAS.
2. Land as soon as practical.

Note

Extreme nose-low attitudes will aggravate the fuel siphoning condition.

15.6 ICING

15.6.1 (B) Electrothermal Propeller Deice Malfunction (Normal 14 to 18 Amps)

Note

If at any time during these procedures a propeller imbalance occurs, increase rpm briefly to aid in ice removal.

If 0 amps:

1. Propeller DE-ICE switch — Check position.

If OFF:

2. Reposition propeller DE-ICE switch to ON after 30 seconds.

If ON and system is inoperative:

3. Propeller DE-ICE switch — OFF.

4. Use manual backup system; monitor loadmeter.

If 0 to 13 amps:

5. Continue operation.

If 19 to 23 amps:

6. Continue operation.

If circuit breaker trips:

7. Use manual system (monitor loadmeter).

If manual mode circuit breaker trips:

8. Avoid icing conditions.

Note

To use manual system, hold to outer position, then inner position. Monitor loadmeter when switching from outer to inner for indication of operation.

15.6.2 (F/M) Electrothermal Propeller Deice Malfunction (Normal 18 to 24 Amps)

Note

If at any time during these procedures a propeller imbalance occurs, increase rpm briefly to aid in ice removal.

If 0 amps:

1. Propeller DE-ICE switch — Check position.

If OFF:

2. Reposition the propeller DE-ICE switch (**F**) AUTO/(**M**) ON after 30 seconds.

If ON and system is inoperative:

3. Propeller DE-ICE switch — OFF.

4. Use manual backup system, monitor loadmeter.

If 0 to 18 amps:

5. Continue operation.

If over 24 amps:

6. Continue operation.

If circuit breaker trips:

7. Use manual system (monitor loadmeter).

If manual mode circuit breaker trips:

8. Avoid icing conditions.

Note

To use manual system, hold the MANUAL propeller DE-ICE switch to MANUAL (approximately 90 seconds) or until ice is dislodged.

15.6.3 Pilot Alternate Static Air Source

The possibility of obstructed static air ports should be considered when the aircraft has been exposed to moisture and/or icing conditions (especially on the ground). Partial obstructions will result in sluggish VSI indications during climb and descent. A suspected obstruction may be verified by switching to the emergency system (ALTERNATE) and noting a change in VSI indication. This may be accompanied by abnormal indication in airspeed and altitude changes beyond normal calibration differences (refer to A1-C12BM-NFM-200 Performance Charts). When obstruction exists or is suspected, the alternate position on the pilot static air source should be selected.

Note

With a complete loss of the pitot static air system, attitude reference flight should be used in conjunction with known power settings.

15.6.4 Surface Deice Malfunction

If boots fail to inflate:

1. Operate manually.

If boots fail to deflate:

2. Pull SURF DEICE circuit breaker and reset as necessary to operate boots.

15.7 PRESSURIZATION SYSTEM EMERGENCIES

15.7.1 Excessive Differential Pressure

If the cabin differential pressure exceeds maximum, ensure that there is normal suction and no obstructions on the aft bulkhead (TA) and proceed with the following:

1. Cabin controller — Higher.

If condition persists:

2. Left bleed air — (**B**/**F**) ENVIR OFF (**M**) PNEU ONLY.

If condition persists:

3. Right bleed air — (**B**/**F**) ENVIR OFF (**M**) PNEU ONLY.

If condition persists:

4. Cabin pressure — DUMP.

5. Bleed air valves — (**B/F**) OPEN (**M**) ON (to provide heat).

15.7.2 Explosive Decompression

An explosive decompression affects everyone onboard and can be extremely dangerous at high altitudes. Some effects that accompany explosive decompression and can be expected are: a rush of air from the lungs, possible gas pains, hypoxia, and a momentary dazed sensation. The fog caused by an explosive decompression could be confused with smoke. If an explosive decompression should occur, proceed as follows:

*1. Oxygen mask — Don/deploy (crew 100 percent) (both/TA) (if above 10,000 feet).

*2. Descent — As required.

3. MIC switch — As required (both).

4. Headset — As required (both).

5. Interphone switch — HOT MIC as required (both).

6. (**B**) Speaker/phone switch — As required (both).

   (**F/M**) Audio speaker switch — As required (both).

15.7.3 Pressurization Failure

If the aircraft fails to pressurize or gradual pressurization loss is experienced:

1. Cabin altitude — Check.

2. Pressurization controller — Check in PRESS position.

3. Bleed air valves — Check open.

4. Cabin pressurization switch — TEST (PNF).

If pressurization returns:

5. Pressurization control circuit breaker — Pull (PNF).

Note

- Pull circuit breaker prior to releasing pressurization test switch.

- Pressurization control circuit breaker must be reset if cabin pressure is to be dumped. Electrical power is required to dump the cabin.

6. Pressurization control circuit breaker — Reset after landing.

If unable to restore pressurization:

7. Oxygen mask — Don/deploy (as required) (on above 10,000 feet) (both/TA).

8. Descend — As required.

9. Assist passengers — As required (TA).

Note

When loss of pressurization occurs, aircrewman must be particularly alert of passenger distress.

15.7.4 Loss of Pressurization (Aircrew)

The following emergencies may result in loss of pressurization:

Environmental pressure systems malfunction.

Smoke and fumes elimination.

Explosive decompression.

*1. Don oxygen — As required.

*2. Assist crew and passengers — COMPLETE.

Note

When loss of pressurization occurs, aircrewman must be particularly alert of passenger distress.

15.8 MISCELLANEOUS

15.8.1 Cracked or Damaged Windshield

1. Eye protection — Don.
2. Pilot/Copilot seats — Lower.
3. Determine if damage is on the inner or outer panel.

Note

Outer panel cracking will typically be distinguished by a break pattern of relatively large fragments. Inner panel cracking will be distinguished by a break pattern of small fragments.

If damage is on the inner panel, or if the cracked panel cannot be determined:

4. Pressure differential — Reduce (no more than 4.0 psid within 10 minutes).
5. Descend — As required.
6. Land as soon as practical.

WARNING

Damage to the inner panel compromises the structural integrity of the windshield. Catastrophic failure is possible.

If crack is positively determined to be on the external panel:

7. No immediate action is necessary.

CAUTION

Windshield wipers may be damaged if used on a cracked outer panel.

Note

Heating elements may be inoperative in the area of the crack.

15.8.2 Cracked Cabin Window

If the external cabin window cracks, unpressurized flight may be continued. Proceed as follows:

1. Oxygen mask — Don/deploy as required.
2. Seatbelts — Fastened (TA).
3. Assist passengers — As required (TA).
4. Cabin pressurization — Depressurize.
5. Descend — As required.

Note

The aircraft shall not be flown once landed without proper ferry flight authorization.

15.8.3 Cracked Cabin Window (Aircrew)

*1. Pilots — Notified.

*2. Seatbelts — Fastened.

*3. Don oxygen — As required.

15.8.4 Emergency Descent Procedure

The emergency descent procedure is a maximum effort intended to be used for a sustained descent. Aircraft damage, MEA, and meteorological condition should be considered.

*1. Power levers — IDLE.

*2. Propeller levers — FULL FORWARD.

*3. Flaps — APPROACH (V_{FE}).

*4. Landing gear — DOWN (V_{LE}).

*5. Airspeed — Do not exceed V_{LE}.

CAUTION

On completion of emergency descent, do not raise the landing gear above V_{LO}.

15.8.5 Loose or Unlatched Cowling

Indication of loose or unlatched cowling requires the following immediate action:

1. Power lever (affected engine) — Reduced.
2. Airspeed — Reduced.
3. Land as soon as possible.

Note

Extending the corresponding ice vane may create a vacuum that will draw the cowling closed.

15.8.6 Duct Overtemperature Light (Aircrew)

A DUCT OVERTEMP caution light will illuminate if the cabin air duct temperature exceeds 300 °F.

1. Floor outlet vents open, not obstructed, or blocked — COMPLETED.
2. Brief pilots — COMPLETE.

15.8.7 Spin Recovery

Intentional spins are not permitted. If a spin is inadvertently entered, use the following recovery procedures that, although not tested, are based on the best available information. Accomplish steps 1 through 3 as simultaneously as possible:

1. Power levers — IDLE.
2. Apply full rudder opposite the direction of the spin rotation.
3. Rapidly move the control wheel forward and neutralize ailerons.
4. When rotation stops, neutralize rudder.
5. Execute a smooth pullout.

WARNING

Do not pull out of the resulting dive too abruptly as this could cause excessive wing loads and possible secondary stall.

15.8.8 Unusual Attitude Recovery

It is essential that all pilots recognize unusual attitude by means of the “picture” on the attitude indicator or by unusual performance on the performance instruments. Unusual attitudes are usually classified as nose high and nose low. If it is positively determined that the aircraft has entered an unusual attitude, the following procedures should be followed.

15.8.8.1 Nose-High Recovery

Factors to consider are pitch attitude and airspeed. If pitch attitude is not extreme and airspeed is not approaching the stall ranges, recovery can be considered to be a normal nose-high attitude.

To recover from a normal nose-high unusual attitude, use power as necessary and smoothly lower the nose toward the level flight attitude. As the nose approaches the level flight attitude, level the wings and readjust power as necessary.

If pitch attitude is extreme or airspeed is approaching stall, recovery can be considered to be for an extreme nose-high attitude.

To recover from an extreme nose-high unusual attitude, roll the aircraft in the shortest direction toward the wingover position. As the nose falls through the horizon, level the wings and raise the nose to the level flight attitude. Use power as necessary throughout the recovery.

15.8.8.2 Nose-Low Recovery

Factors to be considered in recovering from nose-low unusual attitudes are altitude and g-loading during pullout. If altitude permits, avoid rolling pullouts since allowable stresses in an angle of bank are considerably lower than those allowed in a wings-level pullout.

To recover from a nose-low unusual attitude, roll to a wings-level upright position, then raise the nose to the level flight attitude. Decrease power and consider props full forward (as a braking device) as appropriate.

15.8.9 Windshear Escape Maneuver

Windshear is defined as any rapid change in wind direction or velocity. Severe windshear is defined as a rapid change in wind direction or velocity causing airspeed changes greater than 15 knots or vertical speed changes greater than 500 fpm. The best way to escape windshear is to avoid it. Refer to Figure 19-2.

Hourly sequence reports, convective activity, PIREPS, Severe Weather Watch Reports, and LLWAS (Low Level Windshear Alert Systems) can aid a pilot in assessing the potential for windshear conditions. Use ORM techniques to balance the need of operating in areas of severe windshear.

Pilots may inadvertently encounter severe windshear. On approach/landing and takeoff, pilots should use the following guidelines for uncommanded changes from normal flight to prompt immediate escape actions when the aircraft is 1,000 feet AGL or less (or greater, if in the evaluation of the Aircraft Commander that the aircraft is in danger):

± 15 KIAS.
± 500 fpm of vertical speed.
± 5° of pitch attitude.
± 1 dot glideslope displacement (approach only).
Unusual throttle position for a significant period of time (approach only).

CAUTION

- A microburst is beyond the performance capability of transport category airplanes.

- Do not land or take off when tower broadcasts words such as “MICROBURST ALERT,” “MICROBURST,” or “SHEAR OF 30 KNOTS” or greater.

Pilot flying:

*1. Power — MAXIMUM.

*2. Autopilot — DISENGAGE.

*3. Pitch attitude/wings — Rotate toward 15°/gently roll wings level.

*4. Configuration — Do not change.

When clear of the windshear emergency event:

5. Waveoff procedure (normal) — Perform.

Note

- Move power lever aggressively to the forward stops. PNF should maintain power lever position. The additional performance gained by exceeding engine limits may give the margin needed for survival.

- Do not stop or delay for analysis. Rotate smoothly at 3° per second until reaching 15° nose up. Stop rotation if stall warning sounds or initial buffet occurs.

- If ground contact is imminent, rotate past the 15° target attitude and increase pitch to the lower limit of the stall warning threshold. Use the upper limit for the pitch attitude until terrain clearance is assured. The stall warning provides 4 to 12 knots of stall protection.

- Do not change gear, flap, or trim configuration until terrain clearance is assured.

- PNF call out continuous radio altitude trend (i.e., “CLIMBING . . . 200 FEET DESCENDING . . . 150 FEET . . .”).

- Advise ATC of any windshear encounter.

CHAPTER 16

Landing Emergencies

16.1 SINGLE-ENGINE LANDING

Fly a normal pattern and perform the Landing checklist as appropriate. Extend full flaps only if required, and then only after there is no possibility of a waveoff. If altitude and airspeed cannot be maintained while maneuvering for landing, the landing gear and flaps should be retracted, then lowered and checked down when landing is assured. Do not extend full flaps until gear is down and locked. Make a normal touchdown, reducing power during flare. Avoid excessive or abrupt changes in power. A feathered propeller will result in less drag and may cause the aircraft to "float" during landing. After touchdown, apply brakes and reversing as required. Plan all landings to touch down on runway centerline. Figures 16-1, 16-2, 16-3, and 16-4 depict various single-engine landing patterns and approaches.

Note

Single-engine reversing, if used, must be applied cautiously or loss of directional control may result. Use extreme caution if landing surface is not hard and dry. The recommended technique for single-engine reversing is to hold full forward on the yoke, apply aileron into the dead engine, and use rudder as required.

16.1.1 Single-Engine Waveoff/Missed Approach

The decision to wave off must be made as early as possible. For single-engine climb performance, refer to A1-C12BM-NFM-200 Performance Charts.

*1. Power — Maximum (ensure propeller lever is full forward).

*2. Nose attitude — Establish positive rate of climb (7 to 10° nose up). Go-around pitch bar may be helpful.

*3. Airspeed — As required (V_{XSE} or V_{YSE}).

Note

- Steps 1, 2, and 3 are to be accomplished simultaneously in order to ensure a positive rate of climb is established at the required airspeed. If maximum rate or maximum angle of climb is not required, allow the aircraft to accelerate to normal climb airspeed.

- Electric trim may not be adequate to relieve the high longitudinal control forces associated with the transition from landing attitude to climb attitude.

*4. Gear — UP.

*5. Flaps — UP.

Note

If flaps are full down, it is recommended they be raised in increments, set flaps to 40 percent, allow airspeed to increase to at least V_{YSE}, ensure a positive rate of climb is established, then raise full UP.

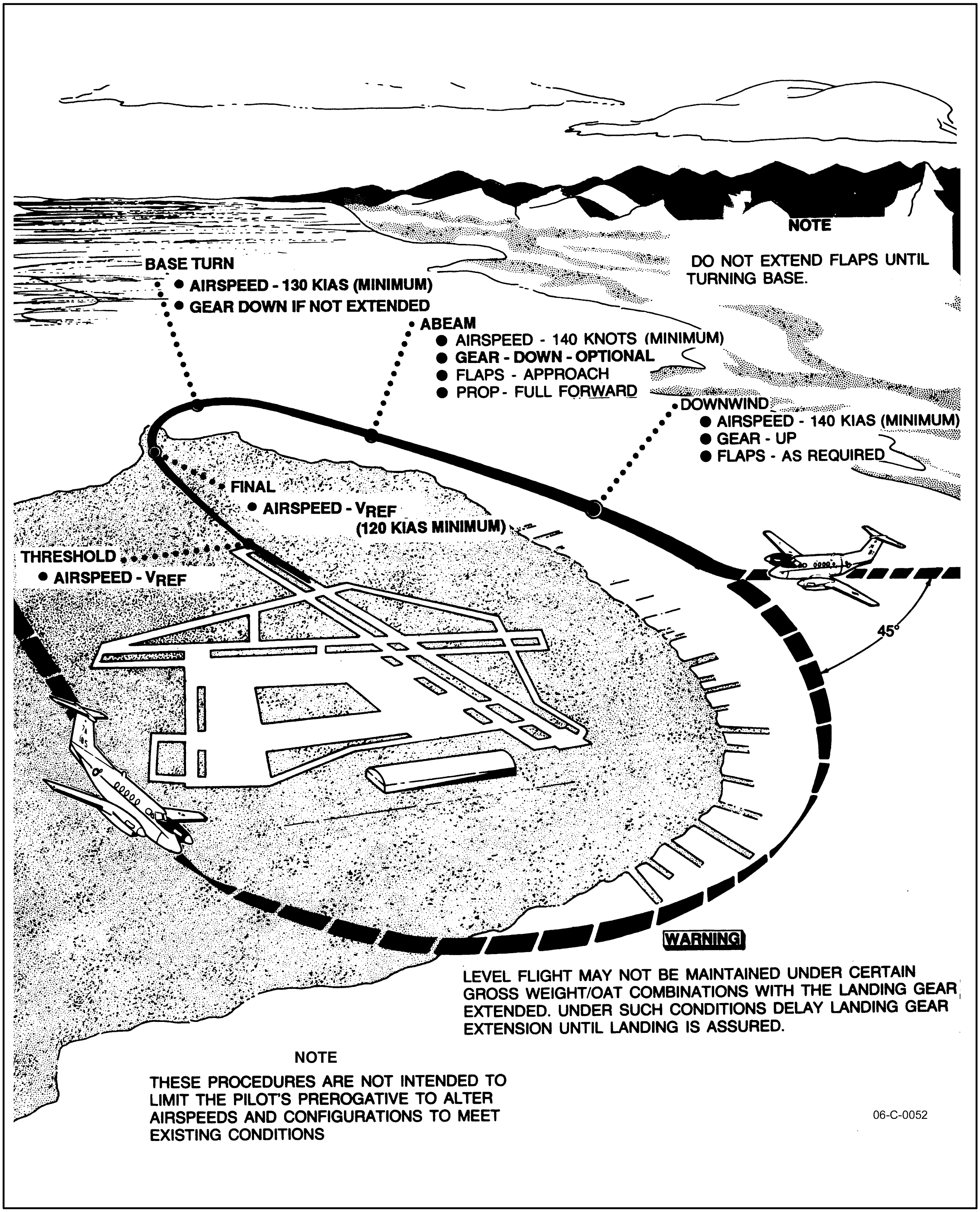


Figure 16-1. Single-Engine Landing Pattern

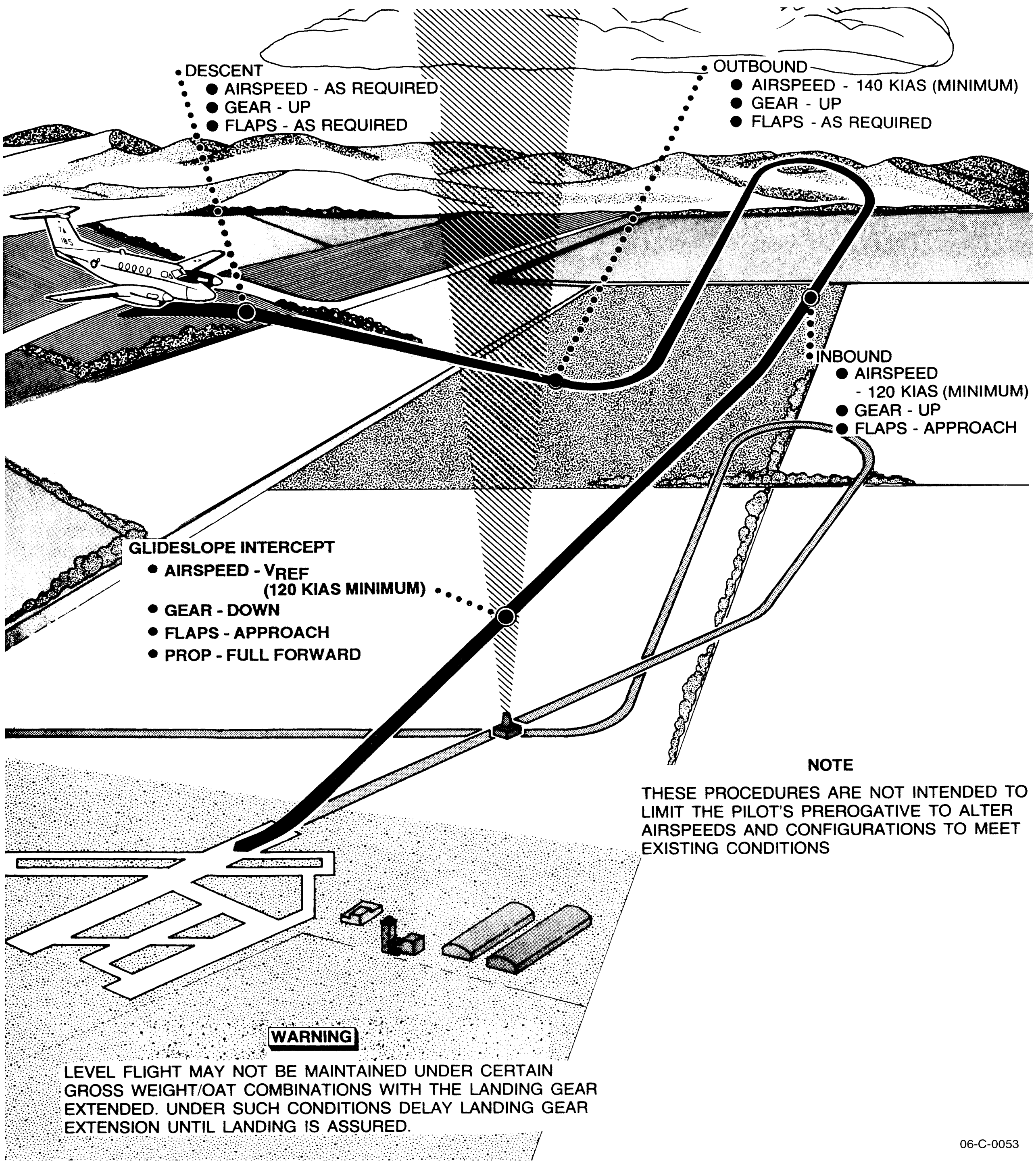


Figure 16-2. Single-Engine ILS Approach (Typical)

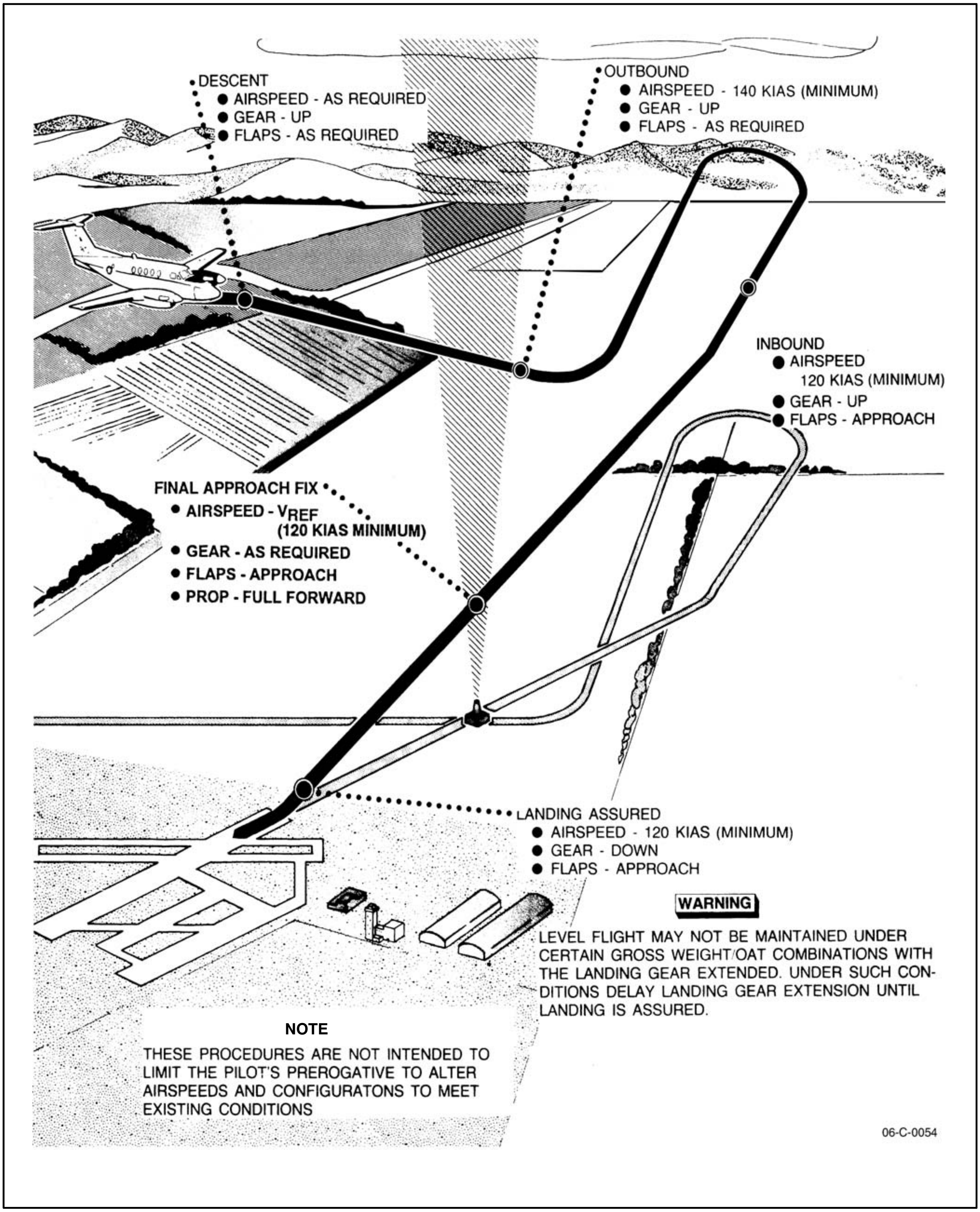


Figure 16-3. Single-Engine Nonprecision Approach (Typical)

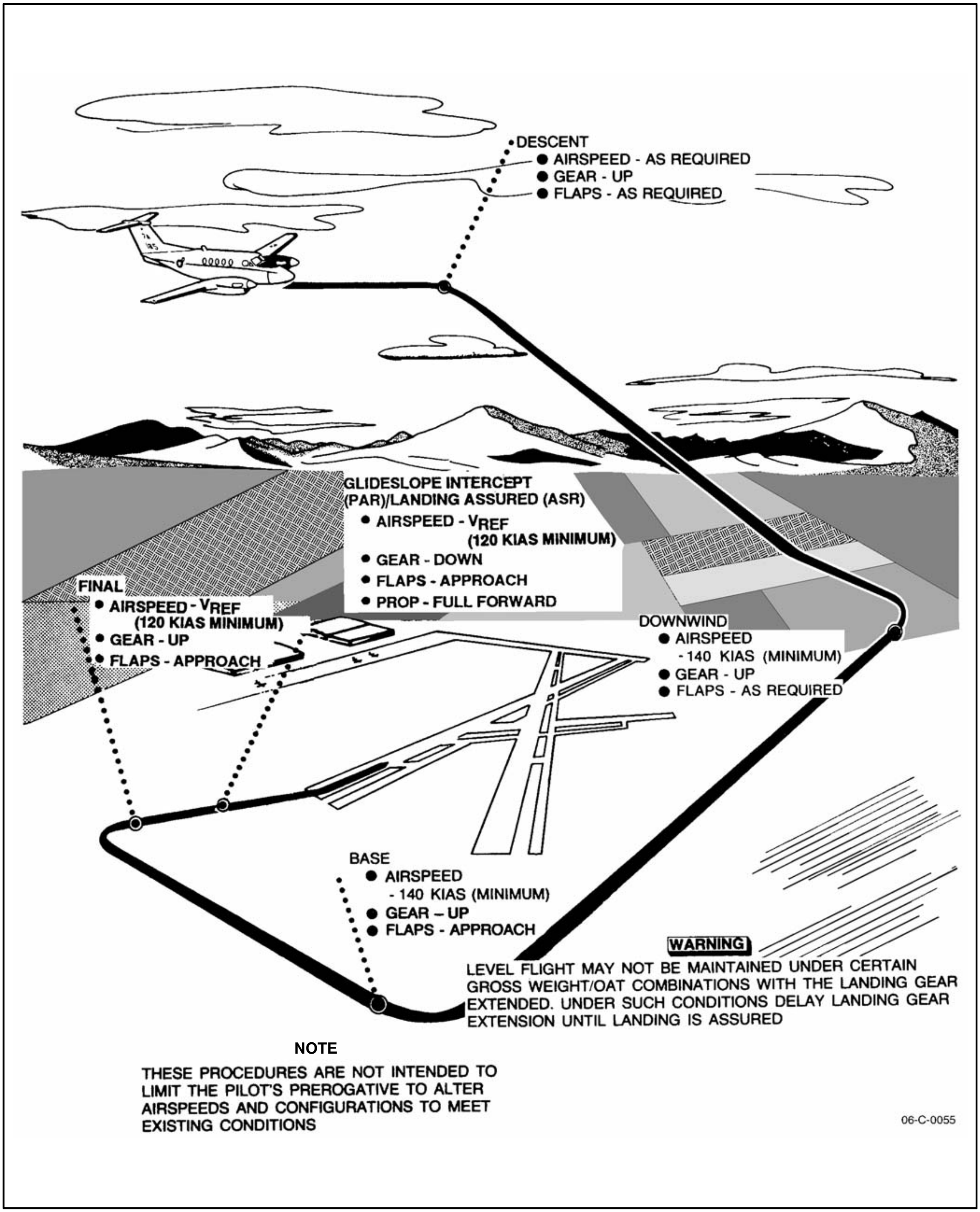


Figure 16-4. Single-Engine Radar Approach (Typical)

16.2 FLAP SYSTEM FAILURE

There are no provisions for emergency flap operation. If wing flaps are inoperative and function cannot be restored, land the aircraft in the existing flap configuration. Refer to the landing distance charts in A1-C12BM-NFM-200 Performance Charts for landing distance. If a split-flap condition is encountered, return the flaps to the previously selected position. The aircraft has been flight tested under all possible asymmetric flap configurations and found to be fully controllable within the normal envelope.

16.3 LANDING GEAR EMERGENCIES

Landing gear emergencies are considered "deferred" emergencies. Provided adequate fuel remains, it is highly recommended that the pilot enter holding or a delta pattern above the duty runway to thoroughly review procedures outlined in this section. Such delay also ensures the aircraft is at a lower fuel state if the pilot must land without all three landing gear down and locked.

16.3.1 (F/M) Low Hydraulic Fluid or Uncommanded Partial Landing Gear Extension

The hydraulic power pack receives hydraulic fluid from the primary hydraulic reservoir and provides the means to extend, retract, and maintain the landing gear in the up position. A HYD FLUID LOW caution light normally indicates critical fluid loss and imminent power pack failure; however, even with a HYD FLUID LOW caution light, it is expected that hydraulic fluid will be available for manual gear extension, provided the leak is not within the alternate extension system. If the leak is in the alternate extension system, failure to promptly extend the landing gear may result in a gear-up landing. It is possible to have low hydraulic fluid quantity without the illumination of the HYD FLUID LOW caution light due to either a failure of the hydraulic fluid sensor or an open landing gear control circuit breaker. In these cases, the only method to identify and monitor hydraulic fluid loss in flight is by observation of streaming or leaking hydraulic fluid from the source of the leak; however, the location of any particular hydraulic leak may preclude observation from the inside of the aircraft. Loss of hydraulic fluid may inhibit proper operation of the landing gear system.

WARNING

If the landing gear control circuit breaker is open or if the hydraulic fluid sensor is inoperative, the HYD FLUID LOW caution light will not illuminate regardless of the hydraulic fluid level.

With or without a HYD FLUID LOW caution light, if there is insufficient hydraulic fluid to maintain the landing gear in the up position, the hydraulic power pack will experience fluid starvation and cavitate. After approximately 14 seconds of continuous operation of the power pack motor, in this condition, the time delay circuit will open and electrical power to the power pack motor will be interrupted. With insufficient hydraulic pressure and no fluid or power pack to reenergize the system, the landing gear will partially extend uncommanded. If a HYD FLUID LOW caution is illuminated or if uncommanded partial landing gear extension occurs, low hydraulic fluid is suspected. Proceed as follows:

1. Landing gear (**F**) relay/(**M**) control circuit breaker — Check.

If circuit breaker is in, proceed with step 2. If out, do not reset. Proceed to step 4.

2. Landing gear handle — As required.

WARNING

Crew should consider extending the landing gear since neither normal nor alternate gear extension may be possible under certain leak conditions if the decision to lower gear is delayed. Failure to extend the landing gear promptly may result in an unavoidable gear-up landing at destination if the hydraulic leak gets progressively larger.

Note

Maximum range available with the landing gear extended may decrease by approximately 22 percent or greater.

If all landing gear indicate down and locked:

3. Landing gear control circuit breaker — Pull.

If the landing gear fails to extend and lock or if the landing gear control circuit breaker has popped:

4. Proceed with Landing Gear Unsafe Down Indication procedures, paragraph 16.3.3.

5. Land as soon as possible.

16.3.2 Landing Gear Unsafe Up Indication

Should one or more of the landing gear fail to retract or fail to indicate a safe up condition, proceed as follows:

1. Landing gear handle — DOWN.

2. Gear position — Check.

3. If a safe indication is obtained and is confirmed visually, land as soon as practical.

CAUTION

Prior to landing, obtain a visual gear position check by utilizing the air-to-air (from another aircraft) or the tower fly-by method.

4. If a safe gear down and locked indication is not obtained or visual check indicates unsafe conditions, proceed to the Landing Gear Unsafe Down Indications procedures.

16.3.3 Landing Gear Unsafe Down Indication

Should one or more of the landing gear fail to extend or fail to indicate a safe condition, the following steps should be taken prior to extending the gear manually:

1. (**M**) HYD FLUID TEST SENSOR test button — Press and hold. HYD FLUID LOW caution light and master caution annunciators should illuminate in approximately 4 seconds.

2. (**M**) HYD FLUID SENSOR button — Release. HYD FLUID LOW caution light should extinguish.

(**M**) If the test is satisfactory, continue. If unsatisfactory, conduct Low Hydraulic Fluid procedure (paragraph 16.3.1).

3. Landing gear (**B**/**F**) relay/(**M**) control circuit breaker — Check in.
4. Landing gear indicator circuit breaker — Check in.
5. Gear down indicator lights — Check (press to test).

CAUTION

(**B**) Do not cycle gear with an unsafe nose gear.

6. Landing gear handle — UP, then DOWN.

CAUTION

Ensure that when cycling the landing gear, all landing gear movement has stopped for the selected position before reversing the direction of the gear handle.

If landing gear extends and safe indication is obtained on all three landing gear, then normal landing can be made.

CAUTION

Prior to landing, obtain a visual gear position check by utilizing the air-to-air (from another aircraft) or the tower fly-by method. It is possible to have a safe gear indication and not have three complete tire or wheel assemblies remaining on the aircraft.

If landing gear did not extend or continues to indicate unsafe, proceed with the following procedures. After notifying the crew and passengers, make alternate pullups and pushovers to increase g forces on the gear mechanism. Do not exceed maximum aircraft g limits of +2.0 g positive and -0.5 g negative pushover. If gear indicates down, request tower or air-to-air fly-by to verify position and land. If gear still indicates unsafe, continue with manual gear extension procedures.

16.3.4 Landing Gear Manual Extension

The landing gear may be extended manually if the normal extension mechanism should fail; however, the gear cannot be retracted manually.

(**B**) When making a manual gear extension, proceed as follows:

Note

- No provision is made for manual gear extension with mechanical linkage failure.
- As airspeed is reduced, it is correspondingly easier to manually actuate the alternate extension handle.

1. Airspeed — 130 KIAS or less.

Note

The autopilot may be used as an aid in maintaining stabilized flight. The flaps may also be used to increase stall margin.

2. Landing gear relay circuit breaker — Pull.

3. Landing gear handle — DOWN.

4. Clutch disengage lever — Lift and turn clockwise.

WARNING

After an emergency landing gear extension has been made, do not stow pump handle, move any landing gear controls, or reset any switches or circuit breakers until aircraft is on the ground and the cause of the malfunction has been determined and corrected.

CAUTION

Do not pump handle after three GEAR DOWN position indicator lights are illuminated. Further movement of the drive handle could damage the drive mechanism.

Note

With a complete electrical failure, continue pumping the extension handle until resistance is felt. Approximately 70 strokes are required to lower the gear. There will be no lights to indicate gear down and locked.

5. Manual extension handle — Pump until three GEAR DOWN indicator lights illuminate.

(F/M) When making a manual gear extension, proceed as follows:

1. Airspeed — 181 KIAS or less.

Note

The autopilot may be used as an aid in maintaining stabilized flight. The flaps may also be used to increase stall margin.

2. Landing gear (**F**) relay/(**M**) control circuit breaker — Pull.

3. Landing gear handle — DOWN.

WARNING

After an emergency extension has been made, do not move any landing gear controls or reset any switches or circuit breakers until the aircraft is on the ground and the cause has been determined and corrected. The failure may be in the gear up circuit, and the gear could retract on the ground.

CAUTION

If for any reason the green GEAR DOWN position indicator lights do not illuminate (e.g., in case of electrical failure), continue pumping until sufficient resistance is felt to ensure the gear is down and locked. Do not stow the handle. Stowing the handle after manual extension without the green indicators will actuate the hydraulic system pressure relief valve and may allow the gear to collapse after landing.

Note

It may require up to 80 strokes to achieve full gear extension.

4. Manual extension handle — Pump until three green gear down indicator lights illuminate or resistance to pumping is felt.

If landing gear does not extend or continues to indicate unsafe, refer to the following sections:

5. Main gear up or unsafe, refer to paragraph 16.3.5.

6. Main gear down, nosegear up or unsafe, refer to paragraph 16.3.6.

7. All gear up, refer to paragraph 16.3.7.

8. All gear stuck in transit (gear appear to be down, but are not locked as indicated by the absence of a safe indication on all three landing gear), refer to paragraph 16.3.8.

16.3.5 Landing Gear Retraction After Practice Manual Extension

(**B**) After a practice manual extension of the landing gear, the gear may be retracted electrically as follows:

1. Emergency engage handle — Rotate counterclockwise and push down.

2. Extension lever — Check for freedom of movement.

Note

Operating the extension lever will ensure that the manual extension system is completely disengaged.

3. Extension lever — Stow.

4. Landing gear relay circuit breaker (pilot subpanel) — Push in.

5. Landing gear handle — UP.

(**F**/**M**) After a practice manual extension of the landing gear, the gear may be retracted electrically as follows:

1. Manual extension handle — Stowed.

2. Landing gear (**F**) relay/(**M**) control circuit breaker — Push in.

3. Landing gear handle — UP.

16.3.6 Landing with One Main Gear Up or Unsafe

Landing with the gear up is preferred over landing with one main gear extended. Attempt to raise the gear and proceed with gear-up landing procedures. If all efforts to retract the extended gear fail, land the aircraft on a runway or firm hard surface in preference to loose dirt or grass. Touch down smoothly, well to the same side of the runway as the extended gear to allow room for eventual ground loop. Roll on the down and locked gear, holding the opposite wing up and the nose straight as long as possible. As the wingtip strikes the ground, apply opposite brake to maintain a straight path.

(**B**) If one main landing gear fails to extend and the opposite gear extends normally, a break in the drive mechanism to the unextended gear has occurred.

CAUTION

Field arresting cables should be removed from the runway to minimize structural damage to the aircraft.

Before touchdown:

1. Fuel load — Reduce.

2. Crew/passenger emergency brief — Complete.

3. Bleed air valves — (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY.

4. Cabin pressurization — DUMP.

5. Cabin emergency hatch — Remove and stow (optional).

6. Landing gear warning horn and GPWS circuit breakers — Pulled.

7. Seatbelts/harnesses — Secure (passengers assume brace position).

8. Emergency lights — As required.

9. Landing checklist — Complete.

Just prior to touchdown:

10. Power levers — IDLE.

11. Condition levers — FUEL CUTOFF (PNF).

12. Propellers — FEATHER (PNF).

After touchdown:

13. Use aileron and rudder as necessary to maintain directional control and keep wings level as long as possible.

14. Brakes — As required.

15. (**B**/**F**) Firewall valves — CLOSED.

    (**M**) FIRE PULL handles — Pulled.

16. Gangbar — OFF.

16.3.7 Landing with Main Gear Down, Nosegear Up or Unsafe

If the nosegear fails to extend or indicates unsafe, a visual inspection should be made to determine if the nosegear is down and locked. Make a normal approach with power using a minimum of wing flaps to hold the nose up as long as possible after touchdown. Lower the nose gently to the deck. Do not use brakes.

CAUTION

Field arresting cables should be removed from the runway to minimize structural damage to the aircraft.

Before touchdown:

1. Fuel load — Reduce.

2. Crew/passenger emergency briefing — Completed.

3. Bleed air valves — (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY.

4. Cabin pressurization — DUMP (PNF).

5. Cabin emergency hatch — Remove and stow (optional).

6. Landing gear warning horn and GPWS circuit breakers — Pulled.

7. Seatbelts/harnesses — Secure (passengers assume brace position).

8. Emergency lights — As required.

9. Landing checklist — Complete.

After touchdown:

10. Power levers — IDLE.

11. Condition levers — FUEL CUTOFF (PNF).

12. Propellers — FEATHER (PNF).

13. (**B**/**F**) Firewall valves — CLOSED.

    (**M**) FIRE PULL handles — Pulled.

14. Gangbar — OFF.

16.3.8 Gear-Up Landing

The main landing gear wheels protrude slightly from the wheelwell in the gear-up position and will roll when the aircraft is landed with the gear retracted. Because of decreased drag with the gear up, the tendency will be to land long. The center of gravity with the gear retracted is aft of the main wheels. This condition will allow the aircraft to be landed with the gear retracted and should result in a minimum amount of structural damage to the aircraft, provided the wings are kept level. It is recommended that the landing be made with full flaps and on a hard surface runway, preferably paved. In landing on soft ground or dirt, sod has a tendency to roll up into chunks, damaging the underside of the aircraft. Plan to touch down at approximately 85 KIAS. When making a gear-up landing, proceed as follows:

CAUTION

Field arresting cables should be removed from the runway to minimize structural damage to the aircraft.

Before touchdown:

1. Fuel load — Reduce.

2. Crew/passenger emergency briefing — Complete.

3. Bleed air valves — (**B**/**F**) ENVIR OFF/(**M**) PNEU ONLY.

4. Cabin pressurization — DUMP (PNF).

5. **(B)** Clutch disengage handle — Lift and turn counterclockwise.

6. Manual extension handle — Stow.

7. (**B**/**F**) Landing gear relay circuit breaker — Pull.

   (**M**) Landing gear control circuit breaker — Pull.

8. Landing gear warning horn and GPWS circuit breakers — Pull.

9. Cabin emergency hatch — Remove and stow (optional).

10. Flaps — DOWN.

11. Seatbelts/harnesses — Secure (passengers assume brace position).

12. Emergency lights — As required.

13. Landing checklist — Complete.

Just prior to touchdown:

14. Power levers — IDLE.

15. Condition levers — FUEL CUTOFF (PNF).

16. Propellers — FEATHER (PNF).

17. Use aileron and rudder as necessary to maintain directional control and keep wings level as long as possible.

After touchdown:

18. Brakes — As required.

19. (**B**/**F**) Firewall valves — Close.

    (**M**) FIRE PULL handles — Pull.

20. Gangbar — OFF.

16.3.9 Landing with All Gear Stuck in Transit

If all three gear are stuck in transit and cannot be lowered by using the emergency extension procedures, a mechanical malfunction within the landing gear mechanism has occurred. Prior to landing, review all other landing gear malfunction procedures as any or all of the gear may collapse on touchdown. The landing should be made on a hard, smooth surface using full flaps and minimum sink rate. Touch down smoothly on runway centerline at approximately 85 KIAS. Secure engines and feather propellers just prior to touchdown.

16.4 TIRE FAILURE

16.4.1 Main Tire Flat

When a landing is made with a flat tire on one main gear, the aircraft may swerve toward the flat tire side. Directional control can be maintained with wheel braking and asymmetrical power. If aware that a main gear tire is flat, a landing close to the edge of the runway opposite the flat tire will help avoid veering off the runway.

1. Land on runway side favoring good tire.

2. Opposite brake — Apply as required.

16.4.2 Nosewheel Tire Flat

If the nosewheel tire is flat, nosewheel stability will be reduced. Maximum aerodynamic braking should be utilized. Light wheel braking should be applied only as required to maintain directional control.

16.5 FORCED LANDING/DITCH

16.5.1 Forced Landing — No Power

If sufficient altitude remains after reaching a suitable landing area, a circular pattern will provide best observation of surface conditions and wind speed and direction. When the condition of the terrain has been noted and the landing area selected, set up a normal pattern and extend the gear when the landing is assured. Fly the base leg as necessary to control the point of touchdown. Plan to overshoot rather than undershoot using flaps as necessary. Keep in mind that with both propellers feathered, the normal tendency is to overshoot because of less drag. In the event a positive gear down and locked indication cannot be determined, prepare for a gear-up landing. Complete the Ditch/Forced Landing checklist in paragraph 16.5.3. Refer to Figure 16-5 for dual-engine failure pattern.

Note

- Do not extend flaps until the landing is assured.
- A gear-up landing should be considered based on the type of touchdown surface.
- Select a landing area of adequate size to accommodate the aircraft, preferably free of obstacles and smooth. Cultivated fields are most desirable. Swamps, boggy ground, shallow lakes, and forests should be avoided if possible.
- Land aircraft into the wind as near as possible.
- The landing should be made at the slowest speed commensurate with complete control.
- If landing into trees, fly into them. Do not attempt to land on the tops.

16.5.2 Ditching

The following ditching procedures are based on the experiences of pilots who have successfully ditched other multi-engine aircraft. These ditches were successful because all crewmembers carried out the correct procedures. Ditches commenced from low altitudes do not always allow time for more than minimum preparation and planning and may not permit relying on a checklist; therefore, it is essential that each crewmember be thoroughly familiar with ditching procedures and assigned responsibilities. Further, the Aircraft Commander must ensure that all passengers have been briefed on the procedures and that they understand how to use installed survival equipment. If at all possible, a ditch should be made while power is still available on both engines; however, if one engine has failed, a ditch should be accomplished in as near symmetrical condition as possible. An engine and/or wing fire is probably the most serious condition from the standpoint of structural integrity and lateral control. A fire concentrated within the wing or nacelle will be sustained by fuel or oil and will destroy effective use of flaps and ailerons in a very short time. With such a fire, except in extremely high wind conditions, the aircraft should be ditched parallel to the primary swell system. Model tests and actual ditches of various aircraft indicate that ditching into the wall of water created by the major swell is roughly analogous to flying into a mountain. Accordingly a careful evaluation of sea condition is essential to successful ditching. While descending, begin analyzing the sea condition as soon as the surface can be seen clearly, 2,000 feet or more if possible. The primary swell can readily be distinguished from high altitude and will be seen first. At low altitude it may be hidden beneath another system plus a surface chop, but from altitude the largest and most dangerous system will be the first one recognized. The wind-driven sea, if any, will be recognized by the appearance of white caps. Where IMC or night operations preclude visual determination of sea conditions, forecast data should be utilized and the ditch must be made on instruments. With no surface reference, the aircraft must be flown into the water on heading and in a fixed attitude that combines safe control speed and rate of descent. Whenever possible, a ditch should be made as close as safety permits to coastlines or in the vicinity of surface vessels to improve the rescue situation. If radios are still available, attempt to contact coastal stations and/or surface vessels for current wind, sea swell, and altimeter setting.

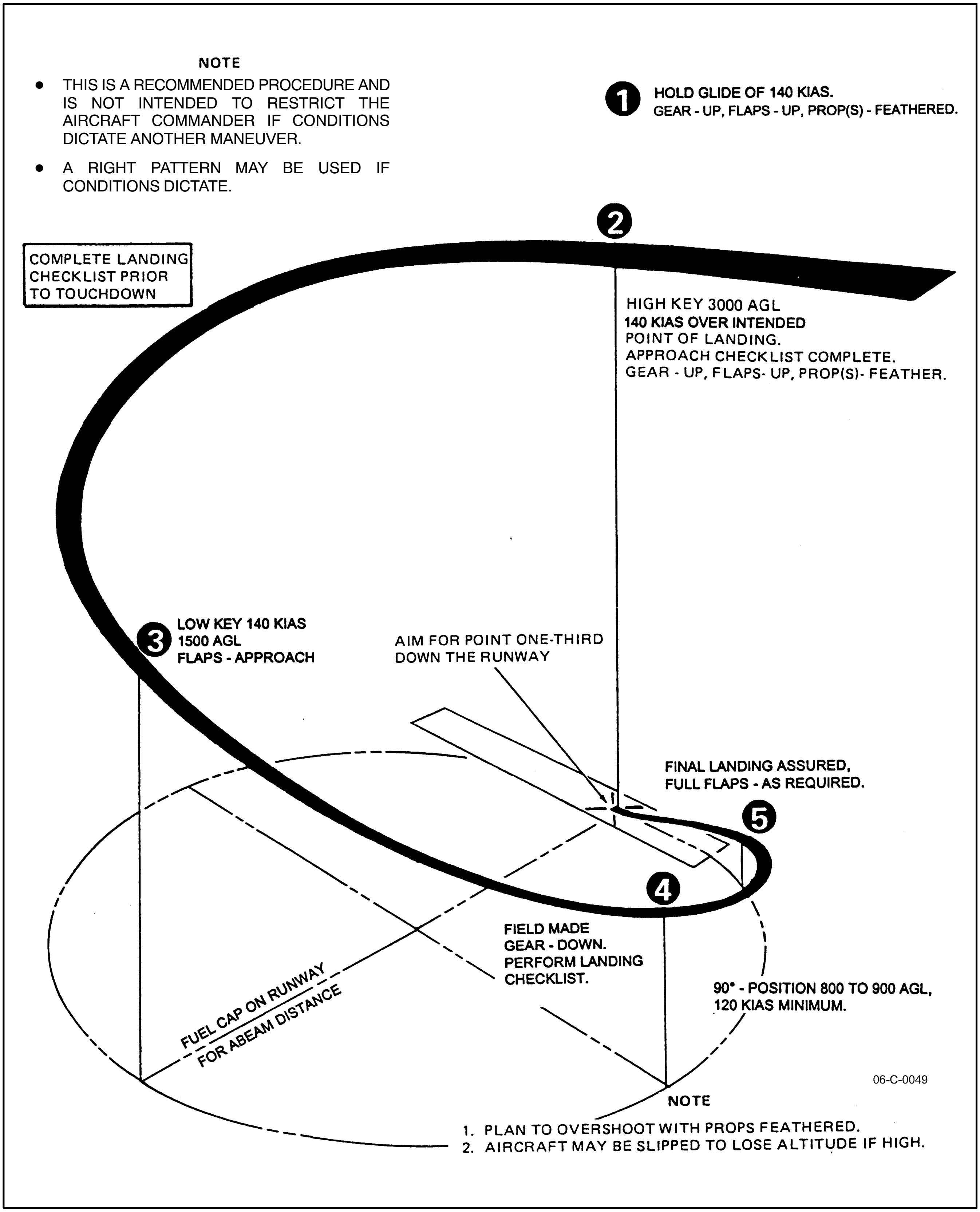


Figure 16-5. Dual-Engine Failure Landing Pattern

Note

- Ditch parallel to and near the crest of the swell unless there is a strong crosswind of 20 knots or more. In strong winds, ditch heading should be more into the wind and slightly across the swell, planning to touch down on the upslope of the swell near the top. Refer to Figure 16-6. Wave motion is indicative of wind direction, but the swell does not necessarily move with the wind. Water surface conditions are indicative of windspeed, as related below:

SURFACE CONDITIONS	WINDSPEED KNOTS
Few white crests	10 to 15
Many white crests	15 to 25
Streaks of foam from crests	25 to 35
Spray blown from tops of waves	35 to 45

- Use of radio altimeter gives a fair approximation of height above the surface.
- Full flaps are recommended for power-on ditches; however, impaired directional control caused by engine loss or aileron damage is another factor to be considered in determining the ditch configuration. If directional control problems are anticipated and available power is insufficient to maintain desired rate of descent, consideration should be given to utilization of approach flaps.

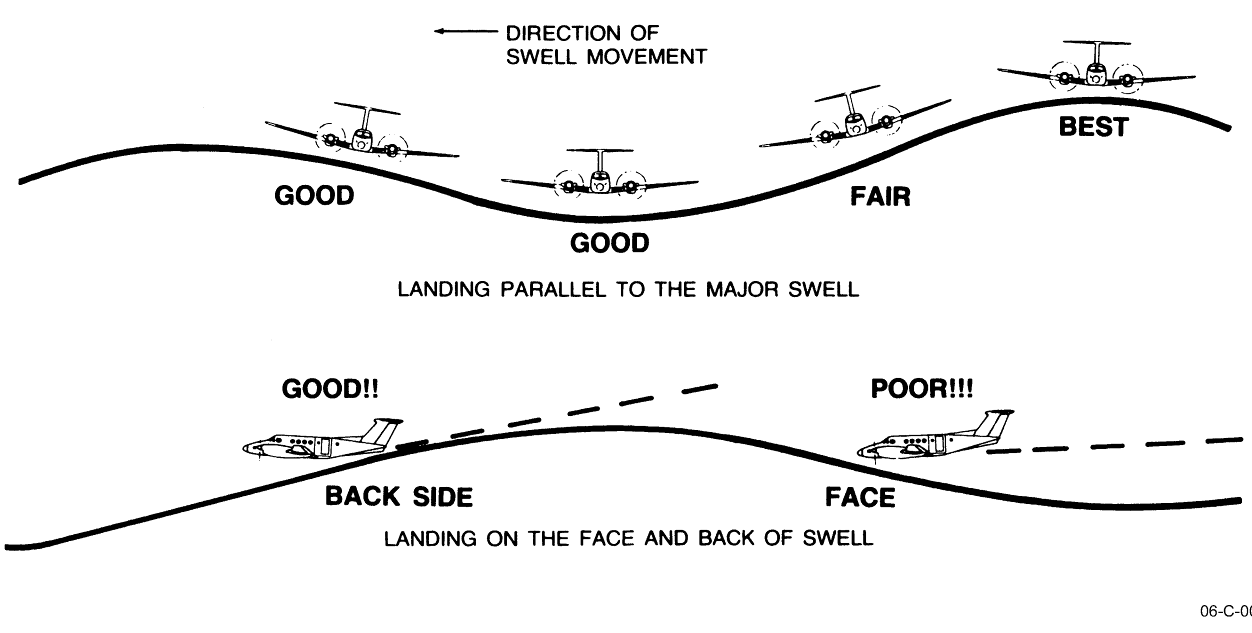


Figure 16-6. Wind Swell Ditch Heading Evaluation

16.5.3 Ditch/Forced Landing Checklist

1. Announce intention and time to ditch (PNF).
2. Mayday message — Transmit (PNF).
3. Transponder — EMERGENCY (PNF).
4. Cabin pressurization — DUMP (PNF).
5. Lifevest — On and adjusted (do not inflate).
6. Cabin emergency hatch — Remove and jettison (TA).
7. Seatbelts/harnesses — Secure (passengers - brace position).
8. Emergency lights — ON.
9. Landing gear — As required.

Note

Consideration should be given to pulling GPWS and landing gear warning CBs if a gear-up ditch/forced landing is intended.

10. Flaps — As required.
11. Airspeed — As required.

16.5.4 Ditch/Forced Landing (Aircrew)

*1. Passengers — Briefed.

  a. Remove all sharp objects.

  b. Operation of emergency exits.

  c. Assignment of after ditch duties.

  d. Proper brace position.

*2. Don lifevest — As required.

  a. Survival radio — Retrieved and stow in pocket.

*3. Escape hatch — Jettison as directed.

*4. Bags/cargo — Jettison as required.

  a. Pilots — Notified.

*5. Brace position — Assume.

*6. After all violent motion stops — Evacuate aircraft.

*7. Raft/survival equipment — As required.

After a ditch or forced landing, egress should proceed as follows:

1. First person out assists others.

2. Aircrewman ensures passengers have exited aircraft.

3. Aircrewman brings liferaft and survival kit forward and passes them out to a crewmember, then egresses. As there will be no passengers in the aircraft, use the seatbacks for support while dragging the survival kit and liferaft to the emergency exit.

16.5.5 Ditching Technique

16.5.5.1 Ditching (Two Engines)

1. Landing gear — UP.

2. GPWS and landing gear warning circuit breakers — Pull.

3. Flaps — DOWN (100 percent).

4. Airspeed — 100 KIAS (100 fpm rate of descent).

Note

- Rate of descent is 100 fpm during final stages of the approach (approximately last 300 feet).

- With flaps full down and gear up, the landing gear warning horn cannot be canceled.

16.5.5.2 Ditching (Single Engine)

1. Landing gear — UP.

2. Flaps — APPROACH (40 percent).

3. Airspeed — 105 KIAS (100 fpm rate of descent).

Note

Rate of descent is 100 fpm during final stages of the approach (approximately last 300 feet).

16.5.5.3 Ditching (No Power Available)

1. Propeller levers — FEATHERED.

2. Landing gear — UP.

3. Flaps — APPROACH (40 percent).

4. Airspeed — 105 KIAS.

Note

Rate of descent should be such that airspeed is maintained at 140 KIAS (maximum glide airspeed) until approximately 200 feet AGL, at which time transition should be made to APPROACH flaps. Allow airspeed to bleed off with a slight nose-up attitude prior to impact by using radio altimeter or any visual reference to the water surface. Water entry should be approximately 100 knots with maximum rate of descent 100 to 200 fpm.

16.5.5.4 Water Entry

It is essential that an attempt be made to control the attitude of the aircraft throughout the ditching until all motion stops.

16.6 EMERGENCY/SURVIVAL EQUIPMENT

16.6.1 Fire Extinguishers

Two hand-operated Halon fire extinguishers are provided for emergency use. One is located under the copilot seat, the other in the baggage compartment. The extinguishers are charged to a pressure of 100 psi and emit a forceful stream. The extinguisher should be used with care within the limited area of the cabin to avoid severe splashing.

WARNING

Repeated or prolonged exposure to high concentrations of Halon or decomposition products should be avoided. The liquid should not be allowed to come into contact with the skin as it may cause frostbite or low temperature burns because of its very low boiling point.

16.6.2 First-Aid Kits

Three first-aid kits are stored in the survival kits located in the aft compartment.

16.6.3 Emergency Locator Transmitter (ELT)

The ELT is located on the right side just aft of the pressure bulkhead and transmits on 121.5/243.0 MHz when activated. A remote switch with a yellow transmit light is located on the left cockpit sidewall next to the OAT gauge. The lever-lock switch is normally left in the ARM position. In an emergency requiring ELT broadcast, if automatic activation was not assured or verified, position the switch to ON. This switch may also be used to reset the transmitter in the event the unit is inadvertently actuated. To reset the unit, switch the selector switch from ARM to OFF and back to reset the transmitter to ARM. Some ELTs have a separate reset switch on the front of the case. Access to the transmitter is through a hatch located on the lower aft fuselage (just aft of station 347.8). This hatch also provides access to the oxygen bottle. The ELT can be removed from the aircraft by releasing the retaining strap that holds it, disconnecting the aircraft antenna cable, and reconnecting the transmitter to the unit's own antenna that is located just inside and above the transmitter access hatch. Following a mishap, in the event the access hatch is not accessible, it may be necessary to cut into the fuselage to retrieve the ELT for portable use.

16.6.4 Liferaft and Survival Equipment

A liferaft and survival kit are provided for use during emergencies over land or sea. The liferaft is contained in a carrying case 31 inches long, 14 inches wide, and 7 inches thick. The overland or remote survival kit (Figure 16-7) is tethered to the raft carrying case with a lanyard and buckle. The survival kit is detachable so that it can be separated and taken in the event of an overland emergency. When not required for geographical location, the raft may be removed to increase aircraft payload. The raft and the remote survival kit are located behind the right side, most aft partial partition. The raft is a 10-man dual tube nonreversible liferaft with a canopy. It includes various accessories (Figure 16-8) including a sea anchor, locator light, and heaving ring. Additionally, an accessory kit (Figure 16-9) is located inside the carrying case with the raft. This internal kit is attached to the raft with a lanyard and contains a set of paddles, emergency locator transmitter, and other related items. Refer to Figure 16-10 for further information.

Note

The tethered external survival kit is the only kit that contains water/food/first aid provisions.

1. Aircrewman brings the liferaft carrying case and tethered survival kit forward from rear section to emergency exit. Do not remove the raft from the carrying case inside the aircraft.

CAUTION

Keep the liferaft away from any damaged surfaces that might tear it.

Note

As there will be no passengers in the aircraft, use the seatbacks for support while dragging survival kit and liferaft to emergency exit.

2. Locate raft retention lanyard and secure to aircraft.

3. Push the raft and survival equipment out the emergency exit hatch to crewman.

4. Exit aircraft through the open hatch and step onto the wing.

Note

Inflation of the raft should be with the identified side facing up since the raft is nonreversible. A righting aid is provided should the raft inflate upside down.

5. Inflate the raft by pulling the handle located in a pocket on the side of the carrying case. The handle is attached to a lanyard that opens the raft carrying case closure and activates a discharge valve on a reservoir, allowing compressed gas to from the reservoir into each of the rafts flotation tubes.

6. Board the raft and follow onboard procedures as described in NATOPS Survival Manual (NAVAIR 00- 80T- 101).

7. Tie down the survival kit in the center of the raft to prevent it from being lost in case the raft capsizes.

8. After all personnel have been evacuated, move liferaft out from under any part of the aircraft that might strike it as it sinks.

9. Remain in the vicinity of the aircraft as long as it remains afloat.

16.6.5 Life Preservers

Ten lifevests are included in the aircraft. Lifevests should be stored in the seat pockets and in the couch drawers.

16.6.6 Survival Radio/Emergency HF Radio Beacon

One voice-capable survival radio per aircraft shall be carried on board. It may be located either in a pocket on the forward side of the flight compartment partition, or aft of the cargo door on the lower left sidewall adjacent to and above the cabin fire extinguisher. When extended overwater flights are flown, an approved HF emergency beacon shall be carried in either the raft or survival kit.

16.6.7 Emergency Exit/Entrance

The cabin airstair door and the emergency exit hatch provide escape routes from the aircraft while on the ground or during a ditch/forced landing. Figure 16-11 illustrates the location of the exits and emergency escape routes and egress procedures.

CAUTION

Jettison of the escape hatch could cause greater damage than the reason for egress. If immediate egress is not required for safety, try to avoid damage to the hatch.

16.6.8 Passenger Information Card

Figures 16-12 and 16-13 depict the passenger information checklist.

	SURVIVAL KIT, REMOTE KIT ITEMS	QTY
M11606-3	Cord, Survival Kit Lanyard (1.5 meters)	1 ea
65458-103	Buckle Assembly	1 ea
M12149-1	Thread, Cotton	AR
65444-101	Container, Survival Kit	1 ea
PPPT60-2	Tape, Green	AR
14A19011-16	Bag, Poly	1 ea
SP331	Compass	1 ea
M11029-1	Cord, Nylon (30 ft)	1 ea
64123-1	Bandage, Adhesive	2 ea
14A19028-0	Rubber Band	5 ea
63836-101	Knife, Utility	1 ea
6505-01-121-2336	Sunburn Prevention Preparation	1 ea
64125-1	Bandage, Compress	2 ea
63746-1	Whistle	3 ea
14A19011-6	Bag, Poly	3 ea
62840-1	Water Pouch	12 ea
Y137	Repellent, Insect	1 ea
63756-1	Mirror, Signaling	3 ea
63765-1	Battery, Alkaline	4 ea
64124-1	Bandage, Triangular	3 ea
371-1	Tape, Clear (5 cm Wide)	AR
14A19011-15	Bag, Poly	1 ea
64122-1	Bandage, Compress	12 ea
SP1032	Blanket, Aluminized	5 ea
4220-00-244-0764	Kit, Fishing	1 ea
63762-101	Kit, Age-Limited Module	1 ea
63767-1	Flare, Aerial	2 ea
B13498-1	Bottle, Water Purification Tablets	1 ea
63713-1	Inhalant, Ammonia	12 ea
63712-1	Ointment, Burn	4 ea
63711-1	Swab, Antiseptic	20 ea
63764-101	Flashlight Assembly	2 ea
LP393A	Tube, Polycarbonate (5 3/8 in Length x 1 1/4 in O.D.)	3 ea
SC1.250-8	Cap (V15819)	6 ea
63835-1	Bag, Easy Open	1 ea
SP5565-4	Food Packet, Survival	10 ea
64943-1	Manual, Survival Kit	1 ea
M12117-2 1/4	Foam, Shock Absorbent (2 1/4 x 8 x 24 in)	3 ea
101-384036-49	Machete	1 ea
101-384036-85	Type II Fire Starter	1 ea
101-384036-33	Water Proof Matches	5 ea
101-384036-49	Illuminating Candle	5 ea
Mk 79	Mk 79 Pencil Flares	6 ea
Mk 124 Mod 0	Mk 124 Signal Flares	6 ea

Figure 16-7. Survival Kit, Remote Kit Items

	LIFERAFT AND ACCESSORIES ITEMS	QTY
64921-101	Liferaft Assembly	1 ea
65449-101	Liferaft Subassembly	1 ea
65446-101	Survival Kit (Liferaft Accessories) (Refer to Figure 16-10 Sheet 2 of 3)	1 ea
65443-101	Survival Kit, Remote (Refer to Figure 16-10 Sheet 3 of 3)	1 ea
65441-101	Carrying Case	1 ea
65426-101	Retaining Strap, Short	2 ea
65418-103	Retaining Strap, Long	2 ea
64672-101	Cover, Valve	1 ea
64666-1	Hose Assembly	2 ea
64922-101	Reservoir And Valve Assembly	1 ea
64422-1	Pin, Breakaway	1 ea
M11145-8	Tubing, PVC (11 in (27.9 cm))	2 ea
M11606-3	Cord, Mooring Line (8 meters)	1 ea
M11606-3	Cord, Survival Kit Lanyard (3 meters)	1 ea
65458-101	Buckle Assembly	1 ea
M11606-3	Cord, Survival Kit Lanyard (1.5 meters)	1 ea
60225-1	Snap Hook	1 ea
65403-101	Pull Handle, Inflation	1 ea
B16367-101	Cable Assembly	1 ea
8947T24	Connector, Chain (2v507)	1 ea
PPPT60-1, 2	Tape, Green (2 types)	AR
P29-1	Tape, Black	AR
64040-1	Record, Maintenance Release	1 ea
B19958-101	Knife, Floating	1 ea
M11029-1	Cord, Floating Knife (5 ft)	1 ea
64944-101	Foam, Knife Protector	1 ea
63726-101	Sling, Sea Anchor	1 ea
D13476-113	Sea Anchor	1 ea
63795-101	Sling, Heaving Line	1 ea
B11114-0	Heaving Ring	1 ea
M11029-2	Cord, Heaving Ring (75.5 ft)	1 ea
20B23387-1	Patch, Light Holder	1 ea
B13562-93	Locator Light	1 ea
64932-101	Canopy	1 ea
B52030	Valve, Inflate/Deflate (V08407)	2 ea
1-020-8317-70	O-Ring, Inflate/Deflate (V08407)	2 ea
B51021	Cap, Dust (V08407)	2 ea
65139-1	Valve, Inlet Check Assembly	2 ea
10144	O-Ring, Inlet Check Valve (V05CTO)	2 ea
64154-5	Valve, Relief	2 ea
980000420	Gasket (V98021)	2 ea

Figure 16-8. Liferaft and Accessories Items

	INTERNAL LIFERAFT ACCESSORIES KIT ITEMS	QTY
65447-101	Container, Survival Kit	1 ea
14A19011-13	Bag, Poly	1 ea
PPPT60-2	Tape, Green	AR
63757-101	Bucket, Bailing	1 ea
SP400	Paddle (2 per set)	1 ea
63745-1	Marker, Sea Dye	4 ea
14A19028-0	Rubber Band	2 ea
63802-1	Emergency Locator Transmitter	1 ea
P4-01-1000-010	Battery (v55827)	1 ea
A3-06-0957	Rain Shield (v55827)	1 ea
83-06-1029	Antenna (v55827)	1 ea
14A19011-15	Bag, Poly	1 ea
RVR-1	Pin, Relief Valve	2 ea
371-2	Tape, Clear (5 cm Wide)	AR
63714-1	Sponge, Dehydrated	1 ea
63709-1	Repair Kit, Package	2 ea
MROD06LS1	Watermaker, Osmosis Pump	1 ea
64700-1	Pump, Manual	1 ea
A51300	Adapter, Pump	1 ea

Figure 16-9. Internal Liferaft and Accessories Items

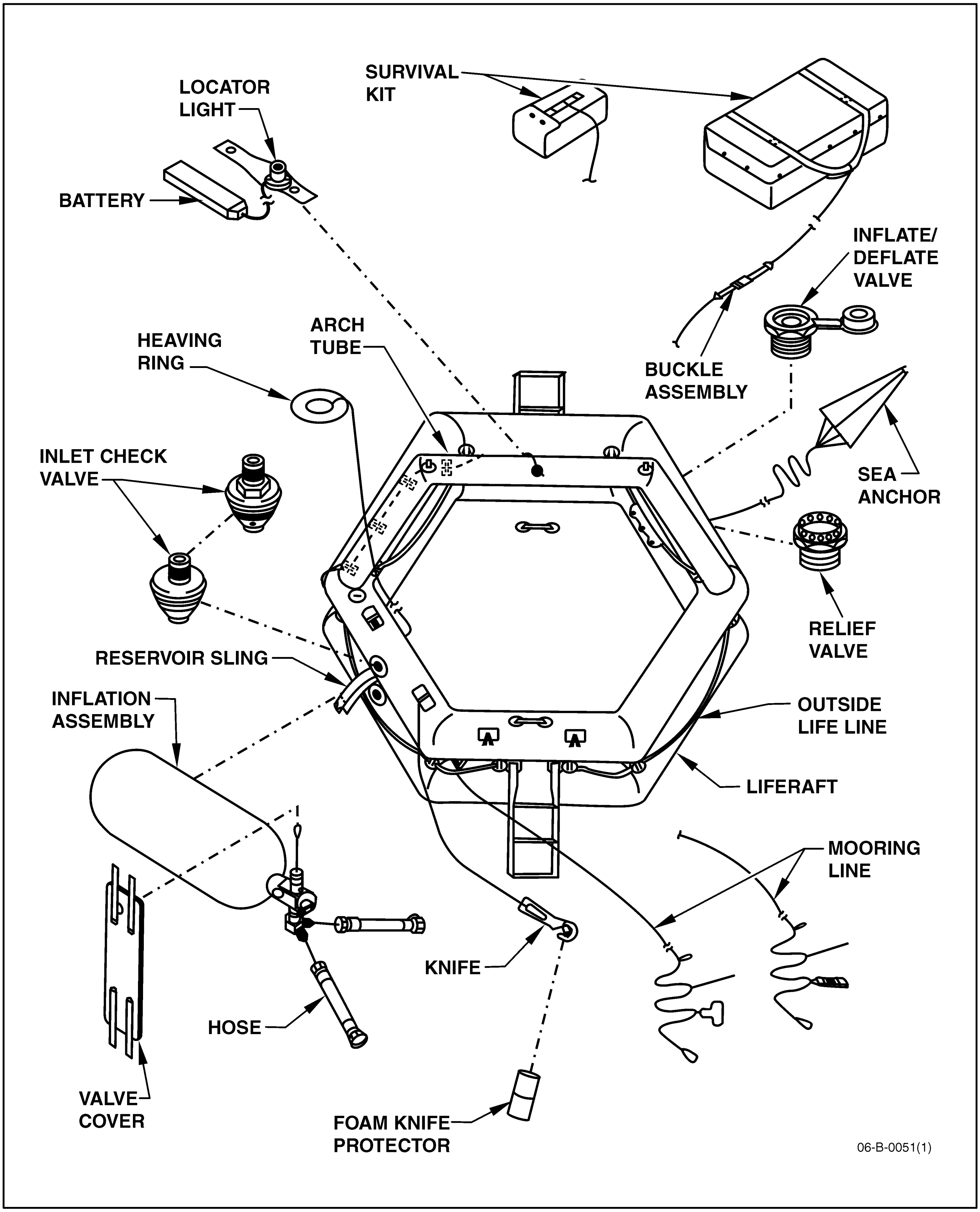


Figure 16-10. Emergency Equipment (Sheet 1 of 3)

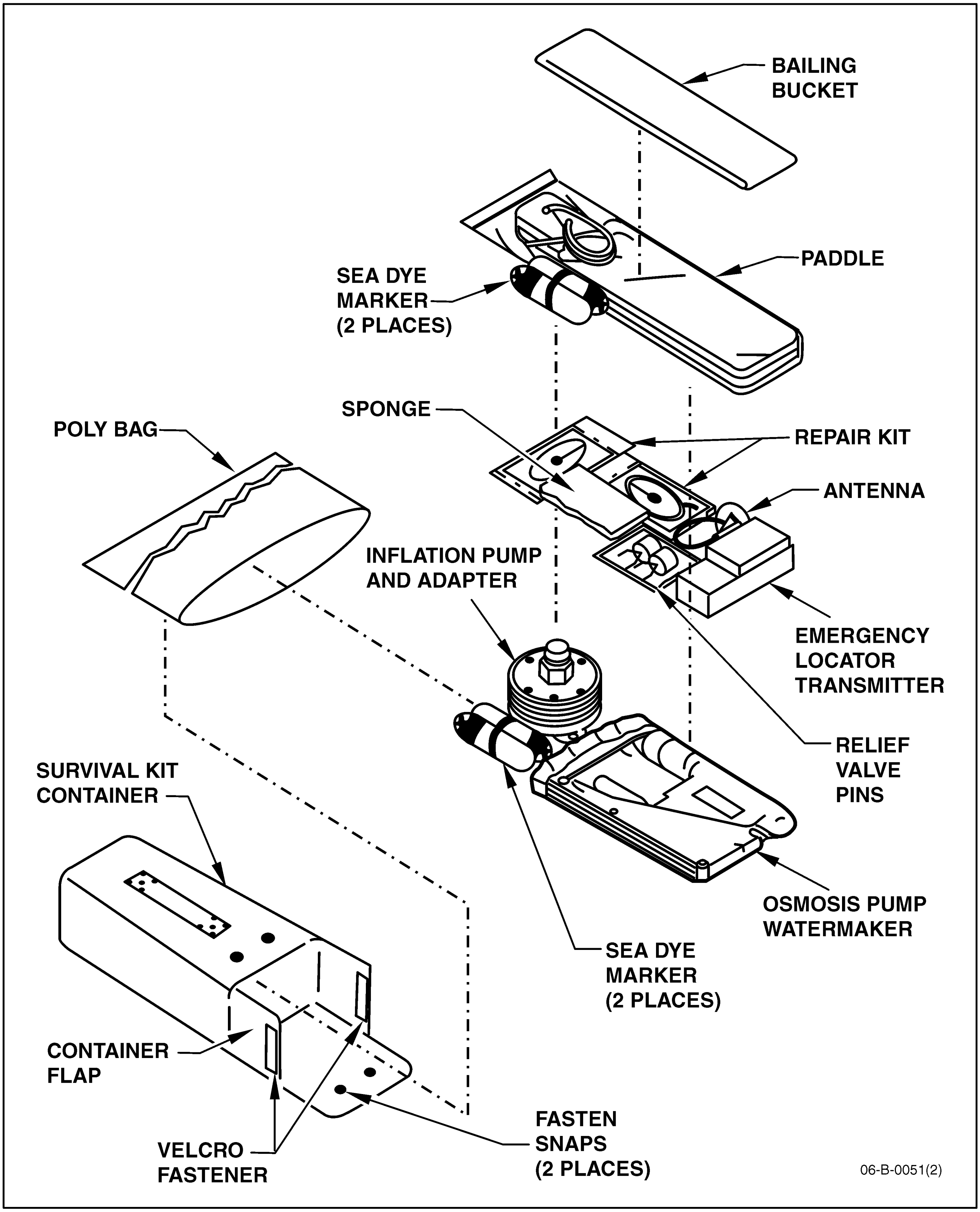


Figure 16-10. Emergency Equipment (Sheet 2 of 3)

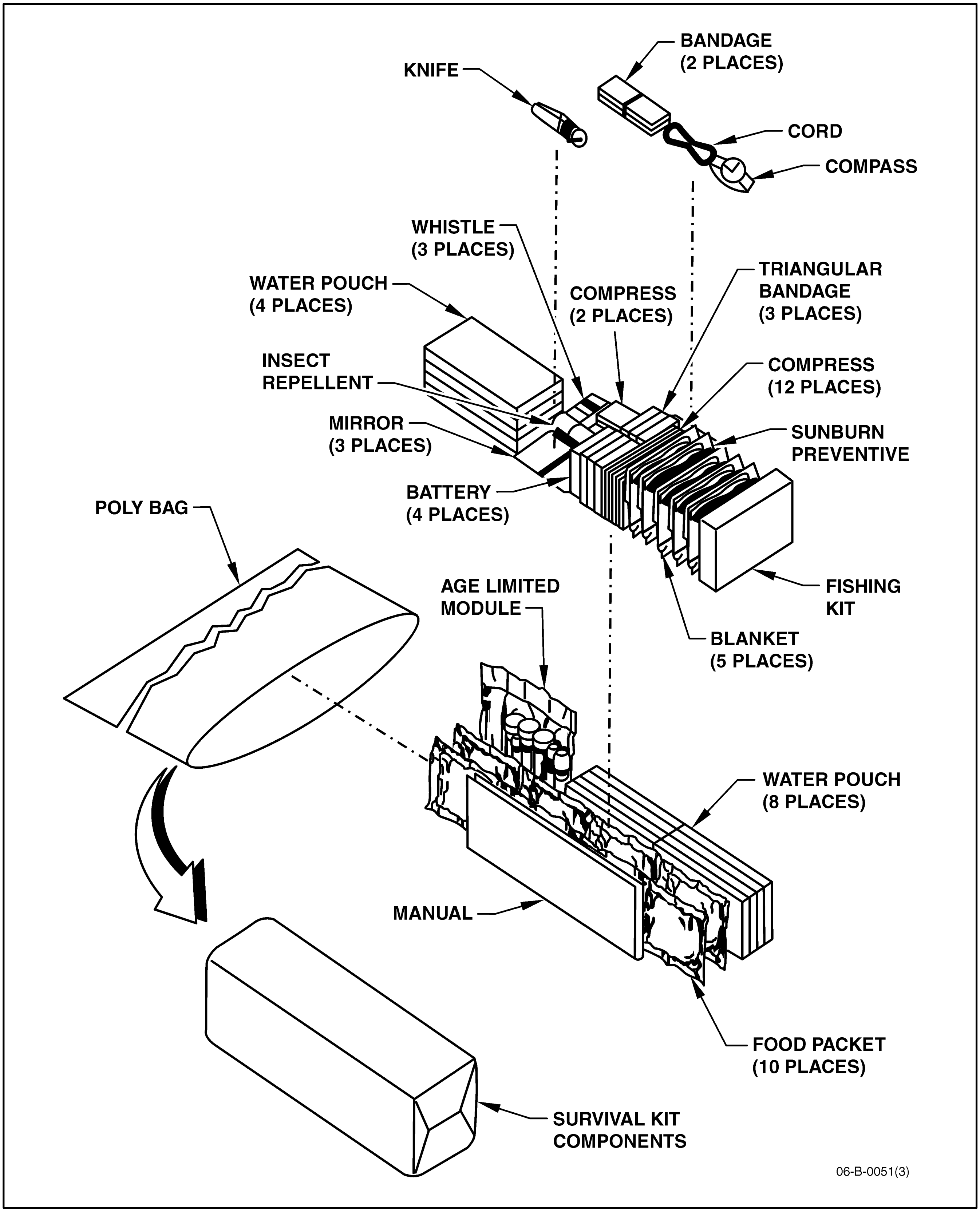


Figure 16-10. Emergency Equipment (Sheet 3 of 3)

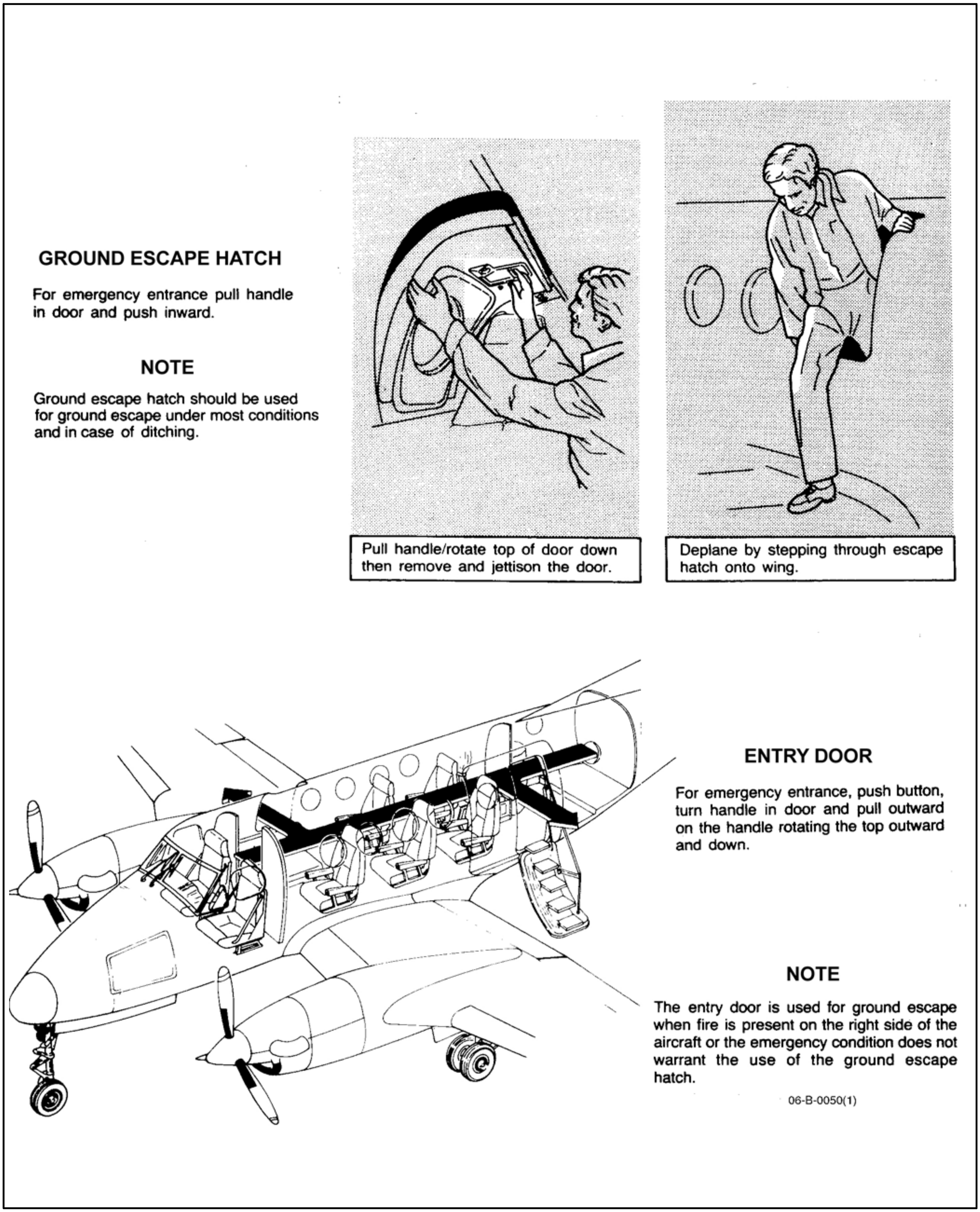


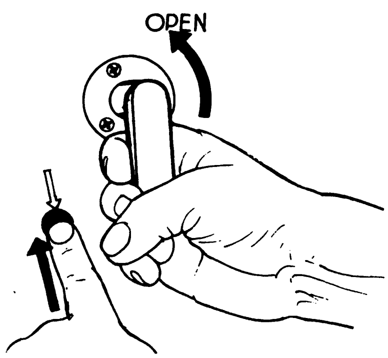
Figure 16-11. Emergency Egress, Emergency Exit Information (Sheet 1 of 3)

EMERGENCY EGRESS (CONTINUED)

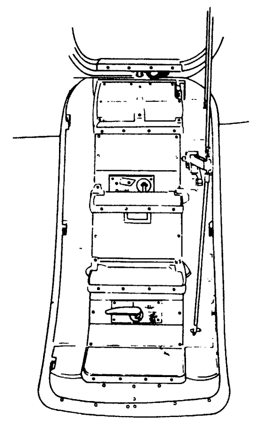
AIRSTAIR DOOR

CAUTION

- DO NOT OPEN DOORS WHILE THE AIRCRAFT IS PRESSURIZED.
- MAIN EXIT DOOR SHOULD NOT BE CONSIDERED PRIMARY EXIT DURING DITCHING.



(1) OPEN DOOR BY DEPRESSING BUTTON ADJACENT TO THE DOOR HANDLE AND THEN TURNING HANDLE COUNTERCLOCKWISE. APPLY OUTWARD PRESSURE TO OPEN DOOR.

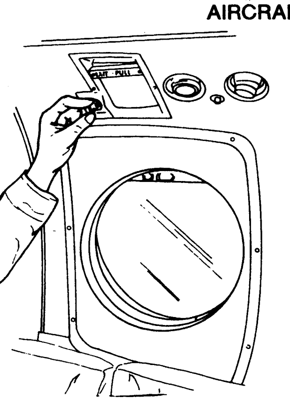


(2) EXIT THROUGH OPEN DOOR.

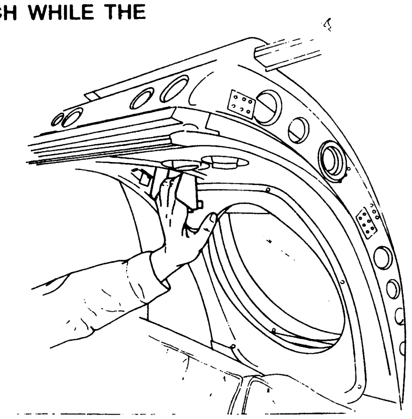
EMERGENCY EXIT HATCH

CAUTION

DO NOT OPEN THE ESCAPE HATCH WHILE THE AIRCRAFT IS PRESSURIZED.



(1) ENSURE HATCH KEY IS IN THE UNLOCKED POSITION (APPLIES TO FORCED LANDING ONLY).



(2) PULL HANDLE DOWN TO RELEASE. hATCH OPENS INWARD. ENSURE HATCH IS REMOVED FROM EXIT PATHWAY BEFORE EXITING.

06-B-0050(2)

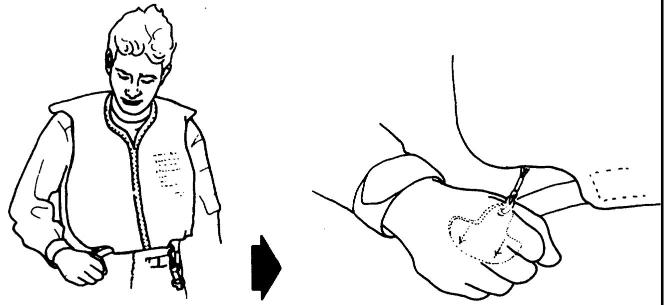
Figure 16-11. Emergency Egress, Emergency Exit Information (Sheet 2 of 3)

LIFE PRESERVER INFLATION

WARNING

DO NOT INFLATE LIFE PRESERVER INSIDE OF AIRCRAFT.

1. A LIFE PRESERVER IS PROVIDED WITH EACH SEAT. THE PILOT'S LIFE PRESERVERS ARE STORED IN THE POCKETS ON THE SEAT BACKS. THE PASSENGER'S LIFE PRESERVERS ARE STORED BEHIND THE RESPECTIVE SEATS AND IN THE STORAGE DRAWERS UNDER THE COUCH FOR AISLE FACING SEATS. THE HANDLE ON THE LIFE PRESERVER IS PLACARDED LIFE VEST PULL.



2. AFTER EXITING THE AIRCRAFT INFLATE LIFE PRESERVER BY PULLING DOWNWARD ON INFLATION TOGGLE.

06-B-0050(3)

Figure 16-11. Emergency Egress, Emergency Exit Information (Sheet 3 of 3)

NO SMOKING
FASTEN SEAT BELT

SMOKING IS PROHIBITED IN DEPARTMENT OF THE NAVY AIRCRAFT.

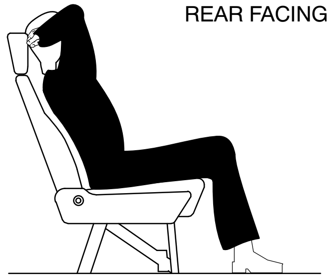
PLEASE COMPLY WHEN THE FASTEN SEAT BELT SIGN IS ON. WHEN THE SEAT BELT SIGN IS OFF, YOU MAY MOVE AROUND IN THE CABIN; HOWEVER, YOUR SEAT BELT SHOULD BE FASTENED AT ALL TIMES WHEN IN YOUR SEAT.

BRACE POSITIONS

IN AN EMERGENCY SITUATION YOU SHOULD ASSUME ONE OF THE BRACING POSITIONS SHOWN.

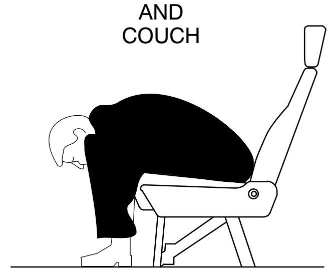
1. REMOVE EYEGLASSES AND SHARP ARTICLES FROM POCKETS.
2. FASTEN SEAT BELT TIGHT AND LOW ACROSS HIPS.
3. SEAT BACK UPRIGHT.
4. ARMRESTS DOWN.

REAR FACING



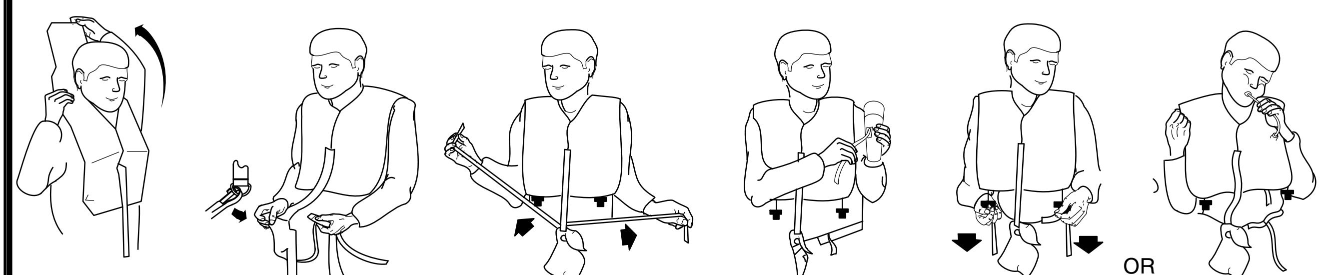
1. ENSURE THAT LAP BELT IS SECURE.
2. RAISE ARMS OVER SHOULDER.
3. GRIP THE TOP OF THE HEADREST. ELBOWS FIRMLY AGAINST HEAD.

FRONT FACING AND COUCH



1. ENSURE THAT LAP BELT IS SECURE.
2. LEAN FORWARD AND AS FAR DOWN AS POSSIBLE.
3. CLASP HANDS FIRMLY UNDER LEGS.

DONNING LIFE JACKET
(ON OVERWATER FLIGHTS)



1. PULL VEST OVER HEAD
2. SNAP CLIPS TO RING
3. PULL WAIST STRAPS
4. AT NIGHT PULL LIGHT TABS
5. AFTER EXITING PULL RED TABS

OR

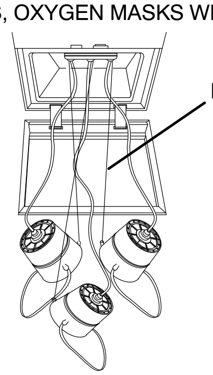
BLOW IN BOTH MOUTH PIECES TO INFLATE

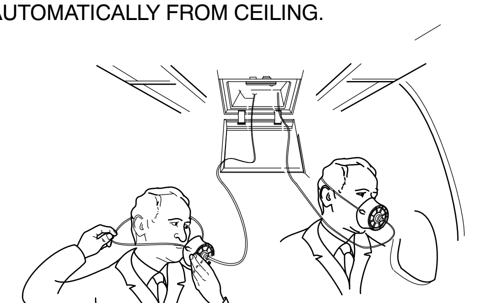
IN THE UNLIKELY EVENT OF CABIN PRESSURE LOSS, THE PILOT WILL ANNOUNCE IF OXYGEN IS NECESSARY. THREE EACH CONICAL MASKS READY FOR DEPLOYMENT ARE STORED IN THREE OVERHEAD COMPARTMENTS ABOVE THE CENTER AISLE. ALSO, THE LAVATORY HAS OVERHEAD DEPLOYABLE FIRST AID OXYGEN WITH A CONICAL MASK AND A SEPARATE AUTO OXYGEN PROVISION WITH CONICAL MASK.

SUPPLEMENTAL OXYGEN

IF AN EMERGENCY OCCURS, OXYGEN MASKS WILL DROP AUTOMATICALLY FROM CEILING.

1. PULL MASK DOWN FIRMLY.





2. BE SURE LANYARD PIN HAS PULLED OUT TO START OXYGEN FLOW.
3. PLACE MASK OVER BOTH NOSE AND MOUTH.
4. BREATHE NORMALLY.

PLEASE DO NOT REMOVE THIS CARD FROM AIRCRAFT

Figure 16-12. (**B**/**F**) Passenger Information Card Front Page (Sheet 1 of 2)

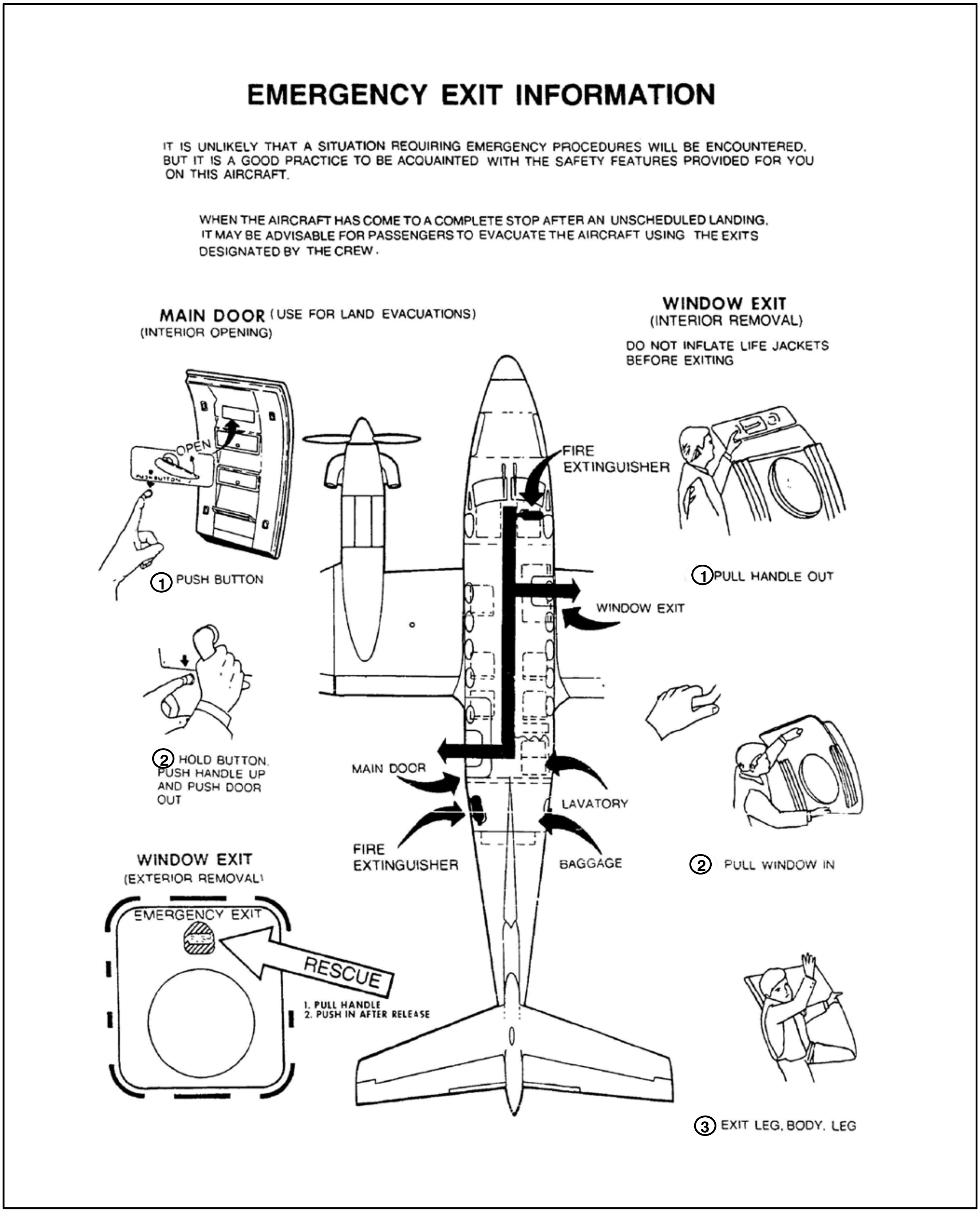


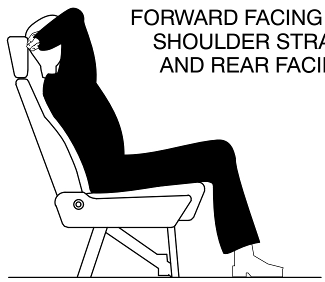
Figure 16-12. (**B**/**F**) Passenger Information Card Back Page (Sheet 2 of 2)

NO SMOKING
FASTEN SEAT BELT

SMOKING IS PROHIBITED IN DEPARTMENT OF THE NAVY AIRCRAFT.

PLEASE COMPLY WHEN THE FASTEN SEAT BELT SIGN IS ON. WHEN THE SEAT BELT SIGN IS OFF, YOU MAY MOVE AROUND IN THE CABIN; HOWEVER, YOUR SEAT BELT SHOULD BE FASTENED AT ALL TIMES WHEN IN YOUR SEAT.

FORWARD FACING WITH SHOULDER STRAPS AND REAR FACING



1. ENSURE THAT LAP BELT AND SHOULDER HARNESS ARE SECURE.
2. RAISE ARMS OVER SHOULDER.
3. GRIP THE TOP OF THE HEADREST. ELBOWS FIRMLY AGAINST HEAD.

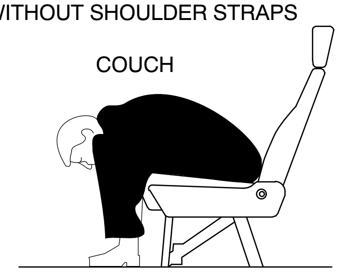
BRACE POSITIONS

IN AN EMERGENCY SITUATION YOU SHOULD ASSUME ONE OF THE BRACING POSITIONS SHOWN.

1. REMOVE EYEGLASSES AND SHARP ARTICLES FROM POCKETS.
2. FASTEN SEAT BELT TIGHT AND LOW ACROSS HIPS.
3. SEAT BACK UPRIGHT.
4. ARMRESTS DOWN.

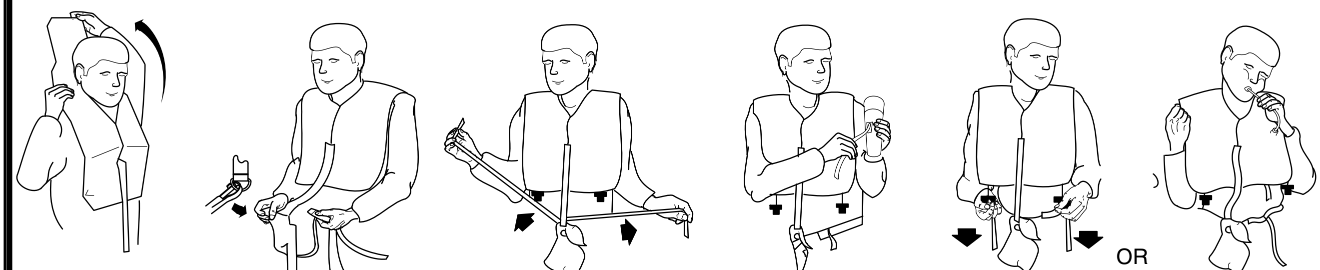
FORWARD FACING WITHOUT SHOULDER STRAPS

COUCH



1. ENSURE THAT LAP BELT IS SECURE.
2. LEAN FORWARD AND AS FAR DOWN AS POSSIBLE.
3. CLASP HANDS FIRMLY UNDER LEGS.

DONNING LIFE JACKET
(ON OVERWATER FLIGHTS)



1. PULL VEST OVER HEAD
2. SNAP CLIPS TO RING
3. PULL WAIST STRAPS
4. AT NIGHT PULL LIGHT TABS
5. AFTER EXITING PULL RED TABS

OR

BLOW IN BOTH MOUTH PIECES TO INFLATE

IN THE UNLIKELY EVENT OF CABIN PRESSURE LOSS, THE PILOT WILL ANNOUNCE IF OXYGEN IS NECESSARY. THREE EACH CONICAL MASKS READY FOR DEPLOYMENT ARE STORED IN THREE OVERHEAD COMPARTMENTS ABOVE THE CENTER AISLE. ALSO, THE LAVATORY HAS OVERHEAD DEPLOYABLE FIRST AID OXYGEN WITH A CONICAL MASK AND A SEPARATE AUTO OXYGEN PROVISION WITH CONICAL MASK.

SUPPLEMENTAL OXYGEN

IF AN EMERGENCY OCCURS, OXYGEN MASKS WILL DROP AUTOMATICALLY FROM CEILING.

1. PULL MASK DOWN FIRMLY.

2. BE SURE LANYARD PIN HAS PULLED OUT TO START OXYGEN FLOW.
3. PLACE MASK OVER BOTH NOSE AND MOUTH.
4. BREATHE NORMALLY.

PLEASE DO NOT REMOVE THIS CARD FROM AIRCRAFT

Figure 16-13. (**M**) Passenger Information Card Front Page (Sheet 1 of 2)

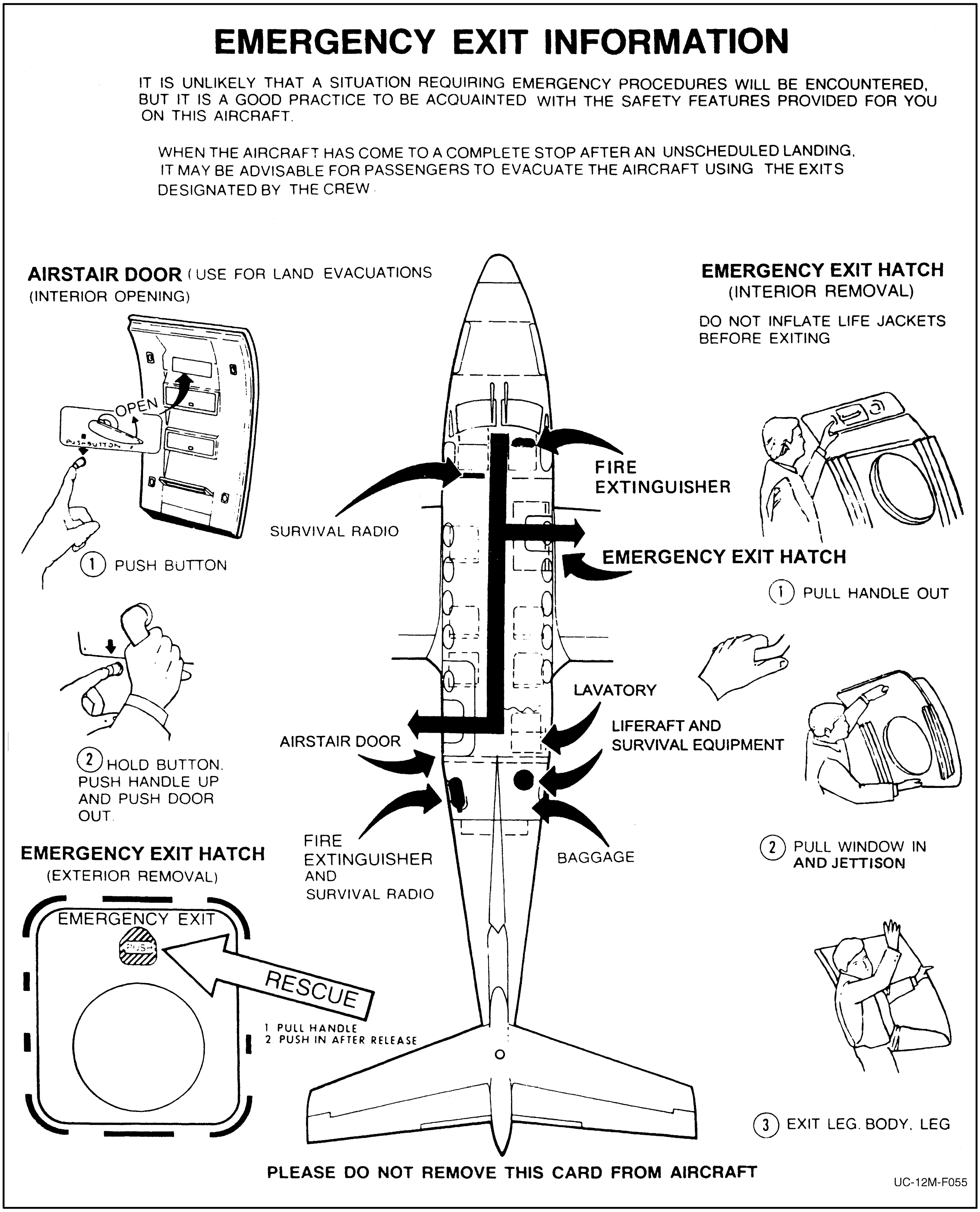


Figure 16-13. (**M**) Passenger Information Card Back Page (Sheet 2 of 2)

CHAPTER 17

Bailout

Not applicable to UC-12 aircraft.

PART VI

All-Weather Operation

CHAPTER 18

Instrument Flight Procedures

18.1 GENERAL

Except for some repetition necessary for emphasis, clarity, or continuity of thought, this chapter contains only procedures that differ from or are in addition to the normal operating procedures covered in Part III. System operations are covered in Part I.

Deicing and anti-icing systems augmented by instrumentation and navigational equipment permit flight in instrument and icing conditions.

18.2 SIMULATED INSTRUMENT FLIGHT

During simulated instrument flight, the following detailed safety precautions must be followed.

18.2.1 Safety Precautions

During all simulated instrument training flights, a qualified observer/safety pilot shall occupy the copilot seat. This pilot will monitor outside the aircraft to ensure safe flight while the practice pilot is "hooded." The practice pilot will not go hooded until instructed.

Although the density of traffic is greater near landing fields and navigational facilities, the possibility of a midair collision is present when operating outside these areas; therefore, to minimize collision danger, all VMC flights, including practice instrument flights, shall conform to appropriate published flight altitudes.

18.2.2 Practice Patterns

Practice patterns are not included in this section. Such procedures will be detailed by local authority or may be obtained from other Navy approved manuals.

18.3 INSTRUMENT FLIGHT PROCEDURES

Flight handling, stability characteristics, and range are the same during instrument flight as during visual flight conditions.

18.3.1 Before Instrument Takeoff

The normal preflight checks in Part III shall be completed before instrument takeoff. In preparation, taxi the aircraft to the center of the runway. Continue rolling straight ahead a few feet before stopping to make certain the aircraft is aligned with the center of the runway and the nosewheel is straight. Hold the brakes and note the heading to be maintained during takeoff roll. Before starting the takeoff roll, set engine controls to obtain maximum power within specified limits (Chapter 4).

18.3.2 Instrument Takeoff

Takeoff shall be accomplished in accordance with procedures established by local authority. The go-around pitch bar may be useful in setting attitude at takeoff.

Note

A slight amount of pitch error in the indication of the attitude indicator will result from accelerations or decelerations. It will appear as a slight climb indication after an acceleration and a slight dive indication after deceleration. The error will be most noticeable at the time the aircraft breaks ground during takeoff. At this time, a climb indication error of approximately one-half bar width will be noticed; however, the exact amount of error will depend on the acceleration and elapsed time of each takeoff. The erection system will automatically remove the error after the acceleration ceases.

18.3.3 Instrument Climb

Instrument climbs are performed as prescribed in Chapter 7. Refer to A1-C12BM-NFM-200 Performance Charts for fuel consumption and rate of climb. When safe altitude and climb airspeed are attained, complete the climb checks as prescribed in Part III.

18.3.4 Instrument Cruise

Stability and flight characteristics are normal throughout the full speed range during instrument flight operations. Power settings during instrument flight should be determined from the performance charts in A1-C12BM-NFM-200 Performance Charts.

18.3.5 Holding

Recommended holding power at a minimum airspeed of 140 knots is approximately 800 foot-pounds/36 percent torque and 1,700 rpm. For extended holding patterns, refer to the appropriate fuel and power charts in A1-C12BM-NFM-200 Performance Charts. For descents in the holding pattern, decrease power and maintain the holding pattern airspeed.

18.3.6 Instrument Descent

When a descent at slower than cruise speed is desired, slow the aircraft to the desired speed before starting the descent. Normal descent or radar controlled descent to traffic pattern altitude can be made using cruise airspeed. Normally, descent will be made with the aircraft in clean configuration, maintaining cruise airspeed, and reducing power as required. A high rate of descent may be obtained using the drag on the propellers in HIGH RPM and/or with landing gear and wing flaps extended.

CAUTION

Observe landing gear and flap operating speeds.

18.3.7 Instrument Approaches

Various procedures can be used for instrument approaches (Figures 18-1, 18-2, and 18-3). Letdowns made in clean or in landing configuration are at the discretion of the pilot. Icing conditions, turbulence, or action to be accomplished when the aircraft reaches the lower altitude will govern the type of letdown. If it is necessary to make an emergency instrument landing, the rate of descent during the last 100 feet should be adjusted to less than 300 fpm.

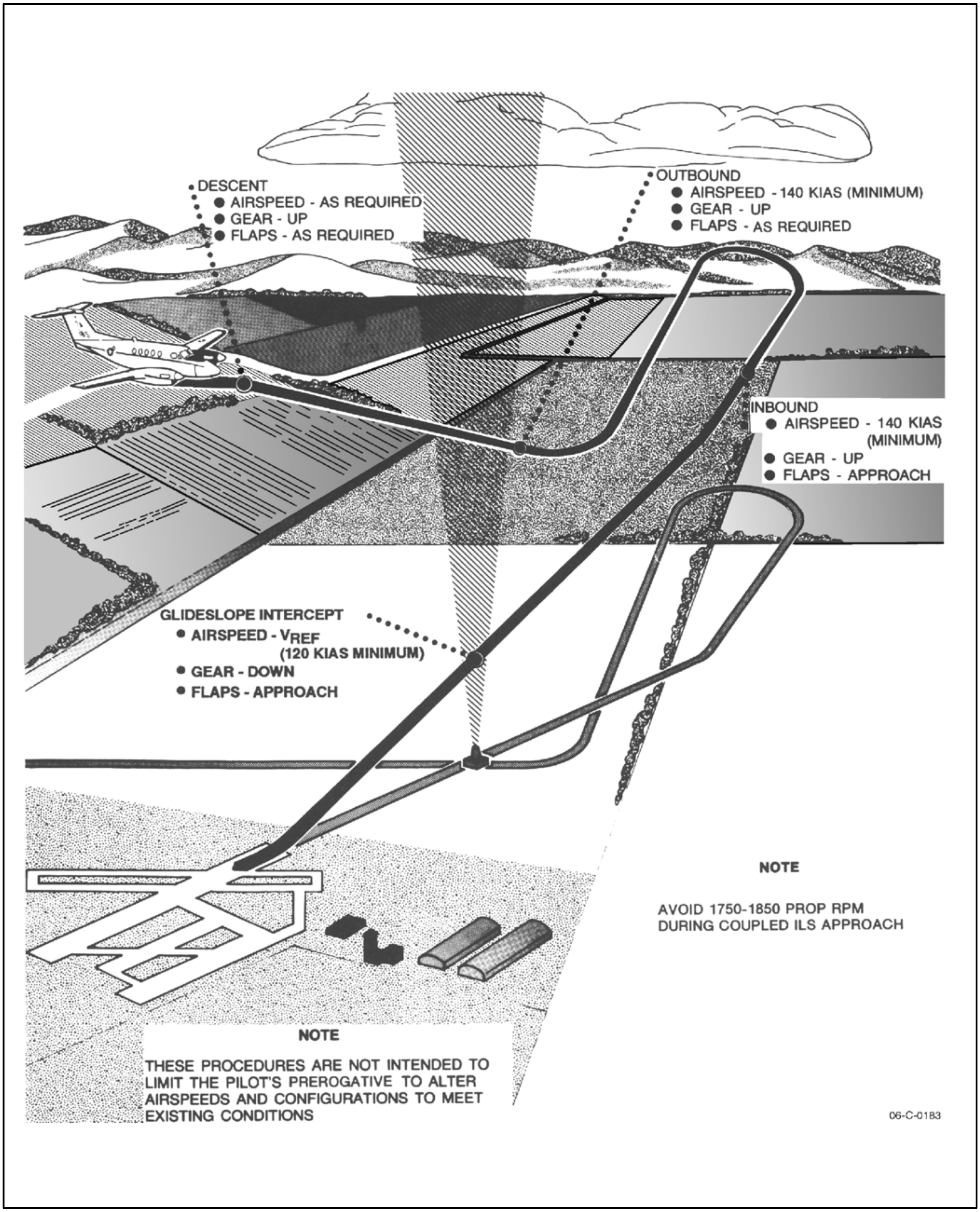


Figure 18-1. ILS Approach (Typical)

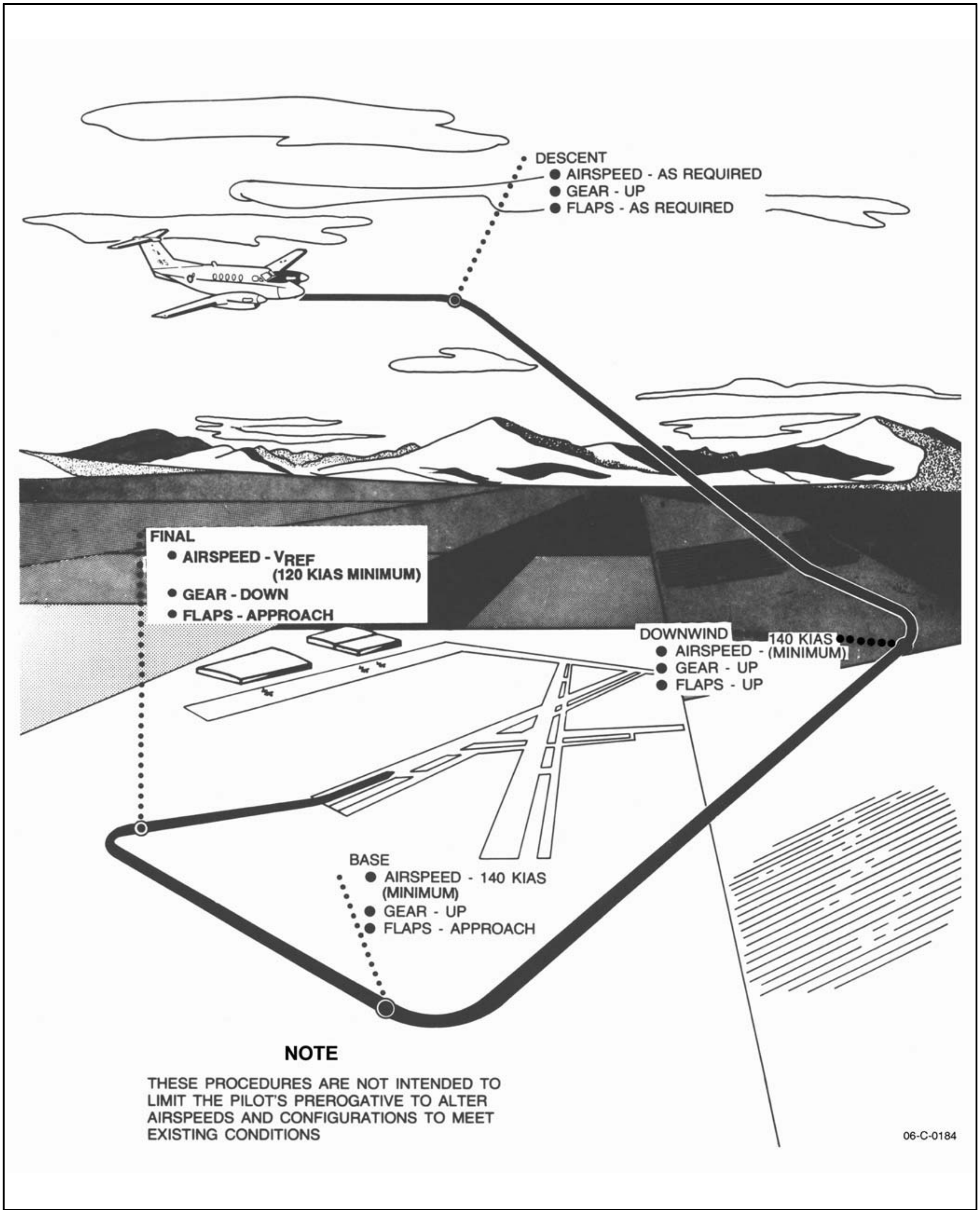


Figure 18-2. Radar Approach (Typical)

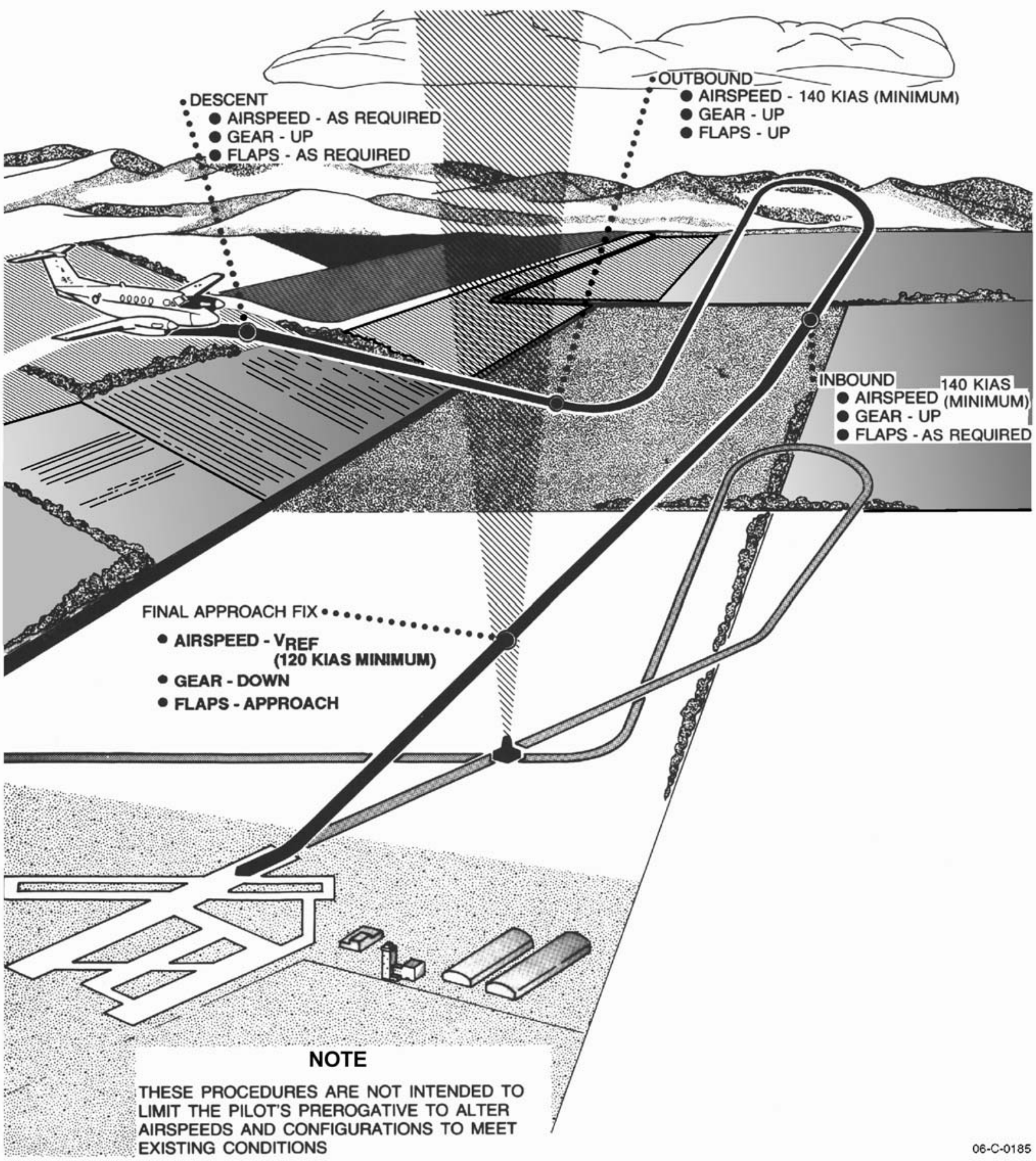


Figure 18-3. Nonprecision Approach (Typical)

18.3.8 Radio Approaches

The recommended cockpit setup is as follows:

18.3.8.1 Automatic Direction Finder Approaches

1. Tune and identify ADF receiver to radio beacon/LOM, and select ADF function switch to ADF.

2. Rotate both RMI selector switches to ADF on pilot and copilot RMIs.

3. Set HSI to inbound course.

Note

- Although the Course Deviation Indicator (CDI) will be inoperative, this will provide a ready reference for the inbound course.

- (**F**) If NAV 1 or NAV 2 is selected with any Localizer (LOC) frequency tuned, the bearing needle on the HSI will display ADF information.

18.3.8.2 VHF Omnidirectional Range (VOR) Approaches

1. Tune and identify VOR 1, then select NAV 1 on pilot HSI selector.

2. Tune and identify VOR 2, then select NAV 2 on copilot HSI selector (may be a different VOR if required for crossfix).

3. Not later than procedure turn inbound, both pilots rotate HSI course set knob to inbound course.

4. Flight director modes:

   a. Engage ALT hold (**F**/**M**) or ALT SEL.

   b. Engage HDG.

   c. (**F**) When cleared for approach, engage APR.

18.3.8.3 TACAN Approaches

1. Tune and identify TACAN, then select TACAN on pilot HSI selector.

Note

- (**B**) The pilot HSI will display TACAN azimuth or Distance Measuring Equipment (DME) information on the CDI. The copilot HSI and the magenta needle will supply azimuth information. The copilot will not be able to view azimuth information on the CDI.

- (**F**) Only the pilot HSI will display TACAN azimuth or DME information. The copilot may display DME information on his/her HSI by selecting the appropriate paired VOR frequency (refer to Chapter 25).

2. Both pilots rotate HSI course set knob to inbound course.

3. Flight director modes:

   a. Engage ALT hold (**F**/**M**) or ALT SEL.

   b. Engage HDG.

   c. When cleared for approach, engage APR.

18.3.8.4 Instrument Landing System/Localizer Approaches

1. Tune and identify VOR 1, then select NAV 1 on pilot HSI selector.

2. Tune and identify VOR 2, then select NAV 2 on copilot HSI selector.

Note

If VOR 2 is used to identify intermediate fixes, it should be tuned to LOC frequency not later than Final Approach Fix (FAF.)

3. Both pilots rotate HSI course set knob to inbound course.

Note

With a LOC frequency selected, the CDI course information displayed will always be the LOC course. Selected HSI course does not affect the CDI needle and is for reference only.

4. Tune and identify ADF receiver to LOM and select ADF function to ADF.

Note

- With a LOC frequency selected, there is no bearing information displayed in the VOR mode of the RMI. If VOR is selected, the needle will park in the 3 o'clock position.

- (**F**) If NAV 1 or NAV 2 is selected with any LOC frequency tuned, the bearing needle on the HSI will display ADF information.

5. Rotate both RMI selector switches to ADF on pilot and copilot RMIs.

6. Select marker beacon audio.

7. Flight director modes:

   a. Engage ALT hold (**F**/**M**) or ALT SEL.

   b. Engage HDG.

   c. When cleared for approach, engage APR.

18.3.8.5 Localizer Back Course Approaches

1. Tune and identify VOR 1, then select NAV 1 on pilot HSI selector.

2. Tune and identify VOR 2, then select NAV 2 on copilot HSI selector.

Note

If VOR 2 is used to identify intermediate fixes, it should be tuned to the LOC frequency not later than FAF.

3. Both pilots rotate HSI course set knob to the published front course.

Note

- With a LOC frequency selected, the CDI course information displayed will always be the LOC course. Selected HSI course does not affect the CDI needle and is for reference only.
- Selecting the published front course on the HSI will indicate a course that is 180° different from the back course; however, the HSI presentation will indicate normal sensing (i.e., fly toward the vertical bar region LOC).
- With LOC frequency selected, there is no bearing information displayed in the VOR mode of the RMI. If VOR is selected, the needle will park in the 3 o'clock position.
- (**F**) If NAV 1 or NAV 2 is selected with any LOC frequency tuned, the bearing needle on the HSI will display ADF information.

4. Flight director modes:

   a. Engage ALT hold (**F**/**M**) or ALT SEL.

   b. Engage HDG.

   c. (**B**) When cleared for the approach, engage — REV.

   (**F**) When cleared for the approach, engage — BC.

Note

To obtain normal flight director sensing for flight director assisted manual approach or for a coupled approach, the Reverse Course (REV/BC) mode of the flight director must be selected.

18.3.9 Ground Control Approach

Fly the pattern as depicted in Figure 18-2 and complete the Approach Checklist prior to entry on downwind. The Landing Checklist should be completed no later than glideslope interception. The copilot will review the Landing Checklist and, when the runway is sighted, will report "CONTACT" to the pilot. Full (100 percent) flaps should not be used until visual contact has been established and landing is assured.

18.3.10 Missed Approach

During an instrument approach, if visual contact with the runway is not established upon reaching the missed approach point, execute a waveoff and comply with missed approach instructions.

18.4 FLIGHT DIRECTOR PROCEDURES

For all flight phase descriptions in this section, the aircraft may be maneuvered automatically by the flight control system. If the autopilot is disengaged, the aircraft may be manually flown to satisfy the flight director commands; the same modes of operation and indicator settings are used.

18.4.1 Takeoff and Climbout

Takeoff is normally made by manually following the flight director commands with the autopilot being engaged above 200 feet AGL.

1. Prior to takeoff, set the heading bug on the HSI to the runway heading. Set the course pointer to the radial of the first desired course. Line up on the runway centerline, selecting GO-AROUND mode then HDG mode; adjust the heading bug to center the command cue. Apply power and keep the command cue centered for low visibility runway guidance during takeoff roll.

2. After liftoff, rotate to center the command cue with aircraft symbol. When stable flight conditions are achieved, engage the autopilot. The GO-AROUND mode is reset with the autopilot, and pitch attitude is held by the autopilot. Indicated Airspeed (IAS) can be selected as a climbout mode.

3. After reaching a safe altitude, use touch control steering to change the desired airspeed through the optimum noise abatement climb profile. Releasing the Touch Control Steering (TCS) button puts the autopilot back in IAS hold and on the climbout heading. Further heading changes may then be made as directed by departure control by moving the heading bug to a new heading.

4. (**B**) As cruise altitude is reached, use TCS to level off at assigned altitude and press ALT to maintain this altitude. Warning of the approaching altitude is given 1,000 feet prior to the selected altitude by an alert light on the altimeter and an aural warning horn. The light extinguishes 300 feet prior to the selected altitude.

5. (**F/M**) A cruise altitude is selected on the altitude alert controller and the ALT SEL mode is selected. The climb is continued in IAS until the ALT SEL capture point is reached. The aircraft is gently leveled off and upon reaching selected altitude, the system automatically switches to the ALT hold mode. Warning of the approaching altitude is given 1,000 feet prior by an alert light on the altimeter and an aural warning horn. The light extinguishes 250 ± 50 feet prior to the selected altitude.

18.4.2 VOR or TACAN Capture and Tracking

The VOR or TACAN mode of operation features automatic capture and tracking of the selected radial. This is usually accomplished with the autopilot engaged and the flight director in the HDG mode. Any vertical mode can be selected without affecting operation (e.g., ALT hold).

1. Tune the navigation receiver to the desired VOR or TACAN station. Set the course pointer on the HSI to the desired course.

2. (**B**) Select V/L mode. HDG, V/L, and roll couple lights illuminate, indicating the system is flying the intercept heading selected with the heading bug on the HSI, and the system is armed for V/L capture.

2. (**F/M**) Select NAV mode; HDG and NAV ARM annunciators illuminate, indicating the system is flying the intercept heading selected with the heading bug on the HSI, and the system is armed for NAV capture.

3. At capture, the HDG (**F/M**) and NAV ARM annunciators will extinguish and (**B**) V/L (**F/M**) NAV CAP annunciators illuminate, indicating the VOR or TACAN capture has occurred. The aircraft will smoothly roll out and track the radial with crosswind washout.

4. If the NAV flag comes into view while tracking the radial, the autopilot will hold heading but the command cue will bias out of view (**F/M**) and the NAV CAP annunciator will extinguish while the flag is in view.

The system includes an overstation sensor that inhibits response to beam deviation when in the cone of confusion above the station. When beam rate becomes excessive, the autopilot automatically flies crosswind corrected course only, providing stable station passage. If desired, a different outbound radial may be selected while over the station when the TO FROM pointer changes direction.

Note

(**F**) The computer uses DME distance as a gain optimizing input; therefore, in order not to degrade performance, it will be necessary to have DME tracking the same station the NAV receiver is tuned to (DME may have to be in hold mode).

18.4.3 ILS Front-Course Approach

On an ILS front-course approach, the localizer and glideslope are automatically captured. The localizer is captured first from heading select in the same manner as the VOR radial. The glideslope can be captured with any vertical mode previously selected and from either above or below the beam. Localizer capture is required before initiation of automatic glideslope capture. To make an ILS front-course approach, perform the following:

1. Tune the navigation receiver to the localizer frequency and set the course pointer to the published inbound course.
2. Set the heading bug to the desired intercept heading.
3. Select (**B**) APP ARM, (**F/M**) APR mode, which arms both the localizer and glideslope as well as heading select circuits. As the aircraft nears the localizer beam, the HDG annunciator will extinguish and (**B**) V/L (**F/M**) NAV CAP annunciator will illuminate, indicating localizer capture. The aircraft will smoothly roll out on the localizer. The expanded localizer pointer at the bottom of the (**B/F**) Flight Director Indicator (FDI) /(**M**) Attitude Director Indicator (ADI) will appear when the localizer deviation is a third of a dot or less. After localizer capture, select the published missed approach heading using the heading bug on the HSI.
4. When the glideslope is captured, the APP ARM annunciator extinguishes and the (**B**) GS (**F/M**) APR CAP annunciator illuminates. Any previously selected vertical mode will automatically release at glideslope capture. The autopilot will track the center of the localizer and glideslope beams with crosswind corrections if required. (**B**) At 250 feet on the radio altimeter or at the middle marker, the GS EXT annunciator will light, indicating the glideslope gains are being reduced to enable smooth tracking of the glideslope beam.
5. When reaching decision height, the decision to land or go around must be made. To assume control of the aircraft for flare and touchdown, press the autopilot disengage button on the control wheel (to the first detent) and land. The rising runway bar becomes visible at 200 feet and provides radio altitude information to touchdown.
6. If either a localizer or glideslope flag comes in view while making an ILS approach, the respective axis will remain coupled on the autopilot, the flight director command cue will bias from view, and the mode light will extinguish.

Note

If the loss of navigation radio signals persists, appropriate new lateral and/or vertical modes must be selected before significant deviation from the desired flight path occurs.

18.4.4 Go-Around

A missed approach may be executed by pressing the GO-AROUND button on the left power lever (**F/M**) and/or copilot yoke. The autopilot will disengage and the GO-AROUND annunciator will illuminate. The flight director command cue will command a wings-level, 7° pitch-up attitude. After the gear and flaps are retracted, reengage the autopilot; go-around is automatically reset. The missed approach departure is made using HDG with the climb being performed using pitch hold or IAS hold. The go-around mode can be selected at any time with any mode previously selected, but it will disengage the autopilot.

18.4.5 Letdown to VOR or TACAN Approach

1. To fly a typical VOR or TACAN letdown, track into the station in the (**B**) V/L (**F/M**) APR mode with the NAV receiver tuned to a VOR or TACAN frequency. After entering the cone of confusion, set the course arrow to the published outbound heading. After station passage, the system will track the new outbound course.

2. If the VOR or TACAN is approached from a heading that requires maneuvering to the outbound leg, select HDG mode and use the heading bug on the HSI to alter the aircraft course.

3. Adjust the heading bug 135° or less in the direction of the 180° turn. Set the course pointer to the inbound radial. After completing 45° of the turn, adjust the heading bug until the 180° turn is completed. While in the inbound turn, select (**B**) APP ARM/(**F/M**) APR. You will automatically capture and track the inbound radial with automatic crosswind washout.

4. (**B**) Use indicated airspeed mode to provide vertical guidance to the runway. First select the VOR or TACAN crossing altitude on the altitude alert controller. Use airspeed (IAS) mode to fly the selected rate of descent. When the selected altitude is approached, engage ALT until crossing the FAF. After crossing FAF, select the Minimum Descent Altitude (MDA) as the next altitude and again use IAS to fly to the MDA. At the MAP, the aircraft should be at MDA and the decision to land or go around must be made.

5. (**F/M**) Use vertical speed or indicated airspeed mode and altitude preselect to provide vertical guidance to the runway. First select the VOR or TACAN crossing altitude on the altitude alert controller and press the ALT SEL mode. The ALT ARM light will come on. Use VS or airspeed (IAS) mode to fly your selected rate of descent. When the selected altitude is approached, the ALT CAP light will indicate the aircraft is leveling out until crossing the FAF. After crossing the FAF, select the MDA as the next altitude and again use IAS or VS to fly MDA as the next altitude and again use IAS or VS to fly to the MDA. At the MAP, the aircraft should be at MDA and the decision to land or go around must be made.

18.4.6 Back Course Approach

Tune the localizer frequency and set the course pointer on the HSI to the FRONT COURSE localizer course. Set the desired intercept heading under the heading bug on the HSI. Select (**B**) REV (**F/M**) BC to arm the system for automatic back course localizer capture. ALT hold may be selected to maintain approach altitude. For best results, brackets should be made beyond 8 miles from the threshold. As in a front course approach, the localizer is captured automatically.

When the aircraft approaches the back localizer, automatic capture will occur. The lateral deviation bar as well as the expanded localizer have the proper sensing and present the proper indication. When (**B**) REV (**F/M**) BC is selected, the glideslope circuits are locked out.

After localizer tracking has begun, the descent phase of the approach should be initiated. Select IAS mode and adjust power for desired rate of descent. (**B**) Use TCS and throttle to make any desired changes to descent profile.

The rising runway bar operates the same as for front course operation. For missed approaches, go-around operation is as previously described.

18.4.7 Holding

To establish a holding pattern over the outer marker or a VOR/TACAN intersection, perform the following:

1. Select HDG and ALT modes. Tune the navigation receiver to the VOR, TACAN, or localizer and set the desired course. Maintain flight to the holding point by adjusting the HDG bug.

2. When the aircraft reaches the holding point, turn the heading bug 135° in the direction of the outbound turn. After completing 45° of the turn, continue moving the heading bug until the reciprocal heading of the inbound course is reached. If crosswind correction is needed, it must be set in manually by adjusting the heading bug for the appropriate crab angle.

3. After the required time on the outbound heading, set the heading bug 135° in the direction of the inbound turn.

4. After completing 45° of the turn, continue moving the heading bug to the inbound course with crosswind correction.

5. If automatic capture and tracking of the inbound radial is desired, select (**B**) V/L (**F/M**) NAV mode after the turn to the inbound radial has been initiated. Crosswind corrections are automatically computed in the (**B**) V/L (**F/M**) NAV mode.

18.5 NIGHT FLYING PROCEDURES

The same procedures used for instrument flying should be used when flying at night. During preflight, make certain that all lights function properly. Since the instrument panel lights are rheostat controlled, instrument lighting can be adjusted for comfortable vision. This will afford maximum visibility outside and at the same time allow the pilot to easily make the transition to instrument flying.

Note

Avoid using landing, taxi, strobe, and/or beacon lights when in haze, smoke, or fog, as reflected light will reduce visibility and may affect depth perception or induce vertigo.

CHAPTER 19

Extreme Weather Operation

19.1 ICE, RAIN, AND SNOW

Icing occurs as the aircraft passes through supercooled water, which depending upon atmospheric conditions can take the form of fog, clouds, or rain. The most severe formation will generally occur at a temperature of approximately –5 °C (23 °F).

19.1.1 Preflight

19.1.1.1 Ice, Snow, and Frost Removal

1. Remove ice, snow, and frost from the wings, empennage, control surfaces and hinges, propellers, windshield, pitot tubes, and fuel tank caps and vents. Use deicing fluid as applicable.

2. Spray aircraft with hot, diluted anti-icing, deicing, and defrosting fluid (MIL-A-8243) mixed in accordance with Figure 19-1. Use a solid stream (not over 15 gallons per minute) to thoroughly saturate all aircraft surfaces and remove any loose ice. Maintain a sufficient quantity of diluted, hot fluid on aircraft surfaces coated with ice to prevent the formation of any additional ice while removing existing deposits. Diluted, hot fluid should be sprayed at a high pressure, not to exceed 300 psi.

3. When facilities for heating defrosting fluid are not available and it is deemed necessary to remove ice accumulations from aircraft surfaces, undiluted defrosting fluid may be used. Spray undiluted defrosting fluid at 15-minute intervals to ensure complete coverage. Removal of ice accumulations using undiluted defrosting fluid is expensive and slow.

4. If tires are frozen to ground, use undiluted defrosting fluid or a ground heater to melt ice around the tires. Move aircraft as soon as tires are free.

Note

When heat is applied to release frozen tires, the temperature of the heat should not exceed 71 °C (160 °F).

To prevent fogging of the interior surfaces of the windshield and other cockpit windows, coat these surfaces with antifogging compound, FSN RN 6850-200-2397-G500, as follows:

1. Wash interior surface if it is excessively soiled.

2. Apply the antifogging compound using the application unit.

3. Wipe the surface with a clean lint-free cloth until it is clear.

CAUTION

- The antifogging compound has a detrimental softening effect on cellulose nitrate instrument lacquer when in contact over 1 hour. Care should be taken to prevent contact of the compound with the instrument panel finish.
- The antifogging compound has a severe swelling effect on rubber. Care should be taken to minimize contact with the rubber and sealant surrounding the windshield.

One application of the antifogging compound is effective for a minimum of 10 fogging and drying cycles. When there is doubt as to the condition of the film, new film should be applied.

19.1.2 Taxiing on Ice, Snow, Slush, or Water

1. (**F/M**) When an aircraft is parked in freezing weather, the brake systems can be contaminated by freezing rain or snow and must be thawed before the aircraft is moved or taxied. Prior to taxi, activating the brake deice system will thaw frozen brake assemblies. Consideration should be given to leaving the brake deice system activated if taxiing through slush, snow, or water in freezing temperatures.
2. If it is necessary to taxi on ice, snow, slush, or water, allow greater distance for braking action. Skidding may occur when sharp turns are made, or if an extremely strong crosswind condition exists. Taxiing in deep snow is difficult and may also cause freezing of brakes and gear after takeoff. (**F/M**) Brake deice should be used.
3. Avoid taxiing through melted snow or slush to prevent ice accumulation on the aircraft surfaces or propellers.
4. Use caution when taxiing in the vicinity of other aircraft. Increase the space between other aircraft to ensure a safe stopping distance. Jet or propeller blast can impair visibility by blowing clouds of dry snow over a large area.

19.1.3 In Flight

Flights through icing conditions should be avoided if possible; however, if flight in these conditions is necessary, make use of anti-icing and deicing systems to prevent the formation of ice on the pitot tubes, fuel vents, and propeller blades. Deice boots are provided to remove ice from the wing and tail leading edges. Windshield anti-icing and defrosters are installed to alleviate conditions resulting from frost or light ice. Windshield wipers are installed for rain removal. An inertial separator is provided for removal of ice and rain from the engine intake air.

WARNING

Flight in freezing rain, freezing drizzle, or mixed icing conditions (supercooled liquid water and ice crystals) may result in ice buildup on protected surfaces exceeding the capability of the ice protection system or may result in ice forming aft of protected surfaces. This ice may not shed using the ice protection systems and may seriously degrade the performance and controllability of the aircraft.

1. Immediately request priority handling from air traffic control to facilitate a route or an altitude change to exit the severe icing conditions.
2. Avoid abrupt or excessive maneuvering that may aggravate control difficulties.

AMBIENT TEMPERATURE (°F)	PERCENT DEFROSTING FLUID BY VOLUME	PERCENT WATER BY VOLUME	FREEZING POINT OF MIXTURE (°F) (APPROXIMATE)
30 and above	20	80	+10°
+20°	30	70	0°
+10°	40	60	–15°
0°	45	55	–25°
–10°	50	50	–35°
–20°	55	45	–45°
–30°	60	40	–55°
Note • Use anti-icing and deicing fluid (MIL-A-8243). • Heat mixture to a temperature of 82° to 93 °C (180° to 200°F).			

Figure 19-1. Deicing Fluid Dilution

3. If autopilot is engaged, hold the controls firmly and disengage the autopilot.

4. Do not engage autopilot.

5. If an unusual roll response or uncommanded roll control movement is observed, reduce angle of attack.

6. Do not extend flaps during extended operation in icing conditions. Operation with flaps extended can result in reduced wing angle of attack with the possibility of ice forming on the upper surface farther aft on the wing than normal, possibly aft of the protected area.

7. If flaps are extended, do not retract them until the aircraft is clear of ice.

19.1.3.1 Stalling Airspeeds

Ice accumulations will increase aircraft weight and change aerodynamic characteristics because of wing surface airflow changes. Airspeed should be held to a comfortable margin above the normal stall speed to avert a stall not preceded by warning alarms. A minimum of 140 KIAS should be maintained to prevent or minimize ice accumulation on unprotected wing and empennage surfaces. Continuous flight in severe icing conditions shall be avoided.

Note

Stall warning in the form of buffet will occur at higher-than-normal airspeeds when the aircraft is weighted by ice accumulations. This also increases drag and distorts airflow over the wing and tail surfaces. The buffer warning zone will be narrower than in normal conditions (i.e., closer to the onset of stall). Govern approach and landing speed accordingly.

19.1.3.2 Engine Ice Vanes

The engine ice vanes shall be extended when the indicated OAT is 5 °C (41 °F) or below in visible moisture. Visible moisture includes clouds, ice crystals, snow, rain, sleet, hail, or any combination of these.

WARNING

If ice formation on the intake screen progresses to a critical point, the engine may flame out.

CAUTION

If the ice vanes are not deployed, moisture may collect on the intake screen and freeze, or snow will melt and refreeze on the screen. When ice separates from the screen, the engine could sustain Foreign Object Damage (FOD).

Note

- The actual (OAT) may be up to 8 °C less than Indicated Outside Air Temperature (IOAT).
- To avoid exceeding the oil temperature limitations, retract the engine ice vanes when operating in ambient temperatures above 15 °C (59 °F).
- Ice vane deployment increases fuel consumption by approximately 15 percent.
- With ice vanes extended, oil temperature may rise to limits with an accompanying drop in oil pressure and/or oil pressure fluctuations. If approaching temperature limits, reduce power or depart icing conditions.

19.1.3.3 Surface Deice

When activated, the deicer boots will dislodge ice accumulations from the leading edges of wing and tail surfaces. Before takeoff on flights in which icing conditions are expected, verify correct pressure reading on the pneumatic pressure gauge, activate both the SINGLE and MANUAL settings of the deice switch, and visually check the boots for inflation and hold down.

During icing conditions, monitor ice buildup on aircraft. When ice accumulation is 1/2 to 1 inch thick, activate the SINGLE CYCLE mode of the surface deice cycle switch to dislodge leading edge accumulation. Repeat as required.

WARNING

- Most effective deicing is accomplished by allowing at least 1/2 to 1 inch of ice to form before attempting removal. Very thin ice may only crack and cling to the boots instead of shedding. Subsequent cycling of the boots will then tend to build a shell of ice outside the leading edge contour, making ice removal efforts ineffective.
- Do not operate deice boots repeatedly. Repeated operation over a short period of time tends to balloon ice over the boots.

CAUTION

Operation of the deicer boots at an OAT of –40 °C or less may crack the boots.

Note

Either engine will supply sufficient air for deice system operation. If SINGLE CYCLE mode of the deice switch is ineffective, use the MANUAL mode.

19.1.3.4 Windshield Anti-Ice

Before flight into icing conditions, the PILOT and COPILOT WSHLD ANTI-ICE switches should be set to the NORMAL position.

CAUTION

At low OAT, whether icing conditions exist or not, moving the windshield anti-ice switch from OFF to HI may cause a crack in the windshield. If windshield heat is desired, place the switch first in the normal position for at least 2 minutes prior to selecting HI, if desired.

Note

Consideration should be given to turning the windshield anti-ice to NORMAL whenever the OAT is below +5 °C.

19.1.3.5 Propeller Deice

Before flight into icing conditions, the PROP heat switch should be set at AUTO position. This system functions automatically until switched OFF. Propeller imbalance (because of ice loads) should be relieved by increasing propeller rpm briefly, then returning rpm to the desired setting. Repeat as necessary.

CAUTION

- If the propeller ammeter reads (**B**) above 18 amperes or below 14 amperes (**F/M**) above 24 amperes or below 18 amperes, refer to paragraphs 15.6.1 or 15.6.2 respectively.
- Propeller deice should not be operated when propellers are not turning. Static operation may damage brushes and slipring.

19.1.3.6 Pitot Heat

The PITOT HEAT switches shall be turned ON before flight.

19.1.3.7 Fuel Vent Heat

The FUEL VENT heat switches shall be turned ON before flight.

19.1.3.8 Stall Warn Heat

The STALL WARN heat switch shall be turned ON before flight.

19.1.3.9 Alternate Static Air Source

The alternate (emergency) static air source should be used for conditions where the normal static source has been obstructed. When the aircraft has been exposed to moisture and/or icing conditions (especially on the ground), and the possibility of obstructed static ports exists, partial obstructions will result in the rate of climb indication being sluggish during a climb or descent. Verification of obstruction is checked by switching to the ALTERNATE system and noting a sudden sustained change in rate indication. This may be accompanied by abnormal airspeed and altitude indications beyond normal calibration differences. Whenever an apparent obstruction exists in the normal static air system or use of the alternate system is desired, switch the static air selector valve to ALTERNATE position (right side panel). Thereafter, for airspeed calibration and altimeter corrections, refer to the respective correction charts in A1-C12BM-NFM-200 Performance Charts.

19.1.3.10 Wing Ice Lights

The wing ice lights are used to illuminate the outboard wing leading edges. The lights circuit is protected and controlled by a circuit breaker-type switch placarded ICE, located on the pilot inboard subpanel.

CAUTION

Prolonged use of the ice lights during ground operations will generate enough heat to damage the light cover.

19.1.3.11 (F/M) Brake Deice

Brake deice is limited for use on the ground for taxi and takeoff. Proper use will prevent brake freezeup on the ground and after liftoff. Brake deice should be energized (when weather conditions dictate) prior to taxi and after landing gear have been lowered for landing. A timer circuit is installed to allow brake deice to operate for 10 minutes after gear retraction to remove ice or slush accumulated on takeoff. Brake deice is then automatically secured.

WARNING

Loss of one engine while BRAKE DEICE is activated may render the rudder boost ineffective.

19.2 COLD-WEATHER OPERATIONS

Cold weather operation difficulties may be encountered unless proper preflight and inspection procedures are accomplished prior to or immediately after flight when the aircraft is exposed to ice, snow, and frost while on the ground.

WARNING

- The accumulation of ice, snow, and frost on aircraft surfaces constitutes a major flight hazard and can result in the loss of lift and cause adverse stall characteristics.
- If runways are wet, icy, or have generally poor braking action, extra care should be devoted when computing accelerate-stop and landing-roll distances (refer to A1-C12BM-NFM-200 Performance Charts).

19.2.1 Fuel Control Icing

Fuel is heated (as required) by the oil-to-fuel heat exchanger prior to entering the fuel control. Since no temperature measurement is available for the fuel at this point, it must be assumed to be the same as the OAT. Figure 3-2 is supplied for use as a guide in preflight planning. It will indicate operating temperatures where icing at the fuel control could occur if using fuel that does not contain an anti-icing additive. If the plot indicates that oil temperatures versus OAT are such that ice formation could occur during takeoff or in flight, anti-icing additive per MIL-L-27686 should be mixed with the fuel at refueling to ensure safe operation. JP-4, JP-5, and JP-8 fuels have anti-icing additive blended in the fuel at the refinery and no further treatment is necessary.

WARNING

If commercial jet fuel is being utilized without anti-ice additive, then engine oil temperature is limited to Figure 3-2 due to the possibility of fuel control icing.

19.2.2 Before Entering Aircraft

1. Check engine air intakes clear.
2. Check fuel drains for frozen condensation. Apply heated air if necessary.
3. Remove ice from fuel caps and vents, static air sources, and pitot tubes (if not covered).
4. Remove dirt and ice from shock struts. Inspect air/ground safety switches, door hinges, and wheels.
5. Check control surfaces and hinges.
6. Check the entire aircraft for freedom from ice, snow, and frost. Remove ice carefully by approved methods and remove snow or frost.
7. Check that wheels are chocked securely.
8. Check tires for proper inflation and that they are not frozen to the ground.

Note

Use ground heaters or undiluted defrosting fluid to free frozen tires. When heat is applied to release tires, the temperature of the heat should not exceed 71 °C (160 °F).

9. Remove all covers and preheaters.

10. Connect Ground Power Unit (GPU) for starting (if available).

19.2.3 On Entering Aircraft

1. Check the flight controls by feel for unrestricted freedom.

2. Complete Before Start Checklist.

19.2.4 Starting

1. Start with propellers feathered to decrease the possibility of the aircraft turning after the first engine comes on speed.

CAUTION

Do not exceed the 1,100 foot-pounds/49 percent torque (propellers feathered) and 85 percent generator load limits.

Note

After the first engine is started, use caution when advancing the condition lever to HIGH IDLE. On very icy ramps, the aircraft brakes may not hold the aircraft in HIGH IDLE. Under these conditions, the aircraft may be started with both propellers feathered, using a GPU for both engine starts, leaving the condition levers in LOW IDLE. If a GPU is not available, leave the right engine in LOW IDLE after start and during battery charge. The right generator shall be off throughout the left engine start sequence. Turn both generators on after the start is complete on the left engine.

2. Visually check all flight, engine, and system instruments to determine if they have warmed sufficiently and are operating normally.

19.2.5 Taxiing

Use normal taxiing procedures if the runways are clean and dry. If it is necessary to taxi on ice, snow, slush, or water, allow greater distance for braking action.

Note

No special handling techniques are required to taxi the aircraft during crosswind conditions unless ice, snow, slush, or water are present.

19.2.6 Engine Runup

Perform runup in an area allowing adequate clearance for power application. If conditions permit, it may be completed prior to taxiing. Runup may have to be completed on the runway.

CAUTION

Monitor for aircraft movement during runup. When operating on slippery surfaces, asymmetrical power may cause the aircraft to slide when power is applied. Extreme caution must be exercised on slippery surfaces; apply power for engine checks symmetrically. Do not attempt to make high-power checks until aircraft is lined up on the runway.

19.2.7 Before Takeoff

1. Windshield anti-ice switches as required.

WARNING

Do not take off with a frosted windshield or with frost, snow, or ice on wings or control surfaces.

2. Left and right pitot heat — ON.
3. Left and right fuel vent heat — ON.
4. Stall warn vane heat — ON.
5. Engine ice vanes — EXTEND as required.

19.2.8 Takeoff

1. At start of takeoff run, advance both power levers to takeoff setting and check that full power is available. If full power is not obtained, immediately discontinue takeoff.
2. Check instruments for correct indications.
3. If takeoff is to be made from a runway covered with standing water or slush up to one-half inch, takeoff distance will be increased significantly. The aircraft may begin to hydroplane at speeds of approximately 72 knots. Consideration should be given to the use of approach flaps to lower V_R.
4. Takeoff should not be attempted with slush accumulations of one-half inch or greater. Anytime takeoff is accomplished in slush or wet snow, there is a possibility of frozen brake assemblies. Do not tap brake pedals during or after water takeoff roll as brake assemblies may freeze in the applied position.

Note

After takeoff in snow or slush, cycle gear to remove snow or slush.

19.2.9 During Flight

1. The flight characteristics of the aircraft are not affected by clear, dry, or cold weather.

19.2.10 Descent

1. Use normal procedures in Part III for descent.

19.2.11 Landing

1. If the runways are clear and dry, make a normal landing.
2. If runways are wet or icy, braking action is generally poor, requiring longer landing rolls.

WARNING

Landing on an icy runway should be attempted only when absolutely necessary and should not be attempted unless the crosswind component is less than 10 knots. Application of brakes without skidding the tires on ice is very difficult because of sensitive hydraulic brakes.

CAUTION

When landing on a wet or slippery runway, the early portion of the roll is the most critical because the aircraft has a hydroplaning tendency until speed has dissipated to below 62 knots. If hydroplaning conditions exist, make a firm touchdown at the slowest safe touchdown speed.

Note

At touchdown, the tires are not rotating and hydroplaning will begin at a lower speed than on takeoff.

19.2.12 After Touchdown

1. Raise the flaps.
2. Lower the nosewheel to the runway prior to applying brakes.
3. After the nosewheel contacts the runway, use light, even application of brakes and reverse as necessary.
4. Maintain directional control by use of rudder.
5. Complete the After Landing Checklist once clear of the runway.

19.2.13 Shutdown and Postflight

When the aircraft is parked outside on ice or in a fluctuating freeze-thaw temperature condition, the following special procedures should be performed:

1. Tie down the aircraft. Place a double layer of paper, fabric, or other insulation material under wheels to prevent them from freezing to the surface. Chock wheels.
2. Release parking brake.
3. Inspect fuel tank caps and vents and remove ice.

Note

Setting the parking brake during low temperatures when an accumulation of moisture is present may cause the brakes to freeze.

4. Clean dirt and ice from shock struts and wheels.

5. Install protective covers.

Note

- Setting the parking brake during low temperatures when an accumulation of moisture is present may cause the brakes to freeze.

- The propeller restraints should be installed on a blade in the 12 o'clock position to preclude moisture from collecting in a low boot and freezing it to the propeller.

19.3 TURBULENT AIR PENETRATION

Even though flight in severe turbulence is to be avoided, turbulent air may be encountered under certain conditions. During night or instrument flight conditions, it is not always possible to detect individual storm areas or areas of low turbulence or calm conditions. When areas of expected turbulence must be penetrated, be ready to counter rapid changes in attitude and to accept major indicated altitude variations.

19.3.1 Airspeed

Flight through turbulent air presents two basic airspeed problems. If excessive airspeed is maintained, structural damage may occur. If airspeed is too low, the aircraft may stall. If turbulence encountered in cruise or descent becomes uncomfortable, reduce speed to the turbulent air penetration speed (170 KIAS). This speed gives the best assurance of avoiding excessive stress loads and at the same time provides margin against inadvertent stalls caused by gusts.

19.3.2 Control

WARNING

Since turbulence imposes heavy loads on the aircraft structure, make all necessary changes in aircraft attitude with the least amount of control pressures to avoid excessive loads on the aircraft structure.

Overcontrolling while attempting to correct for changes in altitude/attitude by applying control pressure abruptly will build up g-forces rapidly and could cause damaging structural stress loads. Watch particularly the angle of bank, making necessary turns as wide and shallow as possible. Be particularly careful with angle of bank corrections to keep the aircraft level. Maintain straight-and-level attitude in either up- or downdrafts. Use trim sparingly to avoid being mistrimmed as the vertical air columns change velocity and direction.

19.4 THUNDERSTORMS AND TURBULENCE

WARNING

Intentional flight through thunderstorms and severe turbulence is prohibited.

Thunderstorms, squall lines, and violent turbulence should be regarded as extremely dangerous and must be avoided whenever possible. If it is absolutely necessary to penetrate a thunderstorm, it should be done in the lower third portion of the cell.

19.4.1 Engine Lightning Strike

CAUTION

Suspected lightning strikes to propeller and engine require engine inspection by qualified maintenance personnel prior to next flight.

19.4.2 Radar Identification of Storm Cells

If a storm cannot be seen, its presence and general proximity may be detected by radar that can establish its location, size, general shape, distance from the aircraft, and direction and rate of movement relative to the aircraft. The presence of snow and rain/hail may also be detected.

WARNING

When using the radar to avoid areas of heavy weather, storm cells should be avoided by at least 10 miles.

19.4.3 Penetration

If storm penetration is unavoidable, complete the following preparations before entry:

1. Attain the altitude most suitable for storm penetration.
2. Adjust power settings, as necessary, for penetration speed of 170 KIAS.
3. Stow loose gear and fasten harnesses and seatbelts.
4. Trim aircraft.
5. Turn pitot heat, windshield anti-ice, and propeller deice switches and windshield wipers ON, as required.
6. Check instruments.
7. Turn ON flight compartment lights, as required, to minimize blinding effects of lightning.

19.4.4 Flight in a Storm

During flight through a storm, use the following procedures:

1. Do not attempt to hold penetration altitude.
2. Maintain heading and level flight attitude. Do not make turns unless necessary.
3. Avoid abrupt pitch corrections. Apply light elevator forces only when necessary to maintain level attitude.

WARNING

Pressure changes within the storm may cause the pressure altimeter to be unreliable. Unstable barometric pressures may cause an indicated gain or loss of several thousand feet. Allowance should be made in determining a minimum safe altitude.

19.4.5 Autopilot Operation

If the altitude hold function is disengaged, the autopilot may be used in turbulent air at pilot discretion.

19.5 HOT-WEATHER OPERATIONS

During hot-weather operations, the principal difficulties encountered are high ITT/TGT during engine starting, overheating of brakes, and longer takeoff and landing rolls because of the less dense hot air. In areas where high humidity is encountered, nonmetallic materials will be subject to moisture absorption. In very dry areas, additional precautions must be taken to protect the aircraft from damage caused by dust or sand. Particular care should be taken to prevent the entrance of dust or sand into the various aircraft components and systems (engine, fuel system, pitot static system, etc.).

19.5.1 Before Starting Engines

1. Make visual inspection of the aircraft exterior, checking for system leaks, sand or dust accumulation, and tire overinflation.

19.5.2 Taxiing and Takeoff

1. Avoid excessive use of brakes.

CAUTION

A limitation based on pressure altitude and ambient temperature prohibits aircraft takeoff (because of engine ITT/TGT limit) when temperatures exceed the operating limits.

2. Monitor ITT/TGT and torque limits.
3. Be prepared for slower acceleration, longer takeoff distance, and reduced thrust at all power settings because of lower density air in hot weather.

19.5.3 Before Leaving Aircraft

1. Install wheel chocks and release wheelbrakes.
2. Check that all protective covers are installed.

19.6 DESERT OPERATIONS

Sand, dust, and high temperatures encountered during desert operation can sharply reduce the operational life of the aircraft and its equipment. The abrasive qualities of dust and sand upon turbine blades and moving parts of the aircraft and the destructive effect of heat upon aircraft instrumentation will necessitate hours of maintenance if basic preventive measures are not followed. In flight, dust and sand will be difficult to escape, since dust clouds over a desert may be found at altitudes up to 10,000 feet.

19.6.1 Before Entering Aircraft

1. Check the position of the aircraft in relation to other aircraft. Propeller-blown sand blast can damage other aircraft.

2. Wipe struts free of dust and sand.

3. Check tires for signs of deterioration.

4. Remove all aircraft protective covers and plugs.

19.6.2 Warmup and Ground Tests

Perform normal warmup and ground test procedures. To minimize possibility of damage to the engine during desert operation, use inertial separators (ice vanes). The inertial separators will separate all but the finest particles of sand and dust from engine intake air.

CAUTION

Monitor oil temperatures carefully when using the ice vanes in high ambient temperatures.

19.6.3 Taxiing and Takeoff

When practical, avoid taxiing over sandy terrain. Propeller and engine deterioration may result from the impingement of sand and gravel. No special technique or procedures are required during takeoff. Avoid taking off in the wake of another aircraft if runway surface is sandy or dusty.

19.6.4 Before Leaving Aircraft

1. Check that all protective covers are installed.

2. Exercise care to prevent sand or dust from entering fuel tanks during servicing.

19.7 WINDSHEAR PROBABILITY EVALUATION

1. The Windshear Probability Guidelines in this section are designed for convective weather conditions (Figure 19-2). They provide a subjective evaluation of various observational clues to aid in making appropriate real-time windshear avoidance decisions. The observation weighting is categorized according to the following scale:

   a. High Probability — Critical attention needs to be given to this observation. A decision to avoid (e.g., divert or delay) is appropriate.

   b. Medium Probability — Consideration should be given to avoiding. Precautions are appropriate.

   c. Low Probability — Considerations should be given to this observation, but a decision to avoid is not generally indicated.

Whenever the probability of windshear exists, but avoidance action is not considered necessary, the aircraft commander should consider taking the following precautions.

19.7.1 Takeoff

1. Use maximum takeoff thrust.
2. Use the longest suitable runway that avoids suspected windshear.
3. Consider using approach flaps. Studies of available flap settings show that greater settings provided the best performance for windshear encounters on the runway, whereas lesser settings show the best performance for in-air windshear encounters.
4. The PNF should closely monitor the vertical flight path instruments, such as vertical speed and altimeters, and call out any deviations from normal.

19.7.2 Landing

1. Configure for landing and establish a stabilized approach as early as possible, prior to the FAF on an instrument approach, or 1,000 feet AGL on a visual approach.
2. Use approach flaps.
3. If available landing field length permits, increase airspeed up to a maximum of 20 knots. Maintain this speed into the flare. Touchdown must occur within the normal touchdown zone — do not allow the airplane to float down the runway.
4. Avoid large thrust or trim changes in response to sudden airspeed increases, as these may be followed by airspeed decreases.
5. Consider using the autopilot and flight director (ILS only) for the approach to provide more monitoring and recognition time. Disconnect the autopilot when continued use appears counterproductive.

The PNF should closely monitor the vertical flight path instruments, such as vertical speed and altimeters, and call out any deviations from normal.

CAUTION

- Clues should be considered cumulative. If more than one is observed, the probability weighting should be increased.
- Currently no quantitative means exist for determining the presence or intensity of microburst windshear. Pilots are urged to exercise caution in determining a course of action.

Note

These guidelines apply to operation in the airport vicinity (within 3 miles of the point of takeoff/landing along with the intended flight path and below 1,000 feet AGL). The hazard increases with the proximity to the convective weather. Weather assessments should be made continuously.

	Observation	Probability of Windshear
Presence of convective weather near intended flight path:		
—	With localized strong winds (tower reports or observed blowing dust, rings of dust, tornado-like features, etc.)	HIGH
—	With heavy precipitation (observed or radar indications of contour or attenuation shadow)	HIGH
—	With rain shower	Medium
—	With lightning	Medium
—	With virga	Medium
—	With moderate or greater turbulence	Medium
—	With temperature/dewpoint spread greater than 15 °C	Medium
—	Microburst Alert from TDWR or LLWAS	HIGH
PIREP of airspeed loss or gain:		
—	15 knots or greater	HIGH
—	less than 15 knots	Medium
LLWAS alert/wind velocity change:		
—	20 knots or greater	HIGH
—	Less than 20 knots	Medium
Forecast of convective weather		Low

Figure 19-2. Windshear Probability Guidelines

PART VII

Communication and Navigation Equipment Procedures

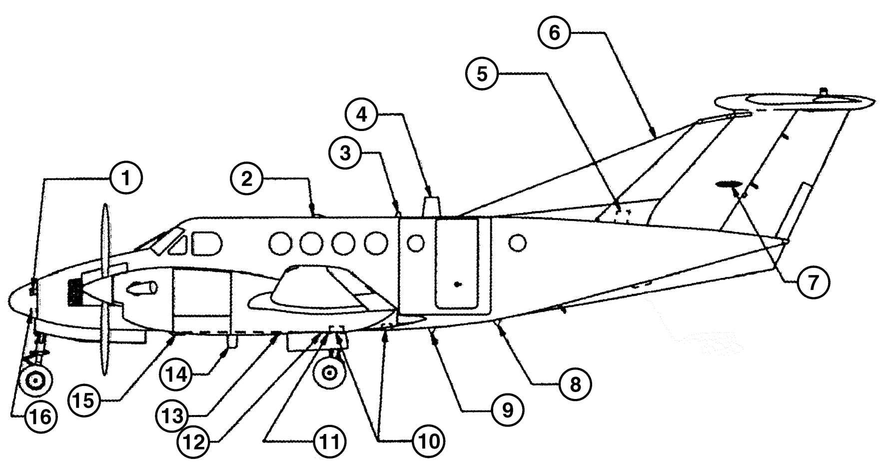
CHAPTER 20

General

20.1 EXTENT OF COVERAGE

This part covers electronic equipment installed in the UC-12. A brief description of each system, associated controls, indicators, and operating procedures is provided. The communication section comprises an interphone system connected to a dual audio control panel with separate controls for the pilot and copilot that interface with VHF, UHF, and HF communication units. The navigation section provides the pilot and copilot with instrumentation to establish and maintain an accurate flight course and to make an approach under IMC. Equipment for determining aircraft altitude, position, range and bearing to destination, groundspeed, and drift angle is installed. A flight control system is provided with autopilot capabilities. Separate flight director indicators serve the pilot and copilot. A transponder, emergency locator transmitter, and weather radar are installed. Antennas associated with these systems are illustrated in Figure 20-1.

(**M**) The avionics equipment receives dc power from the 28 Vdc buses. These buses feed through two 35-ampere circuit breakers placarded AVIONICS MASTER PWR #1 and #2, located in the avionics portion of the overhead circuit breaker panel, to the respective avionics power relays. Each power relay supplies power to the circuit breakers that protect the individual equipment. A 5-ampere circuit breaker, placarded AVIONICS MASTER CONTR, feeds power to the AVIONICS MASTER POWER switch on the overhead control panel. This switch controls the avionics power relays. When the switch is in the OFF (aft) position, the relay is energized and power is withheld from the avionics equipment. When external power is applied to the aircraft, the avionics power relay is automatically



1. RADAR ANTENNA
2. GPS ANTENNA
3. TRANSPONDER UPPER ANTENNA
4. COMM 1 ANTENNA
5. ELT ANTENNA
6. HF ANTENNA
7. VOR/LOC NO. 1 & NO. 2 ANTENNA (RS & LS)
8. TACAN ANTENNA
9. TRANSPONDER LOWER ANTENNA
10. RADIO ALTIMETER ANTENNA
11. ADF ANTENNA
12. TEMP PROBE
13. DME ANTENNA
14. COMM 2 ANTENNA
15. MARKER BEACON ANTENNA
16. GLIDESLOPE ANTENNA

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Figure 20-1. (**F**) Antenna Locations (Sheet 1 of 2)

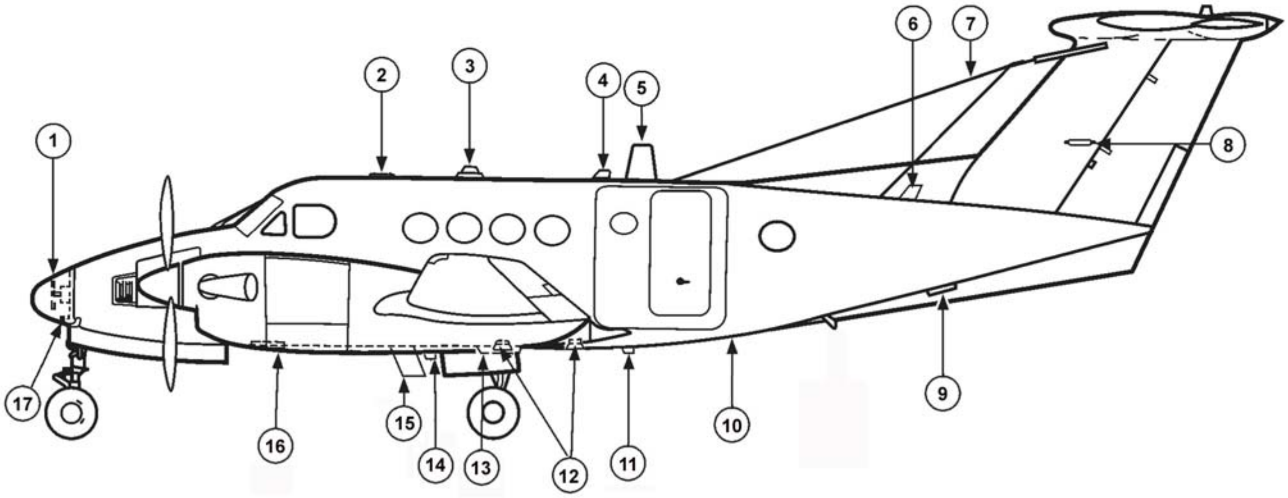


Figure 20-1. (**B**/**M**) FSU Antenna Locations (Sheet 2 of 2)

energized, withholding power to the avionics equipment. If external power to the avionics system is desired, the AVIONICS MASTER POWER switch must be positioned to EXT PWR, overriding the automatic avionics lockout system. The EXT PWR position will deenergize the avionics power relay and power will be applied to the avionics system.

Note

If the AVIONICS MASTER POWER switch fails to operate, power to the individual avionics circuit breakers can be provided by pulling the AVIONICS MASTER CONTR circuit breaker.

(**M**) Ac power for the avionics equipment is provided by two 400 Hz 750 Vac single-phase inverters. The inverters are controlled by two switches placarded INVERTER No. 1 and No. 2, located on the overhead control panel. During normal operations, the No. 1 inverter supplies 115 and 26 Vac to the No. 1 avionics system, while the No. 2 inverter supplies the No. 2 avionics system. Should either inverter fail, the total ac load will be automatically switched to the remaining operative inverter, unless a ground fault exists. The inverters receive dc power through and are protected by two 35 ampere inverter power circuit breakers located on the dc power distribution panel.

20.2 EMERGENCY LOCATOR TRANSMITTER (ELT)

20.2.1 Description

An automatic or manually activated ELT is located in the right side of the fuselage at approximately F.S. 340.00. The associated antenna is mounted on top of the aft fuselage at the same location. An access hole with a spring-loaded cover is located in the right fuselage skin adjacent to the transmitter, enabling a downed pilot to manually activate, terminate, or reset the ELT to an armed mode. There is also a remote switch with a yellow transmit light located on the left cockpit sidewall next to the OAT gauge. The remote switch is lever-locked in the ARM and the ON positions.

The transmitter contains an impact g switch that automatically activates the transmitter following a 3 to 7 g impact along the flight axis of the aircraft. Neither the remote switch nor the switch on the transmitter can be positioned to prevent the automatic activation of the transmitter. When activated, it will radiate omnidirectional radio frequency signals on the international distress frequencies of 121.5 and 243.0 MHz. The radiated signal is modulated with an audio swept tone. Self-contained batteries provide operation for a minimum of 48 hours.

1. ARM — Establishes “readiness” state to start automatic emergency signal transmissions when the force of impact exceeds a preset threshold.

2. ON — Turns set on, initiating emergency signal transmissions.

3. OFF — Turns set off.

20.3 COCKPIT VOICE RECORDER SYSTEM

20.3.1 General

The Cockpit Voice Recorder (CVR) system provides six channels for storage of audio information in solid-state memory. Four channels are used to provide a high quality recording of each of four audio sources. This recording is capable of storing only the last 30 minutes of information. Two channels are used to provide a standard quality recording of the last 120 minutes of information. One of these channels records information from the area mic, and the other channel records a combination of the information provided by the pilot audio, the copilot audio, and the public address system. The impact switch will turn the recorder off if the system experiences a 4g or greater acceleration or deceleration in either the longitudinal axis or the lateral axis.

20.3.2 System Description

The Cockpit Voice Recorder system consists of the CVR and an impact switch, both located in the aft fuselage avionics bay, a control unit located on the pedestal, an area mic located on the top of the instrument panel glareshield just to the right of the warning annunciator panel and an audio mixer amplifier located on the RH sidewall behind the instrument panel. The circuit receives 28 Vdc power from the main battery bus and is protected by a 2 ampere circuit breaker placarded CVR and located on the copilot circuit breaker panel. The system simultaneously records audio information from four sources: the cockpit area mic, the pilot audio amplifier, the copilot audio amplifier, and the public address audio.

20.3.2.1 Control Unit

The control unit (Figure 20-2) contains a TEST button, a green test light, an ERASE button, and a headphone jack. The TEST button is used to activate the CVR self-test feature and should be held for a minimum of 5 seconds. The green test light will illuminate when the CVR has passed its test. If the self-test is run with headphones plugged into the control unit, two tones will be heard immediately before the green light illuminates. The headphone jack provides a means of preflighting the area mic. Sounds picked up by the area mic will be played back in the headphones with no delay. The ERASE button is used to erase the entire recording and will only work when the weight of the airplane is on the landing gear. The ERASE button should be held for a minimum of 2 seconds. If the erase function is conducted with headphones plugged into the control unit, a loud tone, which begins when the ERASE button is released and lasts for 5 to 10 seconds, confirms that the erase feature is functioning properly.

Note

High-impedance headsets are the only approved type headset for use by the flightcrew.

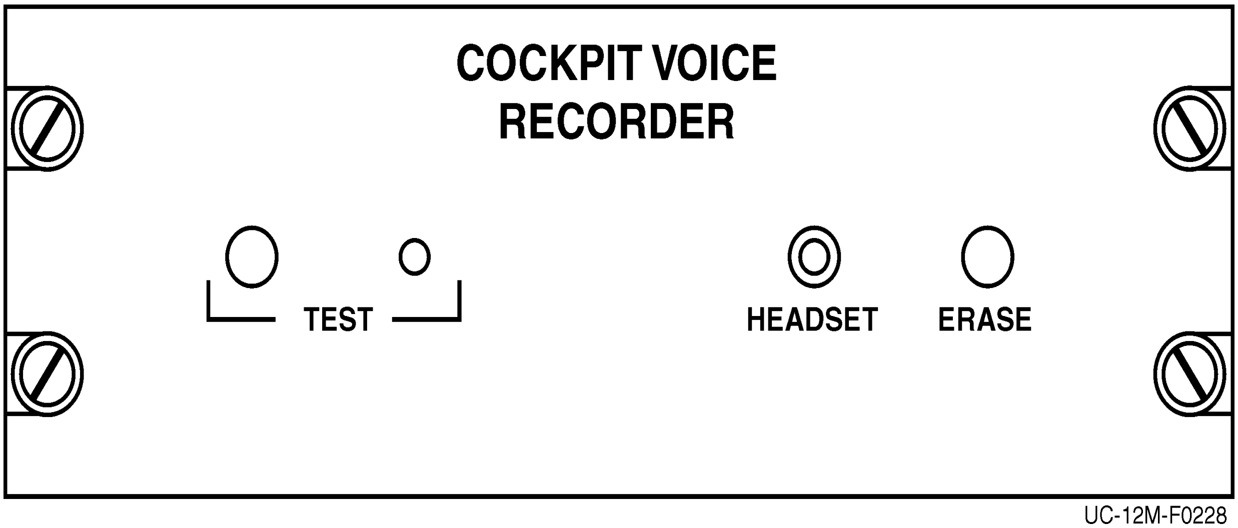


Figure 20-2. Cockpit Voice Recorder

20.3.3 Normal Operation

20.3.3.1 Before Starting Engines

1. Battery — On.
2. CVR TEST button — Press and hold (5 seconds minimum).
3. Green test light — Illuminated.
4. ERASE button — Press and hold for 2 seconds minimum (if desired).

Prior to first flight of the day:

5. Headset — Plug headphones into CVR control unit.
6. Speak into area microphone. Voice will play back in headphones with no delay.

Note

The CVR self-test must be accomplished prior to flight.

20.3.3.2 Audio System Failure

1. Appropriate AUDIO EMER/NORM switch — EMER.
2. Appropriate AUDIO SPKR/PHONE switch — PHONE.

20.4 FLIGHT DATA RECORDER

20.4.1 System Description

The solid-state Flight Data Recorder (FDR) is located in the aft fuselage avionics bay and converts and records analog data into protected solid state memory. The recorder will continuously record and retain the last 25 hours of flight data. Elapsed Time, Heading, pilot Microphone key, Copilot Microphone key, A/P Engage, Vertical Acceleration, Longitudinal Acceleration, Left and Right Engine Torque, Pitch Control Position, Control Wheel Position, Left and Right Engine Prop Reverse, Left and Right Prop rpm, Flap Position (Down, Approach, Up), Pitch and Roll Attitude, Altitude, and Airspeed parameters are recorded.

20.4.2 Fault Annunciator

A FDR FAULT annunciator is located in the caution and advisory annunciator panel ((**B**) Figure 2-34, (**F**) Figure 2-35 and (**M**) Figure 2-36). The annunciator should extinguish approximately 5 seconds after dc and ac power have been applied to the system. Reillumination of the fault annunciator indicates a possible problem in the recorder or incorrect input data to the recorder. There are no controls associated with the recorder and its operation is completely automatic.

20.4.3 Normal Operation

20.4.3.1 Before Taxi

1. Flight data recorder FDR FAULT annunciator — Extinguished.

CHAPTER 21

UC-12B Communications

21.1 GENERAL

The communications section is comprised of an interphone system connected to a dual audio control panel with separate controls for the pilot and copilot that interface with VHF, UHF, and HF communication units.

A third crewmember interphone station, located on the left sidewall of the aircraft, outboard of the third crewmember flight chair, is added to enhance mission intercommunications (Figure 2-5). The station includes an interphone panel, interfaced to the aircraft interphone system, and a microphone cord and switch assembly located in a storage compartment below the interphone panel.

21.2 MICROPHONES

Hand-held, boom, and oxygen mask microphones can be utilized in the aircraft.

21.2.1 Microphone Normal/Oxygen Mask Switch

1. NORMAL — Selects boom or hand-held microphone.
2. OXYGEN MASK — Selects microphone in oxygen mask.

The MIC pushswitches, located on the control wheels or on the hand-held microphones when pressed, route voice from the microphone to the selected transmitter.

21.3 AUDIO CONTROL PANEL

A dual audio control panel (Figure 21-1) on the instrument panel serves both the pilot and copilot. This panel is equipped with two sets of identical controls. Separate speaker and interphone isolation amplifiers are provided so that either the pilot or copilot may transmit to the cabin speakers.

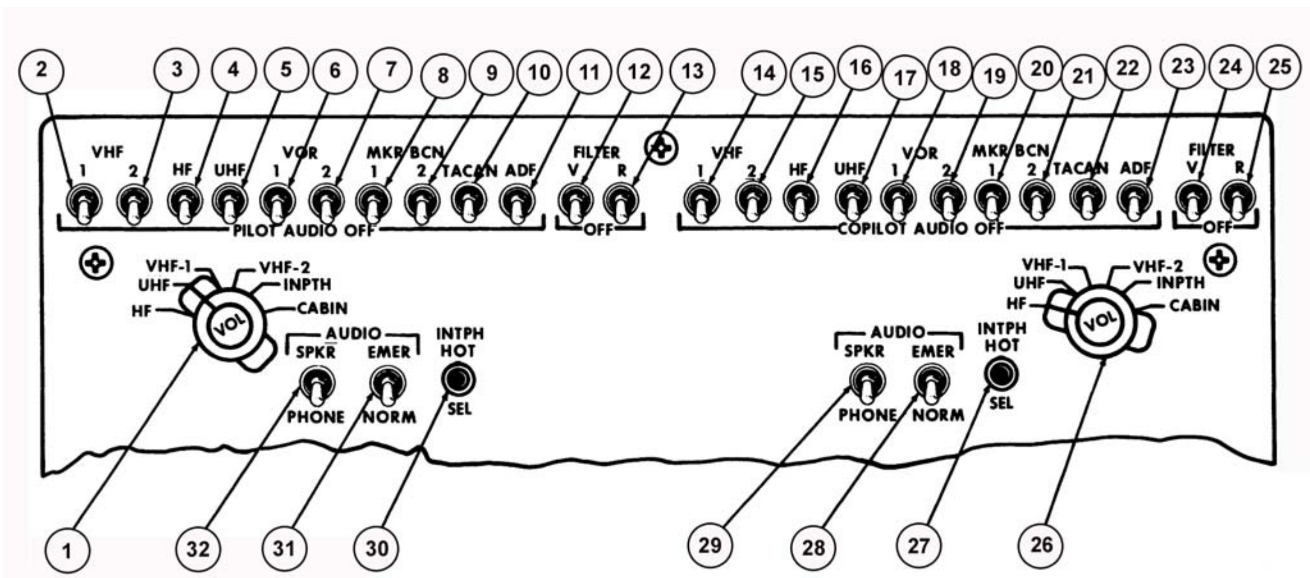
21.3.1 Filter, Interphone, and Audio Switches

1. V/OFF — Kills voice reception (ADF only).
2. R/OFF — Kills 1020-Hz range tone (ADF, VOR only).

Note

If both filter switches are inadvertently positioned the same (both ON or both OFF), voice and range audio will be heard simultaneously.

3. INTPH HOT — Allows interphone communication without keying the MIC button.
4. SEL — User must key MIC button to speak into the interphone system.
5. SPKR/PHONE switch:
   a. SPKR position — Routes audio to overhead speaker.
   b. PHONE position — Routes audio to headphones.



(LOCATION: RADIO PANEL)

1. PILOT MIC SELECT SWITCH AND VOLUME CONTROL
2. PILOT VHF #1 AUDIO/OFF SWITCH
3. PILOT VHF #2 AUDIO/OFF SWITCH
4. PILOT HF AUDIO/OFF SWITCH
5. PILOT UHF AUDIO/OFF SWITCH
6. PILOT VOR #1 AUDIO/OFF SWITCH
7. PILOT VOR #2 AUDIO/OFF SWITCH
8. PILOT MKR BCN #1 AUDIO/OFF SWITCH
9. PILOT MKR BCN #2 AUDIO/OFF SWITCH
10. PILOT TACAN AUDIO/OFF SWITCH
11. PILOT ADF AUDIO/OFF SWITCH
12. PILOT ADF AND NAV VOICE FILTER/OFF SWITCH
13. PILOT ADF AND NAV RANGE FILTER/OFF SWITCH
14. COPILOT VHF #1 AUDIO/OFF SWITCH
15. COPILOT VHF #2 AUDIO/OFF SWITCH
16. COPILOT HF AUDIO/OFF SWITCH
17. COPILOT UHF AUDIO/OFF SWITCH
18. COPILOT VOR #1 AUDIO/OFF SWITCH
19. COPILOT VOR #2 AUDIO/OFF SWITCH
20. COPILOT MKR BCN #1 AUDIO/OFF SWITCH
21. COPILOT MKR BCN #2 AUDIO/OFF SWITCH
22. COPILOT TACAN AUDIO/OFF SWITCH
23. COPILOT ADF AUDIO/OFF SWITCH
24. COPILOT ADF AND NAV VOICE FILTER/OFF SWITCH
25. COPILOT ADF AND NAV RANGE FILTER/OFF SWITCH
26. COPILOT MIC SELECT SWITCH AND VOLUME CONTROL
27. COPILOT INTPH HOT/SEL SWITCH
28. COPILOT EMER/NORM AUDIO SELECT SWITCH
29. COPILOT SPKR/PHONE AUDIO SELECT SWITCH
30. PILOT INTPH HOT/SEL SWITCH
31. PILOT EMER/NORM AUDIO SELECT SWITCH
32. PILOT SPKR/PHONE AUDIO SELECT SWITCH

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Figure 21-1. UC-12 Dual Audio Control Panel

6. NORM/EMER switches:

   a. NORM position — Allows normal operation of the audio amplifier.

   b. EMER position — Allows reception of audio in headphones in the event of failure of audio amplifier.

Note

In EMER position, there will be a decrease in volume and a loss of isolation between the pilot and copilot audio depending on AUDIO switch position.

21.3.2 Normal Operation

Note

All audio volume controls are on the radio section of the instrument panel, except for controls to the HF, UHF, and TACAN systems located on the pedestal.

21.3.2.1 Transmit

Note

The pilot not talking must rotate the transmit selector to the transmitting radio to hear sidetone.

21.3.2.2 Intercommunication

1. SPKR/PHONE switch (audio panel) — PHONE.

2. EMER/NORM switch (audio panel) — NORMAL.

3. MIC NORMAL/OXYGEN MASK switch (instrument panel) — As desired.

Note

With MIC switches in the OXYGEN MASK position, Intercommunication System (ICS) transmissions are not broadcast through the overhead speaker. Headsets must be worn to ensure adequate communications between pilots.

4. INTPH HOT/SEL switch (audio panel) — As desired.

   a. If INTPH HOT selected — Talk when ready.

   b. If SEL is selected — Rotate transmitter selector to INTPH, depress MIC switch, and transmit.

5. VOL knob (center of transmitter selector) — Adjust.

21.3.3 Emergency Operation

Fail-safe emergency audio is available. If either amplifier for the dual audio panel should fail, nonamplified signals will be directed to the headphones.

1. EMER/NORM audio switch — EMER.

2. VOL controls (systems to be monitored) — Adjust.

21.3.3.1 Shutdown

1. AVIONICS MASTER PWR switch (pedestal) — OFF.

2. Leave avionics controls and circuit breakers positioned for normal operation.

3. Aircraft dc power — OFF.

21.4 UHF COMMUNICATIONS

21.4.1 Description

The UHF communications unit is a line-of-sight radio transceiver that provides transmission and reception of amplitude-modulated signals in the ultrahigh frequency range of 225.000 to 399.975 MHz for a range of approximately 50 miles varying with altitude. Channel selection is spaced at 0.025 MHz. A separate receiver is incorporated to provide monitoring capability for the UHF guard frequency (243.0 MHz).

Note

The PRESET channel selector and manual frequency selectors are inoperative when the mode selector is set to GUARD position. The receiver/transmitter will be set to the emergency frequency only.

The transmit and receive sections of the UHF unit operate independently but share the same power supply and frequency control circuits. The UHF antenna is housed in the same mast as the VHF No. 2 antenna (Figure 20-1). Separate cables route the transmit and receive signals to their respective receiver/transmitter. UHF circuits are protected by a UHF circuit breaker in the avionics portion of the copilot right sidewall panel.

1. TONE pushbutton — When pressed, transmits a 1020-Hz tone on the selected frequency.

2. Function selector — Selects operating functions.

   a. OFF — Turns set off.

   b. MAIN — Selects normal transmission with reception on main receiver.

   c. BOTH — Selects normal transmission with reception on both the main receiver and the guard frequency receiver.

   d. ADF — Not used in this installation.

21.4.2 Normal Operation

21.4.2.1 Receive

1. UHF audio switch (audio panel) — ON.
2. SPKR/PHONE switch (audio panel) — As desired.
3. VOL control (UHF control panel, pedestal) — Adjust to midposition.
4. Preset frequency:
   a. Mode selector — PRESET position.
   b. PRESET channel selector — Rotate to channel desired.
5. Non-preset frequency:
   a. Mode selector — MANUAL position.
   b. Manual frequency selectors (five) — Rotate each knob to set desired frequency digits.
6. Volume — Adjust.

Note

To adjust volume when audio is not being received, turn squelch switch OFF, adjust volume for comfortable noise level, then turn squelch switch ON.

7. Squelch — As desired.

21.4.2.2 Transmit

1. Transmitter selector (audio panel) — UHF.
2. MIC NORMAL/OXYGEN MASK switch (instrument panel) — As desired.
3. MIC switch — Depress to transmit.

21.4.2.3 Shutdown

1. Function selector (UHF control panel) — OFF.

21.5 VHF COMMUNICATIONS

21.5.1 Description

VHF communications provide transmission and reception of amplitude-modulated signals in the very high frequency range of 116.000 to 151.975 MHz for a range of approximately 50 miles, varying with altitude. VHF-1 is controlled by the pilot and has two frequency controls and frequency indicators with a selector switch for quick frequency switching. VHF-2 is controlled by the copilot and has one frequency control and frequency indicator. VHF circuits are protected by VHF NO.1 and VHF NO.2 circuit breakers on the avionics portion of the copilot right sidewall panel.

1. TEST pushbutton — Overrides automatic squelch circuit.

21.6 HF COMMUNICATIONS (PROVISIONS ONLY)

21.6.1 Description

The HF unit provides long range communications within the frequency range of 2.0000 to 29.9999 MHz and employs either AM, Lower Sideband (LSB), or Upper Sideband (USB) modulation. The distance range of the set is approximately 2,500 miles and varies with altitude. The unit is protected by a 3-ampere HF RCVR and a 25-ampere HF POWER circuit breaker on the copilot right sidewall panel. The control panel is located on the pedestal extension, and HF audio controls are located on the audio panel (Figure 21-1).

1. RF TEST indicator.

   a. Unkeyed — Tests the lamp.

   b. Keyed — Indicates operational status of the set.

   c. Burning steadily — Indicates a fault in the receiver/exciter.

   d. Blinking — Indicates a fault in the power amplifier/coupler.

   e. Extinguished — Indicates normal operation.

CHAPTER 22

UC-12F Communications

22.1 GENERAL

The communication group is comprised of an interphone system connected to a dual audio control panel with separate controls for the pilot and copilot that interface with VHF, UHF, and HF communication units.

22.1.1 Microphones

Hand-held, boom, and oxygen mask microphones may be utilized in the aircraft.

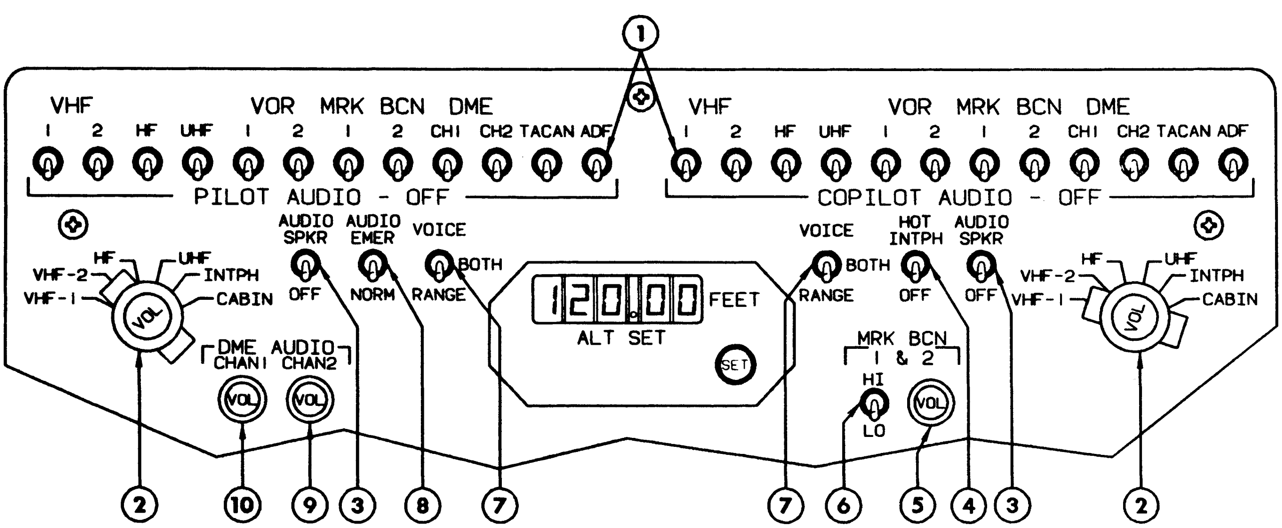
22.1.2 MIC NORMAL/OXYGEN Switch (Pilot and Copilot Subpanels)

1. MIC NORMAL — Selects boom or hand-held microphone.
2. OXYGEN MASK — Selects microphone in oxygen mask.

The MIC pushswitches, located on the control wheels or on the hand-held microphones when pressed, route voice from the microphone to the selected transmitter.

22.2 AUDIO CONTROL PANEL

A dual audio control panel (Figure 22-1) serves both the pilot and copilot. This panel is equipped with two sets of identical controls. Separate speaker and interphone isolation amplifiers are provided so that either the pilot or copilot may transmit to the cabin speakers.



1. AUDIO Switches
2. Transmitter Selector Switch
3. AUDIO SPKR Switches
4. HOT INTPH Switch
5. MRK BCN VOL Control
6. MRK BCN Sensitivity Switch
7. Filter Switches
8. AUDIO EMER Switch
9. DME AUDIO CHAN 2 Volume Control
10. DME AUDIO CHAN 1 Volume Control

06-E-0058

Figure 22-1. Dual Audio Control Panel

22.2.1 HOT INTPH Switch

1. HOT INTPH— Enables interphone communication between pilot and copilot without keying the MIC button.

Note

Both pilot AUDIO SPKR switches must be selected OFF to allow hot interphone communication.

22.2.2 AUDIO SPKR Switches

1. SPKR — Routes audio to overhead speakers.

22.2.2.1 AUDIO EMER/NORM Switch

1. EMER — Enables reception of all audio in headphones in the event of failure of audio amplifier.
2. NORM — Enables normal operation of the audio amplifier.

22.2.3 Normal Operation

22.2.3.1 Receive

1. AUDIO SPKR switches (audio panel) — SPKR.
2. AUDIO EMER/NORM switch (audio panel) — NORM.

Note

Audio panel switches and volume controls are routinely left in positions of normal use.

3. Move separately each audio panel select switch to ON, then OFF to verify audio output from speakers for each system. Adjust volume.

Note

All audio volume controls are on the radio section of the instrument panel except for controls to the HF, UHF, and TACAN systems. These controls are located on the pedestal extension.

4. AUDIO SPKR switch (audio panel) — OFF.
5. Move separately each audio panel select switch to ON, then OFF to verify audio output from headphones for each system.

Note

Headphone audio will always be active regardless of AUDIO SPKR switch position.

6. Audio panel select switches — Select switches ON as desired for communications.

22.2.3.2 Intercommunication

1. Both AUDIO SPKR switches (audio panel) — OFF.
2. AUDIO EMER/NORM switch (audio panel) — NORM.

Interphone communications are inhibited in EMER position.

3. MIC NORMAL/OXYGEN MASK switch (subpanels) — As desired.

Note

With MIC switches in the OXYGEN MASK position, ICS transmissions are not broadcast through the overhead speaker. Headsets must be worn to ensure adequate communications between pilots.

4. HOT INTPH/OFF select switch (audio panel) — As desired.

   a. If HOT INTPH is selected: Talk when ready.

   b. If keyed INTPH is desired: Rotate transmitter selector to INTPH, depress MIC switch, and transmit.

5. VOL knob (center of transmitter selector) — Adjust.

22.2.3.3 Aircraft-to-Ground Intercommunications

A communication jack on the nosegear strut placarded MIC JACK is provided for use between the ground personnel and the pilot. The jack connects headphones and microphone to the aircraft interphone system, but is limited to use between the ground personnel and the pilot (left seat) position only. When in use, the aircraft-to-ground system will inhibit intercommunications between the pilot and copilot regardless of the transmitter select or interphone switches position. The aircraft-to-ground interphone system receives electrical power through and is protected by the circuit breaker placarded MOD located on the hot battery bus.

22.2.3.4 Cabin Intercom Operation

1. Rotate transmitter selector to CABIN.
2. Depress MIC switch and talk.

22.2.3.5 Emergency Audio Operation

Fail-safe emergency audio is available. If either amplifier for the dual audio panel should fail, nonamplified signals will be directed to the headphones.

1. AUDIO EMER/NORM switch — EMER. Both systems are now in emergency audio.

Note

An alternate method of activating emergency audio is to pull both the pilot and copilot audio circuit breakers.

2. VOL controls (systems to be monitored) — Adjust.

22.2.3.6 Shutdown

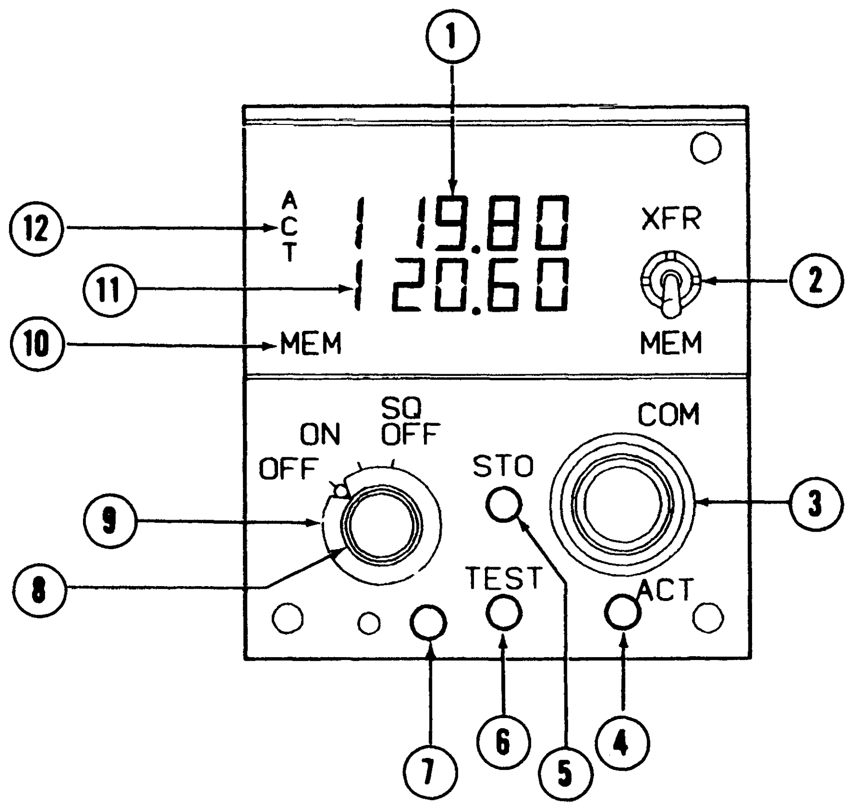
1. AVIONICS MASTER PWR switch (pedestal) — OFF.
2. Leave avionics controls and circuit breakers positioned for normal operation.
3. Aircraft dc power — OFF.

22.3 VHF 1 AND VHF 2 COMMUNICATIONS

22.3.1 Introduction

The VHF communication transceiver provides airborne VHF communications on 1,360 channels from 118.00 through 151.975 MHz and is used with the panel-mounted COM controls (Figure 22-2).

The solid-state transceiver includes capture-effect automatic squelch, plus audio leveling and response shaping. Transmitter sidetone comes from detected transmitter signal.



1. Active Frequency Display
2. XFR/MEM Switch
3. Frequency Select Knobs
4. ACT Button
5. STO Button
6. TEST Button
7. Light Sensor
8. Volume Control
9. Power and Mode Switch
10. Annunciators (MEM, HLD)
11. Preset Frequency Display
12. Compare Annunciator (ACT)

06-E-0059

Figure 22-2. UC-12F VHF COM Controls (Typical)

22.3.2 Operating Controls

All operating controls for the VHF transceiver are located on the COM controls (Figure 22-2).

22.3.2.1 Active Frequency Display

The active frequency (frequency to which the VHF is tuned) and diagnostic messages are displayed in the upper window.

22.3.2.2 Preset Frequency Display

The preset (inactive) frequency and diagnostic messages are displayed in the lower window.

22.3.2.3 Compare Annunciator

ACT (active) momentarily illuminates when frequencies are being changed. ACT also flashes if the actual radio frequency is not identical to the frequency shown in the active frequency display.

22.3.2.4 Annunciators

The COM control contains MEM (memory) and TX (transmit) annunciators. The MEM annunciator illuminates when a preset frequency is being displayed in the lower window. The TX annunciator illuminates when the VHF is transmitting.

22.3.2.5 Volume Control

A volume control is concentric with the power and mode switch.

22.3.2.6 Power and Mode Switch

The power and mode switch has three detent positions. The OFF and ON positions switch system power. The SQ OFF position disables the receiver squelch circuits.

22.3.2.7 Light Sensor

The built-in light sensor automatically controls the display brightness.

22.3.2.8 XFR/MEM Switch

This switch is a three-position, spring-loaded toggle switch. When held to the XFR position, the preset frequency is transferred up to the active display, the previously active frequency becomes the new preset frequency, and the VHF retunes. When this switch is held to the MEM position, one of the six stacked memory frequencies is loaded into the preset display. Successive presses cycle the six memory frequencies through the display (...2, 3, 4, 5, 6, l, 2, 3...).

22.3.2.9 Frequency Select Knobs

Two concentric knobs control the preset or active frequency displays. The larger knob changes the three digits to the left of the decimal point in 1-MHz increments. The smaller knob changes the two digits to the right of the decimal point in 50-kHz increments (or in 25-kHz increments for the first two steps after the direction of rotation has been reversed).

22.3.2.10 ACT Button

Press the ACT button for about 2 seconds to enable the frequency select knobs to directly retune the VHF. The bottom window will display dashes and the upper window will continue to display the active frequency. Press the ACT button a second time to return the control to the normal two-display mode.

22.3.2.11 STO Button

The STO button allows up to six preset frequencies to be selected and entered into the control memory. After presetting the frequency to be stored, press the STO button. The upper window displays the channel number of available memory (CH 1 through CH 6); the lower window continues to display the frequency to be stored. For approximately 5 seconds, the MEM switch may be used to advance through the channel numbers without changing the preset display. After approximately 5 seconds, the control will return to normal operation. Press the STO button a second time to commit the preset frequency to memory in the selected location.

22.3.2.12 TEST Button

Press the TEST button to initiate the radio self-test diagnostic routine (self-test is active only when the TEST button is pressed).

22.3.3 Operating Procedures

The frequencies displayed on the COM control show only five of the six digits. The sixth digit is always a 0 (when the fifth digit is a 0 or 5) or a 5 (when the fifth digit is a 2 or 7); therefore, the sixth digit need not be displayed.

Note

- It is possible that erroneous operation could occur without a fault indication. It is the responsibility of the pilot to detect such an occurrence by continually assessing the reasonableness of operation as displayed on the associated COM control and by the quality of received signals and transmissions.
- It is not advisable to simultaneously monitor the same frequency on both VHF 1 and VHF 2.

22.3.3.1 Equipment Turn-On

The VHF transceiver and the COM control are turned on by rotating the power and mode switch on the COM control to the ON position. When the transceiver is first turned on, it emits a brief audible tone while the microprocessor checks its own memory. If there is a memory defect, the tone continues, indicating that the transceiver will neither receive nor transmit.

After the memory check, the COM control displays the same active and preset frequencies that were present when the equipment was turned off.

Note

If two short 800 Hz tones are heard, the transceiver has detected an internal fault. Press the TEST button on the COM control to initiate a self-test and display the fault code.

Adjust the volume and perform a squelch test by setting the power and mode switch on the COM control to SQ OFF and adjusting the volume level with background noise. After a comfortable listening level has been established, return the power and mode switch to the ON position. All background noise should disappear unless a station or aircraft is transmitting on the active frequency.

22.3.3.2 Frequency Selection

Frequency selection is accomplished using either the frequency select knobs or the XFR/MEM (transfer/memory recall) switch.

Rotation of either frequency select knob increases or decreases the frequency in the preset frequency display.

After the desired frequency is set in the preset frequency display, it can be transferred to the active frequency display by momentarily positioning the XFR/MEM switch to XFR. At the same time that the preset frequency is transferred to the active display, the previously active frequency is transferred to the preset display. A short audio tone is applied to the audio system to indicate that the active frequency has been changed, and the ACT annunciator on the COM control flashes while the transceiver is tuning to the new frequency.

Note

If the ACT annunciator continues flashing, it indicates that the transceiver has not tuned to the frequency displayed in the active display.

The COM control memory permits storing up to six preset frequencies. Once stored, these frequencies can be recalled to the preset display by positioning the XFR/MEM switch to the MEM position. The storage location (CH 1 through CH 6) for the recalled frequency is displayed in the active frequency display while the XFR/MEM switch is held in the MEM position. All six stored frequencies can be displayed one at a time in the preset display by repeatedly positioning the XFR/MEM switch to the MEM position. After the desired stored frequency has been recalled to the preset display, it can be transferred to the active display by momentarily positioning the XFR/MEM switch to the XFR position.

During normal operation, all frequency selections and revisions are done in the preset frequency display; however, the active frequency can be selected directly as described in paragraph 22.3.3.3.

22.3.3.3 Direct Active Frequency Selection

The active frequency can be selected directly with the frequency select knobs by pressing the ACT button for 2 seconds. The active frequency selection mode is indicated by dashes appearing in the preset display. The ACT annunciator will also flash as the frequency select knobs are turned to indicate that the transceiver is being retuned.

Note

If the ACT annunciator continues flashing after the frequency has been selected, it indicates that the transceiver is not tuned to the frequency displayed in the active display.

To return to the preset frequency selection mode, press the ACT button again for about 2 seconds.

As a safety feature, the COM control automatically switches to the direct active frequency selection mode when a frequency select knob is operated while the STO, TEST, or XFR/MEM switches are actuated.

22.3.3.4 Frequency Storage

To program the memory, select the frequency in the preset frequency display using the frequency select knobs and press the STO button once. One of the channel numbers (CH 1 through CH 6) will appear in the active display for approximately 5 seconds. During this time, the channel number can be changed without changing the preset frequency by momentarily positioning the XFR/MEM switch to the MEM position. After the desired channel number has been selected, press the STO button again to store the frequency.

Note

When storing a frequency, the second actuation of the STO button must be done within 5 seconds after selecting the channel number or the first actuation of the STO button. If more than 5 seconds elapse, the control will revert to the normal modes of operation and the second store command will be interpreted as the first store command.

After a frequency has been stored in memory, it will remain in memory until changed using the STO button. Memory is retained even when the unit is turned off for an extended period of time.

22.3.3.5 Stuck MIC Button

Each time the push-to-talk button is pressed, the microprocessor in the transceiver starts a 2-minute timer (the TX annunciator on the COM control is illuminated whenever the transmitter is on). If the transmitter is still on at the end of 2 minutes, the microprocessor turns it off. Most intentional transmissions last much less than 1 minute; a 2-minute transmission is usually the result of a stuck MIC button. This timing feature protects the frequency from long-term interference.

When it turns the transmitter off, the microprocessor switches the VHF to receive operation. A stuck MIC button will prevent hearing received signals or the two warning beeps. The microprocessor then waits until the push-to-talk button unsticks to emit the two beeps.

To transmit for more than 2 minutes, release the MIC button briefly and then press again. The 2-minute timer resets and starts a new count each time the push-to-talk button is pressed.

22.3.3.6 Overtemperature Protection

The microprocessor regularly monitors the temperature of the transmitter. If the transmitter gets too hot during a transmission, the microprocessor stops the transmission. Shutdown temperature is +160 °C (+320 °F). Sidetone ceases at that instant. When the MIC button is released, two beeps will be heard (press the TEST button on the COM control to observe the fault code).

As long as the temperature remains above the limit, the microprocessor will not respond to a normal press of the MIC button; however, if necessity dictates, override the protection by rapidly keying the MIC button twice, holding it on the second press.

22.3.4 UHF Communication Set

The UHF is a line-of-sight radio transceiver that provides transmission and reception of AM signals in the ultrahigh frequency range of 225.000 to 399.975 MHz for a range of approximately 50 miles. Channel selection is spaced at 0.025 MHz. Audio signals are applied through the pilot and copilot UHF AUDIO switches to the respective headsets. A separate receiver is incorporated to provide monitoring capability for the UHF guard frequency (243.0 MHz).

Note

The GUARD position should not be used except in actual emergencies. When operating under emergency conditions, set the MANUAL-PRESET-GUARD switch to the GUARD position and the function switch to MAIN. Do not use the BOTH position since noise from the two receivers may make the incoming signal unreadable.

1. TONE pushbutton — When pressed, transmits a 1020 Hz tone on the selected frequency.

2. Function selector — Selects operating functions.

   a. OFF — Turns set off.

   b. MAIN — Turns set on.

   c. BOTH — Selects main receiver, transmitter and guard receiver.

   d. ADF — Not used in this installation.

22.3.5 HF Communication Set

The HF system consists of three units: the panel-mounted control display, the remote power amplifier/antenna coupler, and the receiver/exciter. The system will operate on any 0.1-kHz frequency between 2.000 and 29.9999 MHz.

With the capability to preset 99 frequencies for selection during flight, the system allows for either selection of other frequencies manually (direct tuning) or reprogramming of any preset frequency. The system will automatically tune the antenna coupler when the microphone is keyed.

22.3.6 HF Control Panel

The HF system has two methods of frequency selection. The first method is called tuning (frequency agile). The second is a channelized operation in which desired operating frequencies are preset, stored, and referenced to a channel number. The operating controls of the HF system are described as follows:

1. Frequency/channel selector — This selector consists of two concentric knobs that control the channel and frequency digits plus the lateral position of the cursor.

2. Frequency control — The outer knob becomes a cursor (flashing light) control with the FREQ/CHAN switch in the FREQ position. The flashing digit is then increased/decreased with the inner knob.

3. Channel control — The outer knob is not functional when the FREQ/CHAN switch is in the CHAN position. The inner knob will provide channel control from 1 through 99, displayed at the right end of the display window.

4. PGM (program) switch — Enables channelized data to be modified. The PGM message will be displayed whenever this switch is depressed.

5. Program — The program mode must be used for setting or changing any of the 99 preset frequencies. Each of the 99 channels may be preset to receive and transmit on separate frequencies (semiduplex), receive only, or transmit and receive on the same frequency (simplex). The operating mode (LSB, USB, or AM) must be the same for both receive and transmit and can also be preset.

6. STO (store) switch — Stores displayed data when programming preset channels.

22.3.6.1 Frequency Tuning (Simplex Only)

Each digit of the frequency may be selected instead of “dialing” up or down to a frequency. The larger concentric knob is used to select the digit to be changed. This digit will “flash” when selected. Rotation of the knob moves the flashing “cursor” in the direction of rotation. After the digit to be changed is flashing, the smaller concentric knob is used to select the numeral desired. This process is repeated until the new frequency has been selected. The flashing cursor may then be stowed by moving it to the extreme left or right of the display and then one more click. This stows the cursor behind the display until needed again. The cursor may be recalled by turning the concentric knob one click left or right.

22.3.6.1.1 Direct Frequency Tuning (Simplex Only)

1. FREQ/CHAN button out (FREQ).

2. Select desired mode (LSB, USB, or AM).

3. Select digit to be changed (outer knob).

Digit (cursor) will flash.

4. Select numerical value of digit (inner knob).

5. Stow cursor (or repeat procedure for additional changes).

6. Tune antenna coupler (press MIC button).

22.3.6.2 Channel Programming

There are three ways to set up a channel: receive only, simplex, and semiduplex. To gain access to channelized operation, depress FREQ/CHAN button. To utilize the existing programmed channels (i.e., no programming required), use the small control knob to select the desired channel number, then momentarily key the microphone to tune the antenna coupler. If channel programming is required, it is necessary to activate the program mode.

With the FREQ/CHAN button in (CHAN), use a pencil or other pointed object to press the PGM button in. The letters PGM will appear in the lower part of the display window and the system will remain in the program mode until the PGM button is pressed again (switch alternate action: push-on, push-off).

22.3.6.2.1 Receive Only

1. Stow the cursor if a frequency digit is flashing.
2. Select the channel to be preset.
3. Set the desired operating mode (LSB, USB, or AM).
4. Set the desired frequency (refer to paragraph 22.3.6.1).
5. Press and release STO button once.

TX will flash in the display window. A receive only frequency is being set; the flashing TX should be ignored.

If another channel is to be set, the cursor must be stowed before a new channel can be selected. Use the smaller concentric knob to select the channel and repeat the steps for selecting a new frequency.

6. To return to an operating mode, press the PGM button.

22.3.6.2.2 Simplex

Setting a channel up for simplex operation (receive and transmit on the same frequency):

1. FREQ CHAN button in (cursor stowed).
2. PGM button in (PGM displayed).
3. Select channel to be preset.
4. Set mode (LSB, USB, or AM).
5. Set desired frequency (refer to paragraph 22.3.6.1).
6. Press and release STO button twice.

The first press of the STO button stores the frequency in the receive position and the second press stores the same frequency in the transmit position. The second press also stores the cursor. If another channel is to be reset, use the smaller concentric knob to select the channel and repeat the steps for selecting a new frequency. The cursor is automatically stowed.

7. To return to one of the operating modes, press the PGM button again.

22.3.6.2.3 Semiduplex

Setting a channel for semiduplex (transmit on one frequency and receive on another):

1. Select channel to be preset.
2. Set desired frequency (refer to paragraph 22.3.6.1).
3. Set mode (LSB, USB, or AM).

4. Press STO button once.

5. Set transmit frequency.

6. Press STO button again.

If another channel is to be reset, use the smaller concentric knob to select the channel and repeat the steps.

7. To return to an operating mode, press the PGM button again.

Note

The mode for each channel (LSB, USB, or AM) is stored along with the frequency. If the mode is changed, the system will receive and transmit in the mode selected for transmit.

CHAPTER 23

UC-12M Communications

23.1 COMMUNICATIONS

23.1.1 General

The communications group is comprised of an interphone system connected to a dual audio control panel with separate controls for the pilot and copilot that interface with VHF, UHF and HF communications units.

A third crewmember interphone station, located on the left sidewall of the aircraft, outboard of the third crewmember flight chair, is added to enhance mission intercommunications (Figure 2-7). The station includes an interphone panel, interfaced to the aircraft interphone system, and a microphone cord and switch assembly located in a storage compartment below the interphone panel.

23.1.1.1 Microphones

Handheld, boom, and oxygen mask microphones may be utilized in the aircraft. The MIC pushswitch (control wheel, handheld microphone, or copilot foot switch), when pressed, routes voice from the microphone to a selected transmitter.

23.1.1.2 MIC HEADSET/OXYGEN MASK Switch (Pilot and Copilot Subpanels)

1. MIC HEADSET — Selects headset boom microphone.

2. OXYGEN MASK — Selects microphone in oxygen mask.

23.1.2 Audio Control Panel

A dual audio control panel (Figure 23-1) serves both the pilot and copilot. This panel is equipped with two sets of identical controls. Separate speaker and interphone isolation amplifiers are provided so that either the pilot or copilot may transmit to the cabin speakers.

23.1.2.1 Transmitter Select Switch

1. INTPH — Selects cockpit interphone system.

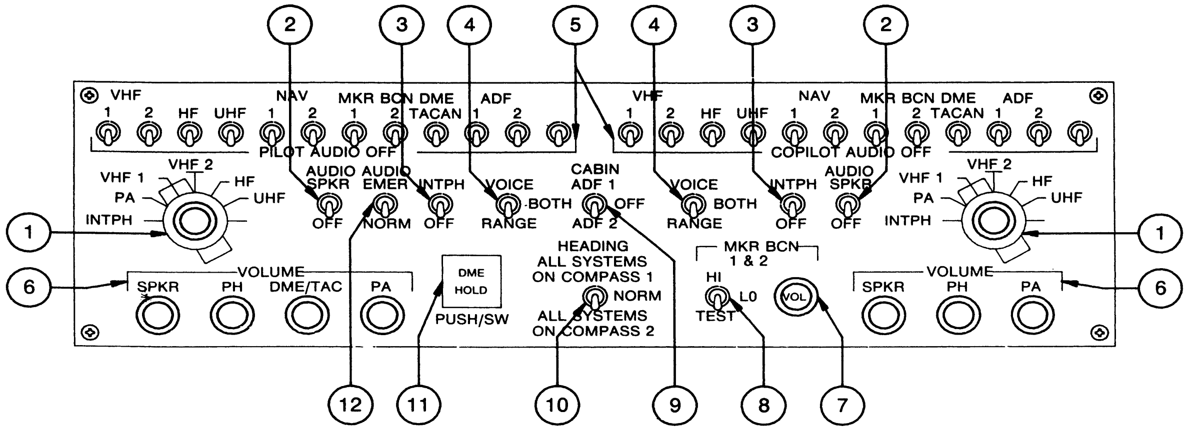
2. PA — Selects cabin public address (removes cabin ADF).

3. VHF 1 — Selects VHF-AM Comm Transceiver #1.

4. VHF 2 — Selects VHF-AM Comm Transceiver #2.

5. HF — Selects HF transceiver.

6. UHF — Selects VHF transceiver.



1. Transmit Interphone Selectors
2. P/CP Overhead Speaker Switches
3. P/CP Interphone Selectors
4. P/CP ADF And VOR Filter Switches
5. P/CP Audio Selector Switches
6. P/PC Volume Controls
7. Marker Beacon Audio Control
8. Marker Beacon Sensitivity Switch
9. Cabin Speaker ADF Switch
10. Compass Heading Selector
11. DME Hold Switch
12. Audio Amplifier Control Switch

UC-12M-F076

Figure 23-1. Dual Audio Control Panel

23.1.2.2 Receiver Audio Switches

1. VHF 1 — Selects #1 VHF-AM receiver.
2. VHF 2 — Selects #2 VHF-AM receiver.
3. HF — Selects HF receiver.
4. UHF — Selects UHF receiver.
5. NAV 1 — Selects VHF omnidirectional range (VOR) LOC No. 1 audio.
6. NAV 2 — Selects VOR/LOC No. 2 audio.
7. MKR BCN 1 — Selects marker beacon No. 1 audio.
8. MKR BCN 2 — Selects marker beacon No. 2 audio.
9. DME-TACAN — Selects distance measuring equipment DME-TACAN audio.
10. ADF 1 — Selects ADF audio.
11. ADF 2 — Selects ADF audio.

23.1.2.3 Voice-Both Range Switch

1. VOICE — Kills RANGE, allows VOICE (ADF and VOR).
2. BOTH — Allows both VOICE and RANGE (ADF and VOR).
3. RANGE — Kills VOICE, allows 1020-Hz RANGE tone (ADF and VOR).

23.1.2.4 INTPH Switch

1. INTPH — Enables interphone communication without keying a MIC switch (voice operated interphone) provided the audio speaker switch is in the off position.
2. OFF — Interphone is enabled only when control wheel switch is depressed to the first position, or INTPH is selected on transmitter selector switch and control wheel MIC switch is depressed to second level, or hand held mic switch or copilot's floor switch is depressed.

23.1.2.5 AUDIO SPKR Switches

Headphone audio is provided continuously, independent of this switch position.

1. SPKR — Routes audio to individual overhead speaker.
2. OFF — Disables overhead speaker audio.

23.1.2.6 AUDIO EMER/NORM Switch

1. EMER — Audio routed directly from receivers to headphones in the event of failure of both audio amplifiers. Speaker audio, PA, and INTPH will be inoperative.
2. NORM — Enables normal operation of the audio amplifiers.

23.1.2.7 CABIN ADF 1 or ADF 2 Switch

Cabin ADF audio is inhibited during cabin PA operation.

1. ADF 1 — Provides ADF 1 audio to cabin speakers.
2. ADF 2 — Provides ADF 2 audio to cabin speakers.
3. OFF — ADF audio to cabin speakers is inhibited.

23.1.2.8 VOLUME Controls (Pilot and Copilot)

1. SPKR — Regulates respective overhead speaker volume.
2. PH — Regulates respective headset volume.
3. DME/TAC (located on Pilot side) — Regulates DME/TACAN identifier volume.
4. PA — Regulates cabin speakers volume.

23.1.2.9 MKR BCN 1 and 2

1. HI — Selects high sensitivity of the marker beacon receiver.

2. LO — Selects low sensitivity of the marker beacon receiver.

3. TEST — Test illuminates the three marker beacon lights.

4. VOL Control — Regulates marker beacon receiver audio volume.

23.1.3 Normal Operation

23.1.3.1 Turn On

1. Aircraft dc power — On.

Note

It is presumed the AVIONICS MASTER POWER switch is ON and that normally used avionic circuit breakers remain depressed.

23.1.3.2 Receive

1. AUDIO SPKR switches (audio panel) — On.

2. AUDIO EMER/NORM switch (audio panel) — NORM.

Note

Audio panel switches and volume controls are routinely left in positions of normal use.

3. Move each audio panel select switch to ON then OFF, separately, to verify audio output from speakers for each system. Adjust volume.

Note

All audio volume controls are on the radio section of the instrument panel, except for controls to the HF and UHF systems. These controls are located on the pedestal extension radio controls.

4. AUDIO SPKR switch (audio panel) — OFF.

5. Move separately each audio panel select switch to ON then OFF, separately, to verify audio output from headphones for each system.

Note

Headphone audio will always be active regardless of AUDIO SPKR switch position.

23.1.3.3 Transmit

1. Transmitter select (audio panel) — As desired (HF, UHF, or VHF).
2. MIC HEADSET/OXYGEN; MASK switch — As desired.
3. MIC switch — Depress to transmit.

Note

When selecting the desired radio for communications with Transmitter Select switch, transmit capability only is achieved. To receive, the associated receiver audio select switch must be ON.

23.1.3.4 Intercommunication

1. Both AUDIO SPKR switches (audio panel) — OFF.

Note

Voice operated key (VOX) interphone is inhibited when speaker switches are in the AUDIO SPKR position.

2. AUDIO EMER/NORM switch (audio panel) — NORMAL.

Interphone communications are inhibited in EMER position.

3. MIC HEADSET/OXYGEN MASK switch — As desired.

Note

With MIC switches in the OXYGEN MASK position, hot interphone transmissions are not broadcast through the overhead speaker. Headsets must be worn to ensure adequate communications between pilots.

4. INTPH/OFF select switch (audio panel) — As desired.
   a. If INTPH is selected — Speak when ready.
   b. If keyed INTPH is desired, depress MIC control wheel switch to 1st detent or rotate transmitter selector to INTPH and depress MIC control wheel switch to 2nd detent and transmit.
5. VOL knob — Adjust.

23.1.3.5 Aircraft-to-Ground Intercommunications

A communication jack on the nosegear strut placarded MIC JACK is provided for use between the ground personnel and the crew. The jack connects headphones and microphone to the aircraft interphone system.

23.1.3.6 Cabin Audio Operation

23.1.3.6.1 PA Operation

1. Rotate transmitter selector to PA.
2. Depress MIC switch and speak.
3. Adjust PA volume knob.

23.1.3.6.2 Cabin ADF Audio

1. CABIN ADF switch — ADF 1 or ADF 2.

   Cabin ADF audio is inhibited during cabin PA use.

23.1.3.7 Emergency Audio Operation

Fail-safe emergency audio is available. If either amplifier for the dual audio panel should fail, nonamplified signals can be directed from the receiver to the headphones by:

1. AUDIO EMER/NORM switch — EMER.

Both systems will switch to emergency audio and the audio select switches will be inoperative.

2. VOL controls (systems to be monitored) — Adjust.

Note

An alternate method of activating emergency audio is to pull both the PILOT and COPILOT AUDIO circuit breakers.

23.1.3.8 Shutdown

1. AVIONICS MASTER POWER switch — OFF.

2. Leave avionic controls and circuit breakers positioned for normal operation.

3. Aircraft dc power — OFF.

23.2 VHF 1 AND VHF 2 COMMUNICATIONS

23.2.1 Introduction

The VHF communication transceiver provides airborne VHF communications on the 1,360 channels from 118.00 through 151.975 megahertz (MHz) and is used with the panel mounted COM control unit (Figure 23-2).

The solid-state transceiver includes capture-effect automatic squelch, plus audio leveling. Transmitter sidetone comes from detected transmitter signals.

All operating controls for the VHF transceiver, except display intensity, are located on the COMM control unit (Figure 23-2). Display intensity is adjusted by a control located adjacent to the VHF Comm control unit in the instrument panel. The intensity control is placarded CONTROL READ OUT VHF NAV ADF.

23.2.1.1 Active Frequency Display

The active frequency (frequency to which the VHF is tuned) is displayed in the upper window. A TX will be displayed to the right of the active frequency when the transceiver is transmitting.

23.2.1.2 Standby Frequency Display

The preset (standby) frequency is displayed in the lower window.

23.2.1.3 Transfer Switch

This switch is a momentary switch. When pressed, the standby frequency is transferred up to the active display, the previous active frequency becomes the new standby frequency, and the VHF retunes. While in the Channel Mode, pressing the transfer switch will return the VHF to Frequency Mode. In Program Mode, pressing the transfer switch will cause the Channel number to stop flashing and the frequency to flash. The frequency may now be programmed.

23.2.1.4 Tuning Knobs

Two concentric knobs control the standby or active displays. The larger knob changes the three digits to the left of the decimal point from 18 to 51 in 1-MHz increments. The smaller knob changes the two digits to the right of the decimal point in 50-kHz increments with the knob pushed in or in 25-kHz with the knob pulled out. In Channel Mode, turning either knob changes the channel.

23.2.1.5 Channel Switch

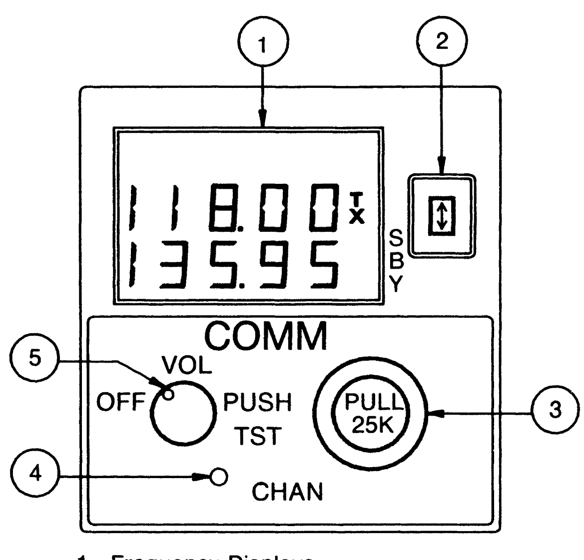
Momentarily pressing the CHAN switch while in frequency mode activates the Channel Mode of operation. Pressing and holding the CHAN switch for longer than 2 seconds activates the Program Mode.

23.2.1.6 Power, Volume, and Squelch (PUSH TST) Switch

The power and volume switch, when turned clockwise, switches system power on. Turning the switch further clockwise increases volume. Pressing the switch (PUSH TST) will disable the automatic squelch level, testing the squelch circuit; pressing the switch a second time will enable automatic squelch.

23.2.2 Operating Procedures

The frequencies displayed on the COMM control show only five of the six digits. The sixth digit is always a zero (when the fifth digit is a 0 or 5) or 5 (when the fifth digit is 2 or 7). Therefore, the sixth digit need not be displayed.



1. Frequency Displays
2. Transfer Switch
3. Tuning Knobs
4. Channel Switch
5. Power, Volume, Test Control

UC-12M-F077

Figure 23-2. VHF COMM Control Unit (Typical)

23.2.2.1 Equipment Turn On

The VHF transceiver and the COMM control are turned on by rotating the power and mode switch on the COMM control to the ON position. When the transceiver is first turned on, a momentary unsquelched state will occur. To override the automatic squelch state, push the PUSH TST knob. To return to the unsquelched state, push the PUSH TST knob once again.

Adjust the volume, and perform a squelch test by pressing the PUSH TST knob and adjusting the volume level with background noise. After a comfortable listening level has been established, return to the squelched state by again pressing PUSH TST knob. All background noise should disappear unless a station or aircraft is transmitting on the active frequency.

23.2.3 Frequency Selection

23.2.3.1 Standby Entry

Frequency selection is accomplished in the standby entry mode by changing the frequency displayed in the STBY window with the tuning knobs, or the standby frequency may be changed from the FMS (Flight Management System) CDU FREQ 1 page. FMS frequency management is discussed in the FMS system description.

Rotation of either frequency select knob increases or decreases the frequency in the standby frequency display.

After the desired frequency is set in the standby frequency display, it can be transferred to the active frequency display by momentarily pressing the transfer switch. At the same time that the standby frequency is transferred to the active display, the previously active frequency is transferred to the standby display. A short audio tone is applied to the audio system to indicate that the active frequency has been changed.

23.2.3.2 Active Entry

During normal operation, all frequency selections are entered in the standby frequency display; however, the active frequency can be entered directly as described in the following paragraph.

The Active Entry mode is entered from the Standby Entry mode or Channel mode by pressing the Transfer switch for longer than 2 seconds. The frequency select knobs operate as in Standby Entry, but will change the Active frequency rather than the Standby frequency. The unit will remain tuned to the Active frequency.

Momentarily pressing the transfer switch returns the control head to Standby Entry. The Standby frequency prior to Active Entry mode remains unchanged.

The active frequency may also be changed or entered from the FMS FREQ 1 or FREQ 2 pages. Once entered from the FMS, the frequencies may be exchanged in the normal transfer switch manner.

23.2.4 Channel Mode

The COMM control memory permits storing up to nine preset frequencies. Once stored, these frequencies can be recalled to the standby display by momentarily pressing the CHAN switch.

The storage locations (CH 1 through CH 9) for the recalled frequency individually appear in the active frequency display by rotating either tuning knob. After the desired stored frequency has been recalled to the preset display, it can be transferred to the active display by momentarily pressing the transfer switch.

23.2.4.1 Frequency Storage

To program the memory, press and hold the CHAN switch 2 seconds or longer. The receiver will tune to the last active frequency displayed. A “P” and the last used channel number will be displayed in the upper display window. The channel number flashes, indicating turning either tuning knob will change the channel number. Momentarily pressing the transfer switch causes the channel number to stop flashing and the frequency to flash. The tuning knob now change the frequency. Momentarily pressing the transfer switch will start the channel number flashing, and the procedure may be repeated until all nine channels have been programmed if desired.

Note

When programming the memory, no action on the panel for 20 seconds will return the unit to Frequency mode, and Standby frequency returns to what it was prior to entering the Program mode.

After a frequency has been stored in memory, it will remain in memory until changed, even when the unit is turned off for an extended period of time.

23.2.4.2 TX Annunciator

Each time the push-to-talk switch is pressed, the microprocessor in the transceiver starts a 90-second timer (the TX annunciator in the COMM display is illuminated whenever the mic is keyed). If the mic is still keyed at the end of 90 seconds, the transmitter will shut down. Transmitter shutdown is indicated when the total display starts flashing. Releasing the press-to-talk switch will clear the TX character, stop the flashing display, and reset the timer. Most intentional transmissions last less than one minute; a 90-second transmission is usually the result of a stuck mic switch. This timing feature protects the frequency from long-term interference.

To transmit for more than 90 seconds, release the mic switch briefly and then press again. The 90-second timer resets and starts a new count each time the push-to-talk switch is pressed.

23.3 UHF COMMUNICATIONS SET

23.3.1 Introduction

The UHF is a line-of-sight radio transceiver (Figure 23-3) that provides transmission and reception of Amplitude Modulated (AM) signals in the ultrahigh frequency range of 225.000 to 399.975 MHz for a distance range of approximately 50 miles. Channel selection is spaced at 0.025 MHz. Audio signals are applied through the pilot and copilot UHF AUDIO switches to the respective headsets. A separate receiver is incorporated to provide monitoring capability for the UHF guard frequency (243.0 MHz).

Existing capabilities of HAVE QUICK modified radios are preserved to the maximum extent possible when the radios are operated in the normal (nonhopping) mode, and no new procedures are required for normal radio operation.

To operate in the AJ mode, the radios must first be initialized. Initialization requires setting two control entries into the radio. The two entries required are Word-of-Day (WOD) and Time-of-Day (TOD). The Word-of-Day defines the choice of frequency hopping pattern for the day. The choice is a managerial function and the same WOD may be used for one or many days. The Time-of-Day must be loaded into the clock contained within the radio.

Complete provisions only are installed for a TSEC/KY-58 voice security device to be located in the extended pedestal.

23.3.1.1 UHF Control Panel

1. Manual frequency selector (hundreds) — Selects hundreds digit of frequency (either 2 or 3) in MHz.

2. Manual frequency selector (tens) — Selects tens digit of frequency (0 through 9) in MHz.

3. Manual frequency selector (units) — Selects unit digit for frequency (0 through 9) in MHz.

4. Preset channel indicator — Displays preset channel selected.

5. Manual frequency selector (tenths) — Selects tenths digit of frequency (0 through 9) in kHz.

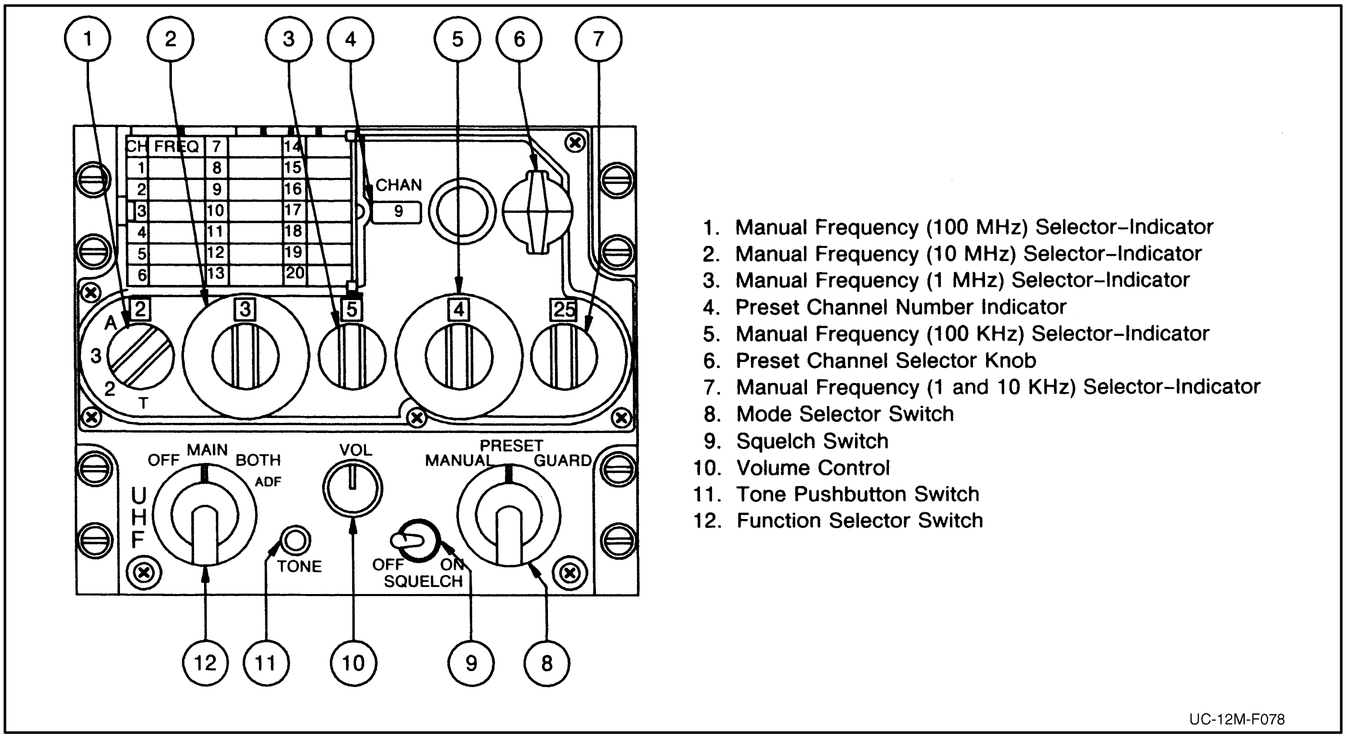


Figure 23-3. UHF Control Panel

6. Preset channel selector — Selects 1 of 20 preset channel frequency.

7. Manual frequency selector (hundredths or thousandths) — Selects hundredths or thousandths digits of frequency (00, 25, 50, or 75) in kHz.

8. Mode switch — Selects method of frequency selection.

9. MANUAL — Any one of 7,000 frequencies can be manually selected using the five manual selectors.

10. PRESET — Frequency is selected using the preset channel selector to select any one of 20 preset channels.

11. GUARD — The main receiver and transmitter are automatically tuned to the guard frequency and the guard receiver is disabled.

Note

The GUARD position should not be used except in actual emergencies. When operating under emergency conditions, set the MANUAL-PRESET-GUARD switch to the GUARD position and the function switch to MAIN. Do not use the BOTH position since noise from the two receivers may make the incoming signal unreadable.

12. Squelch switch — Turns main receiver squelch circuit on or off.

13. Volume control — Adjusts volume.

14. Tone pushbutton — When pressed, transmits a 1020 Hz tone on the selected frequency.

15. Function selector — Selects operating functions.

16. OFF — Turns set off.

17. MAIN — Turns set on.

18. BOTH — Selects main receiver, transmitter, and guard receiver.

19. ADF — Not used in this installation.

23.3.2 UHF Command Set Voice Security Operation (TSEC/KY-58)

Note

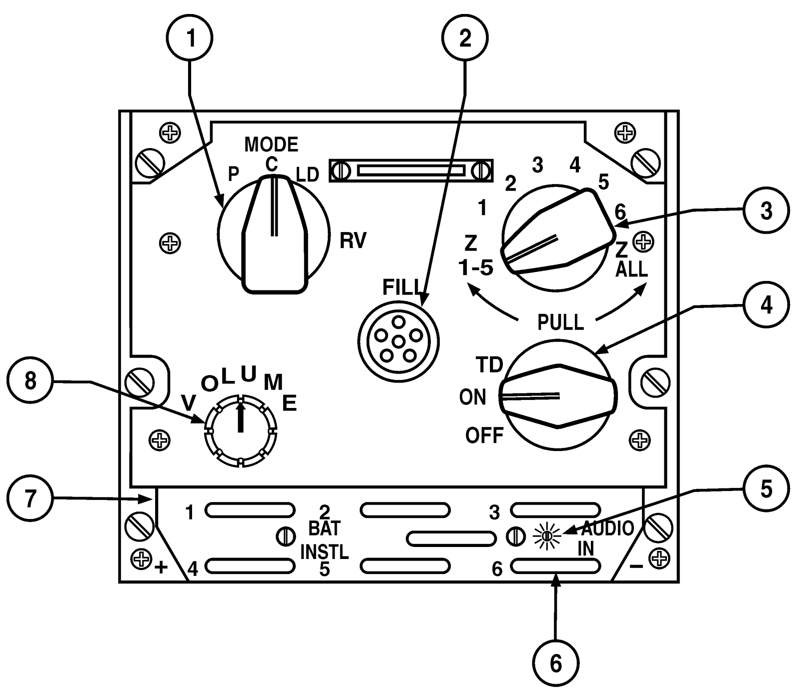
Disregard operating procedures involving the voice security control-indicator if unit is not installed.

23.3.2.1 Turn-On Procedure

1. Power switch (voice security control panel, Figure 23-4) — ON.
2. Function switch (UHF control panel, Figure 23-3) — BOTH.

23.3.2.2 Receiver Operating Procedure

1. Mode selector switch (UHF control panel) — As required.
2. Transmitter-interphone selector switch (audio control panel) — UHF.
3. Set required frequency using preset channel control or manual frequency selector.



1. MODE SWITCH
2. FILL CONNECTOR
3. FILL SWITCH
4. POWER SWITCH
5. AUDIO IN VOLUME
6. WRITING SURFACES (TYPICAL)
7. FILL BATTERY ACCESS COVER
8. VOLUME CONTROL

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Figure 23-4. TSEC/KY-58 Voice Security Front Panel

4. Volume control — Adjust.

Note

To adjust volume when radio signals are not being received, turn squelch switch OFF, adjust volume for comfortable noise level, then turn squelch disable switch ON.

5. Squelch switch — As required.

23.3.2.3 Transmitter Operating Procedure (PLAIN)

1. Transmitter-interphone selector switch (audio control panel) — UHF.

2. Mode switch (voice security control panel) — P (PLAIN).

3. Microphone switch — Press.

23.3.2.4 Transmitter Operating Procedure (CIPHER)

1. Transmitter-interphone selector switch (audio control panel) — UHF.

2. Mode switch (voice security control panel) — C (CIPHER).

Note

When transmitting in CIPHER mode, a beep should be heard each time the microphone switch is pressed.

3. Microphone switch — Press (do not talk). Wait until beep is heard, then speak into microphone.

23.3.2.5 Shutdown Procedure

1. Function selector switch (UHF control panel) — OFF.

2. Power switch (voice security control panel) — OFF.

23.4 VOICE SECURITY SYSTEM KY-58 (PROVISIONS ONLY)

23.4.1 Description

The KY-58 voice security system provides secure (ciphered) two-way voice communications for the pilot and copilot in conjunction with the UHF command set. System circuits are protected by the UHF circuit breaker located on the overhead circuit breaker panel (Figure 2-20). Figure 23-4 illustrates the KY-58 voice security control panel.

23.4.2 Controls/Indicators and Functions

1. MODE switch — Selects type of operation desired.

2. P-PLAIN — Enables unciphered communications on set.

3. C-CIPHER — Enables ciphered communications on set.

4. LD-Load — Enables codes (variables) to be loaded.

5. RV-Receive Variable — Enables remote changing of codes.
6. VOLUME control — Controls audio output volume.
7. FILL connector — Accepts connector from common (KYK-13) fill device, general purpose (KOI-18) tape reader, or net control (KYX-15) device to load variables.
8. FILL/SELECT switch — Used to select any of the six storage registers and to zeroize registers 1 through 5 only, or all six (1 through 6) as desired.
9. POWER switch — Controls system power, and for certain operations, enables Time Delay (TD).

Note

The power switch must be in ON position for secure mission operations in either the plain or cipher mode.

10. BAT INSTL — Two screws permit removal of the cover plate to change the fill battery. The writing surface provides an area to write the date the battery was changed.
11. AUDIO IN — Adjusts the volume level into the KY-58.
12. WRITING SURFACES — Used to record storage position of variables and battery change date.

23.4.3 Loading the KY-58 from the KYK-13 Transfer Device

Check the KYK-13 (Figure 23-5) WRITING SURFACE for registers containing variables. To check for variables in registers:

1. Set the KYK-13 MODE switch to OFF/CHECK.
2. Set the KYK-13 fill/select switch to the register to be checked (position 1 through 6).

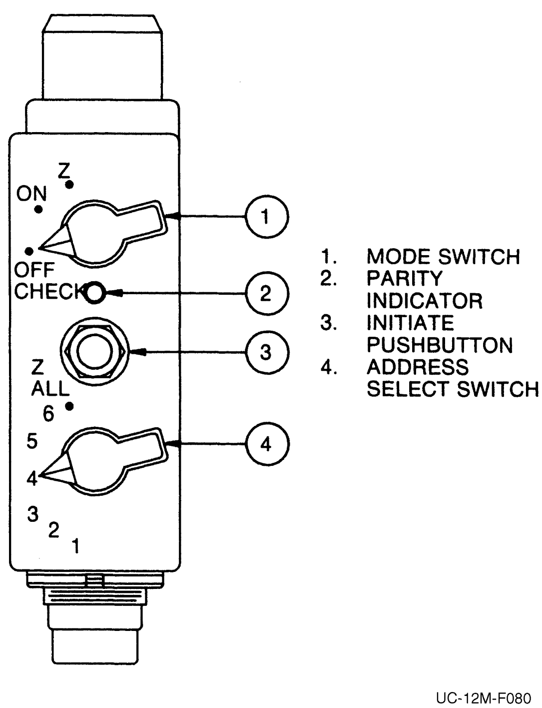


Figure 23-5. TSEC/KYK-13 Transfer Device

3. Push and release the KYK-13 initiate button. If a variable is present in that register, the parity indicator light on the KYK-13 will flash.

4. Repeat steps 2 and 3 for each register.

23.4.3.1 Loading Procedure

CAUTION

Aircraft primary power or power from an APU must be applied to load the KY-58.

Note

These procedures must be accomplished prior to takeoff.

1. Check the fill battery installation date on the KY-58.

Note

The KY-58 will not accept a Fill if the fill battery is dead and/or if primary aircraft power is not applied (at least +18 Vdc).

2. Turn the KYK-13 MODE switch to OFF/CHECK.

3. Connect the KYK-13 to the KY-58 fill connector, either with a fill cable or directly.

4. Turn the KY-58 power switch to ON.

5. Push and release the aircraft MIC switch. This clears the crypto alarm heard.

6. Set the KY-58 fill/select switch to the register to be filled.

7. Set the KY-58 MODE switch to LD (load).

8. Set the KYK-13 MODE switch to ON.

9. Set the KYK-13 fill/select switch to the register containing a variable (positions 1 through 6). This variable will be transferred from the KYK-13 to the KY-58.

10. Push and release the aircraft MIC switch. When the MIC switch is pressed, confirm the KYK-13 parity indicator light has flashed.

Note

Do not press the KYK-13 initiate button.

11. If the parity indicator light has flashed, write the location of the variable on the KY-58 writing surface.

12. Set the KY-58 MODE switch to C (CIPHER).

13. To load more variables into the KY-58 registers, repeat steps 6 through 12.

CAUTION

The Remote Keying Variable (RKV) must be loaded into register 6 in order to perform the Manual Keying (MK) and Automatic Keying (AK) procedures.

14. Set the KYK-13 MODE switch to OFF/CHECK, disconnect the KYK-13.

23.4.4 Loading the KY-58 Using General Purpose Tape Reader (KOI-18)

For this type of loading procedure, a fill cable and paper tape(s) containing keying material are needed. Each paper tape contains a different variable, so a different tape will be needed for each variable to be loaded.

CAUTION

Aircraft primary power or power from an APU must be applied to load the KY-58.

Note

These procedures must be accomplished prior to takeoff.

1. Check the fill battery installation date on the KY-58.

Note

The KY-58 will not accept a Fill if the fill battery is dead and/or if primary aircraft power is not applied (at least +18 Vdc).

2. FILL connector — Connect to tape reader using fill cable. A fill cable must be used when using the KOI-18 to load the KY-58.
3. Set KY-58 power switch to ON.
4. Push and release the MIC switch. This clears the crypto alarm heard.
5. Set to the KY-58 fill/select switch to the register to be filled.
6. Insert the tape leader into the IN slot on tape reader. Line up tape feed holes with the white dots on tape reader.
7. Set the KY-58 MODE switch to LD (load).
8. Push and release the MIC switch.
9. Pull tape through tape reader at a moderate rate. The steady alarm tone heard over the headset should stop, indicating a successful fill.
10. Write the location of the variable on the KY-58 writing surface.
11. Set the KY-58 MODE switch to C (CIPHER).

12. Repeat procedure for each register to be filled.

13. Disconnect fill cable from the KY-58 and secure both the fill cable and the KOI-18.

23.4.5 Secure Voice

To operate the KY-58 in SECURE VOICE:

1. Set KY-58 power switch to ON (press aircraft MIC switch to clear the crypto alarm heard).

2. Set KY-58 MODE switch to C (CIPHER).

3. Set KY-58 VOLUME switch to a comfortable level.

4. Set KY-58 fill/select switch to the numbered storage position (1 through 6) desired.

Note

When transmitting in SECURE mode, a beep should be heard each time the MIC switch is pressed. When receiving transmission, this beep should be heard at the beginning of each transmission. This means the other radio is transmitting in SECURE mode. If the beep is not heard, it means the other radio is transmitting in PLAIN VOICE, and that transmission is not SECURE.

23.4.6 Zeroizing the KY-58

Aircraft power may be ON or OFF for zeroizing the KY-58. When zeroizing, the variables stored in the registers are actually destroyed and must be LOADED again before SECURE transmissions are possible.

23.4.6.1 Zeroizing Positions 1 Through 6

1. Turn the KY-58 fill/select switch to the right.

2. Pull the fill/select switch out and turn to “Z-ALL.”

3. Positions 1 through 6 are now zeroized and SECURE transmissions are no longer possible.

23.4.6.2 Zeroizing Positions 1 Through 5 Only

1. Turn the KY-58 fill/select switch to the left.

2. Pull the fill/select switch out and turn it to “Z 1-5.” Position 6 still has the RKV variable in it and SECURE transmissions in position 6 only are still possible.

23.4.7 Plain Voice

The KY-58 has a plain test override feature that permits transmissions in PLAIN (P) voice. This means the transmissions are not in a SECURE mode. Radio contact is possible, even if the radio being called is in a SECURE mode. Additionally, if the KY-58 is in a SECURE mode, contact from unsecured radios is still possible. The PLAIN (P) mode permits radio contact in case variables are lost for any reason. Plain Voice is also known as Clear Voice.

1. Turn the KY-58 MODE switch to P.

2. Operate the radio normally.

23.4.7.1 Automatic Remote Keying (AK) Procedures

Automatic Remote Keying (AK) causes an old Cryptonet Variable (CNV) to be replaced by a new CNV, or a vacant register to be filled. The new controller simply transmits the new CNV to your KY-58. The procedure is performed as follows:

1. The new controller will make contact using a secure voice channel and issue instructions to stand by for an AK transmission.

Note

Do not make any calls during this standby action.

2. One or two beeps will be heard. This means the old CNV is being replaced.
3. Using the new CNV, the net controller will ask for a radio check.
4. After the radio check is completed, the controller will issue instructions to resume normal radio communications.

23.4.7.2 Manual Remote Keying (MK) Procedures

The net controller will make contact on a secure voice channel, issue instructions to standby for a new CNV, or a replacement variable by a manual Remote Keying action. Upon instructions from the net controller:

1. Turn the KY-58 selector switch to position 6.
2. Notify the controller by radio and stand by.

When notified by the controller:

3. Set the KY-58 MODE switch to RV (Receive Variable).
4. Notify the controller when this is accomplished.

When notified by the controller:

5. Set the KY-58 fill/select switch to the storage position selected to receive the new CNV.
6. Notify the controller when this is accomplished.

Note

When performing the last step, the storage position selected (1 through 6) to receive the new CNV may be unused, or it may contain the variable that is being replaced.

When advised by the controller, perform the following steps:

7. Listen for a beep.
8. Wait 2 seconds.
9. Set the KY-58 MODE switch to C (CIPHER).
10. Confirm that the directions are understood.

If the MK operation was successful, the net controller will not make contact via the new CNV.

If the MK operation was not successful, the net controller will make contact via PLAIN voice transmission, advise you to set the KY-58 fill/select switch to position 6, and stand by while the MK operation is repeated.

23.4.7.3 KY-58 Audio Tones

Some audio tones from KY-58 indicate normal operation, whereas other tones (or lack of tones) may indicate equipment malfunctions. These tones are:

1. Continuous beeping with background noise — This occurs when power is applied to the KY-58, or when zeroizing the KY-58 and returning to positions 1 through 6.

   To clear this tone:

   a. Press and release the MIC switch.

2. Background noise — Indicates the KY-58 is working properly. This noise should occur at TURN ON and when the KY-58 is generating crypto variables.

CAUTION

If the background noise is not heard at TURN ON, the equipment should be checked by maintenance personnel.

3. Continuous tone, parity alarm — This tone could indicate a parity alarm, which occurs when an empty storage register has been selected and the MIC switch is held. This could indicate any of three conditions:

   a. An empty storage register has been selected.

   b. A bad crypto variable is present.

   c. Equipment failure has occurred.

This tone will also be heard when the MODE switch is in the LD position and there is no variable in the storage register selected.

To clear this tone:

d. Follow the Loading Procedures instructions. If the tone is still heard, have the equipment checked by maintenance personnel.

4. Intermittent beeps — "CRYPTO ALARM." This tone indicates a crypto alarm. If this tone is heard, equipment failure has occurred. There is nothing the operator can do to clear this tone.

23.5 HF COMMUNICATION SET

23.5.1 Introduction

The HF system consists of three units: the HF control panel (Figure 23-6), the remote power amplifier/antenna coupler, and the remote/exciter. The system will operate on any 0.1 kHz frequency between 2.0 and 29.9999 MHz.

With the capability to preset 99 frequencies for selection during flight, the system allows either selection of other frequencies manually (direct tuning) or reprogramming of any preset frequency. The remote antenna coupler tunes the power amplifier to the external long-wire antenna whenever the microphone circuit is keyed.

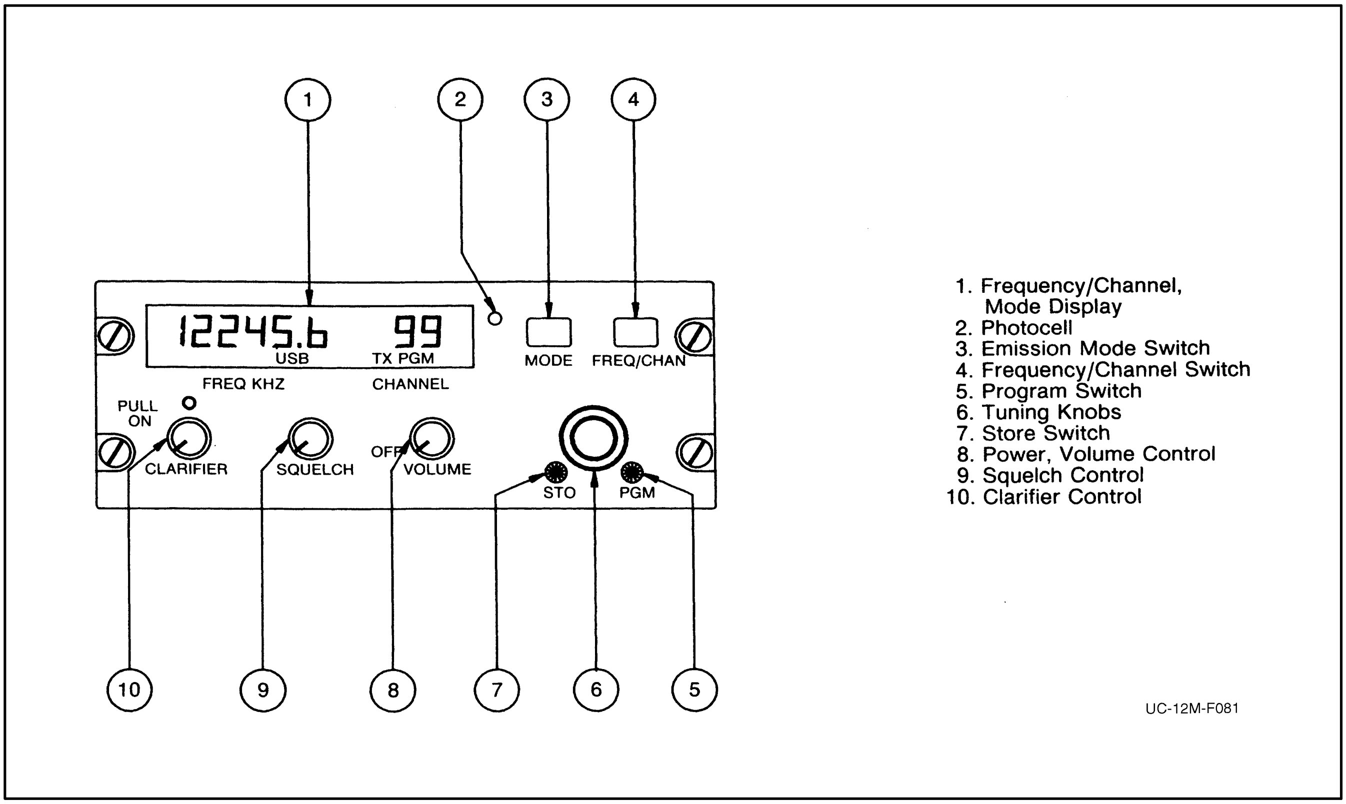


Figure 23-6. HF Control Panel

Complete provisions are provided for a KY-75 voice security system to be operated in conjunction with the HF system. The KY-75 control panel is to be located on the extended pedestal; the voice security processor is to be located under the two place couch.

23.5.2 Control Panel

The HF system has two methods of frequency selection. The first method is called direct tuning (frequency agile). The second is a channelized operation in which desired operating frequencies are preset, stored, and referenced to a channel number. The operating controls of the HF system are described as follows:

1. Freq/Channel Display — Large display indicates frequencies and preset channel numbers. Small display indicates emission type (LSB-AM-USB), transmit (TX) indicator and program (PG) mode. Display intensity is adjusted by a control located adjacent to the TGT gauges in the instrument panel. The intensity control is placarded PEDESTAL CONTROL READ OUT HF.
2. MODE — The emission mode switch is a momentary pushswitch that selects LSB, USB, or AM.
3. FREQ/CHAN — Transfers the HF system from a direct frequency operation to a channelized form of operation.
4. ON/OFF/VOLUME — Applies power to the unit and controls the audio output level.
5. SQUELCH — Provides variable squelch threshold control.
6. CLARIFIER — Clarifies receive frequency in single sideband operating mode.
7. Frequency/channel selector — Consists of two concentric knobs that control the channel and frequency digits, plus the lateral position of the cursor.

8. Frequency/control — The outer knob becomes a cursor (flashing light) control with the FREQ/CHAN switch in the FREQ position. The flashing digit is then increased/decreased with the inner knob.

9. Channel control — The outer knob is not functional when the FREQ/CHAN switch is in the CHAN position. The inner knob will provide channel control from 1 through 99, displayed at the right end of the display window.

10. PGM (Program) switch — Enables channelized data to be modified. The PGM message will be displayed whenever this switch is depressed.

11. Program — The program mode must be used for setting or changing any of the 99 preset frequencies to receive and transmit on separate frequencies. Each of the 99 channels may be preset to receive and transmit on separate frequencies (semiduplex), receive only, or transmit and receive on the same frequency (simplex). The operating mode (LSB, USB, or AM) must be the same for both receive and transmit and can also be preset.

12. STO (Store) switch — Stores displayed data when programming preset channels.

23.5.2.1 Frequency Tuning (Simplex Only)

Each digit of the frequency may be selected instead of dialing up or down to a frequency. The larger concentric knob is used to select the digit to be changed. This digit will flash when selected. Rotation of the knob moves the flashing cursor in the direction of rotation. After the digit to be changed is flashing, the smaller concentric knob is used to select the numeral desired. This process is repeated until the new frequency has been selected. The flashing cursor may then be stowed by moving it to the extreme left or right of the display and then one more click. This stows the cursor behind the display until needed again. The cursor may be recalled by turning the concentric knob one click left or right.

23.5.2.1.1 Direct Frequency Tuning (Simplex Only)

1. FREQ/CHAN button out (FREQ).

2. Select desired Mode (LSB, USB, or AM).

3. Select digit to be changed (outer knob).

   Digit (Cursor) will flash.

4. Select numerical value of digit (inner knob).

5. Stow cursor (or repeat procedure for additional changes).

6. Tune antenna coupler (press MIC switch).

23.5.2.2 Channel Programming

There are three ways to set up up a channel: Receive only, simplex, and semiduplex. To gain access to channelized operation, depress FREQ/CHAN switch. To utilize the existing programmed channels (i.e., no programming required), use the small control knob to select the desired channel number. Then momentarily key the microphone to tune the antenna coupler. If channel programming is required, it is necessary to activate the program mode.

With the FREQ/CHAN switch in (CHAN), use a pencil or other pointed object to press the PGM switch in. The letters PGM will appear in the lower part of the display window and the system will remain in the program mode until the PGM switch is pressed again. (Switch is alternate action: push-on, push-off.)

23.5.2.2.1 Receive Only

1. Stow the cursor if a frequency digit is flashing.
2. Select the channel to be preset.
3. Set the desired emission mode (LSB, USB, or AM).
4. Set the desired frequency. (Refer to Frequency Tuning.)
5. Press and release STO switch once.

TX will flash in the display window. A receive only frequency is being set; the flashing TX should be ignored.

If another channel is to be set, the cursor must be stowed before a new channel can be selected. Use the smaller concentric knob to select the channel and repeat the steps for selecting a new frequency.

6. To return to an operating mode, press the PGM switch.

23.5.2.2.2 Simplex

Setting a channel up for simplex operation (receive and transmit on the same frequency).

1. FREQ CHAN switch in (cursor stowed).
2. PGM switch in (PGM displayed).
3. Select channel to be preset.
4. Set mode (LSB, USB, or AM).
5. Set desired frequency. (Refer to Frequency Tuning.)
6. Press and release STO switch twice.

The first press of the STO switch stores the frequency in the receive position and the second press stores the same frequency in the transmit position. The second press also stores the cursor.

If another channel is to be reset, use the smaller concentric knob to select the channel and repeat the steps for selecting a new frequency. The cursor was automatically stowed.

7. To return to one of the operating modes, press the PGM switch again.

23.5.2.2.3 Semiduplex

Setting a channel for semiduplex (transmit on one frequency and receive on another).

1. Select channel to be preset.
2. Set mode (LSB, USB, or AM).
3. Set desired frequency. (Refer to Frequency Tuning.)
4. Press STO switch once.

5. Set transmit frequency.

6. Press STO switch again.

If another channel is to be reset, use the smaller concentric knob to select the channel and repeat the steps.

7. To return to an operating mode press the PGM switch.

Note

The mode for each channel (LSB, USB, or AM) is stored along with the frequency. If the mode is changed, the system will receive and transmit in the mode selected for transmit.

23.6 KY-75 VOICE SECURITY SYSTEM (PROVISIONS ONLY)

23.6.1 Description

The KY-75 voice security system is used in conjunction with the HF set to provide secure (ciphered) two-way voice communications. Both the voice security control panel (Figure 23-7) and HF control panel (Figure 23-6) are located in the extended pedestal. The KY-75 processor is mounted beneath the two place couch in the forward cabin area.

23.6.2 Controls/Indicators and Functions

1. CIPHER indicator — This indicator illuminates when the PLAIN/CIPHER switch is set to the CIPHER position. The indicator includes a press-to-test feature.

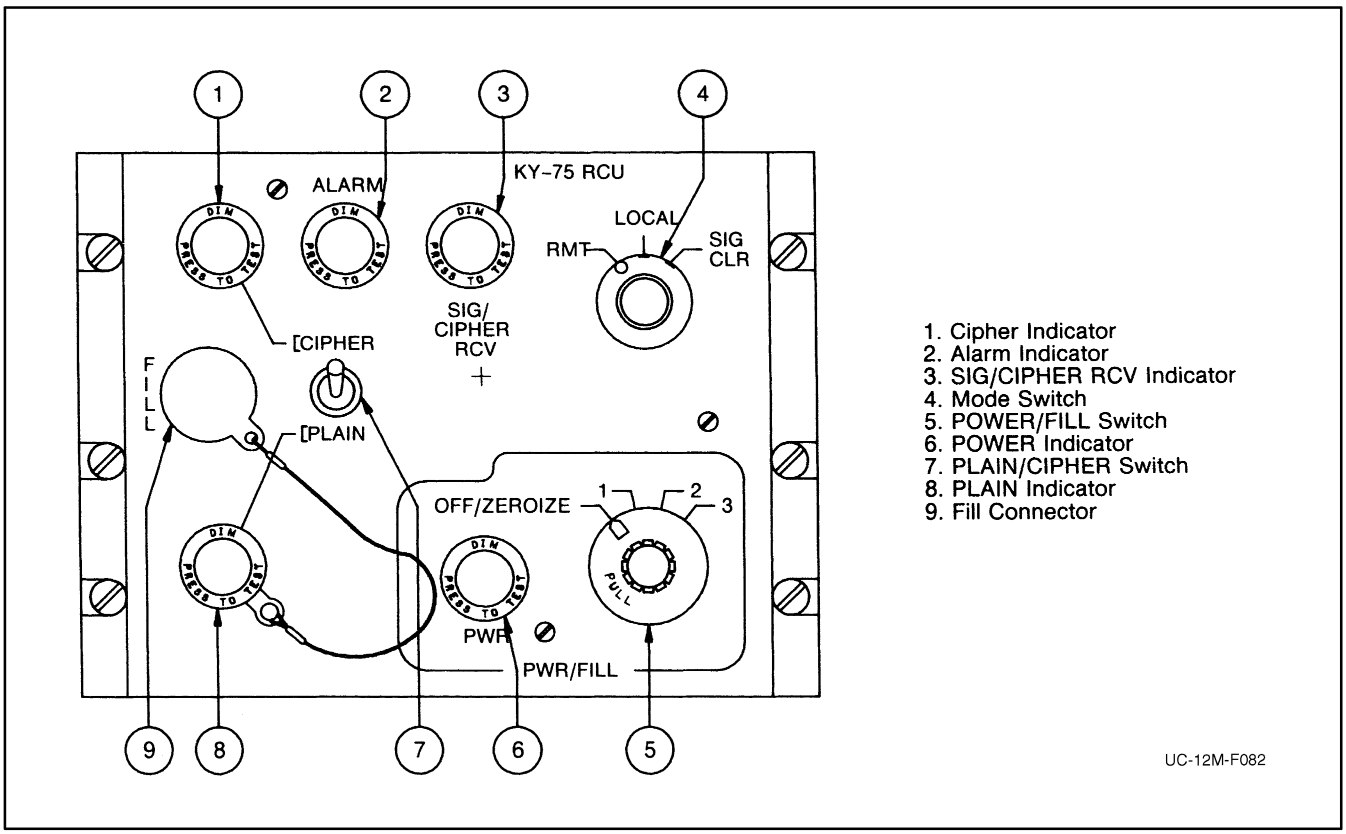


Figure 23-7. KY-75 Voice Security Control Panel

2. ALARM indicator — This indicator illuminates when a fill error, randomizer, or battery failure occurs. The indicator includes a press-to-test feature.

3. SIG/CIPHER RCV indicator — The indicator (blue) blinks continuously when the KY-75 system is receiving ciphered text. The indicator includes a press-to-test feature.

4. Mode switch — Selected operating mode.

   a. RMT — In this position, the PLAIN/CIPHER selection is controlled by input outside KY-75 control panel.

   b. LOCAL — In this position, transmit mode is controlled by PLAIN/CIPHER switch.

   c. SIG CLR — In this position, if a fill device is connected to the FILL connector, the alarms will be set, and the selected fill register will be cleared. Upon release of the switch (it is spring loaded to the LOCAL position), the KY-75 will request a fill variable from the fill device. If a fill device is not connected, a steady tone signal will be transmitted to all other units within the net, indicating a desire to establish communications on that link.

5. PWR/FILL switch — Controls set power and fill positions.

   a. OFF/ZEROIZE — All power is removed from the KY-75 system and all fill registers are zeroized. (To enter this position, the switch must be pulled out and rotated counterclockwise.)

   b. 1, 2, 3 fill positions — These position are used to select the fill register of the KY-75 system to be used during transmission and reception of ciphered messages.

6. PWR indicator — This indicator (white) illuminates when power is applied to the KY-75 system and the PWR/FILL switch is set to one of the numbered fill positions.

7. PLAIN/CIPHER switch — Selects PLAIN or CIPHER mode.

   a. PLAIN — The KY-75 system will receive cipher and plain signals and will transmit plain.

   b. CIPHER — Permits ciphered communications.

8. PLAIN indicator — This indicator illuminates when the PLAIN/CIPHER switch is set to the PLAIN position. The indicator includes a press-to-test feature.

9. FILL connector — This connector, located on the front of the KY-75 control panel, allows connection to a fill device.

A processor connector located on the back of the KY-75 control unit allows connection of the control unit to the processor via a cable.

23.6.3 KY-75 Operating Procedures

23.6.3.1 System Turn-On Procedure

1. PWR/FILL switch — Set to any fill register number. Check that PWR indicator light is illuminated.

2. PLAIN/CIPHER switch — CIPHER. Check that CIPHER indicator light is illuminated.

3. PWR/FILL switch — Set to each fill register (1 through 3). If the position has not already been filled, a steady alarm tone will be heard.

23.6.3.2 Filling KY-75 Using General Purpose Tape Reader (TSEC/KOI-18)

1. FILL connector — Connect to tape reader using fill cable (ON 5124204).
2. PWR/FILL switch — Set to register to be filled.
3. Insert the tape leader into the IN slot on tape reader. Line up tape feed holes with the white dots on tape reader.
4. RMT-LOCAL-SIG CLR switch — Set to SIG CLR clear then release.

   Pull tape through tape reader at a moderate rate. The steady alarm tone heard should stop, indicating a successful fill.

5. Repeat procedure for each register to be filled.

23.6.3.3 Filling KY-75 System Using Transfer Device TSEC/KYK-13

1. Verify that the transfer device contains the variables in its registers that are indicated on its writing surface by:
   a. Transfer device mode switch — OFF/CHECK.
   b. PWR/FILL switch — Set to register to be verified.
   c. Transfer device initiate switch — Press and release. Transfer device indicator light will flash if the register contains a variable.
   d. Repeat procedure for each transfer device register to be verified.

Note

Ensure that the rubber grommet is in the TSEC/KYK-13/P1 connector and that the KY-75 PLAIN/CIPHER switch is in the CIPHER position.

2. FILL connector — Connect to transfer device (either directly or with a fill cable).
3. Transfer device FILL switch — Set to register containing variable to be transferred.
4. Transfer device MODE switch — ON.
5. RMT/LOCAL/SIG CLR switch — Set to SIG CLR and release. Parity indicator light on transfer device should flash, and the steady alarm tone should cease, indicating a successful transfer of the variable.
6. Repeat procedure for each KY-75 register to be filled.
7. Transfer device mode switch — Set to OFF/CK and disconnect from KY-75.

23.6.3.4 KY-75 Secure Voice Operating Procedure

1. PLAIN/CIPHER switch — CIPHER. Check that CIPHER indicator light illuminates.
2. RMT/LOCAL/SIG CLR switch — RMT.
3. PWR/FILL switch — Set to desired fill register.
4. Microphone switch — Press. Wait for the preamble to stop, then talk into the microphone.
5. Microphone switch — Release. Wait for the postamble to stop.

Note

The SIG/CIPHER RCV indicator light will flash during receipt of secure voice communications; wait until the postamble stops before initiating any transmission.

23.6.3.5 KY-75 Clear Voice Operating Procedure

1. PLAIN/CIPHER switch — PLAIN. Check that PLAIN indicator light illuminates.
2. RMT/LOCAL/SIG CLR switch — RMT.
3. Microphone switch — Press to talk, release when finished.

23.6.3.6 Zeroizing KY-75

1. PWR/FILL switch — OFF/ZEROIZE.

Note

All three fill registers of the KY-75 will be zeroized simultaneously.

2. The steady alarm tone should be heard if the PWR/FILL switch is set to any fill position.

Note

When aircraft power is not applied to the KY-75 and the standby fill batteries have been removed or are too weak to maintain the memory circuits, all storage registers of the KY-75 will be zeroized within approximately 45 seconds.

CHAPTER 24

UC-12B Navigation

24.1 GENERAL

The navigation system is composed of two identical VOR/LOC receivers, a Global Positioning System (GPS)-based Flight Management System (FMS), two marker beacon receivers, an ADF receiver, and a TACAN/DME system. Figure 20-1 shows the location of antennas.

24.2 RADIO MAGNETIC INDICATORS

Two identical RMIs are installed, one for the pilot and one for the copilot (Figure 24-1), that provide aircraft heading and radio bearing information. The compass card on the pilot RMI is driven by COMPASS 2 and the compass card on the copilot RMI is driven by COMPASS 1. The RMIs are protected by respective circuit breakers placarded RMI NO. 1 and RMI NO. 2, located on the copilot right sidewall panel.

1. Compass card — Indicates aircraft heading at top of dial.
2. Single-needle pointer — Indicates bearing selected by single-needle switch.
3. Double-needle pointer — Indicates bearing selected by double-needle switch.
4. Warning flag — Indicates loss of power or unreliable heading information.

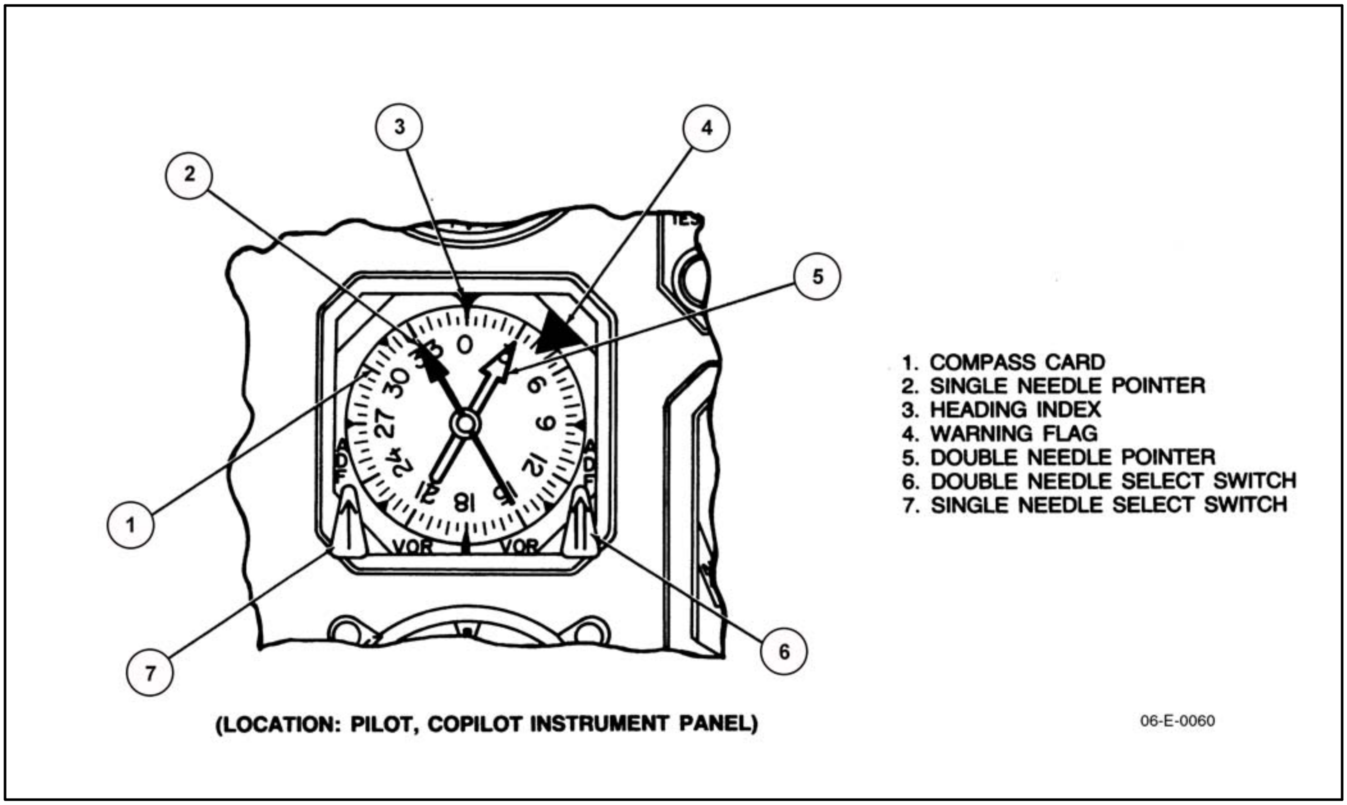


Figure 24-1. Radio Magnetic Indicator

5. Double-needle switch — Selects desired signal to be displayed on double-needle pointer.

   a. ADF position — Selects ADF bearing information.

   b. VOR position — Selects VOR-2 bearing information.

6. Single-needle switch — Selects desired signal to be displayed on single-needle pointer.

   a. ADF position — Selects ADF bearing information.

   b. VOR position — Selects VOR-1 bearing information.

24.3 HORIZONTAL SITUATION INDICATORS

24.3.1 Description

The pilot and copilot have separate HSI instruments on their respective instrument panel sections (Figure 24-2). Depending upon the navigation system selected by means of respective HSI indicator switches, the information displayed by each HSI indicator is derived and controlled by either the VOR-1, the VOR-2, the TACAN, or the FMS. Each HSI indicator combines displays to provide a map-like presentation of the aircraft position. The indicator displays aircraft position relative to VOR, localizer, and glideslope.

1. Course knob — The yellow course pointer is positioned on the heading dial by the course knob to select a magnetic bearing that coincides with the desired VOR radial or localizer course. Like the heading bug, the course pointer rotates with the heading dial to provide a continuous readout of course error to the computer. When one of the radio modes is selected, the vertical command bar in the Flight Director Indicator (FDI) will display bank commands to intercept and maintain the selected radio course.

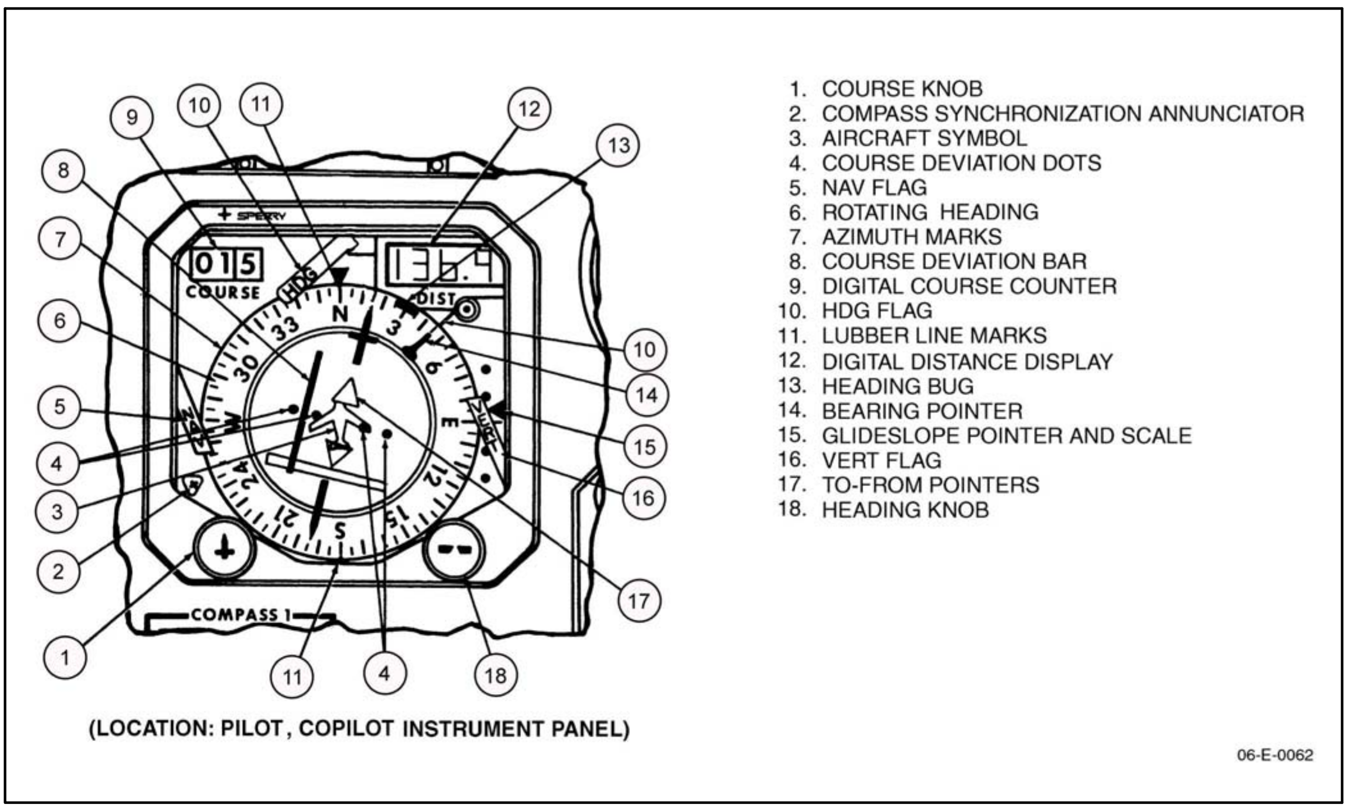


Figure 24-2. Horizontal Situation Indicator

2. Compass synchronization annunciator — When the compass system is in the slaved mode, the compass synchronization annunciator will oscillate between the – and + , indicating that the heading dial is synchronized with gyro-stabilized magnetic heading.

3. Aircraft symbol — A fixed aircraft symbol corresponds to the longitudinal axis of the aircraft and lubber line markings. The symbol shows aircraft position and heading with respect to a radio course and the rotating dial.

4. Course deviation dots — In VOR and TACAN operations, each dot represents 5° deviation from centerline. In ILS operation, each dot represents 1° deviation from centerline. In FMS operation, a full-scale deviation from center represents a ±5 nm in en route, ±1 nm deviation in approach/missed approach, and ±0.3 nm deviation in final approach depending upon FMS mode. Refer to paragraph 24.18 for further discussion on FMS CDI scaling.

5. NAV flag — The NAV flag indicates that the information derived from the selected navigational beacon is invalid and should not be used.

6. Rotating heading dial — The rotating heading dial rotates with the aircraft throughout 360° and displays gyro-stabilized magnetic compass information. The azimuth ring is graduated in 5° increments.

7. Azimuth marks — Azimuth marks are fixed at 45° bearings throughout 360°.

8. Course deviation bar — The course deviation bar represents the centerline of the selected VOR or localizer course. The aircraft symbol shows, pictorially, actual aircraft position in relation to this selected course.

9. Digital course counter — The course counter provides a digital readout of the selected course.

10. HDG flag — The HDG flag indicates that the heading information displayed is invalid and should not be used.

11. Lubber line marks — The fore and aft lubber line marks are fixed and align with the aircraft symbol.

12. Digital distance display — The distance display provides digital displays of the DME distance.

13. Heading bug — The notched orange heading bug is positioned on the rotating dial by the heading knob and displays preselected compass heading. The bug rotates with the heading dial so the difference between the bug and the fore lubber line index is the amount of heading error applied to the flight director computer. In the heading mode, the FDI vertical command bar will display the required bank commands to bring the aircraft onto and maintain the selected heading.

14. Bearing pointer — The bearing pointer provides magnetic bearing to a TACAN station or active FMS waypoint as selected by the HSI selector switches.

15. Glideslope pointer and scale — The glideslope pointer and scale displays glideslope deviation. The pointer is in view only when tuned to a localizer frequency. Aircraft is below glideslope deviation. Aircraft is below glidepath if pointer is displaced upward; each dot represents approximately 0.4° displacement.

16. VERT flag — The VERT flag indicates that the information displayed by the glideslope pointer is invalid and should not be used.

17. To/from pointers — The to/from pointers are situated 180° apart. One always points the direction toward the station along the selected VOR radial.

18. Heading knob — The notched orange heading bug is positioned on the rotating dial by the heading knob and displays preselected compass heading. The bug rotates with the heading dial so the difference between the bug and the fore lubber line index is the amount of heading error applied to the flight director computer. In the heading mode, the FDI vertical command bar will display the required bank commands to bring the aircraft onto and maintain the selected heading.

24.3.2 HSI Select/Annunciator Switches

The pilot and copilot have illuminating push switches with which to select a desired navigation system to control their respective HSI indicators.

Note

Each of the HSI switches has both a green and a white lens. If the pilot and copilot select the same signal source, the pilot will override the copilot. The switch will illuminate green if the position has control of the source. If the copilot should select the same source as the pilot, the copilot switch will illuminate white to indicate the copilot has no control or display of the signal. The switches illuminate white all the time except when selected based on priority shown above.

24.4 FLIGHT DIRECTOR INDICATOR

The flight director indicator (Figure 24-3) provides aircraft pitch and roll attitude display combined with the lateral and vertical steering commands. It also contains an eyelid display, expanded localizer, glideslope scale, rising radio altitude runway bar, inclinometer, decision height annunciator, and go-around annunciator.

Note

The copilot FDI navigation information (command bars on a coupled approach, expanded localizer, and glideslope) is for the navigation aid selected on the pilot HSI indicator switches.

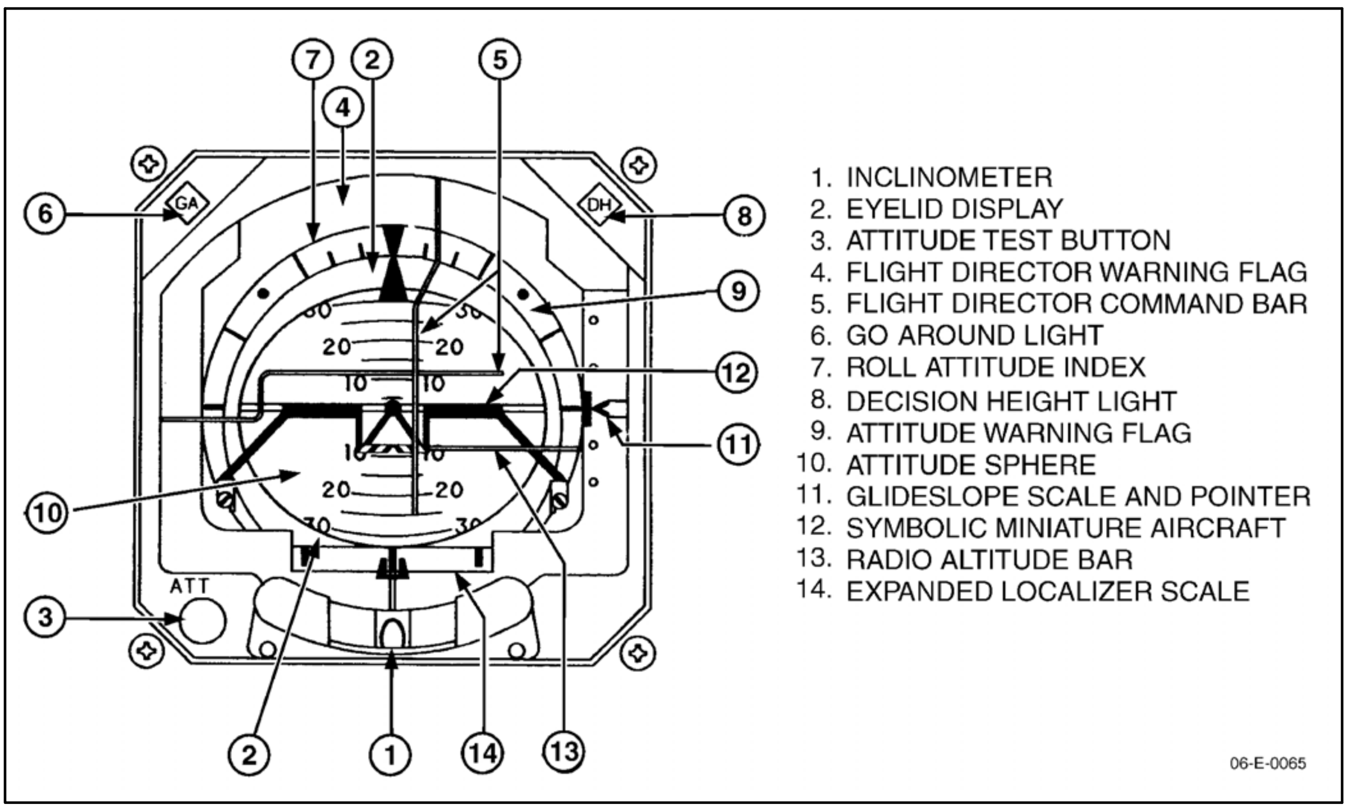


Figure 24-3. Flight Director Indicator

1. Inclinometer — Slip and skid information is displayed by the ball type inclinometer. The ball indicates whether a coordinated turn is being made.

2. Eyelid display — The eyelid display surrounds the attitude sphere and provides positive attitude identification by means of a blue eyelid that always shows the relative position of the sky and a brown eyelid that always shows the relative position of the ground. The eyelids maintain the proper ground-to-sky relationship, regardless of the position of the sphere.

3. Attitude test button — Depressing the attitude test button activates the sphere self-test circuit, which causes a change in attitude of approximately 20° right bank and 10° pitch-up. While the button is depressed, the attitude flag comes into view.

4. Flight director warning flag — The flight director warning flag is used to indicate that the flight director command information displayed on the vertical and horizontal command bars is invalid and should not be used.

5. Flight director command bars — The steering command bars display computed steering commands to intercept and maintain a desired flight path. The horizontal bar displays pitch commands, and the vertical bar displays roll commands. The command bars are operated independently and failure of one (retraction) will not impede usage of the other.

6. GA light — The go-around light indicates that the flight director is in the GO AROUND mode.

7. Roll attitude index — The roll attitude index displays actual roll attitude through a movable pointer on the eyelid display and fixed reference marks at 10°, 20°, 30°, 45°, 60°, and 90°.

8. DH light — The decision height light provides annunciation that decision height set on the radio altimeter has been reached.

9. Attitude warning flag — The attitude warning flag is used to indicate that the attitude information displayed by the sphere is invalid and should not be used.

10. Attitude sphere — The attitude sphere moves with respect to the symbolic aircraft reference to display actual pitch and roll attitude. Pitch attitude marks are in 5° increments on a blue and brown sphere. These colors are most contrasting and acceptable display colors from a human factor standpoint.

11. Glideslope scale and pointer — The glideslope scale and pointer displays aircraft deviation from glideslope beam center only when tuned to ILS frequency and a valid glideslope signal is present. Aircraft is below glidepath if pointer is displaced upward. The glideslope dot represents approximately 0.4° deviation from the beam centerline. The glideslope pointer will bias out of view if it is not tuned to a localizer frequency, the glideslope signal is lost, or a reverse course is selected on the flight director.

12. Symbolic miniature aircraft — The miniature aircraft serves as a stationary symbol of the aircraft. Aircraft pitch and roll attitudes are displayed by the relationship between the fixed miniature aircraft and the movable sphere. The symbolic aircraft is flown to, and the center dot aligned with, the command bars to satisfy the commands of the flight director mode selected.

13. Radio altitude rising runway — Radio altitude is displayed by the radio altitude bar. The bar comes into view at an altitude of approximately 200 feet AGL and stops beneath the aircraft symbol as the aircraft touches the runway.

14. Expanded localizer scale — Raw localizer displacement data from the receiver (HSI display) is amplified approximately 7-1/2 times to permit the expanded localizer pointer to be used as a reference indicator of the aircraft position with respect to the center of the localizer. It is normally used for assessment since the pointer

is very sensitive and difficult to fly through the entire approach. During final approach, the pointer scale is an indicator of the Category II window. Full-scale deflection is equal to 1/4 degree of beam signal. The localizer pointer will bias out of view if the navigation receiver is not turned to a localizer frequency or to indicate loss of a valid localizer signal.

24.5 RADIO ALTIMETER

A radio altimeter is provided to indicate the aircraft height above the terrain during the approach phase of the flight. The scale on the indicator displays absolute altitude between –20 and +2,500 feet with an expanded linear scale under 500 feet. A DH light on the indicator illuminates to advise the pilot of aircraft arrival at a preset altitude. The preset altitude is adjustable by the pilot to the correct value for the intended arrival area.

1. TEST button — The TEST button is used to check the indicator receiver/transmitter unit and flag operation. When the button is depressed, the OFF flag will come into view and the altimeter will indicate 100 ±20 feet.

2. OFF flag — The OFF flag indicates that information displayed on the radio altimeter is invalid and should not be used.

3. DH annunciator — The decision height annunciator light illuminates to indicate that the aircraft is at or below the selected decision height.

4. DH bug — The triangular decision height bug is set to the selected decision height altitude.

5. DH set knob — The decision height set knob is used to position the decision height bug.

24.6 GYRO MAGNETIC COMPASS SYSTEM

24.6.1 Description

Two identical compass systems provide accurate directional information for the aircraft at all latitudes of the Earth. For heading reference, two modes of operation are used: directional gyro (FREE) mode, or slaved (SLAVE) mode.

In areas where magnetic references are reliable, the system is operated in the SLAVE mode. In this mode, the directional gyro is slaved to the magnetic flux valve, which supplies magnetic reference for correction of the apparent drift of the gyro.

Gyro COMPASS 1 provides heading information for the pilot HSI and the copilot RMI. Gyro COMPASS 2 serves the copilot HSI and the pilot RMI. There are no front panel fuses or circuit breakers provided for the gyro magnetic compass systems. Switches are located on the instrument panel below the HSI.

24.6.2 Alignment Procedure

1. COMPASS GYRO SLAVE/FREE switch — SLAVE.

2. COMPASS INCREASE/DECREASE switch — Hold switch momentarily in the direction desired and then release. This will place system in fast erect mode. The gyro will then erect at approximately 30° per minute. While in the fast erect mode the HDG flag will be in view. When the HDG flag retracts from view, the heading displayed will be the magnetic heading.

24.6.3 Magnetic Heading Operating Procedure

1. COMPASS GYRO SLAVE/FREE switch — SLAVE.

2. Compass card on RMIs — Read heading.

24.6.4 Directional Gyro Heading Procedure

1. COMPASS GYRO SLAVE/FREE switch — FREE.
2. COMPASS INCREASE/DECREASE switch — Hold until the RMI compass card aligns with the magnetic heading, then release.
3. Read heading. The heading will agree with the appropriate HSI.

24.7 VERTICAL GYROS

Two vertical gyros are installed to provide roll and pitch information to the FDIs and to the autopilot system. A FAST ERECT pushbutton below each HSI indicator on the instrument panel is provided to assist in the rapid erection of the respective gyros.

24.8 TACAN SYSTEM

24.8.1 Description

The TACAN system operates in conjunction with TACAN and VORTAC ground stations to provide distance, groundspeed, time to station, and bearing to station. It operates in the L band 1,000-MHz frequency range on 1 of 252 preselected frequencies, 126 X-mode and 126 Y-mode channels. Course deviation and distance to TACAN or VORTAC stations are displayed on the HSI. Distance, time to station, and groundspeed are displayed on the TACAN digital display.

The groundspeed and time to station are accurate only if the aircraft is flying directly toward the ground station at a sufficient distance that the slant range and ground range are nearly equal. The system is protected by the TACAN circuit breaker on the AVIONICS portion of the copilot right sidewall panel.

The TACAN system may be operated on the flight director system or connected to and used with the autopilot system. When employed as the primary means of navigation, aircraft flight may be controlled manually or by the autopilot. Indications of aircraft heading and bearing to ground stations are displayed on the horizontal situation indicators. Relative bearing to a station is displayed by the HSI bearing pointer. TACAN slant range is displayed on each HSI in the digital distance display. TACAN distance, groundspeed, and time to station are all displayed on the TACAN indicator located on the copilot instrument panel.

The TACAN control panel enables selection of the TACAN frequency (channel) to be used and provides self-test of TACAN circuits. X or Y channel is selected by the X/Y switch. At the present time, all TACAN and VORTAC stations are operated on the X mode. When Y mode stations are operational, the air navigation charts will designate the Y mode stations. Use of the Y channels has been implemented along with 0.05-MHz spacing for VOR/VORTAC stations and Y channels are paired with these new frequencies (e.g., VOR frequency 113.1 is TACAN channel 78K; VOR frequency 113.15 is TACAN channel 78Y). The small (outer) control provides system power ON/OFF and station identity tone volume control. TACAN circuits are protected by a TACAN circuit breaker on the AVIONICS portion of the copilot right sidewall panel.

24.8.2 Operation

24.8.2.1 TACAN Turn-On/Test Procedures

1. Turn TACAN on.
2. Select TACAN on HSI indicator buttons.

3. Conduct test.

   a. Set course knob on pilot HSI to 180° course.

   b. Hold TACAN TEST switch (TACAN control panel) to TEST and confirm the following results:

      (1) Pilot HSI course indicator centers on 180° ±2° TO indication and the bearing pointers on each course indicator read 180° ±2°.

      (2) Using course knob, increase selected course; note deviation bar moves left.

      (3) Using course knob, decrease selected course; note deviation bar moves through and continues to right of center.

      (4) Full-scale deflection will be 10° ±1°.

24.8.2.2 Normal Operation

1. HSI switches — Depress TACAN.

2. TACAN control panel.

   a. Mode switch (X/Y) as required.

   b. Select desired channel.

3. Wait 5 seconds for signal acquisition and lock-on. If bearing signal lock-on does not occur, the TACAN remains in the bearing search mode and the red bearing pointer on the selected HSI will stay in the park position. If bearing lock-on is not obtained, perform an in-flight self-test to ensure correct operation of the system. Anytime the course indicator flag is in view, the bearing, course deviation, and the to/from information may be inaccurate and should be disregarded.

4. Ensure audio station identification signal is correct for the ground station selected.

5. Red bearing pointer on HSI — Read bearing to station.

6. COURSE knob (selected HSI) — Set course desired.

7. Intercept course as required, verify intercept heading by reference to HSI bearing pointers.

8. Course deviation bar (pilot HSI) — Read deviation from selected course. Course arrow will show wind correction angle when the course deviation bar is centered and the aircraft is tracking the selected course.

9. TACAN indicator — Read range (nm). Cross-reference range represented in indicator with HSI distance readout.

10. To determine course to or course from a TACAN station, rotate course knob (HSI selected TACAN) until course deviation bar is centered and TO/FROM flag reads TO or FROM.

11. To use TACAN with pilot-controlled flight, control aircraft by manual controls responding to information displayed on the flight director, RMI, and other instruments.

12. To use TACAN with the autopilot, depress A/P ENGAGE and monitor autopilot performance on flight director, RMI, and TACAN indicator. Verify adherence to preset heading and course and confirm the execution of displayed steering commands.

Note

The TACAN groundspeed reading will be accurate only when the aircraft is on a course directly to or from the TACAN station. When headed away from the station, the TACAN indicator minutes reading will be in error.

24.8.2.3 Emergency Operations

Not applicable.

24.8.2.4 Shutdown

1. Turn ON-OFF/VOL knob OFF.

24.9 ENHANCED GROUND PROXIMITY WARNING SYSTEM (EGPWS)

24.9.1 System Description

The Mark VII EGPWS system consists of the EGPWS computer that is provided inputs from the NAV receivers, air data computer, radio altimeter, and FMS. The EGPWS displays graphic terrain advisory data on the Multi-Function Display (MFD) located on the center instrument panels.

The EGPWS integrates three alerting functional areas into a single Line Replaceable Unit (LRU) called the Enhanced Ground Proximity Warning Computer (EGPWC). These functional areas are:

Ground Proximity Warning (including altitude and bank angle advisories).

Terrain (or Obstacle) Alerting and Display (TAD) (including manmade obstacles).

Terrain Clearance Floor (TCF).

The system operates by accepting a variety of aircraft parameters as inputs, applying alerting algorithms, and providing the flightcrew with aural alert messages and visual annunciations and displays in the event that the boundaries of any alerting envelope are exceeded. The system comprises the following groups of components:

Aircraft sensors and other systems providing input signals.

The Enhanced Ground Proximity Warning Computer (EGPWC).

Flight compartment audio systems (speakers and headphones).

Annunciators and switch/annunciators, mode and selector switches, and terrain display.

The EGPWS is designed to be fully compatible with normal aircraft operations. Unwanted alerts will be very rare if the pilot maintains situational awareness with respect to the terrain. There is normally no requirement for pilot input to the system, except for preflight self-testing.

The Ground Proximity Warning System (GPWS) modes 1 through 5 and mode 6 altitude callout functions employ the same algorithms that are used in the nonenhanced GPWS systems. Refer to Figure 24-4.

24.9.1.1 Terrain (or Obstacle) Alerting and Display and Terrain Clearance Floor

The major “new” functions of the EGPWS are the TAD and the TCF. Refer to Figure 24-5. These functions use geographic aircraft position, aircraft altitude and a terrain database to predict potential conflicts between the aircraft flight path and the terrain or cataloged manmade obstacles and to provide graphic displays of the conflicting terrain. Obstacles of 100 feet or more have been included from a database provided by NOAA that covers North America and parts of the Caribbean.

24.9.1.1.1 Terrain (or Obstacle) Alerting and Display (TAD)

The TAD alerting algorithms continuously compute terrain clearance envelopes ahead of the aircraft. If the boundaries of these envelopes conflict with terrain elevation data in the terrain database, then alerts are issued. Two envelopes are computed, one corresponding to a terrain caution alert level and the other to a terrain warning alert level.

The caution and warning envelopes use the TCF as a baseline and look ahead of the aircraft in a volume that is calculated as a function of groundspeed, flight path angle, and track.

If the aircraft penetrates the caution envelope boundary, the aural message CAUTION TERRAIN, CAUTION TERRAIN or CAUTION OBSTACLE, CAUTION OBSTACLE is generated, and alert discretes are provided for activation of the amber GPWS annunciators. Simultaneously, terrain areas, which conflict with the caution criteria, are shown in solid yellow color on the display.

If the aircraft penetrates the warning envelope boundary, the aural message TERRAIN, TERRAIN, PULL UP! or OBSTACLE, OBSTACLE, PULL UP! is generated, and alert discretes are provided for activation of the red PULL UP annunciators. Simultaneously, terrain areas that conflict with the warning criteria are shown in solid red color on the display.

Terrain picture data may be selected in place of the weather radar display on the Multi-Function Display (MFD) at any time. When the conditions for either a terrain caution or a terrain warning are dictated, the system automatically changes the MFD from the weather radar picture to the terrain picture and automatically selects 10 nm range. If auto pop-up occurs, once clear of the conflict, any other display range will have to be manually selected.

Mode	Function	Caution	Warning
Mode 1	Excessive descent rate	SINK RATE	PULL UP
Mode 2	Excessive closure to terrain	TERRAIN	PULL UP
Mode 3	Altitude loss after takeoff	DON'T SINK, DON'T SINK	
Mode 4A Mode 4B Mode 4C	Unsafe terrain clearance	TOO LOW, GEAR; TOO LOW, FLAPS; TOO LOW, TERRAIN	
Mode 5	Excessive glideslope deviation	GLIDESLOPE	
Mode 6	Advisory callouts	ONE THOUSAND; FIVE HUNDRED; MINIMUMS, MINIMUMS	
Mode 6	Bank angle callouts	BANK ANGLE, BANK ANGLE	

Figure 24-4. EGPWS Modes

Mode	Function	Caution	Warning
TAD	(Terrain Alerting) (Obstacle Alerting)	CAUTION TERRAIN, CAUTION TERRAIN CAUTION OBSTACLE, CAUTION OBSTACLE	TERRAIN, TERRAIN, PULL UP; PULL UP repeats OBSTACLE, OBSTACLE, PULL UP; PULL UP repeats
TCF	Terrain Clearance Floor	TOO LOW, TERRAIN	TERRAIN, TERRAIN, PULL UP

Figure 24-5. EGPWS Terrain Function

Areas of terrain that satisfy the terrain caution alert criteria are shown in solid yellow, and areas of terrain that satisfy the terrain warning alert criteria are shown in solid red. Terrain that is sufficiently close to the aircraft, but does not satisfy the caution or warning criteria, is shown as red, yellow, or green dot patterns. The density of the dot pattern is coarsely varied to depict terrain altitude with respect to the aircraft. All displayed terrain areas or obstacles are shown as rectilinear shapes that are designed to be easily distinguishable from the display of weather radar images. Magenta (purple) dot patterns are used to indicate areas where terrain information is unavailable.

The TAD and TCF functions may be inhibited by manual selection of the flight compartment GPWS TERR INHBT button. Neither loss (GPWS TERR N/A) nor inhibited TAD/TCF affects the basic GPWS functions (modes 1 to 6).

24.9.1.1.2 Terrain Clearance Floor (TCF)

The TCF alert adds an additional element of protection to the standard ground proximity warning modes. It creates an increasing terrain clearance envelope around the nearest airport runway. TCF alerts are based on current aircraft location, nearest runway center point position, and radio altitude. TCF protection is active regardless of aircraft flight configuration.

24.9.1.2 Switches/Annunciators

Annunciators and switches (external to the EGPWS display) control and annunciate the status of the various modes of the EGPWS. There are three switch-lights and one annunciator located on the center instrument panel near the MFD. There are two sets of switch-lights, GPWS/PULLUP and G/S INHBT, located on the pilot and copilot side of the glareshield. There is one GPWS INOP annunciator located on the master caution panel.

24.9.1.2.1 Upper Center Panel

1. GPWS TEST/GPWS/PULL UP — Annunciator/switch:

   a. GPWS TEST — Not a light. Legend is a permanent white placard on black outer bezel. Momentary pushbutton to initiate system self-test.

   b. GPWS — Legend is amber on black. Illuminates during EGPWS cautionary advisories for modes 1 through 6 and enhanced terrain.

   c. c.PULL UP — Legend is (flashing) red on black. Illuminates for mode 1 SINK-RATE, mode 2 TERRAIN, and enhanced PULL UP messages.

2. G/S INHBT — Annunciator/switch.

   a. G/S — Legend is white on black background and is always illuminated.

   b. INHBT — Legend is amber on black. Momentary pushbutton to inhibit or restore glideslope mode 5 warning. Legend illuminates only when glideslope is inhibited. Refer to Figure 24-6.

24.9.1.2.2 Center Instrument Panel Near MFD

1. TERR/ON — Annunciator/switch.

   a. TERR — Illuminates green (on black) all the time.

   b. ON — Illuminates green (on black) when terrain is selected. Momentary pushbutton to manually turn MFD terrain on or off. “Pop-Up” mode still armed when manual button is in the off position.

2. GPWS TERR INHBT — Annunciator/switch.

   Legend is white on black background when not activated. Legend illuminates amber on black background when terrain display is inhibited. Alternate action button to inhibit the terrain pop-up display on MFD.

3. GPWS FLAP ORIDE — Annunciator/switch.

   Legend is permanent white on black background. Background illuminates amber when flap warnings disabled. Alternate action button to override or restore mode 2 and mode 4 flap warnings.

4. GPWS TERR N/A — Annunciator.

   Legend is amber on black background. Illuminates only when GPWS terrain information is not available.

24.9.1.2.3 Master Caution Panel

GPWS INOP — Annunciator.

Legend is amber. Illuminates when any of the modes 1 through 6 are inoperative.

24.9.1.3 EGPWS Modes 1 to 6

The EGPWS is designed to help prevent accidents caused by Controlled Flight Into Terrain (CFIT). The system achieves this objective by accepting a variety of aircraft parameters as inputs, applying alerting algorithms, and providing the flightcrew with aural alert messages and visual displays in the event that the boundaries of any alerting envelope are exceeded. The system operates in six modes: excessive descent rate to terrain, excessive closure rate to terrain, alert to descent after takeoff, insufficient terrain clearance, inadvertent descent to glideslope, and altitude callouts and excessive bank angle alert.

24.9.1.3.1 Mode 1

Provides the flightcrew with alert/warning for high descent rate into terrain with an average 20 seconds time to impact. This mode also increases alert/warning for sink rate near the runway threshold. The flightcrew receives an alert for rapidly building sink rates exceeding 1,000 feet per minute (fpm).

MODE	INDICATION		
	VISUAL ALERT	AUDIO ALERT	WARNING
1. Excessive sink rate	PULL UP Indicator	SINK RATE	WHOOP WHOOP PULL UP
2. Excessive terrain closure	PULL UP Indicator	TERRAIN TERRAIN	WHOOP WHOOP PULL UP
3. Descent after takeoff	PULL UP Indicator	DON'T SINK	
4. Inadvertent proximity to terrain			
a. Gear up	PULL UP Indicator PULL UP Indicator	TOO LOW GEAR TOO LOW TERRAIN	
b. Flaps up	PULL UP Indicator PULL UP Indicator	TOO LOW FLAPS TOO LOW TERRAIN	
5. Descent below glideslope	G/S Indicator	GLIDESLOPE	
6. Descent below minimums	None	MINIMUMS MINIMUMS	None

Figure 24-6. GPWS Visual/Aural Alerts and Warnings

24.9.1.3.2 Mode 2

Allows for the display of threatening terrain, permitting virtual “look ahead” warnings. CAUTION TERRAIN and TERRAIN AHEAD alerts based on position data and terrain database precede the GPWS warning. Using the speed of the aircraft to expand the warning envelope increases warning time for closure rate to terrain.

24.9.1.3.3 Mode 3

Alerts the flightcrew to an inadvertent descent into terrain after takeoff or missed approach. The alert is given after significant barometric altitude loss has occurred and allows considerable margin for third segment acceleration and flap retraction even under engine-out conditions. Additional warning protection is provided against a shallow accelerating climb into rising terrain during initial climbout.

24.9.1.3.4 Mode 4

Warns the flightcrew of insufficient terrain clearance during climbout, cruise, and initial descent and approach. This warning mode is especially valuable when the aircraft flight path relative to terrain is insufficient to develop excessive closure rate or descent rate warnings. TCF uses navigation position data coupled with the airport/runway database to provide valuable protection in the landing configuration.

24.9.1.3.5 Mode 5

Is armed when an ILS frequency is selected and the gear extends. The warning envelope contains two boundaries: a “soft” alert region and a “hard” alert region. Both boundaries are a function of glideslope deviation. When the aircraft penetrates the “soft” alert region, the aural GLIDESLOPE warning is given at a normal rate. If the glideslope deviation continues to increase, the EGPWS enters the “hard” alert region and increases the frequency of the alert.

24.9.1.3.6 Mode 6

Altitude callouts are optionally available in mode 6. These callouts include aural warnings at 1,000 feet and 500 feet AGL and a callout for MINIMUMS, MINIMUMS based on the altitude bug setting on the radio altimeter indicator. A bank angle alert is available to notify the flightcrew that the aircraft bank has exceeded 40° at 150 feet AGL, to 10° at 30 feet AGL.

24.9.1.4 System Activation

The EGPWS is fully operational when electrical power is on, the GPWS INOP and GPWS TERR N/A messages are not displayed, and the following systems are operational:

Enhanced Ground Proximity Warning Computer (EGPWC).

Radio altimeter.

Air data computer.

VHF NAV receiver 1 or 2.

FMS 1 or 2.

Gear and flaps indicating systems.

Display system (MFD).

The GPWS INOP annunciation signifies a failure of the GPWS. The GPWS TERR N/A annunciation indicates that the GPWS enhanced features TAD and TCF are not available.

Note

In the event that the radio altimeter is not functioning, the basic GPWS modes (1 to 6) and TCF will not be available; however, the enhanced feature of the TAD will be available.

If the EGPWS TAD or TCF features become inoperative either because of a system fault or inaccurate position information, the system basic GPWS functions modes (1 to 6) will still be available.

24.9.1.5 GPWS Circuit Protection

The following circuit breaker is associated with the EGPWS:

Nomenclature	Bus	Location	Amps
GPWS	BUS NO. 1	CB Panel	5

24.9.1.6 Advisory Altitude Callouts (Mode 6)

The following advisory callouts are provided in this installation:

MINIMUMS-MINIMUMS — Announces based on the setting of the pilot decision height selection based on DH bug setting on radio altimeter.

BANK ANGLE, BANK ANGLE: Announces when an excessive roll angle is achieved. Refer to Figure 24-7.

24.9.1.7 Pop-Up Display

In the event of a terrain alert, the display will automatically switch to display terrain. The display may be manually selected to display weather radar, if desired, when the terrain alert has ceased.

24.9.1.8 Use of the Terrain Awareness Display

The terrain awareness display may be shown on the MFD by pressing the TERR ON button. Ranging is controlled by the increase ▲ and decrease ▼ RANGE buttons on the MFD control panel. A numeric field in the lower right of the MFD provides the Mean Sea Level (MSL) heights of the highest and lowest terrain within the displayed range.

WARNING

If the weather radar is ON and TAD is selected for display, the weather radar is still transmitting. On ground operations, make sure outside personnel are not within 25 feet of area scanned by radar.

CAUTION

The terrain display is intended to serve as a situational awareness tool only and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.

24.9.1.9 Aural Declutter

The aural declutter feature provides for a reduction in repetition of warning messages. This feature affects modes 1, 3, 4, and 5.

24.9.1.9.1 Mode 1

Excessive Descent Rate: With Audio-Declutter, the alert/warning message for penetration of the outer boundary will be repeated twice, then will remain silent unless the Excessive Descent Rate condition degrades by approximately 20 percent, as determined by the computed time to impact (i.e., Radio Altitude/Altitude Rate). If a 20 percent degradation in time to impact is computed, then an additional two messages are given and the cycle repeats. This situation will continue until the alert/warning boundary is exited or until the mode 1 inner boundary is penetrated.

24.9.1.9.2 Mode 3

Descent after Takeoff: The aural alert message will repeat twice and remain silent until altitude degrades an additional 20 percent. If an additional 20 percent degradation is realized, then two additional messages are given and the cycle repeats. This function will desensitize over time and by an increase in altitude. The caution annunciator remains illuminated until the Descent after Takeoff condition has been corrected.

24.9.1.9.3 Mode 4

Unsafe Terrain Clearance: The aural alert message will repeat twice and remain silent until altitude degrades an additional 20 percent. If an additional 20 percent degradation is realized, then two additional messages are given and the cycle repeats. This function will desensitize over time and by an increase in altitude. The caution annunciator remains illuminated until the Unsafe Terrain Clearance condition has been corrected.

24.9.1.9.4 Mode 5

Descent below Glideslope: The aural alert message will be given once. Follow-on alerts will be provided for each additional 20 percent that the aircraft descends below glideslope. A hard double GLIDESLOPE will occur at 300 feet with two dots or more deviation. This will be repeated every 3 seconds and the caution annunciator will remain illuminated until the Descent below Glideslope condition has been corrected.

24.9.1.10 Alert Priorities

When an EGPWS warning or caution occurs, the Traffic Collision and Avoidance System (TCAS) is placed in TA ONLY (Traffic Advisory) mode, inhibiting all TCAS aural messages (Figure 24-7).

The following lists the priority of the warnings and alerts:

EGPWS Priority	Alert
1	Mode 1 Pull Up
2	Mode 2 Pull Up
3	Terrain Awareness Warning
4	Obstacle Awareness Warning
4	Mode 2 Terrain
5	Mode 6 Minimums, Minimums
5	Terrain Awareness Caution
6	Obstacle Awareness Caution
7	Mode 4 Too Low, Terrain
7	TCF Too Low, Terrain
8	Mode 6 Altitude Callouts
9	Mode 4 Too Low, Gear
10	Mode 4 Too Low, Flaps
11	Mode 1 Sink Rate
12	Mode 3 Don’t Sink
13	Mode 5 Glideslope
14	Mode 6 Bank Angle

Figure 24-7. EGPWS Alert Priorities

24.9.1.11 System Constraints

If there is no terrain data in the database for a particular area, the affected area is colored magenta.

If the TAD and TCF features of the EGPWS have been inhibited, the EGPWS will revert to basic GPWS protection (modes 1 to 6). In the standard GPWS condition, the system may give little or no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. If the aircraft is flown toward obstructing terrain, the GPWS will give no warnings if all the following conditions apply:

The aircraft is in landing configuration.

The aircraft is in a stabilized descent at a normal approach descent rate.

There is no ILS glideslope signal being received by the EGPWS (i.e., there is no ILS available or the glideslope receiver connected to the EGPWC is not tuned to the appropriate ILS frequency).

Terrain clearances or descent rates during radar vectoring that are not compatible with those required by the minimum regulatory standards for Ground Proximity Warning equipment may cause unwanted warnings or alerts.

Note

- When the GPWS TERR INHBT button/annunciator is selected, the basic GPWS functions remain operational.
- The EGPWS database currently accounts for limited cataloged manmade obstructions within North America and parts of the Caribbean.

24.9.1.12 EGPWS Basic Function Modes

24.9.2 Mode 1 — Excessive Descent Rate

Mode 1 provides alerts for excessive descent rates with respect to altitude AGL and is active for all phases of flight. This mode has inner and outer alert boundaries.

Penetration of the outer boundary activates the EGPWS caution lights and SINK RATE, SINK RATE alert annunciation. Additional SINK RATE, SINK RATE messages will occur for each 20 percent degradation.

Penetration of the inner boundary activates the EGPWS warning lights and changes the audio message to PULL UP, which repeats continuously until the inner warning boundary is exited. Refer to Figure 24-8.

24.9.3 Mode 2 — Excessive Closure to Terrain

Mode 2 provides alerts to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on Radio Altitude and on how rapidly Radio Altitude is decreasing (closure rate).

Note

Mode 2 exists in two forms: Modes 2A and 2B.

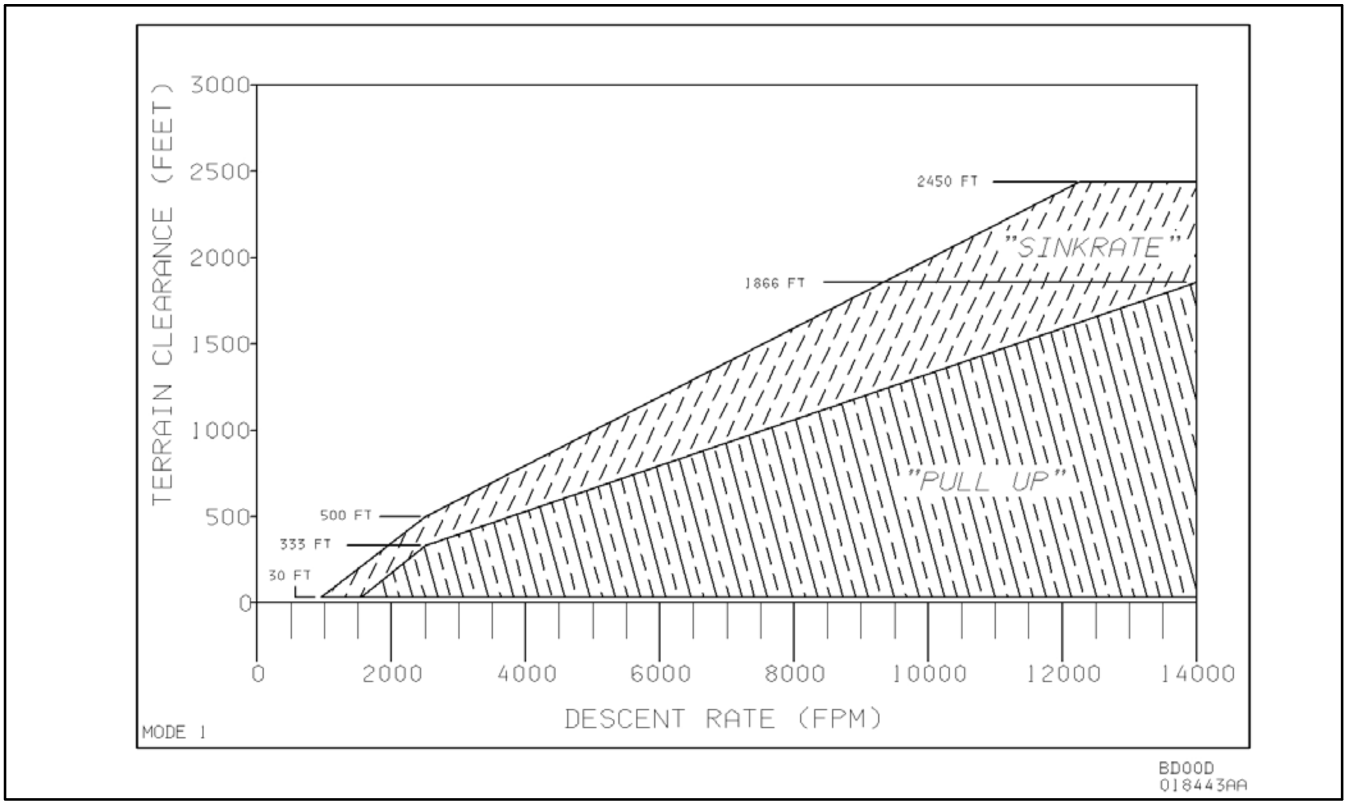


Figure 24-8. Excessive Descent Rate — Mode 1

24.9.3.1 Mode 2A

Mode 2A is active during climbout, cruise, and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centerline). If the aircraft penetrates the Mode 2A caution envelope, the aural message TERRAIN, TERRAIN is generated and cockpit EGPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the EGPWS warning lights will illuminate and the aural warning message PULL UP is repeated continuously until the warning envelope is exited. TERRAIN will be repeated until the terrain clearance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 feet of barometric altitude, 45 seconds have elapsed, or landing flaps or the flap override switch is activated. Refer to Figure 24-9.

24.9.3.2 Mode 2B

Mode 2B provides a desensitized alerting envelope to permit normal landing approach maneuvers close to terrain without unwanted alerts. Mode 2B is automatically selected with flaps in the landing configuration (landing flaps or flap override selected) or when making an ILS approach with glideslope and localizer deviation less than 2 dots. It is also active during the first 50 seconds after takeoff. Refer to Figure 24-10.

24.9.4 Mode 3 — Altitude Loss after Takeoff

Mode 3 provides alerts for significant altitude loss after takeoff or low altitude go-around (less than 245 feet AGL) with gear or flaps not in the landing configuration. The amount of altitude loss that is permitted before an alert is given is a function of the height of the aircraft above the terrain as shown in the Mode 3 graph. This protection is available until the EGPWS determines that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight. Significant altitude loss after takeoff or during a low altitude go-around activates the EGPWS caution lights and the aural message DON’T SINK, DON’T SINK. The aural message is only enunciated twice unless altitude loss continues. Refer to Figure 24-11.

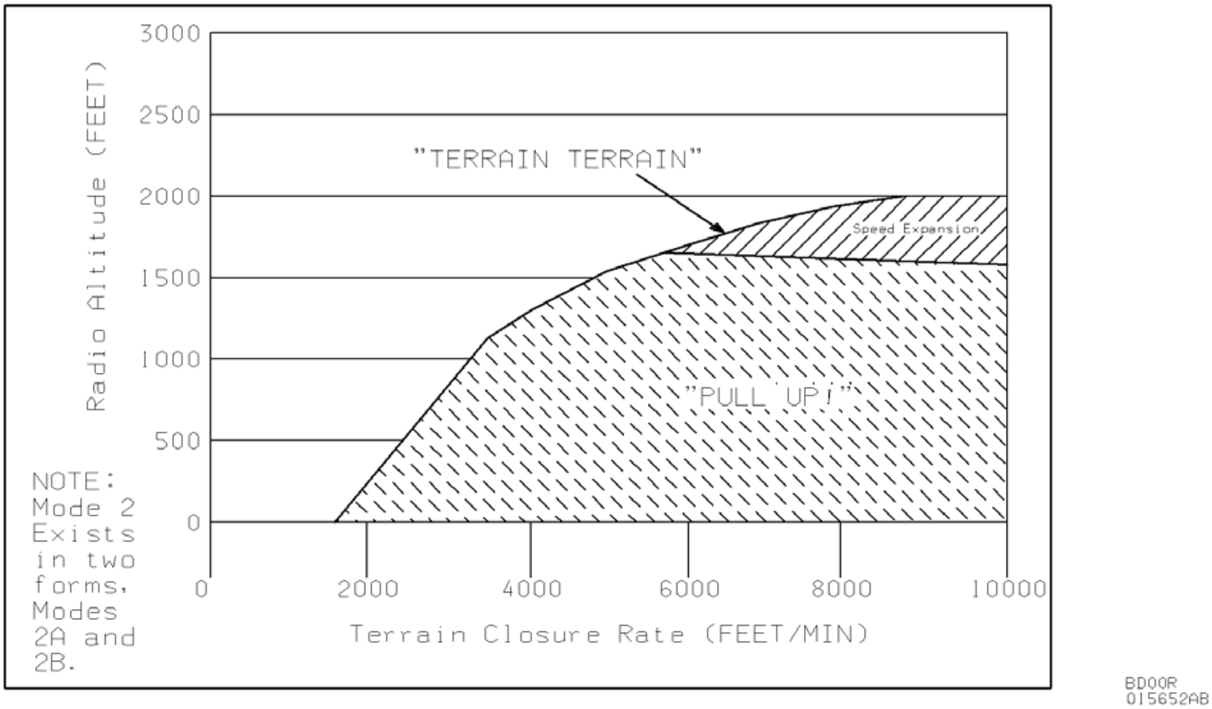


Figure 24-9. Excessive Closure to Terrain — Mode 2A

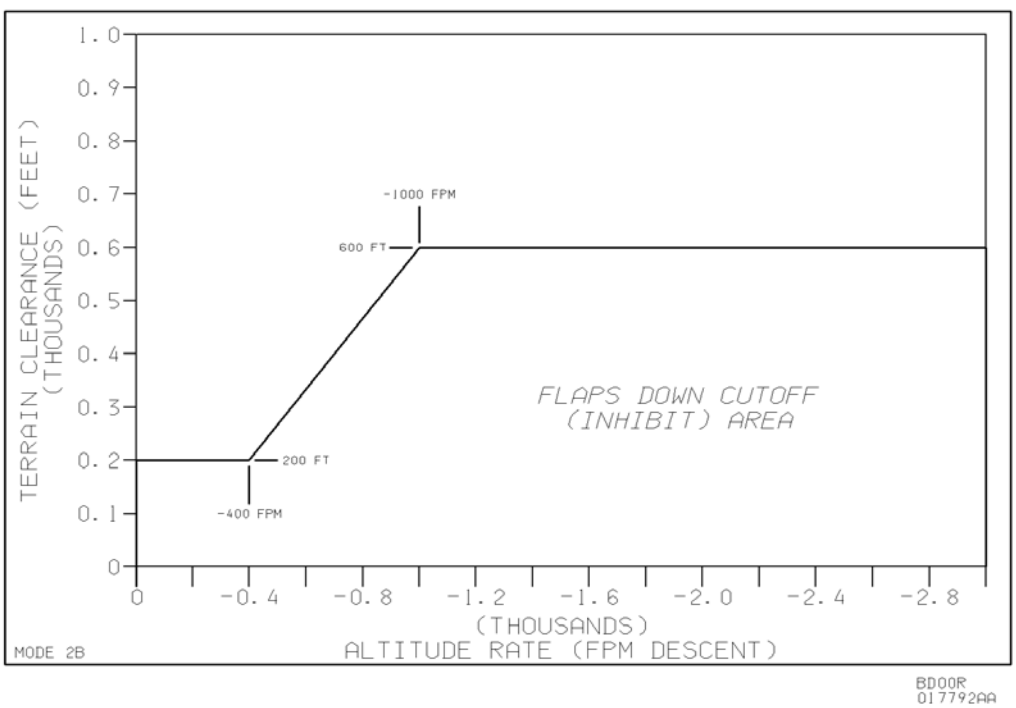


Figure 24-10. Excessive Closure to Terrain — Mode 2B

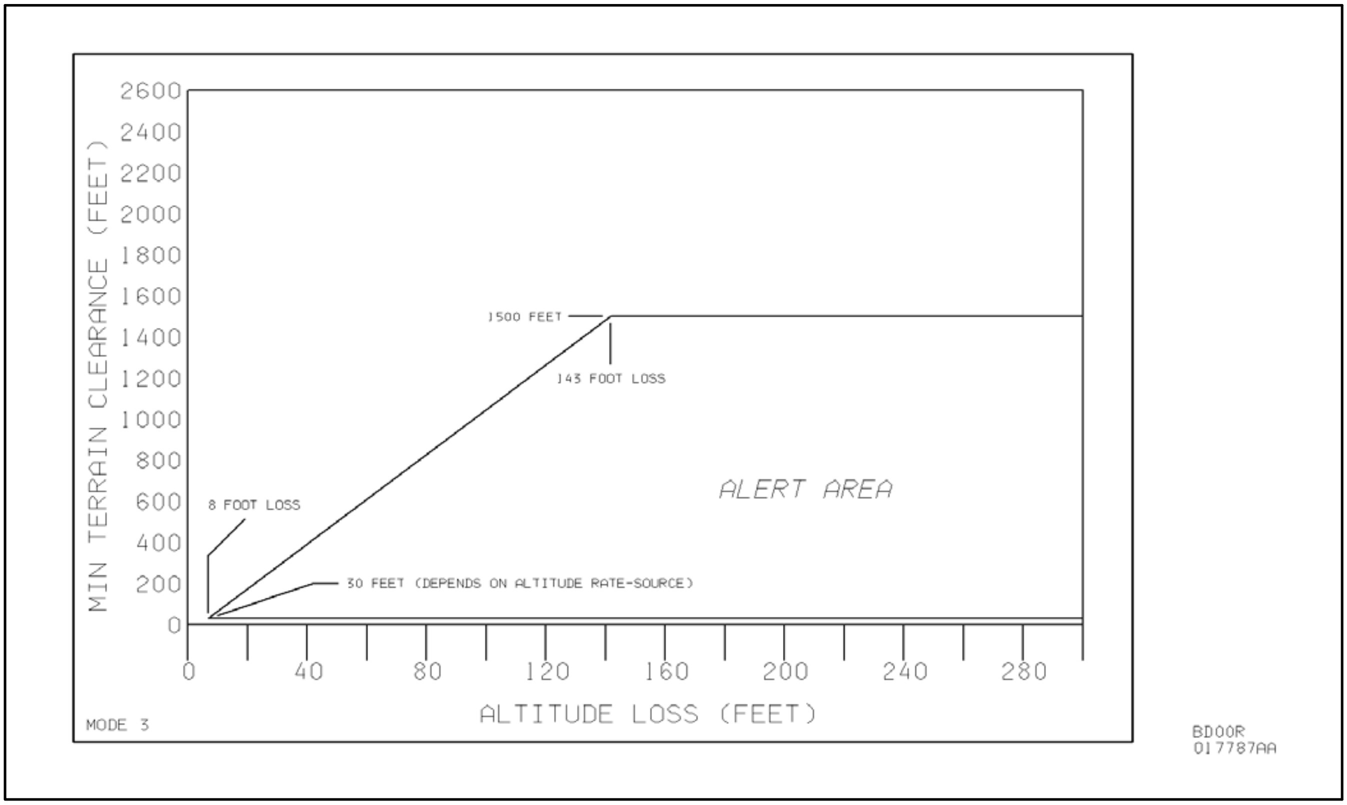


Figure 24-11. Altitude Loss after Takeoff — Mode 3

24.9.5 Mode 4 — Unsafe Terrain Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration, and speed.

Note

- Mode 4 exists in three forms: 4A, 4B, and 4C.
- Mode 4A is active during cruise and approach with the gear and flaps not in the landing configuration.
- Mode 4B is active during cruise and approach with the gear in the landing configuration and flaps not in the landing configuration.
- Mode 4C is active during the takeoff phase of flight with either the gear or flaps not in the landing configuration.

24.9.5.1 Mode 4A

Mode 4A is active during cruise and approach with gear and flaps up.

Below 800 feet AGL and above 178 knots airspeed, the Mode 4A aural alert is TOO LOW TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 400 feet at 178 knots to 800 feet at 226 knots.

Below 400 feet AGL and less than 178 knots airspeed, the Mode 4A aural alert is TOO LOW GEAR. Refer to Figure 24-12.

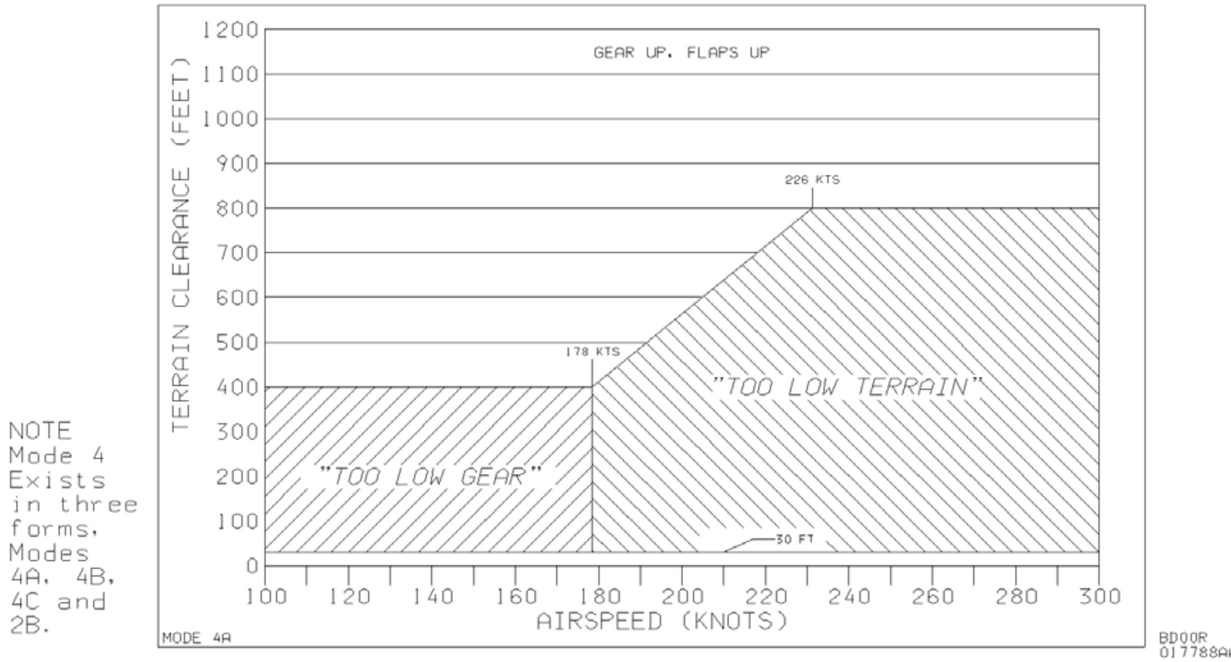


Figure 24-12. Unsafe Terrain Clearance — Mode 4A

24.9.5.2 Mode 4B

Mode 4B is active during cruise and approach with gear down and flaps not in the landing configuration.

Below 800 feet AGL and above 159 knots airspeed, the Mode 4B aural alert is TOO LOW TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 245 feet at 159 knots to 800 feet at 226 knots.

Below 245 feet AGL and less than 159 knots airspeed, the Mode 4B aural alert is TOO LOW FLAPS. If desired the pilot may disable the TOO LOW FLAPS alert by engaging the Flap Override switch. This precludes or silences the Mode 4B flap alert until reset by the pilot. Refer to Figure 24-13.

24.9.6 Mode 4C

The Mode 4C alert is intended to prevent inadvertent controlled flight into the ground during takeoff climb into terrain that produces insufficient closure rate for a Mode 2 alert. After takeoff, Modes 4A and 4B provide this protection.

Mode 4C is based on an EGPWS computed Minimum Terrain Clearance (MTC) floor, which increases with Radio Altitude. It is active after takeoff when the gear or flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

At takeoff, the Minimum Terrain Clearance (MTC) is zero feet. As the aircraft ascends, the MTC is increased to 75 percent of the aircraft Radio Altitude (averaged over the previous 15 seconds). This value is not allowed to decrease and is limited to 400 feet AGL for airspeed less than 178 knots. Beginning at 178 knots, the MTC increases linearly to the limit of 800 feet at 226 knots.

If the aircraft Radio Altitude decreases to the value of the MTC, the EGPWS caution lights and the aural message TOO LOW TERRAIN are provided. Refer to Figure 24-14.

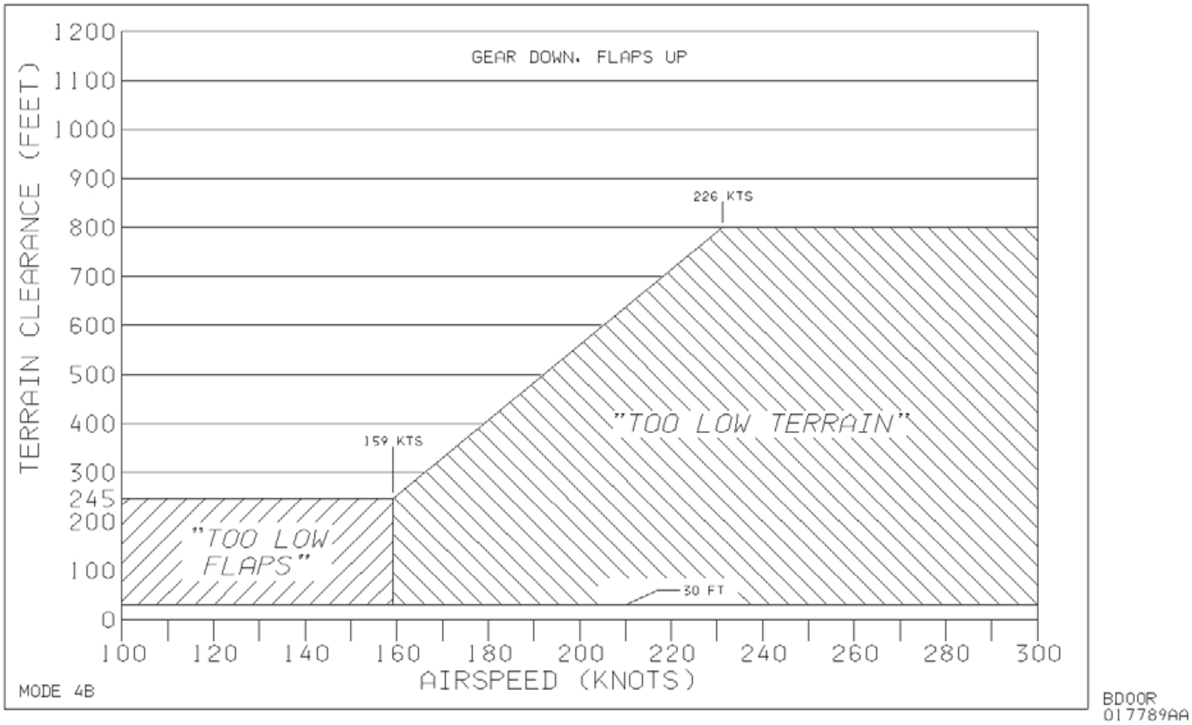


Figure 24-13. Unsafe Terrain Clearance — Mode 4B

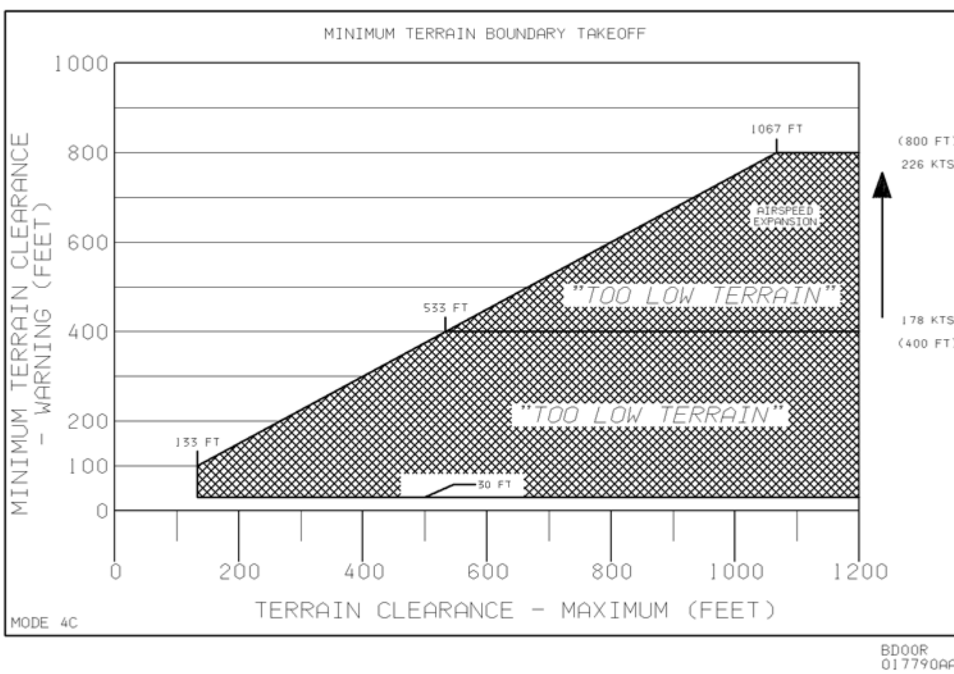


Figure 24-14. Unsafe Terrain Clearance — Mode 4C

24.9.7 Mode 5 — Excessive Deviation Below Glideslope

Mode 5 provides two levels of alerting for when the aircraft descends below glideslope, resulting in activation of EGPWS caution lights and aural messages.

The first level alert occurs when below 1,000 feet Radio Altitude and the aircraft gets 1.3 dots or greater below the beam. This turns on the caution lights and is called a “soft” alert because the audio message GLIDESLOPE is enunciated at half volume. Twenty percent increases in the glideslope deviation cause additional GLIDESLOPE messages to be enunciated at a progressively faster rate.

The second level alert occurs when below 300 feet Radio Altitude with 2 dots or greater glideslope deviation. This is called a “hard” alert because a louder GLIDESLOPE, GLIDESLOPE message is enunciated every 3 seconds continuing until the “hard” envelope is exited. The caution lights remain on until a glideslope deviation less than 1.3 dots is achieved. To avoid unwanted Below Glideslope alerts when capturing the localizer between 500 feet and 1,000 feet AGL, alerting is varied in the following ways:

> Below Glideslope alerts are enabled only if the localizer is within 2 dots and landing gear and flaps are selected. Glideslope Cancel is not active, and a front course approach is determined.
>
> The upper altitude limit for the alert is modulated with vertical speed. For descent rates above 500 fpm, the upper limit is set to the normal 1,000 feet AGL. For descent rates lower than 500 fpm, the upper limit is desensitized (reduced) to a minimum of 500 feet AGL.

EGPWS Mode 5 alerts are inhibited during backcourse approaches to prevent nuisance alerts due to false fly up lobes from the glideslope. Refer to Figure 24-15.

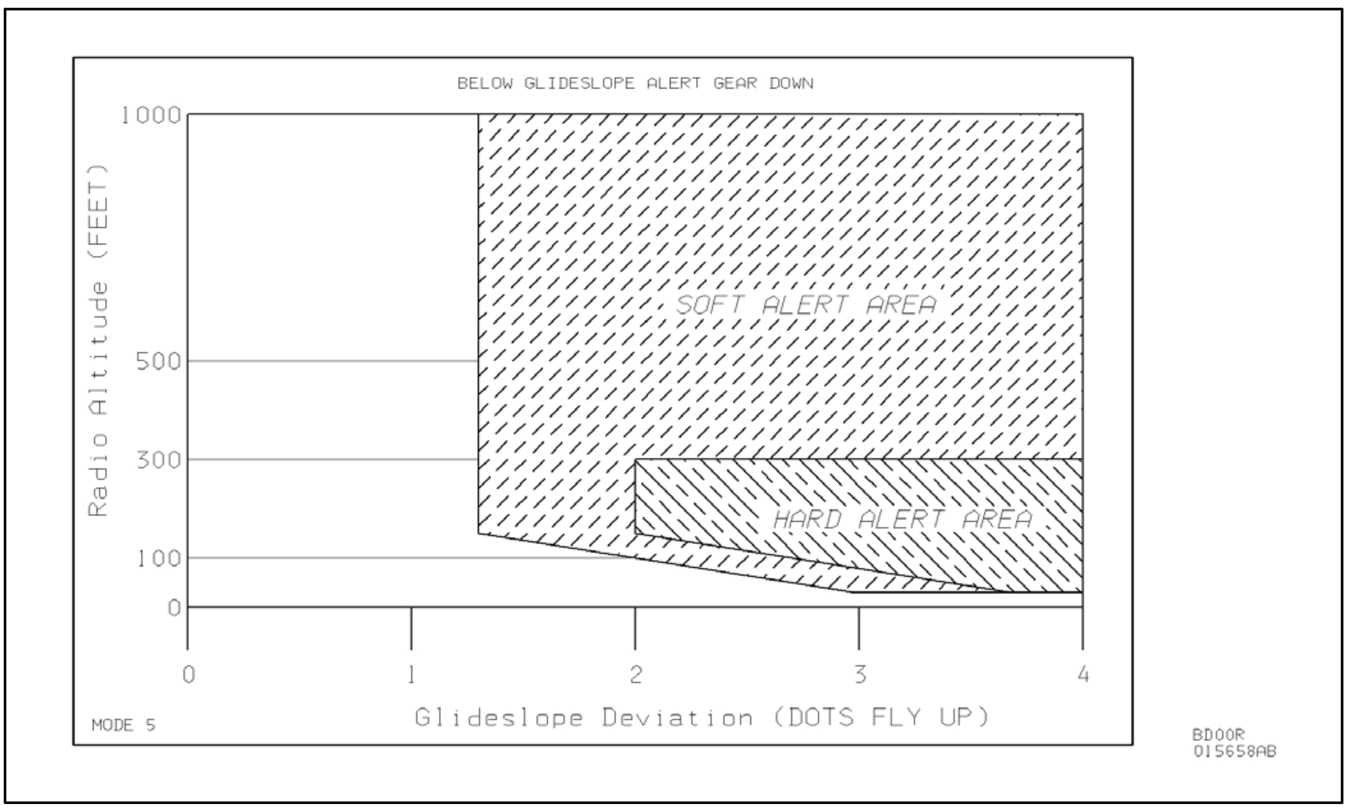


Figure 24-15. Excessive Deviation Below Glideslope — Mode 5

24.9.8 Mode 6 — Altitude Advisory Callouts

Mode 6 provides EGPWS advisory callouts based on the menu-selected option established at installation. These callouts consist of predefined Radio Altitude-based voice callouts or tones and an excessive bank angle warning. There is no visual alerting provided with these callouts. The altitude callouts are:

ONE THOUSAND	1,000*
FIVE HUNDREDS	500*
MINIMUMS MINIMUMS	DH

* May be Barometric Altitude above the field elevation.

Decision Height (DH) based callouts (Minimums) require the landing gear to be DOWN and occur when descending through the Radio Altitude corresponding to the selected DH.

The “500” callout is intended to assist pilots during a nonprecision approach by annunciating FIVE HUNDRED feet independent of the altitude callout menu selection discussed above. The EGPWS determines a nonprecision approach when localizer or glideslope are greater than 2 dots deviation (valid or not) or a backcourse approach is detected.

The callout BANK ANGLE, BANK ANGLE advises of an excessive roll angle.

The envelope provides bank angle advisory (shaded area). Bank angle advisories are inhibited below 10 feet. Refer to Figure 24-16.

$\pm 10°$ between 10 and 30 feet.
± 10 to $58°$ between 30 and 130 feet.
$\pm 58°$ above 130 feet.

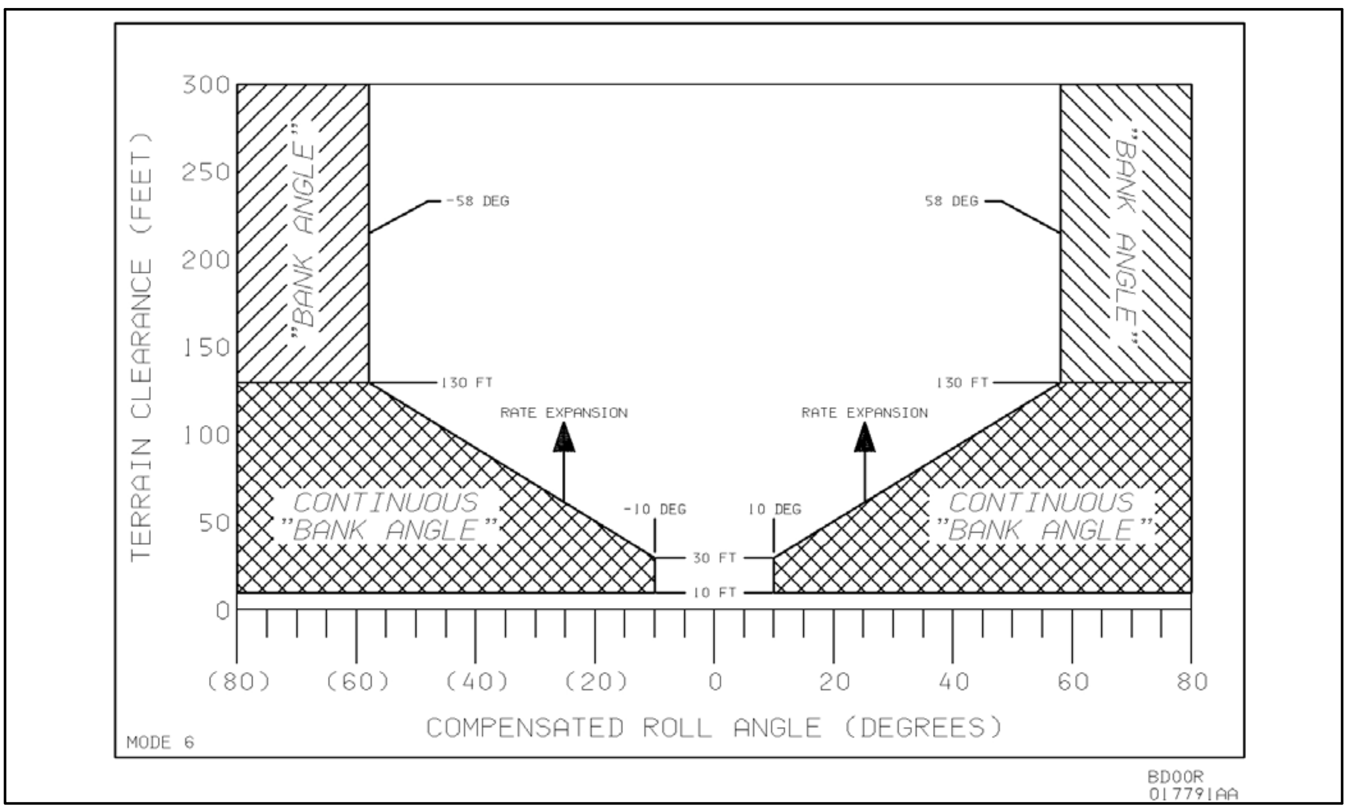


Figure 24-16. Bank Angle — Mode 6C

24.9.9 Limitations

Pilots are authorized to deviate from their current Air Traffic Control (ATC) clearance to the extent necessary to comply with an EGPWS warning.

Navigation must not be predicated upon the use of the Terrain (or Obstacle) Alerting and Display (TAD). The terrain display is intended to serve as a situational awareness tool only and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.

In order to avoid giving unwanted alerts, TAD must be inhibited when within 15 nm of a departure or arrival airport not contained in the EGPWS airport database.

In order to avoid unwanted alerts, TAD must be inhibited when the GPS is either degraded or inoperative.

The copilot altimeter provides barometric altitude input to the EGPWS. Hence, when using the EGPWS, the copilot altimeter must be set to the current barometric setting.

24.9.10 Normal Procedures

An EGPWS self-test should be performed prior to flight to make sure of proper operation.

24.9.10.1 Preflight Self-Test

24.9.10.1.1 Before Takeoff (Runup)

1. Ensure the G/S INHBT and GPWS TERR INHBT functions are not engaged.
2. Select the MFD to MAP mode.
3. Press the PULL UP/GPWS TEST button for less than 2 seconds and verify the following:
   a. The amber GPWS INOP and GPWS TERR N/A annunciators illuminate then extinguish.
   b. Amber GPWS annunciator illuminates.
   c. The aural GLIDESLOPE message is announced.
   d. The amber GPWS annunciators extinguish.
   e. The red PULL UP annunciators illuminate.
   f. The aural PULL UP message is announced.
   g. The red PULL UP annunciators extinguish.
   h. The MFD “pops up” the ARC map mode and the terrain display test pattern is displayed.
   i. The red PULL UP annunciators illuminate.
   j. The aural TERRAIN, TERRAIN, PULL UP message is announced.
   k. The red PULL UP annunciators extinguish.
   l. The amber GPWS annunciators momentarily illuminate.
   m. The terrain display test pattern is removed from the MFD after several sweeps.

24.9.10.1.2 Before Takeoff (Final Items)

EGPWS — On as required.

Note

Activation of the EGPWS by selecting TERR ON enables the EGPWS display on the MFD and disables the weather radar display on the MFD.

24.9.11 Abnormal Procedures

24.9.11.1 Landing

24.9.11.1.1 Landing with Flaps Up or Flaps Approach

GPWS FLAP ORIDE — Select.

When a procedure specifies landing with flap settings not normally used for landing, the GPWS FLAP ORIDE switch/annunciator can be used to simulate landing flaps. This will prevent the aural alert TOO LOW, FLAPS.

24.9.11.2 EGPWS Caution (GPWS Caution Annunciator Illuminated)

Any activation of aural alerts SINK RATE; TERRAIN, TOO LOW TERRAIN; DON'T SINK; TOO LOW, GEAR; TOO LOW, FLAPS; GLIDESLOPE; CAUTION TERRAIN or CAUTION OBSTACLE, perform one of the following according to the CAUTION received, refer to Figure 24-17:

SINK RATE	Monitor terrain clearance visually, or with terrain display, and reduce sink rate as necessary.
TERRAIN, TOO LOW TERRAIN, CAUTION TERRAIN or CAUTION OBSTACLE	Monitor terrain or obstacle clearance visually, or with terrain awareness display, and reduce or stop sink rate or climb as necessary.
DON'T SINK	Correct sink rate and continue takeoff climb as required.
TOO LOW, GEAR	Extend landing gear or execute a go-around.
TOO LOW, FLAPS	Extend flaps or execute a go-around or select GPWS FLAP ORIDE for abnormal configuration landing.
GLIDESLOPE	Correct flight path back to glideslope or select G/S INHBT.

Figure 24-17. EGPWS Caution Annunciators

24.9.12 Emergency Procedures

24.9.12.1 Landing

For off-airport landing, the Terrain (or Obstacle) Alerting and Display (TAD) and Terrain Clearance Floor (TCF) functions should be inhibited by selecting the GPWS TERR INHBT annunciator/switch.

The GPWS circuit breaker may be used to deactivate the EGPWS for ditching, landing with an unsafe gear indication, or landing with the gear up.

24.9.12.2 EGPWS Warning (Gpws Warning Annunciator Illuminated)

Any activation of the aural warning PULL UP; TERRAIN, TERRAIN, PULL UP; or OBSTACLE, OBSTACLE, PULL UP, perform the following action. Refer to Figure 26-62.

1. Autopilot — Disconnect.
2. Propeller levers — Full forward.
3. Throttles — Takeoff power.
4. Pitch attitude — Increase and climb as required to avoid terrain.
5. Flaps — Up.
6. Landing gear — Up.
7. Pitch attitude — Maintain until warning ceases.
8. ATC — Notify (if required).

24.10 COCKPIT VOICE RECORDER SYSTEM

24.10.1 General

The Cockpit Voice Recorder (CVR) system provides six channels for storage of audio information in solid-state memory. Four channels are used to provide a high quality recording of each of four audio sources. This recording is capable of storing only the last 30 minutes of information. Two channels are used to provide a standard quality recording of the last 120 minutes of information. One of these channels records information from the area microphone, and the other channel records a combination of the information provided by the audio of the pilot, the audio of the copilot, and the public address system. The impact switch will turn the recorder off if the system experiences a 4g or greater acceleration or deceleration in either the longitudinal axis or the lateral axis.

24.10.2 System Description

The Cockpit Voice Recorder system consists of the CVR and an impact switch, both located in the aft fuselage avionics bay, a control unit located on the pedestal, an area microphone located on the top of the instrument panel glareshield just to the right of the warning annunciator panel, and an audio mixer amplifier located on the Right-Hand (RH) sidewall behind the instrument panel. The circuit receives 28 Vdc power from the main battery bus and is protected by a 2 ampere circuit breaker placarded CVR located on the copilot circuit breaker panel. The system simultaneously records audio information from four sources: the cockpit area microphone, the pilot audio amplifier, the copilot audio amplifier, and the public address audio.

24.10.2.1 Control Unit

The control unit (Figure 24-18) contains a TEST button, a green test light, an ERASE button, and a headphone jack. The TEST button is used to activate the CVR self-test feature and should be held for a minimum of 5 seconds. The green test light will illuminate when the headphones are plugged into the control unit; two tones will be heard immediately before the green light illuminates. The headphone jack provides a means of preflighting the area microphone. Sounds picked up by the area microphone will be played back in the headphones with no delay. The ERASE button is used to erase the entire recording and will only work when the weight of the airplane is on the landing gear. The ERASE button should be held for a minimum of 2 seconds. If the erase function is conducted with headphones plugged into the control unit, a loud tone, which begins when the ERASE button is released and lasts for 5 to 10 seconds, confirms that the erase feature is functioning properly.

Note

High-impedance headsets are the only approved type headset for use by the flightcrew.

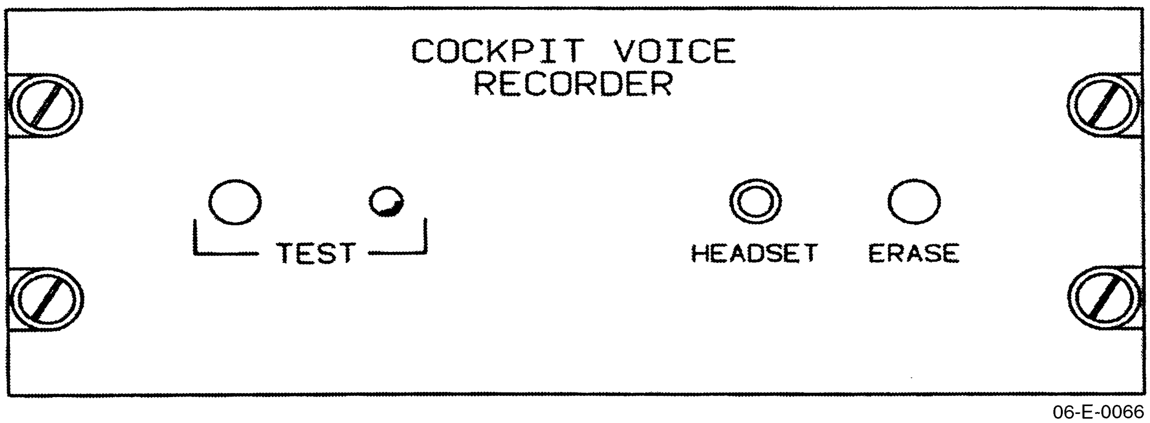


Figure 24-18. Cockpit Voice Recorder

24.10.3 Normal Operation

24.10.3.1 Before Starting Engines

1. Battery — On.
2. CVR test button — Press and hold (5 seconds minimum).
3. Green test light — Illuminated.
4. ERASE button — Press and hold for 2 seconds minimum (if desired).

Prior to first flight of the day:

5. Headset — Plug headphones into CVR control unit.
6. Speak into area microphone. Voice will play back in headphones with no delay.

Note

The CVR self-test must be accomplished prior to flight.

24.10.3.2 Audio System Failure

1. Appropriate AUDIO EMER/NORM switch to EMER.

2. Appropriate AUDIO SPKR/PHONE switch to PHONE.

24.11 FLIGHT DATA RECORDER

24.11.1 System Description

The solid-state Flight Data Recorder (FDR) is located in the aft fuselage avionics bay and converts and records analog data into protected solid-state memory. The recorder will continuously record and retain the last 25 hours of flight data. Elapsed Time, Heading, Pilot Microphone key, Copilot Microphone key, A/P Engage, Vertical Acceleration, Longitudinal Acceleration, Left and Right Engine Torque, Pitch Control Position, Control Wheel Position, Left and Right Engine Prop Reverse, Left and Right Prop rpm, Flap Position (Down, Approach, Up), Pitch and Roll Attitude, Altitude, and Airspeed parameters are recorded.

24.11.1.1 Fault Annunciator

A FDR FAULT annunciator is located in the caution and advisory annunciator panel (Figure 2-34). The annunciator should extinguish approximately 5 seconds after dc and ac power have been applied to the system. Reillumination of the fault annunciator indicates a possible problem in the recorder or incorrect input data to the recorder. There are no controls associated with the recorder and its operation is completely automatic.

24.11.2 Normal Operation

24.11.2.1 Before Taxi

1. Flight data recorder FDR FAULT annunciator — Extinguished.

24.12 ALTITUDE ALERTER

The altitude alerter indicator is mounted at the center of the instrument radio panel. Its purpose is to monitor and display a manually preset altitude and alert the pilot by aural and visual signals when the climbing or descending aircraft approaches or deviates from the preset altitude. The unit receives current altitude input from the pilot encoding altimeter and controls a tone generator and the ALT annunciator light to initiate aural and visual alerting signals. The tone generator initiates an audible sound (similar to stall warning) from beneath the subpanel. The preselected altitude is displayed on the unit. During climbout and/or descent from a higher altitude, when the aircraft reaches 1,000 ±50 feet from the selected altitude, the tone operates for 2 seconds and the ALT light on the indicator illuminates. When the aircraft closes to within 300 ±50 feet of the selected altitude, the ALT light extinguishes and both alert signals will remain off until this deviation distance (up or down) is again exceeded, causing the tone to resound for 2 seconds and the ALT light to reilluminate. If there is loss of dc power or alarm signal, an orange OFF (failure) flag will appear in the left window of the indicator. The altitude alerter is powered by the No. 1 dual-fed bus and is protected by a circuit breaker placarded ALT ALERT in the FLIGHT group on the right side circuit breaker panel.

1. ALT annunciator light — Initially illuminates when climbing or descending aircraft approaches within 1,000 ±50 feet of manually preset, displayed altitude. After preset altitude is reached, reilluminates only when the aircraft deviates 300 ±50 feet up or down from the preset altitude.

2. OFF flag — Appears in left window of indicator if dc power or alarm signal is lost.

3. SET ALTITUDE display — Provides digital display of manually selected altitude in 100-foot increments. Last two digits (00) are fixed.

4. Altitude set knob — Manual control used to select the altitude displayed.

5. Tone horn (not shown) — Produces sound (similar to stall warning) for 2 seconds to alert pilot of same altitude deviation conditions described above for ALT annunciator light.

24.13 AUTOMATIC FLIGHT CONTROL SYSTEM

24.13.1 Description

The automatic flight control system consists of a full three-axis autopilot and flight director. The system provides either full autopilot control of the aircraft with simultaneous flight director monitoring or manual control in response to flight director display steering commands. The yaw axis may be engaged independently of roll and pitch for use as a yaw damper.

When engaged and coupled to the flight director, the autopilot will control the aircraft using the commands generated by the flight director computer/controller.

When the autopilot is engaged but uncoupled from the flight director, manual pitch and roll commands may be inserted using the TCS or the pitch wheel and turn knob.

When the autopilot is coupled to the flight director, the instruments act as a means to monitor the performance of the autopilot. When the autopilot is not coupled to the flight director, the same modes of operation are available for flight director only. The pilot maneuvers the aircraft to satisfy the flight director commands as the autopilot does when it is engaged. Circuits of the automatic flight control system are protected by a 1 ampere FLT DIR circuit breaker and a 7 1/2 ampere AP POWER circuit breaker on the copilot right sidewall panel. System controls and annunciators are illustrated in Figures 24-19 and 24-20.

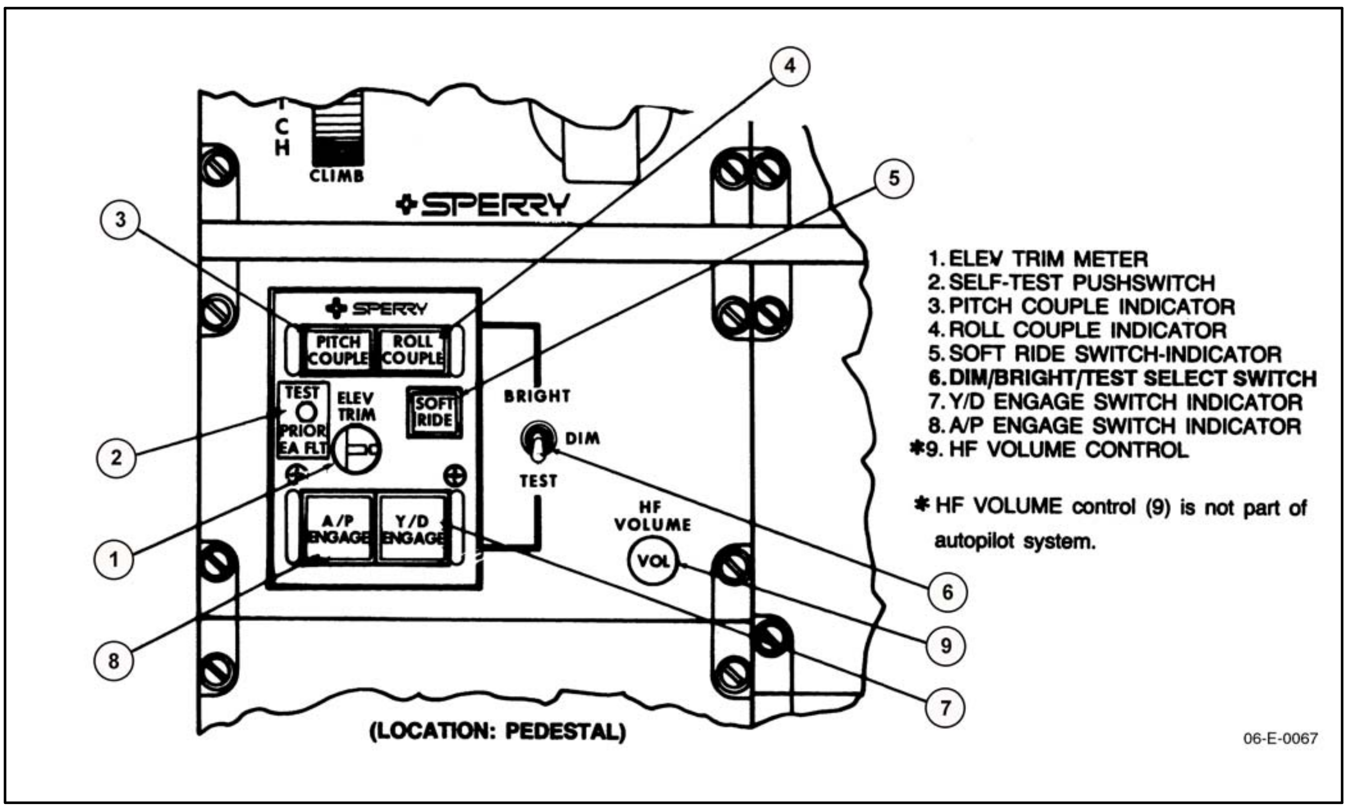


Figure 24-19. Autopilot Engage Controller

24.13.2 Autopilot Engage Controller

1. ELEV TRIM meter — Indicator deflects when sustained signal is applied to the elevator servo, whether or not servo is engaged. Before engaging autopilot, indicator should be close to center.
2. TEST pushbutton — Provides test for the torque limit monitors. After engaging autopilot, pressing the TEST button will disengage the autopilot by simulating torque limit monitor failure.
3. PITCH COUPLE annunciator — Illumination means autopilot is coupled to flight director in pitch axis.
4. ROLL COUPLE annunciator — Illumination means autopilot is coupled to flight director in roll axis.
5. SOFT RIDE switch annunciator — When pushed, this switch reduces autopilot gains while still maintaining stability in rough air. When in the SOFT RIDE mode, the autopilot may be coupled to the flight director computer/controller.
6. BRIGHT, DIM, TEST switch — This switch tests and controls illumination level of annunciator switches.
7. Y/D ENGAGE switch/annunciator — When the autopilot is not engaged, pressing this switch will engage the yaw damper.
8. A/P ENGAGE switch/annunciator — Used to engage the autopilot if aircraft is in a suitable attitude. Engaging the autopilot also engages the yaw damper.
9. HF VOLUME control — Adjusts volume of received HF signal. (Part of HF communication system, not autopilot.)

24.13.3 Autopilot Manual Controller

This unit (Figure 24-20) provides a pitch wheel and turn knob to allow manual insertion of pitch and roll commands into the autopilot computer.

1. PITCH wheel — Rotation of the PITCH wheel results in a change of pitch attitude proportional to the rotation of the wheel and in the direction of wheel movement. If IAS or GS is on the flight director computer controller, rotation of the PITCH wheel resets to SBY. If ALT is on the flight director computer controller, rotation of the pitch wheel disengages ALT.
2. TURN knob — Knob rotation results in a roll command. The roll angle is proportional to and in the direction of the TURN knob rotation. If HDG, V/L, or REV is on the flight director computer controller, rotation of the TURN knob resets the flight director to SBY. The HDG, V/L, or REV mode cannot be selected until the TURN knob is in detent.

24.13.4 Flight Director Computer/Controller

This unit (Figure 24-21) has illumination pushbutton switches to select and annunciate all guidance modes of the autopilot and flight director. When a select button is pushed, its illumination means the flight director is engaged in that mode.

1. REV switch/annunciator — When pressed, engages mode for back course localizer approach. Operation is same as for LOC, except that localizer signals are reversed in the computer for back course inbound or front course outbound localizer tracking. Glideslope is locked out when REV is selected.
2. V/L (VOR, TACAN, or LOC) switch/annunciator — When pressed, the autopilot remains in HDG until system intercepts and captures the signal generated by the selected NAVAID. If HDG had not previously been selected, V/L will automatically engage the heading mode. Upon capture, the HDG light will go out but the V/L annunciator will remain illuminated. Tracking is accomplished by the navigation radio beam with crosswind washout. In VOR or TACAN mode, the overstation sensor aids station passage. A new course can be selected while in OSS.

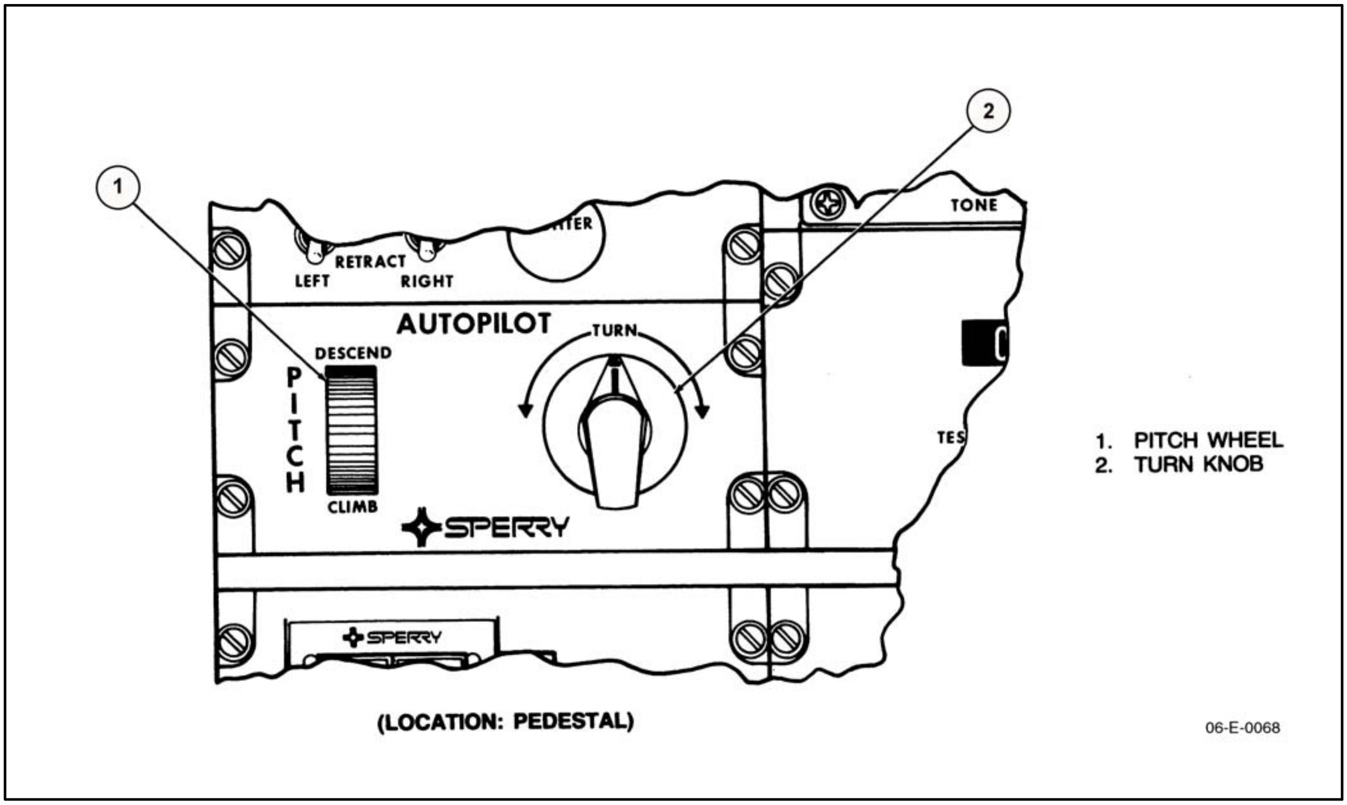


Figure 24-20. Autopilot Manual Controller

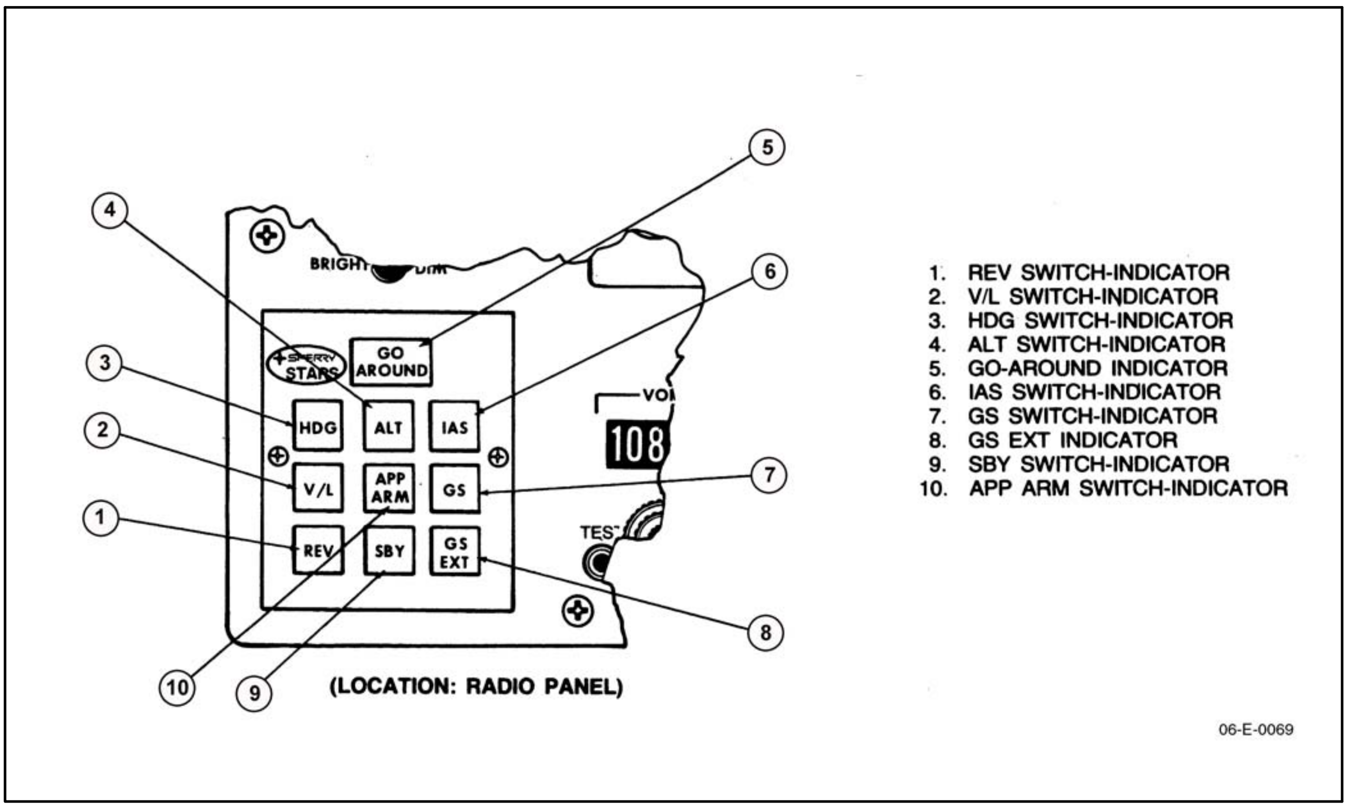


Figure 24-21. Flight Director Computer/Controller

a. TACAN mode — Operation of the V/L button relative to TACAN is the same as for VOR, except TACAN is selected on the pilot HSI switches.

b. FMS mode — Selection of V/L when FMS is selected on pilot HSI switches will result in the following:

(1) HDG and V/L switches will both illuminate (same as NAV ARM mode); however, the system will not be in the HDG select mode. (The HDG bug on pilot HSI is disconnected from circuit.)

(2) The system will follow steering signals from FMS. Intercept of approximately 45° and tracking will be computed by the FMS.

3. HDG switch/annunciator — When pressed, the autopilot banks aircraft to turn to heading set on heading bug of HSI.

4. ALT switch/annunciator — When pressed, autopilot maintains existing altitude. If altitude hold is being flown on flight director and the autopilot is coupled to ALT mode, the altitude reference is resynchronized to the altitude present when coupled, providing transient free engagement. Altitude reference may be resynchronized by using the TCS button.

5. GO AROUND annunciator — Functions only as annunciator. Illuminates when GO AROUND mode is activated by GO AROUND button on the left power lever.

6. IAS switch/annunciator — When pressed, holds aircraft at constant indicated airspeed by varying pitch attitude. Pitch commands are used by the autopilot for IAS hold and are also displayed on the flight director pitch command bar.

7. GS switch/annunciator — When pressed, selects glideslope mode bypassing the vertical beam sensor to provide manual capture of the glideslope.

8. GS EXT annunciator — Annunciator only. Light is activated by radio altitude of 250 feet or middle marker passage. Provides reduced gains for flight smoothness when approaching the glideslope transmitter.

9. SBY switch/annunciator — As aircraft power is turned on, SBY mode is automatically engaged. Pressing the SBY button will illuminate all annunciators on this control to check the bulbs and circuitry and will also disengage any previously engaged modes and return the system to standby mode. The standby mode readies the system for engagement in any other modes. The SBY mode will be obtained anytime a system is reselected on the pilot HSI switches.

10. APP ARM switch/annunciator — In approach mode, the APP ARM button is pressed when ILS approach is desired. Once selected, the roll axis is engaged in the V/L mode and the glideslope is armed. Localizer operation is the same as described for the V/L mode. If a vertical mode has been selected, it automatically drops off with glideslope capture and annunciation changes from APP ARM to GS.

24.13.5 Control Wheel

1. TCS push switch — When held depressed, the aileron and elevator clutches of flight control servos are released. This allows the pilot to assume manual control of the aircraft attitude by normal control wheel movements.

When the TCS button is released, aircraft control will return to the mode previously established (autopilot or manual), and the clutches of flight control servos will reengage to hold the settings established by TCS actions.

2. DISC push switch — This is a bilevel, momentary push-type switch button located on the outboard grip of each control wheel.

a. AP/YD position (first level) — When depressed to this position (first level), the autopilot and yaw damp system are disconnected.

b. TRIM position (second level) — When depressed to this position (second level), the electric trim system is disconnected. The autopilot and yaw damp system are disconnected passing the first level.

24.13.6 Left Power Lever

1. GO AROUND push switch — When pressed, disconnects autopilot. Flight director indicator commands wings-level, 7° noseup attitude.

24.13.7 Touch Control Steering

A switch on the control wheel allows the pilot to manually control the aircraft attitude through normal control wheel movements. When the autopilot is not coupled, TCS provides attitude control, usually accomplished with the turn knob or pitch wheel, without need for the pilot to remove his/her hands from the wheel.

The TCS feature allows the pilot to modify the commanded flight path from the flight director. For example, when coupled to the airspeed hold mode, TCS can be activated and the airspeed manually changed through pitch attitude or power change. Upon release of the switch, the new airspeed is held. If the autopilot was coupled to a flight director roll mode during the airspeed change, the autopilot remains coupled to the roll mode when the switch is released. When the TCS switch is depressed with the flight director in SBY, the roll and pitch attitude of the aircraft can be changed. When the switch is released, pitch attitude is held. If the aircraft is at a roll attitude above 6° when the switch is released, the roll attitude is maintained. If less than 6°, the autopilot is in heading hold. If a large pitch attitude change is made, the pilot should perform the normal trim of the aircraft before release of the TCS button.

If the manual controller turn knob is out of detent, TCS is locked out. Once in roll hold, rotating the turn knob out of detent has no effect. When roll is reduced to less than 6° and the turn knob is out of detent, the autopilot follows the turn knob command.

24.14 AUTOPILOT OPERATION

24.14.1 Engage

The autopilot is engaged by pressing the A/P ENGAGE button on the autopilot engage controller. When the autopilot is engaged, the yaw damper is also automatically engaged as indicated by the lighted Y/D ENGAGE button. The autopilot can be engaged in any reasonable attitude. When engaged, pitch attitude is held and roll attitude is reduced to less than 6°; the roll axis then engages to the existing heading.

24.14.2 Disengage

The autopilot may be disengaged by the following:

1. Actuation of the pilot vertical gyro FAST ERECT button.

2. Actuation of the pilot compass INCREASE — DECREASE switch.

3. Pressing autopilot TEST button on engage controller.

4. Pressing GO AROUND switch on left power lever.

5. Pressing AP DISC switch on control wheel.

6. Operation of the electric trim without TCS depressed by either pilot.

7. Switching inverter OFF.
8. Switching AVIONICS MASTER OFF.
9. Autopilot circuit breaker pulled.

The following functions will cause the autopilot to automatically disengage:

1. Vertical gyro failure.
2. Directional gyro failure.
3. Autopilot power or circuit failure.
4. Torque limiter failure.

24.14.2.1 Autopilot Operating Limits

1. Yaw damper — Roll angle up to 45° left or right bank.
2. Autopilot engage.
   a. Roll angle up to 45° left or right bank.
   b. Pitch angle up to +20°.
3. TCS.
   a. Roll angle up to 40° left or right bank.
   b. Pitch angle up to +20°.
4. Turn knob bank limit — Roll angle up to 32° left or right bank.
5. Pitch knob pitch limit — Pitch angles up to +20°.
6. Bank limit.
   a. HDG mode — 27° left or right bank.
   b. VOR mode — 22° left or right bank.
   c. LOC mode — 27° left or right bank, programming down to 13° left or right bank at ON COURSE.
7. Pitch limits.
   a. GS mode — 20° up, 12° down (maximum).
   b. All other modes — ±20°.
8. LOC capture — Less than 93 percent of full-scale needle deflection.
9. VOR capture — Less than 45 percent of full-scale needle deflection.
10. Glideslope capture.
    a. Above glideslope beam — Any value.
    b. Below glideslope beam — 15 percent of full-scale needle deflection.
11. VOR crosswind capability — Up to 45° of crab angle.

24.14.3 Flight Director Coupling

The autopilot has two basic modes of operation: coupled to or uncoupled from the flight director. When coupled, the autopilot accepts flight path commands from the flight director and from TCS inputs. When engaged and uncoupled as indicated by the absence of PITCH COUPLE and ROLL COUPLE annunciator lights, the autopilot accepts pitch and roll commands from the manual controller or from the TCS input.

Both axes of the autopilot may be uncoupled by selecting the standby mode. If a failure occurs in the guidance computation as indicated by the presence of the Flight Director (FD) flag in the FDI, both the pitch and roll axis will uncouple and the autopilot will revert to flying pitch hold and heading hold. The autopilot will remain in the hold modes until a valid flight director mode is selected by the pilot.

24.14.3.1 Coupled Modes

The flight director provides the computation and mode selection for both the lateral and vertical modes of the autopilot. Two annunciators, ROLL COUPLE and PITCH COUPLE, are located on the autopilot controller. The lateral modes that may be coupled are heading select, VOR, LOC, TACAN, FMS, and reverse course. The vertical modes that may be coupled are altitude hold, airspeed hold, glideslope, and pitch hold.

When the autopilot is engaged and a coupleable mode has been selected on the flight director, the autopilot automatically couples to the mode(s). If the autopilot is engaged when the flight director is not in a lateral mode, subsequent selection of HDG, V/L, or REV couples the autopilot to the mode selected, and the ROLL COUPLE annunciators and PITCH COUPLE annunciators are illuminated.

The roll axis can be uncoupled by any of the following actions:

1. Rotating the manual controller turn knob out of detent.
2. Selecting SBY on the flight director.
3. Changing HSI selector.

The roll axis can be recoupled by the following action:

1. Selecting a lateral mode when in SBY.

The pitch axis can be coupled after the autopilot is engaged by selecting ALT, IAS, GS, or any lateral mode. When coupled, the PITCH COUPLE annunciator is illuminated. When the autopilot is coupled to the altitude hold or airspeed hold modes, the respective air data reference is instantly synchronized to the value present at the time of coupling. This ensures a transient-free entrance into the mode.

The pitch axis can be uncoupled by any of the following actions:

1. Rotating the pitch wheel while in the IAS or GS mode.
2. Selecting SBY on the flight director computer control.
3. Changing the HSI selector.

The pitch axis may be recoupled by the following action:

1. Selecting a vertical or lateral mode when in SBY.

24.14.4 Operation

For all flight phase descriptions in this manual, the aircraft is maneuvered automatically by the flight control system. If the autopilot is disengaged, the aircraft may be manually flown to satisfy the flight director commands. The same modes of operation and indicator settings are used.

24.14.4.1 Takeoff and Climbout

Takeoff is normally made by manually following the flight director commands, with the autopilot being engaged after positive ground separation.

Prior to takeoff, set the heading bug on the HSI to the runway heading. Set the course pointer to the radial of the first desired VOR course. Line up on the runway centerline, depress the GO AROUND switch on the left power lever, select HDG mode on the flight director, and adjust the heading bug to center the vertical command bar. The vertical command bar now provides runway heading guidance and the horizontal bar commands the preset go-around pitch attitude. Apply power and keep the roll bar centered for runway guidance during takeoff roll. After breaking ground, rotate the pitch bar to center and fly left or right to center the vertical command bar. When stable flight conditions are achieved, select IAS hold and engage the autopilot.

After reaching a safe altitude, use TCS to change the desired airspeed through the optimum noise abatement climb profile. Releasing the TCS button puts the autopilot back in IAS hold and on the climbout heading. Further heading changes may then be made as directed by departure control by moving the heading bug to a new heading. As cruise altitude is reached, use TCS to level out on assigned altitude and press ALT to maintain this altitude.

24.14.4.2 VOR/TACAN/FMS Capture and Tracking

24.14.4.2.1 VOR

The VOR mode of operation provides automatic capture and tracking of the radial. This is usually accomplished with the autopilot coupled to the flight director and the HDG mode selected on the flight director control. Any vertical mode can be selected and coupled without affecting VOR operation. To capture and track VOR, proceed as follows:

1. Tune the navigation receiver to the desired VOR station; set the course pointer on the HSI to the desired course.

2. Select V/L mode on the flight director. HDG, V/L, and ROLL COUPLE are lighted, indicating that the system is flying the intercept heading selected with the heading bug on the HSI and is armed for VOR capture.

3. At VOR capture, the HDG light will go out, indicating that VOR capture has occurred. The aircraft will smoothly roll out and track the radial with crosswind correction.

4. If the VOR flag comes into view while tracking the VOR radial, the autopilot will remain coupled but the vertical command bar will bias out of view.

The autopilot includes a VOR overstation sensor that inhibits response to the signal when in the cone of confusion above the station. The autopilot automatically provides stable station passage.

24.14.4.2.2 TACAN

To capture and track, select TACAN on the pilot HSI switches, then operate V/L button (flight director computer/controller) as detailed for VOR.

24.14.4.2.3 FMS

To capture and track, select FMS on the pilot HSI switches, select V/L on the flight director, then confirm proper operation as follows:

1. HDG and V/L buttons will both illuminate (same as NAV ARM mode); however, the system will not be in the HDG select mode. (The HDG bug on pilot HSI is disconnected from circuit.)

2. The system will follow steering signals from FMS, with the flight director in the FMS mode. Intercept and tracking will be computed by the FMS.

24.14.4.3 ILS Front-Course Approach

On an ILS front-course approach, the localizer and glideslope are automatically captured. The localizer is captured from heading select in the same manner that the VOR radial is captured. The glideslope can be captured with any vertical mode previously selected and from either above or below the beam. Localizer capture is required before initiation of automatic glideslope capture. For best results, bracket should be made beyond 6 miles from runway threshold. To make an ILS front-course approach, perform the following:

Note

Deselect soft ride for ILS coupled approaches to increase gain on autopilot servos.

1. Tune the navigation receiver to the localizer frequency and set the course pointer to the published inbound course. The expanded localizer pointer at the bottom of the FDI will appear when the localizer deviation is a third of a dot or less.

2. Set the heading bug to the desired intercept heading.

3. Select APP ARM mode that arms both the localizer, glideslope capture, and heading select circuits. As the aircraft nears the localizer beam, the HDG light will go out, indicating localizer capture. The aircraft will smoothly roll out on the localizer. After localizer capture, select the published missed-approach heading using the heading bug on the HSI.

4. When the glideslope is captured, the APP ARM light goes out and the GS annunciator lights. Any previously selected vertical mode will automatically release. The autopilot will track the center of the localizer and glideslope beams with wind corrections. At 250-foot radio altimeter altitude or middle marker, the GS EXT annunciator will light, indicating that the glideslope gains are being reduced to enable smooth tracking of the glideslope beam. When reaching decision height, the decision to land or go around must be made. To assume control of the aircraft for flare and touchdown, press the autopilot disengage button on the control wheel and land.

5. The rising radio altitude bar becomes visible at 200 feet and remains visible for the remainder of the descent to the runway.

6. If either a localizer or glideslope flag comes in view while making an ILS approach, the respective axis will remain coupled on the autopilot and the flight director bar will bias from view. If the radio failure persists, the axis should be manually uncoupled.

24.14.4.4 Go-Around

A missed approach may be executed by pressing the GO AROUND button on the left power lever. The autopilot will disengage and the GO AROUND annunciator on the flight director computer control will light. The flight director will command a wings-level, pitch-up attitude of 7°. After the gear and flaps are retracted, reengage the autopilot. The missed approach departure is made using HDG with the climb being performed using pitch hold or IAS hold. The go-around mode can be selected at any time with any mode previously selected, but it will disengage the autopilot.

24.14.4.5 Back-Course Approach

Tune the localizer frequency and set the course pointer on the HSI to the front-course inbound localizer course. Set the desired intercept heading on the heading bug on the HSI. Select REV to arm the system for automatic back-course localizer capture. ALT hold may be selected to maintain approach altitude. For best results, bracket should be made beyond 8 miles from runway threshold. As in a front-course approach, the localizer is captured automatically.

When the aircraft approaches the back localizer, automatic capture will occur. The lateral deviation bar as well as the expanded localizer have the proper sensing and present the proper indication. When REV is selected, the glideslope circuits are locked out.

After localizer tracking has begun, the descent phase of the approach should be initiated. Set up a desired IAS hold and adjust power for the rate of descent. Use TCS and throttles to make any necessary changes in your IAS profile.

The rising altitude bar operates the same as for front-course operation. For missed approaches, go-around operation is as previously described.

24.14.4.6 Letdown to VOR Approach

To fly a typical VOR letdown, track into the station in V/L mode.

After entering the cone of confusion, set course arrow to the published heading. After station passage, the system will track the new outbound course. If the VOR is approached from a heading that requires maneuvering to the outbound leg, select HDG mode and use the heading bug on the HSI to alter the aircraft course, then proceed as follows:

1. Select HDG when the outbound leg is completed. Adjust the heading bug 135° or less in the direction of the 180° turn. Set the course pointer to the inbound radial.

2. Set up a desired rate of descent and select IAS hold. Use TCS or adjust power to make any necessary changes in your descent profile.

3. After completing 45° of the turn, adjust the heading bug until the 180° turn is completed. Continue to use TCS or adjust power and IAS hold to control aircraft rate of descent.

4. While in the inbound turn, select V/L on the flight director. This will automatically capture and track the inbound radial with automatic crosswind washout.

24.14.4.7 Holding

To establish a holding pattern over the outer marker or a VOR intersection, perform the following:

1. Select HDG mode on the flight director (ALT or IAS may also be selected). Tune the navigation receiver to the VOR or localizer frequency. Set the course pointer to the inbound VOR or localizer course. Maintain flight to the holding point by adjusting the HDG bug.

2. When the aircraft reaches the holding point, turn the heading bug 135° in the direction of the outbound turn. After completing 45° of the turn, continue moving the heading bug until the reciprocal heading of the inbound course is reached.

Note

If crosswind correction is needed, it must be set in manually by adjusting the heading bug for the appropriate crab angle.

3. After the required time on the outboard heading, set the heading bug 135° in the direction of the inbound turn.

4. After completing 45° of the turn, continue moving the heading bug to the inbound course with crosswind correction.

5. If automatic capture and tracking of the inbound radial is desired, select V/L mode after the turn to the inbound radial has been initiated. Crosswind corrections are automatically computed in the V/L mode.

24.14.5 Shutdown Procedures

In normal practice, the autopilot is disengaged rather than shut off and will thereby remain ON for as long as the avionics circuits are energized; however, to disconnect autopilot power and shut down the system, pull out the AP POWER circuit breaker in the avionics section of the copilot right sidewall panel.

24.15 VOR/LOC NAVIGATION SYSTEM

24.15.1 Description

Two VOR units, placarded VOR-1 and VOR-2, receive and interpret VOR and LOC signals in the frequency range of 108.00 to 117.95 MHz. The system has 160 VOR channels, 40 localizer channels, and 40 glideslope channels. Two VOR antennas, coupled to serve both systems, are installed on the vertical stabilizer. A glideslope antenna, coupled to serve both systems, is installed within the nosecone. Signal reception is line of sight and is affected by the power of the ground transmitter, having a maximum range of 120 miles.

Either VOR can direct input signals to either flight director indicator.

Each VOR system includes independent receiver units for VOR/LOC and glideslope (GS). Each VOR receiver provides a VOR input to a respective RMI indicator and VOR and localizer data to the flight director.

Each glideslope receiver sends GS flag and pointer deviation information to the flight director. The RMIs display VOR and ADF bearing, relative bearing, and magnetic heading.

VOR/LOC indications may be used for navigation during manual control of the aircraft, or the autopilot may be coupled to the VOR system accepting VOR inputs to the autopilot computer.

1. TEST push switch — When pressed, the following indications are presented:
   a. If VOR has been selected, RMI needles will indicate 005°. Check CDI centerline on 005°.
   b. If a LOC frequency has been selected, there will be a lateral deviation to the right (1.5 dot) and a glideslope deviation down (1.5 dot) on the HSIs.

Note

When a LOC frequency is selected and the TEST push switch is pressed, the following NAVAID receivers are tested: LOC/NAV, GLIDESLOPE, and MARKER BEACONS (visual and aural).

2. ON/OFF VOL knob — Turns unit on or off and adjusts volume.
3. Frequency indicator — Indicates selected frequency.
4. Frequency tuning knobs (two outer dials) — Rotate to select frequency.

24.15.2 Operation

Note

Each of the HSI switches has both a green and a white lens. If the pilot and copilot select the same signal source, the pilot will override the copilot. The switch will illuminate green if the position has control of the source. If the copilot should select the same source as the pilot, the copilot switch will illuminate white to indicate the copilot has no control or display of the signal.

24.16 MARKER BEACON

24.16.1 Description

Two identical marker beacon receivers are installed. They are physically located inside the VOR receivers and receive power through the VOR receivers. The marker beacon provides visual and aural indication of the aircraft position over a 75-MHz marker beacon ground transmitter. Upon entering the range of marker beacon signals, blue, amber, and white annunciator lamps will illuminate in sequence and corresponding aural signals will indicate aircraft passage over the outer (O), middle (M), and inner (I) marker beacons. Range is vertical to 50,000 feet. ON-OFF, volume, and sensitivity of both systems are adjusted by a single set of controls on the radio panel.

1. O annunciator — Illuminates when passing over outer marker.
2. M annunciator — Illuminates when passing over middle marker.
3. I annunciator — Illuminates when passing over inner marker.
4. MKR BCN 1-2 (audio panel) — Receives marker beacon audio.
5. HI-LO switch (marker beacon panel) — Controls sensitivity of marker beacon receivers.
6. ON-OFF-VOL knob — Turns unit on or off and adjusts volume.

24.17 AUTOMATIC DIRECTION FINDER

24.17.1 Description

The ADF system is an airborne radio direction finder that operates in the frequency range of 190 to 1749.5 kHz to provide the aircraft bearing in relation to the ground station. It can also be used for homing and position fixing. Reception distance depends on the power output of the transmitting station and the atmospheric conditions. The ADF system is protected by a 2-ampere ADF circuit breaker on the copilot right sidewall panel.

1. ON-OFF-VOL knob — Turns unit on and off and adjusts volume.
2. Frequency display — Indicates selected frequency.
3. Mode selector — Selects operating mode.
   a. ANT — Operates as aural receiver only. Bearing indication will park in a horizontal position.
   b. ADF — Selects normal operation.
   c. Frequency select knobs — Select frequency in 0.5-kHz steps.
   d. BFO-OFF switch — Activates 1000-Hz oscillator to provide tone for Continuous Wave (CW) reception.
4. TEST pushbutton — Momentary contact switch used to activate functional self-test. If the mode selector is in ADF position, ADF has been selected for display on either of the RMIs and a usable signal is being received. The ADF needle will indicate a counterclockwise deflection of 90°, and a 1000-Hz tone will be audible when pressed.
5. ADF switch (audio panel) — Receives ADF audio.
6. FILTER-V-OFF switch (audio panel) — Selects voice filter.
7. FILTER-R-OFF switch (audio panel) — Selects range filter.

24.17.2 Operation

24.17.2.1 Test

Tune a Non-Directional Beacon (NDB), locator outer marker, or broadcast station. Position the mode or function switch to ADF and note that the ADF indicator points to a bearing suitable for the station received.

24.18 FLIGHT MANAGEMENT SYSTEM (FMS)

24.18.1 Description

The Honeywell GNS-XLS "Enhanced" Flight Management System (GNS-XLS) is a GPS-based navigation system that includes a full color flat panel LCD display, "QWERTY" keyboard, and function keys, a global positioning sensor, fuel management capability, and a navigation database. The GNS-XLS is an integrated system designed to give aircrew a user-friendly navigation interface, very precise long-range navigation accuracy, onboard computer-based flight planning, and in-flight fuel management. All of these are centrally located in the pedestal-mounted GNS-XLS Control Display Unit (CDU). The GNS-XLS "Enhanced" is an evolutionary upgrade to the GNS-XLS that incorporates Search and Rescue patterns and flight planning capability, and communications radio tuning and integrates uplinked Weather Graphics capability and enhanced video capability that will accommodate an enhanced Ground Proximity Warning System. Radio tuning, Weather Graphics, and Ground Proximity Warning System capabilities of the GNS-XLS have not been incorporated into the UC-12B aircraft. For easier reading, the Enhanced GNS-XLS FMS will be referred to as simply GNSXLS.

The navigation database is updated on a 28-day cycle by way of a memory card. This card is inserted in a Personal Computer Memory Card International Association (PCMCIA) slot located beneath the keyboard on the CDU. The worldwide database contains over 50,000 waypoints, NAVAIDs, and airports. It contains all applicable departure procedures (formerly SID), arrival procedures (STAR), and approach procedures. The GNS-XLS is capable of storing 999 user-defined waypoints and individual navigation points can be organized into 56 stored flight plans.

A single GNS-XLS output drives the pilot and copilot HSI, Multi-Function Display (MFD), and the Flight Director/Autopilot. The heading channel of the Sperry SPZ200 Autopilot is used to provide lateral roll steering coupling between the Flight Director/Autopilot and the GNS-XLS. Remote annunciators, which indicate the status of certain FMS functions, are installed on each pilot annunciator cluster panel.

With adequate satellite reception the GNS-XLS is capable of:

1. VFR/IFR en route oceanic and Remote Area Navigation (RNAV) operations.

2. U.S. en route operations.

3. U.S. terminal area operations.

4. U.S. instrument approach operations (GPS, VOR, VOR-DME, NDB, NDB-DME, RNAV) within the U.S. National Airspace System using the WGS-84 coordinate reference datum in accordance with the criteria of AC 20-130A, AC 91-49, and AC 120-33.

Note

FAA approval of the GNS-XLS (based solely on GPS navigation) does not necessarily constitute approval for use in foreign airspace.

The GNS-XLS GPS provides Fault Detection and Exclusion (FDE) capability in accordance with FAA Notice N8110.60 and is qualified for Primary Means Oceanic/Remote Area Navigation when used in conjunction with a GPS FDE prediction program. The GNS-XLS contains a built-in prediction program.

Note

A valid Letter of Authorization (LOA) for operations in Special Use Airspace must be issued when appropriate.

The GNS-XLS GPS is qualified for operation in RNP-10 airspace in the Pacific MNPS in accordance with the criteria of Order 8400.12A.

Note

A valid Letter of Authorization (LOA) for operations in Special Use Airspace must be issued when appropriate.

The GNS-XLS is qualified for BRNAV operations in European airspace (in accordance with the criteria of Advisory Circular AC 90-96) providing navigation performance equivalent to RNP-5 standards or better. (Reference ICAO Document 7030 Regional Supplementary Procedures, JAA Technical Guidance Leaflet AMJ20X2 and Euro control RNAV Standard Doc 003-93 Area Navigation Equipment Operational Requirements and Functional Requirements [RNAV].)

A drawing of the GNS-XLS with the QWERTY keyboard is shown in Figure 24-22.

24.18.2 Controls and Indicators

24.18.2.1 External Annunciators

The pilot and copilot instrument panel FMS annunciators (Figure 2-4) are tested using the PRESS TO TEST switch. Since the annunciators are powered through the MASTER AVIONICS switch, the switch must be on in order to test the annunciator lights. Brightness level is controlled by an ANN-BRIGHT/DIM switch on the instrument panel. Annunciators illuminate to indicate the following conditions:

XTRK (Green) — The XTRK annunciator illuminates when a parallel offset track has been selected by the crew.

MSG (Amber) — This annunciator is identical to the GNS-XLS CDU message annunciator and illuminates simultaneously. The MSG light will flash until a SYSTEM or SENSOR message page is viewed.

WPT (Amber) — The waypoint alert annunciator illuminates steadily when the aircraft is within 30 seconds ETE of the next lateral leg change waypoint. The WPT annunciator will flash for 10 seconds then go to a steady state 60 seconds prior to a vertical leg change waypoint.

HDG (Green) — The HDG annunciator illuminates when the system is in FMS HDG mode.

DR (Amber) — The DR annunciator illuminates when the system is in Dead Reckoning mode.

APPR (Green) — The APR annunciator illuminates when the system is in Approach mode.

24.18.2.2 Control Display Unit — FMS

The FMS uses GPS signals, air data from a dedicated ADC, and heading information from the compass system to calculate and display aircraft navigation data. The following controls and displays are provided on the CDU (Figure 24-22) for operation of the FMS.

ON — Used for system startup/shutdown. Depress and release the ON key to apply power to the system. There is a warmup period of approximately 30 seconds. The display illumination will initially be set at 75 percent of full bright. Depressing the ON key for approximately 3 seconds will initiate the system power off sequence. During the sequence, the display will show SYSTEM TURNING OFF. This is to prevent inadvertent system shutdown.

Note

The system will be powered up when the AVIONICS MASTER switch is turned on.

BRT (Brightness) — Used to change the illumination of the display. This key is also used for parallax adjustment of the Line Select keys.

Note

Back lighting to the CDU is controlled by the OVHD, PED & SUBPANEL rheostat located on the overhead panel.

MSG (Message) — Illuminates to alert the flightcrew that a message needs to be viewed on one of the SYSTEM MESSAGES or SENSOR MESSAGES pages. Depressing the MSG key will display the message page. The newest message will be indicated with a flashing asterisk to the left of the message. If the message requires the flightcrew take some action, the MSG annunciator will remain on steadily until the action is completed. If no action is required, the MSG annunciator will extinguish when the message page is exited.

ALPHA keys — Used to enter the 26 letters of the alphabet and an asterisk.

NUMERIC keys — Used to enter numbers 0 to 9, # and ±.

HOLD key — Used to access the Holding Pattern page or the Position Fix page.

BACK key — Used to erase errors and page backward when the cursor is not displayed. It can also be used to change data in a field if the cursor is present.

SP (Space) key — Not used.

ENTER key — Used to enter data into the computer memory.

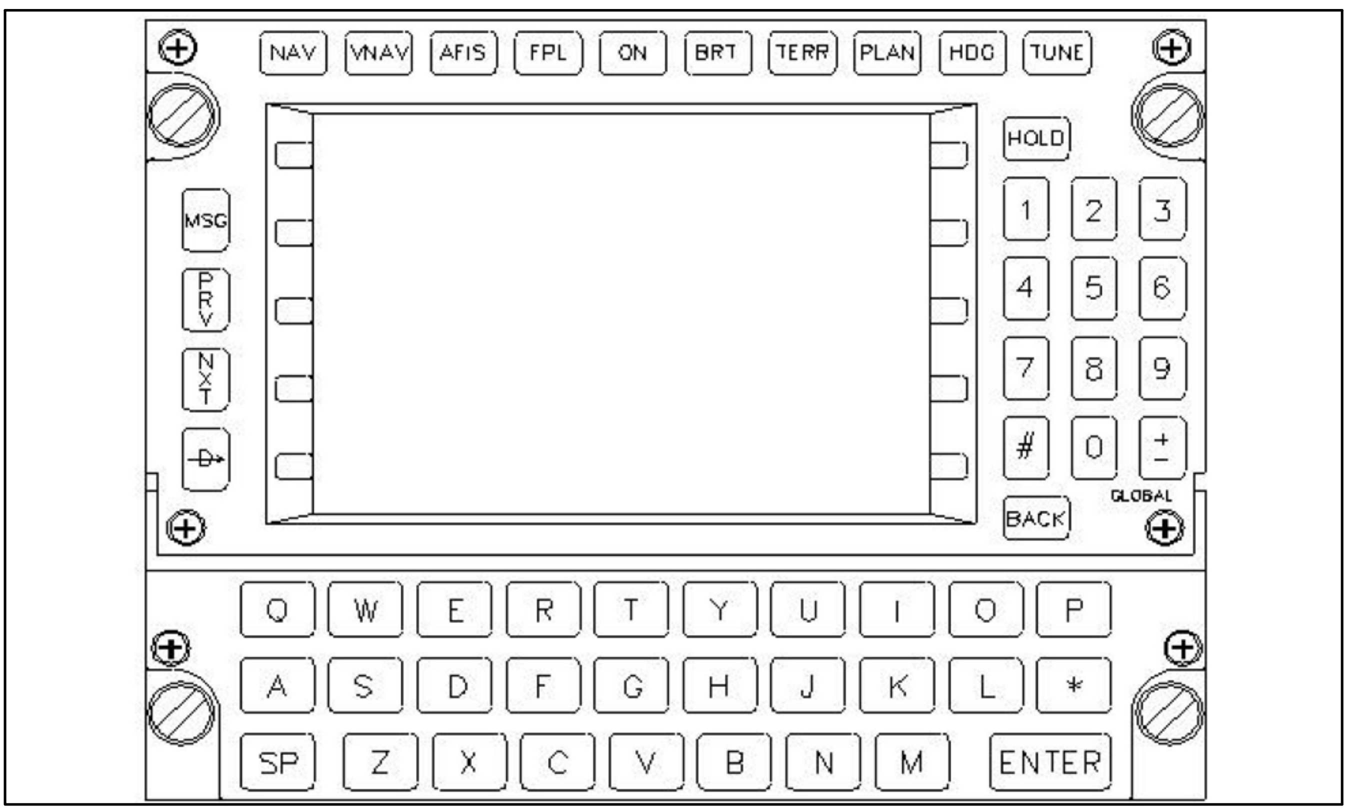


Figure 24-22. GNS-XLS Control Display Unit

NAV (Navigation) key — Used to select the navigation section pages. The first page of the section is displayed first when the NAV key is pressed. With each subsequent press of the NAV key, the next sequential page will be displayed.

VNAV (Vertical Navigation) key — Used to select the vertical navigation section pages. The first page of the section is displayed first when the VNAV key is pressed. With each subsequent press of the VNAV key, the next sequential page will be displayed.

AFIS (Airborne Flight Information System) key — Not used.

FPL (Flight Plan) key — Used to select the flight plan section pages. The first page of the section is displayed first when the FPL key is pressed. With each subsequent press of the FPL key, the next sequential page will be displayed.

TERR (Terrain) key — Not used.

PLAN (Planning) key — Used to select the planning section pages. The first page of the section is displayed first when the PLAN key is pressed. With each subsequent press of the PLAN key, the next sequential page will be displayed.

HDG (Heading) key — Used to select the heading section pages. The first page of the section is displayed first when the HDG key is pressed. With each subsequent press of the HDG key, the next sequential page will be displayed.

TUNE (Radio Tuning) key — Not used.

D▸ (Direct) key — Used to select the direct to section pages. The first page of the section is displayed first when the D▸ key is pressed. With each subsequent press of the D▸ key, the next sequential page will be displayed.

PRV (Previous) key — Used to display the previous page of a section. This key also allows the operator to remain in a section by looping from the first to the last and back to the first page of that section.

NXT (Next) key — Used to display the next page of a section. This key also allows the operator to remain in a section by looping from the first to the last and back to the first page of that section.

Line Select keys — Used to place the cursor in the field next to that key. Each line select key controls two lines of text. White symbols (< or >) displayed on either side of the display indicate active Line Select keys for each individual page.

24.18.3 Limitations

The GNS-XLS FMS is used as a means for en route navigation provided the following limitations are observed:

1. The GNS-XLS Operator's Manual (Honeywell Part No. 006-18233-0000), Rev. 2, dated September 2002 (or later FAA approved revision applicable to the software program shown below) must be available to the flightcrew whenever navigation is predicated upon the use of the GNS-XLS Flight Management System.

2. IFR navigation based on the GNS-XLS is allowed with the following restrictions:

   a. The GNS-XLS FMS must utilize the current software version (SM04 or later approved revision).

   b. IFR navigation with the GNS-XLS is prohibited unless the database is current.

   c. The aircraft must have other approved navigation equipment appropriate to the route of flight installed and operational except where approval has been granted for GPS as the primary means of navigation for operations in oceanic and remote areas.

   d. When operating outside the magnetic variation model area (north of 70 degrees north latitude or south of 60 degrees south latitude), the pilot must manually insert magnetic variation.

e. FMS Approach Procedure Limitations:

(1) The GNS-XLS is approved for published nonprecision approach operations only, provided RAIM is available. Use of the GNS-XLS as the primary means of navigation during Localizer and MLS-based approaches is prohibited.

(2) Use of the GNS-XLS for IFR nonprecision approaches is limited to published approach procedures (contained within the current database) within the U.S. National Airspace System and varies by letter of agreement for operations in airspace controlled by other nations.

(3) Use of the GNS-XLS as the primary means of navigation for approaches in airspace belonging to other nations is not approved unless authorized by the appropriate authority.

(4) Missed Approach procedures should initially be flown manually or coupled using the Flight Director Heading Mode, until waypoint to waypoint FMS navigation can be established and verified, to ensure that all portions of the Missed Approach procedure are flown correctly.

(5) If an Approach procedure has been entered and a new Approach procedure is desired, the original Approach procedure should be erased before selecting a new Approach procedure to ensure proper waypoint sequencing on the Active Flight Plan.

(6) When FMS is the selected navigation source, use of the APR Flight Director mode is inappropriate. Coupled flight using the APR mode (when FMS is the selected navigation source) is prohibited.

f. The FDE prediction function required for Primary Navigation in oceanic operations or RNAV operations using the built-in prediction program can only be performed on the ground. GPS NOTAMS must be checked prior to performing the FDE prediction. It is recommended that the final FDE prediction be performed 2 to 6 hours prior to departure. FDE and navigation capability must be predicted to be available for the appropriate duration of the flight.

g. For BRNAV operations in the European region:

(1) With 23 (24 if the altitude input to the GNS-XLS is not available) or more satellites projected to be operational for the flight, the aircraft can depart without further action.

(2) With 22 (23 if the altitude input to the GNS-XLS is not available) or fewer satellites projected to be operational for the flight, the availability of GPS integrity (RAIM) should be confirmed for the intended flight (route and time). This should be obtained from a prediction program run outside of the aircraft. The prediction program must comply with the criteria of Appendix 1 of AC90-96. In the event of a predicted continuous loss of RAIM of more than 5 minutes for any part of the intended flight, the flight should be delayed, canceled, or rerouted on a track where RAIM requirements can be met.

h. The GNS-XLS fuel and range data (predicated upon manual pilot data input only — no fuel flow interface included in this installation) are advisory only and do not replace primary aircraft fuel quantity or fuel flow instruments for range and endurance calculations.

i. During a period of dead reckoning, or when the GNS-XLS information is not available, or invalid, navigation shall not be predicated on the GNS-XLS as a means of operation in the National Airspace System. Utilize remaining operational avionics.

j. Use of the Flight Director and Autopilot without a selected NAV source is not authorized (e.g., the Flight Director and Autopilot should not be engaged unless one of the pilot HSI Navigation Source Selector switches is illuminated green). When there is no navigation source driving the deviation bar, the Flight Director and Autopilot will not be receiving drift correction inputs. The net effect will be similar to a coupled HDG mode.

24.18.4 Normal Procedures

24.18.4.1 System Power-Up/Preflight

1. Turn system on by selecting the AVIONICS MASTER switch — ON, or by pressing the ON button on the CDU (top row center).

Note

For the first 30 seconds after the system is turned on, the computer performs extensive internal tests that must be successfully completed before proceeding further. If the system detects a problem, the SELF TEST display may be replaced by a NO DATA RECEIVED message.

24.18.4.2 Verify Database and Software

1. After the self-test is successfully completed, the Initialization Page automatically displays with DATE, GMT (Greenwich Mean Time), IDENT (airport identifier), and POS (position).

   DATE is the current Greenwich date and is displayed as day, month, and year.

   GMT is the time of day displayed in Greenwich Mean Time hours and minutes.

   IDENT displays the airport identifier for the airport closest to the system shutdown position. Dashes will be displayed when the cursor is placed over the POS field.

   POS displays the last system position at shutdown.

   Dashes are displayed when the cursor is over the IDENT field. Note that the program version number on the bottom line reads as follows: 17960-0204 (SM04 or later approved revision).

24.18.4.3 Loading a Saved Flight Plan

1. Select FPL key and FLIGHT PLAN LIST 1/1 page will be displayed.

Note

The FLIGHT PLAN LIST page may automatically be displayed if the ENTER key is depressed at least three times while on the Initialization page.

   a. If the initialization airport matches a departure airport on the FLIGHT PLAN LIST, the cursor will automatically be positioned over the first matching Flight Plan. Refer to Figure 24-23.

   b. There are seven pages possible with a maximum of 56 flight plans stored in nonvolatile memory. Each stored flights plan's origin and destination points are listed in alphabetical order. Refer to Figure 24-23.

   c. A new FLIGHT PLAN LIST page is created when the previous page has eight flight plan origin-destination pairs on it. Using the PRV or NXT key pages through the Flight Plan List subsection. Refer to Figure 24-23.

2. Line Select key — Depress to position the cursor over desired Flight Plan Number.

3. ENTER key — Depress.

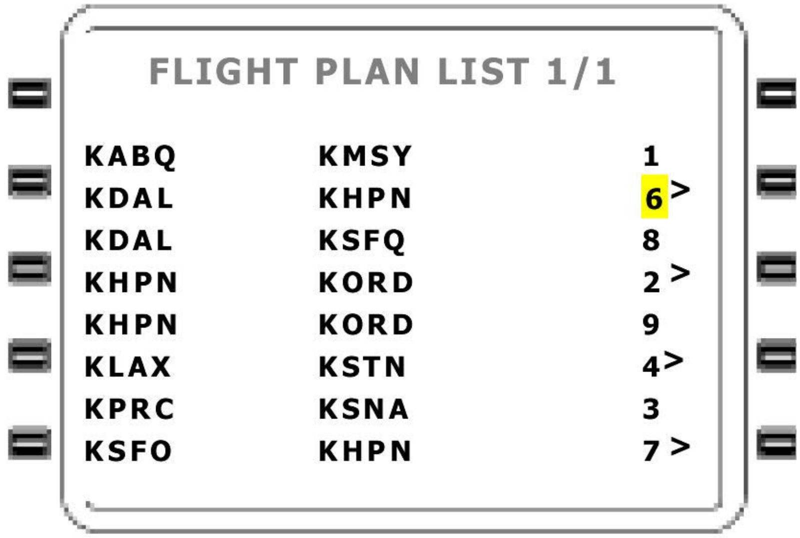


Figure 24-23. Flight Plan List

4. FLIGHT PLAN page — Verify Flight Plan. Review routing by depressing PRV or NXT key to page through multiple Flight Plan pages.
5. Line Select key — Depress to position cursor over SELECT? Refer to Figure 24-24:
   a. To transfer the Stored Flight Plan to Active Flight Plan status, continue with step 6.
   b. To INVERT and transfer the Stored Flight Plan with waypoint sequence reversed to Active Flight Plan status, press the BACK key to display INVERT?.
6. ENTER key — Depress.
7. ACTIVE FPL — Confirm. Observe that the Stored Flight Plan transferred to the ACTIVE FPL page as SELECTED or INVERTED.

24.18.4.4 Creating a Flight Plan

1. FPL key — Depress to display (Stored) FLIGHT PLAN LIST page (if required).
2. Line Select key — Depress to position cursor on blank line to display the NEXT FPL number. Refer to Figure 24-25. If several flight plans are displayed, position cursor anywhere on the page then depress BACK key to show NEXT FPL number available.

Note

If all 56 flight plans are used, NO FPL AVAIL will appear in the field. Any of the stored flight plans may be erased to allow additional entries. To delete a stored flight plan, position the cursor over the flight plan number, depress the BACK key. DELETE? appears in the flight plan field. Depress the ENTER key and the flight plan is deleted.

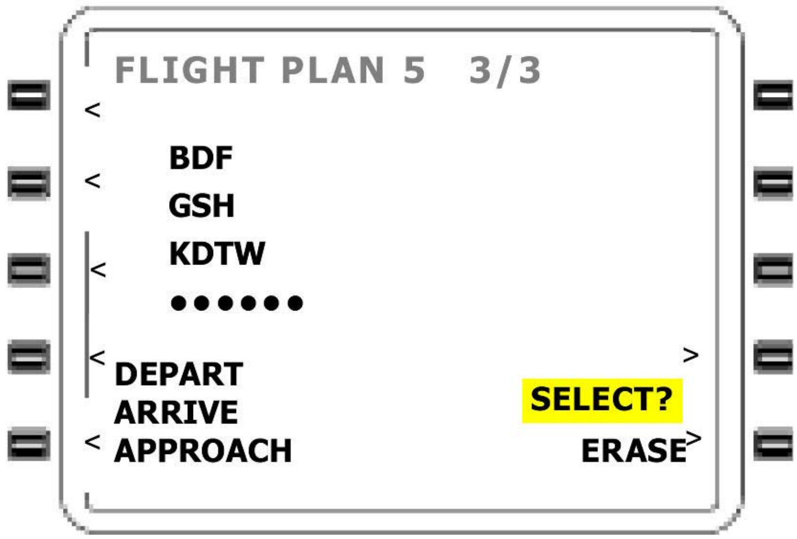


Figure 24-24. Flight Plan Page

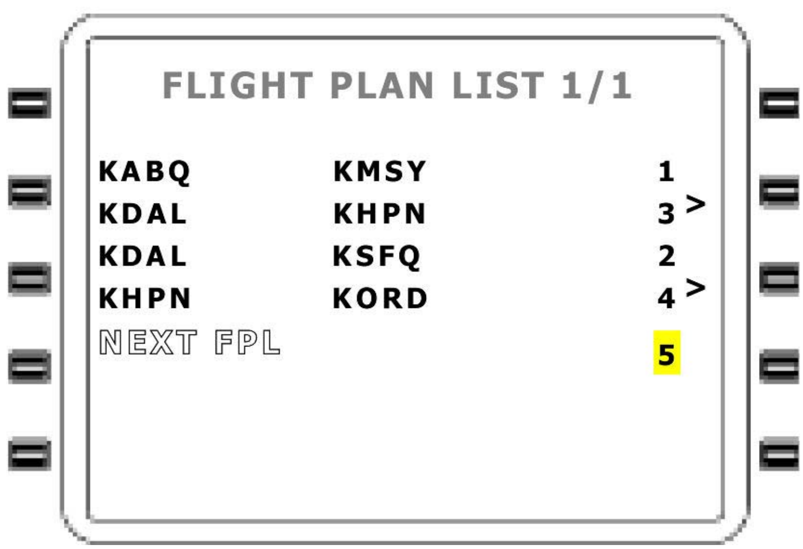


Figure 24-25. Displaying Next FPL

3. ENTER key — Depress to display FLIGHT PLAN page.

4. Type the appropriate departure airport or waypoint identifier in the cursor field.

Note

Identifiers may contain from one to six characters in any combination of letters and numbers. If an entry error is made, press the BACK key to erase a character, then enter the correction.

5. ENTER key — Depress.

6. Waypoint Coordinates and Data — Verify. If a specific runway is desired, depress the appropriate Line Select key to place the cursor over the desired runway.

7. ENTER key — Depress to add waypoint to the FPL.

8. Repeat steps 4 through 7 for the remaining waypoints. The destination airport identifier should be the last waypoint on the flight plan.

9. Procedures for entering airways in a flight plan:

   a. Line Select key — Depress to position cursor directly below the starting waypoint of the desired airway on the Flight Plan page.

   b. Airway ident — Insert.

      (1) # key — Depress then enter the airway identifier (“#J501” in Figure 24-26).

      (2) ± key — Depress and type the destination waypoint. Refer to Figure 24-26.

      (3) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink and the appropriate airway or waypoint identifier must be entered.

      (4) To change ending waypoint, use the Line Select key to position cursor over a different destination waypoint. If applicable, use PRV and NXT keys to access all airway waypoint pages.

   c. ENTER key — Depress to merge the airway waypoints into the Flight Plan and return to the Flight Plan page.

Note

If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message “FPL FULL” will appear.

   d. If applicable, enter additional airway identifiers to chain several airways together.

24.18.4.5 Saving a Flight Plan

Once a Flight Plan is selected and becomes Active, it is automatically saved in the Stored Flight Plan page.

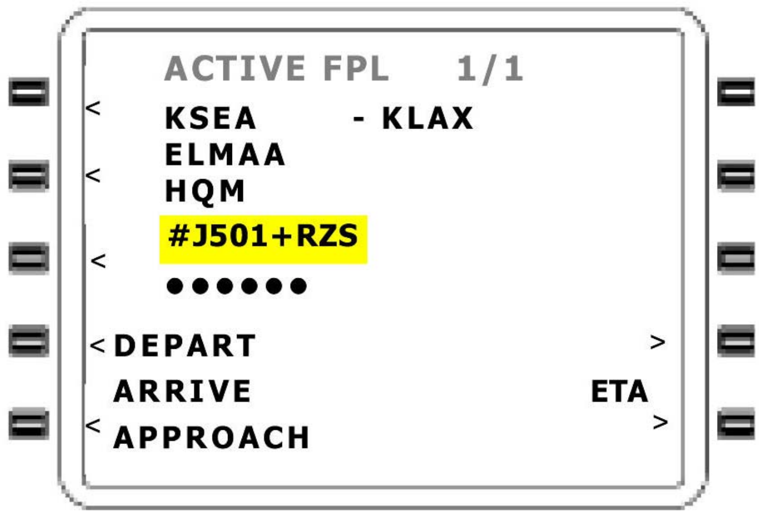


Figure 24-26. Airway Identifier and Destination Waypoint Entered

24.18.4.6 Executing Flight Plan

24.18.4.6.1 Initial Leg Selection

An initial From/To Leg or Direct To Leg must be established in order for the system to provide guidance along the Flight Plan. From the ACTIVE FPL page, the following procedure is used:

1. NAV key — Depress.

2. FR Waypoint — Verify. The first waypoint on the Active Flight Plan will appear in the FR field. To change the FR waypoint, insert the desired identifier.

3. ENTER key — Depress. The next waypoint in the Active Flight Plan sequence will appear in the TO field.

4. TO Waypoint — Verify. To change the TO waypoint, insert the desired identifier.

5. ENTER key — Depress.

6. DIS, DTK — CHECK for reasonableness.

If this leg selection is part of an active flight plan involving Oceanic/Remote operation using GPS as the sole navigation source, an FDE prediction to determine sufficient GPS availability must be performed prior to departure.

24.18.4.6.2 Departure

The GNS-XLS SID (Standard Instrument Departure), STAR (Standard Terminal Arrival), Approach and Airway retrieval feature is designed to relieve flightcrew workload. SIDs and STARs require such procedures as flying headings and altitudes, as well as intercepting VOR radials and DME arcs, etc. Approaches can be flown autopilot/flight director coupled until the Missed Approach Point. Missed Approach procedures must then be flown manually. The GNS-XLS is only designed to provide meaningful input to the HSI when on a track between two waypoints when Pseudo Vortac (selected course) procedures are used. The system is not designed to fly full SID, STAR, or Missed Approach procedures.

When flying those portions of a SID or STAR that are not tracks between fixes, the aircraft should be flown manually or in HEADING mode. In some cases, Pseudo Vortac procedures can be used to establish an intercept to a published track. When using the Pseudo Vortac mode, or upon intercepting a published track between two waypoints (fixes), the aircraft may be flown in reference to the crosstrack deviation provided by the GNS-XLS or by coupling the GNS-XLS roll command to the autopilot.

The first leg of the SID that the FMS can fly is not the first leg of the procedure. To properly fly SIDs, the flightcrew must manually fly the procedure to a point where the FMS can fly the procedure properly. The first leg of the SID that the FMS can fly is usually the first waypoint after the airport identifier or departure runway. After loading the SID onto the Active FPL, access NAV page 1. Enter the first waypoint after the runway or airport identifier in the FR field. Press ENTER. The TO field will display the next waypoint in sequence for the FPL. Press ENTER again to complete the initialization of the first leg of the flight plan. The flightcrew must manually fly the airplane until reaching the first leg of the SID that can be flown by the FMS.

The following operational procedures contain leg types that the FMS cannot automatically fly and require manual intervention on the part of the pilot.

Note

- Some SIDs and STARs require intercept procedures upon reaching a specified altitude. In these cases, execute the Pseudo Vortac, Direct To, or Heading Intercept procedure upon reaching the specified altitude.
- The CDU display in Figure 24-27 shows the waypoints that would be added to the flight plan through reference to the ELMAA5 SID, HQM transition from RW16L.

1. Heading to Intercept Procedures — For procedures like the example in Figure 24-28, the following operational procedures are recommended.

   a. Prior to departure, tune the Seattle VOR, select the VOR as the NAV source and set the HSI course pointer to 158°.

   b. After departure, intercept the SEA 158° radial. After crossing the SEA 5 DME fix at or above 3,000 feet, turn right to 250°.

   c. Select the FMS Heading and enter 250°, then Intercept mode on the FMS. Select ELMAA as the TO waypoint and enter 227 in the DTK field and press ENTER.

   d. Select the FMS as the NAV source.

   e. The FMS will fly the remainder of the SID to HQM.

Note

This is known as the FMS Heading/Intercept procedure.

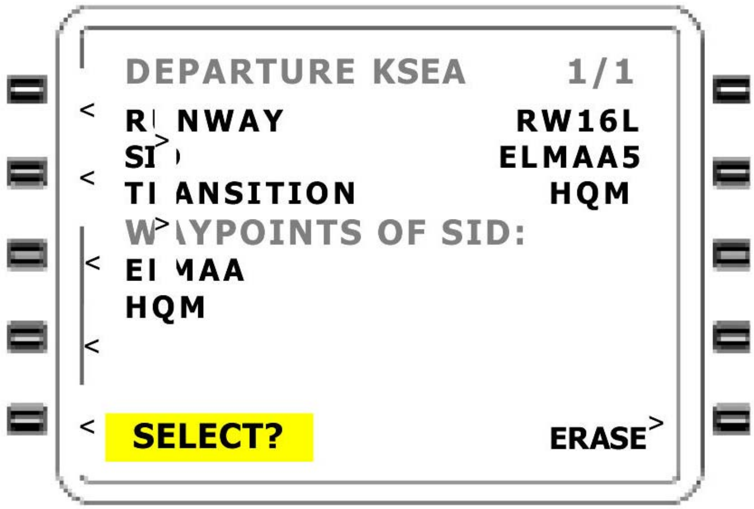


Figure 24-27. CDU Display for Heading to Intercept Procedures Example

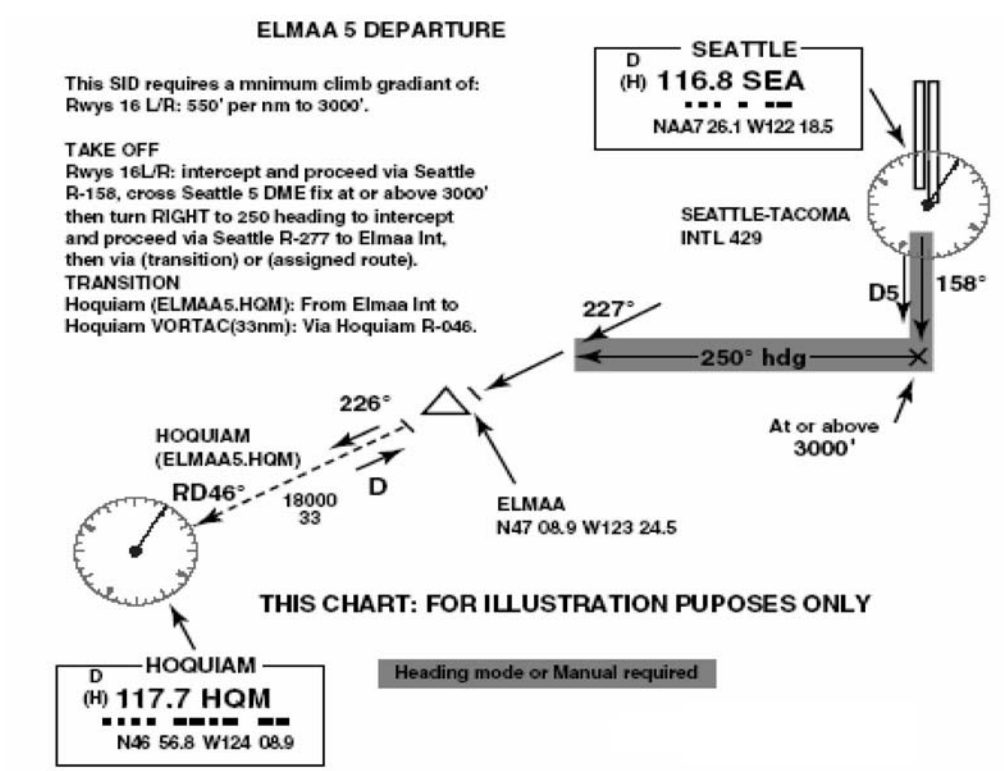


Figure 24-28. Heading to Intercept Procedures

2. Overfly then Intercept Procedures — The following operational procedures are recommended when required to overfly a waypoint then turn to intercept a course to the next waypoint (Figure 24-29 example).

   a. Prior to departure, when the first waypoint is designated flyover, select MAN leg change mode on NAV page 1 and press ENTER.

   b. Select the FMS as the NAV source.

   c. Accurately fly the runway course or heading.

   d. Immediately after passing ZH582, do a Direct To ZH554, enter 255 in the DKT field on NAV page 1 and press ENTER.

Note

This is known as the FMS Pseudo VORTAC procedure.

3. Overfly then DIRECT TO Procedures — The following operational procedures are recommended when required to overfly a waypoint then a Direct To the next waypoint (Figure 24-30 example).

   a. Prior to departure, select MAN leg change mode on NAV page 1 and press ENTER.

   b. Select the FMS as the NAV source.

   c. Accurately fly the runway course or heading.

   d. Immediately after passing WW166, press the D▸ key, cursor over BBKNB and press ENTER.

Note

This is known as the FMS DIRECT TO procedure.

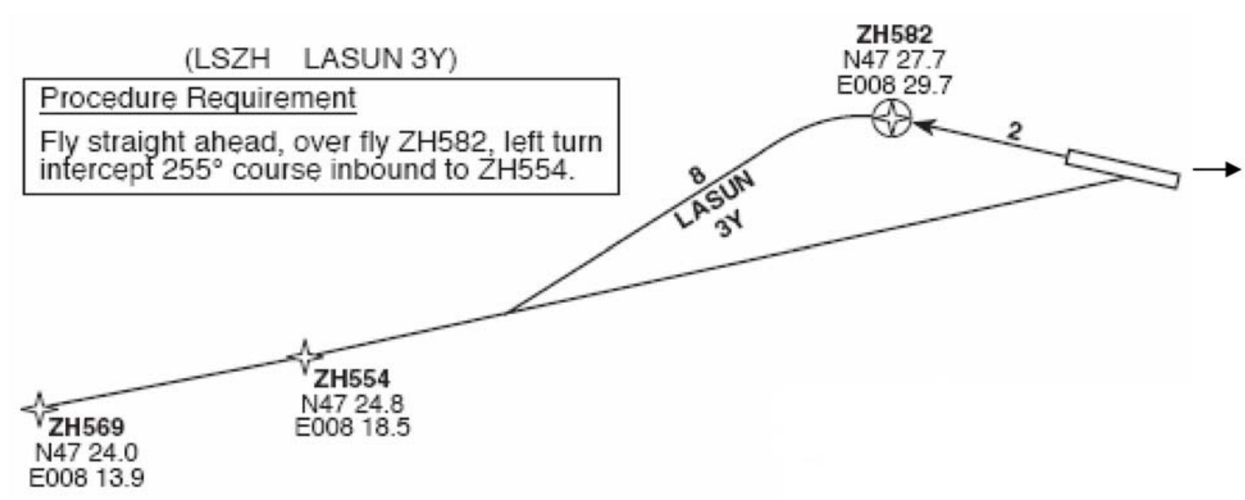


Figure 24-29. Overfly to Intercept Procedures

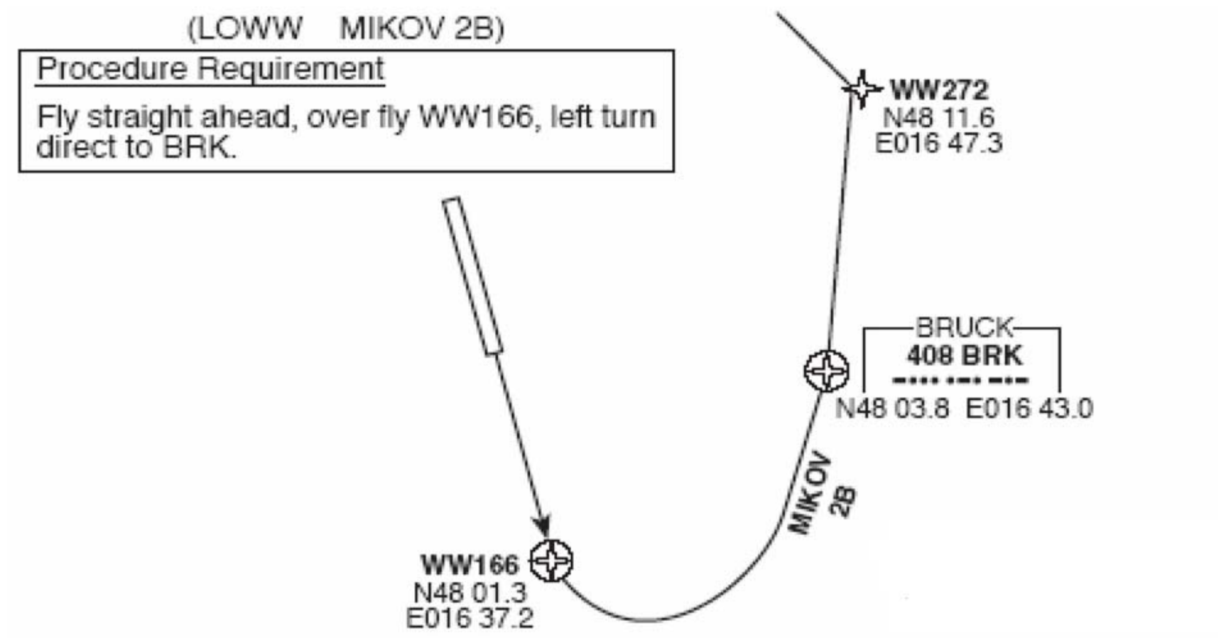


Figure 24-30. Overfly then DIRECT TO Procedures

4. Entering a SID on the Active FPL.

Note

These procedures may also be used with a stored flight plan.

a. FPL key — Depress to display Active FPL page.

b. Line Select key — Depress to position cursor over the DEPART? Field.

c. ENTER key — Depress to display DEPARTURE page.

d. DEPARTURE Airport Identifier — Verify or insert valid Ident.

Note

- If the first waypoint on the Flight Plan is an airport, the Departure ident pre-fills and the cursor is positioned over the first SID identifier on the list.
- If the first waypoint on the Flight Plan is a runway, the RUNWAY field also pre-fills and the cursor is over the first SID identifier on the list.
- If there are no SIDs associated with the Departure Airport, the message "NO SIDS AVAILABLE" appears and the Ident field flashes. Depress the FPL key to return to the Active Flight Plan.

e. Line Select key — Depress to position the cursor over the desired SID, if required.

f. ENTER key — Depress to select SID.

Note

Cursor moves to the first TRANSITION identifier on the list. The TRANSITION field is highlighted in yellow.

g. Line Select key — Depress to position cursor over the desired TRANSITION, if required.

h. ENTER key — Depress to select TRANSITION.

Note

If the SID and TRANSITION are runway dependent, and a runway has not pre-filled, the cursor moves to the first runway on the RUNWAY identifier list and RUNWAY field is highlighted in yellow. If runway is not required, proceed to step k.

i. Line Select key — Depress to position cursor over the desired runway.

j. ENTER key — Depress to select RUNWAY.

k. Departure SID Waypoints — REVIEW (Figure 24-31) then depress the ENTER key to select the SID and insert it into Active Flight Plan. The display will automatically return to the ACTIVE FLIGHT PLAN page.

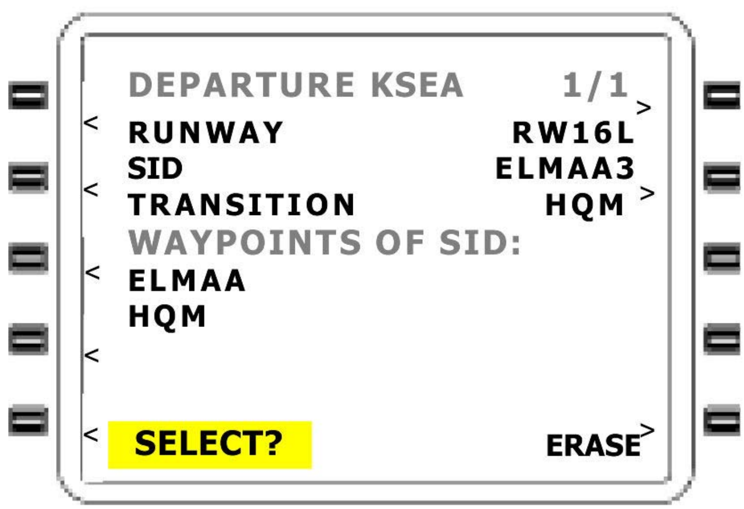


Figure 24-31. Departure SID Waypoints

Note

- If SID is added to a stored flight plan, this display will return to the stored flight plan page after SID is selected.
- SID waypoints appear indented from other waypoints in a Flight Plan that are not part of a procedure (SID, STAR, Approach).

5. Reviewing a SID from any Stored FPL or the Active FPL page.

   a. Line Select key — Depress to position cursor over the DEPART field on the Flight Plan page.

   b. ENTER key — Depress to review SID.

   c. BACK key — Depress to return to Flight Plan page.

Note

SELECT will not appear as an option since a SID already exists in the Flight Plan.

6. Editing a SID from any Stored FPL or the Active FPL page.

   a. Line Select key — Depress to position cursor over the DEPART field on the Flight Plan page.

   b. ENTER key — Depress.

   c. Line Select key adjacent to SID field — Depress to position cursor over the first SID identifier on the list.

Note

A list will only appear if the TRANSITION/RUNWAY are compatible with other SIDs.

   d. Line Select key adjacent to TRANSITION field — Depress to position cursor over the current TRANSITION waypoint on the list.

   e. Line Select key — Depress to position cursor over the desired TRANSITION.

   f. ENTER key — Depress to select the desired TRANSITION. The system will automatically load the compatible SID associated with the selected TRANSITION.

   g. ENTER key — Depress to select a new SID and insert the new SID into the flight plan.

Note

The RUNWAY can also be edited without changing the original SID if the SI/TRANSITION are compatible. This is done by pressing the Line Select key adjacent to the RUNWAY field. Press the Line Select key to position the cursor over the desired RUNWAY. Press ENTER to load the desired RUNWAY on the SID.

   h. ENTER key — Depress to select the edited SID as displayed and insert it into the flight plan.

Note

Look carefully at the flight plan to see if any waypoints are out of sequence. Delete waypoints as necessary.

7. Adding or Deleting Waypoints within a SID.

Note

When a SID is modified by adding or deleting waypoints, the sequence of waypoints is no longer identified as a SID.

To Add a Waypoint:

a. Line Select key — Depress to position the cursor over the SID waypoint identifier that will follow the new entry on the Flight Plan page.

b. Waypoint Ident — Insert.

c. ENTER key — Depress twice.

Note

The previously indented SID waypoints move over one space to the left on the screen and are treated as normal waypoints in the Flight Plan.

To Delete a Waypoint:

d. Line Select key — Depress to position the cursor over the waypoint to be deleted in the Flight Plan page.

e. BACK key — Depress. A DELETE? prompt will appear adjacent to the waypoint to be deleted.

f. ENTER key — Depress. The waypoint will be deleted and the waypoints of the SID will be treated as nonprocedure waypoints in the flight plan.

24.18.4.6.3 Entering an Airway from Any Stored FPL or the Active FPL Page

En route Airways include high-altitude jet routes, low altitude, and colored airways.

1. Line Select key — Depress to position the cursor below the starting waypoint of the desired airway on the Flight Plan page.

2. Airway Ident v Insert. Use Option 1 below if the desired waypoint is unknown. Use Option 2 below to enter the known waypoint.

   a. Option 1.

      (1) # key — Depress then enter the airway identifier.

      (2) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink. The appropriate airway or waypoint identifier must be entered.

(3) Line Select key — Depress to position the cursor over the desired designation waypoint. If applicable, use PRV and NXT keys to access all airway waypoints pages.

Note

As the cursor is moved up or down, “TO” will appear next to the cursor and a question mark will follow the ident. The waypoints between the TO/FROM waypoints will be displayed in yellow.

(4) After selecting the ending waypoint (TO) on the Airway, depress the ENTER key to merge the Airway waypoints into the flight plan and return to the FPL page.

Note

- If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message “FPL FULL” will appear.
- Look carefully at the flight plan to see if any waypoints are out of sequence. Delete waypoints as necessary.

b. Option 2.

(1) # key — Depress then enter the airway identifier.

(2) ± key — Depress and type destination waypoint.

(3) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink and the appropriate airway or waypoint identifier must be entered. If the destination waypoint is not on the airway, the system reverts to Option 1.

(4) To change ending waypoint, use the Line Select key to position the cursor over a different designation waypoint. If applicable, use PRV and NXT keys to access all airway waypoints pages.

Note

As the cursor is moved up or down, “TO” will appear next to the cursor and a question mark will follow the Ident. Waypoints between the TO/FR waypoints will be displayed in yellow.

3. ENTER key — Depress to merge the airway waypoints into the Flight Plan and return to the Flight Plan page.

Note

If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message “FPL FULL” will appear.

4. If applicable, enter additional airway identifiers to chain several airways together.

24.18.4.6.3.1 Editing an Airway

Once an airway is merged into the flight plan, waypoints can be added to or deleted from the flight plan on the Flight Plan page using normal edit procedures.

To add or delete waypoints from a selected segment of the airway, perform the following:

1. Line Select key — Depress to position the cursor over an airway waypoint on the Flight Plan page.
2. # key — Depress then enter the airway identifier.
3. ENTER key — Depress.
4. Line Select key — Depress to move the cursor to shorten or lengthen the previously selected segment of the airway. If applicable, use PRV and NXT keys to access all airway waypoints pages.
5. ENTER key — Depress to merge the edited airway segment into the Flight Plan and return to the Flight Plan page.

24.18.4.6.4 Creating/Changing Pilot-Entered Waypoints

A personalized waypoint may be created by entering a non-NDB (Nav Database) waypoint identifier and inserting the desired position coordinates on the Waypoint page. Refer to Figure 24-32.

The CDU has nonvolatile storage for up to 999 waypoints, which are retained in memory only if the waypoints are entered on a Stored Flight Plan. The ICAO identifiers stored in the database cannot be used for personalized waypoints.

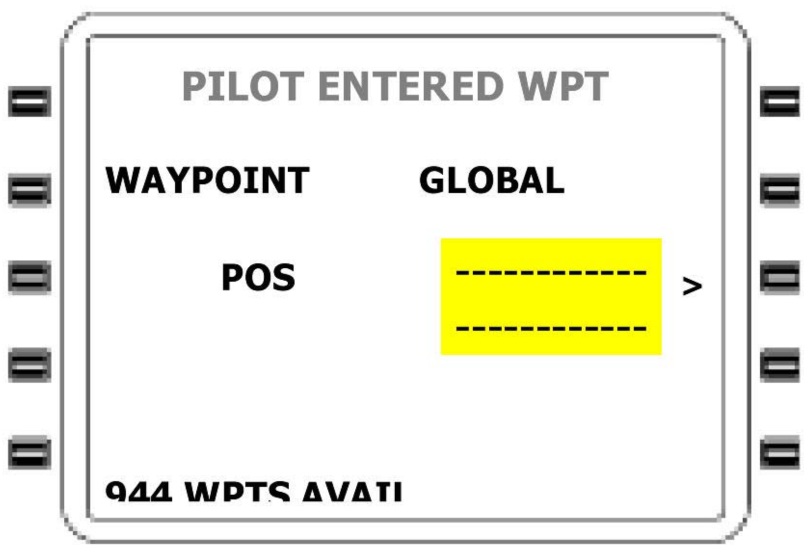


Figure 24-32. Creating Pilot-Entered Waypoints

Attempting to enter more than 999 pilot-entered waypoints in memory causes MEM FULL to be displayed on the FLIGHT PLAN page. The message light will flash and WPT MEM FULL will be displayed on the SYSTEM MESSAGES page.

Select a desired Flight Plan and position the cursor over the desired field. If necessary, refer to the procedure for Creating a Flight Plan or Modifying a Flight Plan.

Creating Pilot-Entered (Personalized) Waypoints:

1. Personalize IDENT — Insert.
2. ENTER key — Depress.
3. Latitude — Insert (N or S first, then degrees, minutes, and hundredths).
4. ENTER key — Depress.
5. Longitude — Insert (E or W first, then degrees, minutes, and hundredths).
6. ENTER key — Depress. The display will change to the appropriate FLIGHT PLAN or DIRECT page.

Changing Pilot-Entered (Personalized) Waypoints:

1. Personalize IDENT — Insert.
2. ENTER key — Depress. PILOT ENTERED WPT page will appear.
3. Line Select key — Depress to position the cursor over POS field.
4. Repeat steps 4 through 6 above.

Note

If an offset waypoint from a pilot-entered waypoint is programmed, the RAD and DIS can be changed, but the coordinates cannot be manually inserted.

24.18.4.6.5 Creating an Offset Waypoint

This procedure enables the system to create a waypoint at a given radial and distance from a known point. The known point (parent waypoint) may be any stored personalized or database waypoint.

An offset waypoint may be inserted in any Waypoint IDENT field. The offset waypoint is retained in memory after system shutdown only if entered on a Stored Flight Plan.

Position the cursor over the desired waypoint IDENT field.

Note

The offset waypoint uses situation declination, if available, or it uses the calculated magnetic variation of the parent waypoint. All waypoints defined by a VHF NAVAID in the National/International Airspace System are based on the VHF NAVAID station declination. Since the magnetic variation and station declination may not be the same at a given NAVAID, the calculated position and the defined FMS position may differ.

1. Parent Waypoint IDENT — Insert with an * following the entry. Refer to Figure 24-33.

Note

More than one offset waypoint is allowed from one parent, using *, *1, *A1, etc., as identifying notation.

2. ENTER key — Depress.

Note

If field blinks, Parent Waypoint does not exist in CDU memory or in database and must be defined on a Flight Plan page.

3. Desired Radial — Insert. The degrees can be entered as whole numbers and the .0 will be loaded automatically (i.e., type 77, 077.0 will be displayed). If a fraction of a degree is desired, all 4 digits must be entered. 0775 will be displayed as 077.5, 3001 will be displayed as 300.1, etc.
4. ENTER key — Depress.
5. Desired distance — Insert (nm and tenths, 1999.9 nm maximum).
6. ENTER key — Depress.
7. POS coordinates — Verify for reasonability.
8. ENTER key — Depress.

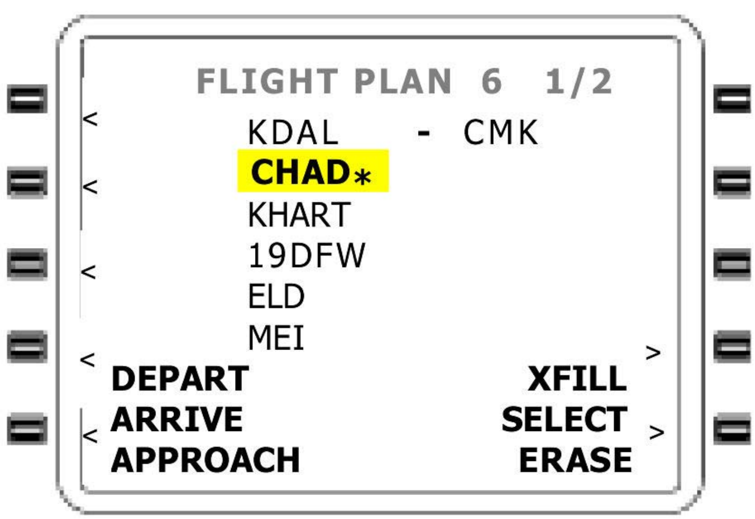


Figure 24-33. Offset Entry From Parent Waypoint

24.18.4.6.6 En Route

24.18.4.6.6.1 Direct To — Active Flight Plan Waypoint

D▸ function enables the pilot to fly direct to any lateral waypoint on the Active Flight plan without reinserting the waypoint identifier (Figure 24-34).

Note

If a Direct To the MAP on the active flight plan is initiated, the selected Approach procedure will be canceled as indicated by the waypoints of the approach no longer being indented and an MSG.

1. D▸ key — Depress. A DIRECT TO page will appear with the cursor over the current TO waypoint.

2. Line Select key — Depress to position the cursor over the desired identifier.

Note

Active Flight Plans exceeding 18 waypoints will be contained on subsequent pages. Press D▸, NXT or PRV key to access remaining waypoints.

3. ENTER key — Depress. Display automatically advances to NAVIGATION page 1.

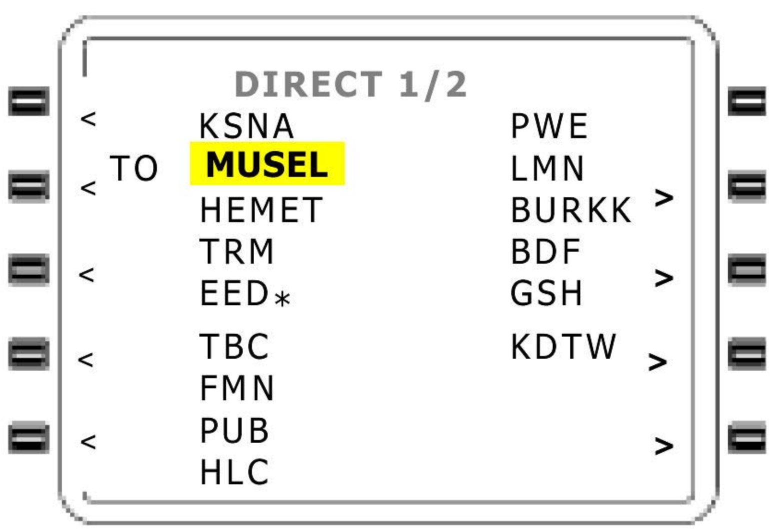


Figure 24-34. DIRECT TO Page

Note

- The system must compute a turn from a wings-level position. If the aircraft is in a turn when the D► key is pressed, the aircraft will roll to wings-level position momentarily. The aircraft will then continue the turn toward the Direct To waypoint.
- If an offset waypoint was selected, an OFFSET WPT page is displayed. Verify data and Depress ENTER. The DIRECT page is displayed with the cursor over the Offset Waypoint. Press ENTER again to proceed direct to the WPT. Display automatically advances to NAVIGATION page 1.

4. DIS, DTK — Check.

24.18.4.6.6.2 Direct To — Random Waypoint

This procedure enables the pilot to add a random waypoint to the ACTIVE FLIGHT PLAN in the desired sequence and proceed direct to it.

1. D► key — Depress. A DIRECT TO page appears with the cursor over the current TO waypoint.
2. Line Select key — Depress to position the cursor over the identifier to follow the new entry.
3. Type in the waypoint identifier.
4. ENTER key — Depress.
5. Waypoint page Coordinates — Verify or insert. To insert Waypoint Coordinates (cursor over POS field):
   a. Latitude — Insert (N or S first, then degrees, minutes, and hundredths [six characters]).
   b. ENTER key — Depress.
   c. Longitude — Insert (E or W first, then degrees, minutes, and hundredths [seven characters]).
6. ENTER key — Depress.
7. Waypoint sequence — Verify that the waypoint is in the proper location.
8. ENTER key — Depress. Display automatically advances to NAVIGATION page 1.

Note

If a Direct To a pilot-entered waypoint is desired, a latitude and longitude entry may be required.

a. Latitude — Insert N or S first, then degrees, minutes, and hundredths (six characters).

b. Longitude — Insert E or W first, then degrees, minutes, and hundredths (seven characters).

If Direct To an offset waypoint is desired, the radial and distance entry from the parent waypoint may be required.

Note

If ENTER key is not depressed prior to leaving DIRECT page, the waypoint identifier will not appear on the Active Flight Plan and the aircraft will not proceed to Direct To this waypoint and will need to be re-entered.

9. DIS, DTK — CHECK.

Note

- A Direct To function may also be accomplished from NAVIGATION page 1, 2, and 3 by placing the cursor over the TO waypoint and typing in the desired waypoint if required. Depress the ENTER key and the system will proceed Direct To the selected waypoint.
- If the selected waypoint was not on the active FPL, a fence will be added to the FPL, and no AUTO LEG CHG will occur beyond this waypoint.
- Anytime the Direct To function is used to go Direct To the MAP, the Approach procedure will be canceled. The SYSTEM message page will display APPROACH CANCELED and the CDI sensitivity will return to Terminal scale of 1nm full scale deflection.

24.18.4.6.6.3 Direct To Closest Airport

This procedure allows the pilot to select a desired airport and proceed DIRECT TO it.

1. D▸ key — Depress until DIR CLOSEST ARP page appears (Figure 24-35).

   When initially accessed, the cursor will be over the airport closest to the aircraft present position at that time.

2. Line Select key — Depress to position the cursor over the desired airport identifier and press ENTER. NAVIGATION page 1 will be displayed and the airplane will proceed D▸ to the selected airport.

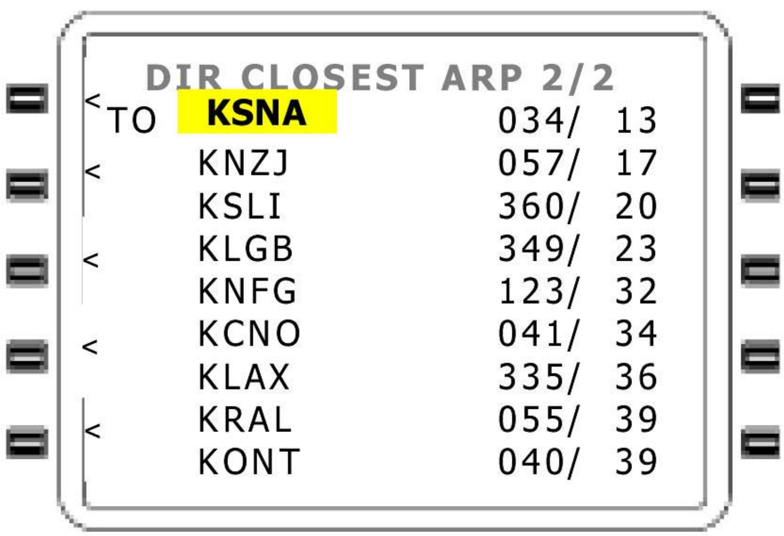


Figure 24-35. DIR CLOSEST ARP Page

Note

The bearing and distance values to the closest airports are based on the aircraft present position at the time this page is accessed. The values are not updated while the page is being displayed. To obtain updated information, it is necessary to exit the page then return.

24.18.4.6.6.4 Pseudo-VORT AC (Selected Course)

1. NAV key — Depress to display NAVIGATION page 1.

Note

The system must be proceeding Direct To a waypoint or DTK will not be an enterable field. If system is proceeding Direct To the desired waypoint, proceed to step 5. If system is not currently proceeding direct to a waypoint, continue with step 2.

2. Line Select key — Depress to position the cursor over the TO field.

3. TO Waypoint Identifier — Insert (if necessary).

4. ENTER key — Depress.

   If Waypoint Page appears:

   a. Waypoint Page coordinates — Verify or insert.

   b. ENTER key — Depress.

5. Desired Track (DTK) — Insert (Figure 24-36).

6. ENTER key — Depress. If the DTK entry positions the aircraft on the FROM, or far, side of the TO waypoint, the Leg Change Mode switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determiner if -MAN- or -AUTO- is appropriate.

Note

- The system will turn the aircraft to intercept the DTK at up to a 45° angle if coupled to the autopilot.

- The D▸ function may also be used to initiate a Pseudo-VORTAC. Following the Direct To entry using the D▸ key, the display automatically advances to NAVIGATION page 1. Manually position the cursor over DTK field and continue as described in steps 5 and 6. To exit Pseudo-VORTAC mode, make any leg change (e.g., D▸ key press and enter current TO waypoint). When exiting Pseudo-VORTAC, the system may return to the -AUT O- Leg Change mode unless the system was in -MAN- prior to initiating Pseudo-VORTAC.

A manual leg change means the system will not automatically sequence to the next waypoint on the active flight plan. To sequence to the next waypoint in the flight plan, use Direct To function or place the cursor over -MAN-. Press the BACK key and AUTO? will be displayed. Press the ENTER key and the system will return to the Automatic Leg Change mode.

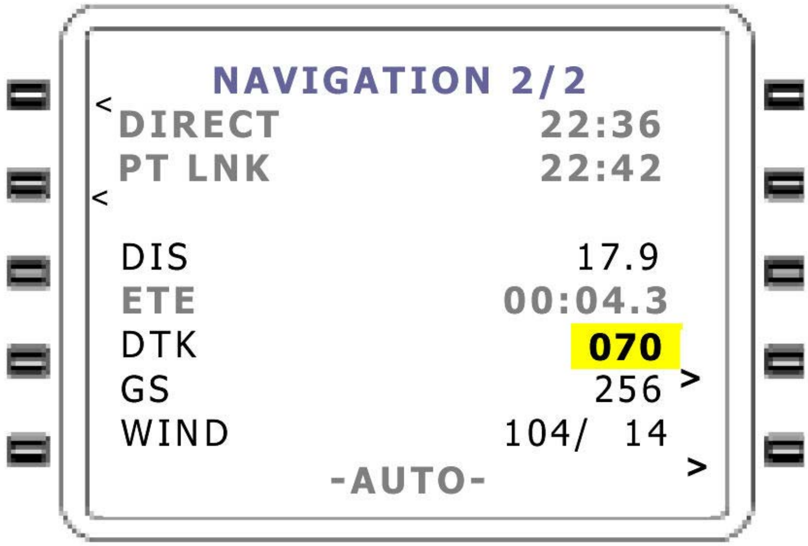


Figure 24-36. Insert DTK in Waypoint Page

24.18.4.6.6.5 Programming a Heading Vector

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.

2. Heading — Insert desired heading in whole degrees, preceded by R or L, if applicable, to indicate a turn direction.

Note

HDG SELECT and the programmed heading are displayed on NAVIGATION page 1 indicating the aircraft is in Heading Select mode.

24.18.4.6.6.6 Changing Heading Vector While in Heading Select Mode

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.

2. Heading — Insert desired heading.

3. ENTER key — Depress.

Note

Cursor moves to the Heading Mode field, but it is not necessary to depress the ENTER key because the system is already in Heading Select mode.

4. NAV or ENTER key — Depress to check heading and return to NAVIGATION page 1.

24.18.4.6.6.7 Changing to Waypoint While in Heading Select Mode

This procedure establishes a leg between the new TO waypoint and the waypoint preceding it on the Active Flight plan or a Pseudo-VORTAC. If crosstrack distance exceeds 125 nm, the HEADING mode will be canceled and the STRG INVALID message will be displayed.

1. HDG key — Depress to display HEADING VECTOR page.
2. Line Select key — Depress to position the cursor over the TO waypoint.
3. BACK key — Depress to cycle through waypoints on the Active Flight Plan or insert alternate waypoint.
4. ENTER key — Depress.

If Waypoint page appears:

   a. Waypoint Page coordinates — Verify or insert.

   b. ENTER key — Depress. Cursor moves to DTK field.

5. Desired Track (DTK) — Verify or insert.
6. ENTER key — Depress. OK? ENTER message appears. Refer to Figure 24-37.
7. ENTER key — Depress to select TO waypoint and return to NAVIGATION page 1. The cursor may be positioned over the Leg Change Mode field.

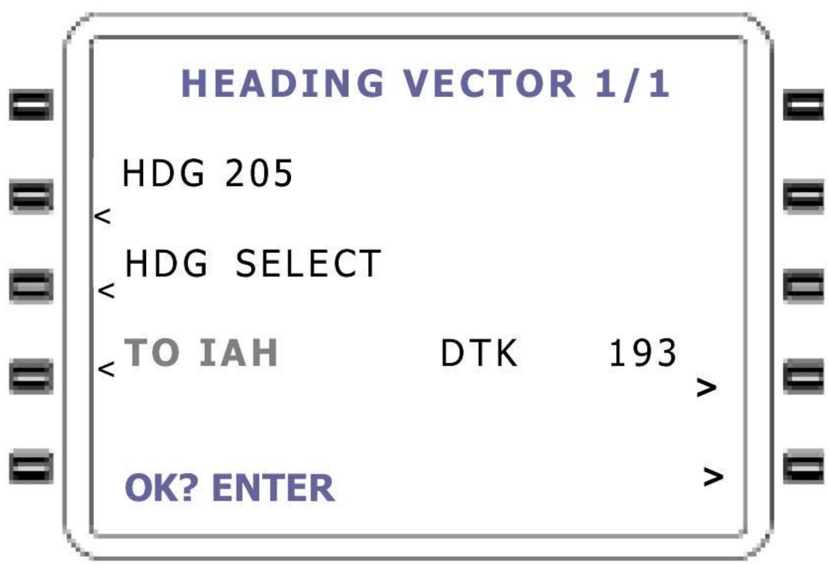


Figure 24-37. Heading Vector Page at TO Waypoint Selection

Note

If the Desired Track is changed, a Pseudo-VORTAC is programmed. If the DTK entry positions the aircraft on the FROM, or far side of the TO waypoint, the Leg Change Mode displayed on NAVIGATION page 1 switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determine if -MAN- or -AUTO- is appropriate.

24.18.4.6.6.8 Canceling Heading Select Mode

Initiate a DIRECT TO procedure, using the D▸ and ENTER keys, which immediately cancels the commanded heading, or perform the following:

1. HDG key — Depress to display HEADING VECTOR page.
2. Line Select key — Depress to position the cursor over HDG SELECT.
3. BACK key — Depress until CANCEL? is displayed.
4. ENTER key — Depress to cancel Heading Vector and return to NAVIGATION page 1.

Note

The system may turn the aircraft to intercept the current TO/FROM leg at up to a 45° angle.

24.18.4.6.6.9 Programming an Intercept

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.
2. Heading — Insert desired Heading in whole degrees, preceded by R or L, if applicable, to indicate a turn direction.

Note

R or L should be used for a heading change greater than 180° from the present heading. A ‘T’ indicates the system is operating in the true heading mode.

3. ENTER key — Depress. The cursor advances to Heading Mode field.
4. BACK key — Depress to select INTERCEPT? prompt.
5. ENTER key — Depress. Cursor moves to the TO Waypoint field.
6. BACK key — Depress, if required, to cycle through waypoints on Active Flight Plan or insert an alternate waypoint.
7. ENTER key — Depress.

If Waypoint page appears:

a. Waypoint Page coordinates — Verify or insert.

b. ENTER key — Depress. Cursor moves to DTK field.

8. Desired Track (DTK) — Verify or insert.

Note

- If the Desired Track is changed, a Pseudo-VORTAC is programmed. If the DTK entry positions the aircraft on the FROM, or far side of the TO waypoint, the Leg Change Mode on NAV page 1 switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determine if -MAN- or -AUT O- is appropriate.
- If a DME Arc endpoint is selected as the TO waypoint, a default DTK will be displayed based on the point at which the ARC will be intercepted and DTK is not selectable.

9. ENTER key — Depress. An Intercept Message may appear (NO COURSE INTERCEPT, or INTERCEPT BEYOND FIX). Refer to Figure 24-38. If no message appears, the intercept will occur on the TO side of the selected TO waypoint.

The intercept messages are based on the current aircraft heading and track. Once the selected heading has been established, the HEADING VECTOR page may be viewed to determine the intercept status. If NO COURSE INTERCEPT or NO ARC INTERCEPT occurs, the message light will illuminate and these messages will be displayed on the SYSTEM MESSAGES page. To view one of these messages on the HDG page, use the Line Select key to remove the cursor from the page.

Note

BUSY — STANDBY may be displayed in yellow momentarily while the intercept is calculated.

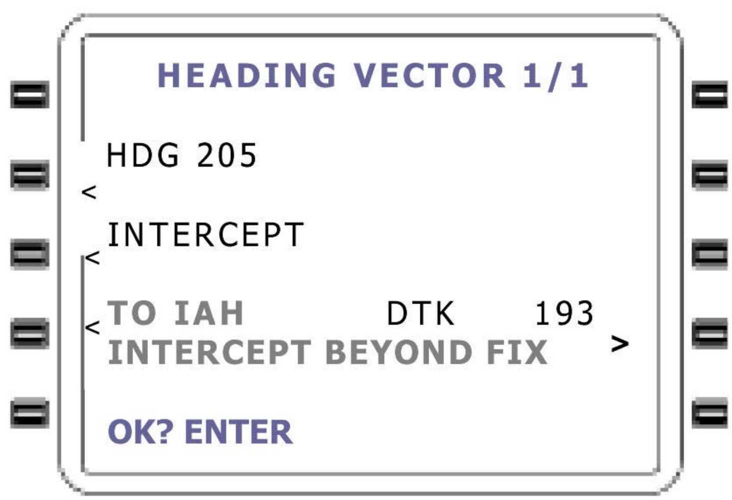


Figure 24-38. Heading Vector Page with Intercept Message

10. ENTER key — Depress to accept data and return to NAV page 1. The cursor is positioned over the Leg Change Mode if the DTK has been entered manually on the Heading page.

24.18.4.6.6.10 Programming a Heading Intercept to the Final Approach Course

This procedure nonprecision approach may be accomplished using the following steps:

1. HDG key — Depress to display HEADING VECTOR page.
2. Type in the assigned heading (e.g., ‘HDG 205’ in Figures 24-37 and 24-38).
3. ENTER key — Depress. The cursor moves to heading mode field.
4. BACK key — Depress to select INTERCEPT? prompt.
5. ENTER key — Depress. The cursor moves to the TO field.
6. BACK key — Depress until the FAF waypoint is displayed.
7. ENTER key — Depress.
8. Enter the inbound final approach course in the DTK field if required.
9. ENTER key — Depress twice to return to Navigation page 1.

NAVIGATION page 1 will be displayed with the TO waypoint, the FAF, and waypoint previous to the FAF in the FR field if no manual DTK was entered. The system will now intercept the Final Approach course and sequence to the MAP.

Note

If an intercept is programmed to a FAF that is part of a Procedure Turn, the DTK must be annually entered. This will cause Pseudo-VORTAC to be displayed on NAV page 1.

24.18.4.6.6.11 Parallel Course Offsets

This procedure is used to establish an offset course (steering reference) parallel to the current leg. This field is inactive when in APPROACH ARMED mode (within 30 nm of the destination airport).

1. NAV key — Depress to display NAVIGATION 2/4/page with Selected Crosstrack field (SXTK).
2. Line Select key — Depress to position cursor over SXTK field.
3. L or R key — Depress.
4. Offset Distance — Insert (nm and tenths). The maximum value that can be entered is 99.9 nm.
5. ENTER key — Depress. XTK deviation remains referenced to the original track; however, the HSI will display a centered needle when the SXTK has been captured. BRG, DIS, ETE remain referenced to the current TO waypoint.

Note

- If the system is coupled to the autopilot, the roll command will turn the aircraft to intercept the parallel course at the selected SXTK distance.
- If XTK is greater than 12.5 nm, VNAV will become INVALID and no vertical deviation information will be displayed.

Canceling Parallel Course:

1. NAV key — Depress to display page with SXTK.
2. Line Select key — Depress to position cursor over SXTK field.
3. BACK key — Depress. The cursor field will display CANCEL? to inform the pilot of the pending change. (Refer to Figure 24-39).
4. ENTER key — Depress. The steering reference will be to the original desired track.

Note

Any Leg Change (manual or automatic) including DIRECT TO will also cancel selected crosstrack (SXTK).

24.18.4.6.6.12 Holding Pattern

WARNING

When entering Procedure Turns (PTs) or a Holding Pattern (HP) airspace, the FMS may not constrain the airplane from violating maneuvering airspace. Pilots are responsible for procedural compliance.

24.18.4.6.6.12.1 Programming a Holding Pattern

This procedure enables the pilot to program a Holding Pattern (HP) at a specific waypoint.

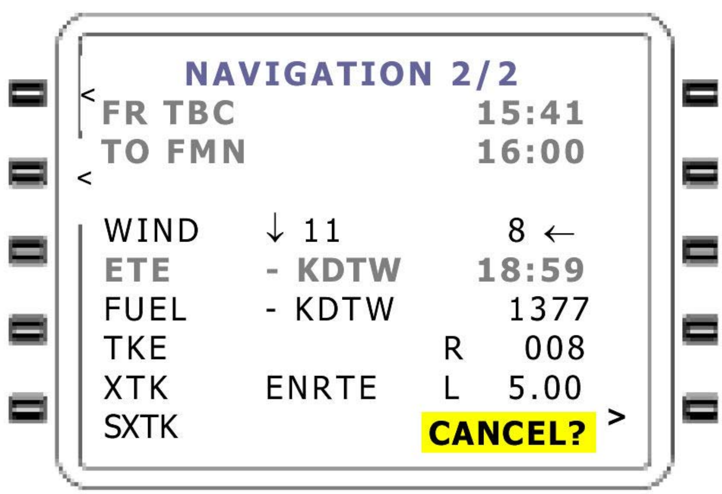


Figure 24-39. Canceling Parallel Course on Navigation 2/4 Page with SXTK

An HP is automatically programmed from the database when it is part of an Arrival or Approach procedure.

Note

No HP can be programmed at an ARC end point on the final approach course manually.

1. NAV, FPL, D▸ key — Depress to display applicable page.

2. Line Select key — Depress to position the cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected, and on the Active Flight Plan page, a Holding Pattern cannot be programmed at the FR or TO Waypoint.

If WPT is a duplicate WPT, the country code will be displayed in this field in parentheses (in green).

3. HOLD key — Depress to display HOLDING PATTERN page with cursor over the INBOUND CRS field. Refer to Figure 24-40.

4. INBOUND CRS — Verify or insert.

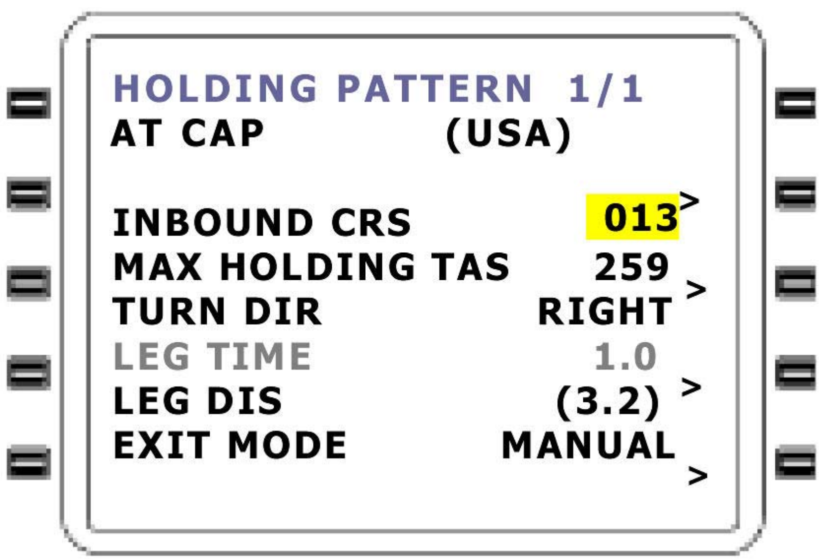


Figure 24-40. HP Page with Cursor Over Inbound CRS Field

Note

A verified Inbound Course programs a DIRECT ENTRY procedure. The system defaults to the inbound course between the previous WPT on the FPL and the waypoint at which the hold is desired. If a Direct TO Leg is displayed on the NAV pages, the inbound course defaults to the leg between the aircraft present position and the current TO waypoint. When an inserted inbound Course value is beyond the DIRECT ENTRY parameters, then a TEARDROP or PARALLEL pattern is programmed.

When a Holding Procedure is initiated, the inbound course is displayed on NAVIGATION page 1. If the CDI needle does not automatically slew to the inbound course, manually set the CDI needle to the inbound course so that the needle sensing is correct.

A “T” adjacent to the value displayed in the INBOUND CRS field indicates the course is referenced to true north.

5. ENTER key — Depress. The type of entry is displayed. Cursor moves to the LEG TIME field (‘1.0’ in Figure 24-41).

6. LEG TIME — Verify or insert (valid range 1.0 to 9.9 min).

7. If Holding Pattern is complete, proceed to step 11. If Optional Entries are required, continue with steps 8, 9, or 10.

Optional Entry: Turn Direction.

8. Line Select key — Depress to position the cursor over TURN DIR.

   a. BACK key — Depress to change direction.

   b. ENTER key — Depress.

Optional Entry: Leg Distance.

9. Line Select key — Depress to position the cursor over LEG DIST.

   a. Leg Distance — Insert or verify (valid range 1.0 nm to 50 nm).

   b. ENTER key — Depress.

Note

When the leg distance is entered, the leg time will be automatically computed. This action is indicated by parentheses around the entry for LEG TIME. Conversely, when leg time is entered, leg distance will be computed as indicated by parentheses around LEG DIST.

Selecting Exit Mode:

10. Line Select key — Depress to position the cursor over MANUAL or AUTO. Press the BACK key to change exit mode option. Selecting MANUAL will initiate a continuous hold. Selecting AUTO will exit the hold the next time the HP fix is crossed or after the entry procedure is completed.

11. ENTER key — Depress. OK? ENTER prompt will appear right below EXIT MODE. Verify inputs.

12. ENTER key — Depress to load the Holding Pattern at the selected waypoint and return to the NAVIGATION, DIRECT TO, or FPL page.

24.18.4.6.6.12.2 Reviewing, Editing, or Canceling a Holding Pattern

This procedure enables the pilot to review, edit, or cancel a Holding Pattern at a specific waypoint.

Reviewing:

1. NAV, FPL, D→ key — Depress to display applicable page.

2. Line Select key — Depress to position the cursor over desired HP waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected, and on the Active Flight Plan page, the TO Waypoint can only be reviewed.

3. Hold key — Depress to display HOLDING PATTERN page.

4. Holding Pattern — REVIEW.

Editing:

5. Line Select key — Depress to position the cursor over desired field.

   a. Insert value for INBOUND CRS, LEG TIME, or LEG DIST or

   b. BACK key — Depress to change TURN DIR or EXIT MODE.

6. ENTER key — Depress. The OK? ENTER prompt will appear.

Note

A re-entry to the Holding Pattern must be flown if the Inbound Course or Turn Direction are changed while holding at the HP Waypoint. No XFILL capability is available to the other system in a dual system installation from one or both systems when a holding pattern is in progress.

7. ENTER key — Depress to return to the NAVIGATION, DIRECT TO, or FPL page.

Canceling:

1. Line Select key — Depress to position the cursor over the CANCEL? prompt (just below the EXIT MODE field).

2. ENTER key — Depress. The HP annunciation is erased from NAVIGATION, DIRECT TO, or FPL pages.

Note

If canceling holding pattern at the current TO Waypoint, HP or AT is replaced by “TO”.

24.18.4.6.6.12.3 Exiting a Holding Pattern

This procedure gives the pilot three options to exit a Holding Pattern: exiting the next time over a holding fix, going Direct To the holding fix, or performing a Leg Change.

Option #1 — Exiting Holding Pattern Next Time Over Holding Fix.

1. NAV key — Depress to display NAVIGATION page 1, 2, or 3.
2. Line Select key — Depress to position the cursor over MANUAL (Figure 24-41).
3. BACK key —Depress to display AUTO?. Refer to Figure 24-41.
4. ENTER key — Depress. The NAVIGATION page indicates that the aircraft will EXIT HOLD the next time over the holding fix (aircraft will complete the loop around the holding pattern).

Note

The next (NX) waypoint information may also appear if the exit is made during Waypoint Alert.

Option #2 - Exiting Holding Pattern By Going Direct To Holding Fix.

1. D▸ key — Depress to display Direct To page with the cursor over current HP Waypoint (Figure 24-42).
2. ENTER key — Depress to display HOLDING PATTERN page with cursor over CANCEL?. (CANCEL? prompt is just below the EXIT MODE field.)

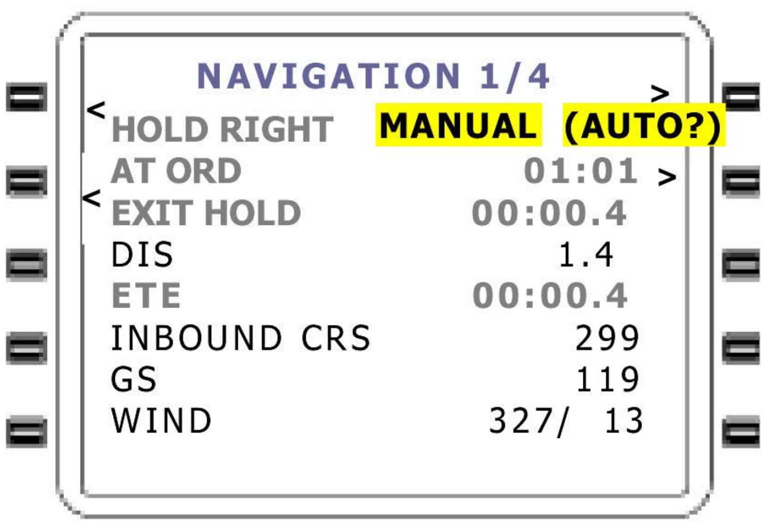


Figure 24-41. Navigation Page Indicating Exit Hold Next Time Over Holding Fix

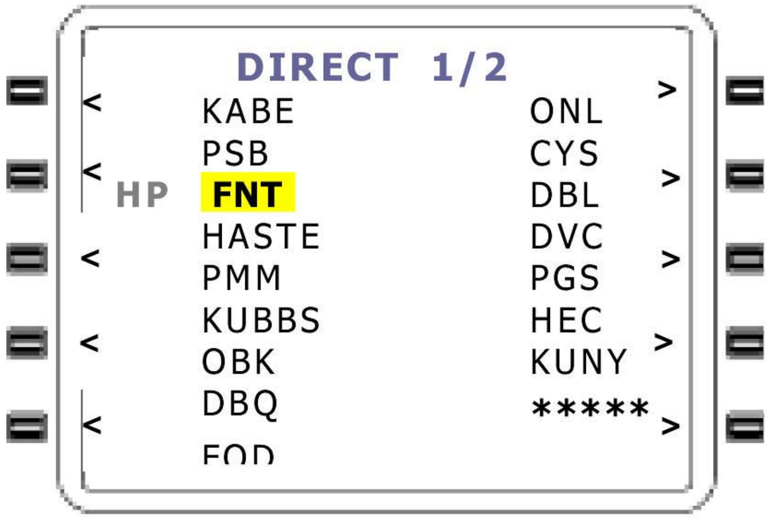


Figure 24-42. Direct To Page With Cursor Over Current HP Waypoint

3. ENTER key — Depress to go Direct To current TO Waypoint (Holding Fix) and cancel Holding Pattern.

Option #3 - Exiting Holding Pattern By Performing a Leg Change.

1. NAV key — Depress to display NAVIGATION page 1.
2. Line Select key — Depress to position the cursor over FROM field (HOLD RIGHT/LEFT).
3. FR Waypoint — Insert desired waypoint.
4. ENTER key — Depress. The next waypoint in the Active Flight Plan sequence will appear in the TO field. (Refer to Figure 24-43).
5. TO Waypoint — Verify. To change the TO waypoint, insert the desired identifier.
6. ENTER key — Depress to activate the new leg and cancel the Holding Pattern.

24.18.4.7 Executing Approaches

WARNING

When entering PTs or HP airspace at high speed, the FMS may not constrain the airplane from violating maneuvering airspace. Pilots are responsible for procedural compliance.

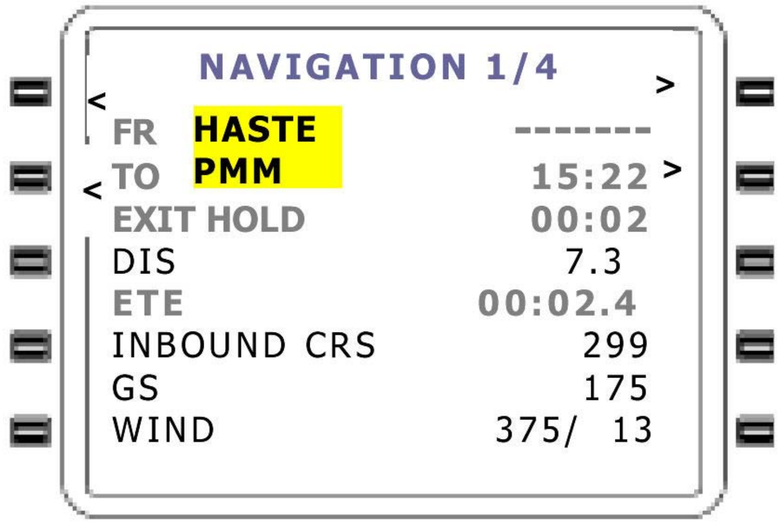


Figure 24-43. Navigation Page With TO Waypoint After FR Waypoint Inserted

When the aircraft is within 30 nm of the airport, the system will go into the Approach Armed mode. The CDI sensitivity will change from 5.0 nm full scale deflection to 1.0 nm full scale deflection. At this point the aircraft may bank slightly due to increased roll steering gains. Anytime the TO waypoint is part of an Approach Procedure, the SXTK field is disabled so that no parallel course can be entered.

The system is capable of executing GPS, GPS Overlay, NDB, RNAV, CIRCLING, and VOR approaches only. No LOC, ILS, or MLS capability is available.

If RAIM is not available at 2 nm from the FAF, an APPROACH WARN message will appear on the SYSTEM MESSAGES page. Also, the HSI flag will be set invalid. At this point, the appropriate missed approach procedures should be executed. The system will remain in the Approach Mode and the discrete APPROACH annunciator will remain illuminated until the HSI is set valid. To set the HSI valid, cancel the Approach on the SYSTEM MESSAGES page by pressing the ENTER key.

The system will not display any interim waypoints between the FAF and the MAP, even though a waypoint may be shown on the approach plate. The system may not give vertical guidance to the interim waypoint. Pilots are responsible for procedural compliance.

Note

If the MAP is abeam or beyond the threshold, or the approach is a circling approach, no altitude constraints will be displayed at the MAP from the database. Constraints may be entered manually.

When the Approach is flown, the system will provide guidance along the final approach course to the Missed Approach Point. When initially executing a missed approach procedure, use the FMS Heading Mode or manually fly the procedure to ensure proper track and turn direction.

Note

A “fence” (++++++) separates the Missed Approach Procedure waypoint from the MAP, the last waypoint of the Approach. No Auto Leg change (waypoint sequencing) will occur to waypoints beyond the “fence” (++++++) once the airplane passes the MAP.

At the MAP, the pilot must manually or via the HDG Mode maneuver the aircraft to the Missed Approach Procedure waypoint. If, after the missed approach, an approach at a different airport is desired, erase the current approach procedure before selecting a procedure at the new airport. This will ensure proper waypoint sequencing on the Active Flight Plan.

24.18.4.7.1 Loading a GPS/GPS Overlay Approach

1. FPL key — Depress until the ACTIVE FPL page appears.
2. Line Select key — Depress to position the cursor over APPROACH?.
3. ENTER key — Depress. APPROACH page is now displayed. Refer to Figure 24-44.
4. Airport Identifier — Insert or verify.
5. ENTER key — Depress twice, if required, to display runway list if not already displayed.

If a circling type approach is desired:

Line Select key — Depress to position cursor over TYPE.

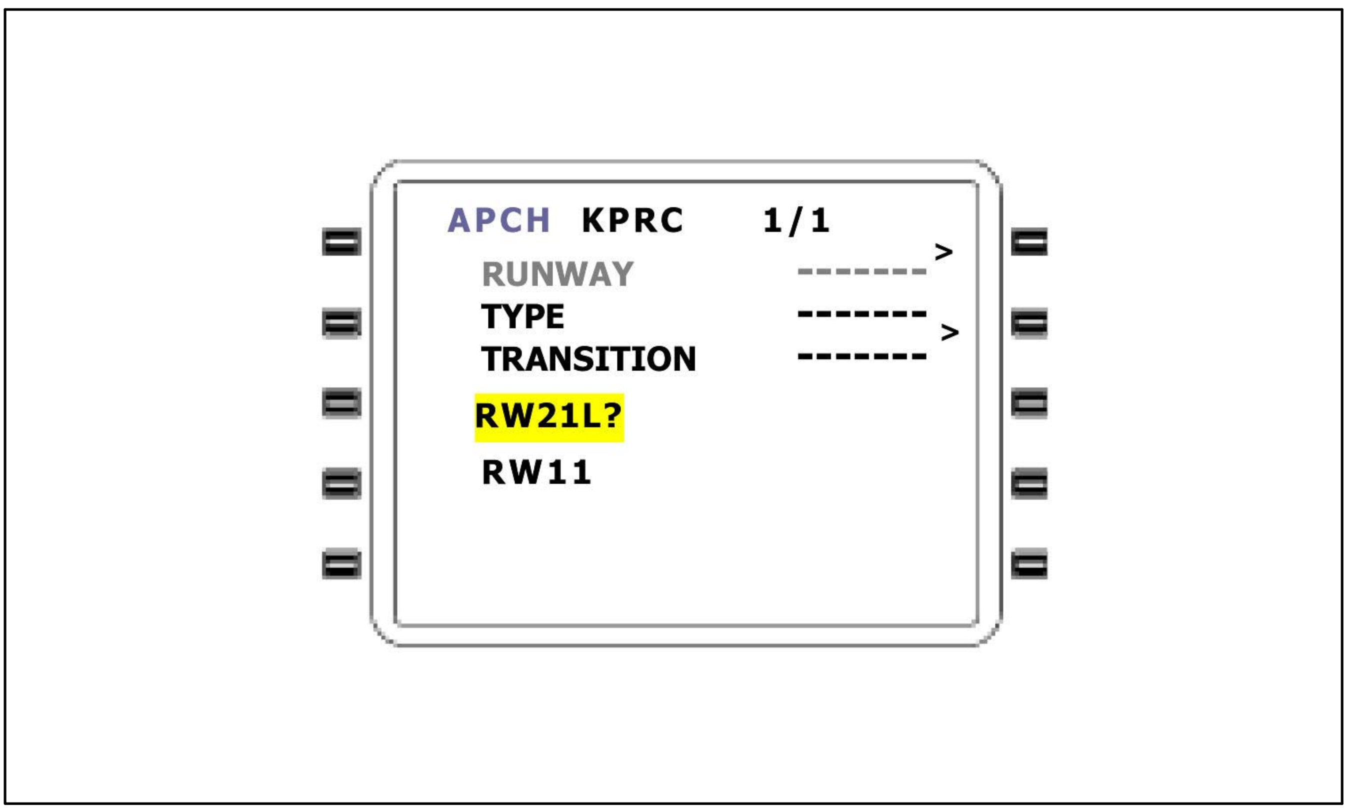


Figure 24-44. Approach Page

ENTER key — Depress to display the TYPE list. Proceed to step 10.

6. Line Select key — Depress to position cursor over desired runway.
7. ENTER key — Depress.
8. TYPE — SELECT if required.
9. ENTER key — Depress.
10. TRANSITION — SELECT if required.
11. ENTER key — Depress.
12. Approach Waypoints — REVIEW.
13. ENTER key — Depress ACTIVE FPL page is displayed. Verify the approach appears as selected.
14. Waypoint Sequencing — Edit, if required, based on assigned route.

24.18.4.7.2 Executing a GPS/GPS Overlay Approach

Note

To fly a full procedure DME ARC or procedure Turn, either coupled or using own navigation, follow the FMS and EFIS/Instrument displays.

Using RADAR Vectors to Final Approach Course:

1. FPL key — Depress to display the ACTIVE FPL page.
2. Approach and Waypoint Sequencing — Verify they appear as selected.
3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.
4. FMS Mode — Select or verify the appropriate mode for guidance if required.
5. Flight Director or Autopilot — ENGAGE the appropriate mode if required.
6. HDG key — Depress to display the HEADING VECTOR page.
7. Heading — Insert as assigned by ATC.
8. ENTER key — Depress twice to engage Heading Select mode.

After receiving the final intercept vector from ATC:

9. HDG key — Depress to display the HEADING VECTOR page.
10. ENTER key — Depress.
11. BACK key — Depress to display INTERCEPT?.
12. ENTER key — Depress. Cursor moves to the TO field.

13. BACK key — If required, depress until the FAF waypoint is displayed.

14. ENTER key — Depress. Cursor moves to the DTK field.

15. Final Approach Course — Insert if a Procedure Turn type approach or verify if any other type approach.

16. ENTER key — Depress twice.

17. CDI Display — Verify the HSI course needle slews to the final approach course or manually select the course.

18. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

Using Own Navigation — No DME ARC:

1. FPL key — Depress to display the ACTIVE FPL page.

2. Approach and Waypoint Sequencing — Verify they appear as selected.

3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.

4. FMS Mode — Select or verify the appropriate mode for guidance.

5. Flight Director or Autopilot — ENGAGE the appropriate mode.

6. Waypoints and HSI Course — Verify proper sequencing during the approach.

7. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

24.18.4.7.3 Procedure Turn

The following is a brief description of the screen displays typically seen while executing a Procedure Turn.

As the aircraft approaches the PT waypoint, a message is displayed on the fourth line of the CDU indicating the next action the aircraft will take. This message is displayed 30 seconds prior to the event and disappears when the action is initiated. Figure 24-45 indicates the aircraft is flying DIRECT to DRK where a Procedure Turn (PT) will take place. Line four indicates the aircraft will turn to a heading of 305° upon reaching DRK. While flying the Procedure Turn, the TO DRK will change to TO INTCPT. When the Procedure Turn is completed, and the aircraft is inbound, the TO INTCPT field changes to TO (the FAF).

Note

- When flying the approach on a transition that specifies NoPT and a “PT” waypoint is depicted on the flight plan, it will be necessary to do a DIRECT TO the next waypoint beyond the “PT” waypoint to avoid flying the Procedure Turn.

- When a Procedure Turn is initiated, the outbound course is displayed on the NAVIGATION 1 page. If the course arrow does not automatically slew to the outbound course, it must be manually set to the outbound course so that the CDI sensing is correct.

Figure 24-46 indicates a right turn to 350° is upcoming.

See the diagram and accompanying Navigation pages of Figure 24-47 as the aircraft sequences through the turn.

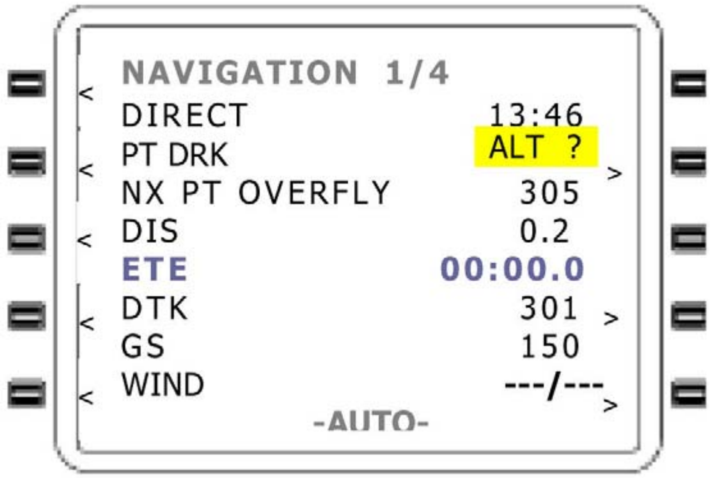


Figure 24-45. DIRECT to DRK Where PT Will Take Place

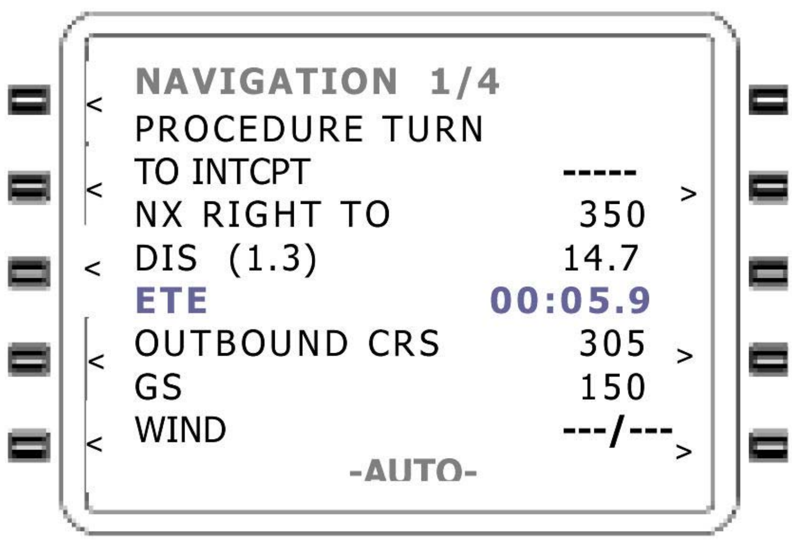


Figure 24-46. Right Turn to 350° is Upcoming

Note

- If aircraft is configured for dual systems, no XFILL? prompt will be displayed during a PT even if dissimilar data exists in each system.
- Estimated Time en Route (ETE) that is displayed after crossing the IAF on the procedure turn is the time from the aircraft present position to where the airplane intercepts the final approach course inbound (INTCPT). After crossing this intercept point, the ETE shown will be from the airplane present position to the FAF.

DIS that is displayed after crossing the IAF on the procedure turn is the distance from the aircraft present position to where the airplane intercepts the final approach course inbound (INTCPT). The DIS shown in parentheses is the straight-line distance from the aircraft present position to the procedure turn fix.

Note

The bearing and distance are with respect to the procedure turn fix.

After crossing this intercept point, the DIS shown will be from the airplane present position to the FAF and the DIS in parentheses will be removed. TO the FAF will be displayed at this time having changed from TO INTCPT on NAV page 1.

24.18.4.7.4 Using RADAR Vectors to Intercept a DME ARC

1. FPL key — Depress to display the ACTIVE FPL page.
2. Approach and Waypoint Sequencing — Verify they appear as selected.
3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.
4. FMS Mode — Select or verify the appropriate mode for guidance.
5. Flight Director or Autopilot — ENGAGE the appropriate mode.
6. HDG key — Depress to display the HEADING VECTOR page.
7. Heading — Insert as assigned by ATC.
8. ENTER key — Depress twice to engage HDG SELECT mode.

After receiving ARC intercept vector from ATC:

9. HDG key — Depress to display the HEADING VECTOR page.
10. Heading — Insert.
11. ENTER key — Depress.
12. BACK key — Depress to display INTERCEPT?

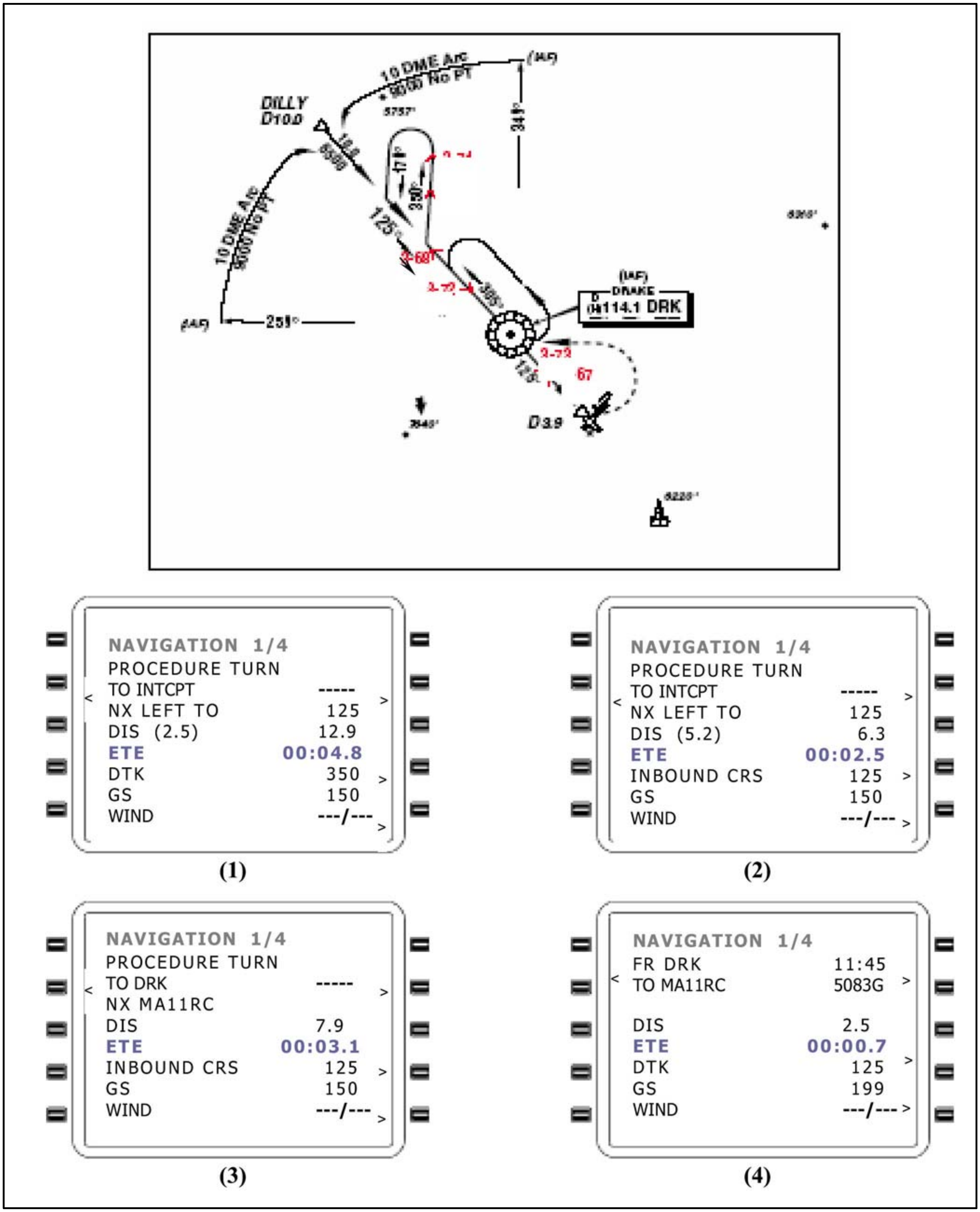


Figure 24-47. Aircraft Sequences Through a Procedure Turn

13. ENTER key — Depress. Cursor moves to the TO field.

14. BACK key — Depress until the ARC End/Final Approach Course Waypoint is displayed.

Note

If an intermediate waypoint exists on the ARC between the ARC beginning point and the ARC endpoint, the ARC intercept point should be approximated so it can be determined whether the ARC end or intermediate waypoint should be used as the TO waypoint. NO ARC INTERCEPT may be displayed if the wrong waypoint is selected.

15. ENTER key — Depress twice (accepts the default DTK).

16. CDI Display — Verify course needle is set to the DTK shown on the HEADING VECTOR page.

17. Waypoints and HSI Course — Verify proper sequencing during the approach.

18. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

24.18.4.7.5 Using Own Navigation to Fly DME ARC

1. FPL key — Depress to display the ACTIVE FPL page.

2. Approach and Waypoint Sequencing — Verify they appear as selected.

3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.

4. FMS Mode — Select or verify the appropriate mode for guidance.

5. Flight Director or Autopilot — ENGAGE the appropriate mode.

6. Waypoints and HSI Course — Verify proper sequencing during the approach.

7. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

The following is a brief description of the screen displays typically seen flying a DME Arc.

Note

- Certain EFIS map displays do not support curved lines to draw DME Arcs. In this case the map will only display waypoints up to and including the IAF waypoint at the beginning of the arc. No waypoints will be displayed while on the arc. Once the aircraft has passed the arc end waypoint, the map will display the remaining waypoints of the active flight plan. Although no waypoints will be displayed during the DME Arc Procedure, the FMS page displays will be as depicted in Figures 24-48, 24-49, and 24-50.

- If aircraft is configured for dual systems, no XFILL? prompt will be displayed during a DME ARC procedure even if dissimilar data exists in each system.

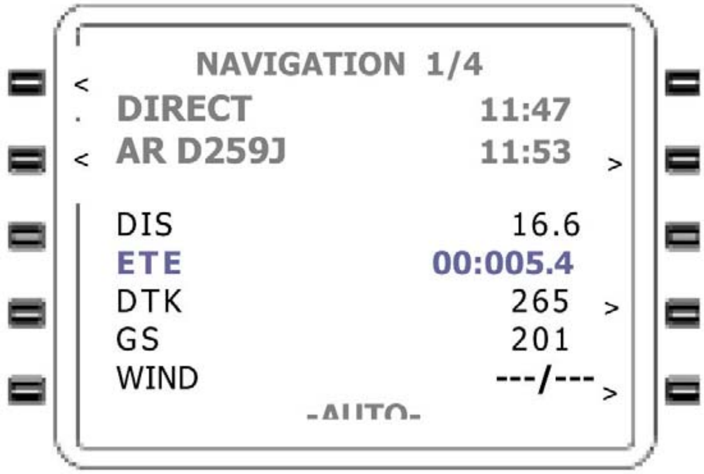


Figure 24-48. DIRECT To D259J Where Aircraft Will Begin Flying DME Arc (AR)

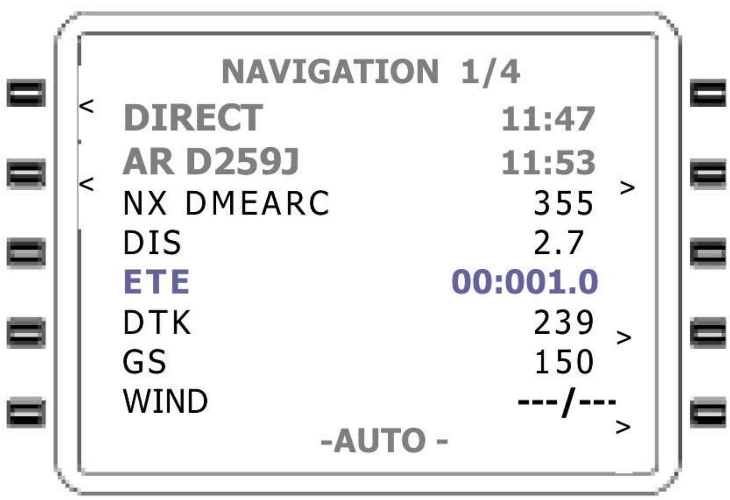


Figure 24-49. Aircraft Within 30 Seconds of Intercepting DME Arc at D259J

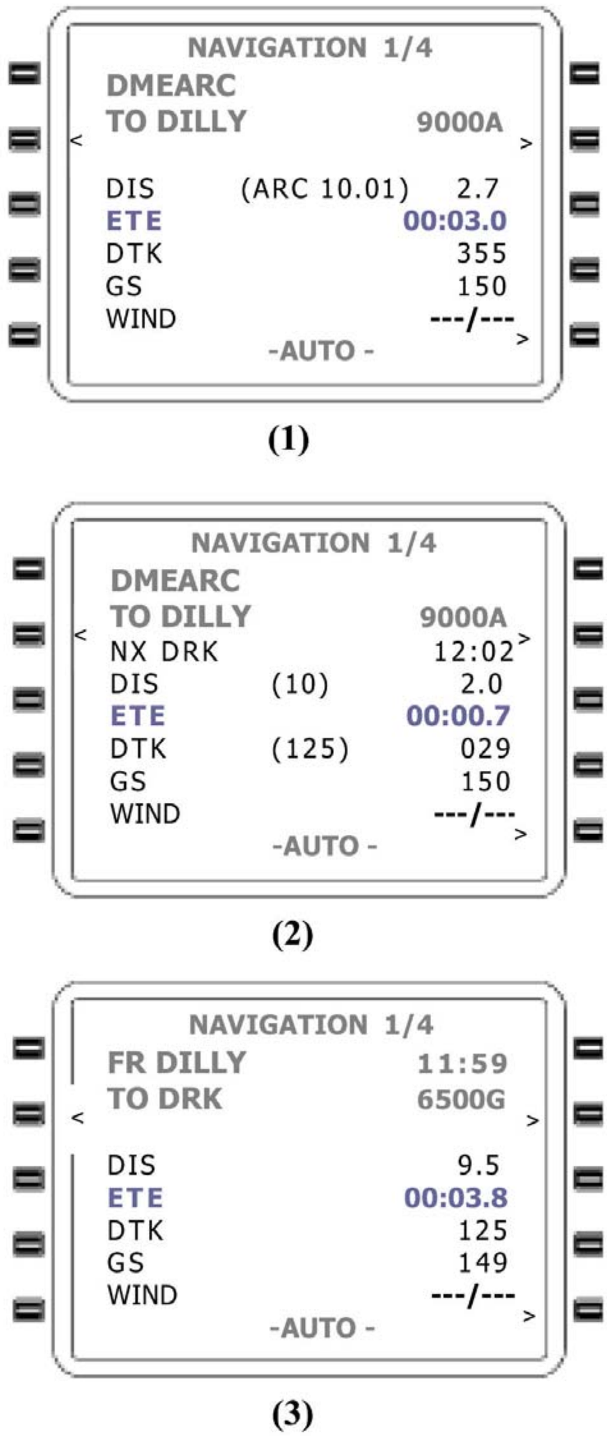


Figure 24-50. Final Three Screen Displays During Aircraft Flying DME Arc

As the aircraft approaches the AR waypoint, a message is displayed on the fourth line of the CDU indicating the next action the aircraft will take (NX DME ARC). This message is displayed 30 seconds prior to the event and disappears when the action is initiated. Figure 24-48 indicates the aircraft is flying DIRECT to D259J where the aircraft will begin flying a DME Arc (AR). Figure 24-49 shows the aircraft is within 30 seconds of intercepting the DME Arc at D259J.

Note

The naming convention for ARC waypoints is as follows: D indicates DME, 259 indicates the radial from the ARC center NAVAID, and J indicates the ARC distance (i.e., A=1 nm, J=10 nm).

Figure 24-50 shows the last three FMS page displays while flying a DME Arc. The first page display shows the aircraft is flying the DME Arc to DILLY. (ARC 10.01) in the DIS field indicates the arc center is 10.0 NM from the aircraft present position.

Note

- Distance (DIS) displayed is the straight line distance from the present aircraft position to the TO waypoint.
- Estimated Time en Route (ETE) is the time around the arc path to the TO waypoint. Use one of the following options to sequence to the missed approach waypoint.

Option 1, Direct To the Missed Approach Procedure Waypoint.

1. D► key — Depress. The DIRECT page will be displayed.
2. Line Select key — Depress to position the cursor over the Missed Approach Procedure waypoint, if required.
3. ENTER key — Depress to sequence to the Missed Approach Procedure waypoint.

Note

If the direction the airplane will turn is in question and the turn direction may not be in accordance with the missed approach procedure, manually turn the airplane toward the missed approach fix then perform the D► to procedure.

Option 2, Heading To Intercept A Course To Missed Approach Procedure Waypoint.

1. HDG key — Depress. The HEADING VECTOR page appears with the cursor over the HEADING field. Type in the appropriate heading using a preceding R or L to establish the turn direction (e.g., L150).
2. ENTER key — Depress. The cursor moves to the Heading Mode field and HDG SELECT? is in the cursor.

Note

Prior to step 3, the enter key may be pressed with the cursor over HDG select field so that the airplane can begin the intercept process. Repeat the procedure from step 1 to complete the HDG intercept procedure.

3. BACK key — Depress until INTERCEPT? is displayed.

4. ENTER key — Depress. The cursor moves to the TO field.

5. BACK key — Depress until the Missed Approach Procedure waypoint is displayed.

6. ENTER key — Depress. The cursor moves to the DTK field. Type in the desired track to be intercepted to the Missed Approach Procedure waypoint.

7. ENTER key — Depress twice. The NAVIGATION page will be displayed with the HDG and DTK displayed in yellow. The autopilot may now be re-engaged if required to fly to the Missed Approach Procedure waypoint.

It is recommended that the ETA field on NAVIGATION page 1 be changed to ALT during approach procedures for a display of the altitude constraints at the current TO waypoint. To change the field from ETA to ALT, perform the following:

1. Line Select key — Depress to position the cursor over the ETA field.

2. BACK key — Depress. ALT? will be displayed in the cursor (Figure 24-51).

3. ENTER key — Depress to change the field to altitude.

Note

If no altitude constraint is programmed at the current TO waypoint, the ALT field will display dashes.

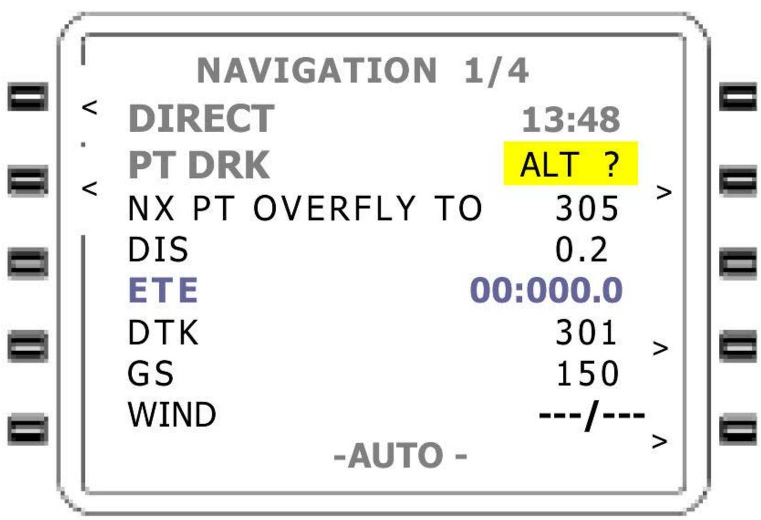


Figure 24-51. Changing ETA to ALT During Approach Procedures

24.18.4.8 Determining RAIM

RAIM availability can be determined by viewing GPS Subsection page 2 of 3. The GNS-XLS Flight Management System has an internal GPS receiver that is the main navigation sensor of the system. The GPS Subsection pages can be accessed through the NAVIGATION 4/4 page by pressing the Line Select key corresponding to the GPS sensor, then pressing ENTER. Pressing the NEXT key will display the second GPS SUBSECTION page in which various information can be observed including RAIM availability.

RAIM availability at the last flight plan waypoint can be observed on PLAN 2/8 page. Upon pressing the Plan key, the PLAN 1/8 page will be displayed. Pressing the PLAN key again will display the PLAN 2/8 page. RAIM at the last flight plan waypoint will display AVAIL (available) or NOT AVAIL (not available) at the ETA. If a manual ground speed or ETA has been entered, STANDBY will be displayed momentarily while the system calculates RAIM availability. If GPS is not functioning, NO NAV will be displayed.

24.18.4.9 Using the SPZ200 Autopilot

1. The pilot HSI Navigation Source Select switches (labeled NAV 1, NAV 2, TACAN, or FMS) are used to select the navigation source. When any navigation source is selected (NAV 1, NAV 2, TACAN, or FMS), and the V/L mode of the Flight Director is engaged, the autopilot receives navigation guidance from the associated navigation source and is coupled to it.

2. When selected, the appropriate mode(s) of the Flight Director will be illuminated. When no modes are active, the SBY segment of the Flight Director will be illuminated in amber.

Note

Whenever the Flight Director is disconnected (illuminating the SBY button), all modes have to be reengaged for the autopilot to be coupled. Altitude Hold must be reselected.

3. The HSI yellow Course Pointer is used for both VOR/LOC and FMS cueing depending on which Navigation source has been selected.

4. Pressing the pilot NAV 1 selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable VHF NAV #1 (VOR/LOC #1) guidance to be fed to the Autopilot. To navigate on a particular radial to/from a VOR station or to track a particular front or backcourse Localizer course, the pilot should select the appropriate course using the yellow Course Pointer and re-engage the Flight Director by selecting V/L and ALT (if altitude hold is desired).

5. Pressing the pilot NAV 2 selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable VHF NAV #2 (VOR/LOC #2) guidance to be fed to the autopilot. To navigate on a particular radial to/from a VOR station or to track a particular front or backcourse Localizer course, the pilot should select the appropriate course using the yellow Course Pointer and re-engage the Flight Director by selecting V/L and ALT (if altitude hold is desired).

6. Pressing the pilot TACAN selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable TACAN guidance to be fed to the autopilot. Relative bearing to a TACAN station is displayed by the red Bearing Pointer. To navigate on a particular radial to/from a TACAN, the pilot should select the appropriate course using the yellow Course Pointer and re-engage the Flight Director by selecting V/L and ALT (if altitude hold is desired).

7. Pressing the pilot FMS selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable FMS guidance to be fed to the

autopilot. For coupled FMS navigation, the pilot should reengage the Flight Director by selecting V/L and ALT (if altitude hold is desired). The FMS will automatically feed roll steering commands to the autopilot (via the Flight Director) and is capable of navigating from waypoint to waypoint, direct to a waypoint, in a Pseudo-Vortac mode (similar to radial tracking with a VOR or TACAN), or in FMS Heading Mode.

Note

When the FMS is coupled to the Flight Director and Autopilot, the HSI Course Pointer does not have to be aligned with the desired course. The FMS will provide the proper roll steering command to the autopilot irrespective of the yellow Course Pointer. The deviation bar will accurately reflect lateral deviation from the GNS-XLS desired track solution no matter what HSI Course has been selected. It is recommended that the pilot marry up the yellow Course Pointer with the GNS-XLS desired track (DTK) for enhanced situational awareness.

8. When the GNS-XLS is coupled to the Flight Director and Autopilot, both the HDG and V/L buttons will be illuminated amber on the Flight Director Control Panel. This is because a heading channel in the Sperry SPZ200 is used to provide roll steering commands from the GNS-XLS to the autopilot. The V/L mode is the only appropriate mode for FMS navigation.

9. When the FMS is coupled to the Flight Director and Autopilot and a temporary heading change is desired (either directed by ATC or to deviate around weather), the pilot can simply select the Flight Director HDG button and steer the aircraft with the Orange Heading Bug. When HDG is selected, the Flight Director Control Panel will no longer illuminate the V/L button and a heading change can be made without decoupling the Autopilot. When FMS navigation is once again desired, the pilot should freshen up the Direct To solution and select V/L.

Note

After a heading change, when the FMS is re-coupled to the Flight Director and Autopilot, the GNS-XLS will attempt to return the aircraft to the original course line unless a fresh Direct To solution is entered.

10. The copilot HSI Navigation Source Select switches (labeled NAV2, NAV2 RPTR, NAV 1, TACAN, or FMS) are used to select the navigation input to the copilot HSI. When selected and a green annunciator is present, the copilot HSI receives navigation cueing from the associated navigation source.

11. The copilot HSI NAV 2, NAV 1, TACAN, and FMS Navigation Source Select switches function identically to the pilot except that the copilot navigation source is for cueing only; they do not engage the Flight Director or couple to the Autopilot.

12. The copilot NAV 2 RPTR Navigation Source Select switch allows the copilot to simultaneously display cueing from VHF NAV #2 (VOR/LOC #2) when desired.

13. In the GNS-XLS, a “fence” (indicated by six plus signs “++++++”) separates the Missed Approach Procedure Holding Fix from the Missed Approach Point. Automatic leg sequencing will cease at the Missed Approach Point. When the Go Around mode is activated, the Flight Director will display a climb command and Autopilot will be decoupled. The GO AROUND button on the Flight Director Control Panel will be illuminated green. Missed Approach procedures should be executed as published and initially flown manually or coupled using the Flight Director Heading Mode, until waypoint to waypoint FMS navigation can be established and verified, to ensure that all portions of the missed approach procedure are flown correctly. After executing the Missed Approach procedure, and en Route to the Missed Approach holding fix, the fix can be automatically selected as the next waypoint by pressing the Direct To key, highlighting and pressing ENTER.

14. When a flight plan has been selected and activated, it will be display on the MFD. The active leg is shown as cyan (blue). Other legs are shown in white. On a GPS approach, when the GNS-XLS determines that the current aircraft position is within 2 nm of the Final Approach Fix (and RAIM is available), then all approach segment legs turn green. Search Pattern waypoints, once calculated, will be displayed on the MFD as flight plan legs. The MFD symbol generator is only capable of displaying a maximum of 15 waypoints at one time, which may limit the display of an entire Search Pattern. If an HSI presentation has been selected for the MFD, the course pointer will automatically point to the active waypoint (as a bearing pointer) irrespective of the pilot or copilot HSI Course selection. Whenever Vertical Deviation cueing has been calculated, a green VNAV pointer will appear on the right side of the MFD.

15. The following data is available from the GNS-XLS when FMS navigation is active and may be displayed on either the pilot or copilot HSI as appropriate:

    a. HSI Desired Track — Manually input by the pilot or copilot.

    b. HSI Bearing to station/waypoint — Red Bearing Pointer (TACAN and FMS only).

    c. HSI Distance to waypoint — (automatic in TACAN and FMS Modes, dependent on station in NAV 1, NAV 2, NAV 2 RPTR Modes).

    d. HSI Course/Cross Track deviation — (All Modes).

    e. HSI To/From flag — (All Modes).

    f. HSI Navigation Invalid Flag — (All Modes).

    g. HSI Vertical Deviation — (NAV 1, NAV 2 Modes only, FMS when VNAV valid).

    h. HSI Vertical Deviation Invalid Flag —(NAV 1 and NAV 2 Modes only).

Note

- If the airplane is in a turn at the time the DIRECT TO function is initiated, the airplane may roll wings level momentarily then continue the turn to the TO waypoint.

- When the FMS sequences from en route to Terminal, the airplane may bank slightly if the crosstrack error is greater than .05 nm because of the increased roll steering gains used in the terminal area.

- Refer to the Flight Manual for complete description and operation of the Flight Director/Autopilot system.

24.18.5 Vertical Navigation (VNAV) Operation

24.18.5.1 (VNAV) Operation — Pre-Departure

24.18.5.1.1 Setting Cruise Altitude, Transition Level, and Default Flight Path Angle

This procedure allows the pilot to define a Cruise Altitude and change the default values for Transition Level and Flight Path Angle.

After Initial Leg Selection:

1. VNAV key — Depress to display VNAV page 1.
2. Line Select key — Depress to position cursor over DATA?. Refer to Figure 24-52.
3. ENTER key — Depress to display VNAV DATA page with cursor over the CRUISE ALT field.
4. Cruise Altitude — Insert. Refer to Figure 24-53.

Only two or three digits are required to input an altitude, (e.g., enter 80 and 8,000 is displayed, enter 120 and 12,000 is displayed).

Any altitude value entered greater than the TRANS LEVEL, altitude value which normally defaults to FL180, is converted and displayed as Flight Level (FL). Entering 210 will display FL210.

An altitude less than 1,000 feet must be entered with a preceding zero (e.g., enter 052 and 52 is displayed).

Note

- CRUISE ALT may also be inserted on VNAV page 1, line 3 (adjacent to the TO waypoint field) when #TOC or #TOD is the TO waypoint. The cruise ALT may automatically be entered by the preselector if the preselector has the capability and the system is configured for digital preselector.
- A (at or above) or B (at or below) constraint entries are not applicable on this page. Setting a cruise altitude will establish a #TOD (Top of Descent) waypoint or a #TOC (Top of Climb) waypoint if VNAV is valid. A #TOC will be established only if there are no altitude constraints between the aircraft and #TOC and the aircraft is climbing.

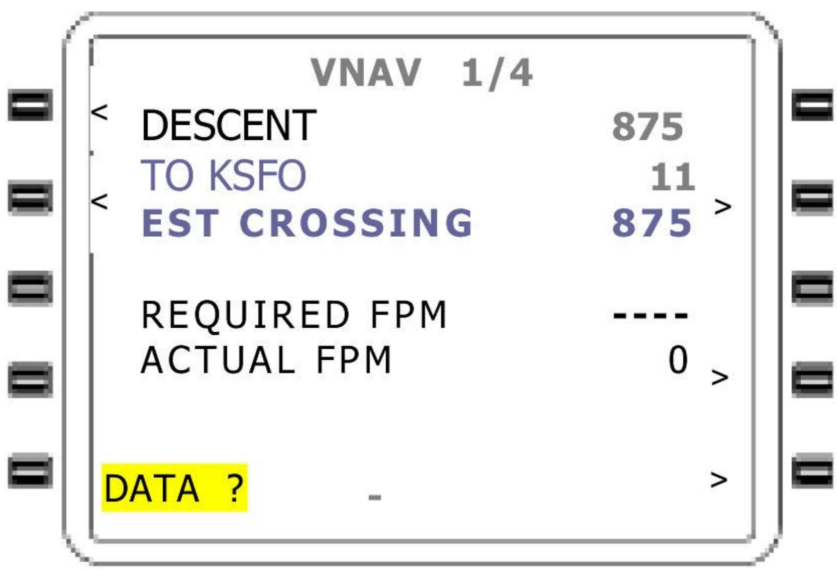


Figure 24-52. VNAV Page 1

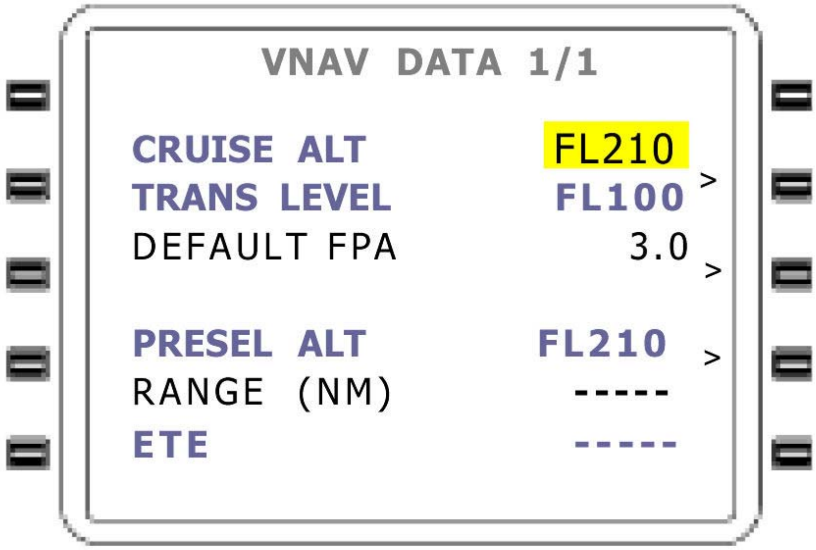


Figure 24-53. VNAV Data Page With Cursor Over CRUISE ALT

5. ENTER key — Depress.

6. Transition Level — Insert or verify.

Note

Field defaults to FL180 if pilot does not enter a value. Anytime a TRANS ALT is entered, the value will remain in non-volatile memory even after the system is shut down.

7. ENTER key — Depress.

8. Default Flight Path Angle (DEFAULT FPA) — Insert or verify (in degrees and tenths, 0.1 to 6.0 range).

Note

- Field defaults to 3.0 if pilot does not enter a value. Anytime an FPA is entered, the value will remain in non-volatile memory even after the system is shut down.

- If configured, altitude preselector information will be displayed at the bottom of the screen. If the aircraft is in a climb or descent, distance and ETA information to the preselected altitude will be displayed. Refer to Figure 24-52.

9. ENTER key — Depress to return to VNAV page 1.

24.18.5.1.2 Creating/Changing VNAV Waypoints

Vertical navigation constraints can only be programmed for waypoints on the Active Flight Plan, and though all Active Flight Plan waypoints are displayed on VNAV pages, new waypoints must be added to the Active Flight Plan before they appear on the VNAV Flight Plan waypoint pages.

After initial leg selection on NAV page 1:

1. NAV, FPL, or D▸ key — Depress to display applicable page.
2. Line Select key — Depress to position cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected. If the waypoint is selected from either the NAV or Direct pages, Direct FPA information pages will be displayed on the last line of the screen.

3. VNAV key — Depress to display VNAV WAYPOINT page for selected waypoint.
4. ALT — Insert altitude constraint followed by A (at or above) or B (at or below), if applicable. Only two or three digits are required to input an altitude (e.g., enter 30A and 3,000A is displayed). Refer to Figure 24-54. Full digit entry may be used to enter an altitude. Altitudes less 1,000 feet enter a preceding zero (e.g., enter 054 and 54 feet is displayed).

   Any altitude entered greater than the transition level is converted and displayed as Flight Level (FL).
5. ENTER key — Depress. Cursor moves to OFFSET field (Figure 24-54).
6. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).
   a. If the offset is prior to the waypoint, enter the range value and a (-) prefills as a default or
   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.
   c. To erase the offset value, insert 0 and press ENTER key. The field changes to dashes, indicating no offset is programmed.
7. ENTER key — Depress. The cursor moves to the FPA field only if the entered constraint is below the aircraft present altitude.

Note

A climb FPA cannot be programmed but the direct FPA field will display the up angle between the aircraft present altitude and the altitude constraint that was entered. If an FPA is programmed to a direct FPA up waypoint, it will be a DN (descent) FPA and an ambiguity will be displayed on the VNAV waypoint page.

8. Flight Path Angle (FPA) — Insert or verify (valid range is 0.1 to 6.0) (Entry ‘3.0’ in Figure 24-54).

Note

The FPA value field pre-fills with the default (DEF) value programmed on the VNAV DATA page if this waypoint was accessed from the FPL page. If accessed from the NAV or D▸ page, the FPA field prefills with the (DIR) value. If an FPA is manually entered, the FPA type field changes to (MAN).

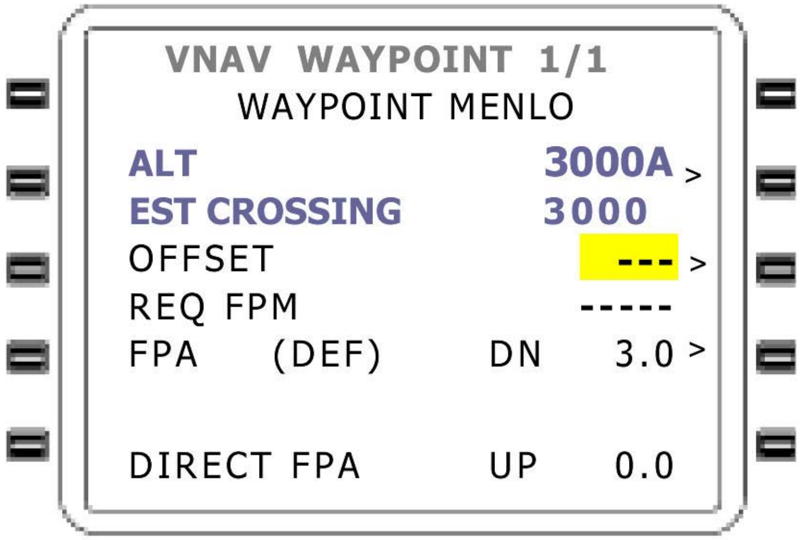


Figure 24-54. VNAV Waypoint Page

With the cursor over the FPA value, Depressing the BACK key will cycle through all or some of the following:

a. (DEF).

b. (DB).

c. (AUTO).

d. (DIR).

e. (MAN).

To cancel the FPA, insert 0 and press ENTER key. The field changes to dashes, indicating no FPA is programmed, the vertical deviation output is invalid, and no vertical deviation information will be displayed on the CDU or the ADI/HSI.

9. ENTER key — Depress to load or verify the FPA value.

Note

When a descent FPA is programmed at a waypoint, a G appears next to the altitude constraint indicating a Glide Path and vertical deviation guidance and information will be available.

24.18.5.1.3 Reviewing VNAV Waypoints

When SIDs, STARs, or Approaches have altitude constraints at waypoints on the procedure, the system automatically loads the altitude constraints from the database on to the Active Flight Plan. No altitude will be loaded at the MAP if the approach is a circling approach or if the MAP is abeam or beyond the runway threshold. The system will not load any “expect to cross” altitudes from the database on to the SIDS or STARS, as part of ACTIVE FLIGHT PLAN or VNAV pages. No altitudes are loaded from the database when an approach procedure contains a Procedure Turn.

Note

The system will not fly a full SID or STAR procedure.

Using Active Flight Plan page:

1. FPL key — Depress to display the ACTIVE FLIGHT PLAN page.
2. Line Select key — Depress to position the cursor over the desired waypoint.
3. VNAV key — Depress. The VNAV WAYPOINT page appears with the cursor over the ALT field.
4. ALT — REVIEW.

Note

If (AUTO) FPA is displayed, the system has automatically programmed a waypoint-to-waypoint FPA for the procedure.

5. ENTER key — Depress until display returns to ACTIVE FLIGHT PLAN page or depress the FPL key.
6. Repeat steps 2 through 5 to review VNAV waypoint data at remaining waypoints.

Using VNAV Flight Plan Waypoints page:

1. VNAV key — Depress to display the VNAV FLIGHT PLAN WAYPOINTS pages.
2. Line Select key — Depress to position the cursor over the desired waypoint.
3. ENTER key — Depress. The VNAV WAYPOINT page appears with the cursor over the ALT field.
4. ALT — REVIEW or insert new value.

Note

If the FPA was retrieved from the database, (DB) appears in the FPA type field.

5. ENTER key — Depress to return to the VNAV FLIGHT PLAN WAYPOINTS page.
6. Repeat steps 2 through 5 to review or change altitude constraints at remaining waypoints.

24.18.5.2 (VNAV) Operation — En Route

24.18.5.2.1 Programming Vertical Path Descents

The pilot can use various methods to load a Flight Path Angle (FPA) and determine the aircraft descent path.

Note

When the system detects a rapid change of barometric altitude setting, non-continuous data from an air data computer, vertical speed change of more than 40 ft/s, or sequencing to the next waypoint on the active flight plan, the vertical deviation output is momentarily set Invalid. When vertical deviation returns to a valid state, the appropriate value of vertical deviation will again be displayed.

Using Database (DB) FPA:

The GNS-XLS database contains Flight Path Angles associated with waypoints on SIDs, STARs, and Approaches that pre-fill when these procedures are programmed into the Active Flight Plan. The FPA field on the VNAV WAYPOINT page displays (DB), which indicates an FPA from the database is loaded and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint. If the FPA at the (DB) VNAV waypoint is changed in any way, the (DB) FPA will no longer be available.

Using Default (DEF) FPA:

The default FPA value will automatically be displayed if an altitude is programmed on the VNAV WAYPOINT page, except if the FPA comes from the database or the VNAV WAYPOINT page was accessed using a Direct To function.

The pilot can load the Default FPA (set on the VNAV DATA page) by pressing the ENTER key when the cursor is on the FPA field of the VNAV WAYPOINT page. The FPA field displays (DEF) and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint.

Using Manual (MAN) FPA:

The pilot can type in a desired Flight Path Angle on the VNAV WAYPOINT page within the valid range, 0.1 to 6.0 degrees. When the ENTER key is depressed, the FPA is loaded, the FPA field indicates (MAN), and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint.

Using Automatic (AUTO) FPA:

The (AUTO) mode is provided to link together descent waypoints that have Cross-At type constraints and to provide a computed Flight Path Angle between them. Refer to Figure 24-55.

The (AUTO) mode may be selected only if the chosen waypoint has a Cross-At type constraint programmed. All Cross-At waypoints that are a part of a STAR or APPROACH are automatically put into (AUTO) mode when the procedure is retrieved from the database and loaded onto the Active Flight Plan.

If the waypoint prior to the selected (AUTO) FPA waypoint has a Cross-AT-or-ABOVE, Cross- AT-or-BELOW , or Cross-BETWEEN constraint programmed, an automatic angle is assigned and will be the same angle as the programmed Default Angle on VNAV DATA page. Vertical Deviation is provided at the programmed angle when the waypoint becomes the Descent Reference Waypoint.

Note

- If no ALT constraints are programmed before the selected (AUTO) FPA waypoint, the (AUTO) FPA is the same as the (DEF) FPA.
- Unless an FPA is programmed at a waypoint, the system uses the (DEF) FPA to the first waypoint on the flight plan with an altitude constraint to establish a #TOD point. To help establish #TOD, the system will automatically load the destination airport elevation on the flight plan, provided the flight plan was not obtained from AFIS. An altitude constraint and FPA must be loaded using the ENTER key to establish a Path Descent and activate Vertical Deviation to any waypoint except a (DB) WPT.

24.18.5.2.2 Editing Altitude Constraints

The following pages allow the pilot to edit altitude constraints for waypoints on the VNAV WAYPOINT page, VNAV pages, referred to as VNAV FPL pages. One of the three following options may be used:

Option 1: Using the VNAV page.

Option 2. Using the VNAV FPL WAYPOINT pages.

Option 3: Using the VNAV WAYPOINT page.

Option 1: Using VNAV page:

1. VNAV key — Depress to display VNAV 1/2 page. The altitude constraint may be changed on this page if the current TO waypoint has a constraint programmed. Type the new altitude in the altitude field adjacent to the TO WPT. All parameters associated with the former constraint will remain unchanged (i.e., FPA, A, B, G, or OFFSET).
2. ENTER key — Depress.

Option 2: Using VNAV FPL WAYPOINT page:

1. VNAV key — Depress to display the VNAV 2/2 page.

Note

More VNAV pages will be available if the active flight plan has several pages of waypoints.

2. Line Select key — Depress to position the cursor over the desired waypoint altitude.
3. Altitude Constraint — Insert new altitude constraint followed by A (at or above) or B (at or below), if applicable. Any altitude value entered greater than the Transition Level value on the data page is converted and displayed as FL (flight level, rounded off to the nearest hundred feet). An altitude less than 1,000 feet must be entered with a preceding zero.
4. ENTER key — Depress.

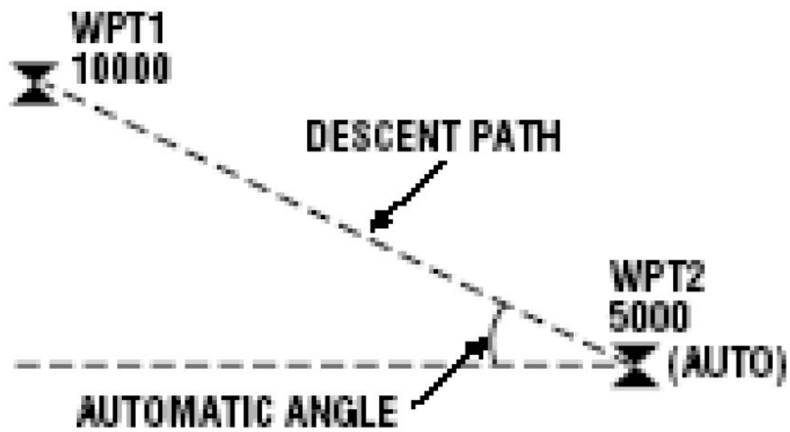


Figure 24-55. Linked Descent Waypoints with Computed Flight Path Angle

Option 3: Using the VNAV WAYPOINT page:

1. NAV, FPL, or D▸ key — Depress to display applicable page.
2. Line Select key — Depress to position cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected.

3. VNAV key — Depress to display VNAV WAYPOINT page for selected waypoint.
4. ALT — Insert new altitude constraint followed by A (at or above) or B (at or below), if applicable. Only two or three digits are required to input an altitude, (e.g., enter 30A and 3000A is displayed).

   Any altitude value entered greater than the Transition Level value on the data page is converted and displayed as Flight Level (FL). An altitude less than 1,000 feet must be entered with a preceding zero.

Note

If the waypoint is part of a SID, STAR, or Approach procedure, the altitude constraint pre-fills from database. “Cross-Between two Altitudes” type constraints cannot be programmed manually.

5. ENTER key — Depress. Cursor moves to OFFSET field.
6. ENTER key — Depress. The cursor moves to the FPA field.
7. ENTER key — Depress to return to the page where the VNAV waypoint was accessed.

24.18.5.2.3 Direct To — VNAV Waypoint as Lateral Waypoint

This procedure enables the pilot to proceed Direct To a waypoint, both vertically and laterally by means of a Vertical Path Descent.

If the current To waypoint is the desired VNAV Direct To waypoint, go to step 4.

1. Line Select key (on NAVIGATION page 1) — Depress to position the cursor over the TO waypoint field. Type in the desired waypoint and press ENTER or, D► key — Depress. A DIRECT TO page appears with the cursor over the current TO waypoint.

2. Line Select key — Depress to position cursor over desired waypoint.

Note

- Active Flight Plans containing more than 18 waypoints will display the remaining waypoints on subsequent pages. Press D► key again, or NXT key, to access remaining pages.

- A Random Waypoint may also be used. See paragraph 24.18.4.6.6.2.

3. ENTER key — Depress. CDU screen automatically advances to NAVIGATION page 1.

Note

If an offset waypoint was selected, the system first displays the OFFSET WPT page. Verify data and Depress ENTER. The DIRECT page will again be displayed with the cursor over the Offset Waypoint. Press ENTER. The display automatically advances to NAVIGATION page 1.

4. Line Select key — Depress to position cursor over TO Waypoint on NAVIGATION page 1.

5. VNAV key — Depress to display the VNAV WAYPOINT page for TO Waypoint.

6. ALT — Insert or verify. If an altitude constraint has already been programmed, the cursor will be displayed over the FPA (DIR) field value. You may proceed to step 10.

Note

If the waypoint is part of a SID, STAR, or Approach procedure, the ALT constraint field prefills from the database.

7. ENTER key — Depress. Cursor moves to OFFSET field.

8. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).

   a. If the offset is prior to the waypoint, enter the range value and a (-) pre-fills as a default or

   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.

Note

To erase the offset value, insert 0 and press ENTER key. The field changes to dashes, indicating no offset is programmed.

9. ENTER key — Depress. Cursor moves to the FPA field.

Note

Cursor only moves to the FPA field if altitude constraint is below current baro altitude.

10. Flight Path Angle — Verify Direct Flight Path Angle is desirable to fly.

Note

Direct Flight Path Angle pre-fills if it is within the valid range (0.1 to 6.0).

11. ENTER key — Depress to accept waypoint entries. VNAV page 1 is displayed, a Vertical Path Descent has been established, and Vertical Deviation information and guidance is enabled if a descent has been programmed.

24.18.5.2.4 Direct To — VNAV Waypoint

This procedure allows the pilot to program a Direct To on the Vertical Flight Plan, while still flying the lateral waypoints on the Active Flight Plan. The VNAV Direct To function automatically deletes any intermediate altitude constraints and sets up a Path Descent to the Vertical TO Waypoint using the Direct Flight Path Angle.

1. D▸ key — Depress. A DIRECT TO page will appear with the cursor over the current TO waypoint.
2. Line Select key — Depress to position cursor over desired waypoint.
3. VNAV key — Depress. VNAV WAYPOINT page appears. If necessary, position cursor over ALT field. If an altitude constraint has already been programmed, the cursor will appear over the FPA value field. Go to step 8.
4. ALT — Insert or verify.
5. ENTER key — Depress. Cursor moves to OFFSET field.
6. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).
   a. If the offset is prior to the waypoint, enter the range value and a (-) pre-fills as a default or
   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.
7. ENTER key — Depress. Cursor moves to FPA field.
8. Flight Path Angle — Verify or insert (in degrees and tenths, 0.1 to 6.0 range).

Note

Direct Flight Path Angle pre-fills if it is within the valid range and an ALT is programmed.

9. ENTER key — Depress to accept waypoint entries and return to VNAV page 1.

24.18.5.2.5 Creating VNAV Profile Waypoints

VNAV profile waypoints (#TOC, #TOD, and #PRESL) are used to provide a prediction of the position of the aircraft on the vertical flight path. These are non-enterable waypoints computed by the system based on current ground speed and vertical speed.

Top of Climb (#TOC):

Top of Climb Altitude is obtained from either the CRUISE ALT entered by the pilot on the VNAV DATA page, or from the Altitude Preselector setting, if available. When the aircraft arrives at the preselected altitude, the system will automatically set cruise altitude to the pre-selected altitude, which will then provide a #TOD prediction.

If vertical climb constraints are programmed, #TOC will automatically appear as the Vertical To Waypoint when the aircraft laterally passes within 1 mile the last vertical waypoint on the active flight plan that has a climb constraint. Once the aircraft has crossed the final climb constraint waypoint, #TOC will then become the Vertical To Waypoint. If there are no vertical constraints programmed for climb, #TOC will be displayed as the first vertical waypoint as long as the aircraft is in a climb.

When the programmed cruise altitude is reached, #TOC is removed from the VNAV Flight Plan, and #TOD becomes the Vertical To Waypoint.

When #TOC is the TO Waypoint:

The pilot may obtain range and ETE to any altitude above the aircraft during a climb.

1. VNAV key — Depress to display VNAV page 1.
2. Line Select key — Depress to position the cursor over the #TOC altitude field.
3. Alternate Altitude — Insert. This value may be above or below the altitude pre-select value, but must be above the current barometric altitude.
4. ENTER key — Depress and observe the change in RANGE and ETE.
5. Repeat steps 2 thru 4 to return to previous #TOC altitude setting.

Top of Descent (#TOD):

The Top of Descent waypoint is the position where the aircraft intercepts the descent path at the cruise altitude. The system calculates the #TOD by establishing a valid Descent Reference Waypoint, then uses either the CRUISE ALT entered by the pilot on the VNAV DATA page, or the Altitude Preselector setting, if available. The default FPA may be used in this calculation.

If no Descent Reference Waypoint with FPA and crossing altitude is programmed, the system will use the arrival airport and elevation (ARP Reference Point, not a runway) and the default FPA to fix Top of Descent as long as the active flight plan is not an AFIS flight plan.

Note

The default FPA may be used to establish #TOD, but no Vertical Deviation Valid will occur until the FPA is actually loaded from the VNAV WPT page.

One minute prior to arriving at #TOD, the system issues the VNAV WPT ALERT message and the discrete waypoint light will flash for 10 seconds, then go steady.

Note

Changing CRUISE ALT on the CDU to a lower altitude should only be done after the aircraft has departed cruise altitude, or #TOD at the current cruise altitude will be lost.

Pre-Selected Altitude Intercept Point (#PRESL):

When the system has an input from an Altitude Pre-selector and the aircraft is flying toward this altitude, a profile waypoint (#PRESL) appears on the VNAV page. #PRESL, however, never becomes the Vertical To Waypoint. When the Pre-selector input is valid, ETE and RANGE to #PRESL can be found on the VNAV DATA page.

Note

With certain types of Pre-Selectors installed (analog), it may be necessary to manually enter a CRUISE ALT when the PRESEL ALT is set higher than the cruise altitude. The system does not read analog Pre-selector output until the aircraft barometric altitude is within approximately 1,000 feet of the pre-selected value.

Descent Reference Waypoints:

Descent Reference Waypoints have a fixed altitude crossing, (i.e., Cross-At type altitude constraint). To create a Descent Reference Waypoint, the pilot can program a Flight Path Angle or a Cross-At altitude constraint.

If a programmed FPA violates a prior vertical constraint, the system reassigns the Descent Reference Waypoint, using the Default FPA from the VNAV DATA page, as illustrated in Figure 24-56.

24.18.6 Search and Rescue

24.18.6.1 Introduction

In addition to the standard GNS-XLS functions, the FMS may be configured for special mission capabilities.

24.18.6.2 Search Patterns

The XLS-MSP generates and steers the aircraft through five search pattern types: Ladder, Expanding Square, Orbit, Sector Search, and Parallel Line. The operator is able to select the pattern and define the specific parameters appropriate to the mission. Search Patterns can be activated, canceled, deleted, or interrupted at any time.

24.18.6.3 Break and Resume

The search pattern being flown can be interrupted, then resumed at the operator’s convenience with the aircraft automatically returned to the point of interruption traveling in the proper direction. This allows the crew to maneuver the aircraft freely, while allowing resumption of the search pattern with no loss of coverage.

24.18.6.4 Enhanced Steering

During an active search, the XLS increases the steering gains to those used during an approach to ensure the aircraft accurately tracks the search pattern. Also during an active search, the scaling of the crosstrack distance indicators is increased to 1 nm full scale deflection (terminal mode scaling). Configuration for steeper bank angles is provided.

24.18.6.5 Target Waypoints

The XLS-MSP allows the flightcrew to generate target waypoints by designating a position via a discrete switch (Mark-On-T arget) or via digital interface such as a weather RADAR. Target waypoints are stored on a flight plan by the XLS for future use. In addition, direct navigation may be selected to one of the latest nine target waypoints from the Direct-To Target Waypoints page.

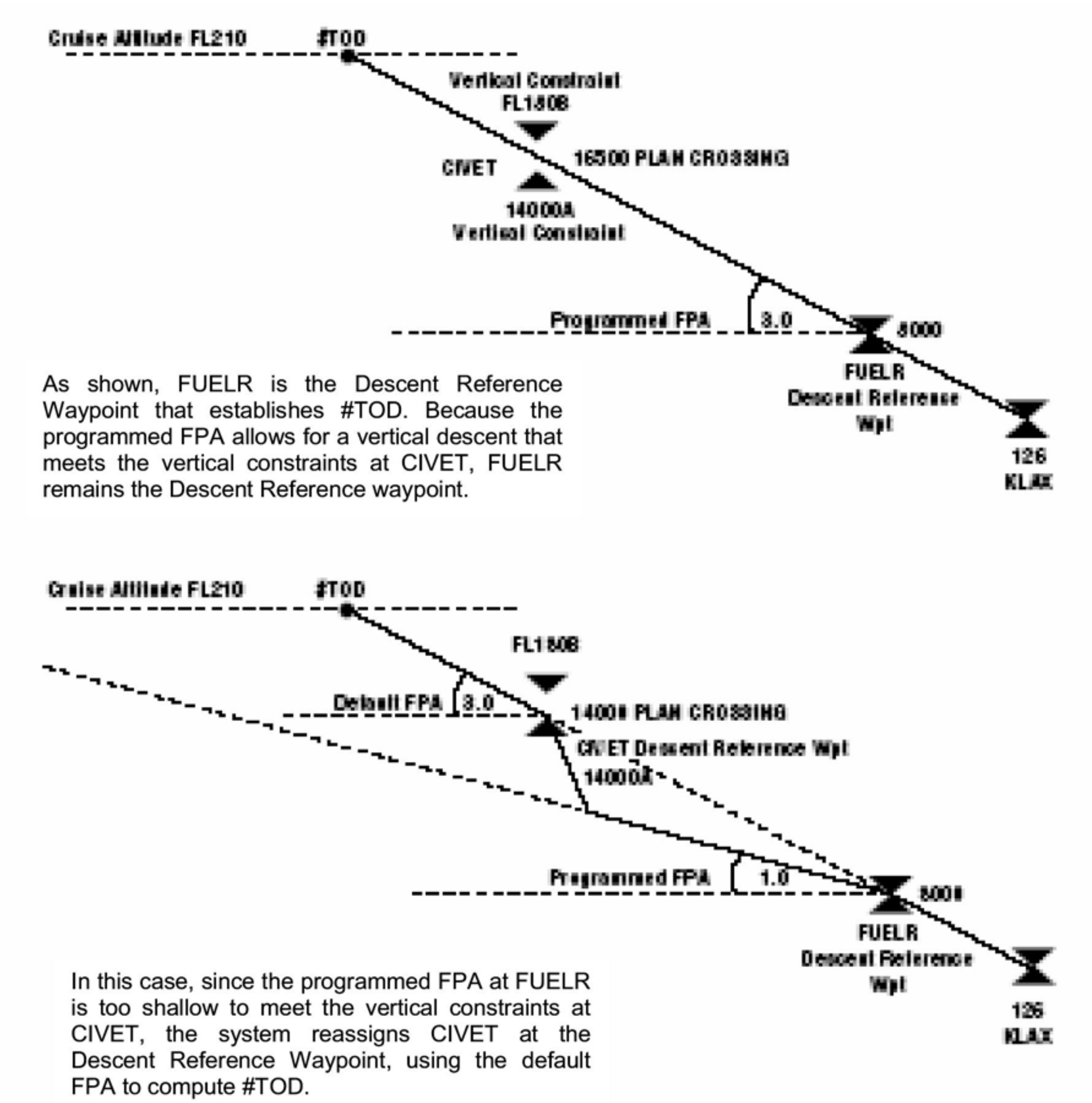


Figure 24-56. Top of Descent and Descent Reference Waypoint

24.18.6.6 WGS-84 to Tokyo Datum Calculation

The XLS may be configured to provide a special PLAN page to convert a position fix between the WGS-84 and the Tokyo coordinate systems.

Note

For further information on accessing the search pattern planning pages and engaging these aspects of system operation, refer to the GNS-XLS Enhanced FMS Operator's Manual.

24.18.7 Emergency Procedures

During an in-flight emergency, the GNS-XLS can provide immediate cueing to the nearest airports. The pilot should press the Direct To (D▸) button twice rapidly. Data showing the Airport Identifier, Magnetic Heading, and Distance for the nine closest airports will be displayed.

24.18.7.1 Loss of Power in Flight

This procedure should only be used in a remote area where NAVAIDs are unavailable and there is reason to believe the sensors contributing to the composite position may be in error.

The procedure allows the pilot to initialize en route when the aircraft has sustained a loss of power for more than 7 seconds. The Power Off Waypoint, “#OFF”, provides a snapshot of system data at the moment power was lost.

To Initialize when power is restored:

Note

When power returns, system performs Self Test and displays the INITIALIZATION page.

1. DATE and GMT — Verify or ENTER current DATE and GMT if required.

2. ENTER key — Depress to place the cursor over the POS field, if required.

Note

The coordinates are a rolling display of the real time blended position of the sensors being updated.

3. ENTER key — Depress to accept real time position.

4. HOLD key — Depress.

5. Power Off Waypoint IDENT — Insert “#OFF”.

6. ENTER key — Depress.

7. MINUTES OFF, LAST TK, LAST GS — Verify and RECORD for future use (Figure 24-57).

8. BACK key — Depress to return to HOLD page.

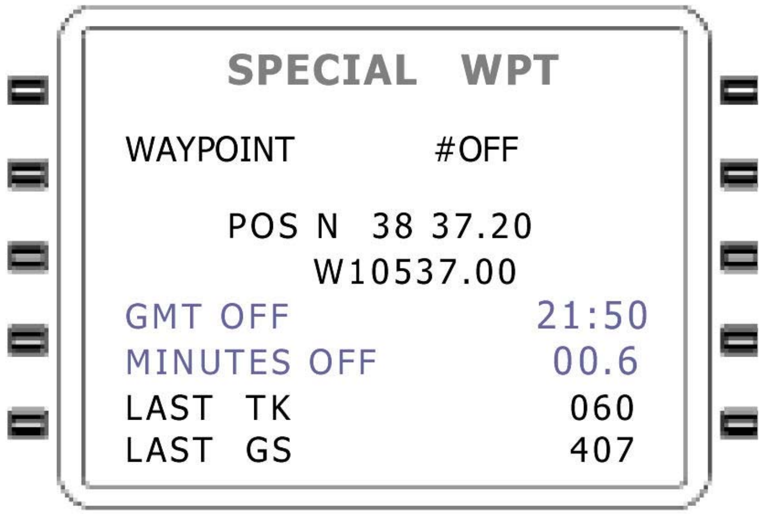


Figure 24-57. Special WPT Page

Note

An Offset Waypoint (#OFF*) can be input with a radial based on the LAST TK value and distance calculated from the LAST GS value as well as the time elapsed from power off, provided significant changes to aircraft track or groundspeed have not been made. If the aircraft has turned or if the speed has changed, the pilot should estimate the track and distance traveled since the loss of power.

9. Offset Waypoint IDENT — Insert.
10. ENTER key — Depress.
11. Recorded or Estimated Radial — Insert LAST TK value or averaged value (Figure 24-58).
12. Distance — Insert calculated distance in nm and tenths.
13. ENTER key — Depress.
14. Waypoint Coordinates — Verify for reasonability.
15. ENTER key — Depress.
16. DIF — CHECK.

If Update Desired:

17. ENTER key — Depress. The VLF (RPU) sensor and the VPU interfaced to the updated CDU are updated as well as the composite position.

If Update Not Desired:

18. NAV, PLAN, FPL, TUNE, VNAV, HDG, or D▸ key — Depress to cancel the HOLD.

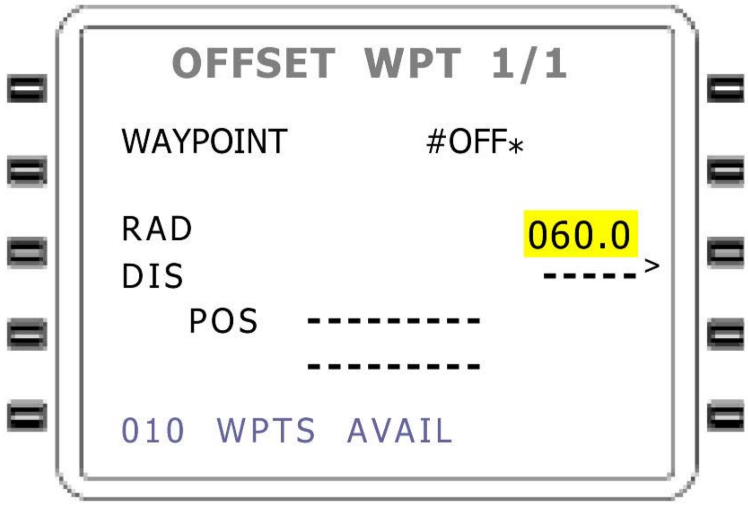


Figure 24-58. Offset WPT Page

CHAPTER 25

UC-12F Navigation

25.1 GENERAL

The navigation system is composed of two identical VOR/LOC receivers, a Global Positioning System (GPS)-based FMS, two marker beacon receivers, an ADF receiver, and a TACAN/DME system. Figure 20-1 shows the location of antennas.

25.2 RADIO MAGNETIC INDICATORS

Two identical RMIs are installed, one for the pilot and one for the copilot (Figure 25-1), that provide aircraft heading and radio bearing information. The compass card on the pilot RMI is driven by COMPASS 2 and the compass card on the copilot RMI is driven by COMPASS 1. The RMIs are protected by respective circuit breakers placarded RMI NO. 1 and RMI NO. 2, located on the copilot right sidewall panel.

1. Double-needle pointer — Indicates bearing selected by double-needle switch.
2. Warning flag — Indicates loss of power or unreliable heading information.
3. Single-needle pointer — Indicates bearing selected by single-needle switch.
4. Double-needle switch — Selects desired signal to be displayed on double-needle pointer.
   a. ADF position — Selects ADF bearing information.
   b. VOR position — Selects VOR-2 bearing information.
5. Single-needle switch — Selects desired signal to be displayed on single-needle pointer.
6. Compass card — Indicates aircraft heading at top of dial.
   a. ADF position — Selects ADF bearing information.
   b. VOR position — Selects VOR-1 bearing information.

25.3 HORIZONTAL SITUATION INDICATORS

25.3.1 Description

The pilot and copilot have separate HSI instruments on their respective instrument panel sections (Figure 25-2). Depending upon the navigation system selected by means of respective HSI indicator switches, the information displayed by each HSI indicator is derived and controlled by either the VOR-1, the VOR-2, the TACAN, or the FMS. Each HSI indicator combines displays to provide a map-like presentation of the aircraft position. The indicator displays aircraft position relative to VOR, localizer, and glideslope.

1. Course knob — The yellow course pointer is positioned on the heading dial by the course knob to select a magnetic bearing that coincides with the desired VOR radial or localizer course. Like the heading bug, the course pointer rotates with the heading dial to provide a continuous readout of course error to the computer. When one of the radio modes is selected, the vertical command bar in the Flight Director Indicator (FDI) will display bank commands to intercept and maintain the selected radio course.
2. Compass synchronization annunciator — When the compass system is in the slaved mode, the compass synchronization annunciator will oscillate between the ● and x, indicating that the heading dial is synchronized with gyro-stabilized magnetic heading.

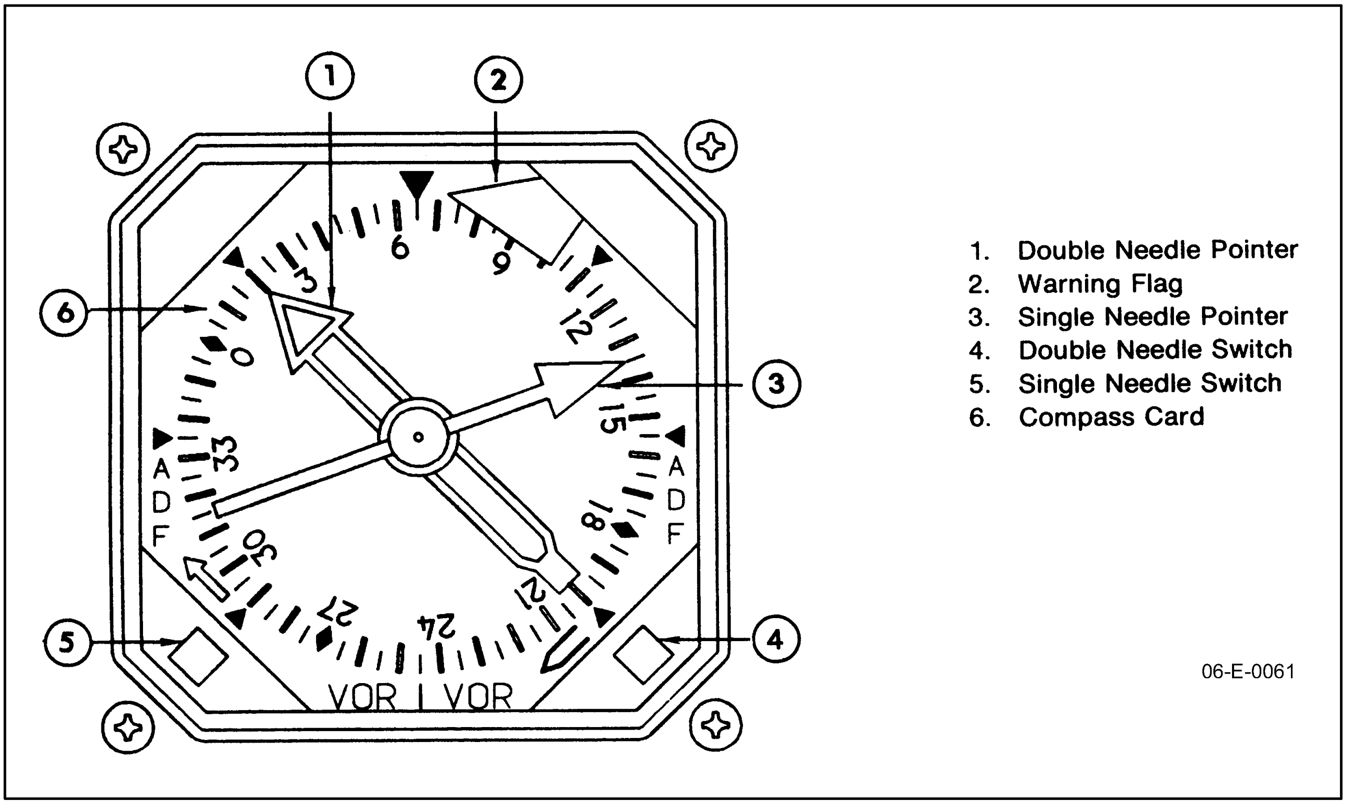


Figure 25-1. Radio Magnetic Indicator

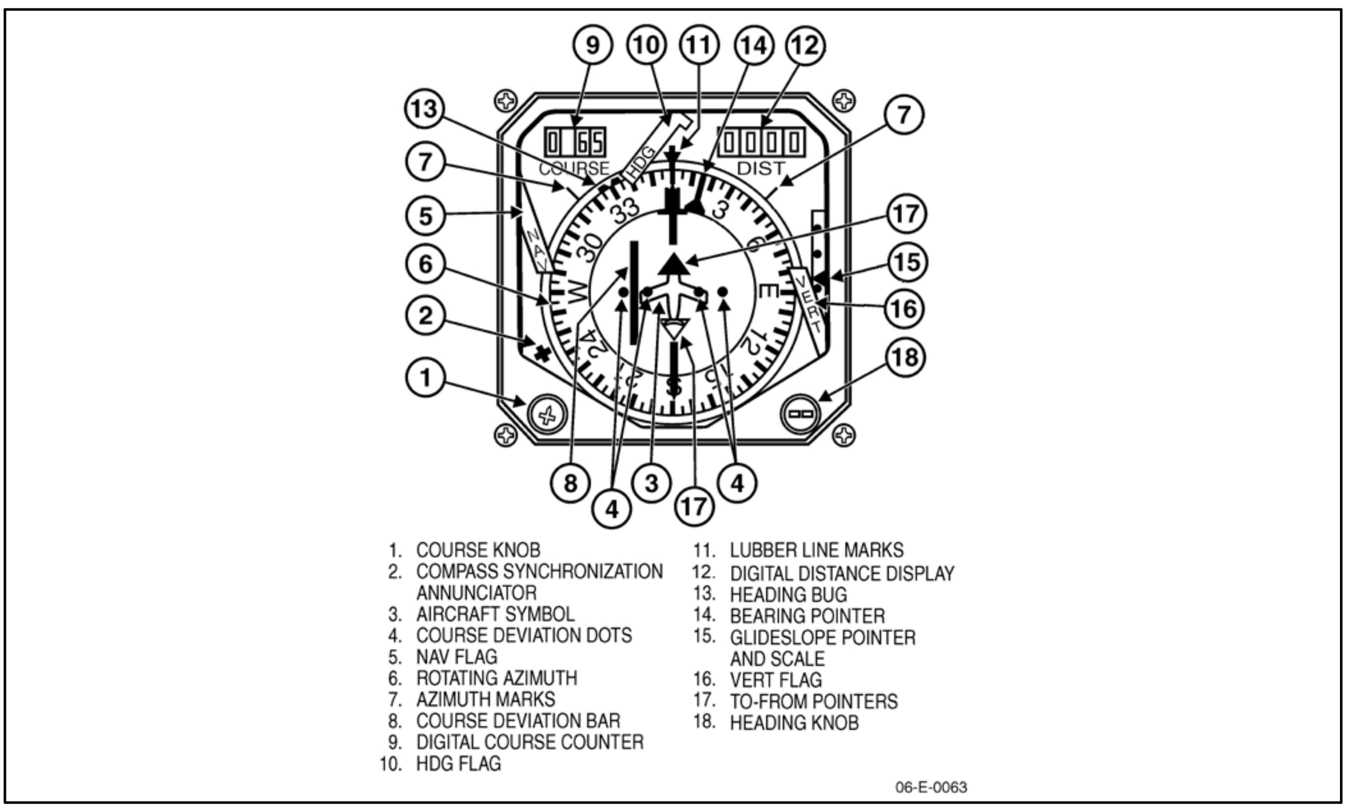


Figure 25-2. Horizontal Situation Indicator

3. Aircraft symbol — A fixed aircraft symbol corresponds to the longitudinal axis of the aircraft and lubber line markings. The symbol shows aircraft position and heading with respect to a radio course and the rotating dial.

4. Course deviation dots — In VOR and TACAN operations, each dot represents 5° deviation from centerline. In ILS operation, each dot represents 1° deviation from centerline. In FMS operation, a full-scale deviation from center represents a ±5 nm in en route, ±1 nm deviation in approach/missed approach, and ±0.3 nm deviation in final approach depending upon FMS mode. Refer to paragraph 24.18 for further discussion on FMS CDI scaling.

5. NAV flag — The NAV flag indicates that the information derived from the selected navigational beacon is invalid and should not be used.

6. Rotating heading dial — The rotating heading dial rotates with the aircraft throughout 360° and displays gyro-stabilized magnetic compass information. The azimuth ring is graduated in 5° increments.

7. Azimuth marks — Azimuth marks are fixed at 45° bearings throughout 360°.

8. Course deviation bar — The course deviation bar represents the centerline of the selected VOR or localizer course. The aircraft symbol shows, pictorially, actual aircraft position in relation to this selected course.

9. Digital course counter — The course counter provides a digital readout of the selected course.

10. HDG flag — The HDG flag indicates that the heading information displayed is invalid and should not be used.

11. Lubber line marks — The fore and aft lubber line marks are fixed and align with the aircraft symbol.

12. Digital distance display — The distance display provides digital displays of the DME distance.

13. Heading bug — The notched orange heading bug is positioned on the rotating dial by the heading knob and displays preselected compass heading. The bug rotates with the heading dial so the difference between the bug and the fore lubber line index is the amount of heading error applied to the flight director computer. In the heading mode, the FDI vertical command bar will display the required bank commands to bring the aircraft onto and maintain the selected heading.

14. Bearing pointer — The bearing pointer provides magnetic bearing to a VOR, TACAN, or active FMS waypoint as selected by the HSI selector switches.

15. Glideslope pointer and scale — The glideslope pointer and scale displays glideslope deviation. The pointer is in view only when tuned to a localizer frequency. Aircraft is below glideslope deviation. Aircraft is below glidepath if pointer is displaced upward; each dot represents approximately 0.4° displacement.

16. VERT flag — The VERT flag indicates that the information displayed by the glideslope pointer is invalid and should not be used.

17. To/from pointers — The to/from pointers are situated 180° apart. One always points the direction toward the station along the selected VOR radial.

18. Heading knob — The notched orange heading bug is positioned on the rotating dial by the heading knob and displays preselected compass heading. The bug rotates with the heading dial so the difference between the bug and the fore lubber line index is the amount of heading error applied to the flight director computer. In the heading mode, the FDI vertical command bar will display the required bank commands to bring the aircraft onto and maintain the selected heading.

25.3.2 HSI Select/Annunciator Switches

The pilot and copilot have illuminating push switches with which to select a desired navigation system to control their respective HSI indicators.

Note

Each of the HSI switches has both a green and a white lens. If the pilot and copilot select the same signal source, the pilot will override the copilot. The switch will illuminate green if the position has control of the source. If the copilot should select the same source as the pilot, the copilot switch will illuminate white to indicate the copilot has no control or display of the signal. The switches illuminate white all the time except when selected based on priority shown above.

25.4 FLIGHT DIRECTOR INDICATOR

The flight director indicator (Figure 25-3) provides aircraft pitch and roll attitude display combined with the lateral and vertical steering commands. It also contains an eyelid display, expanded localizer, glideslope scale, rising radio altitude runway bar, inclinometer, decision height annunciator, and go-around annunciator.

Note

The copilot FDI navigation information (command bars on a coupled approach, expanded localizer, and glideslope) is for the navigation aid selected on the pilot HSI indicator switches.

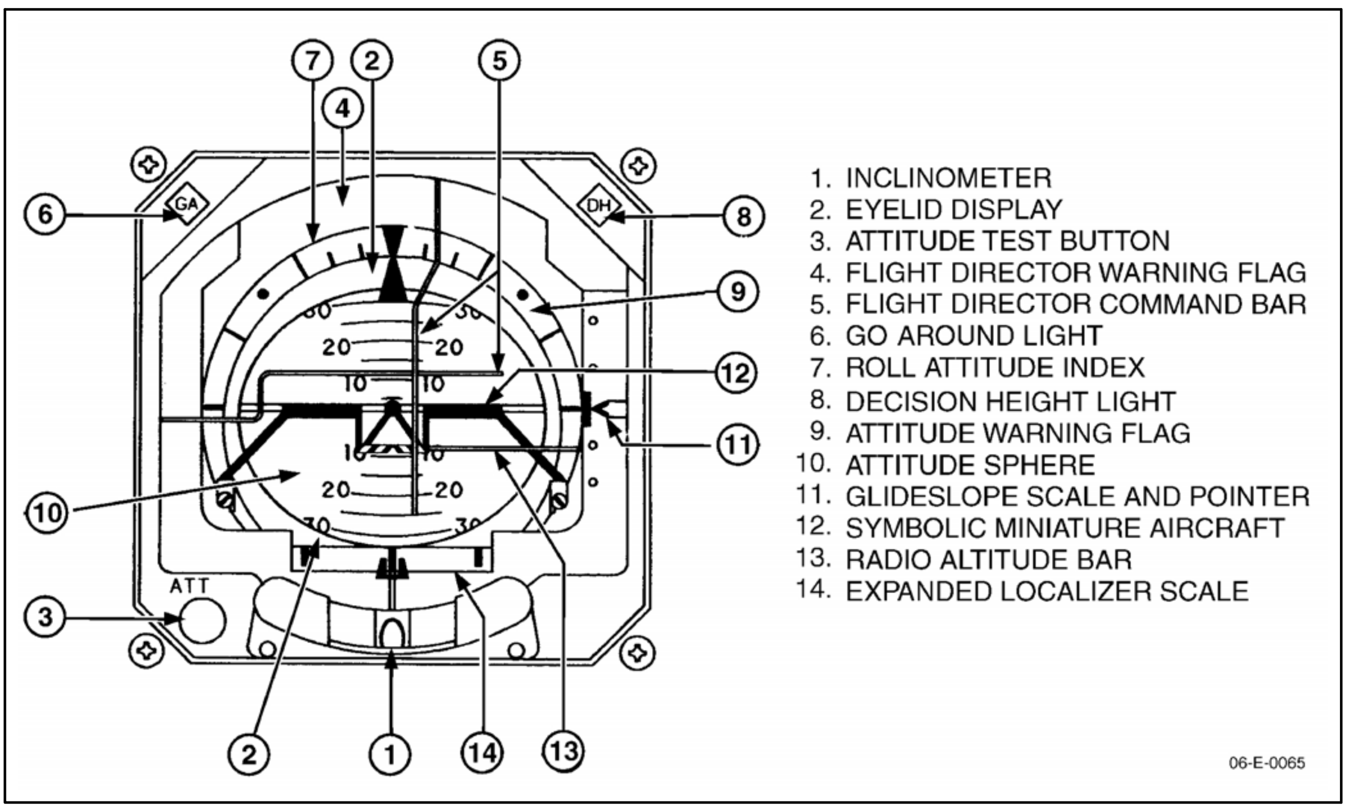


Figure 25-3. Flight Director Indicator

1. Inclinometer — Slip and skid information is displayed by the ball type inclinometer. The ball indicates whether a coordinated turn is being made.
2. Eyelid display — The eyelid display surrounds the attitude sphere and provides positive attitude identification by means of a blue eyelid that always shows the relative position of the sky and a brown eyelid that always shows the relative position of the ground. The eyelids maintain the proper ground-to-sky relationship, regardless of the position of the sphere.
3. Attitude test button — Depressing the attitude test button activates the sphere self-test circuit, which causes a change in attitude of approximately 20° right bank and 10° pitch-up. While the button is depressed, the attitude flag comes into view.
4. Flight director warning flag — The flight director warning flag is used to indicate that the flight director command information displayed on the vertical and horizontal command bars is invalid and should not be used.
5. Flight director command bars — The steering command bars display computed steering commands to intercept and maintain a desired flight path. The horizontal bar displays pitch commands, and the vertical bar displays roll commands. The command bars are operated independently and failure of one (retraction) will not impede usage of the other.
6. GA light — The go-around light indicates that the flight director is in the GO AROUND mode.
7. Roll attitude index — The roll attitude index displays actual roll attitude through a movable pointer on the eyelid display and fixed reference marks at 10°, 20°, 30°, 45°, 60°, and 90°.
8. DH light — The decision height light provides annunciation that decision height set on the radio altimeter has been reached.
9. Attitude warning flag — The attitude warning flag is used to indicate that the attitude information displayed by the sphere is invalid and should not be used.
10. Attitude sphere — The attitude sphere moves with respect to the symbolic aircraft reference to display actual pitch and roll attitude. Pitch attitude marks are in 5° increments on a blue and brown sphere. These colors are most contrasting and acceptable display colors from a human factor standpoint.
11. Glideslope scale and pointer — The glideslope scale and pointer displays aircraft deviation from glideslope beam center only when tuned to ILS frequency and a valid glideslope signal is present. Aircraft is below glidepath if pointer is displaced upward. The glideslope dot represents approximately 0.4° deviation from the beam centerline. The glideslope pointer will bias out of view if it is not tuned to a localizer frequency, the glideslope signal is lost, or a reverse course is selected on the flight director.
12. Symbolic miniature aircraft — The miniature aircraft serves as a stationary symbol of the aircraft. Aircraft pitch and roll attitudes are displayed by the relationship between the fixed miniature aircraft and the movable sphere. The symbolic aircraft is flown to, and the center dot aligned with, the command bars to satisfy the commands of the flight director mode selected.
13. Radio altitude rising runway — Radio altitude is displayed by the radio altitude bar. The bar comes into view at an altitude of approximately 200 feet AGL and stops beneath the aircraft symbol as the aircraft touches the runway.
14. Expanded localizer scale — Raw localizer displacement data from the receiver (HSI display) is amplified approximately 7 1/2 times to permit the expanded localizer pointer to be used as a reference indicator of the aircraft position with respect to the center of the localizer. It is normally used for assessment since the pointer is very sensitive and difficult to fly through the entire approach. During final approach, the pointer scale is an indicator of the Category II window. Full-scale deflection is equal to 1/4 degree of beam signal. The localizer pointer will bias out of view if the navigation receiver is not turned to a localizer frequency or to indicate loss of a valid localizer signal.

25.5 RADIO ALTIMETER

A radio altimeter is provided to indicate the aircraft height above the terrain during the approach phase of the flight. The scale on the indicator displays absolute altitude between –20 and +2,500 feet with an expanded linear scale under 500 feet. A DH light on the indicator illuminates to advise the pilot of aircraft arrival at a preset altitude. The preset altitude is adjustable by the pilot to the correct value for the intended arrival area.

1. TEST button — The TEST button is used to check the indicator receiver/transmitter unit and flag operation. When the button is depressed, the OFF flag will come into view and the altimeter will indicate 100 ±20 feet.

2. OFF flag — The OFF flag indicates that information displayed on the radio altimeter is invalid and should not be used.

3. DH annunciator — The decision height annunciator light illuminates to indicate that the aircraft is at or below the selected decision height.

4. DH bug — The triangular decision height bug is set to the selected decision height altitude.

5. DH set knob — The decision height set knob is used to position the decision height bug.

25.6 GYRO MAGNETIC COMPASS SYSTEM

25.6.1 Description

Two identical compass systems provide accurate directional information for the aircraft at all latitudes of the Earth. For heading reference, two modes of operation are used: directional gyro (FREE) mode, or slaved (SLAVE) mode.

In areas where magnetic references are reliable, the system is operated in the SLAVE mode. In this mode, the directional gyro is slaved to the magnetic flux valve, which supplies magnetic reference for correction of the apparent drift of the gyro.

Gyro COMPASS 1 provides heading information for the pilot HSI and the copilot RMI. Gyro COMPASS 2 serves the copilot HSI and the pilot RMI. There are no front panel fuses or circuit breakers provided for the gyro magnetic compass systems. Switches are located on the instrument panel below the HSI.

25.6.2 Alignment Procedure

1. COMPASS GYRO SLAVE/FREE switch — SLAVE.

2. COMPASS INCREASE/DECREASE switch — Hold switch momentarily in the direction desired and then release. This will place system in fast erect mode. The gyro will then erect at approximately 30° per minute. While in the fast erect mode the HDG flag will be in view. When the HDG flag retracts from view, the heading displayed will be the magnetic heading.

25.6.3 Magnetic Heading Operating Procedure

1. COMPASS GYRO SLAVE/FREE switch — SLAVE.

2. Compass card on RMIs — Read heading.

25.6.4 Directional Gyro Heading Procedure

1. COMPASS GYRO SLAVE/FREE switch — FREE.

2. COMPASS INCREASE/DECREASE switch — Hold until the RMI compass card aligns with the magnetic heading, then release.

3. Read heading. The heading will agree with the appropriate HSI.

25.7 VERTICAL GYROS

Two vertical gyros are installed to provide roll and pitch information to the FDIs and to the autopilot system. A FAST ERECT pushbutton below each HSI indicator on the instrument panel is provided to assist in the rapid erection of the respective gyros.

25.8 TACAN SYSTEM

25.8.1 Description

The TACAN system operates in conjunction with TACAN and VORTAC ground stations to provide distance, groundspeed, time to station, and bearing to station. It operates in the L band 1,000-MHz frequency range on 1 of 252 preselected frequencies, 126 X-mode and 126 Y-mode channels. Course deviation and distance to TACAN or VORTAC stations are displayed on the HSI. Distance, time to station, and groundspeed are displayed on the TACAN digital display.

The groundspeed and time to station are accurate only if the aircraft is flying directly toward the ground station at a sufficient distance that the slant range and ground range are nearly equal. The system is protected by the TACAN circuit breaker on the AVIONICS portion of the copilot right sidewall panel.

The TACAN system may be operated on the flight director system or connected to and used with the autopilot system. When employed as the primary means of navigation, aircraft flight may be controlled manually or by the autopilot. Indications of aircraft heading and bearing to ground stations are displayed on the horizontal situation indicators. Relative bearing to a station is displayed by the HSI bearing pointer. TACAN slant range is displayed on each HSI in the digital distance display. TACAN distance, groundspeed, and time to station are all displayed on the TACAN indicator located on the copilot instrument panel.

The TACAN control panel enables selection of the TACAN frequency (channel) to be used and provides self-test of TACAN circuits. X or Y channel is selected by the X/Y switch. At the present time, all TACAN and VORTAC stations are operated on the X mode. When Y mode stations are operational, the air navigation charts will designate the Y mode stations. Use of the Y channels has been implemented along with 0.05 MHz spacing for VOR/VORTAC stations and Y channels are paired with these new frequencies (e.g., VOR frequency 113.1 is TACAN channel 78K; VOR frequency 113.15 is TACAN channel 78Y). The small (outer) control provides system power ON/OFF and station identity tone volume control. TACAN circuits are protected by a TACAN circuit breaker on the AVIONICS portion of the copilot right sidewall panel.

25.8.2 Operation

25.8.2.1 TACAN Turn-On/Test Procedures

1. Turn TACAN on.

2. Select TACAN on HSI indicator buttons.

3. Conduct test.

   a. Set course knob on pilot HSI to 180° course.

   b. Hold TACAN TEST switch (TACAN control panel) to TEST and confirm the following results:

      (1) Pilot HSI course indicator centers on 180° ±2° TO indication and the bearing pointers on each course indicator read 180° ±2°.

      (2) Using course knob, increase selected course; note deviation bar moves left.

(3) Using course knob, decrease selected course; note deviation bar moves through and continues to right of center.

(4) Full-scale deflection will be 10° ±1°.

25.8.2.2 Normal Operation

1. HSI switches — Depress TACAN.

2. TACAN control panel.

   a. Mode switch (X/Y) as required.

   b. Select desired channel.

3. Wait 5 seconds for signal acquisition and lock-on. If bearing signal lock-on does not occur, the TACAN remains in the bearing search mode and the red bearing pointer on the selected HSI will stay in the park position. If bearing lock-on is not obtained, perform an in-flight self-test to ensure correct operation of the system. Anytime the course indicator flag is in view, the bearing, course deviation, and the to/from information may be inaccurate and should be disregarded.

4. Ensure audio station identification signal is correct for the ground station selected.

5. Red bearing pointer on HSI — Read bearing to station.

6. COURSE knob (selected HSI) — Set course desired.

7. Intercept course as required, verify intercept heading by reference to HSI bearing pointers.

8. Course deviation bar (pilot HSI) — Read deviation from selected course. Course arrow will show wind correction angle when the course deviation bar is centered and the aircraft is tracking the selected course.

9. TACAN indicator — Read range (nm). Cross-reference range represented in indicator with HSI distance readout.

10. To determine course to or course from a TACAN station, rotate course knob (HSI selected TACAN) until course deviation bar is centered and TO/FROM flag reads TO or FROM.

11. To use TACAN with pilot-controlled flight, control aircraft by manual controls responding to information displayed on the flight director, RMI, and other instruments.

12. To use TACAN with the autopilot, depress A/P ENGAGE and monitor autopilot performance on flight director, RMI, and TACAN indicator. Verify adherence to preset heading and course and confirm the execution of displayed steering commands.

Note

The TACAN groundspeed reading will be accurate only when the aircraft is on a course directly to or from the TACAN station. When headed away from the station, the TACAN indicator minutes reading will be in error.

25.8.2.3 Emergency Operations

Not applicable.

25.8.2.4 Shutdown

1. Turn ON-OFF/VOL knob OFF.

25.9 GROUND PROXIMITY WARNING SYSTEM (GPWS) CONTROLLER

25.9.1 General

The GPWS is a completely automatic (requiring no input from the crew) system that continuously monitors the aircraft flight path at altitudes between 50 and 2,450 feet AGL. The system provides visual and aural advisory/warning messages to the crew in the event the aircraft is flown along a projected flight path that would result in contact with the terrain under any of the following conditions:

1. Mode 1 — Excessive rate of descent with respect to terrain when below 2,450 feet AGL.

2. Mode 2 — Excessive closure rate with terrain when below 1,800 feet AGL.

3. Mode 3 — Altitude loss after takeoff, or missed approach, between 65 and 700 feet AGL.

4. Mode 4 — Approach to within 500 feet AGL with the landing gear up or within 150 feet AGL with landing gear and/or flaps not in landing position. This mode is operable after 700 feet AGL has been attained after takeoff or missed approach.

5. Mode 5 — Flying low on an ILS glideslope when below 1,000 feet AGL.

6. Mode 6 — Descent below a selected radio altitude (MDA or DH) between 50 and 1,000 feet AGL.

All alert/warning signals are inhibited below 50 feet AGL.

The system messages always precede the WHOOP-WHOOP aural tone and PULL UP warnings, thus allowing the crew time to identify and correct the specific flight situation. The system messages and warnings are discussed in the various mode descriptions.

In all GPWS warning modes, the warnings cease and the system resets when the pilot establishes a positive pull-up and climb.

25.9.2 System Description

The computer of the GPWS uses signals from the air data computer, radio altimeter, glideslope system, and landing gear and flap position indicator systems to develop warning and alert signals. Signals from the radio altimeter are first conditioned by the GPWS adapter before being applied to the GPWS computer. Discrete signals from the landing gear and flap systems are used in the computer as logic for the development of the warning and alert signals. The alert and warning signals to the pilot and copilot are the lights mounted on the glareshield and nine aural alert/warning messages.

25.9.3 System Components

25.9.3.1 GPWS Computer

The GPWS computer is powered by 115 Vac. It receives and processes input signals to determine the kind of alert/warning signals to be generated. When an alert/warning mode condition is determined, the computer generates signals that actuate visual and aural alert/warning message devices.

The computer also monitors the validity of input signals and internal functions.

25.9.3.2 PULL UP Warning Light

When a mode 1, 2, 3, or 4 condition occurs, the red PULL UP light comes on.

25.9.3.3 BELOW G/S Light

When a mode 5 condition occurs, the amber BELOW G/S light comes on.

25.9.3.4 GPWS Test Switch

This switch is part of the PULL UP indicator. When the PULL UP/GPWS TEST indicator is depressed, a self-test routine is initiated if the aircraft is on the ground or airborne above 1,000 feet with gear and flaps up. The GPWS FLAP OVERRIDE switch must be off (cover down).

25.9.3.5 G/S Cancel Switch

This switch is part of the BELOW G/S indicator and is used to cancel mode 5 when the aircraft is below 1,000 feet of altitude. To cancel G/S, depress the BELOW G/S indicator. When the BELOW G/S indicator is depressed, the glideslope advisory (if in progress) is canceled.

25.9.3.6 GPWS Circuit Breaker

The GPWS circuit breaker is rated at 1 ampere and located on the copilot circuit breaker panel.

WARNING

Do not use the circuit breaker to silence or disable the GPWS.

25.9.3.7 GPWS FLAP OVERRIDE Switch

When this guarded switch (on the pedestal extension) is actuated, a flap down signal is applied to the GPWS irrespective of flap position.

25.9.3.8 Aural Alert/Warning Signals

Aural alert/warning signals are sent to the pilot and copilot via the audio control panel. The panel has two sets of identical controls and each pilot may select to receive audio signals via his/her headphones or an overhead speaker. An overhead speaker is located at each pilot station.

25.9.4 System Operation

25.9.4.1 Normal

The GPWS is functional when aircraft power is applied. It operates automatically and continuously at all radio altitudes between 50 and 2,450 feet and issues alerts and/or warnings anytime the flight path of the aircraft enters the envelope of a mode. The GPWS computer provides continuous signals for aural and visual alerts and warnings while the aircraft is in a mode envelope. The visual signals are provided by a light assembly mounted on top in the center of the glareshield. The aural signals are distributed by the audio control panel to the pilot and copilot headphones or overhead speaker as selected by the pilot and copilot.

The system is silent during all normal flight procedures and requires no pilot/copilot attention. False signaling is kept to a minimum for all normal flight situations.

25.9.4.2 Flap Override

Occasionally it may be desirable to make an approach and landing in a no-flap configuration. To do this without incurring an alert signal in mode 4, actuate the GPWS FLAP OVERRIDE switch prior to descending to below 200 feet AGL. This action simulates landing flaps in the GPWS and affects only the flap alert signals; all other signal modes remain active.

CAUTION

Do not actuate the FLAP OVERRIDE switch in any flight condition other than final approach. When the GPWS is in FLAP OVERRIDE or when the aircraft is in the landing-flap configuration, mode 2 (terrain closure) is partially desensitized in order to reduce nuisance alert/warning signals during approach.

25.9.4.3 Inhibit Function

To avoid nuisance signals caused by ground effect-induced static pressure fluctuations, alert/warning signals in all modes are inhibited when the altitude of the aircraft is below 50 feet AGL.

25.9.5 Mode Descriptions

25.9.5.1 Mode 1: Excessive Sink Rate

Mode 1 is designed to provide alerts and warnings when the rate of descent of the aircraft exceeds the descent rates with respect to terrain clearances. When the aircraft makes an initial entry into the mode 1 envelope, the aural signal is SINK RATE and the visual signal is the red PULL UP indicator on. If the excessive sink rate continues and the second curve of the envelope is penetrated, the aural signal is changed to the warning, WHOOP-WHOOP PULL UP.

25.9.5.2 Mode 2A: Excessive Closure Rate, Flaps Up

Mode 2 provides alerts and warnings for excessive closure rates with respect to terrain. Mode 2A provides alerts and warnings for excessive closure rates with flaps up, mode 2B for flaps down.

At airspeeds of up to 175 knots, the upper limit of the boundary is 1,650 feet. The maximum closure rate limit for these speeds is 4,090 fpm. As airspeed increases from 175 knots to 225 knots, the maximum rate limit is increased linearly to 5,105 fpm. This allows the upper boundary to increase to 2,450 feet.

Alert/warning signals are generated if the aircraft closure rate exceeds these threshold values.

If the aircraft penetrates the mode envelope, the aural message TERRAIN is transmitted twice and the red PULL UP indicator comes on. If this message continues for more than 1.4 seconds, the aural message changes from TERRAIN to WHOOP-WHOOP PULL UP.

When the aircraft leaves this boundary condition with both landing gear and flaps up, the message TERRAIN returns and is repeated every 1.5 seconds until the aircraft gains 300 feet of barometric altitude above the value stored when the aircraft left the boundary.

If an additional pull-up signal occurs, the 300 feet required is reset to be measured relative to the newest value stored when the aircraft left the boundary. The altitude gain function is inhibited when the landing gear is extended.

25.9.5.3 Mode 2B: Excessive Closure Rate, Flaps Down

Penetration of the mode 2B boundary activates the same signal alert/warning conditions as in mode 2A except that the upper limit is lowered to 789 feet and maximum closure rate is 3,000 fpm. Also, below 700 feet terrain clearance with landing gear and flaps down inhibits the pull-up warning. The TERRAIN signal only is transmitted.

25.9.5.4 Mode 3: Descent after Takeoff

Mode 3 alert signals are provided when a 10 percent barometric altitude loss occurs on takeoff or a missed approach. Entering the mode 3 envelope causes a repeated aural alert of DON'T SINK. The mode cuts off at 700 feet AGL. The missed approach mode does not arm until the aircraft is below 200-foot radio altitude and both the flaps and landing gear are in the landing position.

Mode 3 is effective between 65- and 700-foot radio altitude. When the mode 3 envelope is penetrated, it generates the advisory alert signal of DON'T SINK. Above 700 feet AGL, the computer automatically switches to mode 4.

25.9.5.5 Mode 4A: Inadvertent Proximity to Terrain, Gear Up

Mode 4A generates alert advisory signals for insufficient terrain clearance when the aircraft does not have its landing gear down.

The standard upper boundary for mode 4A is 500 feet of radio altitude that increases linearly to 1,000 feet as airspeed increases from 175 to 225 knots. Penetration of the boundary at 500 feet with airspeed of less than 175 knots activates the aural signal TOO LOW GEAR.

Penetration of the boundary between 500 and 1,000 feet with airspeed above 175 knots activates the aural signal TOO LOW TERRAIN.

25.9.5.6 Mode 4B: Inadvertent Proximity to Terrain, Flaps Up

Mode 4B is activated when the landing gear is down but the flaps are not in the landing position.

When the landing gear is lowered, the upper boundary decreases to 200 feet, the audio advisory TOO LOW TERRAIN is transmitted if airspeed is above 145 knots and the upper boundary is penetrated. If airspeed is less than 145 knots and the lower boundary of 200 feet is penetrated with the flaps still not in the landing position, the audio message TOO LOW FLAPS is transmitted.

25.9.5.7 Mode 5: Descent Below Glideslope

Mode 5 is automatically selected when a glideslope frequency and gear down are selected. There are two boundaries for this mode: a soft alerting region and a loud alerting region. The first boundary occurs when the aircraft is below 1,000 feet radio altitude and more than 1.3 dots below glideslope beam. The second boundary occurs when the aircraft is below 300 feet radio altitude and below 2 dots of deviation.

When the first boundary is penetrated, the BELOW G/S indicator light comes on and the aural signal GLIDESLOPE is transmitted at one-half volume (–6 dB). If the second boundary is penetrated, the aural signal is transmitted at normal volume.

The repetition rate of the aural signal is varied as a function of radio altitude and glideslope deviation. The rate is slow at 1,000 feet and 1.3 dots. The rate speeds up as altitude is lowered or deviation increased.

Mode 5 can be inhibited by depressing the BELOW G/S indicator when below 1,000 feet of radio altitude on approach.

25.9.5.8 Mode 6: Descent Below Minimums

Mode 6 provides an alert/warning between 50 and 1,000 feet. The boundary is variable and set at the discretion of the pilot. When the boundary is penetrated, the aural message MINIMUMS-MINIMUMS only is transmitted. No warning light is activated in this mode. If the threshold is reset to a lower altitude, no output is produced. Flying above 1,000 feet or retracting and re-extending the landing gear resets the threshold.

25.9.6 Operating Limits

The GPWS is operationally limited under the following conditions:

1. Below 50 feet AGL — In order to avoid nuisance warning/alert signals caused by ground effect-induced static pressure, all modes are inactive below 50 feet AGL.
2. Above 2,450 feet AGL — This cutoff eliminates possible nuisance warning/alerts at en route altitudes.
3. When there is no preceding rising terrain, the GPWS will not warn of an approach to a sheer cliff.
4. When the aircraft is in normal landing configuration descending at normal sink rate, the GPWS will not warn of an approach to terrain where there is no runway.

25.9.7 Response to GPWS Alerts

The audio alert advisory, which is the first alert given when a mode is activated, identifies a particular flight path or configuration of potential danger. Such an advisory warrants an immediate investigation by the pilot/copilot to identify the specific problem and correction of the situation. Warnings and alert advisories cease when the aircraft exits from the envelope of the mode that produced them. The exception is mode 2A, which requires a 300-foot barometric altitude gain (when both the landing gear and flaps are up) to halt the advisory.

The PULL UP warnings of modes 1 and 2 can indicate that the aircraft is dangerously close to terrain or not in the proper configuration. Immediate action must be taken. Corrective actions for these modes consist of executing and maintaining an immediate positive pull-up by adding climb power and assuming the best climb angle.

The glideslope alert of mode 5 involves bringing the aircraft back on the glideslope beam. The loud alert reverts back to the soft alert when the aircraft is less than 2 dots below the beam.

25.9.8 Preflight Checklist

Check that the GPWS INOP indicator on the caution and advisory annunciator panel is not on.

1. Press and hold the pilot PULL UP warning light.
   a. The BELOW G/S light should illuminate.
   b. The glideslope warning voice will say GLIDESLOPE.
   c. Approximately 1 second after pressing the PULL UP light, both the pilot and copilot PULL UP warning lights will start flashing on and off. A WHOOP WHOOP tone warning followed by a PULL UP voice warning will be heard.
2. Release the light as soon as flashing begins. At the completion of the PULL UP voice warning, all aural warnings and warning lights will extinguish.
3. Repeat the test using the copilot PULL UP light assembly.

25.9.9 Summary of System Visual/Aural Alerts and Warnings

(Refer to Figures 25-4 and 25-5.) Simultaneous visual/audio warnings are issued upon entering the inner envelopes of modes 1 and 2. Modes 3, 4, 5, and 6 issue alert advisories only and are not followed by warnings.

25.10 COCKPIT VOICE RECORDER SYSTEM

25.10.1 General

The Cockpit Voice Recorder (CVR) system provides six channels for storage of audio information in solid-state memory. Four channels are used to provide a high quality recording of each of four audio sources. This recording is capable of storing only the last 30 minutes of information. Two channels are used to provide a standard quality recording of the last 120 minutes of information. One of these channels records information from the area microphone, and the other channel records a combination of the information provided by the audio of the pilot, the audio of the copilot, and the public address system. The impact switch will turn the recorder off if the system experiences a 4g or greater acceleration or deceleration in either the longitudinal axis or the lateral axis.

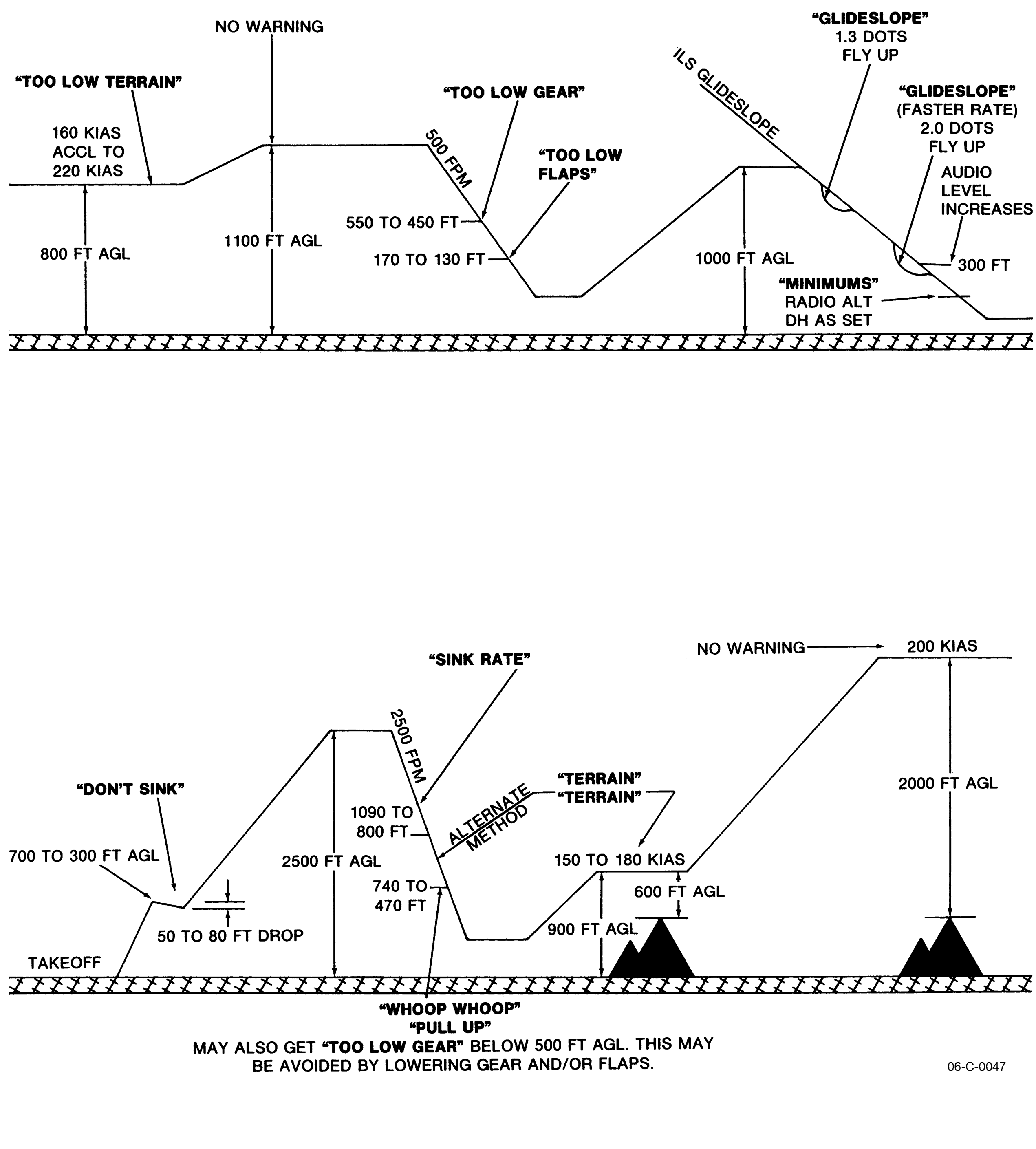


Figure 25-4. Ground Proximity Warning System Test Profile

25.10.2 System Description

The Cockpit Voice Recorder system consists of the CVR and an impact switch, both located in the aft fuselage avionics bay, a control unit located on the pedestal, an area microphone located on the top of the instrument panel glareshield just to the right of the warning annunciator panel and an audio mixer amplifier located on the right-hand (RH) sidewall behind the instrument panel. The circuit receives 28 Vdc power from the main battery bus and is protected by a 2 ampere circuit breaker placarded CVR located on the copilot circuit breaker panel. The system simultaneously records audio information from four sources: the cockpit area microphone, the pilot audio amplifier, the copilot audio amplifier, and the public address audio.

25.10.2.1 Control Unit

The control unit (Figure 25-6) contains a TEST button, a green test light, an ERASE button, and a headphone jack. The TEST button is used to activate the CVR self-test feature and should be held for a minimum of 5 seconds. The green test light will illuminate when the CVR has passed its test. If the self-test is run with headphones plugged into the control unit, two tones will be heard immediately before the green light illuminates. The headphone jack provides a means of preflighting the area microphone. Sounds picked up by the area microphone will be played back in the headphones with no delay. The ERASE button is used to erase the entire recording and will only work when the weight of the airplane is on the landing gear. The ERASE button should be held for a minimum of 2 seconds. If the erase function is conducted with headphones plugged into the control unit, a loud tone, which begins when the ERASE button is released and lasts for 5 to 10 seconds, confirms that the erase feature is functioning properly.

Note

High-impedance headsets are the only approved type headset for use by the flightcrew.

MODE	INDICATION		
	VISUAL ALERT	AUDIO ALERT	WARNING
1. Excessive sink rate	PULL UP Indicator	SINK RATE	WHOOP WHOOP PULL UP
2. Excessive terrain closure	PULL UP Indicator	TERRAIN TERRAIN	WHOOP WHOOP PULL UP
3. Descent after takeoff	PULL UP Indicator	DON'T SINK	
4. Inadvertent proximity to terrain			
a. Gear up	PULL UP Indicator PULL UP Indicator	TOO LOW GEAR TOO LOW TERRAIN	
b. Flaps up	PULL UP Indicator PULL UP Indicator	TOO LOW FLAPS TOO LOW TERRAIN	
5. Descent below glideslope	G/S Indicator	GLIDESLOPE	
6. Descent below minimums	None	MINIMUMS MINIMUMS	None

Figure 25-5. GPWS Visual/Aural Alerts and Warnings

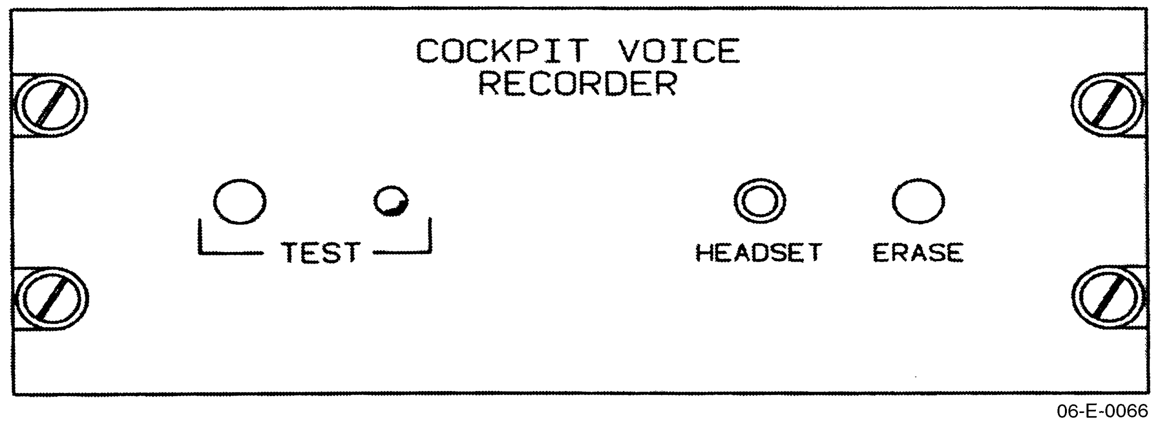


Figure 25-6. Cockpit Voice Recorder

25.10.3 Normal Operation

25.10.3.1 Before Starting Engines

1. Battery — on.
2. CVR TEST button — Press and hold (5 seconds minimum).
3. Green test light — Illuminated.
4. ERASE button — Press and hold for 2 seconds minimum (if desired).

Prior to first flight of the day:

5. Headset — Plug headphones into CVR control unit.
6. Speak into area microphone. Voice will play back in headphones with no delay.

Note

The CVR self-test must be accomplished prior to flight.

25.10.3.2 Audio System Failure

1. Appropriate AUDIO EMER/NORM switch to EMER.
2. Appropriate AUDIO SPKR/PHONE switch to PHONE.

25.11 FLIGHT DATA RECORDER

25.11.1 System Description

The solid-state Flight Data Recorder (FDR) is located in the aft fuselage avionics bay and converts and records analog data into protected solid-state memory. The recorder will continuously record and retain the last 25 hours of flight data. Elapsed Time, Heading, Pilot Microphone Key, Copilot Microphone Key, A/P Engage, Vertical Acceleration, Longitudinal Acceleration, Left and Right Engine Torque, Pitch Control Position, Control Wheel Position, Left and Right Engine Prop Reverse, Left and Right Prop rpm, Flap Position (Down, Approach, Up), Pitch and Roll Attitude, Altitude, and Airspeed parameters are recorded.

25.11.1.1 Fault Annunciator

An FDR FAULT annunciator is located in the caution and advisory annunciator panel (Figure 2-35). The annunciator should extinguish approximately 5 seconds after dc and ac power have been applied to the system. Reillumination of the fault annunciator indicates a possible problem in the recorder or incorrect input data to the recorder. There are no controls associated with the recorder and its operation is completely automatic.

25.11.2 Normal Operation

25.11.2.1 Before Taxi

1. Flight data recorder FDR FAULT annunciator — Extinguished.

25.12 VHF NAV 1 AND NAV 2

25.12.1 Introduction

The navigation receiver provides 200 50-Hz spaced VOR/LOC channels from 108.00 through 117.95 MHz and 40 glideslope (GS) channels automatically paired with localizer channels. It also provides a marker beacon receiver.

The digital navigation receiver provides VOR, LOC, and GS deviation outputs, high and low level flag signals, magnetic bearing to the station, to/from information, marker beacon lamp signals, and VOR and marker beacon audio outputs.

CAUTION

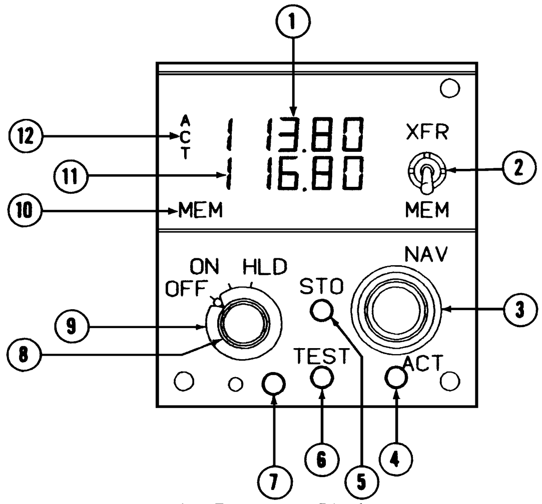
When monitoring for marker beacon passage, always listen for marker beacon audio. Do not rely solely on the marker beacon lights.

25.12.2 Operating Controls

All operating controls for the navigation receiver are located on the NAV control (Figure 25-7).

1. Active frequency display — The active frequency (frequency to which the navigation receiver is tuned) and diagnostic messages are displayed in the upper window.

2. XFR/MEM switch — This switch is a three-position, spring-loaded toggle switch. When held to the XFR position, the preset frequency is transferred to the active display, the previously active frequency becomes the new preset frequency, and the receiver retunes. When this switch is held to the MEM position, one of the four stacked memory frequencies is loaded into the preset display. Successive presses cycle the four memory frequencies through the display (...2, 3, 4, 1, 2, 3...).



1. Active Frequency Display
2. XFR/MEM Switch
3. Frequency Select Knobs
4. ACT Button
5. STO Button
6. TEST Button
7. Light Sensor
8. Volume Control
9. Power and Mode Switch
10. Annunciators (MEM, HLD)
11. Preset Frequency Display
12. Compare Annunciator (ACT)

06-E-0069(A)

Figure 25-7. NAV Control (Typical)

3. Frequency select knobs. Two concentric knobs control the preset or active frequency displays. The larger knob changes the three digits to the decimal point in 1-MHz increments. The smaller knob changes the two digits to the right of the decimal point in 0.05-MHz increments. Frequencies roll over at the upper and lowest limits. The two frequency select switches are independent of each other such that the upper and lower limit rollover of the 0.1 MHz digit will not cause the 1.0 MHz digit to change.

4. ACT button — Press the ACT button for approximately 2 seconds to enable the frequency select knobs to directly retune the receiver. The button window will display dashes and the upper window will continue to display the active frequency. Press the ACT button a second time to return to the normal two-display mode.

5. STO button — The STO button allows up to four preset frequencies to be selected and entered into the memory of the control. After presetting the frequencies to be stored, press the STO button. The upper window displays the channel number of available memory (CH 1 through CH 4); the lower window continues to display the frequency to be stored. For approximately 5 seconds, the MEM switch may be used to advance through the channel numbers without changing the preset display. Press the STO button a second time to commit the preset frequency to memory in the selected location. After approximately 5 seconds, the control will return to normal operation.

6. TEST button — Press the TEST button to initiate the radio self-test diagnostic routine. (Self-test is active only when the TEST button is pressed.)

7. Light sensor — The built-in light sensor automatically controls the display brightness.

8. Volume control — A volume control is concentric with the power and mode switch.

9. Power and mode switch — The power and mode switch contains three detented positions. The ON and OFF positions switch system power. The HLD position allows the NAV frequency to be changed, but holds the DME to the current active frequency.

10. MEM and HLD annunciators — The NAV control contains MEM (memory) and HLD (hold) annunciators. The MEM annunciator illuminates whenever a preset frequency is being displayed in the lower window. The HLD annunciator indicates that the DME is held to the active frequency at time of selection; the NAV frequency may be changed. The upper window now displays the NAV frequency and the lower window displays the held DME frequency.

11. Preset frequency display — The preset (inactive) frequency and diagnostic messages are displayed in the lower window.

12. Compare annunciator — ACT momentarily illuminates when frequencies are being changed. ACT flashes if the actual radio frequency is not identical to the frequency shown in the active frequency display.

25.12.3 Operating Procedures

Note

It is not practical to provide monitoring for all conceivable system failures; it is possible that erroneous operation could occur without a fault indication. It is the responsibility of the pilot to detect such an occurrence by means of cross-checks with redundant or correlated information available in the cockpit.

When a frequency is required to provide DME:

1. Dial the DME frequency into the upper window.

2. Dial the NAV frequency into the lower window.

3. Place the MODE switch to HLD and toggle the XFR/MEM switch up.

The NAV frequency will now be displayed in the upper window and the DME frequency will be displayed in the lower window.

25.12.3.1 Frequency Selection

Frequency selection is made using either the frequency select knobs or the XFR/MEM (transfer/memory recall) switch.

Rotation of either frequency select knob increases or decreases the frequency in the preset frequency display.

After the desired frequency is set in the preset frequency display, it can be transferred to the active frequency display by momentarily setting the XFR/MEM switch to XFR. At the same time that the preset frequency is transferred to the active display, the previously active frequency is transferred to the preset display. The ACT annunciator on the control flashes while the receiver is tuning to the new frequency.

Note

If the ACT annunciator continues flashing, it indicates that the receiver is not tuned to the frequency displayed in the active display.

The NAV control has memory that permits storing up to four preset frequencies. Once stored, these frequencies can be recalled to the preset display by positioning the XFR/MEM switch to the MEM position. The storage location (CH 1 through CH 4) for the recalled frequency is displayed in the active frequency display while the XFR/MEM switch is held in the MEM position. All four stored frequencies can be displayed one at a time in the preset display by repeatedly positioning the XFR/MEM switch to the MEM position. After the desired stored frequency has been recalled to the preset display, it can be transferred to the active display by momentarily positioning the XFR/MEM switch to the XFR position.

During normal operation, all frequency selections and revisions are done in the preset frequency display; however, the active frequency can be selected directly as described in paragraph 25.12.3.2.

25.12.3.2 Direct Active Frequency Selection

The active frequency can be selected directly with the frequency select knobs by pressing the ACT button for about 2 seconds. The active frequency selection mode is indicated by dashes appearing in the preset display. Also, the ACT annunciator will flash as the frequency select knobs are turned to indicate that the receiver is being retuned.

Note

If the ACT annunciator continues flashing after the frequency has been selected, it indicates that the receiver has not tuned to the frequency displayed in the active display.

To return to the preset frequency selection mode, press the ACT button again for about 2 seconds.

The NAV control automatically switches to the active frequency selection mode when a frequency select knob is operated while the STO, TEST, or XFR/MEM switches are actuated.

25.12.3.3 Frequency Storage

Up to four preset frequencies can be stored in the memory in the NAV control for future recall. To program the memory, select the frequency in the preset frequency display using the frequency select knobs and press the STO button once. One of the channel numbers (CH 1 through CH 4) will appear in the active display for approximately 5 seconds. During this time the channel number can be changed without changing the preset frequency by momentarily positioning the XFR/MEM switch to the MEM position. After the desired channel number has been selected, press the STO button again to store the frequency.

Note

When storing a frequency, the second actuation of the STO button must be done within 5 seconds after selecting the channel number or the first actuation of the STO button. If more than 5 seconds elapse, the control will revert to the normal modes of operation and the second store command will be interpreted as the first store command.

After a frequency has been stored in memory, it will remain in memory until changed using the STO button. Memory is retained even when the unit is turned off for an extended period of time.

25.12.3.4 Self-Test

During self-test, the navigation receiver provides VOR, ILS, and marker beacon test outputs. The following paragraphs provide the procedures required and the results to be expected when performing the self-test.

25.12.3.4.1 VOR Self-Test

1. Select a VOR frequency on the NAV control (a specific frequency is not required for test). A signal on frequency will not interfere with the self-test. Rotate the COURSE knob to approximately 0°.

2. Press the TEST button on the NAV control.

3. The NAV flag will come into view.

4. After approximately 2 seconds, the flag will go out of view, the HSI lateral deviation bar will approximately center, and a TO indication will appear. Both the RMI and HSI pointers will indicate approximately a 0° magnetic bearing.

5. The navigation receiver will return to normal operation after approximately 15 seconds, even if the TEST button is held.

25.12.3.4.2 ILS (Localizer and Glideslope) Self-Test

Note

If an ILS frequency is selected, the HSI bearing pointer and associated RMI bearing pointer (if VOR is selected) will drive to park or 3 o'clock position. The RMI bearing pointer (if VOR is selected) will drive to park or 3 o'clock position.

1. Select a localizer frequency on the NAV control (a specific frequency is not required for test).

2. Press the TEST button on the NAV control.

3. The NAV and GS flags will come into view.

4. After approximately 3 seconds, the flags will go out of view, the HSI lateral deviation bar will deflect right approximately two-thirds of full scale, and the glideslope pointer will deflect down approximately two-thirds of full scale.

5. The navigation receiver will return to normal operation after approximately 15 seconds regardless if the TEST button is held.

25.12.3.4.3 Marker Beacon Self-Test

The marker beacon assembly is tested automatically when the self-test is actuated and either a VOR or localizer frequency is selected. Proper operation of the marker beacon assembly is indicated by all three marker lamps lighted (they flicker perceptibly, at a 30-Hz rate). A 30-Hz tone will also be present in the marker audio output.

25.12.3.5 Marker Beacon Audio

Marker beacon audio, generally associated with an ILS, must be source selected by the MKR BCN 1 or MKR BCN 2 audio selector switches located on the audio control panel.

Sensitivity selection for marker beacon audio is accomplished by a toggle switch placarded MKR BCN 1 & 2 HI-LO and located alongside the altitude alert preselector. Marker beacon audio volume is adjusted with a knob placarded VOL and collocated with the toggle switch.

25.12.4 Normal Operation

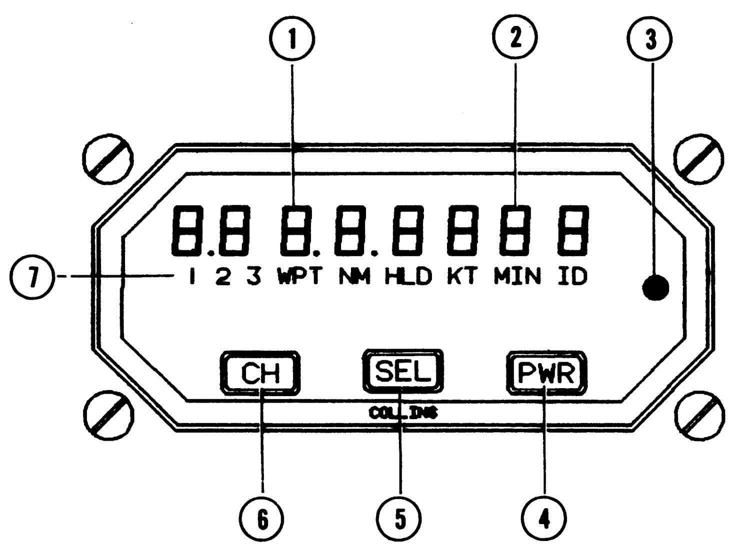
Selection procedures and display of the VHF navigation information is the same as that described for TACAN. When changing VOR frequencies and until signal lock-on, the RMI/HSI bearing pointers will drive to the park or 3 o'clock position and the HSI NAV warning flag will be in view. In the ILS mode, the bearing pointer(s) will remain in the park position.

25.13 DISTANCE MEASURING EQUIPMENT

25.13.1 Introduction

The DME receiver-transmitter and DME indicator can simultaneously track and provide complete information from up to three DME stations. The information displayed on the DME indicator (Figure 25-8) includes channel number (1, 2, or 3), distance, groundspeed, time-to/from-station, and the station identifier including the identifier of a DME collocated with an ILS. A digital display of course and distance to the selected station is provided on the respective (pilot and/or copilot) HSIs.

Three-channel operation is controlled by both (pilot and copilot) NAV controls. These provide serial digital commands to operate on one, two, or three specific frequencies through the single input port of the DME. The DME channel 1 frequency will always be the same as shown by the active frequency display on the pilot NAV control. The DME channel 2 frequency will always be the same as shown by the active frequency display on the copilot side NAV control. The channel 3 frequency is the same as shown by the preset frequency display on the pilot side NAV control.



1. Numeric Display
2. Alphanumeric Display
3. Light Sensor
4. Power Switch
5. Mode Selector Switch
6. Channel Switch
7. Annunciators

Figure 25-8. DME Indicator

25.13.1.1 DME Audio

DME audio is only available for channels 1 and 2. When the DME audio selector switches (pilot/copilot) located on the audio control panel are in the (up) CH 1 or CH 2 position, DME audio is available from the DME channel (1 or 2) selected. DME AUDIO volume from DME channels 1 and 2 is controlled by the DME AUDIO CHAN 1, CHAN 2 VOL knobs located left of the altitude alert preselect unit.

25.13.2 Operating Controls

Except for frequency selection and the self-test switch, all operating controls for the DME system are located on the DME indicator. Frequency selection is accomplished using the NAV control. The DME self-test routine can be initiated using the TEST button on the NAV control.

1. PWR (power) switch — The latching push-on/push-off PWR switch controls the power applied to the DME indicator.
2. Mode SEL (selector) switch — The nonlatching pushbutton SEL switch selects the information to be displayed in the display. (When power is initially applied, NM [distance] is shown in the numeric display and ID [DME station identifier] is shown in the alphanumeric display.) Pressing the SEL switch will sequentially select KT (velocity), MIN (time to station), and ID (two-, three-, or four-letter station identifier). KT, MIN, and ID are shown in the alphanumeric display and NM (distance) is continuously shown in the numeric display.
3. CH (channel) switch — The momentary pushbutton CH switch sequentially selects the information from the next DME channel and lights the appropriate channel annunciator 1, 2 (or 3 if enabled).
4. Annunciators — The annunciators provide an indication of which DME channel is selected, system operational information, and units of measure. The following list describes the annunciators:

25.13.2.1 Annunciator Description

1. 1 2 3 — Sequentially controlled by the CH button to indicate which DME channel is providing the information being displayed in the numeric and alphanumeric displays.
2. WPT— Not used.
3. NM — Automatically illuminates after power on when valid DME data is available. Indicates that the numbers displayed in the numeric display are slant range DME distance in nautical miles.
4. HLD — Indicates DME hold has been selected on the NAV control.
5. KT — Sequentially controlled by the SEL button and indicates the numbers displayed in the alphanumeric display are the computed groundspeed in knots. Groundspeed is based on rate of change of DME distance and accurately reflects slant-range speed only when the aircraft is flying directly to or from the station.
6. MIN — Sequentially controlled by the SEL button and indicates the numbers displayed in the alphanumeric display are the computed time-to-station in minutes. Like the groundspeed (KT) display, time-to-go is also based on rate of change of DME distance.
7. ID — Automatically illuminates after power on. The DME Ident is transmitted once every 30 seconds and it is possible that 2 minutes could elapse before the station identification is displayed in the alphanumeric display. The station identifier is usually three letters, but can be two, three, or four letters, depending on the facility being used.

25.13.2.2 Numeric Display

The numeric display presents the NM (distance) and diagnostic code.

25.13.2.3 Alphanumeric Display

The alphanumeric display presents the KT (velocity), MIN (time to station), ID (two-, three-, or four-letter station identifier), and diagnostic identifier.

25.13.3 Operating Procedures

25.13.3.1 Equipment Turn-on

Apply power by pressing the PWR button on the DME indicator. The NM and ID annunciators and the channel “1” or “2” annunciator will be illuminated. If the DME is within range of the selected station, the numeric display will show the slant range distances. After two DME Idents have been received and processed, the alphanumeric display will show the two-, three-, or four-letter station identifier.

CAUTION

The DME may not decode the identity transmissions correctly. It is the responsibility of the pilot to verify reception of the intended ground station through the audio identifier as necessary.

25.13.3.2 Frequency Selection

The NAV frequency for DME channel 1 is the frequency shown in the active frequency display of the pilot NAV control. This frequency can be changed using the ACT button or the XFR/MEM switch. DME channel 2 is the frequency shown in the active frequency display of the copilot NAV control; DME channel 3 is the frequency shown in the preset frequency display of the pilot NAV control.

Using the pilot and copilot active and the pilot preset displays, select the desired VORTAC or ILS frequency for paired DME channels or the VHF NAV frequency for unpaired channels. The DME channel that is associated with the VORTAC, ILS, or unpaired VHF NAV frequency is automatically selected.

Figure 25-9 lists the VHF NAV frequencies and corresponding DME channels. The frequency is listed across the top and down the left side of the table. This frequency matrix is used to determine the DME channel. For example, ILS-LOC frequency 108.30 MHz is DME channel 20, VOR frequency 114.70 MHz is DME channel 94, etc. DME channels 1 through 126 listed in the table are the DME X channels. The DME Y channels can be determined from the table by adding 0.05 MHz to each of the 0.1-MHz columns. For example, ILS-LOC frequency 108.35 MHz is DME channel 20, VOR frequency 114.75 MHz is DME channel 94Y, etc. The 126 X channels and 126 Y channels total the 252 DME channels available.

25.13.3.3 Channel Selection

After the three VHF NAV frequencies are tuned, DME information from any of the three can be displayed on the DME indicator by sequentially pressing the CH button to call up “1,” “2,” or “3.” If one of the three channels has invalid data, dashes will be displayed.

When DME data is valid, sequentially pressing the CH button on the DME indicator will display the NM and ID for each of the three channels.

25.13.4 Normal Operation

1. Select the three desired NAV frequencies as previously described. Use the CH button on the DME indicator to select the desired channel for display (“1,” “2,” or “3”). The numeric display will show the slant range distance from 0 to 300 nm. The distance is accurate to 0.1 nm, and the display will show tenths of a mile from 0 to 199.9 nm and 1-mile increments from 200 to 300 nm. The NM and ID annunciators will be illuminated, and the alphanumeric display will show the station identifier. A 10- to l4-second memory in the DME prevents dashes from being displayed if the received signal is temporarily lost or weak.

Note

- The maximum range of the DME is 300 nautical miles. The range capability of a DME is limited by aircraft altitude, obstructions such as hills or mountains, and the curvature of the Earth.

- DME slant range is the straight line distance from the aircraft to the ground station. Ground range from the station can be computed by using altitude and slant range. The difference between slant range and ground range is usually insignificant except when flying over the selected ground station. For example, an aircraft that is 100-nm ground range from a station and flying at 35,000 feet of altitude is approximately 100.17-nm slant range from the ground station. When flying directly over the ground station, the DME distance information is the aircraft altitude in nm above the station.

2. Press the SEL button on the DME indicator until KT is annunciated. The alphanumeric display now shows computed groundspeed in knots if the computed groundspeed is between 50 and 999 knots. Accuracy of the display is ±1 knot or ±1 percent, whichever is greater, and will be true only after 30 to 60 seconds. Dashes will be shown in the alphanumeric display if the computed groundspeed is less than 50 knots.

3. Press the SEL button on the DME indicator until MIN is annunciated. The alphanumeric display now shows the time in minutes to or from the station if the computed groundspeed is greater than 50 knots. Dashes will be shown in the alphanumeric display if the computed groundspeed is less than 50 knots. The MIN display ranges from 0 to 120 minutes. Accuracy of the display is ±1 minute.

Note

- The KT and MIN indications are accurate only if the aircraft is tracking directly toward or away from the ground station and the distance is sufficient for the slant range and ground range to be nearly equal. For example, at an altitude of 12,000 feet above the VORTAC station and at a slant range of l0 nm from the station, the groundspeed indication is lower than actual aircraft groundspeed by approximately 2 percent. The MIN indication will have a corresponding error.

- If the DME is put into hold, the ID display will automatically be selected when the HLD annunciator illuminates. The pilot may still select other modes (KT, MIN), but when the pilot stops pressing the SEL button, the display will revert to the ID mode after approximately 5 seconds. This is a safety feature to remind the pilot not only that the DME is in hold, but also to show which station is being held.

- DME hold is not functional for the third DME channel (#1 NAV preselect); therefore, this safety feature is not applicable.

- When the #1 NAV is in the hold mode, the preselected frequency (channeling DME #3) remains active although not displayed.

VHF NAV	0.1 MHz									
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
134	—	—	—	—	1	2	3	5	6	
135	7	8	9	10	11	12	13	15	16	
	Unpaired channels.									
108	17	18	19	20	21	22	23	24	25	26
109	27	28	29	30	31	32	33	34	35	36
110	37	38	39	40	41	42	43	44	45	46
111	47	48	49	50	51	52	53	54	55	56
112	57	58	59	—	—	—	—	—	—	—
	Even-numbered channels paired with ILS localizer. Odd-numbered channels paired with VOR.									
133	—	—	—	60	61	62	63	64	65	66
134	67	68	69	—	—	—	—	—	—	—
	Unpaired channels.									
112	—	—	—	70	71	72	73	74	75	76
113	77	78	79	80	81	82	83	84	85	86
114	87	88	89	90	91	92	93	94	95	96
115	97	98	99	100	101	102	103	104	105	106
116	107	108	109	110	111	112	113	114	115	116
117	117	118	119	120	121	122	123	124	125	126
	Channels paired with VOR.									
NOTE: The unpaired channels (1–16 and 60–69) cannot be received.										

Figure 25-9. VHF Frequencies vs. DME X Channels

25.13.4.1 Self-Test

An extensive self-test diagnostic routine can be initiated in the DME by pressing the TEST button on the NAV control. The self-test routine takes approximately 10 seconds to complete. After initiating self-test, all display segments and annunciators on the DME indicator illuminate for a lamp test. If NM and ID were being displayed, the numeric display will show a test distance of 100 nm. The alphanumeric display will show “AOK” at the completion of the test routine if no faults have been detected. (The DME aural output will be the Morse characters “AOK.”) If KT was being displayed, the alphanumeric display will show a test groundspeed of 100 KT. If MIN was being displayed, the alphanumeric display will show a test time of 60 MIN. Completion of self-test is indicated when either the DME indicator displays return to normal or the word “DIAG” along with a self-test fault code is displayed on the DME indicator.

Note

Because of the approximate l0-second self-test cycle time, the test should be made as a preflight check and not during critical flight times.

25.14 AUTOMATIC DIRECTION FINDER

25.14.1 Introduction

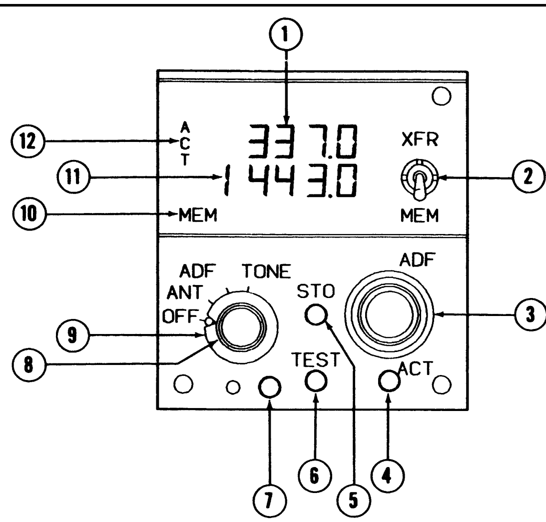
The ADF system provides aural reception of signals from a selected ground station and indicates relative bearing to that station. The ground station must be within the frequency range of 190 to 1749.5 kHz. The ADF system has three functional modes of operation. In ANT mode, the ADF receiver functions as an aural receiver, providing only an aural output of the received signal. In ADF mode, it functions as an automatic direction finder receiver in which relative bearing to the station is presented on an associated bearing indicator, and an aural output of the received signal is provided. A TONE mode provides a 1000-Hz aural output tone, when a signal is being received, to identify keyed CW signals.

25.14.2 ADF Operating Controls and Functions

All operating controls for the ADF system are located on the ADF control panel (Figure 25-10).

1. Active frequency display — The active frequency (frequency to which the ADF is tuned) and diagnostic messages are displayed in the upper window.

2. XFR/MEM switch — This switch is a three-position, spring-loaded toggle switch. When held to the XFR position, the preset frequency is transferred up to the active display and the previously active frequency becomes the new preset frequency and window. When this switch is held to the MEM position, one of the four stacked memory frequencies is loaded into the preset display. Successive presses cycle the four memory properties through the display (...2, 3, 4, 1, 2, 3...).



1. Active Frequency Display
2. XFR/MEM Switch
3. Frequency Select Knobs
4. ACT Button
5. STO Button
6. TEST Button
7. Light Sensor
8. Volume Control
9. Power and Mode Switch
10. Annunciators (MEM, HLD)
11. Preset Frequency Display
12. Compare Annunciator (ACT)

06-E-0071

Figure 25-10. ADF Control Panel

3. Frequency select knob — Two concentric knobs control the preset or active frequency displays. The larger knob changes the 1000s and 100s kHz digits. The smaller knob changes the 10s, units, and tenths kHz digits. Each detent of the larger knob changes the frequency in 100-kHz increments. Each detent of the smaller knob change the frequency in 1-kHz increments with the exception that the first two detent positions following a change in rotational direction will cause a 0.5-kHz change. Rapid rotation of the smaller knob will cause frequency changes greater than 1 kHz as a function of the rate of rotation frequencies roll over at the upper and lower limits. The two frequency select switches are independent of each other such that the upper and lower limit rollover of the 1-kHz digit will cause the l0-kHz digit to change.

4. ACT button — Press the ACT button for approximately 2 seconds to enable the frequency select knobs to directly retune the ADF. The bottom window will display dashes and the upper window will continue to display the active frequency. Press the ACT button a second time to return the control to the normal two-display mode.

5. STO button — The STO button allows up to four preset frequencies to be selected and entered into the control memory. After presetting the frequency to be stored, press the STO button. The upper window displays the channel number of available memory (CH 1 through CH 4); the lower window continues to display the frequency to be stored. For approximately 5 seconds, the MEM switch may be used to advance through the channel numbers without changing the preset display. Press the STO button a second time to commit the preset frequency to memory in the selected location. After approximately 5 seconds, the control will return to normal operation.

6. TEST button — Press the TEST button to initiate the radio self-test routine. (Self-test is active only when the TEST button is pressed.)

7. Light sensor — The built-in light sensor automatically controls the display brightness.

8. Volume control — A volume control is concentric with the power and mode switch.

9. Power and mode switch — The power and mode switch has four detented positions. The OFF position switches system power. Selecting ANT, ADF, or TONE applies power to the ADF system and establishes the system mode of operation.

10. MEM and HLD annunciators — The NAV control contains MEM (memory) and HLD (hold) annunciators. The MEM annunciator illuminates whenever a preset frequency is being displayed in the lower window. The HLD annunciator indicates that the DME is held to the active frequency at time of selection; the NAV frequency may be changed. The upper window now displays the NAV frequency and the lower window displays the held DME frequency.

11. Preset frequency display — The preset (inactive) frequency and diagnostic messages are displayed in the lower window.

12. Compare annunciator — ACT momentarily illuminates when frequencies are being changed. ACT also flashes if the actual radio frequency is not identical to the frequency shown in the active frequency display.

25.14.3 Operating Procedures

25.14.3.1 Frequency Selection

Frequency selection is made using either the frequency select knobs or the XFR/MEM (transfer/memory recall) switch.

For future developments, the ADF control has a normal frequency range of 190.00 to 1799.5 kHz; however, when used with the ADF, the upper frequency is limited to 1749.5 kHz. Rotation of either frequency select knob increases or decreases the frequency in the preset frequency display.

After the desired frequency is set in the preset frequency display, it can be transferred to the active frequency display by momentarily setting the XFR/MEM switch to XFR. At the same time that the preset frequency is transferred to the active display, the previously active frequency is transferred to the preset display. The ACT annunciator on the ADF control flashes while the receiver is tuning to the new frequency.

Note

If the ACT annunciator continues flashing, it indicates the receiver has not tuned to the frequency displayed in the active display.

The ADF control has a memory that permits storing up to four preset frequencies. Once stored, these frequencies can be recalled to the preset display by positioning the XFR/MEM switch to the MEM position. The storage location (CH 1 through CH 4) for the recalled frequency is displayed in the active frequency display while the XFR/MEM switch is held in the MEM position. All four stored frequencies can be displayed one at a time in the preset display by repeatedly positioning the XFR/MEM switch to the MEM position. After the desired stored frequency has been recalled to the preset display, it can be transferred to the active display by momentarily positioning the XFR/MEM switch to the XFR position.

During normal operation, all frequency selections and revisions are done in the preset frequency display; however, the active frequency can be selected directly as described in paragraph 25.14.3.2.

25.14.3.2 Direct Active Frequency Selection

The active frequency can be selected directly with the frequency select knobs by pressing the ACT button for about 2 seconds. The active frequency selection mode is indicated by dashes appearing in the preset display. Also, the ACT annunciator will flash as the frequency select knobs are turned to indicate that the transceiver is being retuned.

Note

If the ACT annunciator continues flashing after the frequency has been selected, it indicates that the receiver is not tuned to the frequency displayed in the active display.

To return to the preset frequency selection mode, press the ACT button again for about 2 seconds.

As a safety feature, the ADF control automatically switches to the active frequency selection mode when a frequency select knob is operated while the STO, TEST, or XFR/MEM switches are actuated or the memory recall inputs to the control are grounded.

25.14.3.3 Frequency Storage

Up to four preset frequencies can be stored in the memory in the ADF control for future recall. To program the memory, select the frequency in the preset frequency display using the frequency select knobs and press the STO button once. One of the channel numbers (CH 1 through CH 4) will appear in the active display for approximately 5 seconds. During this time, the channel number can be changed without changing the preset frequency by momentarily positioning the XFR/MEM switch to the MEM position. After the desired channel number has been selected, press the STO button again to store the frequency.

Note

When storing a frequency, the second actuation of the STO button must be done within 5 seconds after selecting the channel number of the first actuation of the STO button. If more than 5 seconds elapse, the control will revert to the normal modes of operation and the second store command will be interpreted as the first store command.

After a frequency has been stored in memory, it will remain in memory until changed using the STO button. Memory is retained even when the unit is turned off for an extended period of time.

25.14.4 Normal Operation

1. Function selection — Position the power and mode switch to ANT, ADF, or TONE Beat Frequency Oscillator (BFO).
2. Frequency selection — Using the preceding frequency select procedures, tune the ADF until the desired frequency is indicated in the active frequency display and verify the station identifier.
   a. ANT function — Position the power and mode switch to ANT. The RMI pointer will park horizontally. Select ADF on the audio system and adjust the volume.
   b. ADF function — Position the power and mode switch to ADF. The RMI pointer will indicate relative bearing to the tuned station.

Note

When the ADF system is not receiving a reliable signal, the RMI pointer will remain parked in the ADF mode. The ADF may momentarily park during station crossings because of signal loss.

   c. TONE function — Position the power and mode switch to TONE (BFO). A 1000-Hz tone will identify keyed CW stations.

25.14.4.1 Self-Test

Position the power and mode switch to ADF and tune a nearby NDB, locator outer marker, or broadcast station. Press the TEST button. The RMI pointer will rotate 90° from the previous valid indications. Release the TEST button and verify the RMI pointer returns to that indication.

Note

If the signal received is weak or of poor quality, the bearing pointer rotation will be slow.

25.15 DATA NAV SYSTEM

25.15.1 Introduction

The DATA NAV equipment (Figures 25-11 and 25-12) enables the operator to use the color weather radar indicator to display radar returns, checklists, or navigation symbology/alphanumerics. The navigation data displayed on the radar is derived from a VOR/DME, TACAN, or the FMS depending on what has been selected on the HSI source selection switches located outboard of each HSI.

There are four principal display modes in which the radar indicator can be operated: radar returns (WXD), navigation (NAV), checklists, and auxiliary.

25.15.1.1 Data Navigation Switches and Controls

1. NAV 1 — The pilot navigation information is displayed via the latching pushbutton switch, NAV 1, and is displayed on the radar screen in green.

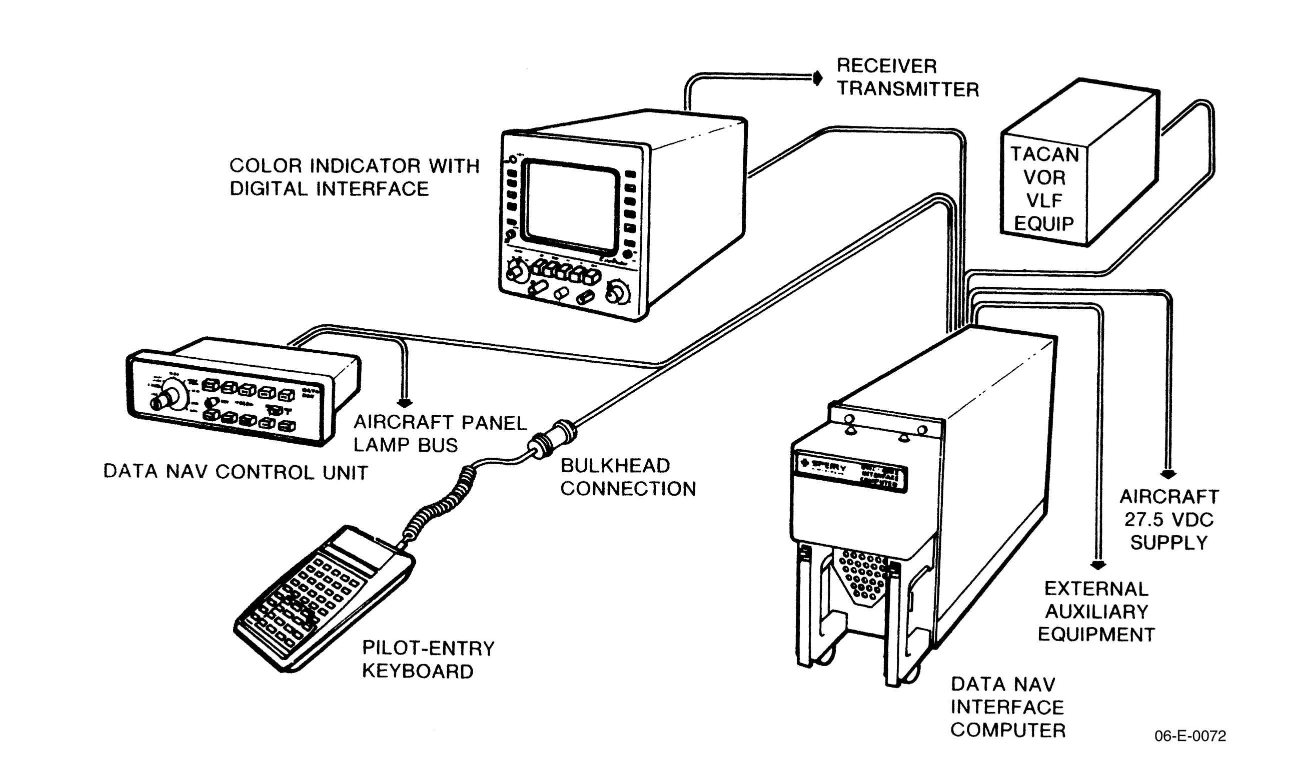
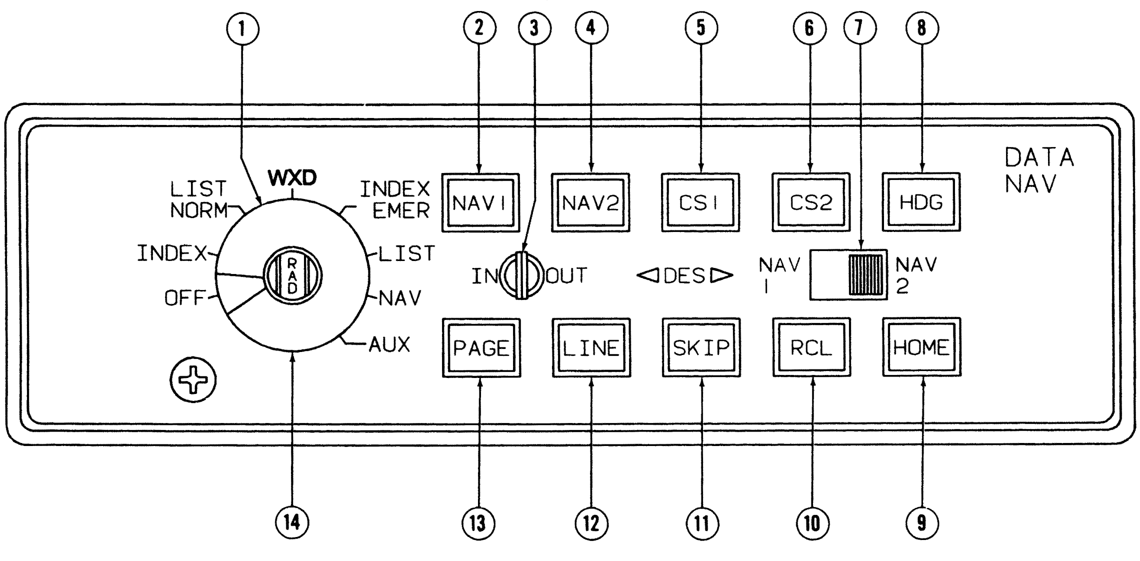


Figure 25-11. Data NAV Installation



1. Rotary Selector Switch
2. NAV 1 Selector Switch
3. DESignator IN - OUT Control Switch
4. NAV 2 Selector Switch
5. CS 1 Course Line and Readout Switch For NAV 1
6. CS 2 Course Line and Readout Switch For NAV 2
7. DESignator NAV 1 - NAV 2 Selector Switch
8. HDG Heading Switch
9. HOME Designator Switch
10. RCL Recall Item Switch
11. SKIP Item Switch
12. LINE Advance Switch
13. PAGE Advance Switch
14. RADial Placement Switch

06-E-0073

Figure 25-12. Data NAV Control Panel

2. DES IN-DES OUT — Momentary left-right three-position switch used to move the designator along radial established by RAD control.

3. NAV 2 — The copilot navigation information is displayed via the latching pushbutton switch, NAV2, and is displayed on the radar screen in yellow.

4. CS1 — Latching pushbutton switch used to select course line and readout for NAV 1 station and is displayed as green on the radar screen.

5. CS2 — Latching pushbutton switch used to select course line and readout for NAV 2 station and is displayed as yellow on the radar screen.

6. DES NAV 1-DES NAV 2 — Slide-switch used to select designator for NAV 1 or NAV 2 station.

7. HDG — Latching pushbutton switch used to select a line display and is displayed as white on the radar screen.

8. HOME — Momentary pushbutton switch used to position designator on VOR symbol, with tick pointing to Magnetic North.

9. RAD — Left-right counterclockwise/clockwise action switch used to radially rotate designator about VOR display.

10. RCL — Momentary pushbutton switch used to recall the first item skipped during checklist operation. Not enabled in INDEXes.

11. SKIP — Momentary pushbutton switch used to SKIP and not check any item during checklist operation. Not enabled in INDEXes.

12. LINE — Momentary pushbutton switch used to advance from one LINE to next during checklist operation.

13. PAGE — Momentary pushbutton switch used to advance from one PAGE to next during checklist operation.

14. OFF-NORM INDEX-NORM LIST-WXD-EMER INDEX-EMER LIST-NAV-AUX — Rotary switch used to turn DATA NAV interface computer OFF or turn it ON by selection of checklist, weather (WXD), NAV (navigation) (NAV with weather), or AUX (auxiliary) operation.

WARNING

The checklists located under INDEX, LIST NORM, INDEX EMER, and LIST on the DAT NAV interface computer switch and displayed on the radar are not NATOPS authorized checklists. Procedures shall be accomplished utilizing checklists found in Chapter 6 — Flight Preparation, Chapter 7 — Shore-Based Procedures, and Part V — Emergency Procedures.

25.15.1.1.1 DAT NAV Interface Computer Switch

1. INDEX — Permits a review of the normal checklist procedures.
2. NORM LIST — Permits a display of the first page of normal procedure checklist.
3. WXD — Disconnects the interface computer from the indicator and allows the display of normal weather radar returns. The system can be turned on or off independently of an operating radar.
4. EMER INDEX — Permits a review of the emergency checklist procedures.
5. LIST — Permits a display of the first page of emergency procedures checklist.
6. NAV — Allows the operator to display radar returns superimposed with navigational symbols and navigational data from external sources.
7. AUX — Permits the interface computer to receive inputs from the auxiliary equipment.

25.15.1.2 Radar Returns (WXD)

Setting the control unit rotary switch to WXD disconnects the interface computer from the indicator and allows the display of normal radar returns.

The system can be turned on or off independently of an operating radar. Selection of the radar (WXD) mode at the control unit is a default selection (i.e., it disconnects the system from the radar system so that the radar can operate in normal fashion).

The system supplies no indication to an auxiliary device that it has been selected or rejected. With certain exceptions, the auxiliary equipment operates only in response to its own controls, whether or not its outputs are displayed. Except for the display, the radar operates in whatever mode has been selected for it on the indicator control panel, regardless of switch selection on the control unit. Only the display is affected by control unit switches; however, the radar will override a system input if the target-alert mode is active and a target enters the target-alert sector. When the target-alert sector clears, the radar indicator resumes the display selected at the control unit.

25.15.2 Navigation

The navigation function allows the operator to display radar returns superimposed with navigational symbols (Figure 25-13) and navigational data from external sources.

25.15.2.1 Navigation Displays

The navigation displays are selected by placing the rotary switch on the control unit to NAV. In this mode, DATA NAV enables data from two independent navigation sources (if available) and displays either or both on the indicator. Additionally, the HSI(s) COURSE knobs can be used to control a course line about the VOR when selected from the control unit.

The current magnetic heading of the aircraft is displayed on a scale at the top of the screen to establish a visual reference point for pilot orientation. Selected heading can also be displayed graphically on the indicator when HDG is activated on the control unit.

When the appropriate designator is selected via the control unit, the active VOR establishes a reference point for the designator. The designator controls on the control unit will then move the designator symbol to any point on or off the screen with the VOR as reference and display the radial and distance to the designator from the VOR. A solid line is displayed connecting the designator position to the VOR and will be visible as long as the NAVAID or the designator are displayed on the radar screen. The homed designator position is the VOR.

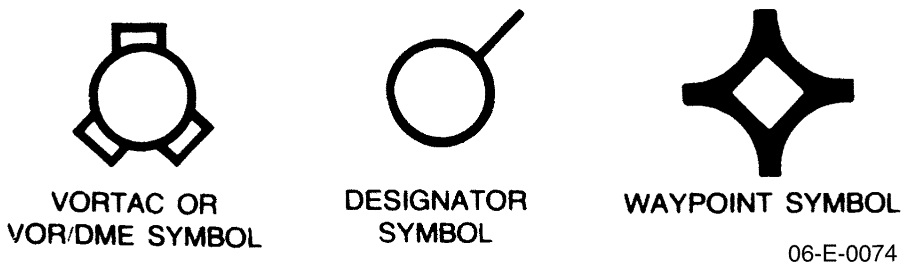


Figure 25-13. Navigational Symbols

The designator can be selected to work with the VOR for either of the navigation sources via the NAV 1-NAV 2 slide-switch on the control unit. Alphanumeric readout of radial and distance of the designator from the VOR as well as bearing (magnetic) and distance to the designator from the aircraft is displayed on the screen.

The designator can be used to create a waypoint on the display from VOR or RNAV input. The designator does not enter the data directly in the RNAV unit, but it will provide the information needed to key in the waypoint data. Since the designator is fixed geographically relative to VOR, it can be used similar to a waypoint, although not coupled to CDI.

When the HOME button is pressed, the designator is returned to the VOR and the readout of distance to designator and radial of designator with respect to VOR goes to 0.

When the designator is activated for one VOR and then the other VOR is selected, the system will retain the data for the first navigation source in memory. An asterisk in the color of the first navigation source will be displayed in the top left hand of the screen to the right of the station-to-designator (S-D) legend, provided that data on the position of the first navigation source is present. This asterisk will be removed when position data is lost.

The VORTAC or VOR/DME symbol is accompanied by a readout of the station radial and ID, displayed in the lower left portion of the display.

The designator symbol is selected to work with the VOR for either station by the control unit DES NAV 1 DES NAV 2 slide switch. The designator IN-OUT and RAD controls are used to move the designator symbol to any point on or off the screen with the VOR as reference and display radial and distance to the designator from the VOR, whether or not the VOR station is within radar range, as long as signals are being received. The S-D readout is displayed in the upper left portion of the display; the aircraft-to-designator (A-D) readout is displayed in the lower right portion of the display. With the designator in the home position or positioned on the VOR, a “tick” is displayed to indicate the direction of OUT movement. This tick is removed once the designator is moved out from the ground station symbol. A solid line connects the designator symbol to the VOR symbol. By pressing the HOME switch, the designator is positioned on the VOR with the tick pointing to Magnetic North.

The waypoint symbol is displayed in NAV or to mark the latitude/longitude position used for course definition. A waypoint may be associated with either NAV 1 station or NAV 2 station or a waypoint for each station.

25.15.2.2 Compass Heading

The current magnetic heading of the aircraft is displayed on a scale at the top center of the screen. A selected heading line may also be displayed by pressing the HDG switch on the control unit.

25.15.2.3 Course Lines

The waypoint and ground station symbol course lines are displayed as solid lines through the symbols and originate from a position determined by the settings of the HSI(s) COURSE knob.

25.15.3 Navigation Operation

WARNING

To prevent electromagnetic radiation in ramp, terminal, taxiway, or other areas occupied by personnel, operate radar only in STANDBY mode.

CAUTION

Do not operate radar system, even in STANDBY mode, without 115-Vac, 400-Hz power applied to the system. Without power, the receiver-transmitter cooling blower will not operate, which could result in circuit damage and/or automatic shutdown.

The following paragraphs provide the procedures utilizing the capabilities of the NAV function. These paragraphs are presented in sequential order from initialization to a composite navigation display.

For the purpose of explanation, only NAV 1 controls and symbols are addressed in the following procedures, except for the composite selection.

25.15.3.1 Initial Entry

1. Perform turn-on of radar set and external navigation equipment (e.g., compass, DME, radio, etc.).
2. Set rotary switch to NAV and observe that disclaimer notice appears and remains until any NAV switch is changed.
3. With no selections made on the control unit, the only display is the magnetic heading readout (if for some reason the compass is inoperative, the three digits are replaced with dashes).

25.15.3.2 NAV 1/DES NAV Selection

1. Tune in desired VOR stations to be used as NAV 1 and NAV 2.
2. Place DES NAV 1-NAV 2 switch to NAV 1.
3. Press NAV 1 pushbutton and note that green VOR symbol, distance, bearing, and station ID readouts appear. If DES NAV 1-NAV 2 switch is placed to NAV 2, the VOR symbol remains, but designator readouts disappear.

Note

This assumes that the station is located in the area shown on the display. The ID readout will not appear until acquired by the DME receiver; this may take up to 2 minutes.

25.15.3.3 NAV 1/HDG Selection

1. Press HDG pushbutton and note that heading line (white) is displayed.
2. The selected heading line may now be moved by rotating the HDG knob on the HSI.

CAUTION

The operator must compare the heading error line display to the HSI heading bug to ensure the display is in the correct quadrant. The display is correct only for heading errors less than 60°.

25.15.3.4 NAV 1/CS1 Selection

1. Press CSl pushbutton; note that a green course line through the NAV 1 station symbol has been added to the display of the preceding paragraph.
2. Note that green CRS, bearing, and station ID appear in the lower left corner of the display.

25.15.3.5 NAV 1/DES Selection

1. Rotate RAD control to position designator symbol to desired radial.
2. Hold DES IN-OUT switch in OUT position to move designator symbol to desired position.
3. Note that designator and connecting line are displayed from the station symbol and that station-to-designator data and aircraft-to-designator data appear in the upper left and lower right corners, respectively, of the display.
4. The designator may be homed to the selected NAV station symbol by pressing HOME pushbutton; the S-D readout is now all zeros and the A-D readout provides bearing distance information from the aircraft to the NAVAID.

25.15.3.6 Composite Selection

1. Verify two external stations have been selected.
2. Press NAV 2 and CS2 pushbuttons.
3. Place DES NAV 1-NAV 2 switch to NAV 2 position.
4. Move DES IN-OUT and RAD controls to present a display.

25.15.3.7 DME Hold Display

The pilot may manually place the DME in a hold condition, in which case the S-D/A-D readouts, VOR, and designator symbols disappear and the WPT CRS bearing numerals change to DMEH (DME hold).

25.15.4 Checklist

The rotary switch on the control unit has four checklist positions (i.e., INDEX and LIST positions for both EMER [emergency] and NORM [normal] operations). With the switch in either INDEX position, the indicator displays the appropriate INDEX of procedures contained in the memories. The PAGE and LINE advance, SKIP and RCL momentary pushbutton switches are used in conjunction with the checklist displays. The PAGE switch allows the operator to advance from one page to the next in an index or list. The LINE switch allows the operator to advance from one procedure to another in an index or from one item to another in a list. The SKIP switch allows the operator to bypass or not check any item in a list. The RCL (recall) switch allows the operator to return to the first page and item not checked or skipped remains.

25.15.4.1 Definitions

The following terms define the elements of the checklist displays:

Checklist — A checklist is a collection of sequential procedures to be followed by a pilot. There are two checklists: one for normal procedures and one for emergency procedures.

Procedures — A procedure consists of one or more related items that are checked in sequence by the pilot.

Item — An item is a specific action taken or condition checked by the pilot. An item may be displayed on one or more lines.

Index — An index consists of a list of all procedures by title, with each title numbered sequentially. There are two indexes: one for normal procedures and one for emergency procedures.

Cursor — The cursor consists of changing the color of a selected procedure or item being checked in a list. The cursor turns the letters yellow in the NORM INDEX or NORM LIST and red in the EMER INDEX or EMER LIST. Unselected procedures in an index or unchecked items in a list are green. Items already checked in a list are blue.

25.15.5 Checklist Operation

WARNING

To prevent electromagnetic radiation in ramp, terminal, taxiway, or other areas occupied by personnel, operate radar only in STANDBY mode.

CAUTION

Do not operate radar system, even in STANDBY mode, without 115 Vac, 400-Hz power applied to the system. Without ac power, the receiver-transmitter cooling blower will not operate, which could result in circuit damage and/or automatic shutdown.

After turning on the radar, use the following procedure to sequence through the checklists:

25.15.5.1 Initial Entry

1. To review the list of procedures, set the rotary switch to NORM INDEX for normal procedures or to EMER INDEX for emergency procedures.

2. To go directly to the first procedure, set the rotary switch to NORM LIST or EMER LIST.

3. A disclaimer notice will be displayed. Press PAGE to clear the notice and display the first page of the selected index or procedure.

25.15.5.2 Procedure Selection Through Normal or Emergency Indexes

1. Set rotary switch to NORM INDEX (EMER INDEX). Press PAGE to clear disclaimer notice and to display first page of index. Note that the first item is displayed in yellow (normal procedures), red (emergency procedures).

2. If that is the desired procedure, set rotary switch to NORM LIST (EMER LIST) to display first page of selected procedure.

3. To select another procedure, press LINE until the title of desired procedure is displayed in yellow (red).

4. Set rotary switch to NORM LIST (EMER LIST) to display first page of selected procedures.

In a multiple-page index, you may review the listed titles by pressing PAGE to display subsequent index pages. At the last page of the index, you may loop back to the first page by pressing PAGE.

25.15.5.3 Item Sequencing Through Normal Procedures

1. To check off an item, press LINE. Note that the yellow cursor moves to the next item and that the checked item is displayed in blue.
2. To skip an item, press SKIP. Note that the yellow cursor moves to the next item and that the skipped item remains displayed in green.
3. Successively press LINE or SKIP to sequence through all items of the procedure.
4. To return to an unchecked item, press RCL. The display will return to the first page containing an unchecked item, with that item displayed in yellow.

5. After checking off skipped items on that page, the display will automatically advance to the next page containing an unchecked item.

6. If the last item in a procedure and all previous items in the procedure have been checked, advance to the first item of the next procedure by pressing LINE.

7. If the last item in a procedure, but some previous items in the procedure have been skipped, pressing LINE will cause the cursor to return to the first unchecked item in the procedure (i.e., you may not advance to the next procedure until skipped items are checked off).

In a multiple-page procedure, to review the listed items, press PAGE to display subsequent pages. At the last page of the procedure, you may loop back to the first page by pressing PAGE.

25.15.5.4 Block Checkoff in Normal Procedures

The "block check" feature permits the checking off of many items simultaneously. This feature can be used as follows:

1. On the displayed page, position the yellow cursor to the first item of the block (using LINE or SKIP).
2. Press PAGE to advance to the next or subsequent page.
3. Press LINE and note that the cursor appears on the first unchecked item on the displayed page.

All items between the original cursor position, inclusive, and the current cursor position have been checked off. To verify, press PAGE a sufficient number of times to loop back to the original page and note that all items from the beginning of the block to the present cursor position, exclusive, are now displayed in blue.

Note

Block check is available only in NORM LIST mode; it is inhibited in EMER LIST mode.

25.15.5.5 Item Sequencing Through Emergency Procedure

1. To check off an item, press LINE. Note that the red cursor moves to the next item and that the checked item is displayed in blue.
2. To skip an item, press SKIP. Note that the red cursor moves to the next item and that the skipped item remains displayed in green.
3. To return to an unchecked item, press RCL. The display will return to the first page containing an unchecked item, with that item displayed in red.
4. When the last unchecked item in the emergency procedure is checked off and all previous items in the procedure have been checked and LINE is pressed, the word COMPLETE is re-entered in red in the center of the last available line on the last page of the procedure.

Note

In EMER LIST, the LINE button will not sequence to the next emergency procedure when the current emergency procedure is completed. To enter the next emergency procedure, set rotary switch to EMER INDEX and press LINE to move the cursor to the next procedure. Then set rotary switch to EMER LIST to display the first page of the next procedure.

25.15.5.6 Reinitialization

If the checklist display is not functioning properly, reinitialize the checklist operation as follows:

1. Set rotary switch to OFF.
2. Set rotary switch to any desired INDEX or LIST position.
3. Press PAGE pushbutton to display first page of chosen index or list.

25.15.6 Auxiliary

When the rotary switch on the control unit is set to AUX, the interface computer is available for inputs from the auxiliary equipment.

25.16 AUTOMATIC FLIGHT CONTROL SYSTEM

The automatic flight control system is a completely integrated autopilot/flight director/air data system that has a full complement of horizontal and vertical flight guidance modes. These include all radio guidance modes and air data-oriented vertical modes.

When engaged and coupled to the flight director commands, the system will control the aircraft using the same commands displayed on the flight director indicator. When engaged and uncoupled from the flight director commands, manual pitch and roll commands may be inserted using the TCS or the pitch wheel and turn knob.

When the autopilot is coupled, the flight director instruments act as a means to monitor the performance of the autopilot. When the autopilot is not engaged, the same modes of operation are available for flight director only. The pilot maneuvers the aircraft to satisfy the FD commands as does the autopilot when it is engaged.

Note

The autopilot will disengage when transferring between the pilot and copilot flight directors.

25.16.1 Autopilot Flight Director Transfer Panel

An alternate action autopilot and flight director transfer switch placarded AP FD 1 and AP FD 2 is located above the pilot airspeed indicator. This switch is used to select which autopilot flight director computer controls the aircraft flight servos. If AP FD 2 is selected, the annunciators placarded AP FLT DIR NO. 2 and located above the copilot airspeed indicator will illuminate to alert both pilots that the No. 2 autopilot flight director computer is controlling the aircraft. The No. 1 APFD is not annunciated on the copilot side of the instrument panel.

Note

If VOR is selected on both pilot and copilot HSIs, the DME readout and radar NAV display will accompany the selected autopilot flight director.

25.16.2 Air Data Computer

A digital air data computer is located on the bottom shelf in the forward avionics compartment and provides the altitude information for the pilot encoding altimeter, altitude alerter, and transponder. The computer also provides altitude and airspeed hold function data to the flight control computers and generates and provides TAS to the FMS system with inputs from the airspeed/temperature probe. The air data computer receives 28 Vdc power through and is protected by a 5-ampere circuit breaker placarded AIR DATA-ENCDR and located in the AVIONICS section of the circuit breaker panel. All air data computer functions are automatic in nature and require no flightcrew action.

25.16.3 Flight Director/Mode Selector

The flight director/mode selector (Figure 25-14) provides all mode selection (except go-around, which is initiated by a remote switch) for the flight director. The top row of light annunciated pushbuttons contains the lateral modes and the bottom row contains the vertical modes. The split light pushbuttons illuminate amber for armed conditions and green for captured. When more than one lateral or vertical mode is selected, the FD system automatically “arms” and “captures” the submode. The mode annunciations are repeated on the remote annunciator blocks above both FDIs, with the addition of GS ARM, GS CAP, AP ENG, YD ENG, and GA (Figure 2-6).

25.16.3.1 Heading (HDG) Select Mode

The heading select mode is selected by depressing the HDG button on the mode selector (HDG annunciator illuminates). In the HDG mode, the flight director computer provides inputs to the command cue on the HSI to command a turn to the heading indicated by the heading bug. The heading select signal is gain programmed as a function of airspeed. When HDG is selected, it overrides the NAV BC APR and VOR APR modes. In the event of a loss of valid signal from the vertical gyro or compass, the command cue is biased out of view.

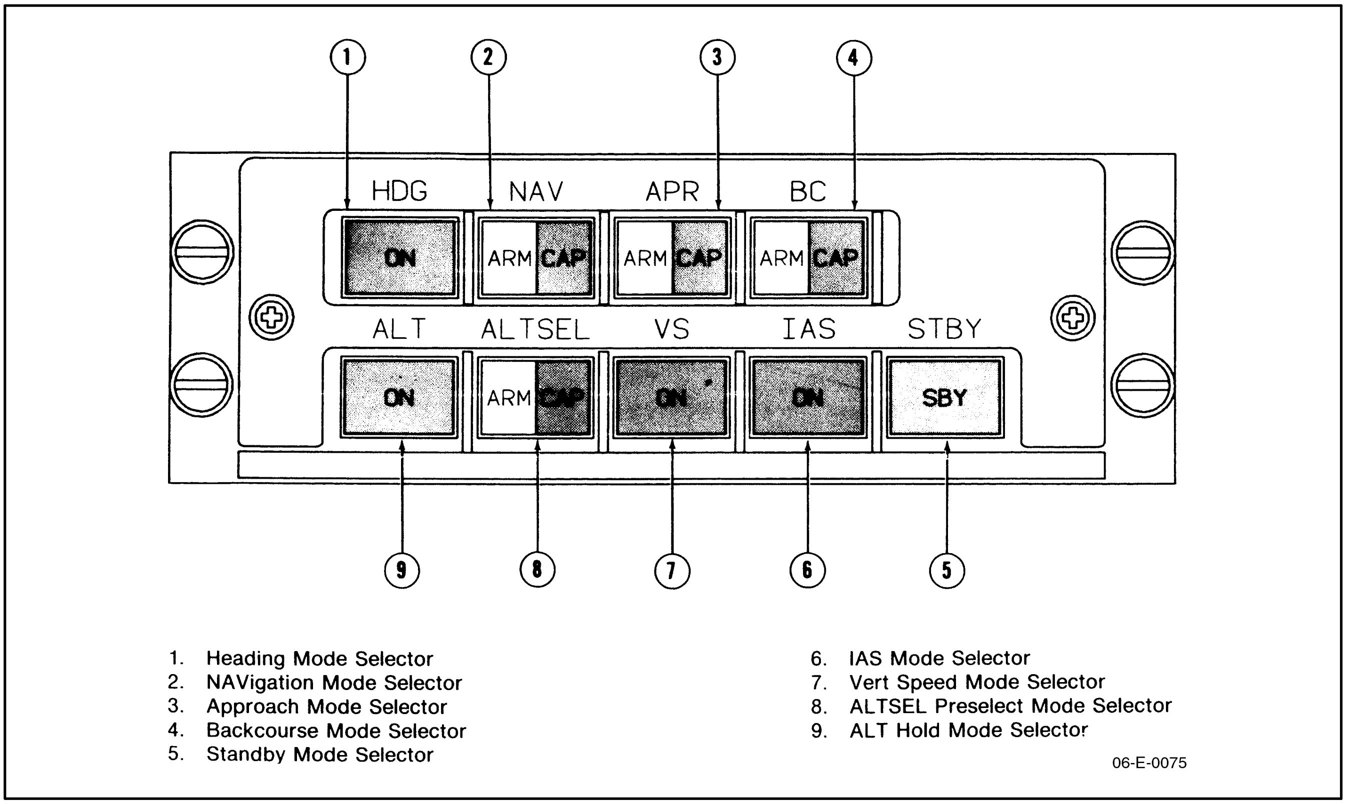


Figure 25-14. Flight Director/Mode Selector

25.16.3.2 Navigation (NAV) Mode

The navigation mode represents a family of modes for various navigation systems including VOR, Localizer, TACAN, or FMS as selected by the HSI selector switches.

25.16.3.2.1 VOR Mode

The VOR mode is selected by depressing the NAV button on the mode selector with the navigation receiver tuned to a VOR frequency and DME greater than 20 miles from the station. Prior to VOR capture, the command cue receives a heading select command as described above and the HDG mode annunciator on the mode selector is illuminated along with the NAV ARM annunciator on the mode selector.

Upon VOR capture, the system automatically switches to the VOR mode, HDG and NAV ARM annunciators extinguish, and the NAV capture (NAV CAP) annunciator on the mode selector will illuminate. At capture, a command is generated to capture and track the VOR beam. VOR deviation is gain programmed as a function of distance from the station. This programming corrects for beam convergence, thus optimizing the gain through the useful VOR range. To utilize this feature, the DME must be tuned to the same VOR station as the NAV receiver, which is feeding the flight director. The course error signal is gain programmed as a function of airspeed. Crosswind washout is included, which maintains the aircraft on beam center in the presence of crosswind. The intercept angle and DME distance are used in determining the capture point to ensure smooth and comfortable performance during bracketing.

When passing over the station, an overstation sensor detects station passage, removing the VOR deviation signal from the command until it is no longer erratic. While over the station, course changes may be made by selecting a new course on the HSI.

If the NAV receiver is not valid prior to the capture point, the lateral beam sensor will not trip and the system will remain in the HDG mode. After capture, if the NAV receiver, compass data, or vertical gyro go invalid, the command cue will bias out of view. The NAV CAP annunciator on the mode selector will extinguish if the NAV receiver becomes invalid.

25.16.3.2.2 VOR Approach Mode

The VOR approach mode is selected by depressing the APR button on the mode selector with the navigation receiver tuned to a VOR or TACAN frequency and less than 20 DME miles from the station. The mode operates identically to the VOR mode with the gains optimized for a VOR or TACAN approach.

25.16.3.2.3 Localizer Mode

The localizer mode is selected by depressing the NAV button on the mode selector with the navigation receiver tuned to a LOC frequency. Mode selection and annunciation in the LOC mode is similar to the VOR mode. The localizer deviation signal is gain programmed as a function of radio altitude, time, and airspeed. If the radio altimeter is invalid, gain programming is a function of glideslope capture, time, and airspeed. Other valid logic is the same as the VOR mode.

25.16.3.2.4 Back Course (BC) Mode

The BC mode is selected by pressing the BC button on the mode selector. BC operates the same as the LOC mode with the deviation and course signals reversed to make a BC approach on the localizer. When BC is selected and when outside the lateral beam sensor trip point, BC ARM and HDG will be annunciated on the mode selector. At the capture point, BC CAP will be annunciated with BC ARM and HDG extinguished. When BC is selected, the glideslope circuits are locked out.

Note

Set the LOC front course in the HSI. The course indicated will be 180° from the inbound BC, but the HSI will present normal sensing.

25.16.3.2.5 Localizer Approach (APR) Mode

The approach mode is used to make an ILS approach. Pressing the APR button with a LOC frequency tuned arms both the localizer and glideslope modes. No alternate NAV source can be selected and the NAV receiver must be tuned to an ILS frequency. When the APR button is pressed and the above conditions are met, both the NAV and APR modes are armed to capture the localizer and glideslope, respectively. Operating LOC mode is the same as described above except, if the radio altimeter is invalid in APR mode, gain programming is a function of glideslope capture, time, and airspeed.

With the APR mode armed, the pitch axis can be in any one of the other pitch modes except go-around. When reaching the vertical beam sensor trip point, the system automatically switches to the glideslope mode. The pitch mode and APR ARM annunciators extinguish and APR CAP annunciator illuminates on the controller. At capture, a command is generated to asymptotically approach the glideslope beam. Capture can only be made from below the beam. The glideslope gain is programmed as a function of radio altitude, time, and airspeed. The APR CAP annunciator on the mode selector will extinguish if the GS receiver becomes invalid after capture.

Glideslope capture is interlocked so that the localizer must be captured prior to glideslope capture. If the glideslope receiver is not valid prior to capture, the vertical beam sensor will not trip and the system will remain in the pitch mode. After capture, if the NAV receiver, GS receiver, compass data, or vertical gyro becomes invalid, command cue will bias out of view. If the radio altimeter is not valid, the glideslope gain programming is a function of glideslope capture, time, airspeed, and middle marker.

25.16.3.2.6 Pitch Hold Mode

Whenever a roll mode is selected without a pitch mode, the command cue will display a pitch attitude hold command. The pitch attitude can be changed by pressing the TCS button on the control wheel and maneuvering the aircraft. The command cue will be synchronized to zero while the button is depressed. Upon release of the button, the pitch command will be such as to maintain the new pitch attitude. In the pitch hold mode, the command cue will be biased out of view if the vertical gyro is not valid.

25.16.3.2.7 TACAN Mode

The TACAN mode is selected by depressing the HSI source selector TACAN button.

Note

The TACAN receiver must be tuned to a valid TACAN frequency. TACAN fluctuations are identical to VOR using TACAN information rather than VOR signals. The ARM/CAP annunciation is the same as in VOR mode.

25.16.3.3 Altitude Hold (ALT) Mode

The altitude hold mode is selected by depressing the ALT button on the mode selector. When ALT is selected, it overrides the APR CAP, GA, IAS, VS, ALT SEL CAP, or PITCH HOLD modes. In the ALT mode, the pitch command is proportional to the altitude error provided by the air data computer. The altitude error signal is gain programmed as a function of airspeed. Depressing and holding the TCS button allows the pilot to maneuver the aircraft to a new altitude hold reference without disengaging the mode. Once engaged in the altitude hold mode, the mode will be reset if the air data computer is not valid and the command cue will bias out of view if the vertical gyro is not valid.

Note

If the Baro setting on the altimeter is changed, a command is generated to fly the aircraft back to the original altitude reference.

25.16.3.4 Indicated Airspeed Hold (IAS) Mode

The indicated airspeed hold mode is selected by depressing the IAS button on the mode selector. When IAS is selected, it overrides the APR CAP, GA, ALT, VS, ALTSEL CAP, or PITCH HOLD modes. In the IAS mode, the pitch command is proportional to airspeed error provided by the air data computer. Depressing and holding the TCS button allows the pilot to maneuver the aircraft to a new airspeed hold reference without disengaging the mode. Once engaged in the IAS mode, the mode will be reset if the air data computer is not valid and the cue will bias out of view if the vertical gyro is not valid.

25.16.3.5 Vertical Speed Hold Mode (VS)

The VS hold mode is selected by depressing the VS button on the mode selector. When VS is selected, it overrides the APR CAP, GA, ALT, ALTSEL CAP, IAS, or PITCH HOLD modes. In the VS mode, the pitch command is proportional to VS error provided by the air data computer. Depressing and holding the TCS button allows the pilot to maneuver the aircraft to a new vertical speed hold reference without disengaging the mode. Once engaged in the VS mode, the mode will be reset if the air data computer is not valid and the command cue will bias out of view if the vertical gyro is not valid.

25.16.3.6 Altitude Preselect Mode (ALTSEL)

The altitude preselect mode is selected by pressing the ALTSEL button on the mode selector. The desired altitude is selected on the altitude preselect controller. Pitch hold, VS, or IAS may be selected as a mode to fly to the selected altitude. When outside the altitude bracket trip point, the ALTSEL ARM annunciator along with the selected pitch mode is illuminated on the mode selector. When reaching the bracket altitude, the system automatically switches to the ALTSEL CAP mode and the previously selected pitch mode is canceled. At bracket, a command is generated to asymptotically capture the selected altitude. When the altitude is reached, the ALTSEL CAP mode is automatically canceled and the flight director switches to the ALT mode. If the air data computer is not valid, the altitude preselect mode cannot be selected. The command cue will bias out of view if the vertical gyro is not valid.

25.16.3.7 Standby (SBY) Mode

The SBY mode is selected by depressing the SBY button on the mode selector. This resets all the other flight director modes and biases the command cue from view. While depressed, SBY acts as a lamp test causing all mode annunciators to illuminate and the flight director warning flag on the FDI to come in view. When the button is released, the mode annunciator lights extinguish and the FD warning flag retracts from view.

25.16.3.8 Go-Around (GA) Mode

The GA mode is selected by depressing the remote GA switch. When selected, all other modes are reset and the remote GA annunciator “GA” is illuminated. The command cue receives a wings-level command (zero command when roll is zero). The command cue also receives the GA command, which is a 7°, pitch-up attitude command. Selecting GA disconnects the autopilot. The yaw damper remains on.

Once GA is selected, any roll mode can be selected and will cancel the wings-level roll command. The GA mode is canceled by selecting another pitch mode or TCS.

25.16.4 Autopilot Controller

The autopilot controller (Figure 25-15) provides the means of engaging the autopilot and yaw damper as well as manually controlling the autopilot through the turn knob and pitch wheel. The autopilot system limits are provided in Figure 25-16.

25.16.4.1 AP ENGAGE Pushbutton

The ENGAGE switch is used to engage the autopilot. Engaging the autopilot automatically engages the yaw damper. The autopilot may be engaged with the aircraft in any reasonable attitude.

Note

When engaged on deck, the AP and YD engage pushbuttons flash. The controls must be overpowered to engage the autopilot. On-deck sensing is provided to the autopilot computer by the air data computer and the radio altimeter.

25.16.4.2 Autopilot Disengage

The autopilot is normally disengaged by momentarily depressing the control wheel AP DISC switch.

The autopilot may, however, be disengaged by any of the following:

1. Actuation of the control wheel AP DISC button. Disengagement is confirmed by five flashes of the AP ENG annunciator.

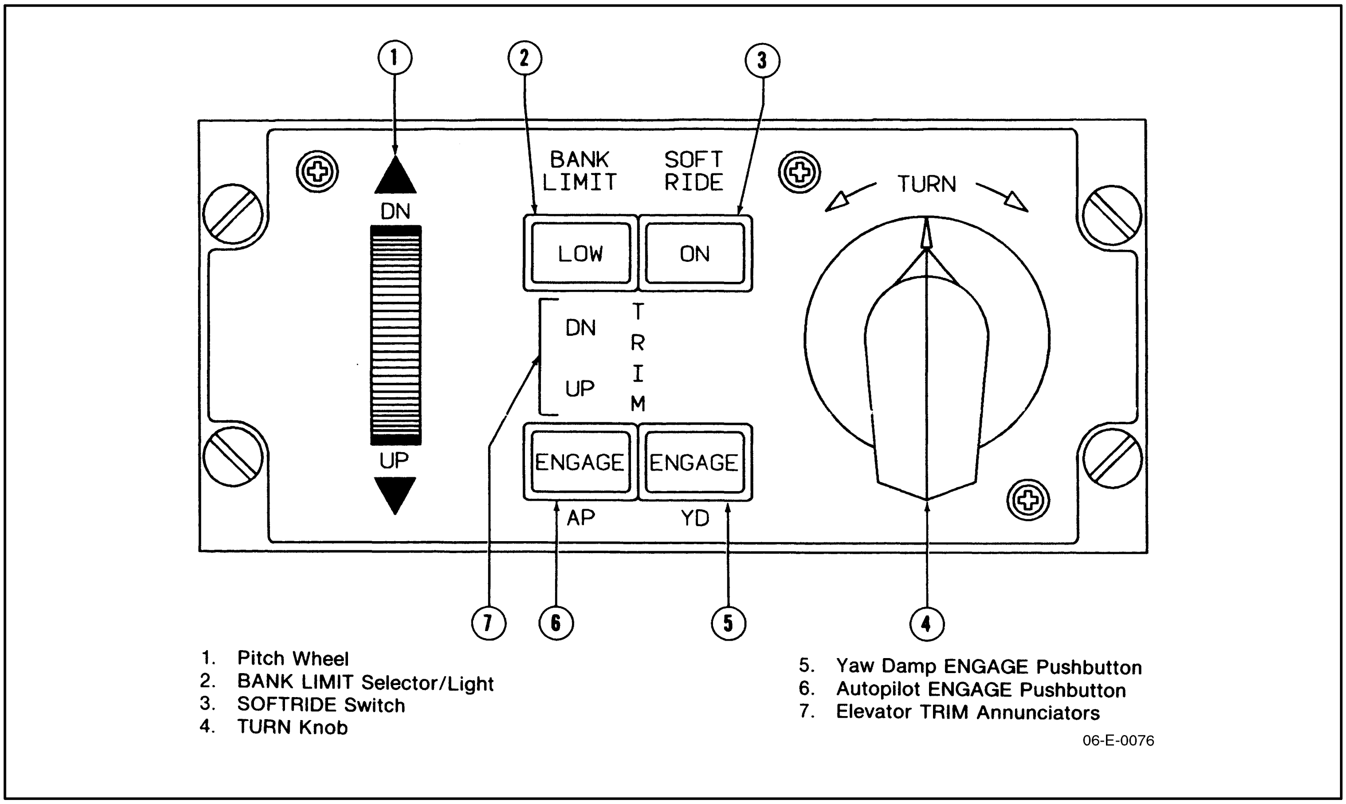


Figure 25-15. Autopilot Controller

2. Pressing the respective vertical gyro FAST ERECT button.

3. Actuation of the respective compass INCREASE-DECREASE switch.

4. Selection of GA mode. Disengagement is confirmed by the AP ENG annunciator flashing five times and illumination of the GA annunciators.

5. Pulling the autopilot AP CONTROL circuit breaker.

6. Pressing the autopilot AP ENGAGE pushbutton.

7. When transferring between pilot and copilot flight directors.

Any of the following malfunctions will cause the autopilot to automatically disengage:

8. Vertical gyro failure.

9. Directional gyro failure.

10. Autopilot power or circuit failure.

11. Torque limiter failure.

Disengaging under any of the last four conditions will illuminate the AP DISC annunciator and the flashing MASTER WARNING light. Pressing the control wheel AP DISC switch will extinguish the AP DISC annunciator.

25.16.4.3 YD ENGAGE Pushbutton

When the autopilot is not engaged, the yaw damper may be utilized by depressing the YD ENGAGE pushbutton.

Note

When engaged on deck, the AP and YD ENGAGE pushbuttons flash. The controls must be overpowered to engage the autopilot. On-deck sensing is provided to the autopilot computer by the air data computer and the radio altimeter.

25.16.4.4 BANK LIMIT

Selection of the BANK LIMIT mode on the autopilot controller provides a lower maximum bank angle while in the HDG select mode. LOW will illuminate on the BANK LIMIT switch. The lower bank limit is inhibited and LOW is extinguished during NAV mode captures. If heading select is again engaged, BANK LIMIT will again be illuminated. Pressing BANK LIMIT when illuminated will return autopilot to normal bank limits.

25.16.4.5 SOFT RIDE Pushbutton

SOFT RIDE reduces autopilot gains while still maintaining stability in rough air. This mode may be used with any flight director mode selector.

25.16.4.6 Elevator Trim Annunciator

The elevator trim annunciator indicates UP or DN when a sustained signal is being applied to the elevator servo. The annunciator should not be illuminated before the autopilot is engaged.

25.16.4.7 Turn Knob

Rotation of the turn knob out of detent results in a roll command. The roll angle is proportional to and in the direction of the turn knob rotation. The turn knob turn must be in detent (center position) before the autopilot can be engaged. Rotation of the turn knob cancels any other previously selected lateral mode.

25.16.4.8 Pitch Wheel

Movement of the pitch wheel will cancel only ALT HOLD and ALTSEL CAP. With vertical modes of VS or IAS selected on the mode selector, rotation of the pitch wheel will change the respective displayed vertical mode reference. VS or IAS mode may be canceled by pressing the mode button on the mode selector. If VS or IAS is not selected, the pitch wheel works as described above. The pitch wheel is always disabled during a coupled glideslope.

25.16.5 Touch Control Steering (TCS)

The TCS pushbutton located on the control wheel allows the pilot to manually change aircraft attitude, altitude, vertical speed and/or airspeed without disengaging the autopilot. After completing the manual maneuver, the TCS pushbutton is released; the autopilot has automatically resynchronized to the vertical mode (e.g., with IAS mode selected, the pilot may depress the TCS pushbutton and manually change speed). Once trimmed at the new airspeed, the TCS pushbutton is released and the autopilot will hold this airspeed. If a large pitch attitude change is made, the pilot should perform his/her normal trim of the aircraft before release of the TCS button.

25.17 ALTITUDE SELECT CONTROLLER

The altitude select controller provides a means for setting the desired altitude reference for the altitude alerting and altitude preselect system.

25.17.1 Altitude Alerter

An altitude alerter is mounted on the center radio panel. The unit receives input data from the encoding altimeter and controls a tone generator and an ALT annunciator light. These provide aural and visual alerting signals when approaching or deviating from a preselected altitude. When the tone generator operates, the tone, similar to stall warning, is audible from beneath the subpanel. A knob at the lower right corner of the unit is used to preselect the desired altitude. A preselected altitude (–900 to 37,000 feet in 100-foot increments) is presented on a counter-type display. During climbs and descents when the aircraft is within 1,000 ±50 feet of the selected altitude, the tone operates for 2 seconds and the ALT annunciator light illuminates. When the aircraft is within 300 ±50 feet of the selected altitude, the ALT light extinguishes. If the aircraft is maintained within 300 ±50 feet below or above the preselected altitude, the ALT light and tone will remain off. Any deviation from the 300 ±50 feet will cause the tone to resound for 2 seconds and the ALT light to reilluminate. The altitude alerter is powered by the No. 1 dual-fed bus and is protected by a circuit breaker placarded ALT ALERT in the FLIGHT group on the right side circuit breaker panel.

25.17.1.1 Altitude Preselect

The altitude is selected by turning the selector knob until the altitude display reads the desired value. No further action is taken on the controller. To initiate altitude preselect, the ALTSEL button is selected on the flight director controller. The pilot must initiate a maneuver to fly toward the preselected altitude. Any of the following pitch modes may be engaged: pitch hold, airspeed hold, or vertical speed hold. Upon initiation of altitude preselect capture, the previously selected pitch mode is automatically reset.

25.18 FLIGHT MANAGEMENT SYSTEM (FMS)

25.18.1 Description

The Flight Management System (FMS) provides flight planning, navigation, and flight progress status by providing guidance information to the autopilot, Horizontal Situation Indicator (HSI), and Flight Director. The system consists of a Control Display Unit (CDU) located in the pedestal (Figure 25-17), a Receiver Processor Unit (RPU) located in the aft fuselage avionics compartment, an Air Data Computer (ADC) located in the nose avionics compartment, a Global Positioning System (GPS) receiver antenna located on the top of the fuselage, and an ADC Temperature Probe (Figure 20-1) located on the underside of the fuselage. Provisions only are installed for a GPS (P/Y code) Receiver Unit (GRU).

The FMS utilizes the Course Acquisition (C/A) code GPS signal as its primary navigation source for autopilot, HSI, and flight director input. The FMS also generates and displays flight status messages to the flightcrew for use in planning a flight, monitoring flight progress, and en route, terminal, and nonprecision approach navigation. The FMS stores a worldwide Jeppesen database of all VHF NAVAIDs; all airports with hard-surface runways longer than 3,000 feet; all intersections, nondirectional beacons, outer markers, and runway thresholds; all high altitude jet routes and low altitude airways; all Standard Instrument Departures (SIDs); and all Standard Terminal Arrival Routes (STARs). Approaches depend on the underlying NAVAID by which defined. The database is updated every 28 days by a Portable Data Loader (PDL) connected to the data loader receptacle located on the copilot side of the pedestal.

The antenna receives signals from all GPS satellites in line of sight and sends the signals to the RPU, which tracks all satellites in view. The FMS derives time data and aircraft position and velocity information from the GPS signals, using the civilian C/A code. The RPU combines and processes GPS information, aircraft heading information from the No. 1 compass, and true airspeed and corrected barometric altitude information from the dedicated ADC. The CDU displays the data and related flight status messages to the flightcrew on a color LCD panel and provides control keys and an alphanumeric keypad for data entry and FMS control.

MODE	CONTROL	PARAMETER	VALUE
Yaw Damper	Yaw Control	Engage Limit	Unlimited
A/P Engage		Engage Limit	Roll Up to ±90° Pitch Up to ±30°
Basic A/P	Touch Control Steering TCS	Roll Control Limit Pitch Control Limit	Up to ±45° Roll Up to ±20° Pitch
	Turn Knob	Roll Angle Limit Roll Rate Limit	±30° ±15°/Second
	Pitch Wheel Heading Hold	Pitch Angle Limit Roll Angle Limit	±15° Pitch Less Than 6° and No Roll Mode Selected
Heading Select	Heading SEL Knob on HSI	Roll Angle Limit Roll Rate Limit	±25° ±3.5°/Second
		CAPTURE	
VOR/TACAN	Course Knob, NAV Receiver and DME	Beam Angle Intercept(HDG SEL)	Up to ±90°
	Receiver	Roll Angle Limit	±25°
		Course Cut Limit at Capture	±45° Course
		Capture Point	Function of Beam, Beam Rate, Course Error, and DME Distance
		ON COURSE	
		Roll Angle Limit	±13° Roll
		Crosswind Correction	Up to ±45° Course Error
		OVER STATION	
		Course Change Roll Angle Limit	Up to ±90° ±17°
		LOC CAPTURE	
LOC or APR or BC	Course Knob and NAV Receiver	Beam Intercept	Up to ±90°
		Roll Angle Limit	±25°
		Roll Rate Limit	±5°/Second
		Capture Point	Function of Beam, Beam Rate and Course Error
		NAV ON-COURSE	
		Roll Angle Limit	±17° Roll
		Crosswind Correction Limit	±30° of Course Error
		Gain Programming	Function of Time and (TAS). Starts at 1200 ft Radio Altitude

Figure 25-16. Autopilot System Limits (Sheet 1 of 2)

MODE	CONTROL	PARAMETER	VALUE
LOC or APR or BC (cont.)	GS Receiver and Air Data Computer	**GLIDESLOPE CAPTURE**	
		Beam Capture	Function of Beam and Beam Rate
		Pitch Command Limit	±10°
		Glideslope Damping	Vertical Velocity
		Pitch Rate Limit	Function of (TAS)
		Gain Programming	Function of Time and(TAS). Starts at 1200 ft Radio Altitude
			Function of (Radio Alt) Starts at 250 ft
GA	Control Switch on Power Lever	Fixed Pitch-Up Command, Wings Level	7° Pitch Up
Pitch Sync	TCS Switch on Control Wheel	Pitch Altitude Command	±20° Maximum
ALT Hold	Air Data Computer	ALT Hold Engage Range	0 to 50,000 ft
		ALT Hold Engage Error	±20 ft
		Pitch Limit	±20°
		Pitch Rate Limit	Function of (TAS)
VS Hold	Air Data Computer	VERT Speed Engage Range	0 to ±6,000 ft/Minute
		ALT Speed Hold Engage Error	±30° ft
		Pitch Limit Pitch Rate Limit	±20° Function of (TAS)
IAS Hold	Air Data Computer	IAS Engage Range	80 to 450 Knots
		IAS Hold Engage Error Pitch Limit	±5 Knots ±20°
		Pitch Limit	Function of (TAS)
ALT Preselect	Air Data Computer	Preselect Capture Range	0 to 50,000 ft
		Maximum Vertical Speed for Capture	±400 ft/Minute
		Maximum Gravitation Force During Capture Maneuver	±20g
		Pitch Limit Pitch Rate Limit	±20° Function of (TAS)

Figure 25-16. Autopilot System Limits (Sheet 2 of 2)

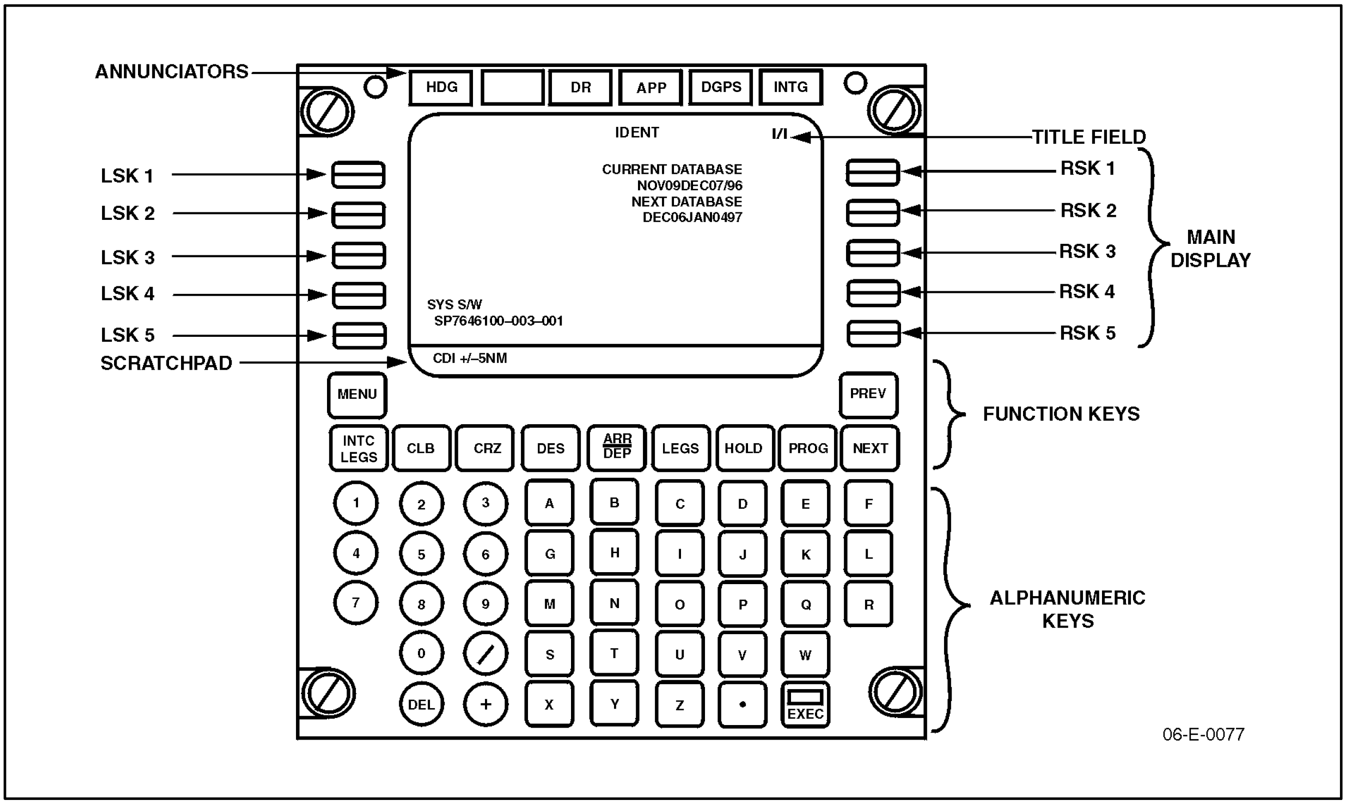


Figure 25-17. Control Display Unit

25.18.2 Controls and Indicators

25.18.2.1 External Annunciators

The pilot and copilot instrument panel FMS annunciators (Figure 2-6) are tested using the PRESS TO TEST switch located on the glareshield. Since the annunciators are powered through the master avionics switch, the switch must be on in order to test the annunciator lights. Brightness level is controlled by an ANN-BRIGHT/DIM switch on the instrument panel. Annunciators illuminate to indicate the following conditions:

1. FAIL (Red) — A failure has occurred in the FMS. If the FMS has been selected for display on the HSI, the NAV flag will appear.

2. MSG (Amber) — Indicates that the FMS has generated a message.

3. WPT (Amber) — Illuminates steadily 2 minutes prior to reaching a waypoint in the en route and terminal modes and 15 seconds prior to reaching a waypoint in the approach mode, or when a discontinuity follows the active waypoint.

4. XTRK (Amber) — Indicates parallel cross track has been selected.

5. INTEG (Amber) — (Shown as INTG on the CDU.) This annunciator indicates that the FMS has detected one of the following integrity problems:

   a. The GPS satellites currently tracked cannot provide autonomous integrity checking (RAIM NOT AVAILABLE message displayed).

b. RAIM (Receiver Autonomous Integrity Monitoring) is an algorithm in the FMS system that constantly compares navigation solutions from the different satellite signals the system is receiving. In order to solve for an accurate solution, either five satellites must be in view or four satellites must be in view in conjunction with the barometric altitude information input from the BAR ALT encoder. If the RAIM algorithm detects that one or more GPS measurements have caused a potential position error larger than is acceptable for the current phase of flight, the RAIM FAULT DETECT message is displayed. This warning is displayed within 30 seconds of navigation error detection of greater than 2 nm en route; within 10 seconds of navigation error detection of greater than 1 nm in the terminal phase; within 10 seconds of navigation error detection of greater than 0.3 nm in the approach phase of flight. The receiver continues to navigate if the RAIM alarm is active.

6. APPR (Green) — (Shown as APP on the CDU.) Indicates that the FMS Approach Mode has been activated. The requirements for this annunciator are:

   a. A valid navigation signal.

   b. The airplane within 30 nm of the destination airport.

   c. The approach is defined.

7. HDG (Green) — Indicates that the FMS is operating in the Heading mode.

8. FMS (green when selected, white when deselected). This switch/annunciator allows selection of the FMS navigational information for display on the HSI.

   When the FMS switch is selected, GPS navigation information (course deviation, bearing pointer, and distance to the active waypoint) is displayed only on the HSI. The course arrow is not automatically slaved to the desired track and must be manually set to agree with the information displayed on the CDU. Unlike any other mode, the CDI displays the correct deviation from the FMS course regardless of the COURSE knob selected heading. The sensitivity of the CDI is dependent on the mode of operation and varies as follows:

MODE	LATERAL SCALE (From Center to Full Scale Deflection)
En route	5.0 nm
Approach Transition and Missed Approach	1.0 nm
Final Approach	0.3 nm

Note

CDI scaling, while within 30 nm of the departure and arrival airport, is ±1.0 nm. “CDI sensitivity is always available for view on PROGRESS, page 3.” This will eliminate confusion, but will have to be applied throughout this section for continuity. CDI scaling may be manually selected on page 3 of the Main Menu; however, such manual selection only affects the sensitivity of the CDI and does not affect the sensitivity of the roll gains sent to the Flight Director and Autopilot. The FMS must be in the Terminal or Approach mode before the correct gains are input to the Flight Director and the Autopilot. The net effect of this is that if the CDI sensitivity is selected to ±1 or ±0.3 nm and the FMS is operating in the En route mode, satisfying the Flight Director may not keep the CDI perfectly centered.

9. The TO/FROM indicator will always point to the active waypoint. If FMS outputs are invalid, the NAV flag will appear.

25.18.2.2 Control Display Unit — FMS

The FMS uses GPS signals, air data from a dedicated ADC, and heading information from the compass system to calculate and display aircraft navigation data. The following controls and displays are provided on the CDU (Figure 25-17) for operation of the FMS:

Note

Backlighting to the CDU is controlled by the OVHD, PED & SUBPANEL rheostat located on the overhead panel.

1. MSG annunciator (Amber) — Illuminates to alert flightcrew of an FMS-generated message.
2. Dead Reckoning (DR) — Not used.
3. APP annunciator (Green) — Illuminates to indicate that the FMS is in Approach mode.
4. DGPS annunciator (Green) — Not used.
5. INTG annunciator (Amber) — Illuminates to alert the flightcrew that the FMS has detected a GPS integrity fault.
6. LCD display — Title field (top line of display) identifies page number and function of current screen. Main body of display (center five pairs of lines) provides navigation and flight status data. Scratch pad (bottom line) displays FMS-generated messages and alphanumeric characters entered on the keyboard by the flightcrew.
7. Left Select (Soft) keys (LSK) — Each key selects the associated display line or field to become active.
8. Right Select (Soft) keys (RSK) — Each key selects the associated display line or field to become active.
9. Alphanumeric Keys — Used to enter alphanumeric data into the scratch pad.
10. EXEC Key — Executes selected functions displayed on the screen and activates any changes specified for the current screen.
11. MENU key — Displays the FMS Main Menu screen on the LCD.
12. INTC LEG key — Displays the Intercept Leg screen on the LCD.
13. CLB key — Not used.
14. CRZ key — Not used.
15. DES key — Not used.
16. DEP/ARR key — Displays the Departure/Arrival menu on the LCD.
17. LEGS key — Displays the Flight Plan Legs screens on the LCD.
18. HOLD key — Suspends the current flight plan.
19. PROG key — Displays a sequence of three screens showing the progress of the flight.
20. PREV key — Displays the screen preceding the current screen.
21. NEXT key — Displays the screen following the current screen.

25.18.3 Limitations

The FMS is used as a means for en route navigation provided the following limitations are observed:

1. The Interstate Electronics Corporation (IEC) 9002M Operator's Manual Publication no. 7646113-01 dated November 1997 (or later revision applicable to the version SP7646100-503-001 software program) must be immediately available to the flightcrew whenever navigation is predicated on the use of the IEC 9002M FMS.
2. The IEC 9002M must utilize software version SP7646100-503-001 or later FAA-approved revisions.
3. Instrument Flight Rules (IFR) en route and terminal navigation is prohibited unless the pilot verifies the currency of the database or verifies each selected waypoint for accuracy by reference to current approved data.
4. The FMS is approved for lateral flight director and autopilot-coupled (GPS stand-alone and GPS overlay VOR, VOR-DME, TACAN, and NDB) approaches only when the FMS is in the Approach mode.
5. Instrument approaches must be accomplished in accordance with approved instrument approach procedures that are retrieved from the FMS equipment database. The FMS database must incorporate the current update cycle.
6. Instrument approaches must be conducted in the FMS Approach mode. GPS integrity monitoring (when using GPS for approach guidance) must be available at the final approach fix as indicated by the INTG annunciator being extinguished.
7. When an alternate airport is required by the applicable operating rules, it must be served by an approach based on other than GPS navigation. Also, the aircraft must have operational equipment capable of using that navigation aid, and the required navigation aid must be operational.
8. GPS can only be used for approach guidance if the reference coordinate datum system for the approach is WGS 84 or NAD 83. GPS approaches for any Jeppesen approach outside of the USA and Canada database regions are not approved for IFR use.
9. The FMS will not automatically fly the arc portion of an approach; thus, approaches that require an arc to be flown solely by reference to GPS information are not approved.
10. The aircraft must have other approved navigation equipment installed and operating appropriate to the route of flight.
11. Displayed FMS navigation parameters are referenced to Magnetic North. Operation of the aircraft is limited to latitudes between N74° and S60°.
12. Due to the lack of an aircraft True North navigational reference, operation of the FMS in the True North mode is prohibited.

25.18.4 Normal Procedures

Note

- There are instances where the FMS does not provide automatic guidance and pilot input will be required. Refer to the Operator's Manual for additional details.
- The predicted RAIM at the destination airport may not be available for up to 15 minutes after the FMS is powered up if the FMS has not been operated for a long period of time, or if it has been physically relocated while in an unpowered state.

The following abbreviated procedures assume a basic knowledge of the FMS system. Only one method of accomplishing a task is shown. There may be others depending on the particular task.

25.18.4.1 System Power-Up/Preflight

There is no ON/OFF switch for the CDU. It will be powered up when the avionics switch is turned on.

1. Rotate the course selector to coincide with the aircraft heading.

2. Turn the inverter and avionics switches on.

3. Select the FMS mode for the HSI.

4. The CDU will display DISPLAY DIAGNOSTICS PASSED.

Note

If this message is not displayed (i.e., the screen is blank), the diagnostics test has failed.

5. Simultaneously, the HSI will begin sequence of events as shown in the table below. The self-test will take approximately 90 seconds and is complete when the CDU displays the IDENT page.

CDI	TO/FROM	NAV FLAG	DME	BRG PTR
Full Left	Off	Displayed	Blank	3 o'clock
Center	Off	Displayed	Blank	3 o'clock
Full Right	From	Displayed	Blank	3 o'clock
Full Left	To	Displayed	Blank	3 o'clock
Full Left	Off	Displayed	Blank	3 o'clock
Center	To	Pulled	000.0	3 o'clock
Center	To	Displayed	Blank	3 o'clock

25.18.4.2 Verify Database and Software

1. Review IDENT screen for proper database and software.

2. Press EXEC key.

25.18.4.3 Creating a Route

1. Select ROUTE on the IDENT page using RSK3 or:

   a. Select page 1 of Main Menu.

   b. Select ROUTE using LSK1 (ROUTE will be displayed at top of page).

2. Enter ORIGIN airport in International Civil Aviation Organization (ICAO) format (ROUTE will change to ODK ROUTE) displayed. Select the desired approach transition.

3. Enter DEST airport in ICAO format. (A route cannot be inserted unless the destination airport is defined.)
4. Press the DEP/ARR function key. (DEP/ARR screen is displayed.)
5. Select DEP using LSK1. (DEPARTURE screen is displayed.)
6. Press RSK1 to view available runways. (RUNWAYS screen is displayed.)
7. Select the desired runway.
8. The SIDs screen will automatically be displayed. Select the desired SID.
9. The TRANSITIONS screen will automatically be displayed. Select the desired TRANSITION.
10. The DEPARTURE screen will automatically be displayed. Review the departure.
11. Select ROUTE using RSK3 and complete the definition of the route.
12. Press the DEP/ARR function key. (The DEP/ARR screen will be displayed.)
13. Select ARR for the destination using RSK2. (The ARRIVAL screen will be displayed.)
14. Select STAR using LSK1. (The STARS screen will be displayed.)
15. Select the desired STAR.
16. The TRANSITIONS screen will automatically be displayed. Select the desired TRANSITION.
17. The RUNWAYS screen will automatically be displayed. Select the desired runway.
18. The ARRIVAL screen will automatically be displayed.
19. Select the APPROACH screen using RSK3. (APPROACHES screen will be displayed.)
20. Select the desired approach.
21. The APP TRANS screen will automatically be displayed. Select the desired approach transition.
22. The ARRIVAL screen will automatically be displayed. Review the arrival.
23. Press the LEGS function key.
24. Review the ODK (or MOD) legs.
25. Press EXEC to activate the flight plan.
26. Procedures for creating and deleting routes:
    a. To delete a route, insert a new departure airport or re-enter the existing departure airport.
    b. To go Direct-To a waypoint, enter it in the TO field using an RSK.
    c. To go to a waypoint via an airway, enter “Airway/Waypoint” in the VIA field.
    d. If the route contains several intermediate NAVAIDs along a single airway, only the final NAVAID of the airway needs to be specified. The intermediate NAVAIDs and intersections will automatically be displayed on the LEGS page.

e. If intermediate intersections are programmed along an airway, they will automatically be deleted when the next waypoint is inserted. The ROUTE page shows only the beginning and ending waypoints along an airway, not intermediate waypoints.

f. If a flight plan consists of only a direct route from one airport to another, after putting in the departure and destination it is necessary to put in a TO waypoint consisting of the destination airport in order to have a valid flight plan.

g. A Direct-To waypoint that is defined as a radial/distance from a specific NAVAID can be entered as a daughter waypoint using an RSK; thus, if the fix is defined as the 140° radial at 25 nm from the XYZ VOR, enter XYZ/140/25 using an RSK.

25.18.4.4 Creating a Waypoint

1. Select page 1 of the Main Menu.

2. Select WYPNT/FIX using LSK3 or

   a. Access the WYPNT/FIX page from the NAV DATA page.

      (1) Select page 1 of the Main Menu.

      (2) Select NAV DATA using RSK4 or

   b. Access the WYPNT/FIX page from the PLT DATBSE page.

      (1) Select page 2 of the Main Menu.

      (2) Select PLT DATBSE using RSK5.

      (3) Select WYPNT/FIX using RSK3.

3. Enter the desired name of the waypoint using LSK1 (WAYPOINT/FIX page or LSK2 NAV DATA page). Scratch pad will display NOT A WAYPOINT.

4. Define position of new waypoint using one of the five techniques shown in paragraph 25.18.4.5.

5. Press the EXEC key.

6. The ROUTE screen will be displayed with new waypoint in scratch pad. Enter new waypoint here or on LEGS page as follows:

   a. Press the LEGS key.

   b. Insert new waypoint at the desired location. LEGS changes to MOD LEGS.

   c. A discontinuity will appear after the new waypoint. Close it up by advancing the next waypoint over the discontinuity.

   d. Press EXEC.

25.18.4.5 How to Define Pilot-Created Waypoints

1. Lat/Long Method — Enter the Lat/Long in hundredths or tenths of a degree using RSK2.

   a. A leading zero must be used for longitudes less than 100°. Example: N3645.45/W09736.67.

2. Radial/Distance from a VOR or Fix Method — Enter the VOR/radial/distance using RSK3. Example: ICT/090.2/18.7.

3. Radials from two VORs Method — Enter VOR/radial using RSK3. Enter second VOR/radial using RSK4.

4. Current Position Method — When over a known position, in flight or on the ground, press POS MARK using LSK5. The existing Lat/Long at the moment LSK5 is pressed will be entered in the LAT/LONG field. Current position waypoints do not have to be named before creating them. When POS MARK is selected, the waypoint name is defined with a four-digit number beginning with P0000.

5. Daughter Waypoints Method — Daughter waypoints are waypoints that are defined as a function of an existing NAVAID. Daughter waypoints can be created from the WAYPOINT/FIX page, the LEGS page, or the ROUTE page.

   a. Using the WAYPOINT/FIX page — When the NAVAID is entered as the name of the waypoint, the message FIX EXISTS AS NAVAID is displayed in the scratch pad and a two-digit number is automatically added to the name of the NAVAID (e.g., ICT01). The waypoint is then defined by entering the radial/distance from the VOR using RSK3 (e.g., ICT/090.2/18.7).

Note

Daughter waypoints of NAVAIDs that are in an existing flight plan cannot be created using the WYPNT/FIX page.

   b. Using the LEGS page or the ROUTE page, select the desired NAVAID from the flight plan into the scratch pad. After the NAVAID, enter “/radial/distance.” Line select the entry into the flight plan using appropriate soft key. The name of the NAVAID will change automatically as discussed above.

25.18.4.6 Loading a Saved Route

1. Select page 2 of the Main Menu.
2. Select PLT DATBSE using the RSK5. This will display the PILOT DEFINED DATA page.
3. Press LSK1 until the location of where the route is to be loaded is shown in magenta (ACT, MOD, or ODK).
4. Press LSK2, ROUTE NAME to display all saved routes.
5. Select the desired route into the scratch pad.
6. Return to the PILOT DATA page using LSK5.
7. Insert the route into ROUTE NAME using LSK2.
8. Select LOAD using LSK3.
9. Press EXEC.
10. The ROUTE page may then be accessed using RSK5.

11. Additional comments on recalling a saved route:

    a. The ODK ROUTE page is automatically recalled on initial power-up; thus, if a route is loaded into the ACT ROUTE, it will not be shown when the ROUTE page is recalled. EXIT the ODK ROUTE using the LSK1 on page 3 of the Main Menu.

    b. If an ACT ROUTE exists, another route cannot be recalled into the ACT page. The message CANNOT LOAD TO ACTIVE will be displayed in the scratch pad.

25.18.4.7 Loading a Company Route

No Company Routes are programmed into the FMS database nor can the flightcrew create them.

25.18.4.8 Saving a Route

1. Select page 2 of the Main Menu.
2. Select PLT DATBSE using the RSK5. This displays the PILOT DEFINED DATA page.
3. Press LSK1 until the location of the route that is to be saved is shown in magenta (ACT, MOD, or ODK).
4. Enter the name of the route using LSK2.

Note

Only letters and numbers may be used to name a route. Do not use the "/" key.

5. Press LSK4 to indicate the route is to be SAVED.
6. Press the EXEC key to save the route.
7. Press the LSK2, ROUTE NAME to view the list of all saved routes.

25.18.4.9 Reviewing Takeoff Status

1. Select TAKEOFF on the ROUTE page using LSK5 or on page 1 of the Main Menu using RSK2.
2. If the departure and arrival airports and the departure runway have been defined, the TAKEOFF page will display PRE FLT COMPLETE. If the preflight is not complete, the TAKEOFF page will display PRE FLT STATUS and allow the selection of DEP using LSK4 and/or ROUTE using LSK5.

25.18.4.9.1 Executing Flight Plan

1. Select the LEGS page using the LEGS function key.
2. Review the flight plan for accuracy.
3. If no corrections are required, press the EXEC key.

25.18.4.10 Selecting P/Y Code N/A

GRU is not installed to support use of the P/Y code.

25.18.4.11 Determining RAIM

1. Select page 3 of the Main Menu.
2. Select the RAIM screen using the LSK3.
3. The RAIM screen can also be selected from page 2 of 3 and 3 of 3 of the PROGRESS SCREEN or from the TAKEOFF screen accessed from page 1 of MAIN MENU.
4. Page 2, CALC RAIM AVAIL will be displayed.
5. Enter the Estimated Time of Arrival (ETA) using LSK1.
6. The RAIM availability will be displayed. The PREDICATED RAIM screen (Page 1) may then be selected to view the predicted RAIM in 5-minute increments.

Note

If the RAIM screen is selected in flight, an ETA will be available from the FMS computer and Page 1 will be displayed first.

25.18.4.12 Using the SPZ4000 Autopilot

1. The NAV mode of the flight director is used for en route, terminal, and approach operations when the FMS is selected as the navigational source.
2. When the NAV button is pushed on the flight director, the HDG button will also illuminate and remain illuminated; however, the system will not be in the HDG select mode.

25.18.4.13 Departure

Note

- In many instances the departure requires radar vectors to intercept a course or fly a heading and intercept a course. In either case, the pilot should select the INTC LEGS key and create the course to be intercepted (to provide situational awareness).
- The pilot must be aware that if an intercept to a course is created and the aircraft enters the FROM side of the course/waypoint, the FMS sequences the INTC LEGS waypoint and flies a course to intercept the next valid leg. An exception to this occurs when a discontinuity follows the INTC LEGS waypoint.
- The INTC LEGS function constructs a 45° intercept angle from the present position to the leg. The resulting heading may not be the desired heading if given vectors from Air Traffic Control (ATC). This case will require the use of the flight director HDG mode, the FMS HEADING mode, or manual navigation until converging on the leg.
- The desired course to the first waypoint that is displayed prior to takeoff will constantly change with aircraft movement until airborne and within 15° of the desired track, or 60 seconds has elapsed since the computer has detected a greater than 50 knot groundspeed, whichever occurs first.

25.18.4.14 Flying an FMS Controlled Heading After Takeoff

1. Select HEADING on page 1 of the MENU using LSK4.

2. Enter the desired heading using LSK1. If the desired heading is less than 180°, the aircraft will turn the shortest direction. If the opposite direction is required, or for heading changes greater than 180°, enter an L or R preceding the heading to denote a left or a right turn.

3. Press the EXEC key. Ensure the HDG annunciator is illuminated on the instrument panel.

4. For situational awareness, position the heading bug on the HSI over the desired heading.

5. Ensure FMS selector switch is selected for the HSI.

6. After takeoff, select NAV mode on the flight director and engage the autopilot, if desired.

Note

If a DISCONTINUITY is displayed as the first waypoint, a NAV flag will appear on the HSI and the NAV mode of the flight director will not be selectable.

25.18.4.15 Intercepting a Course After Takeoff

To intercept radials outbound from a fix:

1. When creating the route, enter the fix from which the desired radial is associated using RSK1.

2. Complete the desired route.

3. Line select the second waypoint over the third waypoint to create a discontinuity after the first waypoint, if one does not already exist.

4. Select the INTC LEGS page.

5. Insert the desired radial using LSK1. Ensure the FROM designation on LSK3 is magenta, indicating that the programmed intercept will command a track from the fix.

6. Press EXEC. When EXEC is pressed, the entire flight plan will be executed. The flight plan should then be reviewed for accuracy before the intercept radial is programmed.

7. After takeoff, the FMS will command a 45° intercept to the radial when coupled to the flight director using NAV mode. If a different heading is required after takeoff, use the flight director HDG mode, the FMS HEADING mode, or hand-fly the aircraft until course interception. Then select NAV mode.

8. When ready to proceed to the first fix, line select it to LSK1.

Intercept a course inbound to a fix:

1. When creating the route, enter the fix to which the desired radial is associated using RSK1.

2. Complete the desired route.

3. Select the INTC LEGS page.

4. Insert the desired course using LSK1. Ensure the TO designation opposite LSK3 is magenta, indicating that the programmed intercept will command a track to the fix.

5. Press EXEC. When EXEC is pressed, the entire flight plan will be executed. The flight plan should then be reviewed for accuracy before the intercept radial is programmed.

6. After takeoff, the FMS will command a 45° intercept to the course when coupled to the flight director using NAV mode. If a different heading is required after takeoff, use the flight director HDG mode, the FMS HEADING mode, or hand-fly the aircraft until course interception is desired. Then select NAV mode.

25.18.4.16 En Route

Note

- Use of the FMS HEADING mode does not automatically position the HSI heading bug.

- The FMS does not provide automatic guidance for holding patterns, entries, or exits. The aircraft must be flown using FMS HEADING mode, the flight director HDG mode, or manual navigation.

- The FMS does not provide continuous automatic guidance for execution of procedure turns. Use manual navigation, flight director HDG mode, or FMS HEADING mode.

- Ten seconds after encountering a flight plan discontinuity for the TO waypoint (i.e., DISCONTINUITY shown as the TO waypoint), the HSI NAV flag will be displayed. The flag remains displayed until the pilot closes up the flight plan discontinuity.

- Three important facts when using the FMS HOLD key: first, the HOLD key suspends the flight plan, suspending the sequencing of waypoints; second, when the FMS encounters a flight plan discontinuity, the course the FMS was commanding the aircraft to fly continues to be the course the FMS commands the aircraft to fly until flightcrew action alters the flight plan in such a way as to eliminate the discontinuity or commands an FMS Heading; third, if the flightcrew presses the HOLD key and defines a new inbound holding course or defines a new holding waypoint, the FMS will command the aircraft to fly an intercept heading to the new course upon execution of the MOD flight plan.

- Range information on the pilot and copilot HSI will be displayed only up to 299.9 nm. If the range to the waypoint exceeds this value, the range display will be blank.

25.18.4.17 CDI Sensitivity

1. Select page 3 of the Main Menu.

2. Select CDI SENS using RSK3.

3. Select the desired sensitivity.

4. Return to AUTO using the LSK5.

Note

- If sensitivity is in manual, it will automatically revert to auto when the 30 nm veil is penetrated.
- Roll gains provided to the autopilot by the FMS are predicated on the mode the FMS is actually in, not the CDI sensitivity that is manually selected. Thus, if the FMS is in the En Route mode, and ± 0.3 nm or ±1 nm sensitivity is manually selected, the flight director/autopilot may not keep the CDI centered, since the roll gains will be based on the En Route mode.

25.18.4.18 Direct-to a Waypoint

1. Press the LEGS function key.
2. Enter the waypoint identifier into the scratch pad or line select an existing waypoint into the scratch pad.
3. Press LSK1. The LEGS page displays MOD LEGS in amber and the waypoint name is shown as the first waypoint.
4. Press EXEC.
5. Manually reposition the course selector on the HSI to the new desired track.

25.18.4.19 Creating Discontinuities

A discontinuity suspends the automatic sequencing of the flight plan. When a discontinuity is reached in a flight plan, the TO/FROM flag switches to FROM, the last course is maintained, and the GPS distance begins increasing from zero. The following methods may be used to create a discontinuity in the flight plan:

METHOD 1 (IMMEDIATE SUSPENSION OF FLIGHT PLAN)

1. Line select the TO waypoint at the top of the LEGS page to the next line down. A discontinuity will be created at the top of the page.
2. Push EXEC.

Note

With a discontinuity at the top of the page, there is no TO waypoint. The NAV flag will be displayed on the HSI and the V/L mode of the flight director/autopilot will not engage.

METHOD 2 (INSERTING A DISCONTINUITY BETWEEN TWO WAYPOINTS)

1. Select the waypoint on the line where the discontinuity is to occur.
2. Insert it on the following line.
3. Push EXEC.

METHOD 3 (DELETING A WAYPOINT)

1. Press the DELETE key and line select DELETE over the waypoint that is to be deleted. A discontinuity takes the place of the deleted waypoint.

METHOD 4 (USING THE HOLD KEY)

1. Refer to paragraph 25.18.4.24.

25.18.4.20 Deleting Discontinuities

METHOD 1

1. Line select the waypoint that follows the discontinuity.
2. Insert this waypoint over the discontinuity and push EXEC.

Note

If the discontinuity is at the top of the page, the course associated with the waypoint will be lost, and the Direct-To mode will be entered.

METHOD 2 (IF DISCONTINUITY IS THE “TO” WAYPOINT)

1. Select DEL and line select it over the discontinuity.
2. Press EXEC. This will delete the discontinuity and retain the course associated with the next waypoint.

Note

The DEL key will only delete DISCONTINUITIES that exist in the TO waypoint position.

25.18.4.21 Parallel Course Offsets

1. Select page 2 of Main Menu.
2. Select OFFSET using LSK1.
3. Insert direction and distance of offset (e.g., L3.5). Max offset = 20 nm.
4. Press EXEC key (XTRK annunciator illuminates).
5. Screen automatically transfers to the ROUTE screen.
6. Select LEGS function key. Offset will be annotated for the current leg.
7. A 45° intercept heading will be flown to intercept the offset course and a 45° intercept heading will be flown to reintercept the original course to the next waypoint.

Note

- The Offset applies to the active leg only.
- The Offset can be canceled by (1) Direct-To operation, (2) entry of 0 offset, (3) sequencing of active waypoint, or (4) line select DELETE at top of the Offset page.
- The progress page will show the aircraft right of course (for a left offset). This will decrease to zero as the offset is reached. The CDI will deflect to the left (for a left offset), indicating the aircraft is right of course. When established on the offset, the CDI will be centered and the cross track error on the progress page will show zero error.

Note

If a discontinuity follows the waypoint that is being approached with a parallel offset, the FMS will maintain the offset. When abeam of the waypoint, the TO-FROM flag will transition to FROM and the airplane will continue on the track defined by the parallel offset.

25.18.4.22 Abeam Waypoints

Abeam waypoints may be created after a downstream waypoint has been selected as the TO waypoint, bypassing intermediate waypoints. An abeam waypoint lies on the new desired track and is located by passing a line that is perpendicular to the new desired track through the intermediate waypoint.

1. After selecting the new TO waypoint, the ROUTE key, LSK5, automatically changes to ABEAM once the aircraft is on a Direct-To course.
2. Press ABEAM.
3. Press EXEC.
4. The intermediate waypoints change to abeam waypoints. The abeam waypoints retain the winds aloft values associated with the original waypoints.

25.18.4.23 Intercept Legs

The Intercept Legs screen (INTC LEG Function Key) provides a means to define a new inbound course to the TO waypoint.

1. Select INTC LEG function key.
2. Input the new desired course using LSK1.
3. Input the desired waypoint, if different from the current TO waypoint, using LSK2.
4. Press the EXEC key. (Note that the distance and bearing will be shown on the right side of the page.)
5. Situational awareness can be improved by monitoring the x-track distance on the PROGRESS page and the bearing pointer on the HSI.

Note

- This procedure will cancel all waypoints between the current position and a new intercept waypoint unless a HOLD is inserted.
- Course and waypoint can be entered at the same time with the LSK1 using the format COURSE/WAYPOINT.

The TO/FROM annotation next to the LSK3 is not selectable by the operator. After the waypoint and course have been input, the appropriate term will turn magenta to inform the operator whether the proposed course will provide guidance TO or FROM the waypoint. If FROM is illuminated, the waypoint will be sequenced out of the flight plan when EXEC is pressed. The exception to this occurs when a discontinuity follows the waypoint.

To erase inputs to the INTC LEG page prior to pressing EXEC, press the INTC LEG function key.

25.18.4.24 Holding

Assume FMS Heading mode is utilized.

1. Press the HOLD function key. The HOLD page will be displayed.
2. The existing TO waypoint will be displayed. If that waypoint and its associated inbound course do not define the holding fix and inbound course, insert both using LSK1 and LSK2.
3. Press EXEC.

Note

When EXEC is pressed, the FMS will immediately change the inbound course to the holding fix to that inserted on the holding page and will then fly a 45° intercept to that course. If the route to the holding fix is not to be changed, do not input the new holding course until after passing the holding fix.

4. Select the LEGS screen. A HOLD DISCONT will be displayed after the holding fix followed by another entry of the holding fix.
5. While inbound to the holding fix, select the HEADING screen. Enter the outbound heading.
6. At station passage, push the EXEC key to activate the FMS heading mode.
7. If a new inbound hold course is requested, program it at this time using the HOLD or the INTC LEGS function keys.
8. While outbound, select the inbound heading. At the end of the outbound leg, press EXEC to turn inbound.
9. When within 45° of the inbound course, select RESUME FLIGHT PLAN from the HEADING screen. The aircraft will intercept the inbound course to the holding fix.
10. When inbound on the final holding leg, close up the discontinuity by line selecting the holding fix following the discontinuity over the discontinuity.

25.18.4.25 Approach

Note

- Since the FMS does not support all possible missed approach leg types, the flightcrew must use the flight director HDG mode, or hand-fly the aircraft during the missed approach procedure.
- The FMS does not support all possible leg types between the Missed Approach Point (MAP) and the Missed Approach Holding Point (MAHP). The leg types not supported are DME Arc, course from, hold, procedure turn, or heading to an altitude. The FMS replaces these leg types with a Point-To-Point leg. This leg results in a course from the MAP to the next waypoint. When the next leg is defined as a Point-to-Point leg, and the flightcrew presses the EXEC key, this automatically defines a 45° course to intercept the leg. The flightcrew should review the missed approach procedure and the course displayed above the missed approach waypoint and determine if the defined course is consistent with the missed approach procedure before pressing the EXEC key.

Note

- If a discrepancy is noted between the FMS approach waypoints and the instrument approach procedure chart, the charted procedure takes precedence.

- The navigation database does not provide step-down waypoints after the Final Approach Fix (FAF). In all cases the next waypoint is the MAP. The pilot should use DME distance or other means to identify step-down waypoints following the FAF.

- Flying the final approach outbound from an off-airport VORTAC or VOR/DME on an overlay approach, beware of the DME distance increasing on final approach, and the GPS distance-to-waypoint decreasing, and not matching the numbers on the approach plate.

- When constructing an approach that includes a STAR and APPROACH but no approach transition, the FMS will insert a discontinuity between the end of the STAR and the APPROACH. Check the waypoint with the approach plate before closing the discontinuity.

GENERAL APPROACH PROCEDURES

1. Use the NAV mode of the Flight Director when conducting coupled approaches.

2. Only one approach can be in the flight plan at a time.

3. Check the RAIM prediction window for the approach while en route. System self-checking occurs continually in flight for the ETA only (does not apply for radar vectors or other delays). If RAIM ceases to be available for the approach, a message will indicate RAIM NOT AVAILABLE FOR APP.

4. Data cannot be altered, added to, or deleted from the approach procedures contained in the database. This includes manual waypoints or altitude entries from the FAF to the MAP. (Modifications may be made following the MAP waypoint.)

5. Step-down waypoints between the FAF and the MAP are not available in the Jeppesen database, so they will not be available in the FMS.

6. The DME arc IAF identifier may be unfamiliar. Example: D098G where 098 stands for the 098° radial from the referenced VOR, and G is the seventh letter in the alphabet, indicating a 7 DME arc.

7. Transition to the final APR MODE is automatic provided the following conditions are met:

   a. APPR annunciator is illuminated (normally automatic).

   b. The FMS is not in the HOLD mode.

   c. The FAF is the active waypoint.

   d. Aircraft is within 2 nm of the FAF.

   e. Aircraft is outside of the FAF.

   f. Aircraft is inbound to the FAF.

8. Direct-To-Operation between the FAF and MAP.
9. APR mode may be canceled at any time by executing a Direct-To leg to a point beyond the FAF.
10. The course displayed on the FMS between the FAF and the MAP may be slightly different than that printed on the approach chart and should not affect the approach performance. This is due to the way the FMS connects the approach waypoints.

25.18.4.26 Approach Mode Sequencing and RAIM Prediction

1. Prior to arrival, select a STAR and transition if appropriate. Select an approach and an approach transition (if required).

Note

To replace a SID, STAR, or approach, simply repeat the procedure and select a different procedure.

2. En route, check for RAIM availability at the destination airport ETA.

Note

RAIM must be available at the FAF in order to fly an instrument approach. Be prepared to terminate the approach upon loss of RAIM (INTEG annunciator illuminated).

3. At 30 nm from the FAF:
   a. Verify automatic annunciation of APPR.
   b. Note automatic CDI scaling change from ±5.0 nm to ±1.0 nm.
   c. Internally the FMS will transition from en route to terminal integrity monitoring.
4. If receiving radar vectors, two options are available:
   a. The FMS HDG mode may be utilized while coupled to the FMS with NAV engaged on the Flight Director mode selector.
   b. The Flight Director HDG mode may be employed to follow the HSI heading bug setting.

Note

Programming and use of the FMS HDG mode does not automatically position the HSI heading bug. Likewise, moving the HSI heading bug does not set the FMS HDG.

5. If a procedure turn or holding pattern is required, fly in HOLD mode until inbound to the FAF. The HOLD page may be used to select the holding course.

Note

- The FMS does not provide automatic guidance for holding patterns, entries, or exits. The aircraft must be flown using FMS HDG, flight director HDG, or alternate means.
- When flying the final approach outbound from an off-airport VORTAC on an overlay approach, beware of the DME distance increasing on final approach. The GPS distance-to-waypoint will decrease and not match the numbers on the approach plate.

Note

HOLD navigation is TO-FROM (like VOR) without waypoint sequencing. Do not utilize HOLD mode for NoPT routes. Hold mode usage past the FAF will cancel FMS Approach mode.

6. Arcing Approaches.

   a. Since TACAN and FMS bearing information cannot be displayed simultaneously, arcing approaches are not approved.

7. Procedure Turns.

   a. Fly the procedure turn using the FMS Heading mode, the Flight Director mode, or hand-fly the aircraft.

   b. During the outbound leg, line select the FAF waypoint over the HOLD/PT DISCONT and press EXEC. This will bring the FAF waypoint to the top of the screen and retain its associated inbound course.

   c. When established on the intercept heading to the final approach course, return to the FMS V/L mode.

Note

There are many occasions when it is necessary to close up discontinuities during an approach, such as when arcs and procedure turns are involved. The objective is to delete the final discontinuity so that the FAF and its associated inbound course are repositioned to the top of the ACT LEGS page 1 screen as the TO waypoint.

Two scenarios can exist that will cause the above process to be carried out differently by the FMS.

FIRST SCENARIO (PROCEDURE TURNS ONLY)

This scenario occurs when the approach procedure utilizes the same waypoint to define the outbound leg and the inbound leg to the FAF. For this situation, the HOLD/PT DISCONT can be collapsed out of the flight plan (by selecting LSK3 over LSK2) at any point along the outbound leg or during the procedure turn. The MOD LEGS page will match the subsequent ACT LEGS page. Both flight plans will show that the outbound leg has been deleted and the FAF is the TO waypoint.

SECOND SCENARIO (PROCEDURE TURNS)

This scenario occurs when the waypoint on either side of the discontinuity is defined by a different fix. Thus, for a procedure turn, the outbound leg will be defined using one fix, and the inbound leg will be defined using a different fix. Two important facts are associated with this scenario. First, when the discontinuity is deleted from the ACT LEGS page, the MOD LEGS page will always display the previous TO waypoint at the LSK1 position. Second, the previous TO waypoint may or may not be sequenced out of the ACT LEGS page when the EXEC key is pressed. The determining factor is based on when the MOD LEGS page is executed. In order for the previous TO waypoint to be sequenced out of the LEGS page and be replaced with the desired FAF waypoint, the discontinuity must be removed before the airplane deviates 5 nm or more cross track or more than 80° in course from the waypoint just passed. When conducting approaches that are constructed as described in this scenario, it is imperative that the pilot observe the TO waypoint on the ACT LEGS page 1 after executing the removal of the discontinuity. If the previous leg has not sequenced out of the flight plan, the pilot must delete the leg by pressing the DELETE key and then selecting DELETE over the TO waypoint using LSK1. This will advance the FAF waypoint to the active position and retain its associated course.

The following is an example of the second scenario using the NDB35 approach to Newton, Kansas.

After passing EWK and tracking outbound on the 178° radial, the ACT LEGS page 1 will display (in shorthand form):

ACT LEGS

LSK1 178 EWK

LSK2 HOLD/PT DISCOUNT

LSK3 358 FAF FN35

LSK4 359 MAP EWK

If LSK3 is line selected over LSK2 shortly after the procedure turn is started, the MOD and ACT LEGS pages would be changed as follows. Note that the MOD LEGS page does not display what the FMS will generate on the subsequent ACT LEGS page when the modification is executed.

MOD LEGS	**ACT LEGS**
LSK1 178 EWK	LSK1 358 FAF FN35
LSK2 358 FAF FN 35	LSK2 359 MAP EWK
LSK3 359 MAP EWK	LSK3 DISCONTINUITY
LSK4 DISCONTINUITY	LSK4 EWK

However, if the above procedure is not accomplished until the airplane has deviated from the 178° outbound course in excess of the limits noted above, the resulting flight plan will be:

MOD LEGS	**ACT LEGS**
LSK1 178 EWK	LSK1 178 EWK
LSK2 358 FAF FN35	LSK2 358 FAF FN35
LSK3 359 MAP EWK	LSK3 359 MAP EWK
LSK4 DISCONTINUITY	LSK4 DISCONTINUITY

In both cases the same MOD LEGS page is presented, but the resulting ACT LEGS page is different. In order to move the inbound course to the LSK1 position, the 178 EWK waypoint must be deleted using the DELETE key. Remember not to line select LSK2 over LSK1 to accomplish this, as that will delete the 358 course associated with the FAF and it will be replaced with a Direct-To course.

WARNING

The pilot must confirm that the proper leg is displayed as the TO waypoint prior to engaging the flight director NAV mode or selecting a RESUME FLT PLAN from the FMS HEADING page. Failure to do so may result in the aircraft turning to reintercept the outbound course. If this were to occur, the aircraft may exceed protected airspace for the instrument procedure before the pilot can correct the error.

WARNING

Collapsing a HOLD/PT DISCONT when the legs immediately preceding and following the HOLD/PT DISCONT are based off of different waypoints may result in loss of the reference distance upon which the protected airspace is defined. In these cases, the pilot may wish to delay collapsing the flight plan until the aircraft is progressing toward the FAF and the reference distance is decreasing. Also, the outbound leg preceding the HOLD/PT DISCONT will not automatically sequence out of the LEGS page, when executed, and the pilot will need to delete this leg using the DELETE key.

8. Utilize the INTC LEGS function for:

   a. Radar vectors to the selected approach course.

   b. Intercepting any course inbound or outbound from a waypoint.

Note

INTC LEGS will remove (delete) waypoints prior to the waypoint selected.

9. At or before 2 nm from the FAF inbound:

   a. Select the FAF as the active waypoint, if not accomplished already.

   b. Discontinue HOLD mode operation (ensure no discontinuity exists between the FAF and the MAP).

10. Approaching the FAF inbound (within 2 nm):

    a. Verify the APPR annunciator is illuminated.

    b. Note automatic CDI scaling change from ±1.0 nm to ±0.3 nm begins.

    c. Internally, the IEC 9002M will transition from terminal to approach integrity monitoring.

11. If APPR is not annunciated or the INTEG annunciator is illuminated when crossing the FAF:

    a. Do not descend.

    b. Execute the missed approach procedure.

12. Missed Approach:

    a. Climb per the missed approach or ATC instructions.

    b. Navigate to the MAP via the missed approach procedure.

CAUTION

The FMS may or may not provide proper guidance along the missed approach path.

c. After establishing a climb in accordance with the published missed approach procedure or ATC instruction, pressing the G/A button on the power lever will:

(1) Select the LEGS screen.

(2) Position the first missed approach waypoint as the TO waypoint.

(3) Illuminate the MSG annunciator.

(4) Arm the EXEC key.

d. The CDU scratch pad will indicate one of four possible situations:

(1) MA NOT AVAILABLE — The G/A switch was pressed before the FMS entered final approach mode. No change was made on the LEGS screen.

(2) MA ARMED — Guidance along the missed source of navigation and discontinue the use of the approach path is available. Monitor this.

(3) MA ARMED-CHK MA PROC — The missed approach includes a leg type that is not supported by the FMS. Utilize an alternate means of guidance along the missed approach.

(4) MA CHANGED-CHK MA PROC — The pilot has manually altered the missed approach procedure after the MAP. Guidance is available, but the pilot must monitor this.

25.18.5 Emergency Procedures

1. Loss of FMS Electrical Power.

a. If power is lost to the FMS, the CDU will blank. If the FMS was selected for display on the HSI, the green FMS selector switch will turn white and the NAV flag will be displayed on the HSI. The FMS will, upon power-up, reacquire GPS satellites and compute a new position. When the position is valid, the NAV flag will be removed from view. Although the entire database remains intact, the flight plan must be reentered by the pilot.

b. Check the FMS circuit breaker located on the right circuit breaker panel. Determine the cause of power failure. When power is restored, check the position before use.

c. If the power cannot be restored, select another NAV source (VOR or TACAN). The FMS selector switch will remain white and cannot be reselected until power is restored to the FMS.

2. GPS RAIM (INTEG Annunciator).

a. If GPS RAIM (Receiver Autonomous Integrity Monitoring) becomes unavailable (indicated by various scratch pad messages and the INTEG amber annunciator), GPS position should be cross-checked with other available sources such as VOR/DME or TACAN. If the INTEG annunciator illuminates during an IFR approach prior to the FAF, discontinue the approach and execute the possible situations: published missed approach procedure or utilize another approved source of navigation to continue the approach, if available.

3. FMS System Fail (FAIL annunciator).

In the event of a red FAIL annunciator, select another source of navigation and discontinue use of the FMS.

4. FMS Circuit Breaker Locations.

a. The FMS and its sensors receive power and are protected by the following circuit breakers:

(1) FMS — 5 ampere, 28 Vdc, located on the right circuit breaker panel.

(2) FMS — ADC-1 ampere, 28 Vdc, located on the right circuit breaker panel.

(3) FMS — FDR-1 ampere, 115 Vac, located in the nose avionics bay (for the data loader).

5. Reinitialization of GPS Location.

a. If the GPS solution appears incorrect, or satellites are not tracked within 10 minutes of powering up the unit, the critical memory should be reinitialized as follows:

(1) Select page 2 of the Main Menu.

(2) Press RSK3, MAINT prompt. This will cause the MAINTENANCE page to appear.

(3) Press the keys for the characters D, A, T, and A (DATA) in that order. Asterisks will appear in the scratch pad when these keys are pressed.

(4) Press RSK5, PASSWORD prompt. MAINT menu page 1/1 will appear.

(5) Press LSK2, DSPLY I/O prompt. The DISPLAY I/O page 1/1 will appear.

(6) Press RSK5, TRKR MNT prompt. The TRKR MAINT page 1/1 will appear.

(7) Press LSK3, CLEAR CRIT prompt. The TRKR STATUS page 1/2 will appear, with satellite numbers printed out in order at the top line.

(8) Pull the FMS circuit breaker, wait 5 seconds, and push the FMS circuit breaker in. The FMS will go through its power-up sequence, then display the IDENT page.

(9) Press the EXEC key. The IDENT page will remain on screen with additional prompts.

(10) Repeat steps (1) to (6).

(11) Press LSK2, TRKR INIT prompt. The TRKR INIT page 1/1 will appear.

(12) Enter the current date based on UTC time into the scratch pad in the format ddmmyyyy (dd represents two digits for the day of the month, mm represents two digits for the month of the year, and yyyy represents four digits for the year). These characters will echo on the scratch pad. Example: 07101997 is used to enter 7 October, 1997. Leading zeroes are required.

(13) Press LSK1. The entered date will be displayed next to LSK1.

(14) Enter the current UTC (Zulu) time into the scratch pad in the format hhmm (where hh represents two digits for the hour and mm represents two digits for the minute). These characters will echo on the scratch pad. Example: 0925 is used to enter 9:25 UTC time. Leading zeroes are required for single-digit times, as shown.

(15) Press LSK2. The entered time will be displayed next to LSK2.

(16) Enter the current latitude into the scratch pad in the format sddmm (s represents N for North or S for South, dd represents two digits for the degrees of latitude, and mm represents two digits for the minutes of latitude). These characters will echo on the scratch pad. Example: N3823 is used to enter North latitude of 38 degrees, 23 minutes. Leading zeroes are required.

(17) Press LSK3. The entered latitude will be displayed next to LSK3.

(18) Enter the current longitude into the scratch pad in the format sdddmm (s represents W for West or E for East, ddd represents three digits for the degrees of longitude, and mm represents two digits for the minutes of longitude). These characters will echo on the scratch pad. MAINT MENU page 1/1 will appear. Example: W09723 is used to enter West longitude of 97 degrees, 23 minutes. Leading zeroes are required.

(19) Press LSK4. The entered longitude will be displayed next to LSK4.

(20) Enter the current altitude in meters into the scratch pad in the format nnnnn (nnnnn represents up to five digits for the altitude in meters). Leading zeroes are not required for this field. Example: 0 is used to enter a zero altitude. It is not critical that the altitude be entered precisely.

(21) Press LSK5. The entered altitude will be displayed next to LSK5, the EXEC key will illuminate, and a message “EXEC KEY ACTIVE” will be displayed.

(22) Press EXEC. The NAV STATUS page will appear with the entered quantities displayed. Altitude will be converted to ellipsoidal height.

(23) Press RSK5, TRKR MAINT prompt. The TRKR MAINT screen 1/1 will display.

(24) Press LSK5, MAINT MENU prompt. The MAIN MENU screen 1/1 will display.

(25) Press LSK5, EXIT MAINT prompt. The MAIN MENU screen 1/3 will display.

Note

After this procedure is complete, the FMS may take up to 15 minutes to acquire satellites, develop an initial position solution, and extinguish the integrity annunciator. The acquisition of a new GPS almanac will take at least 12.5 minutes due to the signal structure of the GPS almanac. If reinitialization is required, it is likely that the internal lithium batteries are discharged and maintenance action will be required.

CHAPTER 26

UC-12M Navigation

26.1 VHF NAV-1/TACAN

26.1.1 Introduction

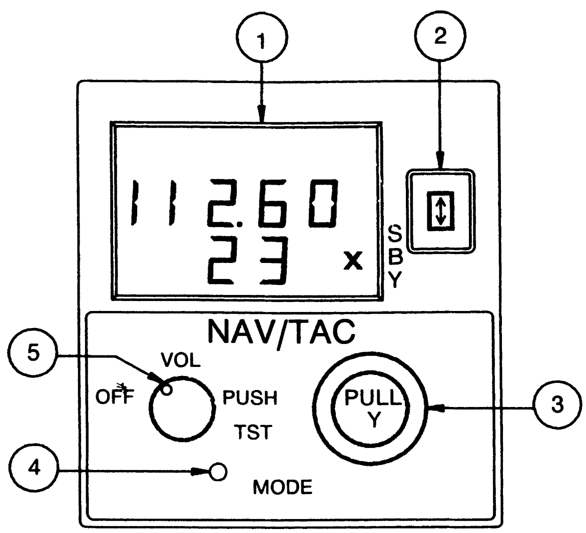
The NAV-1/TACAN receiver provides 200 50-kHz spaced VHF omnidirectional (VOR/Line Of Communication [LOC]) channels from 108.00 through 117.95 MHz and 40 glideslope (GS) channels automatically paired with localizer channels. It also provides all 252 TACAN channels and the 75 MHz marker beacon signals.

All operating controls for the NAV-1 receiver and the TACAN receiver/transmitter are located on the NAV-1/TACAN control unit (Figure 26-1). Display intensity is adjusted by a control located adjacent to the VHF Comm control unit in the instrument panel. The intensity control is placarded CONTROL READ OUT VHF NAV ADF.

1. Active frequency display — The active frequency (frequency to which the navigation receiver is tuned) or TACAN channel is displayed in the upper window.

2. Standby/frequency display — The standby (SBY) frequency or standby TACAN channel is displayed in the lower window.

3. Transfer switch — Transfers the standby frequency to the active display. The previously active frequency becomes the new standby frequency. The receiver is returned to the new active frequency.



1. Frequency Displays
2. Transfer Switch
3. Tuning Knobs
4. Mode Switch
5. Power, Volume, Test Control

UC-12M-F083

Figure 26-1. NAV-1/TACAN Control

4. Tuning knobs — Two concentric knobs control the standby or active frequency displays. The larger knob changes the three digits to the left of the decimal point from 108 to 117 MHz (NAV frequencies), or the tens digits from 1 to 12 (TACAN channels). The smaller knob changes the two digits to the right of the decimal point from .00 to .95 MHz (NAV frequencies), or the ones digit from 0 to 9 (TACAN channels). In TACAN mode, pulling out and rotating the small inner knob placarded PULL Y will change the TACAN channel from X to Y.

5. MODE switch — The mode of the standby display is changed from TACAN channel to the NAV frequency or NAV frequency to TACAN channel by momentarily pressing the MODE switch.

6. Power/volume/push test switch — Rotating the switch clockwise from the OFF position switches system power on. Rotating the switch further clockwise increases NAV audio volume. Pushing the knob in when the unit is tuned to a TACAN station activates the self-test mode to verify range and bearing computation.

26.1.2 Operating Procedures

26.1.2.1 Equipment Turn On

The navigation receiver and the NAV control are turned on by rotating the power and volume switch clockwise from the OFF position. After power is applied, the NAV control displays the same active and standby frequencies that were present when the equipment was turned off.

26.1.2.2 Frequency Selection

26.1.2.2.1 Standby Entry

In normal operation, frequency selection is accomplished in the standby entry mode by changing the frequency in the STBY display. This is accomplished by rotating either of the tuning knobs.

After the desired frequency is set in the standby display, it can be transferred to the active display by momentarily pressing the transfer switch. As the standby frequency is transferred to the active display, the previously active frequency is simultaneously transferred to standby.

26.1.2.2.2 Active Entry

During normal operation, all frequencies are entered/corrected in the standby frequency display; however, the active frequency can be entered directly as described in the following paragraph.

The active entry mode is entered from the standby mode by pressing and holding the transfer switch for longer than 2 seconds. The frequency select knobs operate as in the standby entry mode; however, the standby display is blanked out and only the active display is changed. Momentarily pressing the transfer switch returns the control to standby entry mode. The standby frequency or TACAN channel prior to active entry remains unchanged.

26.2 VHF NAV 2

26.2.1 Introduction

The NAV 2 receiver provides 200 50-kHz spaced VOR/LOC channels from 108.00 through 117.95 MHz and 40 glideslope (GS) channels automatically paired with localizer channels. The 75-MHz marker beacon signals are also provided. Up to 9 preset frequencies (channels) may be programmed into the NAV 2 memory.

26.2.2 Operating Controls

All operating controls for the NAV-2 receiver are located on the NAV-2 control unit (Figure 26-2). Display intensity is adjusted by a control located adjacent to the VHF-1 Comm control unit located in the instrument panel. The intensity control is placarded CONTROL READ OUT VHF NAV ADF.

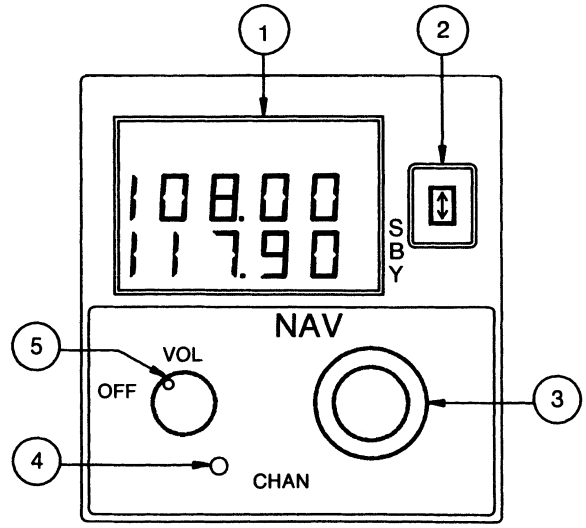


Figure 26-2. NAV-2 Control

1. Active frequency display — The active frequency/channel (frequency to which the navigation receiver is tuned) is displayed in the upper window.

2. Standby frequency display — The standby frequency/channel is displayed in the lower window.

3. Transfer switch — In operating mode, momentarily pressing the switch transfers the standby frequency or channel to the active display, the previously active frequency/channel becomes the new standby frequency, and the receiver retunes to the new active frequency. While in channel mode, pressing the transfer switch will return the receiver to the frequency mode. In program mode, pressing the transfer switch will return the receiver to the frequency mode. In program mode, pressing the transfer switch will cause the channel number to stop flashing and the frequency to flash. The frequency may now be programmed.

4. Tuning knobs — Two concentric knobs control the preset or active frequency displays. The larger knob changes the three digits to the left of the decimal point from 118 to 117 MHz in 1-MHz increments. The smaller knob changes the two digits to the right of the decimal point from .00 to .95 MHz. In channel mode, turning either knob changes the displayed channel number.

5. Channel button — Momentarily pressing the CHAN switch while in Frequency mode activates the Channel mode of operation. Pressing and holding the CHAN switch for longer than 2 seconds activates the Program mode.

6. Power and volume switch — Rotating the switch clockwise from the OFF position switches system power on. Rotating the switch further clockwise increases NAV audio volume.

26.2.3 Operating Procedures

26.2.3.1 Equipment Turn On

The navigation receiver and the NAV control are turned on by rotating the power and volume switch clockwise from the OFF position. After power is applied, the NAV control displays the same active and standby frequencies as when the equipment was turned off.

26.2.3.2 Frequency Selection

26.2.3.2.1 Standby Entry

In normal operation, frequency selection is accomplished in the standby entry mode by changing the frequency in the STBY (lower) window. This is accomplished by rotating either of the tuning knobs.

After the desired frequency is set in the standby display, it can be transferred to the active display by momentarily pressing the transfer switch. As the standby frequency is transferred to the active display, the previously active frequency is transferred to the standby display.

26.2.3.2.2 Active Entry

During normal operation, all frequency selections are entered in the standby frequency display; however, the active frequency can be entered directly as described in the following paragraph.

The active entry mode is entered from the standby entry mode or channel mode by pressing and holding the transfer switch for longer than 2 seconds. The frequency select knobs operate as in the standby entry mode, but will change the active display frequency rather than the standby frequency.

Note

During the active entry mode, the unit will remain tuned to the active frequency.

Momentarily pressing the transfer switch returns the control to the standby entry mode. The standby frequency prior to entering active entry mode remains unchanged.

26.2.3.2.3 Channel Mode

The NAV control memory permits storing up to nine preset frequencies. Once stored, these frequencies can be recalled to the standby display by momentarily pressing the CHAN switch.

The storage locations (CH 1 through CH 9) for the recalled frequency individually appear in the active frequency display and are changed by rotating either tuning knob. After the desired stored frequency has been recalled to the standby display, it can be transferred to the active display by momentarily pressing the transfer switch.

26.2.3.3 Frequency Storage

Up to nine preset frequencies can be stored in the NAV memory for future recall. To program the memory, press and hold the CHAN switch for 2 seconds or longer. The receiver will tune to the last active frequency displayed. A “P” and the last used channel number will be displayed in the upper display window. The channel number flashes, indicating that turning either tuning knob will change the channel number. Momentarily pressing the transfer switch causes the channel number to stop flashing and the frequency to flash. At this time the tuning knobs will change the frequency. Momentarily pressing the transfer switch will start the channel number flashing and the procedure may be repeated until all nine channels have been programmed if desired.

Note

When programming the memory, no action on the panel for 20 seconds will return the unit to frequency mode, and standby frequency returns to what it was prior to entering the program mode.

After a frequency has been stored in memory, it will remain in memory until changed, even when the unit is turned off for an extended period of time.

26.3 TACAN/DME

26.3.1 Description

The TACAN system consists of the following components: TACAN receiver/transmitter, TACAN antenna NAV-1/TACAN control unit and TACAN/DME indicator. The TACAN system uses NAV-1/TACAN for the bearing converter.

The tactical air navigation (TACAN) system is a polar coordinate UHF navigation system that provides bearing, groundspeed, time-to-station, and slant-range distance information with respect to a selected TACAN or VORTAC ground station. The effective range of the TACAN is limited to line-of-sight. Actual operating range depends on the altitude of the aircraft, weather, type of terrain, location, and altitude of the ground transmitter, and transmitter power. Usually line-of-sight limitations will prevent an aircraft on the ground from receiving and locking on to a TACAN or VORTAC ground station. The TACAN system operates on any of 252 channels (126X and 126Y) selected. The TACAN channels provide airborne interrogation (transmit) frequencies from 1025 to 1150 MHz and airborne receive frequencies from 962 to 1213 MHz.

The range measurement portion of the TACAN system electronically converts elapsed time-to-station by measuring the length of time between the transmission of a radio signal to a preselected TACAN or VORTAC station and reception of the reply signal. The distance is then indicated in nautical miles on the range/groundspeed/time-to-station indicator. The distance is measured on a slant from the aircraft to the ground and is commonly referred to as slant-range distance. The difference between slant-range distance and ground distance is smallest at a low altitude and long range. If the distance from the aircraft to the TACAN/DME station is at least three times the aircraft altitude, the slant-range error will be negligible. To obtain accurate groundspeed and time-to-station, the aircraft must be on a direct course to or from a TACAN or VORTAC ground station.

The TACAN system provides an audio capability allowing the pilot to identify the TACAN or VORTAC ground station by listening to international Morse code identification tones transmitted at 30-second intervals and an in-flight self-test mode for bearing and range. The system is protected by a circuit breaker placarded TACAN, located on the overhead circuit breaker panel (Figure 2-8).

The NAV-1/TAC (Figure 26-1) control is capable of tuning all 252 TACAN channels. Fifty-two of the 252 TACAN channels are paired with frequencies in the communications band. These are channels 1 through 16 and 60 through 69, which correspond to VHF frequencies 134.40 MHz through 135.95 MHz and 133.30 MHz through 134.25 MHz, respectively. TACAN distance and bearing information can be displayed on the pilot and copilot HSIs as selected by the HSI source selector switches.

The TACAN/DME indicator (Figure 26-3) is slaved to the NAV-1/TAC control and displays range to the nearest tenth of a nautical mile from 0 to 99.9 nm and to the nearest 1 nautical mile from 100 to 389 nm. Groundspeed is displayed to the nearest knot from 0 to 999 knots. Time-to-station is displayed to the nearest minute from 0 to 99 minutes. The display will indicate 99 minutes for any computed time-to-station greater than 99 minutes. The indicator will display dashes while in search or when power is first turned on, or momentarily interrupted while in the frequency hold mode indicating loss of the DME holding frequency. TACAN/DME indicator display intensity is adjusted by a control located adjacent to the VHF-1 Comm control head. The intensity control is placarded CONTROL READ OUT VHF NAV ADF.

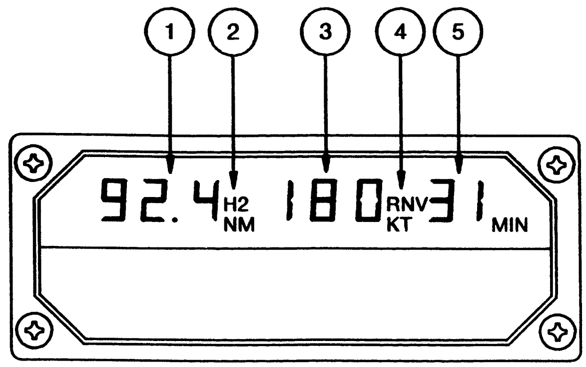


Figure 26-3. TACAN/DME Indicator

A DME-HOLD push switch located on the audio control panel is utilized to select DME HOLD mode of operation. DME HOLD is disabled during TACAN or FMS mode of operation. A MODE selector switch, located on the NAV-1/TAC control panel, permits selection of VOR/DME or TACAN mode of operation. In the TACAN mode, bearing and distance information is derived from the TACAN station signal. The TACAN system is now serving as a navigation receiver and as a DME. The distance and bearing information will be displayed on both HSIs along with a display of range/ groundspeed/time-to-station data on the TACAN/DME indicator.

CAUTION

Since the TACAN ground system does not provide guidance during Instrument Landing System (ILS) approaches, any ILS approach must be flown in the VOR/ILS mode, using the TACAN for DME only.

26.3.1.1 TACAN/DME Indicator

The indicator (Figure 26-3) displays nautical miles, groundspeed, and time-to-station.

1. NM — Displays nautical miles to the station.
2. KT — Displays aircraft groundspeed.
3. MIN — Displays time-to-station.

Note

The indicator display changes to an additional radar altimeter display below 1,000 feet AGL.

26.3.2 TACAN/DME System Operation

CAUTION

The TACAN system should not be turned on until after engine start.

26.3.2.1 Operating Procedure

1. NAV/TAC OFF VOL switch — Turn clockwise.
2. VOR/DME/TAC mode — As required.
3. Frequency/channel — Select.

Note

Prior to station lock-on, dashes will appear in the window of the TACAN/DME control indicator as the system searches for the station. Once the system has locked on, the distance readout will appear, followed by groundspeed and time-to-station computations.

4. DME/TACAN audio switch — ON (verify station).
5. VOL control — As required.

26.3.2.2 Shutdown Procedure

OFF-VOL switch — OFF.

26.4 ADF

26.4.1 Introduction

The ADF system provides aural reception of signals from a selected ground station and indicates relative bearing to that station. The ground station must be within the frequency range of 190 to 1799 kHz. The ADF system has three functional modes of operation. In ANT mode, the ADF receiver functions as an aural receiver, providing only an aural output of the received signal. The indicator needle will be parked in the 90° relative position. If the station is a keyed CW station, the ANT/BFO mode is required to hear the audio ident. In ADF mode, it functions as an automatic direction finder receiver in which relative bearing-to-the-station is presented on an associated bearing indicator, and an aural output of the received signal is provided. If the station is a keyed CW station, the ADF/BFO mode is required to hear the audio identifier.

26.4.2 ADF Operating Controls and Functions

The operating controls for the dual ADF systems are located on the ADF control units (Figure 26-4). The ADF systems may also be tuned through the frequency management feature of the flight management system. In this description, only the individual controls are discussed. ADF control unit display intensity is adjusted by a control located adjacent to the VHF-1 Comm control head in the instrument panel. The intensity control is placarded CONTROL READ OUT VHF NAV ADF.

1. Active frequency display — The active frequency/channel (to which the ADF is tuned) and active mode is displayed in the upper display. The X character beside (when displayed) the active display indicates the bearing indicator directional information is not valid. If at any time the displayed frequency is below 190 kHz, the display flashes.

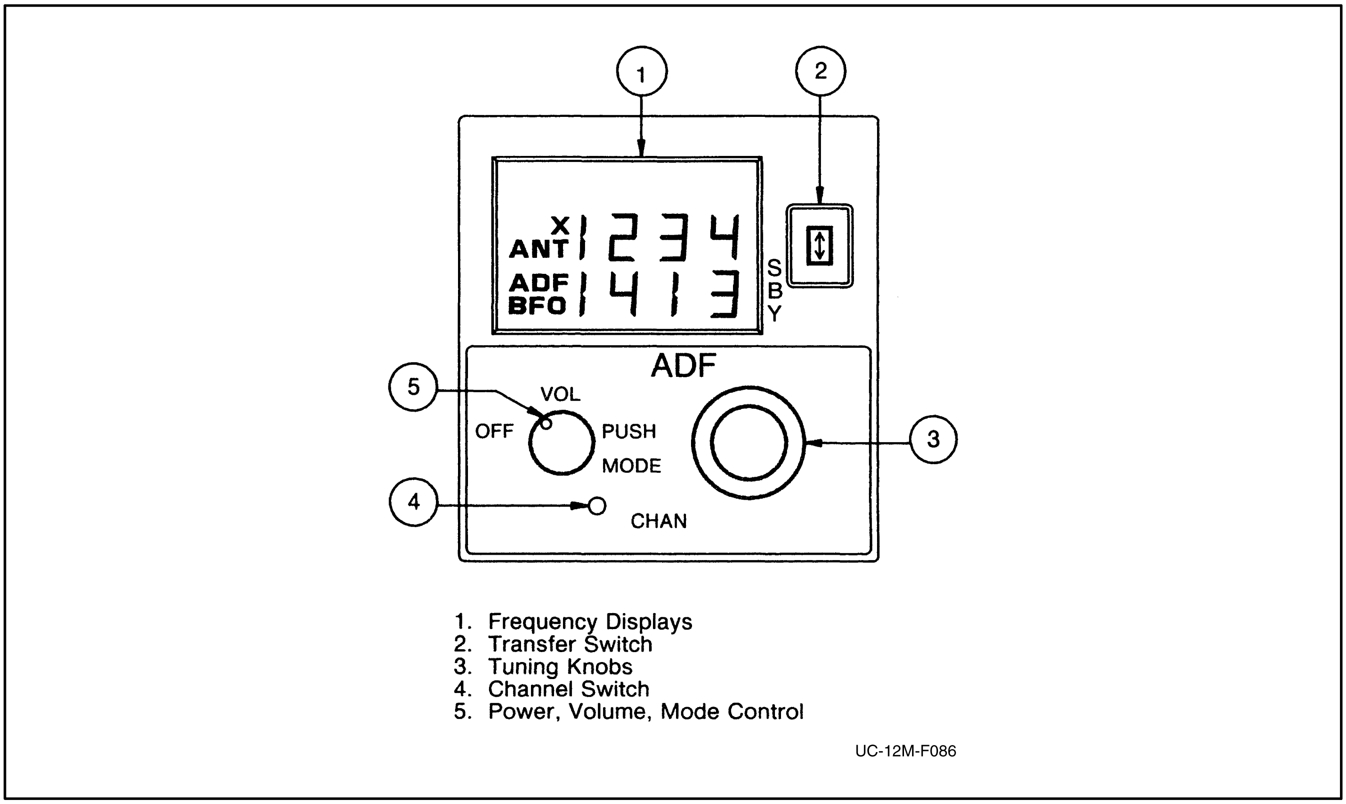


Figure 26-4. ADF Control Unit

2. Standby frequency display — The standby (inactive) frequency/channel and mode is displayed in the lower window.

3. Transfer switch — In operating mode, momentarily pressing the switch transfers the standby frequency or channel to the active display, the previously active frequency/channel becomes the new standby frequency, and the receiver retunes to the new active frequency. While in channel mode, pressing the transfer switch will return the receiver to the frequency mode. In program mode, pressing the transfer switch will cause the channel number to stop flashing and the frequency to flash. The frequency may now be programmed.

4. Select knobs — Two concentric knobs control the preset or active frequency displays. The larger knob changes the 100 kHz from 1 to 17. The smaller knob changes the 10 kHz when pushed in and the 1 kHz pushed in or pulled out. In channel mode, turning either knob changes the displayed channel number.

5. Channel button — Momentarily pressing the CHAN switch while in Frequency mode activates the Channel mode of operation. Pressing and holding the CHAN switch for longer than 2 seconds activates the Program mode.

6. Power and volume switch — Rotating the switch clockwise from the OFF position switches system power on. Rotating the switch further clockwise increases audio volume.

26.4.3 Operating Procedures

26.4.3.1 Equipment Turn On

The ADF receiver and the ADF control are turned on by rotating the power and volume switch clockwise from the OFF position. After power is applied, the ADF control displays the same active and standby frequencies as when the equipment was turned off.

26.4.3.2 Frequency Selection

26.4.3.2.1 Standby Entry

In normal operation, frequency selection is accomplished in the standby entry mode by changing the frequency in the STBY (lower) window. This is accomplished by rotating either of the tuning knobs.

After the desired frequency is set in the standby display, it can be transferred to the active display by momentarily pressing the transfer switch. As the standby frequency is transferred to the active display, the previously active frequency is transferred to the standby display.

26.4.3.2.2 Active Entry

During normal operation, all frequency selections are entered in the standby frequency display; however, the active frequency can be entered directly as described in the following paragraph.

The active entry mode is entered from the standby entry mode or channel mode by pressing and holding the transfer switch for longer than 2 seconds. The frequency select knobs operate as in the standby entry mode, but will change the active display frequency rather than the standby frequency.

Note

During the active entry mode, the unit will remain tuned to the active frequency.

Momentarily pressing the transfer switch returns the control to the standby entry mode. The standby frequency prior to entering active entry mode remains unchanged.

26.4.3.2.3 Channel Mode

The ADF control memory permits storing up to nine preset frequencies. Once stored, these frequencies can be recalled to the standby display by momentarily pressing the CHAN switch.

The storage locations (CH 1 through CH 9) for the recalled frequencies individually appear in the active frequency display and are changed by rotating either tuning knob. After the desired stored frequency has been recalled to the standby display, it can be transferred to the active display by momentarily pressing the transfer switch.

26.4.3.3 Frequency Storage

Up to nine preset frequencies can be stored in the ADF memory (channels) for future recall. To program the memory, press and hold the CHAN switch for 2 seconds or longer. The receiver will tune to the last active frequency displayed. A “P” and the last used channel number will be displayed in the active display window. The channel number will flash, indicating that turning either tuning knob will change the channel number. Momentarily pressing the transfer switch causes the channel number to stop flashing and the frequency to flash. At this time, the tuning knobs will change the frequency. Momentarily pressing the transfer switch will start the channel number flashing and the procedure may be repeated until all nine channels have been programmed if desired.

Note

When programming the memory, no action on the panel for 5 seconds will return the unit to frequency mode, and standby frequency returns to what it was prior to entering the channel mode, and places the channel frequency in the SBY display unless no channels were programmed, in which case the previous frequencies are unchanged.

After a frequency has been stored in memory, it will remain in memory until changed, even when the unit is turned off for an extended period of time.

26.5 FLIGHT MANAGEMENT SYSTEM (FMS)

26.5.1 Description

The Honeywell GNS-XLS "Enhanced" Flight Management System (GNS-XLS) is a GPS-based navigation system that includes a full color flat panel LCD display, QWERTY keyboard, and function keys, a global positioning sensor, fuel management capability, and a navigation database. The GNS-XLS is an integrated system designed to give aircrew a user-friendly navigation interface, very precise long range navigation accuracy, onboard computer-based flight planning, and in-flight fuel management. All of these are centrally located in the pedestal-mounted GNS-XLS Control Display Unit (CDU). The GNS-XLS "Enhanced" is an evolutionary upgrade to the GNS-XLS that incorporates Search and Rescue patterns and flight planning capability, and communications radio tuning and integrates uplinked Weather Graphics capability and enhanced video capability that will accommodate an enhanced Ground Proximity Warning System. Radio tuning, Weather Graphics and Ground Proximity Warning System capabilities of the GNS-XLS have not been incorporated into the UC-12M aircraft. For easier reading, the Enhanced GNS-XLS FMS will be referred to as simply GNS-XLS.

The navigation database is updated on a 28-day cycle by way of a memory card. This card is inserted in a Personal Computer Memory Card International Association (PCMCIA) slot located beneath the keyboard on the CDU. The worldwide database contains over 50,000 waypoints, NAVAIDs, and airports. It contains all applicable departure procedures (formerly SID), arrival procedures (STAR), and approach procedures. The GNS-XLS is capable of storing 999 user-defined waypoints and individual navigation points can be organized into 56 stored flight plans.

A Single GNS-XLS output drives the pilot and copilot HSI, Multi-Function Display (MFD), and the Flight Director/Autopilot. The heading channel of the Sperry SPZ4000 Autopilot is used to provide lateral roll steering coupling between the Flight Director/Autopilot and the GNS-XLS. Remote annunciators, which indicate the status of certain FMS functions, are installed on each pilot annunciator cluster panels.

With adequate satellite reception, the GNS-XLS is capable of:

1. VFR/IFR en route oceanic and Remote Area Navigation (RNAV) operations.
2. U.S. en route operations.
3. U.S. terminal area operations.
4. U.S. instrument approach operations (GPS, VOR, VOR-DME, NDB, NDB-DME, RNAV) within the U.S. National Airspace System using the WGS-84 coordinate reference datum in accordance with the criteria of AC 20-130A, AC 91-49, and AC 120-33.

Note

FAA approval of the GNS-XLS (based solely on GPS navigation) does not necessarily constitute approval for use in foreign airspace.

The GNS-XLS GPS provides Fault Detection and Exclusion (FDE) capability in accordance with FAA Notice N8110.60 and is qualified for Primary Means Oceanic/Remote Area Navigation when used in conjunction with a GPS FDE prediction program. The GNS-XLS contains a built-in prediction program.

Note

A valid Letter of Authorization (LOA) for operations in Special Use Airspace must be issued when appropriate.

The GNS-XLS GPS is qualified for operation in RNP-10 airspace in the Pacific MNPS in accordance with the criteria of Order 8400.12A.

Note

A valid Letter of Authorization (LOA) for operations in Special Use Airspace must be issued when appropriate.

The GNS-XLS is qualified for BRNAV operations in European airspace (in accordance with the criteria of Advisory Circular AC 90-96) providing navigation performance equivalent to RNP-5 standards or better. (Reference ICAO Document 7030 Regional Supplementary Procedures, JAA Technical Guidance Leaflet AMJ20X2 and Euro control RNAV Standard Doc 003-93 Area Navigation Equipment Operational Requirements and Functional Requirements [RNAV].)

A drawing of the GNS-XLS with the QWERTY keyboard is shown in Figure 26-5.

26.5.2 Controls and Indicators

26.5.2.1 External Annunciators

The pilot and copilot instrument panel FMS annunciators (Figure 2-4) are tested using the PRESS TO TEST switch. Since the annunciators are powered through the MASTER AVIONICS switch, the switch must be on in order to test the annunciator lights. Brightness level is controlled by an ANN-BRIGHT/DIM switch on the instrument panel. Annunciators illuminate to indicate the following conditions:

XTRK (Green) — The XTRK annunciator illuminates when a parallel offset track has been selected by the crew.

MSG (Amber) — This annunciator is identical to the GNS-XLS CDU message annunciator and illuminates simultaneously. The MSG light will flash until a SYSTEM or SENSOR message page is viewed.

WPT (Amber) — The waypoint alert annunciator illuminates steadily when the aircraft is within 30 seconds ETE of the next lateral leg change waypoint. The WPT annunciator will flash for 10 seconds then go to a steady state 60 seconds prior to a vertical leg change waypoint.

HDG (Green) — The HDG annunciator illuminates when the system is in FMS Heading mode.

DR (Amber) — The DR annunciator illuminates when the system is in Dead Reckoning mode.

APPR (Green) — The APR annunciator illuminates when the system is in Approach mode.

26.5.2.2 Control Display Unit — FMS

The FMS uses GPS signals, air data from a dedicated ADC, and heading information from the compass system to calculate and display aircraft navigation data. The following controls and displays are provided on the CDU (Figure 26-5) for operation of the FMS.

ON — Used for system start-up/shutdown. Depress and release the ON key to apply power to the system. There is a warmup period of approximately 30 seconds. The display illumination will initially be set at 75 percent of full bright. Depressing the ON key for approximately 3 seconds will initiate the system power off sequence. During the sequence, the display will show SYSTEM TURNING OFF. This is to prevent inadvertent system shutdown.

Note

The system will be automatically powered up when the AVIONICS MASTER switch is turned on.

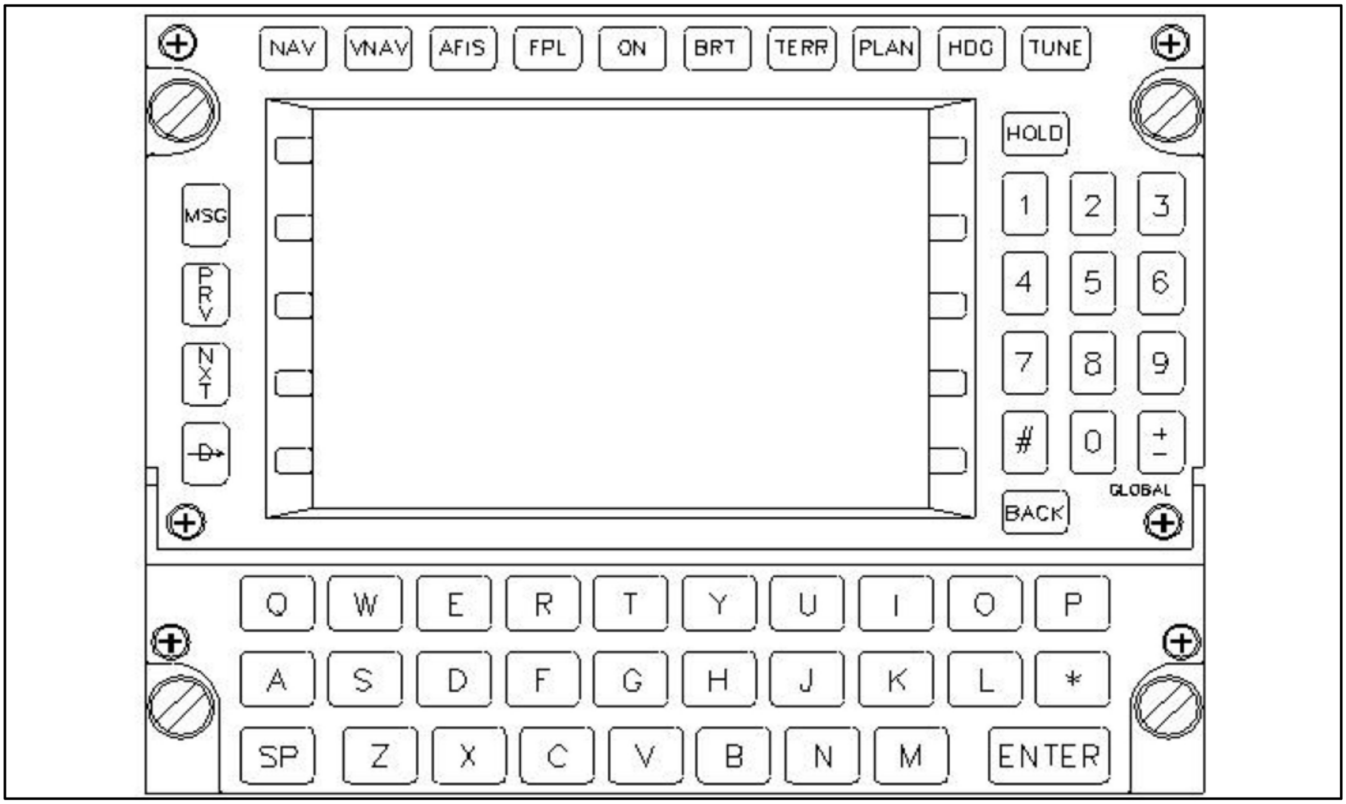


Figure 26-5. GNS-XLS Control Display Unit

BRT (Brightness) — Used to change the illumination of the display. This key is also used for parallax adjustment of the Line Select keys.

Note

Back lighting to the CDU is controlled by the CONSOLE LIGHTS rheostat located on the overhead panel.

MSG (Message) — Illuminates to alert the flightcrew that a message needs to be viewed on one of the SYSTEM MESSAGES or SENSOR MESSAGES pages. Depressing the MSG key will display the message page. The newest message will be indicated with a flashing asterisk to the left of the message. If the message requires the flightcrew take some action, the MSG annunciator will remain on steadily until the action is completed. If no action is required, the MSG annunciator will extinguish when the message page is exited.

ALPHA keys — Used to enter the 26 letters of the alphabet and an asterisk.

NUMERIC keys — Used to enter numbers 0 to 9, # and ±.

HOLD key — Used to access the Holding Pattern page or the Position Fix page.

BACK key — Used to erase errors and page backward when the cursor is not displayed. It can also be used to change data in a field if the cursor is present.

SP (Space) key — Not used.

ENTER key — Used to enter data into the computer memory.

NAV (Navigation) key — Used to select the navigation section pages. The first page of the section is displayed first when the NAV key is pressed. With each subsequent press of the NAV key, the next sequential page will be displayed.

VNAV (Vertical Navigation) key — Used to select the vertical navigation section pages. The first page of the section is displayed first when the VNAV key is pressed. With each subsequent press of the VNAV key, the next sequential page will be displayed.

AFIS (Airborne Flight Information System) key — Not used.

FPL (Flight Plan) key — Used to select the flight plan section pages. The first page of the section is displayed first when the FPL key is pressed. With each subsequent press of the FPL key, the next sequential page will be displayed.

TERR (Terrain) key — Not used.

PLAN (Planning) key — Used to select the planning section pages. The first page of the section is displayed first when the PLAN key is pressed. With each subsequent press of the PLAN key, the next sequential page will be displayed.

HDG (Heading) key — Used to select the heading section pages. The first page of the section is displayed first when the HDG key is pressed. With each subsequent press of the HDG key, the next sequential page will be displayed.

TUNE (Radio Tuning) key — Not used.

D► (Direct) key — Used to select the direct to section pages. The first page of the section is displayed first when the D► key is pressed. With each subsequent press of the D► key, the next sequential page will be displayed.

PRV (Previous) key — Used to display the previous page of a section. This key also allows the operator to remain in a section by looping from the first to the last and back to the first page of that section.

NXT (Next) key — Used to display the next page of a section. This key also allows the operator to remain in a section by looping from the first to the last and back to the first page of that section.

Line Select keys — Used to place the cursor in the field next to that key. Each line select key controls two lines of text. White symbols (< or >) displayed on either side of the display indicate active Line Select keys for each individual page.

26.5.3 Limitations

The GNS-XLS FMS is used as a means for en route navigation provided the following limitations are observed:

1. The GNS-XLS Operator's Manual (Honeywell Part No. 006-18233-0000), Rev. 2, dated September 2002 (or later FAA approved revision applicable to the software program shown below) must be available to the flightcrew whenever navigation is predicated upon the use of the GNS-XLS Flight Management System.

2. IFR navigation based on the GNS-XLS is allowed with the following restrictions:

   a. The GNS-XLS must utilize the current software version (SM04 or later approved revision).

   b. IFR navigation with the GNS-XLS is prohibited unless the database is current.

   c. The aircraft must have other approved navigation equipment appropriate to the route of flight installed and operational except where approval has been granted for GPS as the primary means of navigation for operations in oceanic and remote areas.

d. When operating outside the magnetic variation model area (north of 70 degrees north latitude or south of 60 degrees south latitude), the pilot must manually insert magnetic variation.

e. FMS Approach Procedure Limitations:

(1) The GNS-XLS is approved for published nonprecision approach operations only, provided RAIM is available. Use of the GNS-XLS as the primary means of navigation during Localizer and MLS-based approaches is prohibited.

(2) Use of the GNS-XLS for IFR nonprecision approaches is limited to published approach procedures (contained within the current database) within the U.S. National Airspace System and varies by letter of agreement for operations in airspace controlled by other nations.

(3) Use of the GNS-XLS as the primary means of navigation for approaches in airspace belonging to other nations is not approved unless authorized by the appropriate authority.

(4) Missed Approach procedures should initially be flown manually or coupled using the Flight Director Heading Mode, until waypoint to waypoint FMS navigation can be established and verified, to ensure that all portions of the Missed Approach procedure are flown correctly.

(5) If an Approach procedure has been entered and a new Approach procedure is desired, the original Approach procedure should be erased before selecting a new Approach procedure to ensure proper waypoint sequencing on the Active Flight Plan.

(6) When FMS is the selected navigation source, use of the APR Flight Director mode is inappropriate. Coupled flight using the APR mode (when FMS is the selected navigation source) is prohibited.

f. The FDE prediction function required for primary navigation in oceanic operations or RNAV operations using the built-in prediction program can only be performed on the ground. GPS NOTAM must be checked prior to performing the FDE prediction. It is recommended that the final FDE prediction be performed 2 to 6 hours prior to departure. FDE and navigation capability must be predicted to be available for the appropriate duration of the flight.

g. For BRNAV operations in the European region:

(1) With 23 (24 if the altitude input to the GNS-XLS is not available) or more satellites projected to be operational for the flight, the aircraft can depart without further action.

(2) With 22 (23 if the altitude input to the GNS-XLS is not available) or fewer satellites projected to be operational for the flight, the availability of GPS integrity (RAIM) should be confirmed for the intended flight (route and time). This should be obtained from a prediction program run outside of the aircraft. The prediction program must comply with the criteria of Appendix 1 of AC90-96. In the event of a predicted continuous loss of RAIM of more than 5 minutes for any part of the intended flight, the flight should be delayed, canceled, or rerouted on a track where RAIM requirements can be met.

h. The GNS-XLS fuel and range data (predicated upon manual pilot data input only — no fuel flow interface included in this installation) are advisory only and do not replace primary aircraft fuel quantity or fuel flow instruments for range and endurance calculations.

i. During a period of dead reckoning, or when the GNS-XLS information is not available, or invalid, navigation shall not be predicated on the GNS-XLS as a means of operation in the National Airspace System. Utilize remaining operational avionics.

j. Use of the Flight Director and Autopilot without a selected NAV source is not authorized (e.g., the Flight Director and Autopilot should not be engaged unless one of the pilot HSI Navigation Source Selector switches is illuminated green). When there is no navigation source driving the deviation bar, the Flight Director and Autopilot will not be receiving drift correction inputs. The net effect will be similar to a coupled HDG mode.

26.5.4 Normal Procedures

26.5.4.1 System Power-Up/Preflight

1. Turn system on by selecting the AVIONICS MASTER Switch — ON, or by pressing the ON button on the CDU (top row center).

Note

For the first 30 seconds after the system is turned on, the computer performs extensive internal tests that must be successfully completed before proceeding further. If the system detects a problem, the SELF TEST display may be replaced by a NO DATA RECEIVED message.

26.5.4.2 Verify Database and Software

1. After the Self-Test is successfully completed, the Initialization Page automatically displays with DATE, GMT (Greenwich Mean Time), IDENT (airport identifier), and POS (position).

   DATE is the current Greenwich date and is displayed as day, month, and year.

   GMT is the time of day displayed in Greenwich Mean Time hours and minutes.

   IDENT displays the airport identifier for the airport closest to the system shutdown position. Dashes will be displayed when the cursor is placed over the POS field.

   POS displays the last system position at shutdown.

   Dashes are displayed when the cursor is over the IDENT field. Note that the program version number on the bottom line reads as follows: 17960-0204 (SM04 or later approved revision).

26.5.4.3 Loading a Saved Flight Plan

1. Select FPL key and FLIGHT PLAN LIST 1/1 page will be displayed.

Note

The FLIGHT PLAN LIST page may automatically be displayed if the ENTER key is depressed at least three times while on the Initialization Page.

   a. If the initialization airport matches a departure airport on the FLIGHT PLAN LIST, the cursor will automatically be positioned over the first matching Flight Plan. Refer to Figure 26-6.

   b. There are 7 pages possible with a maximum of 56 flight plans stored in non-volatile memory. Each stored flights plan's origin and destination points are listed in alphabetical order. Refer to Figure 26-6.

   c. A new FLIGHT PLAN LIST Page is created when the previous page has eight flight plan origin-destination pairs on it. Using the PRV or NXT key pages through the Flight Plan List subsection. Refer to Figure 26-6.

2. Line Select key — Depress to position the cursor over desired Flight Plan Number.

3. ENTER key — Depress.

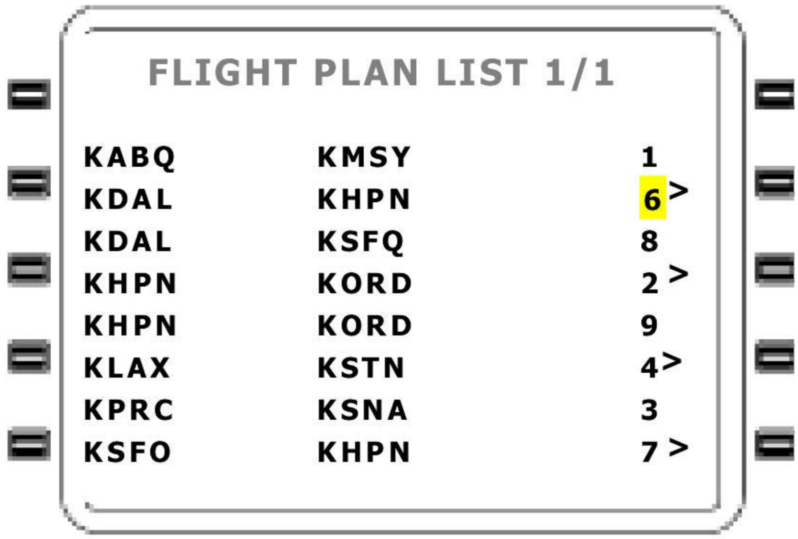


Figure 26-6. Flight Plan List

4. FLIGHT PLAN Page — Verify Flight Plan. Review routing by depressing PRV or NXT key to page through multiple Flight Plan pages.
5. Line Select key — Depress to position cursor over SELECT? (Refer to Figure 26-7):
   a. To transfer the Stored Flight Plan to Active Flight Plan status, continue with step 6.
   b. To INVERT and transfer the Stored Flight Plan with waypoint sequence reversed to Active Flight Plan status, press the BACK key to display INVERT?
6. ENTER key — Depress.
7. ACTIVE FPL — Confirm. Observe that the Stored Flight Plan transferred to the ACTIVE FPL page as SELECTED or INVERTED.

26.5.4.4 Creating a Flight Plan

1. FPL key — Depress to display (Stored) FLIGHT PLAN LIST Page (if required).
2. Line Select key — Depress to position cursor on blank line to display the NEXT FPL number. Refer to Figure 26-8. If several Flight Plans are displayed, position cursor anywhere on the page then depress BACK key to show NEXT FPL number available.

Note

If all 56 Flight Plans are used, NO FPL AVAIL will appear in the field. Any of the stored flight plans may be erased to allow additional entries. To delete a stored flight plan, position the cursor over the flight plan number, depress the BACK key. DELETE? appears in the flight plan field. Depress the ENTER key and the flight plan is deleted.

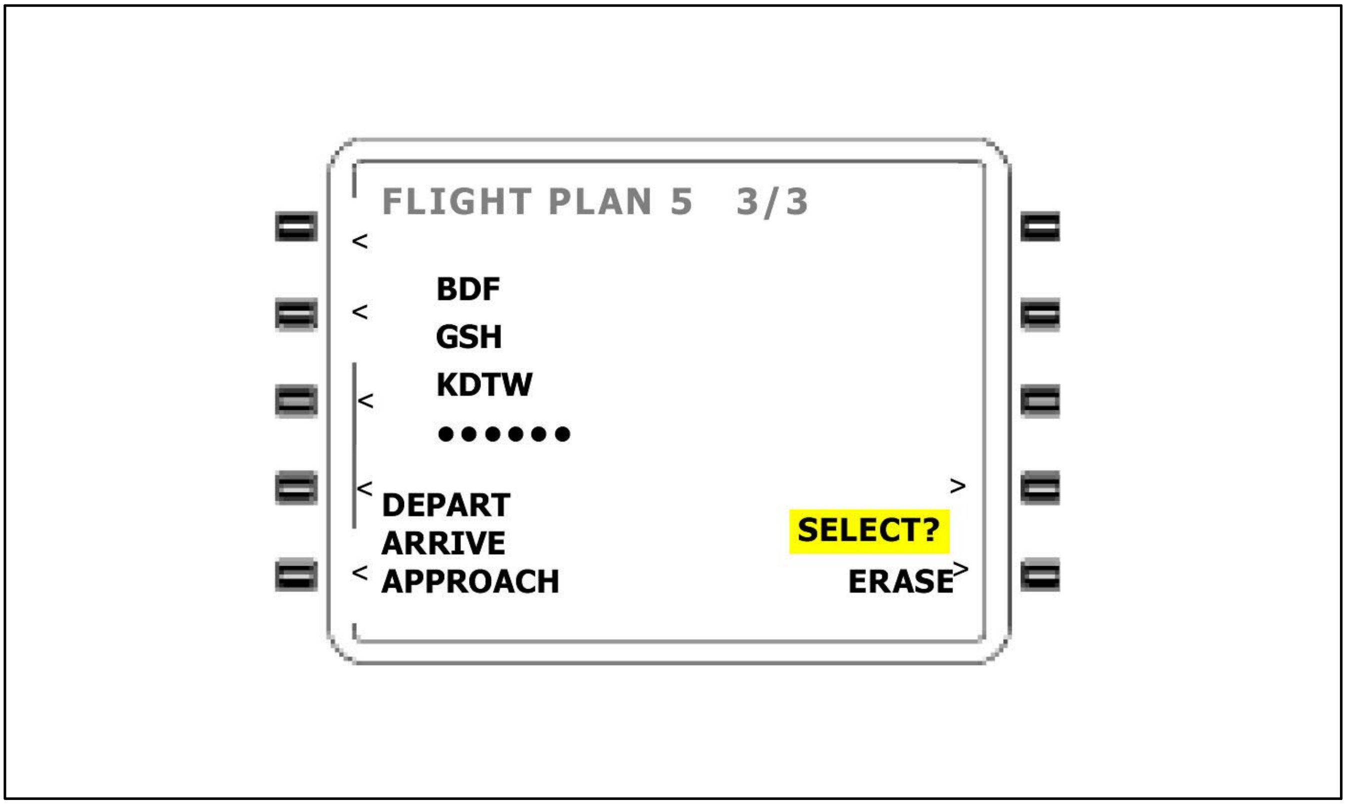


Figure 26-7. Flight Plan Page

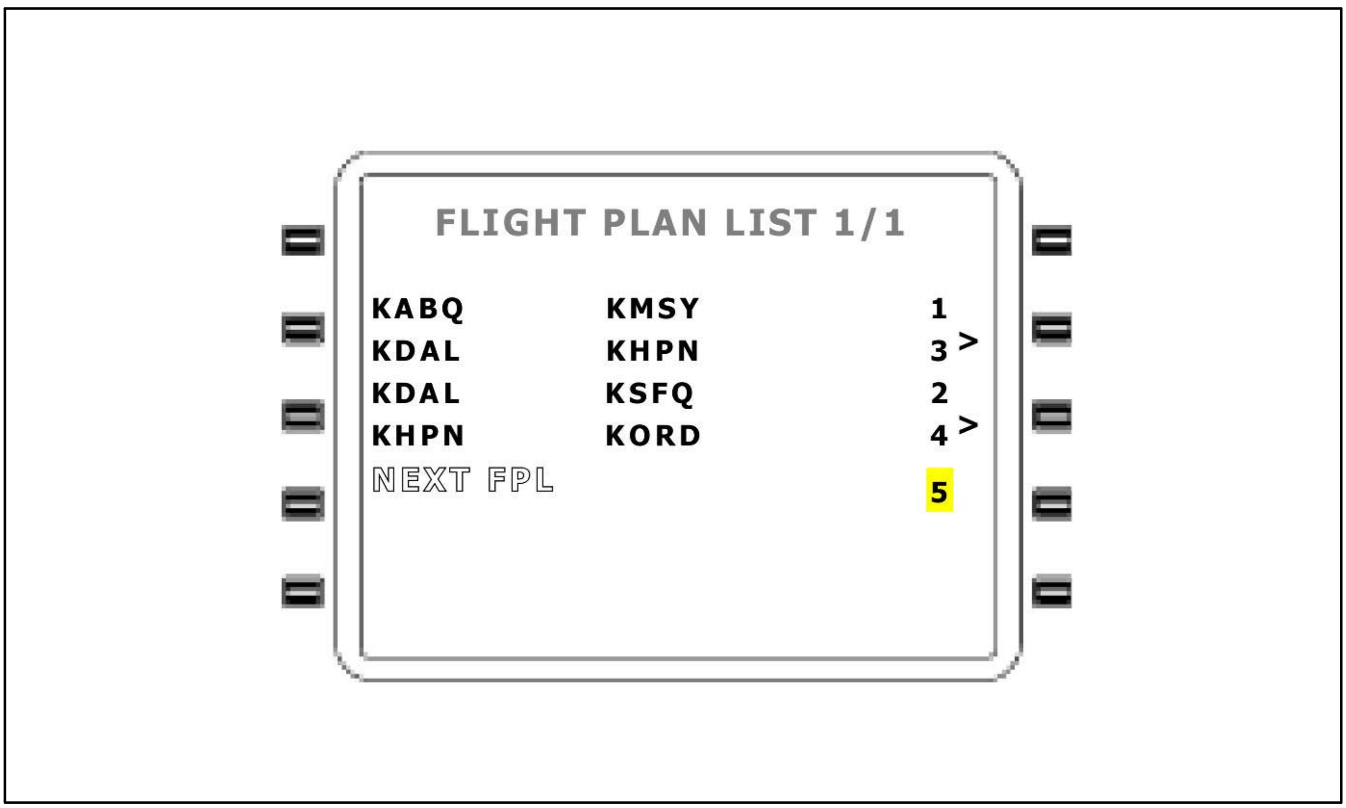


Figure 26-8. Displaying Next FPL

3. ENTER key — Depress to display FLIGHT PLAN page.

4. Type the appropriate departure airport or waypoint identifier in the cursor field.

Note

Identifiers may contain from one to six characters in any combination of letters and numbers. If an entry error is made, press the BACK key to erase a character, then enter the correction.

5. ENTER key — Depress.

6. Waypoint Coordinates and Data — Verify. If a specific runway is desired, depress the appropriate Line Select key to place the cursor over the desired runway.

7. ENTER key — Depress to add waypoint to the FPL.

8. Repeat steps 4 through 7 for the remaining waypoints. The destination airport identifier should be the last waypoint on the flight plan.

9. Procedures for entering airways in a flight plan:

   a. Line Select key — Depress to position cursor directly below the starting waypoint of the desired airway on the Flight Plan page.

   b. Airway ident — Insert.

      (1) # key — Depress then enter the airway identifier ("#J501" in Figure 26-9).

      (2) ± key — Depress and type the destination waypoint. Refer to Figure 26-9.

      (3) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink and the appropriate airway or waypoint identifier must be entered.

      (4) To change ending waypoint, use the Line Select key to position cursor over a different destination waypoint. If applicable, use PRV and NXT keys to access all airway waypoint pages.

   c. ENTER key — Depress to merge the airway waypoints into the Flight Plan and return to the Flight Plan Page.

Note

If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message "FPL FULL" will appear.

   d. If applicable, enter additional airway identifiers to chain several airways together.

26.5.4.5 Saving a Flight Plan

Once a Flight Plan is selected and becomes Active, it is automatically saved in the Stored Flight Plan page.

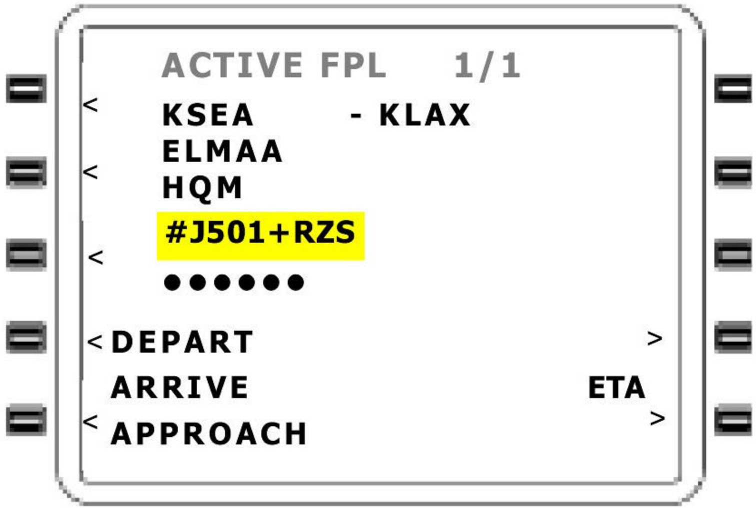


Figure 26-9. Airway Identifier and Destination Waypoint Entered

26.5.4.6 Executing Flight Plan

26.5.4.6.1 Initial Leg Selection

An initial From/To Leg or Direct To Leg must be established in order for the system to provide guidance along the Flight Plan. From the ACTIVE FPL Page, the following procedure is used:

1. NAV key — Depress.

2. FR Waypoint — Verify. The first waypoint on the Active Flight Plan will appear in the FR field. To change the FR waypoint, insert the desired identifier.

3. ENTER key — Depress. The next waypoint in the Active Flight Plan sequence will appear in the TO field.

4. TO Waypoint — Verify. To change the TO waypoint, insert the desired identifier.

5. ENTER key — Depress.

6. DIS, DTK — CHECK for reasonableness.

If this leg selection is part of an active flight plan involving oceanic/remote operation using GPS as the sole navigation source, an FDE prediction to determine sufficient GPS availability must be performed prior to departure.

26.5.4.6.2 Departure

The GNS-XLS SID (Standard Instrument Departure), STAR (Standard Terminal Arrival), Approach and Airway retrieval feature is designed to relieve flightcrew workload. SIDs and STARs require such procedures as flying headings and altitudes, as well as intercepting VOR radials and DME arcs, etc. Approaches can be flown autopilot/flight director coupled until the Missed Approach Point. Missed Approach Procedures must then be flown manually. The GNS-XLS is only designed to provide meaningful input to the HSI when on a track between two waypoints when Pseudo Vortac (selected course) procedures are used. The system is not designed to fly full SID, STAR, or Missed Approach procedures.

When flying those portions of a SID or STAR that are not tracks between fixes, the aircraft should be flown manually or in Heading mode. In some cases, Pseudo Vortac procedures can be used to establish an intercept to a published track. When using the Pseudo Vortac mode, or upon intercepting a published track between two waypoints (fixes), the aircraft may be flown in reference to the crosstrack deviation provided by the GNS-XLS or by coupling the GNS-XLS roll command to the autopilot.

The first leg of the SID that the FMS can fly is not the first leg of the procedure. To properly fly SIDs, the flightcrew must manually fly the procedure to a point where the FMS can fly the procedure properly. The first leg of the SID that the FMS can fly is usually the first waypoint after the airport identifier or departure runway. After loading the SID onto the Active FPL, access NAV page 1. Enter the first waypoint after the runway or airport identifier in the FR field. Press ENTER. The TO field will display the next waypoint in sequence for the FPL. Press ENTER again to complete the initialization of the first leg of the flight plan. The flightcrew must manually fly the airplane until reaching the first leg of the SID that can be flown by the FMS.

The following operational procedures contain leg types that the FMS cannot automatically fly and require manual intervention on the part of the pilot.

Note

- Some SIDs and STARs require intercept procedures upon reaching a specified altitude. In these cases, execute the Pseudo Vortac, Direct To, or Heading Intercept procedure upon reaching the specified altitude.
- The CDU display in Figure 26-10 shows the waypoints that would be added to the flight plan through reference to the ELMAA5 SID, HQM transition from RW16L.

1. Heading to Intercept Procedures — For procedures like the example in Figure 26-11, the following operational procedures are recommended.
   a. Prior to departure, tune the Seattle VOR, select the VOR as the NAV source and set the HSI course pointer to 158°.
   b. After departure, intercept the SEA 158° radial. After crossing the SEA 5 DME fix at or above 3,000 feet, turn right to 250°.
   c. Select the FMS Heading and enter 250°, then Intercept mode on the FMS. Select ELMAA as the TO waypoint and enter 227 in the DTK field and press ENTER.
   d. Select the FMS as the NAV source.
   e. The FMS will fly the remainder of the SID to HQM.

Note

This is known as the FMS Heading/Intercept procedure.

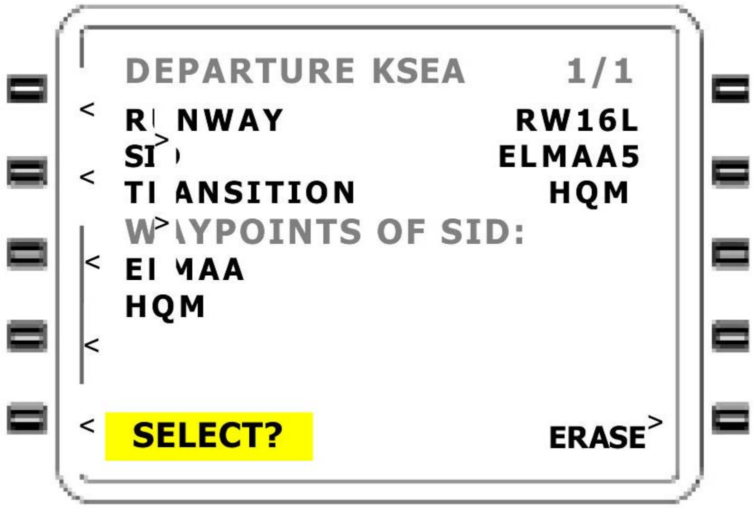


Figure 26-10. CDU Display for Heading to Intercept Procedures Example

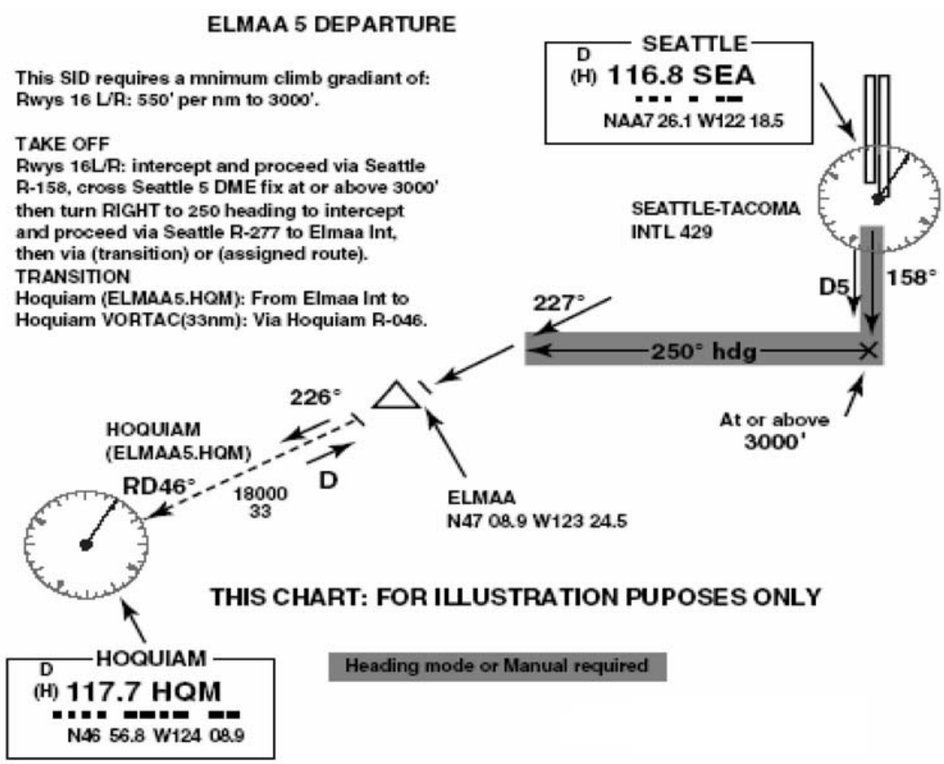


Figure 26-11. Heading to Intercept Procedures

2. Overfly then Intercept Procedures — The following operational procedures are recommended when required to overfly a waypoint then turn to intercept a course to the next waypoint (Figure 26-12 example).

   a. Prior to departure, when the first waypoint is designated flyover, select MAN leg change mode on NAV Page 1 and press ENTER.

   b. Select the FMS as the NAV source.

   c. Accurately fly the runway course or heading.

   d. Immediately after passing ZH582, do a Direct To ZH554, enter 255 in the DKT field on NAV Page 1 and press ENTER.

Note

This is known as the FMS Pseudo VORTAC procedure.

3. Overfly then DIRECT TO Procedures — The following operational procedures are recommended when required to overfly a waypoint then a Direct To the next waypoint (Figure 26-13 example).

   a. Prior to departure, select MAN leg change mode on NAV Page 1 and press ENTER.

   b. Select the FMS as the NAV source.

   c. Accurately fly the runway course or heading.

   d. Immediately after passing WW166, press the D▸ key, cursor over BBKNB and press ENTER.

Note

This is known as the FMS Direct To procedure.

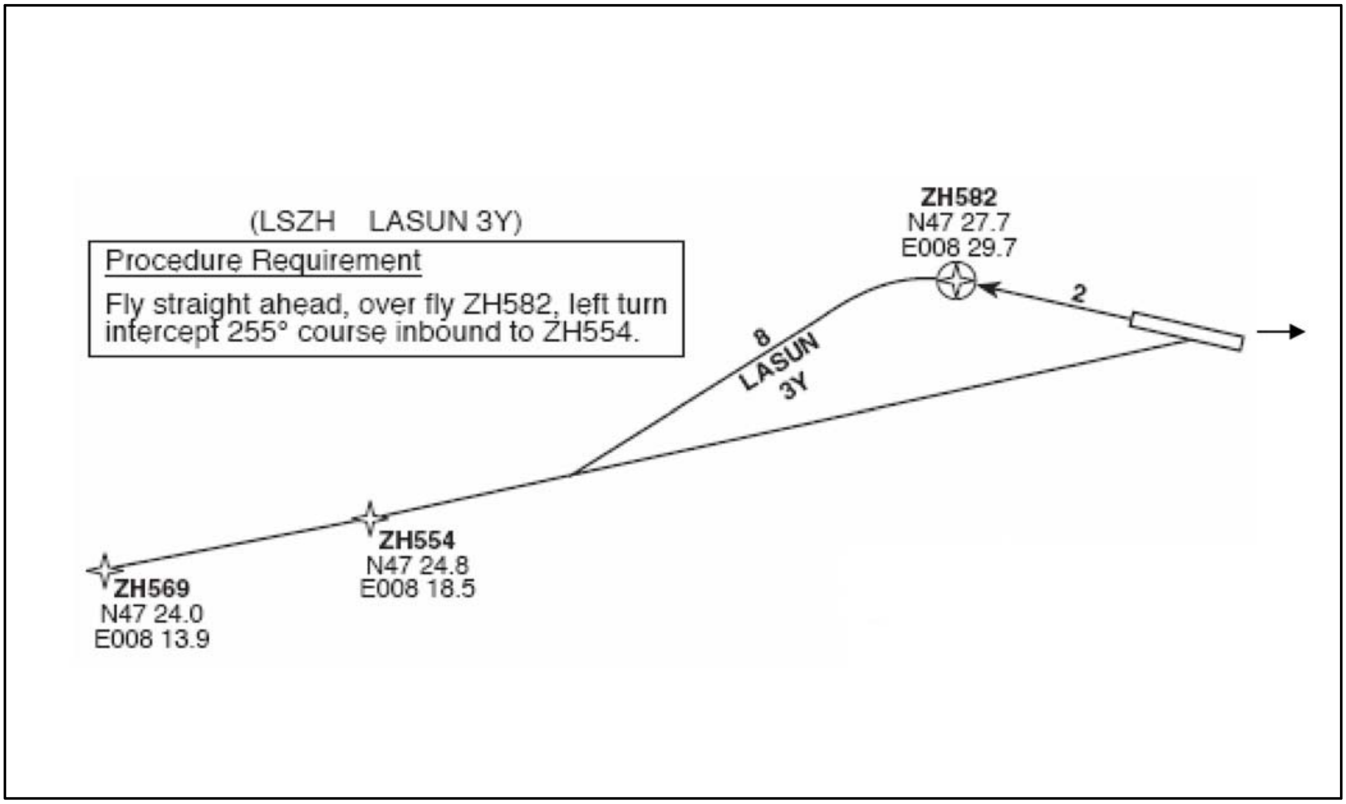


Figure 26-12. Overfly to Intercept Procedures

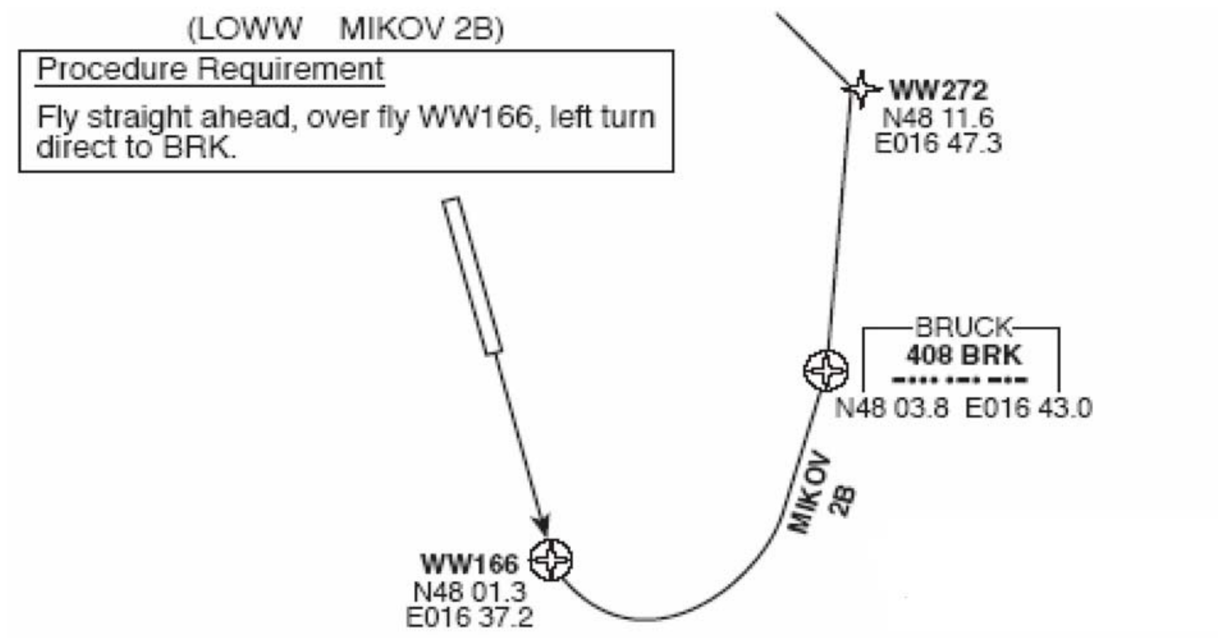


Figure 26-13. Overfly then DIRECT TO Procedures

4. Entering a SID on the Active FPL.

Note

These procedures may also be used with a stored flight plan.

a. FPL key — Depress to display Active FPL page.

b. Line Select key — Depress to position cursor over the DEPART? Field.

c. ENTER key — Depress to display DEPARTURE page.

d. DEPARTURE Airport Identifier — Verify or insert valid ident.

Note

- If the first waypoint on the Flight Plan is an airport, the Departure ident pre-fills and the cursor is positioned over the first SID identifier on the list.
- If the first waypoint on the Flight Plan is a runway, the RUNWAY field also pre-fills and the cursor is over the first SID identifier on the list.
- If there are no SIDs associated with the Departure Airport, the message “NO SIDS AVAILABLE” appears and the ident field flashes. Depress the FPL key to return to the Active Flight Plan.

e. Line Select key — Depress to position the cursor over the desired SID, if required.

f. ENTER key — Depress to select SID.

Note

Cursor moves to the first TRANSITION identifier on the list. The TRANSITION field is highlighted in yellow.

g. Line Select key — Depress to position cursor over the desired TRANSITION, if required.

h. ENTER key — Depress to select TRANSITION.

Note

If the SID and TRANSITION are runway dependent, and a runway has not pre-filled, the cursor moves to the first runway on the RUNWAY identifier list and RUNWAY field is highlighted in yellow. If runway is not required, proceed to step k.

i. Line Select key — Depress to position cursor over the desired runway.

j. ENTER key — Depress to select RUNWAY.

k. Departure SID Waypoints — REVIEW (Figure 26-14) then depress the ENTER key to select the SID and insert it into Active Flight Plan. The display will automatically return to the ACTIVE FLIGHT PLAN page.

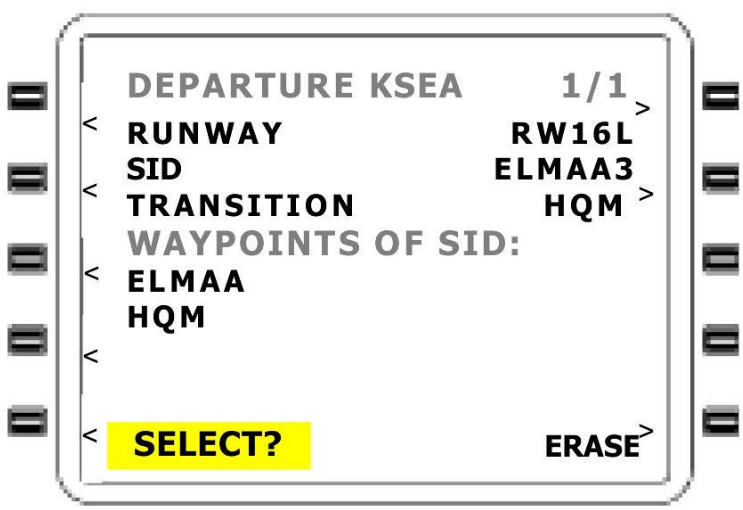


Figure 26-14. Departure SID Waypoints

Note

- If SID is added to a stored Flight Plan, this display will return to the stored flight plan page after SID is selected.
- SID waypoints appear indented from other waypoints in a Flight Plan that are not part of a procedure (SID, STAR, APPROACH).

5. Reviewing a SID from any Stored FPL or the Active FPL page.

   a. Line Select key — Depress to position cursor over the DEPART field on the Flight Plan page.

   b. ENTER key — Depress to review SID.

   c. BACK key — Depress to return to Flight Plan page.

Note

SELECT will not appear as an option since a SID already exists in the Flight Plan.

6. Editing a SID from any Stored FPL or the Active FPL page.

   a. Line Select key — Depress to position cursor over the DEPART field on the Flight Plan page.

   b. ENTER key — Depress.

   c. Line Select key adjacent to SID field — Depress to position cursor over the first SID identifier on the list.

Note

A list will only appear if the TRANSITION/RUNWAY are compatible with other SIDs.

   d. Line Select key adjacent to TRANSITION field — Depress to position cursor over the current TRANSITION waypoint on the list.

   e. Line Select key — Depress to position cursor over the desired TRANSITION.

   f. ENTER key — Depress to select the desired TRANSITION. The system will automatically load the compatible SID associated with the selected TRANSITION.

   g. ENTER key — Depress to select a new SID and insert the new SID into the flight plan.

Note

The RUNWAY can also be edited without changing the original SID if the SI/TRANSITION are compatible. This is done by pressing the Line Select key adjacent to the RUNWAY field. Press the Line Select key to position the cursor over the desired RUNWAY. Press ENTER to load the desired RUNWAY on the SID.

   h. ENTER key — Depress to select the edited SID as displayed and insert it into the flight plan.

Note

Look carefully at the flight plan to see if any waypoints are out of sequence. Delete waypoints as necessary.

7. Adding or Deleting Waypoints within a SID.

Note

When a SID is modified by adding or deleting waypoints, the sequence of waypoints is no longer identified as a SID.

To Add a Waypoint:

a. Line Select key — Depress to position the cursor over the SID waypoint identifier that will follow the new entry on the Flight Plan page.

b. Waypoint Ident — Insert.

c. ENTER key — Depress twice.

Note

The previously indented SID waypoints move over one space to the left on the screen and are treated as normal waypoints in the Flight Plan.

To Delete a Waypoint:

d. Line Select key — Depress to position the cursor over the waypoint to be deleted in the Flight Plan page.

e. BACK key — Depress. A DELETE? prompt will appear adjacent to the waypoint to be deleted.

f. ENTER key — Depress. The waypoint will be deleted and the waypoints of the SID will be treated as nonprocedure waypoints in the flight plan.

26.5.4.6.3 Entering an Airway from Any Stored FPL or the Active FPL Page

En route Airways include high-altitude jet routes, low altitude, and colored airways.

1. Line Select key — Depress to position the cursor below the starting waypoint of the desired airway on the Flight Plan Page.

2. Airway Ident v Insert. Use Option 1 below if the desired waypoint is unknown. Use Option 2 below to enter the known waypoint.

   a. Option 1.

      (1) # key — Depress then enter the airway identifier.

      (2) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink. The appropriate airway or waypoint identifier must be entered.

(3) Line Select key — Depress to position the cursor over the desired designation waypoint. If applicable, use PRV and NXT keys to access all airway waypoints pages.

Note

As the cursor is moved up or down, “TO” will appear next to the cursor and a question mark will follow the ident. The waypoints between the TO/FROM waypoints will be displayed in yellow.

(4) After selecting the ending waypoint (TO) on the Airway, depress the ENTER key to merge the Airway waypoints into the flight plan and return to the FPL page.

Note

- If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message “FPL FULL” will appear.
- Look carefully at the flight plan to see if any waypoints are out of sequence. Delete waypoints as necessary.

b. Option 2.

(1) # key — Depress then enter the airway identifier.

(2) ± key — Depress and type destination waypoint.

(3) ENTER key — Depress.

Note

If the waypoint above the cursor is not a waypoint on the selected airway, the airway identifier will blink and the appropriate airway or waypoint identifier must be entered. If the destination waypoint is not on the airway, the system reverts to Option 1.

(4) To change ending waypoint, use the Line Select key to position the cursor over a different designation waypoint. If applicable, use PRV and NXT keys to access all airway waypoints pages.

Note

As the cursor is moved up or down, “TO” will appear next to the cursor and a question mark will follow the Ident. Waypoints between the TO/FR waypoints will be displayed in yellow.

3. ENTER key — Depress to merge the airway waypoints into the Flight Plan and return to the Flight Plan page.

Note

If inserting the airway segment into the Flight Plan results in more than 50 waypoints in the stored Flight Plan or 100 waypoints on the Active Flight Plan, the message “FPL FULL” will appear.

4. If applicable, enter additional airway identifiers to chain several airways together.

26.5.4.6.3.1 Editing an Airway

Once an airway is merged into the flight plan, waypoints can be added to or deleted from the flight plan on the Flight Plan page using normal edit procedures.

To add or delete waypoints from a selected segment of the airway, perform the following:

1. Line Select key — Depress to position the cursor over an airway waypoint on the Flight Plan page.
2. # key — Depress then enter the airway identifier.
3. ENTER key — Depress.
4. Line Select key — Depress to move the cursor to shorten or lengthen the previously selected segment of the airway. If applicable, use PRV and NXT keys to access all airway waypoints pages.
5. ENTER key — Depress to merge the edited airway segment into the Flight Plan and return to the Flight Plan page.

26.5.4.6.4 Creating/Changing Pilot-Entered Waypoints

A personalized waypoint may be created by entering a non-NDB (Nav Database) waypoint identifier and inserting the desired position coordinates on the Waypoint page. Refer to Figure 26-15.

The CDU has nonvolatile storage for up to 999 waypoints, which are retained in memory only if the waypoints are entered on a Stored Flight Plan. The ICAO identifiers stored in the database cannot be used for personalized waypoints.

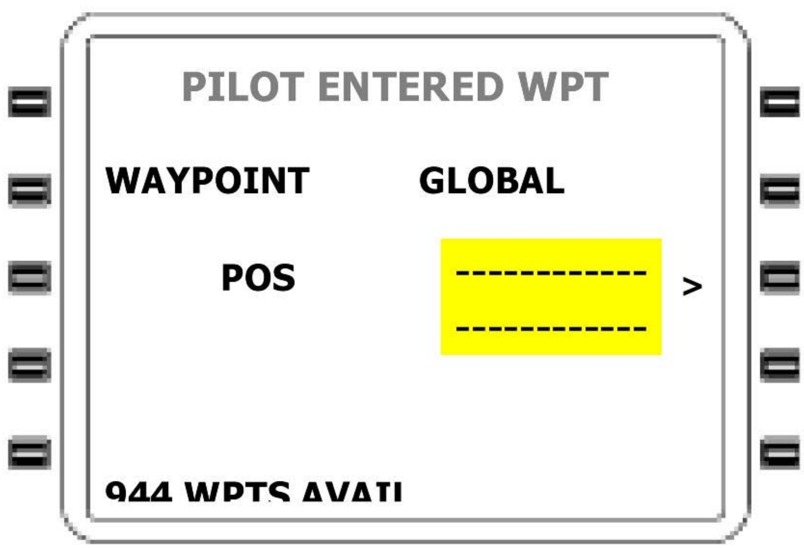


Figure 26-15. Creating Pilot Entered Waypoints

Attempting to enter more than 999 pilot-entered waypoints in memory causes MEM FULL to be displayed on the FLIGHT PLAN page. The message light will flash and WPT MEM FULL will be displayed on the SYSTEM MESSAGES page.

Select a desired Flight Plan and position the cursor over the desired field. If necessary, refer to the procedure for Creating a Flight Plan or Modifying a Flight Plan.

Creating Pilot-Entered (Personalized) Waypoints:

1. Personalize IDENT — Insert.
2. ENTER key — Depress.
3. Latitude — Insert (N or S first, then degrees, minutes, and hundredths).
4. ENTER key — Depress.
5. Longitude — Insert (E or W first, then degrees, minutes, and hundredths).
6. ENTER key — Depress. The display will change to the appropriate FLIGHT PLAN or DIRECT page.

Changing Pilot-Entered (Personalized) Waypoints:

1. Personalize IDENT — Insert.
2. ENTER key — Depress. PILOT ENTERED WPT page will appear.
3. Line Select key — Depress to position the cursor over POS field.
4. Repeat Steps 4 to 6 above.

Note

If an offset waypoint from a pilot-entered waypoint is programmed, the RAD and DIS can be changed, but the coordinates cannot be manually inserted.

26.5.4.6.5 Creating an Offset Waypoint

This procedure enables the system to create a waypoint at a given radial and distance from a known point. The known point (parent waypoint) may be any stored personalized or database waypoint.

An offset waypoint may be inserted in any Waypoint IDENT field. The offset waypoint is retained in memory after system shutdown only if entered on a Stored Flight Plan.

Position the cursor over the desired waypoint IDENT field.

Note

The offset waypoint uses situation declination, if available, or it uses the calculated magnetic variation of the parent waypoint. All waypoints defined by a VHF NAVAID in the National/International Airspace System are based on the VHF NAVAID station declination. Since the magnetic variation and station declination may not be the same at a given NAVAID, the calculated position and the defined FMS position may differ.

1. Parent Waypoint IDENT — Insert with an * following the entry. Refer to Figure 26-16.

Note

More than one offset waypoint is allowed from one parent, using *, *1, *A1, etc., as identifying notation.

2. ENTER key — Depress.

Note

If field blinks, Parent Waypoint does not exist in CDU memory or in database and must be defined on a Flight Plan page.

3. Desired Radial — Insert. The degrees can be entered as whole numbers and the .0 will be loaded automatically (i.e., type 77, 077.0 will be displayed). If a fraction of a degree is desired, all 4 digits must be entered. 0775 will be displayed as 077.5, 3001 will be displayed as 300.1, etc.
4. ENTER key — Depress.
5. Desired distance — Insert (nm and tenths, 1999.9 NM maximum).
6. ENTER key — Depress.
7. POS coordinates — Verify for reasonability.
8. ENTER key — Depress.

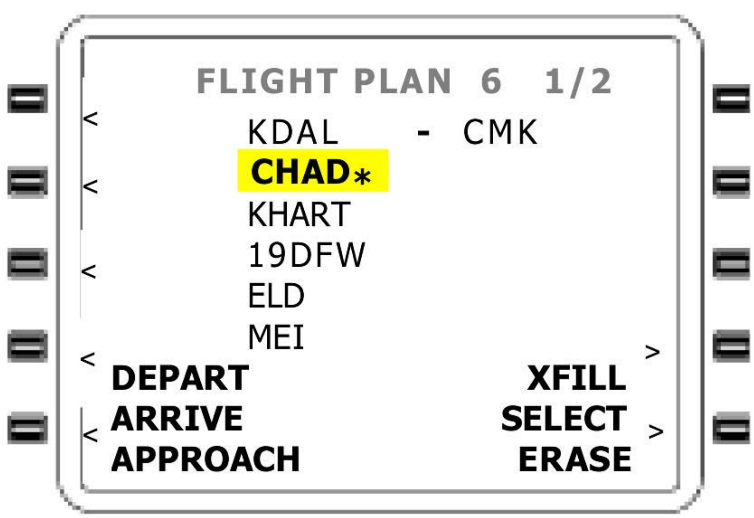


Figure 26-16. Offset Entry From Parent Waypoint

26.5.4.6.6 En Route

26.5.4.6.6.1 Direct To — Active Flight Plan Waypoint

D→ function enables the pilot to fly direct to any lateral waypoint on the Active Flight plan without reinserting the waypoint identifier (Figure 26-17).

Note

If a Direct To the MAP on the active flight plan is initiated, the selected Approach procedure will be canceled as indicated by the waypoints of the approach no longer being indented and a MSG.

1. D→ key — Depress. A DIRECT TO page will appear with the cursor over the current TO waypoint.

2. Line Select key — Depress to position the cursor over the desired identifier.

Note

Active Flight Plans exceeding 18 waypoints will be contained on subsequent pages. Press D→, NXT, or PRV key to access remaining waypoints.

3. ENTER key — Depress. Display automatically advances to NAVIGATION page 1.

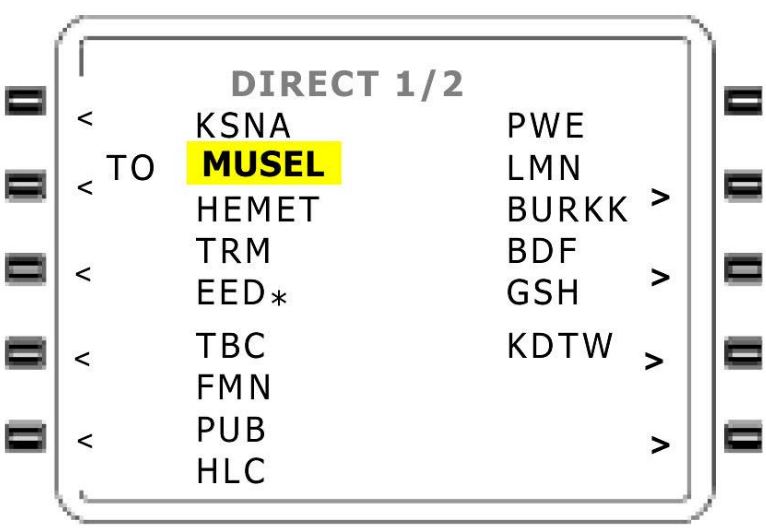


Figure 26-17. DIRECT TO Page

Note

- The system must compute a turn from a wings-level position. If the aircraft is in a turn when the D▶ key is pressed, the aircraft will roll to wings-level position momentarily. The aircraft will then continue the turn toward the Direct To waypoint.
- If an offset waypoint was selected, an OFFSET WPT page is displayed. Verify data and Depress ENTER. The DIRECT page is displayed with the cursor over the Offset Waypoint. Press ENTER again to proceed direct to the WPT. Display automatically advances to NAVIGATION page 1.

4. DIS, DTK — Check.

26.5.4.6.6.2 Direct To — Random Waypoint

This procedure enables the pilot to add a random waypoint to the Active Flight Plan in the desired sequence and proceed direct to it.

1. D▶ key — Depress. A DIRECT TO page appears with the cursor over the current TO waypoint.
2. Line Select key — Depress to position the cursor over the identifier to follow the new entry.
3. Type in the waypoint identifier.
4. ENTER key — Depress.
5. Waypoint page Coordinates — Verify or insert. To insert Waypoint Coordinates (cursor over POS field):
   a. Latitude — Insert (N or S first, then degrees, minutes, and hundredths [six characters]).
   b. ENTER key — Depress.
   c. Longitude — Insert (E or W first, then degrees, minutes, and hundredths [seven characters]).
6. ENTER key — Depress.
7. Waypoint sequence — Verify that the waypoint is in the proper location.
8. ENTER key — Depress. Display automatically advances to NAVIGATION page 1.

Note

If a Direct To a pilot-entered waypoint is desired, a latitude and longitude entry may be required.

a. Latitude — Insert N or S first, then degrees, minutes, and hundredths (six characters).

b. Longitude — Insert E or W first, then degrees, minutes, and hundredths (seven characters).

If Direct To an offset waypoint is desired, the radial and distance entry from the parent waypoint may be required.

Note

If ENTER key is not depressed prior to leaving DIRECT page, the waypoint identifier will not appear on the Active Flight Plan and the aircraft will not proceed to Direct To this waypoint and will need to be re-entered.

9. DIS, DTK — CHECK.

Note

- A Direct To function may also be accomplished from NAVIGATION page 1, 2, and 3 by placing the cursor over the TO waypoint and typing in the desired waypoint if required. Depress the ENTER key and the system will proceed Direct To the selected waypoint.
- If the selected waypoint was not on the active FPL, a fence will be added to the FPL and no AUTO LEG CHG will occur beyond this waypoint.
- Anytime the Direct To function is used to go Direct To the MAP, the Approach procedure will be canceled. The SYSTEM message page will display APPROACH CANCELED and the CDI sensitivity will return to Terminal scale of 1 nm full scale deflection.

26.5.4.6.6.3 Direct To Closest Airport

This procedure allows the pilot to select a desired airport and proceed DIRECT TO it.

1. D▸ key — Depress until DIR CLOSEST ARP page appears (Figure 26-18).

   When initially accessed, the cursor will be over the airport closest to the aircraft present position at that time.

2. Line Select key — Depress to position the cursor over the desired airport identifier and press ENTER. NAVIGATION page 1 will be displayed and the airplane will proceed D▸ to the selected airport.

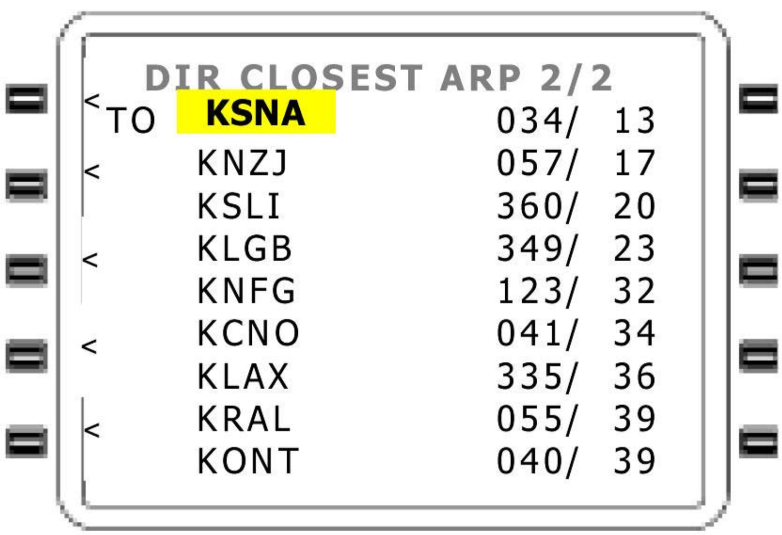


Figure 26-18. DIR CLOSEST ARP Page

Note

The bearing and distance values to the closest airports are based on the aircraft present position at the time this page is accessed. The values are not updated while the page is being displayed. To obtain updated information, it is necessary to exit the page then return.

26.5.4.6.6.4 Pseudo-VORT AC (Selected Course)

1. NAV key — Depress to display NAVIGATION page 1.

Note

The system must be proceeding Direct To a waypoint or DTK will not be an enterable field. If system is proceeding Direct To the desired waypoint, proceed to step 5. If system is not currently proceeding direct to a waypoint, continue with step 2.

2. Line Select key — Depress to position the cursor over the TO field.

3. TO Waypoint Identifier — Insert (if necessary).

4. ENTER key — Depress.

   If Waypoint Page appears:

   a. Waypoint Page coordinates — Verify or insert.

   b. ENTER key — Depress.

5. Desired Track (DTK) — Insert (Figure 26-19).

6. ENTER key — Depress. If the DTK entry positions the aircraft on the FROM, or far, side of the TO waypoint, the Leg Change Mode switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determiner if -MAN- or -AUTO- is appropriate.

Note

- The system will turn the aircraft to intercept the DTK at up to a 45° angle if coupled to the autopilot.

- The D▸ function may also be used to initiate a Pseudo-VORTAC. Following the Direct To entry using the D▸ key, the display automatically advances to NAVIGATION page 1. Manually position the cursor over DTK field and continue as described in steps 5 and 6. To exit Pseudo-VORTAC mode, make any leg change (e.g., D▸ key press and enter current TO waypoint). When exiting Pseudo-VORTAC, the system may return to the -AUTO- Leg Change mode unless the system was in -MAN- prior to initiating Pseudo-VORTAC.

A manual leg change means the system will not automatically sequence to the next waypoint on the active flight plan. To sequence to the next waypoint in the flight plan, use Direct To function or place the cursor over -MAN-. Press the BACK key and AUTO? will be displayed. Press the ENTER key and the system will return to the Automatic Leg Change mode.

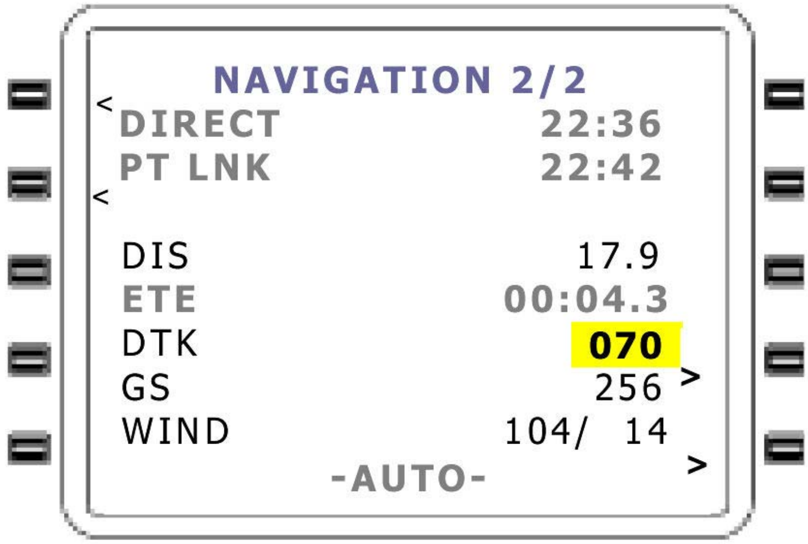


Figure 26-19. Insert DTK in Waypoint Page

26.5.4.6.6.5 Programming a Heading Vector

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.
2. Heading — Insert desired heading in whole degrees, preceded by R or L, if applicable, to indicate a turn direction.

Note

HDG SELECT and the programmed heading are displayed on NAVIGATION page 1, indicating the aircraft is in Heading Select mode.

26.5.4.6.6.6 Changing Heading Vector While in Heading Select Mode

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.
2. Heading — Insert desired heading.
3. ENTER key — Depress.

Note

Cursor moves to the Heading Mode field, but it is not necessary to depress the ENTER key because the system is already in Heading Select mode.

4. NAV or ENTER key — Depress to check heading and return to NAVIGATION page 1.

26.5.4.6.6.7 Changing to Waypoint While in Heading Select Mode

This procedure establishes a leg between the new TO waypoint and the waypoint preceding it on the Active Flight plan or a Pseudo-VORTAC. If crosstrack distance exceeds 125 nm, the HEADING mode will be canceled and the STRG INVALID message will be displayed.

1. HDG key — Depress to display HEADING VECTOR page.

2. Line Select key — Depress to position the cursor over the TO waypoint.

3. BACK key — Depress to cycle through waypoints on the Active Flight Plan or insert alternate waypoint.

4. ENTER key — Depress.

If Waypoint page appears:

a. Waypoint Page coordinates — Verify or insert.

b. ENTER key — Depress. Cursor moves to DTK field.

5. Desired Track (DTK) — Verify or insert.

6. ENTER key — Depress. OK? ENTER message appears. Refer to Figure 26-20.

7. ENTER key — Depress to select TO waypoint and return to NAVIGATION Page 1. The cursor may be positioned over the Leg Change Mode field.

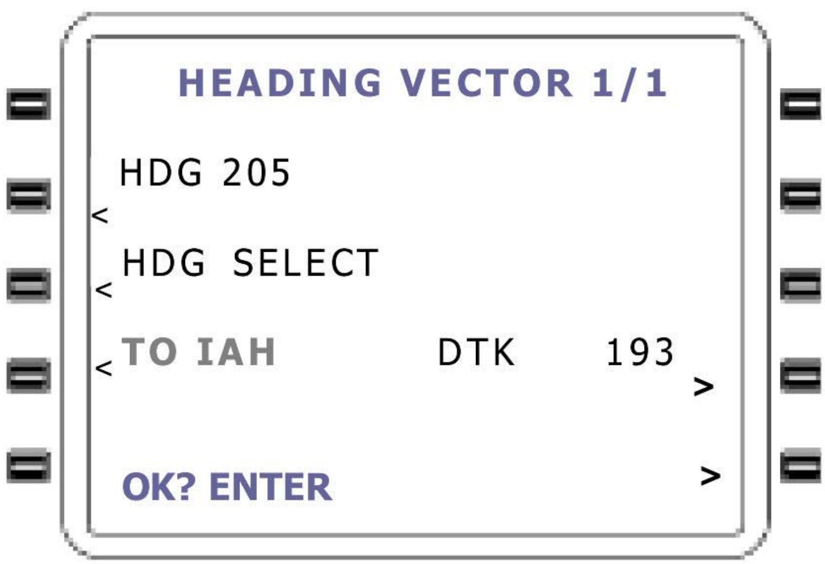


Figure 26-20. Heading Vector Page at TO Waypoint Selection

Note

If the Desired Track is changed, a Pseudo-VORTAC is programmed. If the DTK entry positions the aircraft on the FROM, or far side of the TO waypoint, the Leg Change Mode displayed on NAVIGATION page 1 switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determine if -MAN- or -AUTO- is appropriate.

26.5.4.6.6.8 Canceling Heading Select Mode

Initiate a DIRECT TO procedure, using the D▸ and ENTER keys, which immediately cancels the commanded heading, or perform the following:

1. HDG key — Depress to display HEADING VECTOR page.

2. Line Select key — Depress to position the cursor over HDG SELECT.

3. BACK key — Depress until CANCEL? is displayed.

4. ENTER key — Depress to cancel Heading Vector and return to NAVIGATION page 1.

Note

The system may turn the aircraft to intercept the current TO/FROM leg at up to a 45° angle.

26.5.4.6.6.9 Programming an Intercept

1. HDG key — Depress to display HEADING VECTOR page with cursor over the HDG field.

2. Heading — Insert desired heading in whole degrees, preceded by R or L, if applicable, to indicate a turn direction.

Note

R or L should be used for a heading change greater than 180° from the present heading. A ‘T’ indicates the system is operating in the true heading mode.

3. ENTER key — Depress. The cursor advances to Heading Mode field.

4. BACK key — Depress to select INTERCEPT? prompt.

5. ENTER key — Depress. Cursor moves to the TO Waypoint field.

6. BACK key — Depress, if required, to cycle through waypoints on Active Flight Plan or insert an alternate waypoint.

7. ENTER key — Depress.

If Waypoint Page Appears:

a. Waypoint Page Coordinates — Verify or insert.

b. ENTER key — Depress. Cursor moves to DTK field.

8. Desired Track (DTK) — Verify or insert.

Note

- If the Desired Track is changed, a Pseudo-VORTAC is programmed. If the DTK entry positions the aircraft on the FROM, or far side of the TO waypoint, the Leg Change Mode on NAV Page 1 switches to -MAN-, otherwise it remains in -AUTO-. The pilot must determine if -MAN- or -AUTO- is appropriate.
- If a DME Arc endpoint is selected as the TO waypoint, a default DTK will be displayed based on the point at which the ARC will be intercepted and DTK is not selectable.

9. ENTER key — Depress. An Intercept Message may appear (NO COURSE INTERCEPT, or INTERCEPT BEYOND FIX) (Figure 26-21). If no message appears, the intercept will occur on the TO side of the selected TO waypoint.

The intercept messages are based on the current aircraft heading and track. Once the selected heading has been established, the HEADING VECTOR page may be viewed to determine the intercept status. If NO COURSE INTERCEPT or NO ARC INTERCEPT occurs, the message light will illuminate and these messages will be displayed on the SYSTEM MESSAGES page. To view one of these messages on the HDG page, use the Line Select key to remove the cursor from the page.

Note

BUSY — STANDBY may be displayed in yellow momentarily while the intercept is calculated.

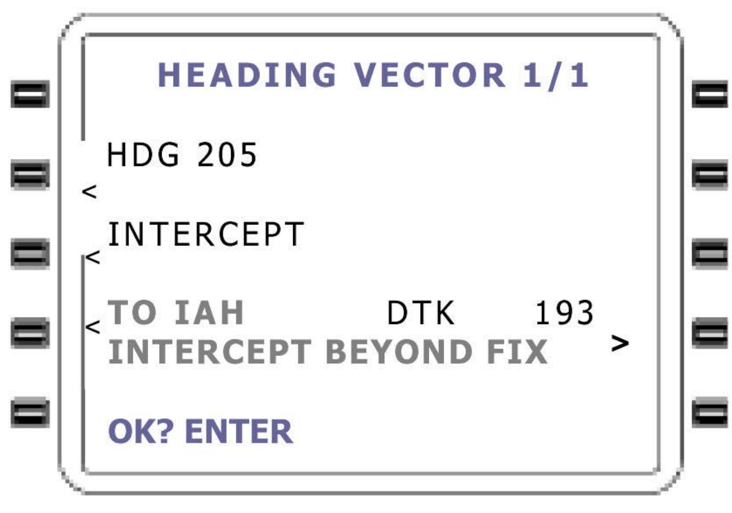


Figure 26-21. Heading Vector Page with Intercept Message

10. ENTER key — Depress to accept data and return to NAV page 1. The cursor is positioned over the Leg Change Mode if the DTK has been entered manually on the Heading page.

26.5.4.6.6.10 Programming a Heading Intercept to the Final Approach Course

This procedure nonprecision approach may be accomplished using the following steps:

1. HDG key — Depress to display HEADING VECTOR page.
2. Type in the assigned heading (e.g., 'HDG 205' in Figures 26-20 and 26-21).
3. ENTER key — Depress. The cursor moves to heading mode field.
4. BACK key — Depress to select INTERCEPT? prompt.
5. ENTER key — Depress. The cursor moves to the TO field.
6. BACK key — Depress until the FAF waypoint is displayed.
7. ENTER key — Depress.
8. Enter the inbound final approach course in the DTK field if required.
9. ENTER key — Depress twice to return to Navigation page 1.

NAVIGATION page 1 will be displayed with the TO waypoint, the FAF, and waypoint previous to the FAF in the FR field if no manual DTK was entered. The system will now intercept the Final Approach course and sequence to the MAP.

Note

If an intercept is programmed to a FAF that is part of a Procedure Turn, the DTK must be annually entered. This will cause Pseudo-VORTAC to be displayed on NAV page 1.

26.5.4.6.6.11 Parallel Course Offsets

This procedure is used to establish an offset course (steering reference) parallel to the current leg. This field is inactive when in APPROACH ARMED mode (within 30 nm of the destination airport).

1. NAV key — Depress to display NAVIGATION 2/4/ page with Selected Crosstrack field (SXTK).
2. Line Select key — Depress to position cursor over SXTK field.
3. L or R key — Depress.
4. Offset Distance — Insert (nm and tenths). The maximum value that can be entered is 99.9 nm.
5. ENTER key — Depress. XTK deviation remains referenced to the original track; however, the HSI will display a centered needle when the SXTK has been captured. BRG, DIS, ETE remain referenced to the current TO waypoint.

Note

- If the system is coupled to the autopilot, the roll command will turn the aircraft to intercept the parallel course at the selected SXTK distance.
- If XTK is greater than 12.5 nm, VNAV will become INVALID and no vertical deviation information will be displayed.

Canceling Parallel Course:

1. NAV key — Depress to display page with SXTK.
2. Line Select key — Depress to position cursor over SXTK field.
3. BACK key — Depress. The cursor field will display CANCEL? to inform the pilot of the pending change. Refer to Figure 26-22.
4. ENTER key — Depress. The steering reference will be to the original desired track.

Note

Any Leg Change (manual or automatic) including DIRECT TO will also cancel selected crosstrack (SXTK).

26.5.4.6.6.12 Holding Pattern

WARNING

When entering Procedure Turns (PTs) or a Holding Pattern (HP) airspace, the FMS may not constrain the airplane from violating maneuvering airspace. Pilots are responsible for procedural compliance.

26.5.4.6.6.12.1 Programming a Holding Pattern

This procedure enables the pilot to program a Holding Pattern (HP) at a specific waypoint.

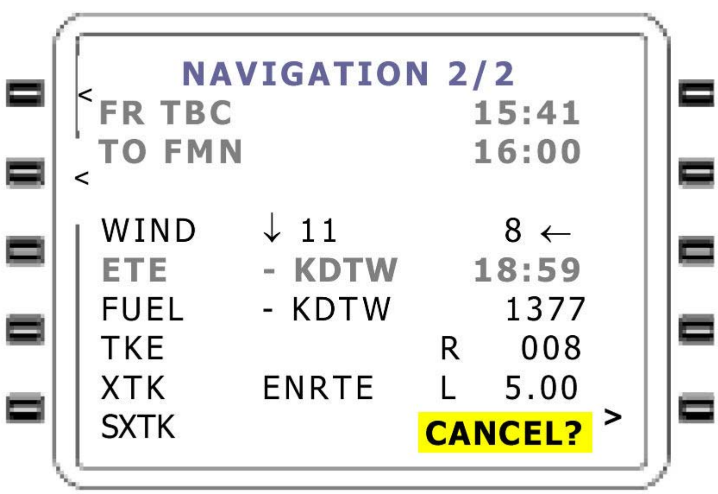


Figure 26-22. Canceling Parallel Course on Navigation 2/4 Page with SXTK

An HP is automatically programmed from the database when it is part of an Arrival or Approach procedure.

Note

No HP can be programmed at an ARC end point on the final approach course manually.

1. NAV, FPL, D▸ key — Depress to display applicable page.

2. Line Select key — Depress to position the cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected, and on the Active Flight Plan page, a Holding Pattern cannot be programmed at the FR or TO Waypoint.

If WPT is a duplicate WPT, the country code will be displayed in this field in parentheses (in green).

3. HOLD key — Depress to display HOLDING PATTERN page with cursor over the INBOUND CRS field (Figure 26-23).

4. INBOUND CRS — Verify or insert.

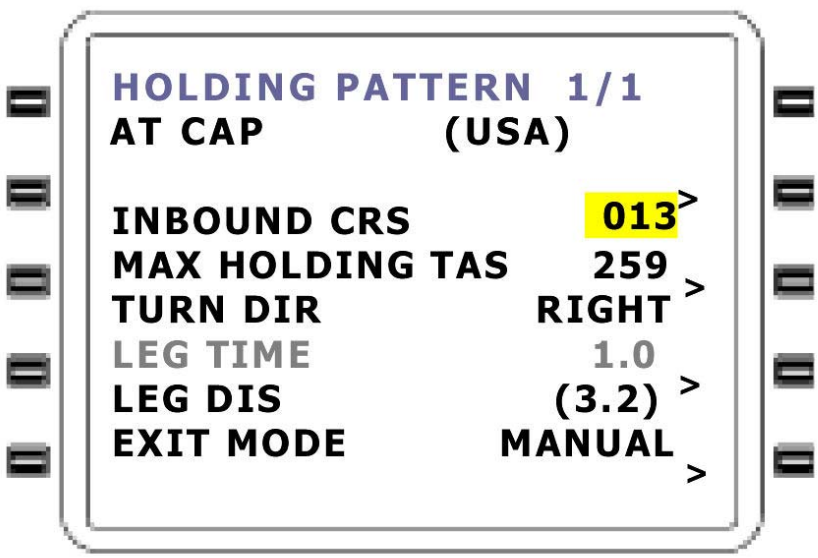


Figure 26-23. HP Page with Cursor Over Inbound CRS Field

Note

A verified Inbound Course programs a DIRECT ENTRY procedure. The system defaults to the inbound course between the previous WPT on the FPL and the waypoint at which the hold is desired. If a Direct TO Leg is displayed on the NAV pages, the inbound course defaults to the leg between the aircraft present position and the current TO waypoint. When an inserted inbound Course value is beyond the DIRECT ENTRY parameters, then a TEARDROP or PARALLEL pattern is programmed.

When a Holding Procedure is initiated, the inbound course is displayed on NAVIGATION page 1. If the CDI needle does not automatically slew to the inbound course, manually set the CDI needle to the inbound course so that the needle sensing is correct.

A “T” adjacent to the value displayed in the INBOUND CRS field indicates the course is referenced to true north.

5. ENTER key — Depress. The type of entry is displayed. Cursor moves to the LEG TIME field (‘01.01’ in Figure 26-23).

6. LEG TIME — Verify or insert (valid range 1.0 to 9.9 min).

7. If Holding Pattern is complete, proceed to step 11. If Optional Entries are required, continue with steps 8, 9, or 10.

Optional Entry: Turn Direction.

8. Line Select key — Depress to position the cursor over TURN DIR.

   a. BACK key — Depress to change direction.

   b. ENTER key — Depress.

Optional Entry: Leg Distance.

9. Line Select key — Depress to position the cursor over LEG DIST.

   a. Leg Distance — Insert or verify (valid range 1.0 nm to 50 nm).

   b. ENTER key — Depress.

Note

When the leg distance is entered, the leg time will be automatically computed. This action is indicated by parentheses around the entry for LEG TIME. Conversely, when leg time is entered, leg distance will be computed as indicated by parentheses around LEG DIST.

Selecting Exit Mode:

10. Line Select key — Depress to position the cursor over MANUAL or AUTO. Press the BACK key to change exit mode option. Selecting MANUAL will initiate a continuous hold. Selecting AUTO will exit the hold the next time the HP fix is crossed or after the entry procedure is completed.

11. ENTER key — Depress. OK? ENTER prompt will appear right below EXIT MODE. Verify inputs.

12. ENTER key — Depress to load the Holding Pattern at the selected waypoint and return to the NAVIGATION, DIRECT TO, or FPL page.

26.5.4.6.6.12.2 Reviewing, Editing, or Canceling a Holding Pattern

This procedure enables the pilot to review, edit, or cancel a Holding Pattern at a specific waypoint.

Reviewing:

1. NAV, FPL, D▸ key — Depress to display applicable page.
2. Line Select key — Depress to position the cursor over desired HP waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected, and on the Active Flight Plan page, the TO Waypoint can only be reviewed.

3. Hold key — Depress to display HOLDING PATTERN page.
4. Holding Pattern — REVIEW.

Editing:

5. Line Select key — Depress to position the cursor over desired field.
   a. Insert value for INBOUND CRS, LEG TIME, or LEG DIST or
   b. BACK key — Depress to change TURN DIR or EXIT MODE.
6. ENTER key — Depress. The OK? ENTER prompt will appear.

Note

A re-entry to the Holding Pattern must be flown if the Inbound Course or Turn Direction are changed while holding at the HP Waypoint. No XFILL capability is available to the other system in a dual system installation from one or both systems when a holding pattern is in progress.

7. ENTER key — Depress to return to the NAVIGATION, DIRECT TO, or FPL page.

Canceling:

1. Line Select key — Depress to position the cursor over the CANCEL? prompt (just below the EXIT MODE field).
2. ENTER key — Depress. The HP annunciation is erased from NAVIGATION, DIRECT TO, or FPL pages.

Note

If canceling holding pattern at the current TO Waypoint, HP or AT is replaced by "TO."

26.5.4.6.6.12.3 Exiting a Holding Pattern

This procedure gives the pilot three options to exit a Holding Pattern: exiting the next time over a holding fix, going Direct To the holding fix, or performing a Leg Change.

Option #1 - Exiting Holding Pattern Next Time Over Holding Fix.

1. NAV key — Depress to display NAVIGATION page 1, 2, or 3.
2. Line Select key — Depress to position the cursor over MANUAL (Figure 26-24).
3. BACK key — Depress to display AUTO?. (Refer to Figure 26-24.)
4. ENTER key — Depress. The NAVIGATION page indicates that the aircraft will EXIT HOLD the next time over the holding fix (aircraft will complete the loop around the holding pattern).

Note

The next (NX) waypoint information may also appear if the exit is made during Waypoint Alert.

Option #2 - Exiting Holding Pattern By Going Direct To Holding Fix.

1. D▸ key — Depress to display Direct To page with the cursor over current HP Waypoint (Figure 26-25).
2. ENTER key — Depress to display HOLDING PATTERN page with cursor over CANCEL?. (CANCEL? prompt is just below the EXIT MODE field.)
3. ENTER key — Depress to go Direct To current TO Waypoint (Holding Fix) and cancel Holding Pattern.

Option #3 - Exiting Holding Pattern By Performing a Leg Change.

1. NAV key — Depress to display NAVIGATION page 1.

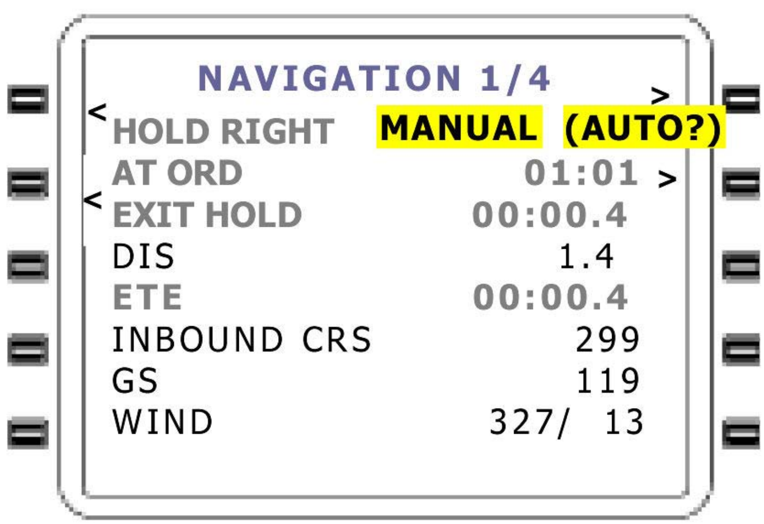


Figure 26-24. Navigation Page Indicating Exit Hold Next Time Over Holding Fix

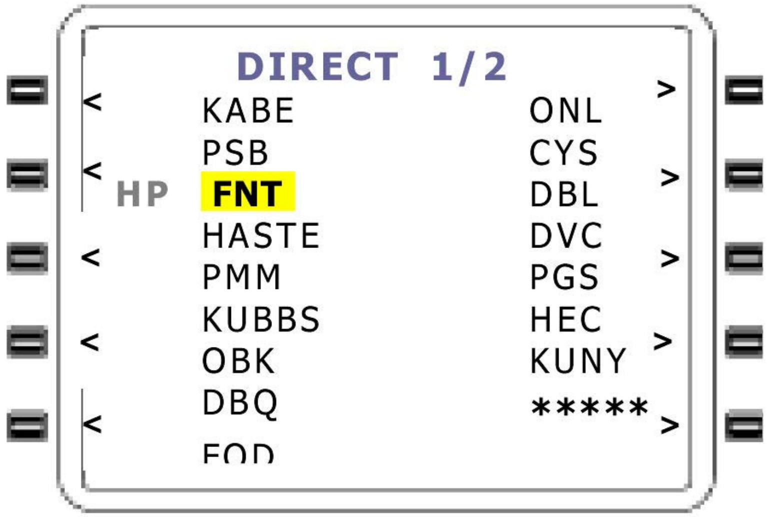


Figure 26-25. Direct To Page With Cursor Over Current HP Waypoint

2. Line Select key — Depress to position the cursor over FROM field (HOLD RIGHT/LEFT).
3. FR Waypoint — Insert desired waypoint.
4. ENTER key — Depress. The next waypoint in the Active Flight Plan sequence will appear in the TO field. Figure 26-26.
5. TO Waypoint — Verify. To change the TO Waypoint, insert the desired identifier.
6. ENTER key — Depress to activate the new leg and cancel the Holding Pattern.

26.5.4.7 Executing Approaches

WARNING

When entering PTs or HP airspace at high speed, the FMS may not constrain the airplane from violating maneuvering airspace. Pilots are responsible for procedural compliance.

When the aircraft is within 30 nm of the airport, the system will go into the Approach Armed mode. The CDI sensitivity will change from 5.0 nm full scale deflection to 1.0 nm full scale deflection. At this point the aircraft may bank slightly due to increased roll steering gains. Anytime the TO waypoint is part of an Approach Procedure, the SXTK field is disabled so that no parallel course can be entered.

The system is capable of executing GPS, GPS Overlay, NDB, RNAV, CIRCLING, and VOR approaches only. No LOC, ILS, or MLS capability is available.

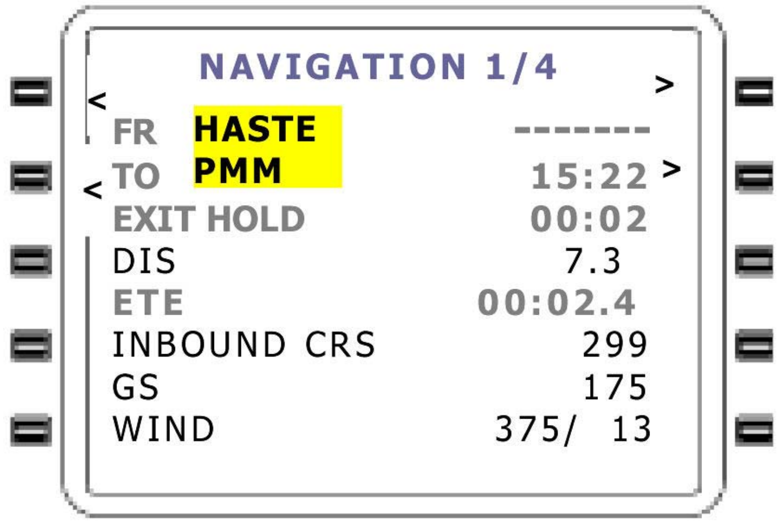


Figure 26-26. Navigation Page With TO Waypoint After FR Waypoint Inserted

If RAIM is not available at 2 nm from the FAF, an APPROACH WARN message will appear on the SYSTEM MESSAGES page. Also, the HSI flag will be set invalid. At this point, the appropriate missed approach procedures should be executed. The system will remain in the Approach Mode and the discrete APPROACH annunciator will remain illuminated until the HSI is set valid. To set the HSI valid, cancel the Approach on the SYSTEM MESSAGES page by pressing the ENTER key.

The system will not display any interim waypoints between the FAF and the MAP, even though a waypoint may be shown on the approach plate. The system may not give vertical guidance to the interim waypoint. Pilots are responsible for procedural compliance.

Note

If the MAP is abeam or beyond the threshold, or the approach is a circling approach, no altitude constraints will be displayed at the MAP from the database. Constraints may be entered manually.

When the Approach is flown, the system will provide guidance along the final approach course to the Missed Approach Point. When initially executing a missed approach procedure, use the FMS Heading Mode or manually fly the procedure to ensure proper track and turn direction.

Note

A “fence” (++++++) separates the Missed Approach Procedure waypoint from the MAP, the last waypoint of the Approach. No Auto Leg change (waypoint sequencing) will occur to waypoints beyond the “fence” (++++++) once the airplane passes the MAP.

At the MAP, the pilot must manually or via the HDG Mode maneuver the aircraft to the Missed Approach Procedure waypoint. If, after the missed approach, an approach at a different airport is desired, erase the current approach procedure before selecting a procedure at the new airport. This will ensure proper waypoint sequencing on the Active Flight Plan.

26.5.4.7.1 Loading a GPS/GPS Overlay Approach

1. FPL key — Depress until the ACTIVE FPL page appears.
2. Line Select key — Depress to position the cursor over APPROACH?
3. ENTER key — Depress. APPROACH page is now displayed. Refer to Figure 26-27.
4. Airport Identifier — Insert or verify.
5. ENTER key — Depress twice, if required, to display runway list if not already displayed.

If a circling type approach is desired:

Line Select key — Depress to position cursor over TYPE.

ENTER key — Depress to display the TYPE list. Proceed to step 10.

6. Line Select key — Depress to position cursor over desired runway.
7. ENTER key — Depress.
8. TYPE — SELECT if required.

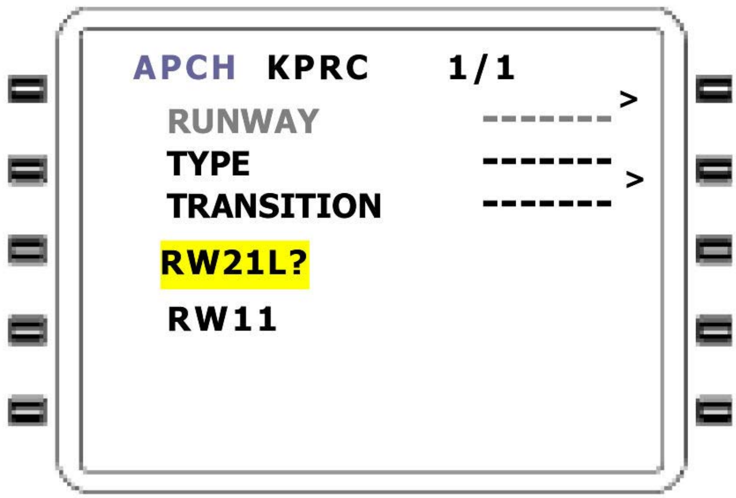


Figure 26-27. Approach Page

9. ENTER key — Depress.
10. TRANSITION — SELECT if required.
11. ENTER key — Depress.
12. Approach Waypoints — REVIEW.
13. ENTER key — Depress ACTIVE FPL page is displayed. Verify the approach appears as selected.
14. Waypoint Sequencing — Edit, if required, based on assigned route.

26.5.4.7.2 Executing a GPS/GPS Overlay Approach

Note

To fly a full procedure DME ARC or procedure Turn, either coupled or using own navigation, follow the FMS and EFIS/Instrument displays.

Using RADAR Vectors to Final Approach Course:

1. FPL key — Depress to display the ACTIVE FPL page.
2. Approach and Waypoint Sequencing — Verify they appear as selected.
3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.
4. FMS Mode — Select or verify the appropriate mode for guidance if required.
5. Flight Director or Autopilot — ENGAGE the appropriate mode if required.
6. HDG key — Depress to display the HEADING VECTOR page.
7. Heading — Insert as assigned by ATC.
8. ENTER key — Depress twice to engage Heading Select mode.

After receiving the final intercept vector from ATC:

9. HDG key — Depress to display the HEADING VECTOR page.
10. ENTER key — Depress.
11. BACK key — Depress to display INTERCEPT?
12. ENTER key — Depress. Cursor moves to the TO field.
13. BACK key — If required, depress until the FAF waypoint is displayed.
14. ENTER key — Depress. Cursor moves to the DTK field.
15. Final Approach Course — Insert if a Procedure Turn type approach or verify if any other type approach.
16. ENTER key — Depress twice.

17. CDI Display — Verify the HSI course needle slews to the final approach course or manually select the course.
18. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

Using Own Navigation — No DME ARC:

1. FPL key — Depress to display the ACTIVE FPL page.
2. Approach and Waypoint Sequencing — Verify they appear as selected.
3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.
4. FMS Mode — Select or verify the appropriate mode for guidance.
5. Flight Director or Autopilot — ENGAGE the appropriate mode.
6. Waypoints and HSI Course — Verify proper sequencing during the approach.
7. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

26.5.4.7.3 Procedure Turn

The following is a brief description of the screen displays typically seen while executing a Procedure Turn.

As the aircraft approaches the PT waypoint, a message is displayed on the fourth line of the CDU indicating the next action the aircraft will take. This message is displayed 30 seconds prior to the event and disappears when the action is initiated. Figure 26-28 indicates the aircraft is flying DIRECT to DRK where a Procedure Turn (PT) will take place. Line four indicates the aircraft will turn to a heading of 305° upon reaching DRK. While flying the Procedure Turn, the TO DRK will change to TO INTCPT. When the Procedure Turn is completed, and the aircraft is inbound, the TO INTCPT field changes to TO (the FAF).

Note

- When flying the approach on a transition that specifies NoPT and a “PT” waypoint is depicted on the flight plan, it will be necessary to do a DIRECT TO the next waypoint beyond the “PT” waypoint to avoid flying the Procedure Turn.
- When a Procedure Turn is initiated, the outbound course is displayed on the NAVIGATION 1 page. If the course arrow does not automatically slew to the outbound course, it must be manually set to the outbound course so that the CDI sensing is correct.

Figure 26-29 indicates a right turn to 350° is upcoming.

See the diagram and accompanying Navigation pages of Figure 26-30 as the aircraft sequences through the turn.

Note

- If aircraft is configured for dual systems, no XFILL? prompt will be displayed during a PT even if dissimilar data exists in each system.
- Estimated Time En Route (ETE) that is displayed after crossing the IAF on the procedure turn is the time from the aircraft present position to where the airplane intercepts the final approach course inbound (INTCPT). After crossing this intercept point, the ETE shown will be from the airplane’s present position to the FAF.

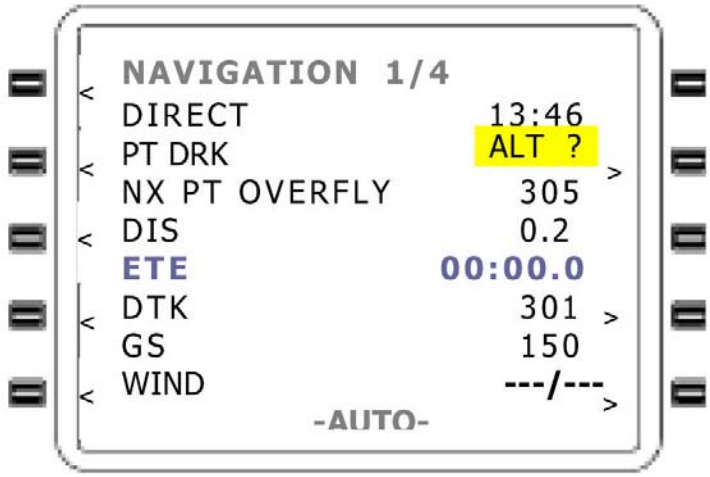


Figure 26-28. DIRECT to DRK Where PT Will Take Place

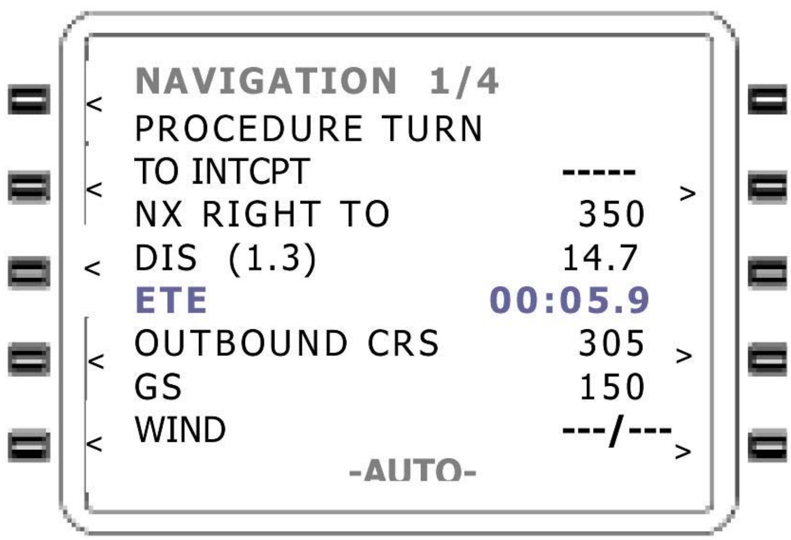


Figure 26-29. Right Turn to 350° is Upcoming

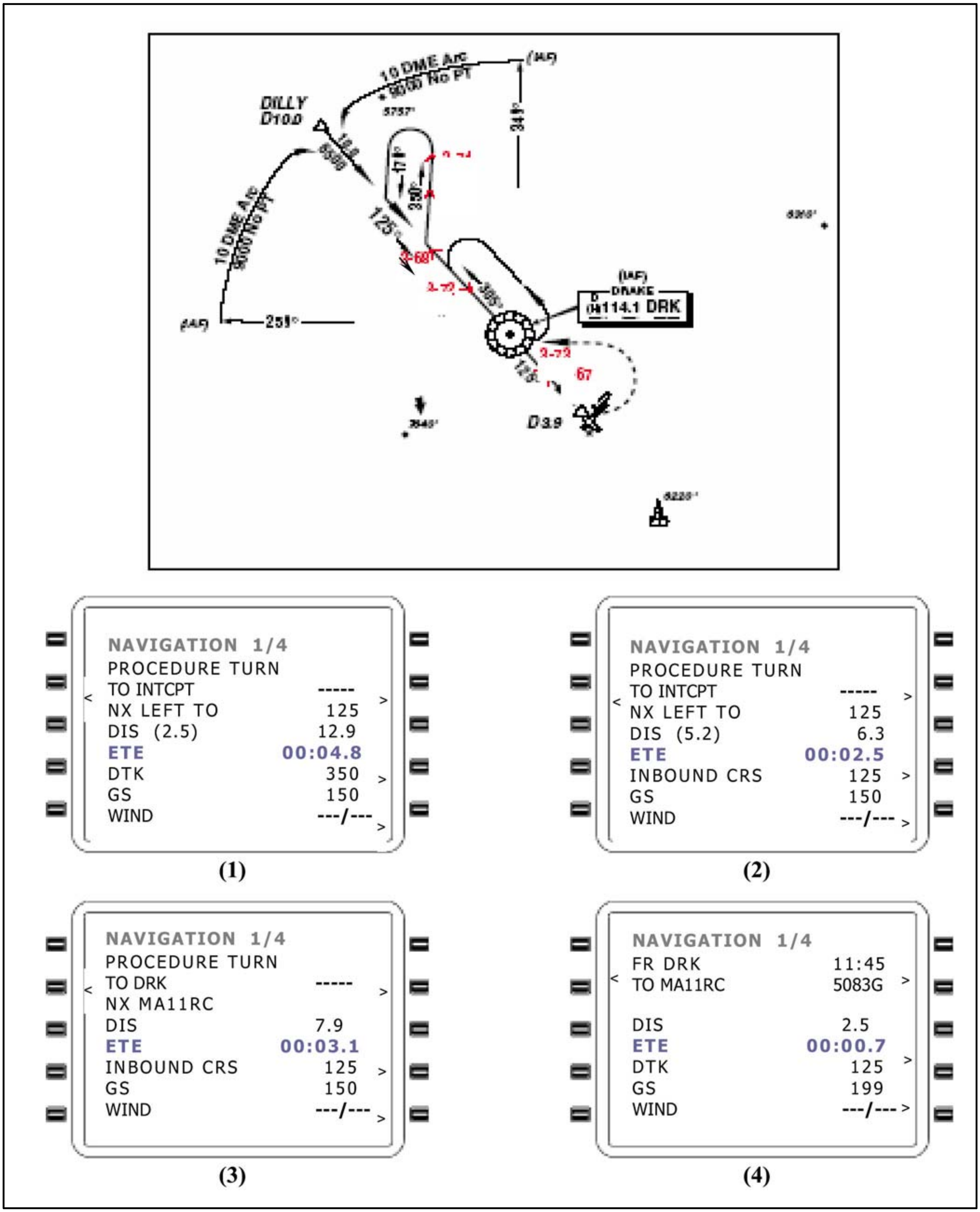


Figure 26-30. Aircraft Sequences Through a Procedure Turn

DIS that is displayed after crossing the IAF on the procedure turn is the distance from the aircraft present position to where the airplane intercepts the final approach course inbound (INTCPT). The DIS shown in parentheses is the straight-line distance from the aircraft present position to the procedure turn fix.

Note

The bearing and distance are with respect to the procedure turn fix.

After crossing this intercept point, the DIS shown will be from the airplane present position to the FAF and the DIS in parentheses will be removed. TO the FAF will be displayed at this time having changed from TO INTCPT on NAV page 1.

26.5.4.7.4 Using RADAR Vectors to Intercept a DME ARC

1. FPL key — Depress to display the ACTIVE FPL page.
2. Approach and Waypoint Sequencing — Verify they appear as selected.
3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.
4. FMS Mode — Select or verify the appropriate mode for guidance.
5. Flight Director or Autopilot — ENGAGE the appropriate mode.
6. HDG key — Depress to display the HEADING VECTOR page.
7. Heading — Insert as assigned by ATC.
8. ENTER key — Depress twice to engage HDG SELECT mode.

After receiving ARC intercept vector from ATC:

9. HDG key — Depress to display the HEADING VECTOR page.
10. Heading — Insert.
11. ENTER key — Depress.
12. BACK key — Depress to display INTERCEPT?
13. ENTER key — Depress. Cursor moves to the TO field.
14. BACK key — Depress until the ARC End/Final Approach Course Waypoint is displayed.

Note

If an intermediate waypoint exists on the ARC between the ARC beginning point and the ARC endpoint, the ARC intercept point should be approximated so it can be determined whether the ARC end or intermediate waypoint should be used as the TO waypoint. NO ARC INTERCEPT may be displayed if the wrong waypoint is selected.

15. ENTER key — Depress twice (accepts the default DTK).

16. CDI Display — Verify course needle is set to the DTK shown on the HEADING VECTOR page.

17. Waypoints and HSI Course — Verify proper sequencing during the approach.

18. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

26.5.4.7.5 Using Own Navigation to Fly DME ARC

1. FPL key — Depress to display the ACTIVE FPL page.

2. Approach and Waypoint Sequencing — Verify they appear as selected.

3. MSG key — Verify approach is armed within 30 nm of the airport and the HSI scaling output has changed to TRMNL on NAVIGATION page 2.

4. FMS Mode — Select or verify the appropriate mode for guidance.

5. Flight Director or Autopilot — ENGAGE the appropriate mode.

6. Waypoints and HSI Course — Verify proper sequencing during the approach.

7. Approach Annunciator — When over the FAF, verify annunciation and the HSI scaling output has changed to APPR on NAVIGATION page 2.

The following is a brief description of the screen displays typically seen flying a DME Arc.

Note

- Certain EFIS map displays do not support curved lines to draw DME Arcs. In this case the map will only display waypoints up to and including the IAF waypoint at the beginning of the arc. No waypoints will be displayed while on the arc. Once the aircraft has passed the arc end waypoint, the map will display the remaining waypoints of the active flight plan. Although no waypoints will be displayed during the DME Arc Procedure, the FMS page displays will be as depicted in Figures 26-31, 26-32, and 26-33.

- If aircraft is configured for dual systems, no XFILL? prompt will be displayed during a DME ARC procedure even if dissimilar data exists in each system.

As the aircraft approaches the AR waypoint, a message is displayed on the fourth line of the CDU indicating the next action the aircraft will take (NX DME ARC). This message is displayed 30 seconds prior to the event and disappears when the action is initiated. Figure 26-31 indicates the aircraft is flying DIRECT to D259J where the aircraft will begin flying a DME Arc (AR). Figure 26-32 shows the aircraft is within 30 seconds of intercepting the DME Arc at D259J.

Note

The naming convention for ARC waypoints is as follows: D indicates DME, 259 indicates the radial from the ARC center NAVAID, and J indicates the ARC distance (i.e., A=1 nm, J=10 nm).

Figure 26-33 shows the last three FMS page displays while flying a DME Arc. The first page display shows the aircraft is flying the DME Arc to DILLY. (ARC 10.01) in the DIS field indicates the arc center is 10.0 NM from the aircraft present position.

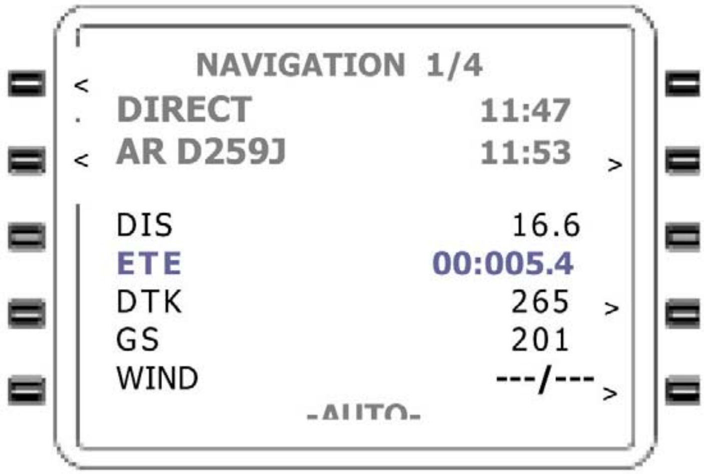


Figure 26-31. DIRECT To D259J Where Aircraft Will Begin Flying DME Arc (AR)

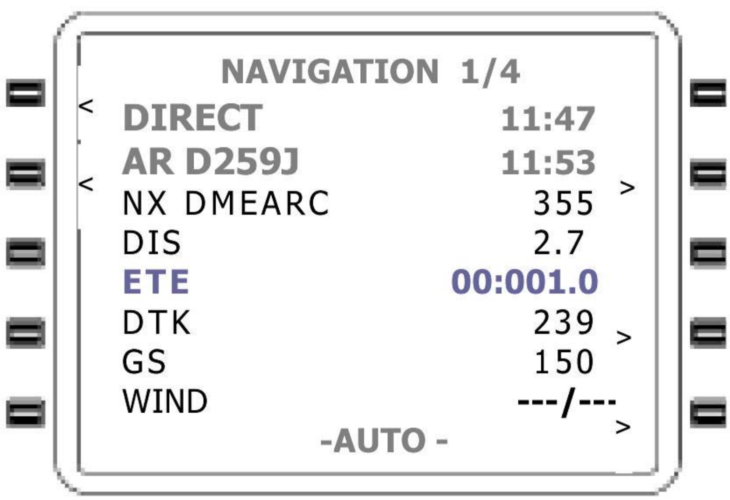


Figure 26-32. Aircraft Within 30 Seconds of Intercepting DME Arc at D259J

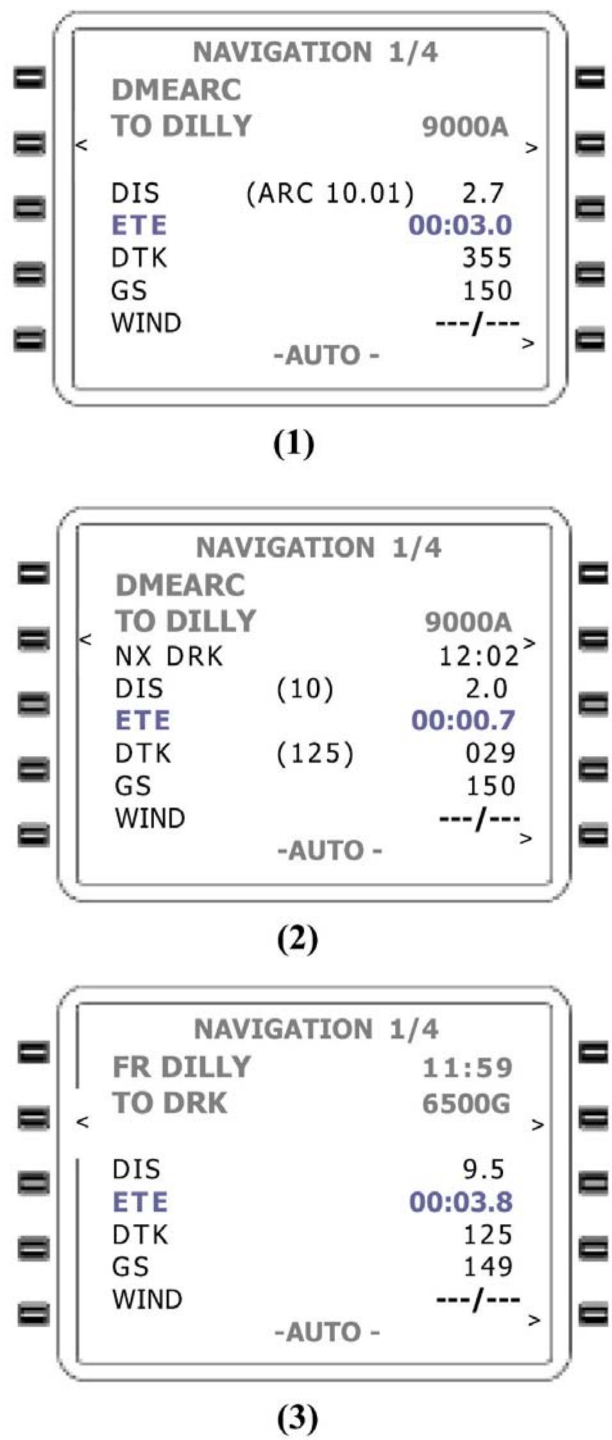


Figure 26-33. Final Three Screen Displays During Aircraft Flying DME Arc

Note

- Distance (DIS) displayed is the straight line distance from the present aircraft position to the TO waypoint.
- Estimated Time En Route (ETE) is the time around the arc path to the TO waypoint. Use one of the following options to sequence to the missed approach waypoint.

Option 1, Direct To the Missed Approach Procedure Waypoint.

1. D▸ key — Depress. The DIRECT page will be displayed.
2. Line Select key — Depress to position the cursor over the Missed Approach Procedure waypoint, if required.
3. ENTER key — Depress to sequence to the Missed Approach Procedure waypoint.

Note

If the direction the airplane will turn is in question and the turn direction may not be in accordance with the missed approach procedure, manually turn the airplane toward the missed approach fix, then perform the D▸ to procedure.

Option 2, Heading To Intercept A Course To Missed Approach Procedure Waypoint.

1. HDG key — Depress. The HEADING VECTOR page appears with the cursor over the HEADING field. Type in the appropriate heading using a preceding R or L to establish the turn direction (e.g., L150).
2. ENTER key — Depress. The cursor moves to the Heading Mode field and HDG SELECT? is in the cursor.

Note

Prior to step 3, the ENTER key may be pressed with the cursor over HDG select field so that the airplane can begin the intercept process. Repeat the procedure from step 1 to complete the HDG intercept procedure.

3. BACK key — Depress until INTERCEPT? is displayed.
4. ENTER key — Depress. The cursor moves to the TO field.
5. BACK key — Depress until the Missed Approach Procedure waypoint is displayed.
6. ENTER key — Depress. The cursor moves to the DTK field. Type in the desired track to be intercepted to the Missed Approach Procedure waypoint.
7. ENTER key — Depress twice. The NAVIGATION page will be displayed with the HDG and DTK displayed in yellow. The autopilot may now be re-engaged if required to fly to the Missed Approach Procedure waypoint.

It is recommended that the ETA field on NAVIGATION page 1 be changed to ALT during approach procedures for a display of the altitude constraints at the current TO waypoint. To change the field from ETA to ALT, perform the following:

1. Line Select key — Depress to position the cursor over the ETA field.

2. BACK key — Depress. ALT? will be displayed in the cursor (Figure 26-34).

3. ENTER key — Depress to change the field to altitude.

Note

If no altitude constraint is programmed at the current TO waypoint, the ALT field will display dashes.

26.5.4.8 Determining RAIM

RAIM availability can be determined by viewing GPS Subsection page 2 of 3. The GNS-XLS Flight Management System has an internal GPS receiver that is the main navigation sensor of the system. The GPS Subsection pages can be accessed through the NAVIGATION 4/4 page by pressing the Line Select key corresponding to the GPS sensor, then pressing ENTER. Pressing the NEXT key will display the second GPS SUBSECTION Page in which various information can be observed including RAIM availability.

RAIM availability at the last flight plan waypoint can be observed on PLAN 2/8 page. Upon pressing the PLAN key, the PLAN 1/8 page will be displayed. Pressing the PLAN key again will display the PLAN 2/8 page. RAIM at the last flight plan waypoint will display AVAIL (available) or NOT AVAIL (not available) at the ETA. If a manual ground speed or ETA has been entered, STANDBY will be displayed momentarily while the system calculates RAIM availability. If GPS is not functioning, NO NAV will be displayed.

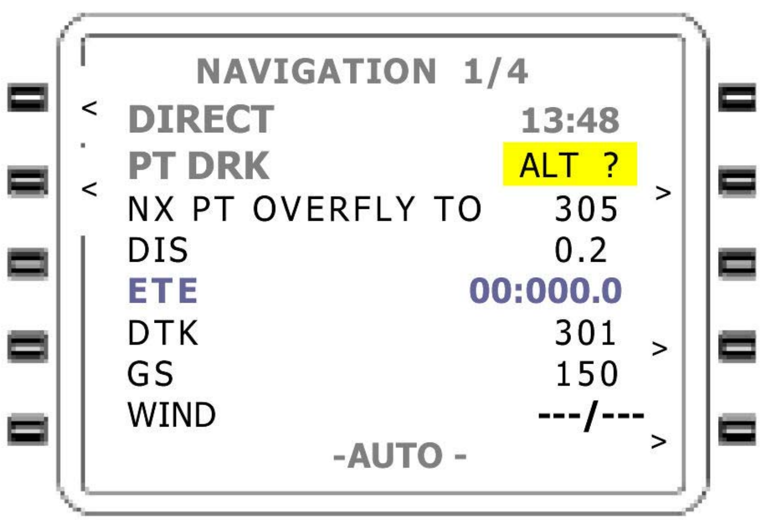


Figure 26-34. Changing ETA to ALT During Approach Procedures

26.5.4.9 Using the SPZ4000 Autopilot

1. With the integration of an FMS, automated, coupled flight in the aircraft is possible from shortly after takeoff until shortly before touchdown provided appropriate switch selections have been made by the pilot. The switching is critical. The following paragraphs describe the switching required for normal operation (whether the FMS is the navigation source or not).

2. The Autopilot Select switch (labeled AP FD 1 and AP FD 2) is used to activate one of the two Autopilot/Flight Director pairs. A single 3/4 inch-square pushbutton/segment light (located adjacent the NAV Select switch on the top right side of the pilot instrument panel) displays a lighted green/black annunciation segment indicating which Autopilot/Flight Director pair has been selected. To switch between AP/FD 1 and AP/FD 2, the pilot should push the Autopilot Select switch and verify the appropriate green/black annunciator is lighted (then select appropriate modes on the corresponding Flight Director Control Panel). The NAV Select switch is also a single 3/4 inch-square pushbutton/segment light (located adjacent the Autopilot Select switch on the top right side of the pilot instrument panel). The NAV Select switch (labeled VOR 1 TCN and VOR 2) is used in conjunction with the pilot and copilot HSI Navigation Source Select switches to couple either NAV 1 TAC (combination VOR/LOC #1 and TACAN) or NAV 2 (VOR/LOC #2) to the active Autopilot/Flight Director. To switch between NAV 1 TAC and NAV 2 as the navigation source that corresponds to the NAV button on the active HSI Navigation Source Selection switches, the pilot should push the corresponding NAV Select switch and verify the appropriate green/black annunciator is lighted.

3. The pilot HSI Navigation Source Select switches (labeled NAV, NAV REPEAT and FMS) are used to select the navigation source for the Autopilot/Flight Director. Three 3/4 inch-square pushbutton/segment lights, stacked vertically on the left side of the instrument panel, display a lighted green/black annunciation segment when selected. When any navigation source is selected (NAV 1 {VOR or TACAN}, NAV REPEAT {NAV 2}, or FMS), and the NAV mode of the Flight Director is engaged, the autopilot receives navigation guidance from the associated navigation source and is coupled to it. These switches correspond to the choice selected on the NAV Select switch. For example, if NAV 1 TAC has been selected on the NAV Select switch, NAV 1 TAC (VOR/LOC #1 and TACAN) guidance can be coupled to the active Autopilot/Flight Director by: selecting NAV on the HSI Navigation Source Select switches, selecting the appropriate Flight Director modes, and engaging the Autopilot.

4. When selected, the appropriate mode(s) of the Flight Director will be illuminated. When no modes are active, the SBY segment of the Flight Director will be illuminated in amber (or green depending on part number).

5. The HSI yellow Course Pointer is used for VOR/LOC, TACAN and FMS cueing depending on which Navigation source has been selected.

6. Pressing the pilot HSI NAV button will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable the selected NAV Select switch navigation source guidance to be fed to the Autopilot. Relative bearing to/from a VOR or TACAN is displayed via the single/double needles in either RMI when NAV (vice ADF) is selected for the appropriate needle. DME is displayed in both the HSI and TACAN/DME indicator located on the copilot panel. To navigate on a particular radial to/from a VOR/TACAN station or to track a particular front or back-course Localizer course, the pilot should select the appropriate course using the yellow Course Pointer and re-engage the Flight Director by selecting NAV and ALT (if altitude hold is desired).

7. Pressing the pilot NAV REPEAT selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable the navigation guidance selected by the copilot HSI Navigation Source Selector switch to be fed to the autopilot (provided NAV has been selected on the copilot side). To navigate on a particular radial to/from a VOR station or to track a particular front or backcourse Localizer course, the pilot should select the appropriate course using the yellow Course Pointer and re-engage the Flight Director by selecting NAV and ALT (if altitude hold is desired).

8. Pressing the pilot FMS selector switch will decouple the active navigation source from the autopilot, disengage the selected Flight Director mode (illuminating the SBY button), and enable FMS guidance to be fed to the autopilot. For coupled FMS navigation, the pilot should reengage the Flight Director by selecting NAV and ALT (if altitude hold is desired). The FMS will automatically feed roll steering commands to the autopilot (via the Flight Director) and is capable of navigating from waypoint to waypoint, direct to a waypoint, in a Pseudo-VORTAC mode (similar to radial tracking with a VOR or TACAN) or in FMS Heading Mode.

Note

- When the FMS is coupled to the active Flight Director and Autopilot, the yellow HSI Course Pointer will automatically sequence and slew to the desired course. The corresponding Flight Director Control Panel's Course Selection knob will be disabled (while the FMS is the selected navigation source).

- The NAV mode is the only appropriate mode for FMS navigation. When the GNS-XLS is coupled to the Flight Director and Autopilot, the NAV button will be illuminated amber (or green depending on the part number) with either an ARM or CAP annunciation on the Flight Director Control Panel depending on the state of navigation capture.

9. When the FMS is coupled to the Flight Director and Autopilot and a temporary heading change is desired (either directed by ATC or to deviate around weather), the pilot can simply select the Flight Director HDG button and steer the aircraft with the Orange Heading Bug. When HDG is selected, the Flight Director Control Panel will no longer illuminate the ARM or CAP segment and a heading change can be made without decoupling the Autopilot. When FMS navigation is once again desired, the pilot should freshen up the Direct To solution and select NAV.

Note

After a heading change, when the FMS is recoupled to the Flight Director and Autopilot, the GNS-XLS will attempt to return the aircraft to the original course line unless a fresh Direct To solution is entered.

10. The copilot HSI Navigation Source Select switches (labeled NAV, NAV REPEAT and FMS) are used to select the navigation input to the copilot HSI. Three 3/4 inch-square pushbutton/segment lights, stacked vertically on the left side of the instrument panel, display a lighted green/black annunciation segment when selected. When selected and a green/black annunciator is present, the copilot HSI and Flight Director receive navigation cueing from the selected navigation source.

11. The copilot HSI NAV, NAV REPEAT and FMS Navigation Source Select switches function identically to the pilot except they are married to Autopilot/Flight Director 2 — they do not engage the Flight Director or couple to the Autopilot unless AP/FD 2 is active. To switch between AP/FD 1 and AP/FD 2, the pilot should push the Autopilot Select switch, verify the appropriate green/black annunciator is lighted, and select appropriate modes on the corresponding Flight Director Control Panel.

12. The copilot NAV REPEAT navigation Source Select switch allows the copilot to simultaneously display cueing from NAV 1 TAC (VOR/LOC #1) when desired.

13. In the GNS-XLS a “fence” (indicated by six plus signs “++++++”) separates the Missed Approach Procedure Holding Fix from the Missed Approach Point. Automatic leg sequencing will cease at the Missed Approach Point. When the Go Around mode is activated, the Flight Director will display a climb command and Autopilot will be decoupled. The GO AROUND button on the Flight Director Control Panel will be illuminated green. Missed Approach procedures should be executed as published and initially flown manually or coupled using the Flight Director Heading Mode, until waypoint to waypoint FMS navigation can be established and verified, to ensure that all portions of the missed approach procedure are flown correctly. After executing the Missed Approach procedure, and en route to the Missed Approach holding fix, the fix can be automatically selected as the next waypoint by pressing the Direct To key, highlighting and pressing ENTER.

14. When a flight plan has been selected and activated, it will be display on the MFD. The active leg is shown as cyan (blue). Other legs are shown in white. On a GPS approach, when the GNS-XLS determines that the current aircraft position is within 2 nm of the Final Approach Fix (and RAIM is available), then all approach segment legs turn green. Search Pattern waypoints, once calculated, will be displayed on the MFD as flight plan legs. The MFD symbol generator is only capable of displaying a maximum of 15 waypoints at one time, which may limit the display of an entire Search Pattern. If an HSI presentation has been selected for the MFD, the course pointer will automatically point to the active waypoint (as a bearing pointer) irrespective of the pilot or copilot HSI Course selection. Whenever Vertical Deviation cueing has been calculated, a green VNAV pointer will appear on the right side of the MFD.

15. The following data is available from the GNS-XLS when FMS navigation is active and may be displayed on either the pilot or copilot HSI as appropriate:

    a. HSI Desired Track — Automatically displayed (FMS only).

    b. HSI Distance to waypoint — (All Modes).

    c. HSI Course/Cross Track deviation — (All Modes).

    d. HSI To/From flag — (All Modes).

    e. HSI Navigation Invalid Flag — (All Modes).

    f. HSI Course/Cross Track deviation — (All Modes).

    g. HSI Vertical Deviation — (NAV & NAV Repeat Modes only, FMS when VNAV valid).

    h. HSI Vertical Deviation Invalid Flag — (NAV & NAV Repeat Modes only).

16. Additional GNS-XLS details:

Note

- If the airplane is in a turn at the time the DIRECT TO function is initiated, the airplane may roll wings level momentarily then continue the turn to the TO waypoint.

- When the FMS sequences from en route to Terminal, the airplane may bank slightly if the cross-track error is greater than .05 nm because of the increased roll steering gains used in the terminal area.

17. Refer to the Flight Manual for complete description and operation of the Flight Director/Autopilot system.

26.5.5 Vertical Navigation (VNAV) Operation

26.5.5.1 (VNAV) Operation — Pre-Departure

26.5.5.1.1 Setting Cruise Altitude, Transition Level, and Default Flight Path Angle

This procedure allows the pilot to define a Cruise Altitude and change the default values for Transition Level and Flight Path Angle.

After Initial Leg Selection:

1. VNAV key — Depress to display VNAV page 1.
2. Line Select key — Depress to position cursor over DATA?. Refer to Figure 26-35.
3. ENTER key — Depress to display VNAV DATA page with cursor over the CRUISE ALT field.
4. Cruise Altitude — Insert. Refer to Figure 26-36.

Only two or three digits are required to input an altitude, (e.g., enter 80 and 8000 is displayed, enter 120 and 12000 is displayed).

Any altitude value entered greater than the TRANS LEVEL altitude value, which normally defaults to FL180, is converted and displayed as flight level (FL). Entering 210 will display FL210.

An altitude less than 1000 feet must be entered with a preceding zero (i.e., enter 052 and 52 is displayed).

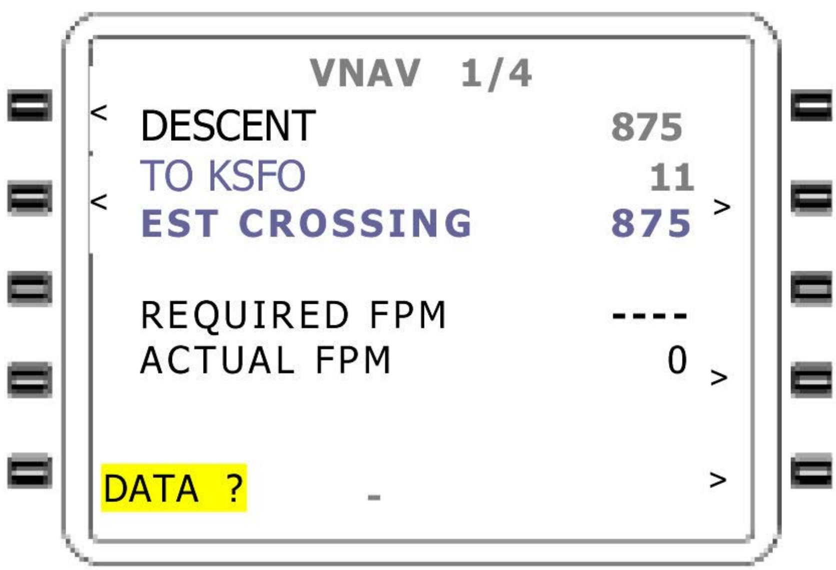


Figure 26-35. VNAV Page 1

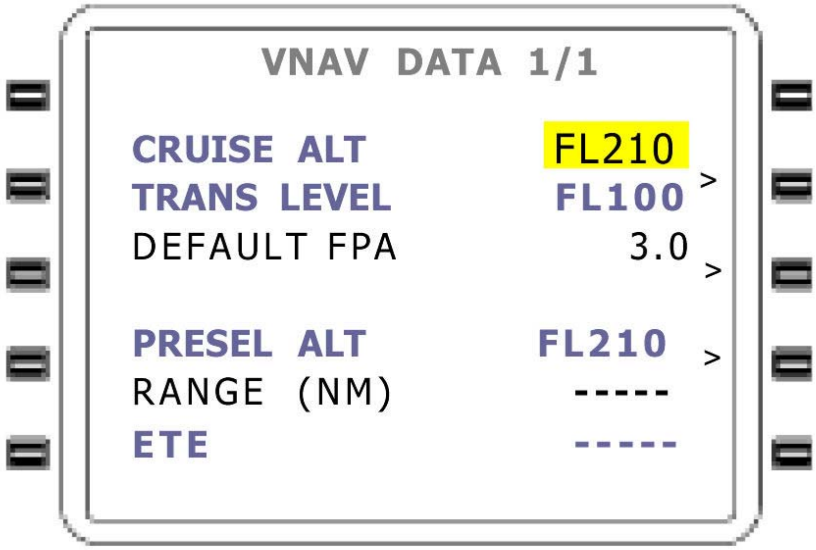


Figure 26-36. VNAV Data Page With Cursor Over CRUISE ALT

Note

- CRUISE ALT may also be inserted on VNAV page 1, line 3 (adjacent to the TO waypoint field) when #TOC or #TOD is the TO waypoint. The cruise ALT may automatically be entered by the preselector if the preselector has the capability and the system is configured for digital preselector.
- A (at or above) or B (at or below) constraint entries are not applicable on this page. Setting a cruise altitude will establish a #TOD (Top of Descent) waypoint or a #TOC (Top of Climb) waypoint if VNAV is valid. A #TOC will be established only if there are no altitude constraints between the aircraft and #TOC and the aircraft is climbing.

5. ENTER key — Depress.
6. Transition Level — Insert or verify.

Note

Field defaults to FL180 if pilot does not enter a value. Anytime a TRANS ALT is entered, the value will remain in nonvolatile memory even after the system is shut down.

7. ENTER key — Depress.
8. Default Flight Path Angle (DEFAULT FPA) — Insert or verify (in degrees and tenths, 0.1 to 6.0 range).

Note

- Field defaults to 3.0 if pilot does not enter a value. Anytime an FPA is entered, the value will remain in nonvolatile memory even after the system is shut down.

- If configured, altitude preselector information will be displayed at the bottom of the screen. If the aircraft is in a climb or descent, distance and ETA information to the preselected altitude will be displayed. Refer to Figure 26-35.

9. ENTER key — Depress to return to VNAV page 1.

26.5.5.1.2 Creating/Changing VNAV Waypoints

Vertical navigation constraints can only be programmed for waypoints on the Active Flight Plan, and though all Active Flight Plan waypoints are displayed on VNAV pages, new waypoints must be added to the Active Flight Plan before they appear on the VNAV Flight Plan waypoint pages.

After initial leg selection on NAV page 1:

1. NAV, FPL, or D→ key — Depress to display applicable page.

2. Line Select key — Depress to position cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected. If the waypoint is selected from either the NAV or Direct pages, Direct FPA information pages will be displayed on the last line of the screen.

3. VNAV key — Depress to display VNAV WAYPOINT page for selected waypoint.

4. ALT — Insert altitude constraint followed by A (at or above) or B (at or below), if applicable. Only two or three digits are required to input an altitude (e.g., enter 30A and 3000A is displayed). Refer to Figure 26-37. Full digit entry may be used to enter an altitude. Altitudes less 1,000 feet enter a preceding zero (e.g., enter 054 and 54 feet is displayed).

   Any altitude entered greater than the transition level is converted and displayed as Flight Level (FL).

5. ENTER key - Depress. Cursor moves to OFFSET field (Figure 26-37).

6. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).

   a. If the offset is prior to the waypoint, enter the range value and a (-) pre-fills as a default or

   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.

   c. To erase the offset value, insert 0 and press ENTER key. The field changes to dashes, indicating no offset is programmed.

7. ENTER key — Depress. The cursor moves to the FPA field only if the entered constraint is below the aircraft present altitude.

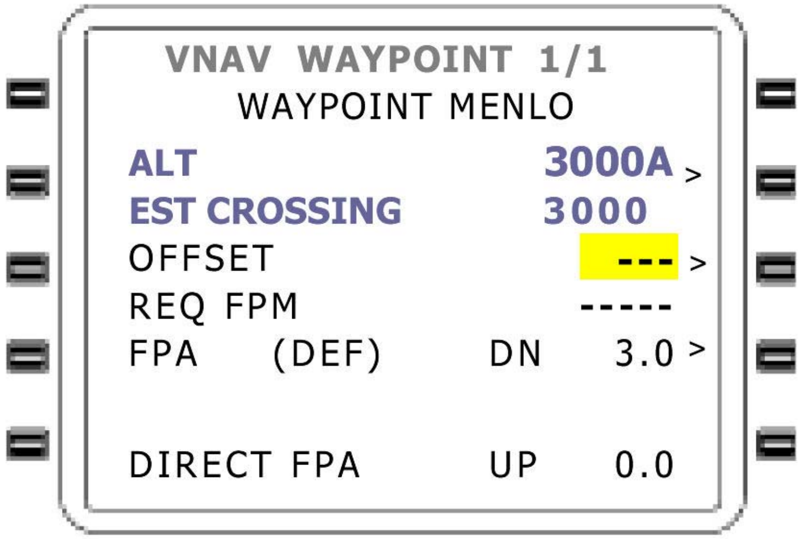


Figure 26-37. VNAV Waypoint Page

Note

A climb FPA cannot be programmed but the direct FPA field will display the up angle between the aircraft present altitude and the altitude constraint that was entered. If an FPA is programmed to a direct FPA up waypoint, it will be a DN (descent) FPA and an ambiguity will be displayed on the VNAV waypoint page.

8. Flight Path Angle (FPA) — Insert or verify (valid range is 0.1 to 6.0) (Entry ‘3.0’ in Figure 26-37).

Note

The FPA value field pre-fills with the default (DEF) value programmed on the VNAV DATA page if this waypoint was accessed from the FPL page. If accessed from the NAV or D▸ page, the FPA field pre-fills with the (DIR) value. If an FPA is manually entered, the FPA type field changes to (MAN).

With the cursor over the FPA value, depressing the BACK key will cycle through all or some of the following:

a. (DEF).

b. (DB).

c. (AUTO).

d. (DIR).

e. (MAN).

To cancel the FPA, insert 0 and press ENTER key. The field changes to dashes, indicating no FPA is programmed, the vertical deviation output is invalid, and no vertical deviation information will be displayed on the CDU or the ADI/HSI.

9. ENTER key — Depress to load or verify the FPA value.

Note

When a descent FPA is programmed at a waypoint, a G appears next to the altitude constraint indicating a Glide Path and vertical deviation guidance and information will be available.

26.5.5.1.3 Reviewing VNAV Waypoints

When SIDs, STARs, or Approaches have altitude constraints at waypoints on the procedure, the system automatically loads the altitude constraints from the database on to the Active Flight Plan. No altitude will be loaded at the MAP if the approach is a circling approach or if the MAP is abeam or beyond the runway threshold. The system will not load any “expect to cross” altitudes from the database on to the SIDS or STARS, as part of ACTIVE FLIGHT PLAN or VNAV pages. No altitudes are loaded from the database when an approach procedure contains a Procedure Turn.

Note

The system will not fly a full SID or STAR procedure.

Using Active Flight Plan Page:

1. FPL key — Depress to display the ACTIVE FLIGHT PLAN page.
2. Line Select key — Depress to position the cursor over the desired waypoint.
3. VNAV key — Depress. The VNAV WAYPOINT page appears with the cursor over the ALT field.
4. ALT — REVIEW.

Note

If (AUTO) FPA is displayed, the system has automatically programmed a waypoint-to-waypoint FPA for the procedure.

5. ENTER key — Depress until display returns to ACTIVE FLIGHT PLAN page or depress the FPL key.
6. Repeat steps 2 through 5 to review VNAV waypoint data at remaining waypoints.

Using VNAV Flight Plan Waypoints Page:

1. VNAV key — Depress to display the VNAV FLIGHT PLAN WAYPOINTS pages.
2. Line Select key — Depress to position the cursor over the desired waypoint.
3. ENTER key — Depress. The VNAV WAYPOINT page appears with the cursor over the ALT field.
4. ALT — REVIEW or insert new value.

Note

If the FPA was retrieved from the database, (DB) appears in the FPA type field.

5. ENTER key — Depress to return to the VNAV FLIGHT PLAN WAYPOINTS page.
6. Repeat steps 2 through 5 to review or change altitude constraints at remaining waypoints.

26.5.5.2 (VNAV) Operation — En Route

26.5.5.2.1 Programming Vertical Path Descents

The pilot can use various methods to load a Flight Path Angle (FPA) and determine the aircraft descent path.

Note

When the system detects a rapid change of barometric altitude setting, noncontinuous data from an air data computer, vertical speed change of more than 40 ft/s, or sequencing to the next waypoint on the active flight plan, the vertical deviation output is momentarily set Invalid. When vertical deviation returns to a valid state, the appropriate value of vertical deviation will again be displayed.

Using Database (DB) FPA:

The GNS-XLS database contains Flight Path Angles associated with waypoints on SIDs, STARs, and Approaches that pre-fill when these procedures are programmed into the Active Flight Plan. The FPA field on the VNAV WAYPOINT page displays (DB), which indicates an FPA from the database is loaded and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint. If the FPA at the (DB) VNAV waypoint is changed in any way, the (DB) FPA will no longer be available.

Using Default (DEF) FPA:

The default FPA value will automatically be displayed if an altitude is programmed on the VNAV WAYPOINT page, except if the FPA comes from the database or the VNAV WAYPOINT page was accessed using a Direct To function.

The pilot can load the Default FPA (set on the VNAV DATA page) by pressing the ENTER key when the cursor is on the FPA field of the VNAV WAYPOINT page. The FPA field displays (DEF) and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint.

Using Manual (MAN) FPA:

The pilot can type in a desired Flight Path Angle on the VNAV WAYPOINT page within the valid range, 0.1 to 6.0 degrees. When the ENTER key is depressed, the FPA is loaded, the FPA field indicates (MAN), and Vertical Deviation is provided at the programmed angle when the waypoint becomes the Vertical TO Waypoint.

Using Automatic (AUTO) FPA:

The (AUTO) mode is provided to link together descent waypoints that have Cross-At type constraints and to provide a computed Flight Path Angle between them. Refer to Figure 26-38.

The (AUTO) mode may be selected only if the chosen waypoint has a Cross-AT type constraint programmed. All Cross-AT waypoints that are a part of a STAR or APPROACH are automatically put into (AUTO) mode when the procedure is retrieved from the database and loaded onto the Active Flight Plan.

If the waypoint prior to the selected (AUTO) FPA waypoint has a Cross-AT-or-ABOVE, Cross- AT-or-BELOW , or Cross-BETWEEN constraint programmed, an automatic angle is assigned and will be the same angle as the programmed Default Angle on VNAV DATA page. Vertical Deviation is provided at the programmed angle when the waypoint becomes the Descent Reference Waypoint.

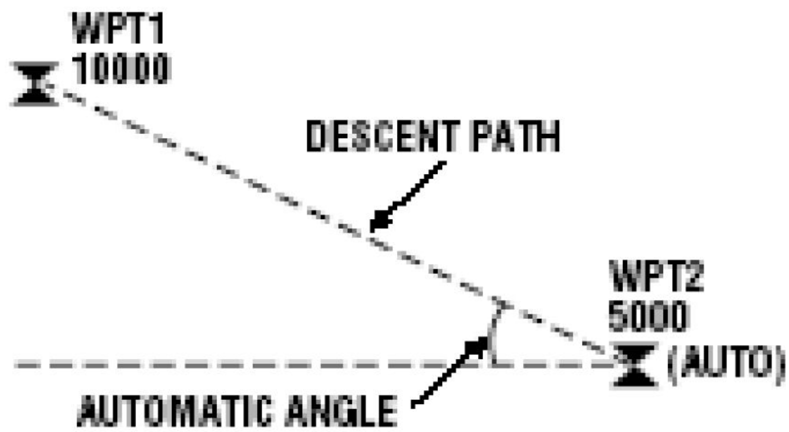


Figure 26-38. Linked Descent Waypoints with Computed Flight Path Angle

Note

- If no ALT constraints are programmed before the selected (AUTO) FPA waypoint, the (AUTO) FPA is the same as the (DEF) FPA.

- Unless an FPA is programmed at a waypoint, the system uses the (DEF) FPA to the first waypoint on the flight plan with an altitude constraint to establish a #TOD point. To help establish #TOD, the system will automatically load the destination airport elevation on the flight plan, provided the flight plan was not obtained from AFIS. An altitude constraint and FPA must be loaded using the ENTER key to establish a Path Descent and activate Vertical Deviation to any waypoint except a (DB) WPT.

26.5.5.2.2 Editing Altitude Constraints

The following pages allow the pilot to edit altitude constraints for waypoints on the VNAV WAYPOINT page, VNAV pages, referred to as VNAV FPL pages. One of the three following options may be used:

Option 1: Using the VNAV page.

Option 2. Using the VNAV FPL WAYPOINT pages.

Option 3: Using the VNAV WAYPOINT page.

Option 1: Using VNAV page:

1. VNAV key — Depress to display VNAV 1/2 page. The altitude constraint may be changed on this page if the current TO waypoint has a constraint programmed. Type the new altitude in the altitude field adjacent to the TO WPT. All parameters associated with the former constraint will remain unchanged (i.e., FPA, A, B, G, or OFFSET).

2. ENTER key — Depress.

Option 2: Using VNAV FPL WAYPOINT page:

1. VNAV key — Depress to display the VNAV 2/2 page.

Note

More VNAV pages will be available if the active flight plan has several pages of waypoints.

2. Line Select key — Depress to position the cursor over the desired waypoint altitude.

3. Altitude Constraint — Insert new altitude constraint followed by A (at or above) or B (at or below), if applicable. Any altitude value entered greater than the Transition Level value on the data page is converted and displayed as FL (flight level, rounded off to the nearest hundred feet). An altitude less than 1,000 feet must be entered with a preceding zero.

4. ENTER key — Depress.

Option 3: Using the VNAV WAYPOINT page:

1. NAV, FPL, or D→ key — Depress to display applicable page.

2. Line Select key — Depress to position cursor over desired waypoint.

Note

On NAVIGATION pages, only the TO Waypoint can be selected.

3. VNAV key — Depress to display VNAV WAYPOINT page for selected waypoint.

4. ALT — Insert new altitude constraint followed by A (at or above) or B (at or below), if applicable. Only two or three digits are required to input an altitude (e.g., enter 30A and 3000A is displayed).

   Any altitude value entered greater than the Transition Level value on the data page is converted and displayed as Flight Level (FL). An altitude less than 1,000 feet must be entered with a preceding zero.

Note

If the waypoint is part of a SID, STAR, or Approach procedure, the altitude constraint pre-fills from database. "Cross-Between two Altitudes" type constraints cannot be programmed manually.

5. ENTER key — Depress. Cursor moves to OFFSET field.

6. ENTER key — Depress. The cursor moves to the FPA field.

7. ENTER key — Depress to return to the page where the VNAV waypoint was accessed.

26.5.5.2.3 Direct To — VNAV Waypoint as Lateral Waypoint

This procedure enables the pilot to proceed Direct To a waypoint, both vertically and laterally by means of a Vertical Path Descent.

If the current To waypoint is the desired VNAV Direct To waypoint, go to step 4.

1. Line Select key (on NAVIGATION page 1) — Depress to position the cursor over the TO waypoint field. Type in the desired waypoint and press ENTER or, D▸ key — Depress. A DIRECT TO page appears with the cursor over the current TO waypoint.

2. Line Select key — Depress to position cursor over desired waypoint.

Note

- Active Flight Plans containing more than 18 waypoints will display the remaining waypoints on subsequent pages. Press D▸ key again, or NXT key, to access remaining pages.

- A Random Waypoint may also be used. See paragraph 26.5.4.6.6.2.

3. ENTER key — Depress. CDU screen automatically advances to NAVIGATION page 1.

Note

If an offset waypoint was selected, the system first displays the OFFSET WPT page. Verify data and depress ENTER. The DIRECT page will again be displayed with the cursor over the Offset Waypoint. Press ENTER. The display automatically advances to NAVIGATION page 1.

4. Line Select key — Depress to position cursor over TO Waypoint on NAVIGATION page 1.

5. VNAV key — Depress to display the VNAV WAYPOINT page for TO Waypoint.

6. ALT — Insert or verify. If an altitude constraint has already been programmed, the cursor will be displayed over the FPA (DIR) field value. You may proceed to step 10.

Note

If the waypoint is part of a SID, STAR, or Approach procedure, the ALT constraint field prefills from the database.

7. ENTER key — Depress. Cursor moves to OFFSET field.

8. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).

   a. If the offset is prior to the waypoint, enter the range value and a (-) pre-fills as a default or

   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.

Note

To erase the offset value, insert 0 and press ENTER key. The field changes to dashes, indicating no offset is programmed.

9. ENTER key — Depress. Cursor moves to the FPA field.

Note

Cursor only moves to the FPA field if altitude constraint is below current baro altitude.

10. Flight Path Angle — Verify Direct Flight Path Angle is desirable to fly.

Note

Direct Flight Path Angle pre-fills if it is within the valid range (0.1 to 6.0).

11. ENTER key — Depress to accept waypoint entries. VNAV page 1 is displayed, a Vertical Path Descent has been established, and Vertical Deviation information and guidance is enabled if a descent has been programmed.

26.5.5.2.4 Direct To — VNAV Waypoint

This procedure allows the pilot to program a Direct To on the Vertical Flight Plan, while still flying the lateral waypoints on the Active Flight Plan. The VNAV Direct To function automatically deletes any intermediate altitude constraints and sets up a Path Descent to the Vertical TO Waypoint using the Direct Flight Path Angle.

1. D▸ key — Depress. A DIRECT TO page will appear with the cursor over the current TO waypoint.

2. Line Select key — Depress to position cursor over desired waypoint.

3. VNAV key — Depress. VNAV WAYPOINT page appears. If necessary, position cursor over ALT field. If an altitude constraint has already been programmed, the cursor will appear over the FPA value field. Go to step 8.

4. ALT — Insert or verify.

5. ENTER key — Depress. Cursor moves to OFFSET field.

6. OFFSET — If applicable, insert value in nautical miles (-99 to +99 range).

   a. If the offset is prior to the waypoint, enter the range value and a (-) pre-fills as a default or

   b. Enter a (+), then the range value to indicate the offset is beyond the waypoint.

7. ENTER key — Depress. Cursor moves to FPA field.

8. Flight Path Angle — Verify or insert (in degrees and tenths, 0.1 to 6.0 range).

Note

Direct Flight Path Angle pre-fills if it is within the valid range and an ALT is programmed.

9. ENTER key — Depress to accept waypoint entries and return to VNAV page 1.

26.5.5.2.5 Creating VNAV Profile Waypoints

VNAV profile waypoints (#TOC, #TOD, and #PRESL) are used to provide a prediction of the position of the aircraft on the vertical flight path. These are non-enterable waypoints computed by the system based on current ground speed and vertical speed.

Top of Climb (#TOC):

Top of Climb Altitude is obtained from either the CRUISE ALT entered by the pilot on the VNAV DATA page, or from the Altitude Preselector setting, if available. When the aircraft arrives at the preselected altitude, the system will automatically set cruise altitude to the preselected altitude, which will then provide a #TOD prediction.

If vertical climb constraints are programmed, #TOC will automatically appear as the Vertical To Waypoint when the aircraft laterally passes within 1 mile the last vertical waypoint on the active flight plan that has a climb constraint. Once the aircraft has crossed the final climb constraint waypoint, #TOC will then become the Vertical To Waypoint. If there are no vertical constraints programmed for climb, #TOC will be displayed as the first vertical waypoint as long as the aircraft is in a climb.

When the programmed cruise altitude is reached, #TOC is removed from the VNAV Flight Plan, and #TOD becomes the Vertical To Waypoint.

When #TOC is the TO Waypoint:

The pilot may obtain range and ETE to any altitude above the aircraft during a climb.

1. VNAV key — Depress to display VNAV page 1.
2. Line Select key — Depress to position the cursor over the #TOC altitude field.
3. Alternate Altitude — Insert. This value may be above or below the altitude preselect value, but must be above the current barometric altitude.
4. ENTER key — Depress and observe the change in RANGE and ETE.
5. Repeat steps 2 thru 4 to return to previous #TOC altitude setting.

Top of Descent (#TOD):

The Top of Descent waypoint is the position where the aircraft intercepts the descent path at the cruise altitude. The system calculates the #TOD by establishing a valid Descent Reference Waypoint, then uses either the CRUISE ALT entered by the pilot on the VNAV DATA page, or the Altitude Preselector setting, if available. The default FPA may be used in this calculation.

If no Descent Reference Waypoint with FPA and crossing altitude is programmed, the system will use the arrival airport and elevation (ARP Reference Point, not a runway) and the default FPA to fix Top of Descent as long as the active flight plan is not an AFIS flight plan.

Note

The default FPA may be used to establish #TOD, but no Vertical Deviation Valid will occur until the FPA is actually loaded from the VNAV WPT page.

One minute prior to arriving at #TOD, the system issues the VNAV WPT ALERT message and the discrete waypoint light will flash for 10 seconds, then go steady.

Note

Changing CRUISE ALT on the CDU to a lower altitude should only be done after the aircraft has departed cruise altitude, or #TOD at the current cruise altitude will be lost.

Pre-Selected Altitude Intercept Point (#PRESL):

When the system has an input from an Altitude Pre-selector and the aircraft is flying toward this altitude, a profile waypoint (#PRESL) appears on the VNAV page. #PRESL, however, never becomes the Vertical To Waypoint. When the Pre-selector input is valid, ETE and RANGE to #PRESL can be found on the VNAV DATA page.

Note

With certain types of Pre-Selectors installed (analog), it may be necessary to manually enter a CRUISE ALT when the PRESEL ALT is set higher than the cruise altitude. The system does not read analog Pre-selector output until the aircraft barometric altitude is within approximately 1,000 feet of the preselected value.

Descent Reference Waypoints:

Descent Reference Waypoints have a fixed altitude crossing, (i.e., Cross-At type altitude constraint). To create a Descent Reference Waypoint, the pilot can program a Flight Path Angle or a Cross-At altitude constraint.

If a programmed FPA violates a prior vertical constraint, the system reassigns the Descent Reference Waypoint, using the Default FPA from the VNAV DATA page, as illustrated in Figure 26-39.

26.5.6 Search and Rescue

26.5.6.1 Introduction

In addition to the standard GNS-XLS functions, the FMS may be configured for special mission capabilities.

26.5.6.2 Search Patterns

The XLS-MSP generates and steers the aircraft through five search pattern types: Ladder, Expanding Square, Orbit, Sector Search, and Parallel Line. The operator is able to select the pattern and define the specific parameters appropriate to the mission. Search Patterns can be activated, canceled, deleted, or interrupted at any time.

26.5.6.3 Break and Resume

The search pattern being flown can be interrupted, then resumed at the operator’s convenience with the aircraft automatically returned to the point of interruption traveling in the proper direction. This allows the crew to maneuver the aircraft freely, while allowing resumption of the search pattern with no loss of coverage.

26.5.6.4 Enhanced Steering

During an active search, the XLS increases the steering gains to those used during an approach to ensure the aircraft accurately tracks the search pattern. Also during an active search, the scaling of the crosstrack distance indicators is increased to 1 nm full scale deflection (terminal mode scaling). Configuration for steeper bank angles is provided.

26.5.6.5 Target Waypoints

The XLS-MSP allows the flightcrew to generate target waypoints by designating a position via a discrete switch (Mark-On- Target) or via digital interface such as a weather RADAR. Target waypoints are stored on a flight plan by the XLS for future use. In addition, direct navigation may be selected to one of the latest nine target waypoints from the Direct-To Target Waypoints page.

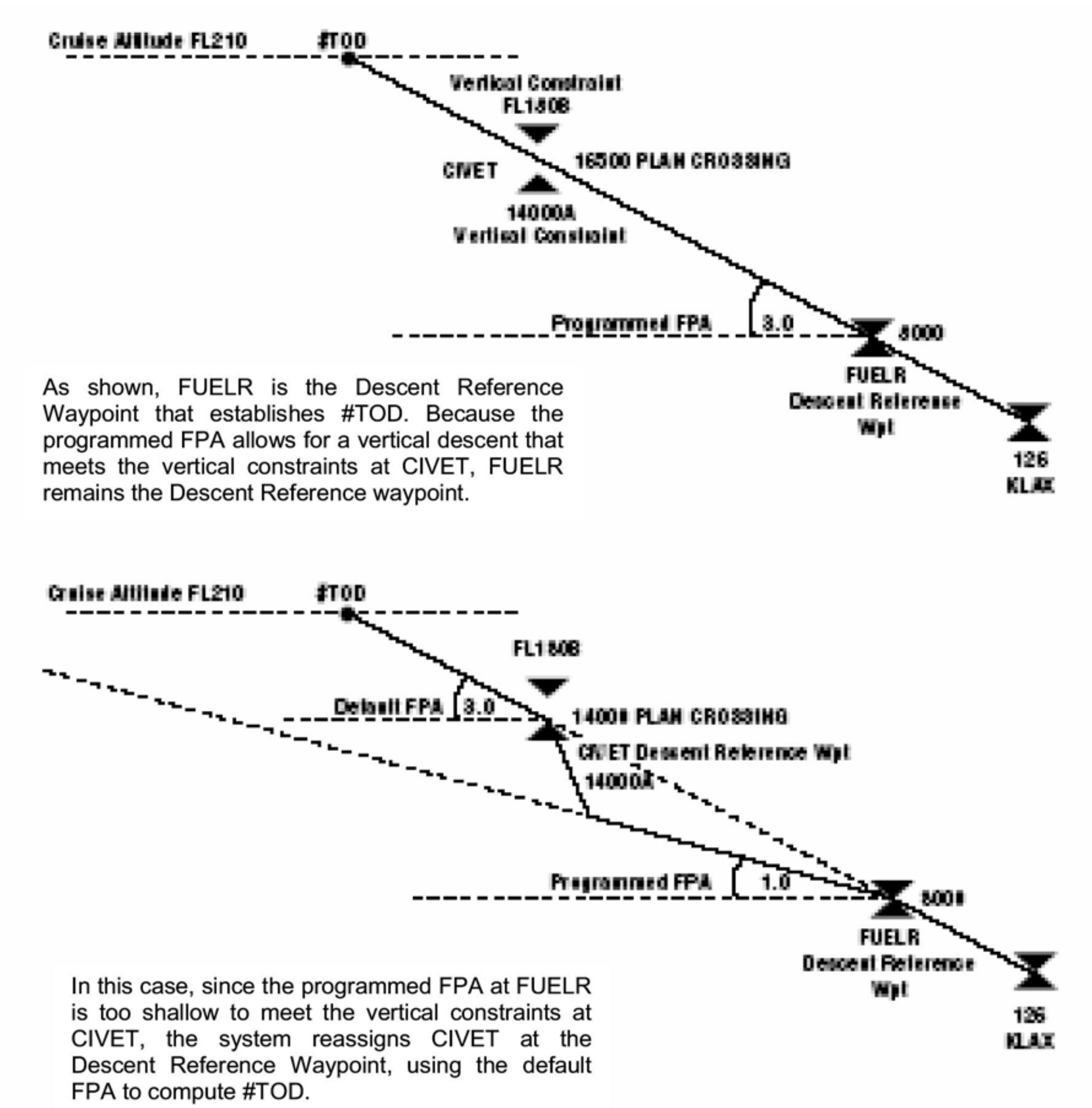


Figure 26-39. Top of Descent and Descent Reference Waypoint

26.5.6.6 WGS-84 to Tokyo Datum Calculation

The XLS may be configured to provide a special PLAN page to convert a position fix between the WGS-84 and the Tokyo coordinate systems.

Note

For further information on accessing the search pattern planning pages and engaging these aspects of system operation, refer to the GNS-XLS Enhanced FMS Operator's Manual.

26.5.7 Emergency Procedures

During an in-flight emergency, the GNS-XLS can provide immediate cueing to the nearest airports. The pilot should press the Direct To (D▸) button twice rapidly. Data showing the Airport Identifier, Magnetic Heading, and Distance for the nine closest airports will be displayed.

26.5.7.1 Loss of Power in Flight

This procedure should only be used in a remote area where NAVAIDs are unavailable and there is reason to believe the sensors contributing to the composite position may be in error.

The procedure allows the pilot to initialize en route when the aircraft has sustained a loss of power for more than 7 seconds. The Power Off Waypoint, "#OFF," provides a snapshot of system data at the moment power was lost.

To initialize when power is restored:

Note

When power returns, system performs Self-Test and displays the INITIALIZATION page.

1. DATE and GMT — Verify or ENTER current DATE and GMT if required.

2. ENTER key — Depress to place the cursor over the POS field, if required.

Note

The coordinates are a rolling display of the real time blended position of the sensors being updated.

3. ENTER key — Depress to accept real time position.

4. HOLD key — Depress.

5. Power Off Waypoint IDENT — Insert "#OFF."

6. ENTER key — Depress.

7. MINUTES OFF, LAST TK, LAST GS — Verify and RECORD for future use (Figure 26-40).

8. BACK key — Depress to return to HOLD page.

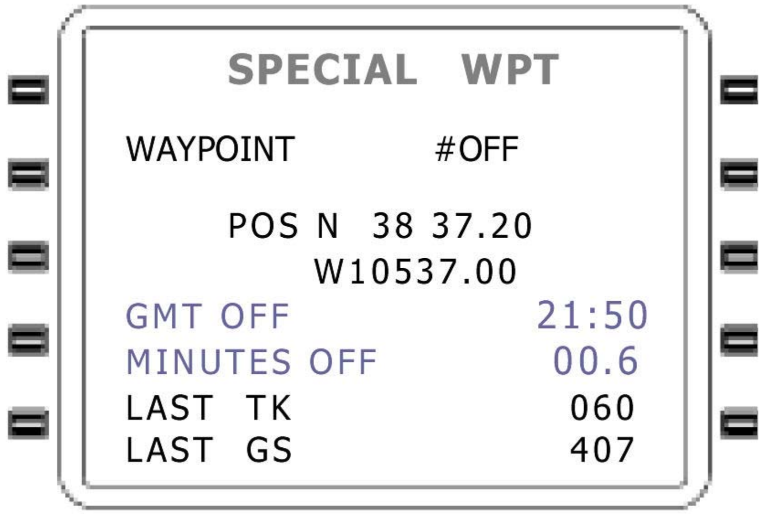


Figure 26-40. Special WPT Page

Note

An Offset Waypoint (#OFF*) can be input with a radial based on the LAST TK value and distance calculated from the LAST GS value as well as the time elapsed from power off, provided significant changes to aircraft track or groundspeed have not been made. If the aircraft has turned or if the speed has changed, the pilot should estimate the track and distance traveled since the loss of power.

9. Offset Waypoint IDENT — Insert.
10. ENTER key — Depress.
11. Recorded or Estimated Radial — Insert LAST TK value or averaged value (Figure 26-41).
12. Distance — Insert calculated distance in nm and tenths.
13. ENTER key — Depress.
14. Waypoint Coordinates — Verify for reasonability.
15. ENTER key — Depress.
16. DIF — CHECK.

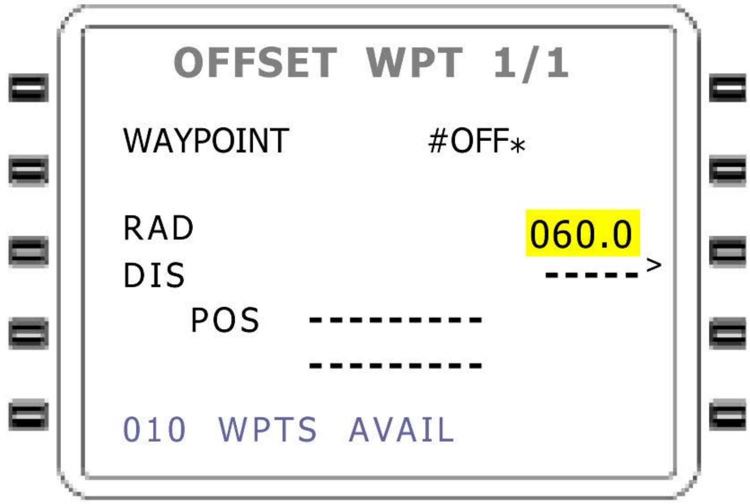


Figure 26-41. Offset WPT Page

If Update Desired:

17. ENTER key — Depress. The VLF (RPU) sensor and the VPU interfaced to the updated CDU are updated as well as the composite position.

If Update Not Desired:

18. NAV, PLAN, FPL, TUNE, VNAV, HDG, or D▸ key — Depress to cancel the HOLD.

26.6 AUTOMATIC FLIGHT CONTROL SYSTEM

26.6.1 Introduction

The automatic flight control system is a completely integrated autopilot/flight management/air data system which has a full complement of horizontal and vertical flight guidance modes. These include all radio guidance, and air data oriented vertical modes.

When engaged and coupled to the flight director commands, the system will control the aircraft using the same commands displayed on the Attitude Director Indicator (ADI). When engaged and uncoupled from the flight director commands, manual pitch and roll commands may be inserted using the Touch Control Steering (TCS) or the pitch wheel and turn knob.

When the autopilot is coupled, the flight director instruments act as a means to monitor the performance of the autopilot. When the autopilot is not engaged, the same modes of operation are available for flight director only. The pilot maneuvers the aircraft to satisfy the FD commands, as does the autopilot when it is engaged.

Note

The autopilot will disengage when transferring between the pilot and copilot flight directors.

26.6.2 Autopilot and Flight Director Selectors

Two press-to-actuate autopilot and flight director selector switches, placarded AP FD 1 and AP FD 2, are located above the pilot altimeter. These switches are used to select which autopilot flight director computer controls the aircraft flight servos. If AP FD 2 is selected, the annunciator placarded AP FLT DIR NO. 2, located above the copilot airspeed indicator and the pilot switch annunciator, will both illuminate to alert both pilots that the No. 2 autopilot flight director computer is controlling the aircraft. The No. 1 AP FD is not annunciated on the copilot side of the instrument panel.

26.6.3 Air Data Computer

A digital air data computer located on the bottom shelf in the forward avionics compartment provides the altitude information for the pilot altimeter, altitude alerter, and transponder. The computer also provides altitude and airspeed hold function data to the flight control computers. The air data computer receives 28 Vdc power through and is protected by a circuit breaker placarded AIR DATA ENCDR located in the AVIONICS section of the circuit breaker panel. All air data computer functions are automatic in nature and require no flightcrew action.

26.6.4 Flight Director Mode Selector

The flight director mode selector (Figure 26-42) provides all mode selection (except go-around, which is initiated by a remote switch) for the flight director. The top row of light annunciated pushbuttons contains the lateral modes and the bottom row contains the vertical modes. The split light pushbuttons illuminate ARM for armed conditions and CAP for captured. When more than one lateral or vertical mode is selected, the flight director system automatically arms and captures the submode. The mode annunciations are repeated on the remote annunciator blocks above both ADIs, with the addition of GS ARM, GS CAP, AP ENG, YD ENG and GA.

26.6.4.1 Heading Select Mode

The heading select mode is selected by pressing HDG on the mode selector (HDG annunciator illuminates). In the HDG mode, the flight director computer provides inputs to the command cue on the HSI, to command a turn to the heading indicated by the heading bug. The heading select signal is gain programmed as a function of airspeed. When HDG is selected, it overrides the NAV, BC APR, and VOR APR modes. In the event of a loss of valid signal from the vertical gyro or compass, the command cue is biased out of view.

26.6.4.2 Navigation Mode

The navigation mode represents a family of modes for various navigation systems including VOR, localizer, TACAN, or FMS as selected by the HSI selector switches.

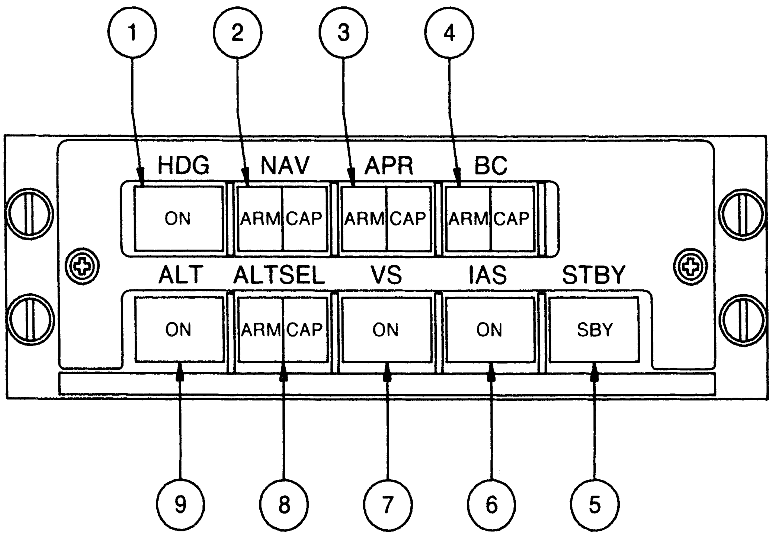


Figure 26-42. MS-400 Flight Director Mode Selector

26.6.4.2.1 VOR Mode

The VOR mode is selected by pressing NAV on the mode selector with the navigation receiver tuned to a VOR frequency and DME greater than 20 miles from the station. Prior to VOR capture, the command cue receives a heading select command as described above and the HDG mode and NAV ARM annunciators on the mode selector are illuminated. Upon VOR capture, the system automatically switches to the VOR mode — HDG and NAV ARM annunciators extinguish and NAV CAP annunciator on the mode selector will illuminate. At capture, a command is generated to capture and track the VOR beam. VOR deviation is gain programmed as a function of distance from the station. This programming corrects for beam convergence, thus optimizing the gain through the useful VOR range. To utilize this feature, the DME must be tuned to the same station as the NAV receiver that is feeding the flight director. The course error signal is gain programmed as a function of airspeed. Crosswind washout is included which maintains the aircraft on beam center in the presence of crosswind. The intercept angle and DME distance are used in determining the capture point to ensure smooth and comfortable performance during bracketing.

When passing over the station, an overstation sensor detects station passage removing the VOR deviation signal from the command until it is no longer erratic. While over the station, course changes may be made by selecting a new course on the HSI.

If the NAV receiver is not valid prior to the capture point, the lateral beam sensor will not trip and the system will remain in the HDG mode. After capture, if the NAV receiver, compass data or vertical gyro go invalid, the command cue will bias out of view. The NAV CAP annunciator on the mode selector will extinguish if the NAV receiver becomes invalid.

26.6.4.2.2 VOR Approach Mode

The VOR approach mode is selected by pressing APR on the mode selector with the navigation receiver tuned to a VOR frequency and less than 20 DME miles from the station. The mode operates identically to the VOR mode with the gains optimized for a VOR approach.

26.6.4.2.3 Localizer Mode

The localizer mode is selected by pressing NAV on the mode selector with the navigation receiver tuned to a localizer frequency. Mode selection and annunciation in the LOC mode is similar to the VOR mode. The localizer deviation signal is gain programmed as a function of radio altitude, time, and airspeed. If radio altimeter information is invalid, gain programming is a function of glideslope capture, time, and airspeed and middle marker. Other valid logic is the same as the VOR mode.

26.6.4.2.4 Back Course Mode

The back course mode is selected by pressing BC on the mode selector. The normal front course for the localizer beam is set for the selected course. Back course operates the same as the localizer mode with the deviation and course signals reversed to make a back course approach on the localizer. When BC is selected, and outside the lateral beam sensor trip point, BC ARM and HDG will be annunciated on the mode selector. At the capture point, BC CAP will be annunciated with BC ARM and HDG extinguished. When BC is selected, the glideslope circuits are locked out.

26.6.4.2.5 Localizer Approach Mode

The approach mode is used to make an ILS approach. Pressing the APR switch with a localizer frequency tuned arms both the localizer and glideslope modes. No alternate NAV source can be selected and the NAV receiver must be tuned to an ILS frequency. When the APR switch is pressed and the above conditions are met, both the NAV and APR modes are armed to capture the localizer and glideslope. Operating LOC mode is the same as described above except, if the radio altimeter is invalid in APR mode, gain programming is a function of glideslope capture, time, and airspeed.

With the APR mode armed, the pitch axis can be in any one of the other pitch modes except go-around. When reaching the vertical beam sensor trip point, the system automatically switches to the glideslope mode. The pitch mode and APR ARM annunciators extinguish and APR ARM annunciators extinguish and APR CAP annunciator illuminates on the controller. At capture, a command is generated to asymptotically approach the glideslope beam. Capture can be made from below the beam only. The glideslope gain is programmed as a function of radio altitude, time, and airspeed. The APR CAP annunciator on the mode selector will extinguish if the GS receiver becomes invalid after capture.

Glideslope capture is interlocked so that the localizer must be captured prior to glideslope capture. If the glideslope receiver is not valid prior to capture, the vertical beam sensor will not trip and the system will remain in the pitch mode. After capture, if the NAV receiver, G/S receiver, compass data or vertical gyro becomes invalid, the command cue will bias out of view. If the radio altimeter is not valid, the glideslope gain programming is a function of GS capture, time, airspeed, and middle marker.

26.6.4.2.6 Pitch Hold Mode

Whenever a roll mode is selected without a pitch mode, the command cue will display a pitch attitude hold command. The pitch attitude can be changed by pressing the TCS switch on the control wheel and maneuvering the aircraft. The command cue will be synchronized to zero while the switch is depressed. Upon release of the switch, the pitch command will be such as to maintain the new pitch attitude. In the pitch hold mode, the command cue will be biased out of view if the vertical gyro is not valid.

26.6.4.2.7 TACAN Mode

The TACAN mode is selected by depressing the HSI source selector NAV switch. TACAN navigation information is then selected and displayed on the HSI.

Note

> The NAV 1/TACAN receiver must be tuned to a valid TACAN frequency. TACAN functions are identical to VOR using TACAN information rather than VOR signals. The ARM/CAP annunciation is the same as in VOR mode.

26.6.4.2.8 FMS Mode

The FMS mode is selected by depressing the PILOT HSI source selector switch, placarded FMS and located in the instrument panel. FMS works in conjunction with the NAV-1/TACAN system. The annunciator switch, placarded VOR 1 TACAN and located above the pilot altimeter, must also be depressed to enter the FMS mode. FMS repeat mode is selected when the pilot side annunciator switch, placarded VOR 2, is depressed while FMS is selected on the COPLT HSI source selector switch. Pilot and copilot annunciator lamps, placarded FMS REPEAT, indicate when FMS repeat mode is in operation.

FMS mode may also be selected on the COPLT HSI source selector by depressing the switch placarded FMS. This switch selects FMS if the VOR 1 TACAN annunciator, above copilot airspeed indicator, is illuminated. FMS repeat mode is selected if the VOR 1 TACAN annunciator is not illuminated while FMS is selected on the PILOT HSI source selector switch.

FMS navigation information is displayed on the pilot and/or copilot HSI. The selected HSI course must be the same as the desired track shown on the IEC 9002 control display unit (Figure 2-4) located in the pedestal extension. ARM/CAP annunciation on the MS-400 Flight Director Mode Selector is the same as in VOR or TACAN.

26.6.4.3 Altitude Hold Mode

The altitude hold mode is selected by pressing ALT on the mode selector. When ALT is selected, it overrides the APR CAP, GA, IAS, VS, ALT SEL CAP, or pitch hold modes. In the ALT mode, the pitch command is proportional to the altitude error provided by the air data computer. The altitude error signal is gain programmed as a function of airspeed. Depressing and holding the TCS switch allows the pilot to maneuver the aircraft to a new altitude hold reference without disengaging the mode. Once engaged in the altitude hold mode, the mode will be reset if the air data computer is not valid and the command cue will bias out of view if the vertical gyro is not valid.

Note

If the baro setting on the altimeter is changed, a command is generated to fly the aircraft back to the original altitude reference.

26.6.4.4 Indicated Airspeed Hold Mode

The indicated airspeed hold mode is selected by pressing IAS on the mode selector. When IAS is selected, it overrides the APR CAP, GA, ALT, VS, ALTSEL CAP, or pitch hold modes. In the IAS mode, the pitch command is proportional to airspeed error provided by the air data computer. Depressing and holding the TCS switch allows the pilot to maneuver the aircraft to a new airspeed hold reference without disengaging the mode. Once engaged in the IAS mode, the mode will be reset if the air data computer is not valid and the command cue will bias out of view if the vertical gyro is not valid.

26.6.4.5 Vertical Speed Hold Mode

The vertical speed hold mode is selected by pressing VS on the mode selector. When VS is selected, it overrides the APR CAP, GA, ALT, ALTSEL CAP, IAS, or pitch hold modes. In the VS mode, the pitch command is proportional to VS error provided by the air data computer. Depressing and holding the TCS switch allows the pilot to maneuver the aircraft to a new vertical speed hold reference without disengaging the mode. Once engaged in the VS mode, the mode will be reset if the air data computer is not valid and the command cue will bias out of view if the vertical gyro is not valid.

26.6.4.6 Altitude Preselect Mode

The altitude preselect mode is selected by pressing ALTSEL on the mode selector. The desired altitude is selected on the altitude preselect controller located above the radar screen. Pitch hold, VS or IAS may be selected as a mode to fly to the selected altitude. When outside the altitude bracket trip point, ALTSEL ARM along with the selected pitch mode is illuminated on the mode selector. When reaching the bracket altitude, the system automatically switches to the ALTSEL CAP mode and the previously selected pitch mode is canceled. At bracket, a command is generated to asymptotically capture the selected altitude. When the altitude is reached, the ALT SEL CAP mode is automatically canceled and the flight director switches to the ALT HOLD mode. If the air data computer is not valid, the altitude preselect mode cannot be selected. The command cue will bias out of view if the vertical gyro is not valid.

26.6.4.7 Standby Mode

The standby mode is selected by pressing SBY on the mode selector. This resets all the other flight director modes and biases the command cue from view. While depressed, SBY acts as a lamp test causing all mode annunciators to illuminate and the flight director warning flag (FD) on the ADI to come in view. When the switch is released, the mode annunciator lights extinguish and the flight director warning flag retracts from view.

26.6.4.8 Go-Around Mode

The go-around mode is selected by depressing a remote (copilot control wheel or No. 1 engine power lever) go-around (GA) switch. When selected, all other modes are reset and the remote go-around annunciators “GA” are illuminated. The command cue receives a wings level command (zero command when roll is zero). The command cue also receives the go-around command which is a 7° pitchup attitude command. Selecting GA disconnects the autopilot. The yaw damper remains on.

Once go-around is selected, any roll mode can be selected and will cancel the wings level roll command. The go-around mode is canceled by selecting another pitch mode or TCS.

26.6.5 Autopilot Controller

The autopilot controller (Figure 26-43) provides a method of engaging the autopilot and yaw damp system, selecting a LOW bank limit and SOFT RIDE mode, or manually controlling the autopilot through the turn knob and pitch wheel. The autopilot system limits are provided in the Autopilot System Limits charts (Figure 26-44, sheets 1 and 2).

26.6.5.1 A/P Engage Pushswitch

The AP ENGAGE switch is used to engage the autopilot. Engaging the autopilot automatically engages the yaw damp system. The autopilot may be engaged with the aircraft in any reasonable attitude.

26.6.5.2 Autopilot Disengage

The autopilot is normally disengaged by momentarily depressing the control wheel AP DISC switch.

The autopilot may however be disengaged by any of the following:

1. Actuation of the control wheel AP DISC switch. Disengagement is confirmed by five flashes of the AP ENG annunciator.

2. Pressing the respective vertical gyro FAST ERECT switch.

3. Actuation of respective compass INCREASE-DECREASE switch.

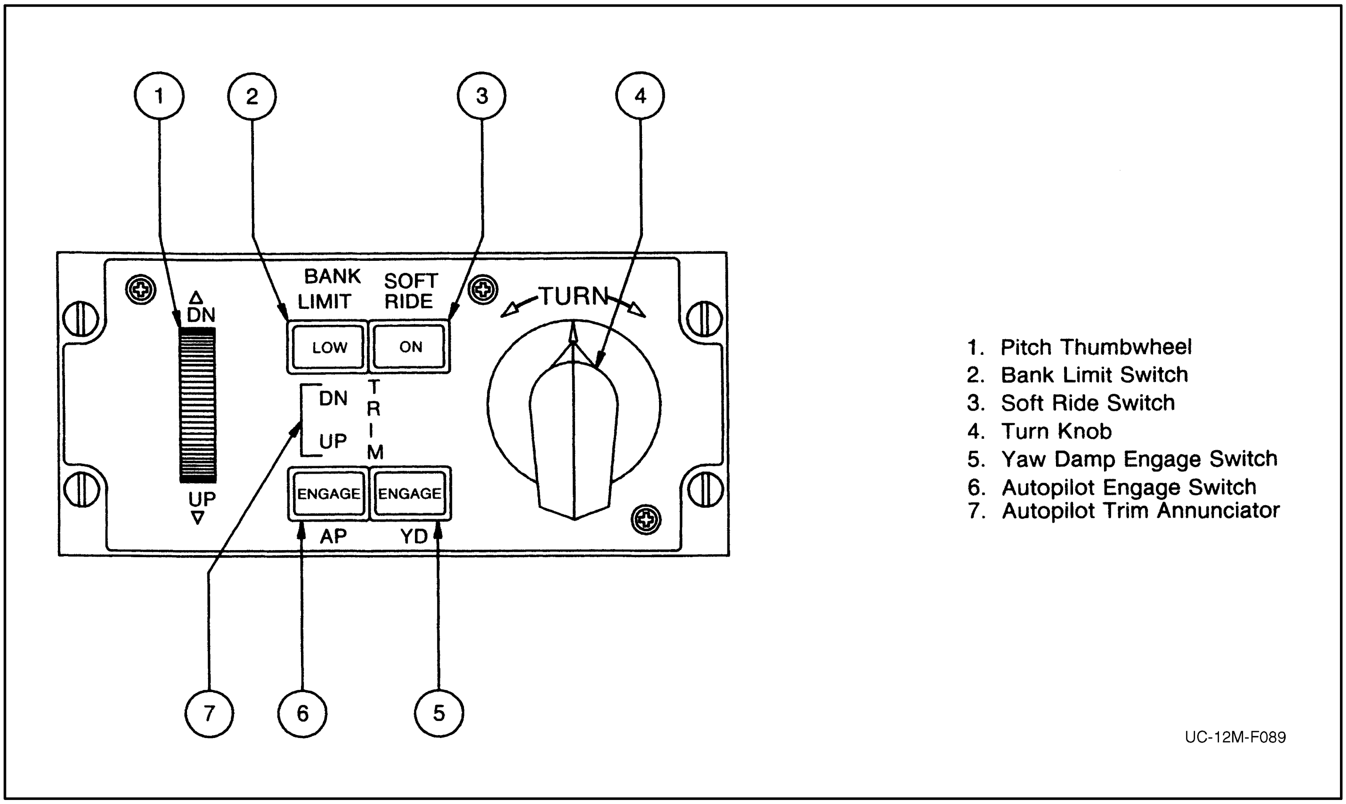


Figure 26-43. Autopilot Controller

4. Selection of go-around mode. Disengagement is confirmed by the AP ENG annunciator flashing five times and illumination of the GA annunciators.

5. Pulling the autopilot AP POWER circuit breaker.

6. Pressing the autopilot AP ENGAGE push switch.

7. When transferring between pilot and copilot flight directors.

8. Vertical gyro failure.

9. Directional gyro failure.

10. Autopilot power or circuit failure.

11. Torque limiter failure.

Disengaging under any of the last four conditions will illuminate the AP DISC annunciator and the MASTER WARNING light. Pressing the control wheel AP DISC switch will extinguish the AP DISC annunciator.

Any of the following malfunctions will cause the autopilot to automatically disengage.

MODE	CONTROL OR SENSOR	PARAMETER	VALUE
Yaw Damper	Yaw Control	Engage Limit	Unlimited
A/P Engage		Engage Limit	Roll Up to ±90° Pitch Up to ±30°
Basic A/P	Touch Control Steering	Roll Control Limit	Up to ±45° Roll
	TCS	Pitch Control Limit	Up to ±20° Pitch
	Turn Knob	Roll Angle Limit	±30°
		Roll Rate Limit	±15°/Second
	Pitch Wheel	Pitch Angle Limit	±15° Pitch
	Heading Hold	Roll Angle Limit	Less Than 6° and No Roll Mode Selected
Heading Select	Heading SEL Knob on HSI	Roll Angle Limit	±25°
		Roll Rate Limit	±3.5°/Second
		CAPTURE	
VOR	Course Knob, NAV Receiver, and DME Receiver	Beam Angle Intercept (HDG SEL)	Up to ±90°
		Roll Angle Limit	±25°
		Course Cut Limit at Capture	±45° Course
		Capture Point	Function of Beam, Beam Rate, Course Error, and DME Distance
		ON COURSE	
		Roll Angle Limit	±13° Roll
		Crosswind Correction	Up to ±45° Course Error
		OVER STATION	
		Course Change	Up to ±90°
		Roll Angle Limit	±17°
LOC or APR or BC	Course Knob and NAV Receiver	**LOC CAPTURE**	
		Beam Intercept	Up to ±90°
		Roll Angle Limit	±25°
		Roll Rate Limit	±5°/Second
		Capture Point	Function of Beam, Beam Rate, and Course Error
		NAV ON-COURSE	
		Roll Angle Limit	±17° Roll
		Crosswind Correction Limit	±30° of Course Error
		Gain Programming	Function of Time and (TAS). Starts at 1200 ft Radio Altitude

Figure 26-44. Autopilot System Limits (Sheet 1 of 2)

MODE	CONTROL OR SENSOR	PARAMETER	VALUE
LOC or APR or BC (cont.)	GS Receiver and Air Data Computer	**GLIDESLOPE CAPTURE**	
		Beam Capture	Function of Beam and Beam Rate
		Pitch Command Limit	±10°
		Glideslope Damping	Vertical Velocity
		Pitch Rate Limit	Function of (TAS)
		Gain Programming	Function of Time and (TAS). Starts at 1200 ft Radio Altitude. Function of (Radio Alt) Starts at 250 ft
GA	Control Switch on Power Lever	Fixed Pitch-Up Command, Wings Level	7° Pitch Up
Pitch Sync	TCS Switch on Control Wheel	Pitch Attitude Command	±20° Maximum
ALT Hold	Air Data Computer	ALT Hold Engine Range	0 to 50,000 ft
		ALT Hold Engine Error	±20 ft
		Pitch Limit	±20°
		Pitch Rate Limit	Function of (TAS)
VS Hold	Air Data Computer	VERT Speed Engage Range	0 to ±6000 ft/Minute
		ALT Speed Hold Engage Error	±30 ft
		Pitch Limit	±20°
		Pitch Rate Limit	Function of (TAS)
IAS Hold	Air Data Computer	IAS Engage Range	80 to 450 Knots
		IAS Hold Engage Error	±5 Knots
		Pitch Limit	±20°
		Pitch Rate Limit	Function of (TAS)
ALT Preselect	Air Data Computer	Preselect Capture Range	0 to 50,000 ft
		Maximum Vertical Speed for Capture	±400 ft/Minute
		Maximum Gravitation Force During Capture Maneuver	±20g
		Pitch Limit	±20°
		Pitch Rate Limit	Function of (TAS)

Figure 26-44. Autopilot System Limits (Sheet 2 of 2)

26.6.5.3 Y/D Engage Pushswitch

When the autopilot is not engaged, the yaw damper may be utilized by depressing YD Engage pushswitch.

26.6.5.4 Bank Limit

Selection of the bank limit mode on the autopilot controller provides a lower maximum bank angle while in a (HDG) heading select mode. LOW will illuminate on the bank limit switch. The lower bank limit is inhibited and LOW is extinguished during NAV mode captures. If heading select is again engaged, BANK LIMIT will again be illuminated. Pressing BANK LIMIT when illuminated will return autopilot to normal bank limits.

26.6.5.5 Soft Ride Pushswitch

Soft ride reduces autopilot gains while still maintaining stability in rough air. This mode may be used with any flight director mode selected.

26.6.5.6 Elevator Trim Annunciator

The elevator trim annunciator indicates UP or DN when a sustained signal is being applied to the elevator servo. The annunciator should not be illuminated before the autopilot is engaged.

26.6.5.7 Turn Knob

Rotation of the turn knob out of detent results in a roll command. The roll angle is proportional to and in the direction of the turn knob rotation, the turn knob must be in detent (center position) before the autopilot can be engaged. Rotation of the turn knob cancels any other previously selected lateral mode.

26.6.5.8 Pitch Wheel

Movement of the pitch wheel will cancel only ALT HOLD, and ALT SEL CAP. With vertical modes of VS or IAS selected on the mode selector, rotation of the pitch wheel will change the respective displayed vertical mode reference. VS or IAS mode may be canceled by pressing the mode switch on the mode selector. If VS or IAS are not selected, the pitch wheel works as described above. The pitch wheel is always disabled during a coupled glideslope.

26.6.6 Touch Control Steering (TCS)

The TCS press switch located on the control wheel allows the pilot to manually change aircraft attitude, altitude, vertical speed and/or airspeed without disengaging the autopilot. After completing the manual maneuver, the TCS push switch is released, and the autopilot is automatically resynchronized to the vertical mode: for example, with IAS mode selected, the pilot may depress the TCS push switch and manually change airspeed; once trimmed at the new airspeed, the TCS push switch is released and the autopilot will hold this airspeed. If a large pitch attitude change is made, the pilot should perform his normal trim of the aircraft before release of the TCS switch.

26.7 ALTITUDE SELECT CONTROLLER

The altitude select controller (Figure 26-45) provides a means for setting the desired altitude reference for the altitude preselect and altitude alerting system.

26.7.1 Altitude Preselect

The altitude is selected by turning the altitude select controller selector knob until the altitude window display indicates the desired value. No further action is taken on the controller. To initiate altitude preselect, the ALTSEL button is pressed on the flight director controller. Then a maneuver to fly toward the preselected altitude must be initiated. Any of the following pitch modes may be engaged: pitch hold, airspeed hold or, vertical speed hold. Upon initiation of altitude preselect capture, the previously selected pitch mode is automatically reset, and the system switches to ALT hold mode.

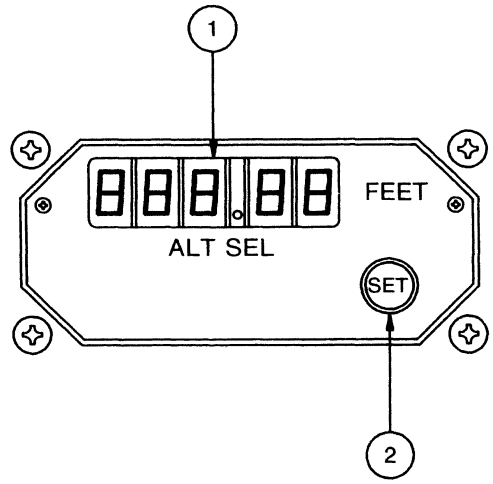


Figure 26-45. Altitude Select Controller

26.7.2 Altitude Alert

As the aircraft reaches a point 1,000 feet from the selected altitude, a signal is generated to illuminate the ALT warning light on both altimeters and activate a warning horn for 1 second. This light remains illuminated until the aircraft is 250 (±50 feet) from the selected altitude, then extinguishes. If the aircraft deviates by 250 (±50 feet) or more from the selected altitude, the light will again illuminate and the horn will re-sound. The light will remain illuminated until the aircraft returns to within 250 (±50 feet) of, or deviates by, more than 1,000 feet from the selected altitude.

26.8 RADIO MAGNETIC INDICATORS

26.8.1 Description

Two identical Radio Magnetic Indicators (RMIs) (Figure 26-46) provide aircraft heading and radio bearing information to or from a VOR, TACAN, NDB (ADF). The RMIs are powered through circuit breakers placarded No. 1 or No. 2 RMI, located in the AVIONICS section of the overhead circuit breaker panel.

26.8.2 RMI Controls and Functions

26.8.2.1 Compass System Selector Switch

A three-position switch placarded HEADING, ALL SYSTEMS ON COMPASS 1, NORM, ALL SYSTEMS ON COMPASS 2, located on the audio control panel (Figure 21-1), selects the compass system (number 1 or 2) that will supply heading information to the RMIs. When the switch is set to the ALL SYSTEMS ON COMPASS 1 position, both RMIs receive compass information from the number 1 compass system. When the switch is set to the NORMAL position, the copilot RMI receives heading information from the number 1 compass system, the pilot RMI receives heading information from the number 2 compass system. When the switch is set to the ALL SYSTEMS ON COMPASS 2 position, both RMIs will receive heading information from the number 2 compass system.

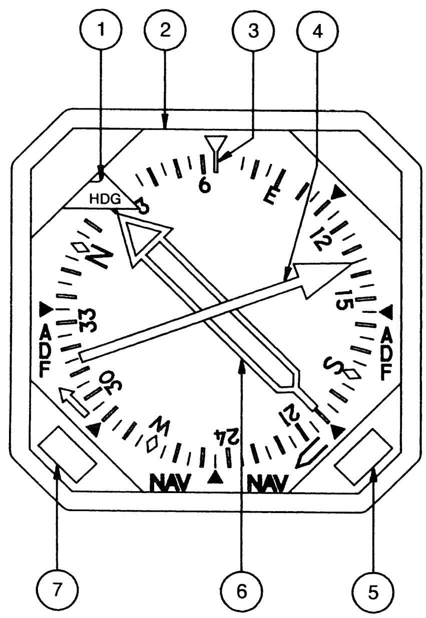


Figure 26-46. Radio Magnetic Indicator

26.8.2.2 Single-Needle Annunciators

Two annunciators, located on the extreme left and right sides of the instrument panel (Figure 2-4), are provided to show what bearing information source is being used by the single-needle pointer of the pilot and copilot RMIs. When illuminated, the annunciator, placarded NAV 1 — ADF 1, indicates the RMI single-needle is displaying bearing information from NAV 1 (or FMS if the HSI selector switch is set to FMS), and the RMI single-needle selector switch is set to the NAV position, or that the single needle is displaying ADF 1 information, if the single-needle selector switch is set to the ADF position. When the annunciator, placarded TACAN — ADF 1, is illuminated, the single needle is displaying bearing information from TACAN or FMS if HSI selector switch is set to FMS, if the RMI single-needle selector switch is set to the NAV position, or ADF 1 if the single-needle selector switch is set to the ADF position.

26.8.2.3 Compass Warning Flag

The compass warning flag placarded HDG located on the left portion of each RMI, when in view, indicates the compass system heading information displayed on the compass card is invalid.

26.8.2.4 Compass Card

This rotating card repeats gyro-stabilized magnetic compass information.

26.8.2.5 Lubber Line

Aircraft magnetic heading is read from the compass card under the lubber line.

26.8.2.6 Single-Needle Pointer

The single-needle pointer indicates the magnetic heading to a VOR, NDB (ADF) station, or a flight management system waypoint. The NAV 1, TACAN, ADF 1 or flight management system bearing information displayed is dependent upon the position of the single-needle pointer selector switch and the pilot HSI selector switch.

26.8.2.7 Double-Needle Pointer

The double-needle pointer indicates the magnetic heading to a VOR or NDB (ADF) station. The double-needle pointer displays bearing information from NAV 2 or ADF 2 depending upon the position of the double-needle pointer selector switch.

26.8.2.8 Double-Needle Pointer Selector Switch

A two-position selector switch is located on the lower right corner of each RMI. When pressed to the in position, ADF 2 bearing information is supplied to the double needle. When in the out position, NAV 2 bearing information is supplied to the double-needle pointer.

26.8.2.9 Single-Needle Pointer Selector Switch

A two-position selector switch is located on the lower left corner of the RMI. When pressed to the in (ADF) position, ADF 1 bearing information is supplied to the single needle. When in the out (NAV) position, NAV 1 information (TACAN information if NAV 1/TACAN control is in TACAN mode) is supplied to the single needle, or if the pilot HSI FMS selector is depressed, FMS bearing information is displayed by the single needle.

26.9 HORIZONTAL SITUATION INDICATORS

26.9.1 Description

The Horizontal Situation Indicators (HSIs) (Figure 26-47) combine several navigation information displays to provide a map-like presentation of the aircraft position with respect to magnetic heading. The indicator displays aircraft displacement relative to VOR, TACAN, localizer, glideslope, flight management system course to waypoint and selected heading. Relative bearing to a VOR, TACAN, station or FMS waypoint is displayed with respect to magnetic north.

26.9.2 HSI Controls, Indicators, and Functions

26.9.2.1 Digital Course Display

A three-digit counter displays the course selected in degrees by the remote (extended pedestal) mounted course select knob.

26.9.2.2 Compass Card

This rotating card repeats gyro stabilized magnetic compass information in 5° increments and rotates with the aircraft throughout 360°.

26.9.2.3 Lubber Lines

Aircraft heading is read from the compass card under the fore lubber line. The reciprocal is read under the aft lubber line.

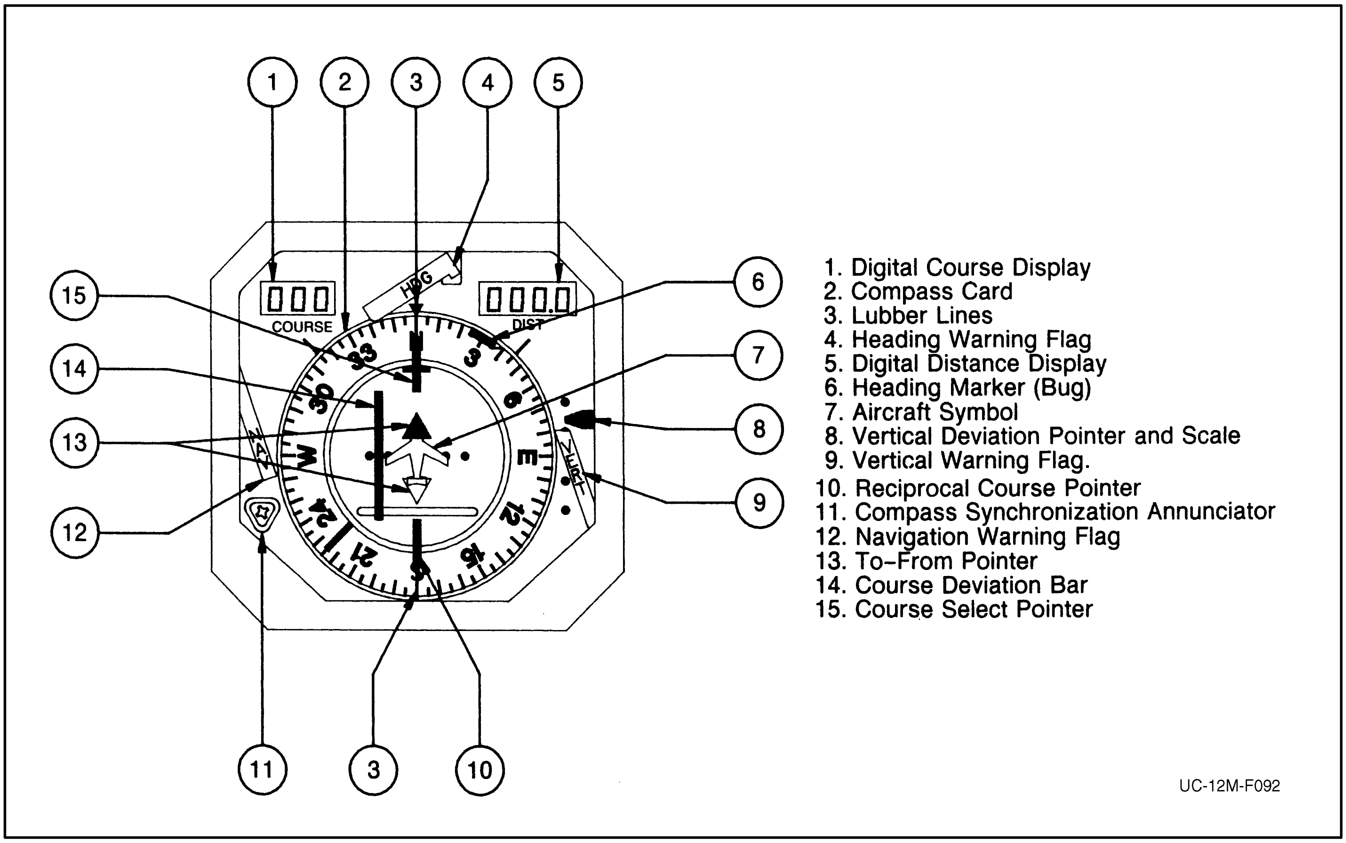


Figure 26-47. Horizontal Situation Indicator

26.9.2.4 Heading Warning Flag

A flag placarded HDG, located on the upper portion of the HSI, falls into view when heading signal from the directional gyro is invalid, primary power to the indicator is lost, or the error between the heading displayed and the heading signal is excessive.

26.9.2.5 Digital Distance Display

A four-digit display indicates the distance in nautical miles to the selected DME/TACAN station or FMS waypoint. The display is blank (off) when the display input is removed or invalid.

26.9.2.6 Heading Marker (Bug)

The orange heading marker is positioned on the compass card by the remote extended-pedestal heading knob to select and display a selected compass heading. Once set to the desired heading, the heading marker maintains its position on the compass card. The difference between the heading marker and the lubber line index is the amount of heading error applied to the flight director computer. In the heading mode, the ADI flight director command cue will display the proper bank commands to turn to and maintain this selected heading.

26.9.2.7 Aircraft Symbol

A fixed miniature aircraft symbol corresponds to the longitudinal axis of the aircraft and lubber line marks. The symbol shows position and heading with respect to the rotating compass card. It also shows the aircraft position in relation to a radio course.

26.9.2.8 Vertical Deviation Pointer and Scale

The vertical deviation pointer displays glideslope deviation information. The pointer is in view only when tuned to a localizer frequency. If the aircraft is below glideslope path, the pointer is displayed upward on the scale. Each division (dot) on the scale represents approximately 0.4° deviation from glideslope when operating on an ILS signal.

26.9.2.9 Vertical Warning Flag

A flag placarded VERT comes into view when valid glideslope information is not being received.

26.9.2.10 Compass Synchronization Annunciator

The compass synchronization annunciator consists of the symbol ● or X (dot or cross) displayed in a window on the lower left corner of the face. When the system is in the slaved mode, and synchronized, the display will slowly oscillate between the ● and X symbols, indicating the compass card is synchronized with a gyro stabilized magnetic heading.

26.9.2.11 Navigation Warning Flag

The NAV flag in view indicates a loss of or unreliable signal from navigation source being used by HSI.

26.9.2.12 To-From Pointer

Two triangular indicators, which remain aligned with the yellow course pointer, indicate VOR to-from information.

26.9.2.13 Course Deviation Bar

The course deviation bar represents the centerline of the selected VOR course, localizer course, or flight management system course to waypoint.

During VOR operation, the distance between each graduation (dot) represents a 5° deviation from course. During localizer operation, the distance between each graduation (dot) represents a 1° deviation from course. During flight management system en route operation, the distance between each graduation represents 2-1/2 miles deviation from course to waypoint. During flight management system approach operation, the distance between each graduation (dot) represents 0.625 nm deviation from course.

26.9.2.14 Course Select Pointer

The yellow course pointer is positioned on the heading dial by the remote extended-pedestal course knob to a magnetic bearing that coincides with a selected VOR radial or localizer course.

26.9.2.15 Pilot HSI

1. FMS — With FMS selected, the flight management system provides automatic course needle drive while using the AUTO/LEG method of operation; however, it will not provide course needle drive while using the OBS method of operation. In this case, the pilot must set the selected course manually either via the HSI course knob, located on the pedestal, or through the system control unit. The course needle provides left/right steering information from the system. The DME display provides distance to the waypoint in nautical miles. Also, the TACAN/DME indicator will display distance, groundspeed in knots, and time to the WPT. The bearing pointer provides bearing information derived from either the ADF or the FMS depending upon whether ADF or VOR respectively are selected by the RMI selector.

2. NAV — With NAV selected, the pilot must set the selected course manually via the HSI course knob, located on the pedestal. VOR/LOC/GS tuning is through the NAV 1 TAC frequency control unit. Both VOR and LOC signals provide left/right steering information. The DME display provides distance to the station in nautical miles. Also, the TACAN/DME indicator will display distance, groundspeed in knots, and time to station. The bearing pointer provides bearing information derived from either the ADF or the NAV 1 receiver depending upon whether ADF or VOR, respectively, are selected by the RMI selector.

3. NAV REPEAT — With NAV REPEAT selected, the pilot HSI repeats the copilot HSI display information providing the copilot HSI source switch has NAV selected.

26.9.2.16 Copilot HSI

1. FMS — With FMS selected, the flight management system provides course needle left/right steering information; however, the copilot must set the selected course manually either via the HSI course knob, located on the pedestal, or through the system control unit. The TACAN/DME slave indicator will display distance, groundspeed in knots, and time to the WPT.

2. NAV — With NAV selected, the copilot must set the selected course manually via the HSI course knob, located on the pedestal. VOR/LOC/GS tuning is through the NAV 1 TAC frequency control unit. Both VOR and LOC signals provide left/right steering information. The DME display provides distance to the station in nautical miles. Also, the TACAN/DME indicator will display distance, groundspeed in knots, and time to station. The bearing pointer provides bearing information derived from either the ADF or the NAV 1 receiver depending upon whether ADF or VOR, respectively, are selected by the RMI selector.

3. NAV REPEAT — With NAV REPEAT selected, the copilot HSI repeats the pilot HSI display information providing the pilot HSI source switch has NAV selected.

26.9.3 Pilot and Copilot RMIs

1. FMS — With FMS selected, the single bar needle provides bearing information derived from either the ADF or the FMS depending upon whether ADF or VOR, respectively, are selected on the RMI.

2. NAV — With NAV selected, the single-bar needle provides bearing information derived from either the ADF or the NAV 1 or TACAN receiver depending upon whether ADF or VOR, respectively, are selected on the RMI.

26.10 ATTITUDE DIRECTOR INDICATORS

26.10.1 Description

The pilot and copilot Attitude Director Indicators (ADIs) (Figure 26-48) combine an attitude sphere display with computed steering information to provide the commands required to intercept and maintain a desired flight path. The ADIs also contain an eyelid display, expanded localizer, glideslope, digital radio altitude, decision height display, a go-around and a decision height annunciator, and inclinometer.

26.10.2 ADI Controls, Indicators, and Functions

26.10.2.1 Go-Around Annunciator

The Go-Around (GA), located on the upper left portion of the ADI, illuminates when go-around mode has been selected.

26.10.2.2 Flight Director Warning Flag

The Flight Director (FD) flag will come into view when the flight director valid signal is lost or during an ATT test.

26.10.2.3 Bank Scale and Attitude Pointer

The bank angle pointer indicates aircraft bank angle when aligned with the fixed bank angle scale reference marks.

26.10.2.4 Decision Height Annunciator

The Decision Height (DH) annunciator illuminates when the aircraft arrives at the decision height set by the DH SET knob.

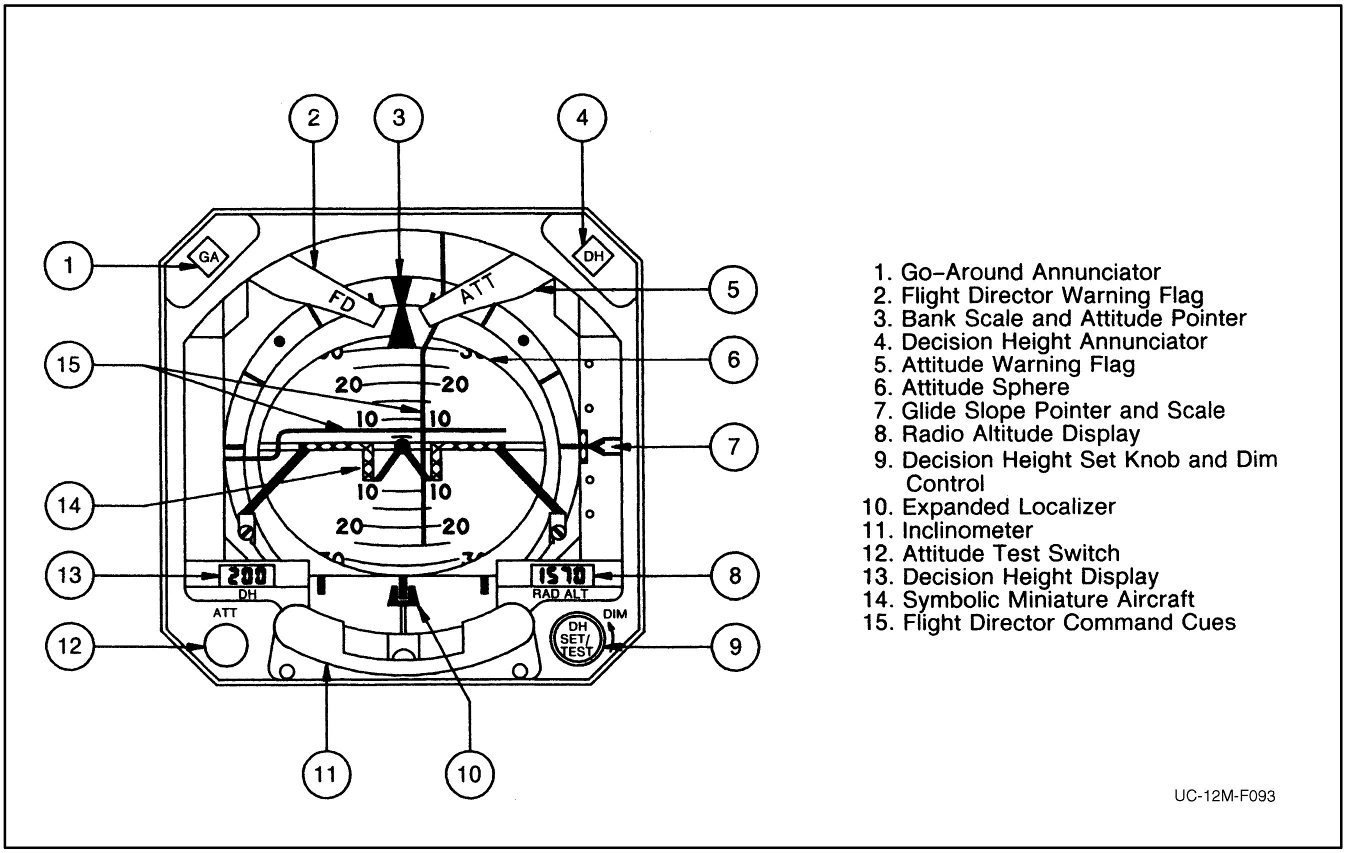


Figure 26-48. Attitude Director Indicator

26.10.2.5 Attitude Warning Flag

The attitude warning (ATT) flag falls into view when any of the following conditions exist: attitude test switch is pressed; vertical gyro validity is lost, primary power is lost; or excessive error between the displayed attitude and the attitude received from the vertical gyro occur.

26.10.2.6 Attitude Sphere

The sphere moves with respect to the symbolic aircraft reference to display actual pitch and roll attitude. The pitch attitude marks are in 5° increments.

An eyelid display surrounds the attitude sphere and provides positive attitude identification. When the aircraft is in an upright position, the upper (blue) eyelid is located next to the upper (blue) half of the attitude sphere, while the lower (brown) eyelid display is located next to the lower (brown) half of the attitude sphere. Thus the eyelid display maintains the proper ground-sky relationship, regardless of the position of the sphere, to aid in recovery from unusual attitudes.

26.10.2.7 Glideslope Pointer and Scale

The glideslope pointer displays glideslope deviation information. The pointer comes into view only when tuned to an ILS frequency. If the aircraft is below glideslope path, the pointer is displayed upward on the scale. Each division (dot) on the scale represents approximately 0.4° deviation from glideslope when operating an ILS signal. Category II information is displayed as a green area on the glideslope scale.

26.10.2.8 Radio Altitude Display

Radio altitude absolute above the terrain is displayed by a digital display from –20 to 2,500 feet. Above 200 feet, the resolution is 10 feet, and below 200 feet, the resolution is 5 feet. Altitude greater than 2,500 feet is indicated by a blanked display. When radio altitude data is invalid, a dash is displayed at each digit.

26.10.2.9 Decision Height Set Knob and Dim Control

The inner knob placarded DH SET is used to set an altitude between 0 and 990 feet AGL in the DH display window. The outer DIM control knob is used to control the RADIO ALT and DH displays, and HSI COURSE and DIST displays.

26.10.2.10 Expanded Localizer

The expanded localizer pointer and scale, located below the attitude sphere, takes raw localizer displacement data from the navigation receiver (HSI display) and amplifies it approximately 7 1/2 times to permit the expanded localizer pointer to be used as a sensitive reference indicator of the aircraft position with respect to the center of the localizer course. Normally, the scale is used for assessment only, since the pointer is very sensitive and difficult to fly throughout the entire approach. During final approach, the pointer serves as an indicator of the Category II window. Full scale deflection of the expanded localizer pointer is equal to ±33 feet of the runway centerline. The expanded localizer is displayed by the localizer pointer only when a valid localizer signal is being received.

26.10.2.11 Inclinometer

The inclinometer, located below the expanded localizer, provides a conventional display of aircraft slip or skid and is used as an aid to coordinated maneuvers.

26.10.2.12 Attitude Test Switch

A momentary push switch placarded ATT TEST, located on the lower left portion of the ADI, controls the operation of the ADI self-test function. When depressed, the sphere will show an approximate attitude of 20° right bank and 10° pitch-up, and the ATT and FD warning flaps will come into view.

26.10.2.13 Decision Height Display

A 3-digit display indicates the selected altitude between 0 and 990 feet, with a 10-foot display resolution.

26.10.2.14 Symbolic Miniature Aircraft

Aircraft pitch and roll attitudes are displayed by the relationship between the fixed miniature aircraft and the movable attitude sphere.

Aircraft pitch angle may be read at the upper point of the orange symbolic miniature aircraft on a vertical pitch angle scale located on the attitude sphere. The pitch scale is graduated in 5° increments.

26.10.2.15 Flight Director Command Cues

Displays pitch and roll commands computed by the flight director computer to capture and maintain a desired flight path. To follow the flight director computer commands, the symbolic miniature aircraft is flown to the flight director command cue. The command cue will move from view if a failure occurs in either the pitch or roll channel.

26.11 ENHANCED GROUND PROXIMITY WARNING SYSTEM (EGPWS)

26.11.1 System Description

The Mark VII EGPWS system consists of the EGPWS computer that is provided inputs from the NAV receivers, air data computer, radio altimeter, and FMS. The EGPWS displays graphic terrain advisory data on the Multi-Function Display (MFD) located on the center instrument panels.

The EGPWS integrates three alerting functional areas into a single Line Replaceable Unit (LRU) called the Enhanced Ground Proximity Warning Computer (EGPWC). These functional areas are:

Ground Proximity Warning (including altitude and bank angle advisories).

Terrain (or Obstacle) Alerting and Display (TAD) (including manmade obstacles).

Terrain Clearance Floor (TCF).

The system operates by accepting a variety of aircraft parameters as inputs, applying alerting algorithms and providing the flightcrew with aural alert messages and visual annunciations and displays in the event that the boundaries of any alerting envelope are exceeded. The system comprises the following groups of components:

Aircraft sensors and other systems providing input signals.

The Enhanced Ground Proximity Warning Computer (EGPWC).

Flight compartment audio systems (speakers and headphones).

Annunciators and switch/annunciators, mode and selector switches, and terrain display.

The EGPWS is designed to be fully compatible with normal aircraft operations. Unwanted alerts will be very rare if the pilot maintains situational awareness with respect to the terrain. There is normally no requirement for pilot input to the system, except for preflight self-testing.

The Ground Proximity Warning System (GPWS) modes 1 through 5 and mode 6 altitude callout functions employ the same algorithms that are used in the non-enhanced GPWS systems. Refer to Figure 26-49.

Mode	Function	Caution	Warning
Mode 1	Excessive descent rate	SINK RATE	PULL UP
Mode 2	Excessive closure to terrain	TERRAIN	PULL UP
Mode 3	Altitude loss after takeoff	DON'T SINK, DON'T SINK	
Mode 4A Mode 4B Mode 4C	Unsafe terrain clearance	TOO LOW, GEAR; TOO LOW, FLAPS; TOO LOW, TERRAIN	
Mode 5	Excessive glideslope deviation	GLIDESLOPE	
Mode 6	Advisory callouts	ONE THOUSAND; FIVE HUNDRED; MINIMUMS, MINIMUMS	
Mode 6	Bank angle callouts	BANK ANGLE, BANK ANGLE	

Figure 26-49. EGPWS Modes

26.11.1.1 Terrain (or Obstacle) Alerting and Display and Terrain Clearance Floor

The major "new" functions of the EGPWS are the TAD and the TCF. Refer to Figure 26-50. These functions use geographic aircraft position, aircraft altitude and a terrain database to predict potential conflicts between the aircraft flight path and the terrain or cataloged manmade obstacles, and to provide graphic displays of the conflicting terrain. Obstacles of 100 feet or more have been included from a database provided by NOAA that covers North America and parts of the Caribbean.

Mode	Function	Caution	Warning
TAD	(Terrain Alerting) (Obstacle Alerting)	CAUTION TERRAIN, CAUTION TERRAIN; CAUTION OBSTACLE, CAUTION OBSTACLE	TERRAIN, TERRAIN, PULL UP; PULL UP repeats OBSTACLE, OBSTACLE, PULL UP; PULL UP repeats
TCF	Terrain Clearance Floor	TOO LOW, TERRAIN	TERRAIN, TERRAIN, PULL UP

Figure 26-50. EGPWS Terrain Function

26.11.1.1.1 Terrain (or Obstacle) Alerting and Display (TAD)

The TAD alerting algorithms continuously compute terrain clearance envelopes ahead of the aircraft. If the boundaries of these envelopes conflict with terrain elevation data in the terrain database, then alerts are issued. Two envelopes are computed, one corresponding to a terrain caution alert level and the other to a terrain warning alert level.

The caution and warning envelopes use the TCF as a baseline and look ahead of the aircraft in a volume that is calculated as a function of groundspeed, flight path angle, and track.

If the aircraft penetrates the caution envelope boundary, the aural message CAUTION TERRAIN, CAUTION TERRAIN or CAUTION OBSTACLE, CAUTION OBSTACLE is generated, and alert discretes are provided for activation of the amber GPWS annunciators. Simultaneously, terrain areas, which conflict with the caution criteria, are shown in solid yellow color on the display.

If the aircraft penetrates the warning envelope boundary, the aural message TERRAIN, TERRAIN, PULL UP! or OBSTACLE, OBSTACLE, PULL UP! is generated, and alert discretes are provided for activation of the red PULL UP annunciators. Simultaneously, terrain areas that conflict with the warning criteria are shown in solid red color on the display.

Terrain picture data may be selected in place of the weather radar display on the Multi-Function Display (MFD) at any time. When the conditions for either a terrain caution or a terrain warning are dictated, the system automatically changes the MFD from the weather radar picture to the terrain picture and automatically selects 10 nm range. If auto pop-up occurs, once clear of the conflict, any other display range will have to be manually selected.

Areas of terrain that satisfy the terrain caution alert criteria are shown in solid yellow, and areas of terrain that satisfy the terrain warning alert criteria are shown in solid red. Terrain that is sufficiently close to the aircraft, but does not satisfy the caution or warning criteria, is shown as red, yellow, or green dot patterns. The density of the dot pattern is coarsely varied to depict terrain altitude with respect to the aircraft. All displayed terrain areas or obstacles are shown as rectilinear shapes that are designed to be easily distinguishable from the display of weather radar images. Magenta (purple) dot patterns are used to indicate areas where terrain information is unavailable.

The TAD and TCF functions may be inhibited by manual selection of the flight compartment GPWS TERR INHBT button. Neither loss (GPWS TERR N/A) nor inhibited TAD/TCF affects the basic GPWS functions (modes 1 to 6).

26.11.1.1.2 Terrain Clearance Floor (TCF)

The TCF alert adds an additional element of protection to the standard ground proximity warning modes. It creates an increasing terrain clearance envelope around the nearest airport runway. TCF alerts are based on current aircraft location, nearest runway center point position, and radio altitude. TCF protection is active regardless of aircraft flight configuration.

26.11.1.2 Switches/Annunciators

Annunciators and switches (external to the EGPWS display) control and annunciate the status of the various modes of the EGPWS. There are three switch-lights and one annunciator located on the center instrument panel near the MFD. There are two sets of switch-lights, GPWS/PULLUP and G/S INHBT, located on the pilot and copilot side of the glareshield. There is one GPWS INOP annunciator located on the master caution panel.

26.11.1.2.1 Upper Center Panel

1. GPWS TEST/GPWS/PULL UP — Annunciator/switch:

   a. GPWS TEST — Not a light. Legend is a permanent white placard on black outer bezel. Momentary push button to initiate system self-test.

   b. GPWS — Legend is amber on black. Illuminates during EGPWS cautionary advisories for modes 1 through 6 and enhanced terrain.

   c. c.PULL UP — Legend is (flashing) red on black. Illuminates for mode 1 SINK-RATE, mode 2 TERRAIN and enhanced PULL UP messages.

2. G/S INHBT — Annunciator/switch.

   a. G/S — Legend is white on black background and is always illuminated.

   b. INHBT — Legend is amber on black. Momentary push button to inhibit or restore glideslope mode 5 warning. Legend illuminates only when glideslope is inhibited.

26.11.1.2.2 Center Instrument Panel Near MFD

1. TERR/ON — Annunciator/switch.

   a. TERR — Illuminates green (on black) all the time.

   b. ON — Illuminates green (on black) when terrain is selected. Momentary push button to manually turn MFD terrain on or off. “Pop-Up” mode still armed when manual button is in the off position.

2. GPWS TERR INHBT — Annunciator/switch.

   Legend is white on black background when not activated. Legend illuminates amber on black background when terrain display is inhibited. Alternate action button to inhibit the terrain pop-up display on MFD.

3. GPWS FLAP ORIDE — Annunciator/switch.

   Legend is permanent white on black background. Background illuminates amber when flap warnings disabled. Alternate action button to override or restore mode 2 and mode 4 flap warnings.

4. GPWS TERR N/A — Annunciator.

   Legend is amber on black background. Illuminates only when GPWS terrain information is not available.

26.11.1.2.3 Master Caution Panel

GPWS INOP — Annunciator.

Legend is amber. Illuminates when any of the modes 1 through 6 are inoperative.

26.11.1.3 EGPWS Modes 1 to 6

The EGPWS is designed to help prevent accidents caused by Controlled Flight Into Terrain (CFIT). The system achieves this objective by accepting a variety of aircraft parameters as inputs, applying alerting algorithms, and providing the flightcrew with aural alert messages and visual displays in the event that the boundaries of any alerting envelope are exceeded. The system operates in six modes: excessive descent rate to terrain, excessive closure rate to terrain, alert to descent after takeoff, insufficient terrain clearance, inadvertent descent to glideslope, and altitude callouts and excessive bank angle alert.

26.11.1.3.1 Mode 1

Provides the flightcrew with alert/warning for high descent rate into terrain with an average 20 seconds time to impact. This mode also increases alert/warning for sink rate near the runway threshold. The flightcrew receives an alert for rapidly building sink rates exceeding 1,000 feet per minute (fpm).

26.11.1.3.2 Mode 2

Allows for the display of threatening terrain, permitting virtual “look ahead” warnings. CAUTION TERRAIN and TERRAIN AHEAD alerts based on position data and terrain database precede the GPWS warning. Using the speed of the aircraft to expand the warning envelope increases warning time for closure rate to terrain.

26.11.1.3.3 Mode 3

Alerts the flightcrew to an inadvertent descent into terrain after takeoff or missed approach. The alert is given after significant barometric altitude loss has occurred and allows considerable margin for third segment acceleration and flap retraction even under engine-out conditions. Additional warning protection is provided against a shallow accelerating climb into rising terrain during initial climb out.

26.11.1.3.4 Mode 4

Warns the flightcrew of insufficient terrain clearance during climb out, cruise, and initial descent and approach. This warning mode is especially valuable when the aircraft flight path relative to terrain is insufficient to develop excessive closure rate or descent rate warnings. TCF uses navigation position data coupled with the airport/runway database to provide valuable protection in the landing configuration.

26.11.1.3.5 Mode 5

Is armed when an ILS frequency is selected and the gear extends. The warning envelope contains two boundaries: a “soft” alert region and a “hard” alert region. Both boundaries are a function of glideslope deviation. When the aircraft penetrates the “soft” alert region, the aural GLIDESLOPE warning is given at a normal rate. If the glideslope deviation continues to increase, the EGPWS enters the “hard” alert region and increases the frequency of the alert.

26.11.1.3.6 Mode 6

Altitude callouts are optionally available in mode 6. These callouts include aural warnings at 1,000 feet and 500 feet AGL and a callout for MINIMUMS based on the altitude bug setting on the radio altimeter indicator. A bank angle alert is available to notify the flightcrew that the aircraft bank has exceeded 40° at 150 feet AGL, to 10° at 30 feet AGL.

26.11.1.4 System Activation

The EGPWS is fully operational when electrical power is on, the GPWS INOP and GPWS TERR N/A messages are not displayed and the following systems are operational:

Enhanced Ground Proximity Warning Computer (EGPWC).

Radio altimeter.

Air data computer.

VHF NAV receiver 1 or 2.

FMS.

Gear and flaps indicating systems.

Display system (MFD).

The GPWS INOP annunciation signifies a failure of the GPWS. The GPWS TERR N/A annunciation indicates that the GPWS enhanced features TAD and TCF are not available.

Note

In the event that the radio altimeter is not functioning, the basic GPWS modes (1 to 6) and TCF will not be available; however, the enhanced feature of the TAD will be available.

If the EGPWS TAD or TCF features become inoperative either because of a system fault or inaccurate position information, the system basic GPWS functions modes (1 to 6) will still be available.

26.11.1.5 GPWS Circuit Protection

The following circuit breaker is associated with the EGPWS:

Nomenclature	Bus	Location	Amps
GPWS	BUS NO. 1	Right Sidewall CB Panel	5

26.11.1.6 Advisory Altitude Callouts (Mode 6)

The following advisory callouts are provided in this installation:

MINIMUMS-MINIMUMS — Announces based on the setting of the pilot decision height selection based on DH bug setting on radio altimeter.

BANK ANGLE, BANK ANGLE: Announces when an excessive roll angle is achieved. Refer to Figure 26-51.

26.11.1.7 Pop-up Display

In the event of a terrain alert, the display will automatically switch to display terrain. The display may be manually selected to display weather radar, if desired, when the terrain alert has ceased.

26.11.1.8 Use of the Terrain Awareness Display

The terrain awareness display may be shown on the MFD by pressing the TERR ON button. Ranging is controlled by the increase ▲ and decrease ▼ RANGE buttons on the MFD control panel. A numeric field in the lower right of the MFD provides the Mean Sea Level (MSL) heights of the highest and lowest terrain within the displayed range.

WARNING

If the weather radar is ON and TAD is selected for display, the weather radar is still transmitting. On ground operations, make sure outside personnel are not within 25 feet of area scanned by radar.

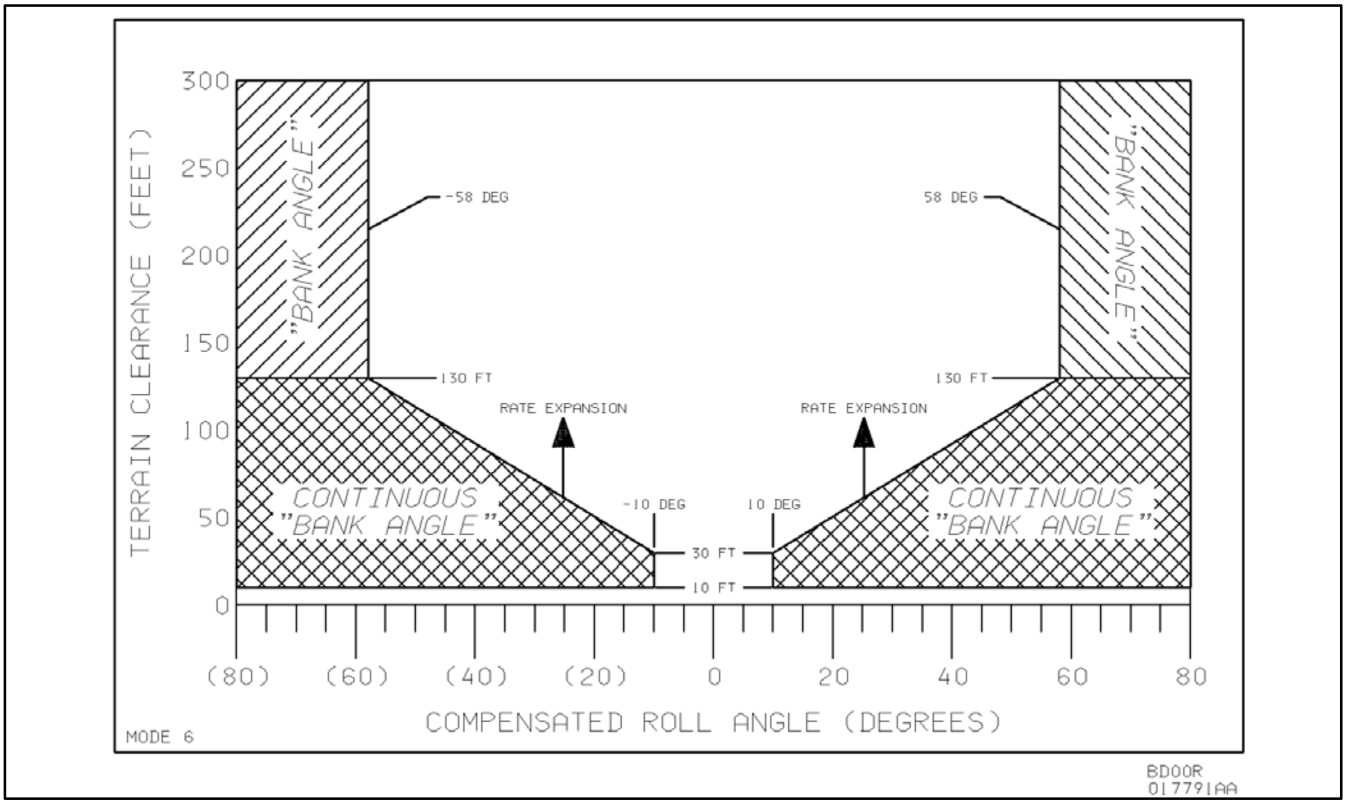


Figure 26-51. Bank Angle — Mode 6C

CAUTION

The terrain display is intended to serve as a situational awareness tool only and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.

26.11.1.9 Aural Declutter

The aural declutter feature provides for a reduction in repetition of warning messages. This feature affects modes 1, 3, 4, and 5.

26.11.1.9.1 Mode 1

Excessive Descent Rate: With Audio-Declutter the alert/warning message for penetration of the outer boundary will be repeated twice, then will remain silent unless the Excessive Descent Rate condition degrades by approximately 20 percent, as determined by the computed time to impact (i.e., Radio Altitude/Altitude Rate). If a 20 percent degradation in time to impact is computed, then an additional two messages are given and the cycle repeats. This situation will continue until the alert/warning boundary is exited or until the mode 1 inner boundary is penetrated.

26.11.1.9.2 Mode 3

Descent after Takeoff: The aural alert message will repeat twice and remain silent until altitude degrades an additional 20 percent. If an additional 20 percent degradation is realized, then two additional messages are given and the cycle repeats. This function will desensitize over time and by an increase in altitude. The caution annunciator remains illuminated until the Descent after Takeoff condition has been corrected.

26.11.1.9.3 Mode 4

Unsafe Terrain Clearance: The aural alert message will repeat twice and remain silent until altitude degrades an additional 20 percent. If an additional 20 percent degradation is realized, then two additional messages are given and the cycle repeats. This function will desensitize over time and by an increase in altitude. The caution annunciator remains illuminated until the Unsafe Terrain Clearance condition has been corrected.

26.11.1.9.4 Mode 5

Descent below Glideslope: The aural alert message will be given once. Follow-on alerts will be provided for each additional 20 percent that the aircraft descends below glideslope. A hard double GLIDESLOPE will occur at 300 feet. with two dots or more deviation. This will be repeated every 3 seconds and the caution annunciator will remain illuminated until the Descent below Glideslope condition has been corrected.

26.11.1.10 Alert Priorities

When an EGPWS warning or caution occurs, the Traffic Collision and Avoidance System (TCAS) is placed in TA ONLY (Traffic Advisory) mode, inhibiting all TCAS aural messages (Figure 26-52).

The following lists the priority of the warnings and alerts:

EGPWS Priority	Alert
1	Mode 1 Pull Up
2	Mode 2 Pull Up
3	Terrain Awareness Warning
4	Obstacle Awareness Warning
4	Mode 2 Terrain
5	Mode 6 Minimums
5	Terrain Awareness Caution
6	Obstacle Awareness Caution
7	Mode 4 Too Low, Terrain
7	TCF Too Low, Terrain
8	Mode 6 Altitude Callouts
9	Mode 4 Too Low, Gear
10	Mode 4 Too Low, Flaps
11	Mode 1 Sink Rate
12	Mode 3 Don't Sink
13	Mode 5 Glideslope
14	Mode 6 Bank Angle

Figure 26-52. EGPWS Alert Priorities

26.11.1.11 System Constraints

If there is no terrain data in the database for a particular area, the affected area is colored magenta.

If the TAD and TCF features of the EGPWS have been inhibited, the EGPWS will revert to basic GPWS protection (modes 1 to 6). In the standard GPWS condition, the system may give little or no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. If the aircraft is flown toward obstructing terrain, the GPWS will give no warnings if all the following conditions apply:

The aircraft is in landing configuration.

The aircraft is in a stabilized descent at a normal approach descent rate.

There is no ILS glideslope signal being received by the EGPWS (i.e., there is no ILS available or the glideslope receiver connected to the EGPWC is not tuned to the appropriate ILS frequency).

Terrain clearances or descent rates during radar vectoring that are not compatible with those required by the minimum regulatory standards for Ground Proximity Warning equipment may cause unwanted warnings or alerts.

Note

- When the GPWS TERR INHBT button/annunciator is selected, the basic GPWS functions remain operational.
- The EGPWS database currently accounts for limited cataloged manmade obstructions within North America and parts of the Caribbean.

26.11.1.12 EGPWS Basic Function Modes

26.11.1.12.1 Mode 1 — Excessive Descent Rate

Mode 1 provides alerts for excessive descent rates with respect to altitude AGL and is active for all phases of flight. This mode has inner and outer alert boundaries.

Penetration of the outer boundary activates the EGPWS caution lights and SINK RATE, SINK RATE alert enunciation. Additional SINK RATE, SINK RATE messages will occur for each 20 percent degradation.

Penetration of the inner boundary activates the EGPWS warning lights and changes the audio message to PULL UP, which repeats continuously until the inner warning boundary is exited. Refer to Figure 26-53.

26.11.1.12.2 Mode 2 — Excessive Closure to Terrain

Mode 2 provides alerts to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on radio altitude and on how rapidly radio altitude is decreasing (closure rate). Mode 2 exists in two forms: 2A and 2B.

26.11.1.12.2.1 Mode 2A

Mode 2A is active during climbout, cruise and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centerline). If the aircraft penetrates the mode 2A caution envelope, the aural message TERRAIN, TERRAIN is generated and flight compartment EGPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the EGPWS warning lights will illuminate and the aural warning message PULL UP is repeated continuously until the warning envelope is exited.

TERRAIN will be given until the terrain clearance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 feet of barometric altitude, 45 seconds has elapsed, or landing flaps or the flap override switch is activated. Refer to Figure 26-54.

26.11.1.12.2.2 Mode 2B

Mode 2B provides a desensitized alerting envelope to permit normal landing approach maneuvers close to terrain without unwanted alerts. Mode 2B is automatically selected with flaps in the landing configuration (landing flaps or flap override selected) or when making an ILS approach with glideslope and localizer deviation less than 2 dots. It is also active during the first 50 seconds after takeoff. Refer to Figure 26-55.

26.11.1.12.3 Mode 3 — Altitude Loss After Takeoff

Mode 3 provides alerts for significant altitude loss after takeoff or low altitude go-around (less than 245 feet AGL) with gear or flaps not in the landing configuration. The amount of altitude loss that is permitted before an alert is given is a function of the height of the aircraft above the terrain as shown below. This protection is available until the EGPWS determines that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight. Significant altitude loss after takeoff or during a low altitude go-around activates the EGPWS caution lights and the aural message DON'T SINK, DON'T SINK. The aural message is only enunciated twice unless altitude loss continues. Refer to Figure 26-56.

26.11.1.12.4 Mode 4 — Unsafe Terrain Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration, and speed. Mode 4 exists in three forms: 4A, 4B and 4C.

26.11.1.12.4.1 Mode 4A

Mode 4A is active during cruise and approach with gear and flaps up. Refer to Figure 26-57.

Below 800 feet AGL and above 178 knots airspeed, the mode 4A aural alert is TOO LOW, TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 400 feet at 178 knots to 800 feet at 226 knots.

Below 400 feet AGL and less than 178 knots airspeed, the mode 4A aural alert is TOO LOW, GEAR.

26.11.1.12.4.2 Mode 4B

Mode 4B is active during cruise and approach, with gear down and flaps not in the landing configuration. Refer to Figure 26-58.

Below 800 feet AGL and above 159 knots airspeed, the mode 4B aural alert is TOO LOW, TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 245 feet at 159 knots to 800 feet at 226 knots.

Below 245 feet AGL and less than 159 knots airspeed, the mode 4B aural alert is TOO LOW, FLAPS. If desired, the pilot may disable the TOO LOW, FLAPS alert by engaging the GPWS FLAP ORIDE switch. This precludes or silences the mode 4B flap alert until reset by the pilot.

26.11.1.12.4.3 Mode 4C

The mode 4C alert is intended to prevent inadvertent controlled flight into the ground during takeoff climb into terrain that produces insufficient closure rate for a mode 2 alert. After takeoff, mode 4A and 4B provide this protection. Refer to Figure 26-59.

Mode 4C is based on an EGPWS computed Minimum Terrain Clearance (MTC) floor, which increases with radio altitude. It is active after takeoff when the gear or flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

At takeoff the MTC is zero feet. As the aircraft ascends the MTC is increased to 75 percent of the aircraft radio altitude (averaged over the previous 15 seconds). This value is not allowed to decrease and is limited to 400 feet AGL for airspeed less than 178 knots. Beginning at 178 knots, the MTC increases linearly to the limit of 800 feet at 226 knots.

If the aircraft radio altitude decreases to the value of the MTC, the EGPWS caution lights and the aural message TOO LOW, TERRAIN are provided.

26.11.1.12.5 Mode 5 — Excessive Deviation Below Glideslope

Mode 5 provides two levels of alerting for when the aircraft descends below glideslope, resulting in activation of EGPWS caution lights and aural messages. Refer to Figure 26-60.

The first level alert occurs when below 1,000 feet radio altitude and the aircraft gets 1.3 dots or greater below the beam. This turns on the caution lights and is called a “soft” alert because the audio message GLIDESLOPE is enunciated at half volume. Twenty percent increases in the glideslope deviation cause additional GLIDESLOPE messages enunciated at a progressively faster rate.

The second level alert occurs when below 300 feet radio altitude with 2 dots or greater glideslope deviation. This is called a “hard” alert because a louder GLIDESLOPE, GLIDESLOPE message is enunciated every 3 seconds continuing until the “hard” envelope is exited. The caution lights remain on until a glideslope deviation less than 1.3 dots is achieved.

To avoid unwanted below glideslope alerts when capturing the localizer between 500 and 1,000 feet AGL, alerting is varied in the following ways:

1. Below glideslope alerts are enabled only if the localizer is within 2 dots, landing gear and flaps are selected, glideslope cancel is not active, and a front course approach is determined.

2. The upper altitude limit for the alert is modulated with vertical speed. For descent rates lower than 500 fpm, the upper limit is set to the normal 1,000 feet AGL. For descent rates lower than 500 fpm, the upper limit is desensitized (reduced) to a minimum of 500 feet AGL.

EGPWS mode 5 alerts are inhibited during backcourse approaches to prevent nuisance alerts due to false fly up lobes from the glideslope.

26.11.1.12.6 Mode 6 — Altitude Advisory Callouts

Mode 6 provides EGPWS advisory callouts based on the menu-selected option established at installation. These callouts consist of predefined radio altitude based voice callouts or tones and an excessive bank angle warning. There is no visual alerting provided with these callouts. The altitude callouts are:

ONE THOUSAND	1,000
FIVE HUNDREDS	500
MINIMUMS MINIMUMS	DH

Decision Height (DH) based callouts, MINIMUMS, require the landing gear to be DOWN and occur when descending through the radio altitude corresponding to the selected DH.

The “500” callout is intended to assist pilots during a nonprecision approach by enunciating FIVE HUNDRED feet independent of the altitude callout menu selection discussed above. The EGPWS determines a nonprecision approach when localizer or glideslope are greater than 2 dots deviation (valid or not) or a back-course approach is detected.

The callout BANK ANGLE, BANK ANGLE advises of an excessive roll angle.

The envelope provides a bank angle advisory (shaded area). Bank angle advisories are inhibited below 10 feet.

±10° between 10 and 30 feet.
±10 to 58° between 30 and 130 feet.
±58° above 130 feet.

Refer to Figure 26-51.

26.12 EGPWS BASIC FUNCTION MODES

26.12.1 Mode 1 — Excessive Descent Rate

Mode 1 provides alerts for excessive descent rates with respect to altitude AGL and is active for all phases of flight. This mode has inner and outer alert boundaries.

Penetration of the outer boundary activates the EGPWS caution lights and SINK RATE, SINK RATE alert enunciation. Additional SINK RATE, SINK RATE messages will occur for each 20 percent degradation.

Penetration of the inner boundary activates the EGPWS warning lights and changes the audio message to PULL UP, which repeats continuously until the inner warning boundary is exited. Refer to Figure 26-53.

26.12.2 Mode 2 — Excessive Closure to Terrain

Mode 2 provides alerts to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on Radio Altitude and on how rapidly Radio Altitude is decreasing (closure rate).

Note

Mode 2 exists in two forms: Modes 2A and 2B.

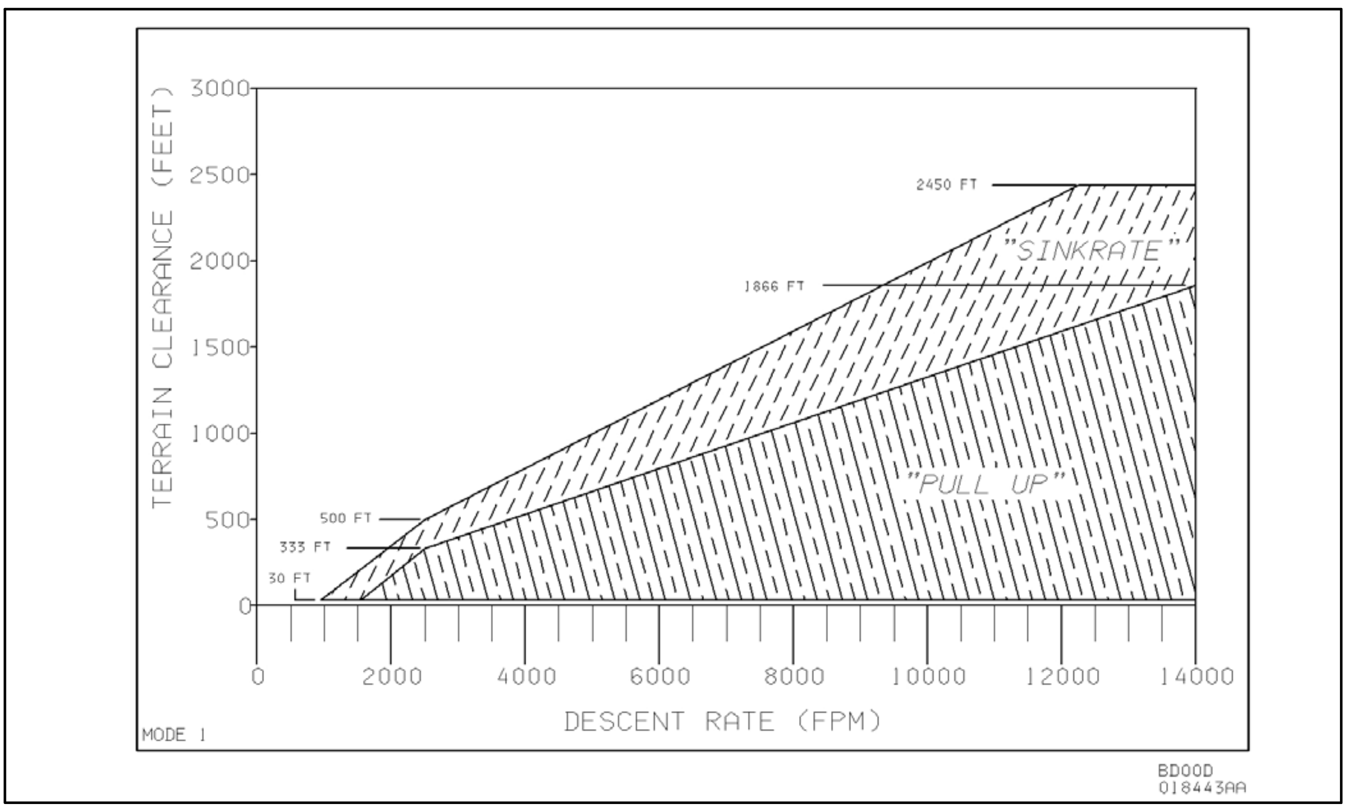


Figure 26-53. Excessive Descent Rate — Mode 1

26.12.2.1 Mode 2A

Mode 2A is active during climbout, cruise, and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centerline). If the aircraft penetrates the Mode 2A caution envelope, the aural message TERRAIN, TERRAIN is generated and cockpit EGPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the EGPWS warning lights will illuminate and the aural warning message PULL UP is repeated continuously until the warning envelope is exited. TERRAIN will be repeated until the terrain clearance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 feet of barometric altitude, 45 seconds has elapsed, or landing flaps or the flap override switch is activated. Refer to Figure 26-54.

26.12.2.2 Mode 2B

Mode 2B provides a desensitized alerting envelope to permit normal landing approach maneuvers close to terrain without unwanted alerts. Mode 2B is automatically selected with flaps in the landing configuration (landing flaps or flap override selected) or when making an ILS approach with Glideslope and Localizer deviation less than 2 dots. It is also active during the first 50 seconds after takeoff. Refer to Figure 26-55.

26.12.3 Mode 3 — Altitude Loss after Takeoff

Mode 3 provides alerts for significant altitude loss after takeoff or low altitude go-around (less than 245 feet AGL) with gear or flaps not in the landing configuration. The amount of altitude loss that is permitted before an alert is given is a function of the height of the aircraft above the terrain as shown in the Mode 3 graph. This protection is available until the EGPWS determines that the aircraft has gained sufficient altitude that it is no longer in the takeoff phase of flight. Significant altitude loss after takeoff or during a low altitude go-around activates the EGPWS caution lights and the aural message DON'T SINK, DON'T SINK. The aural message is only enunciated twice unless altitude loss continues. Refer to Figure 26-56.

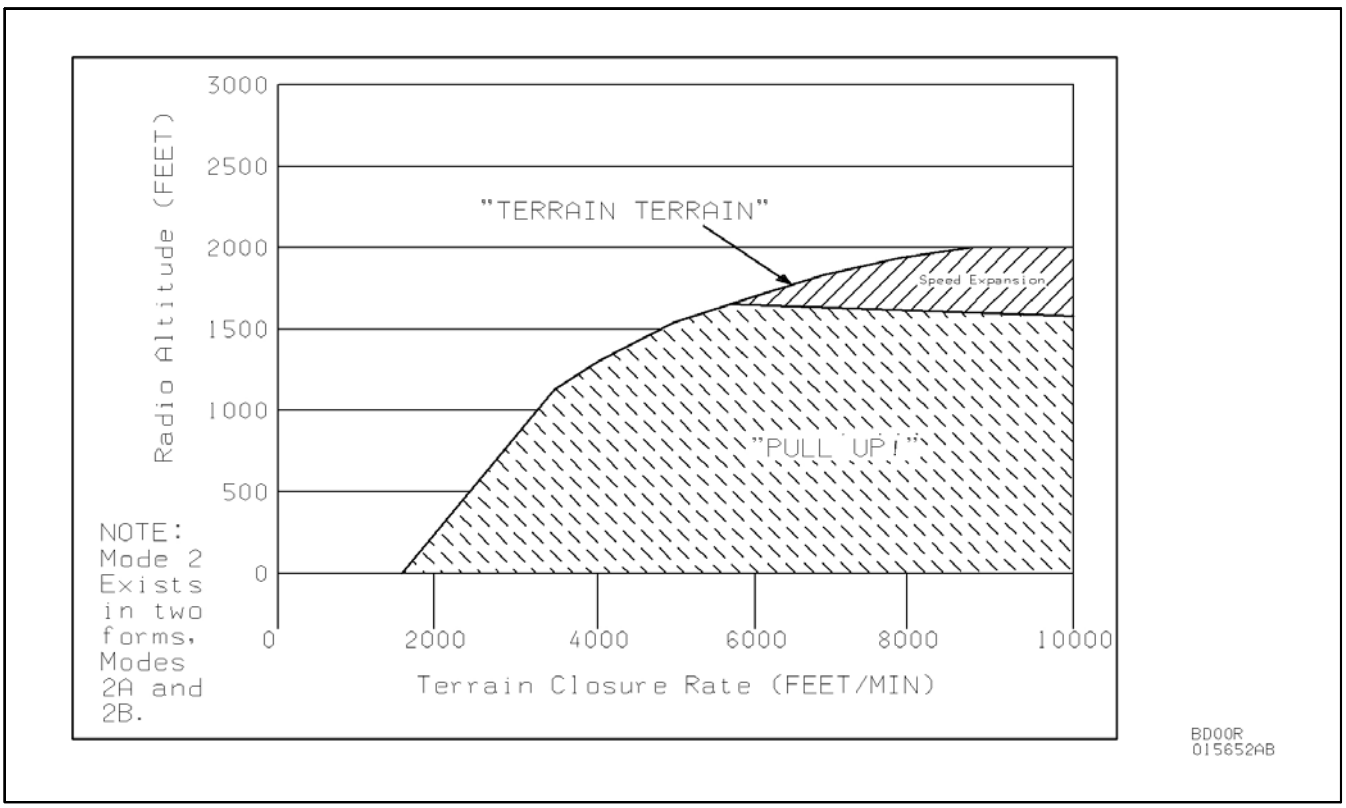


Figure 26-54. Excessive Closure to Terrain — Mode 2A

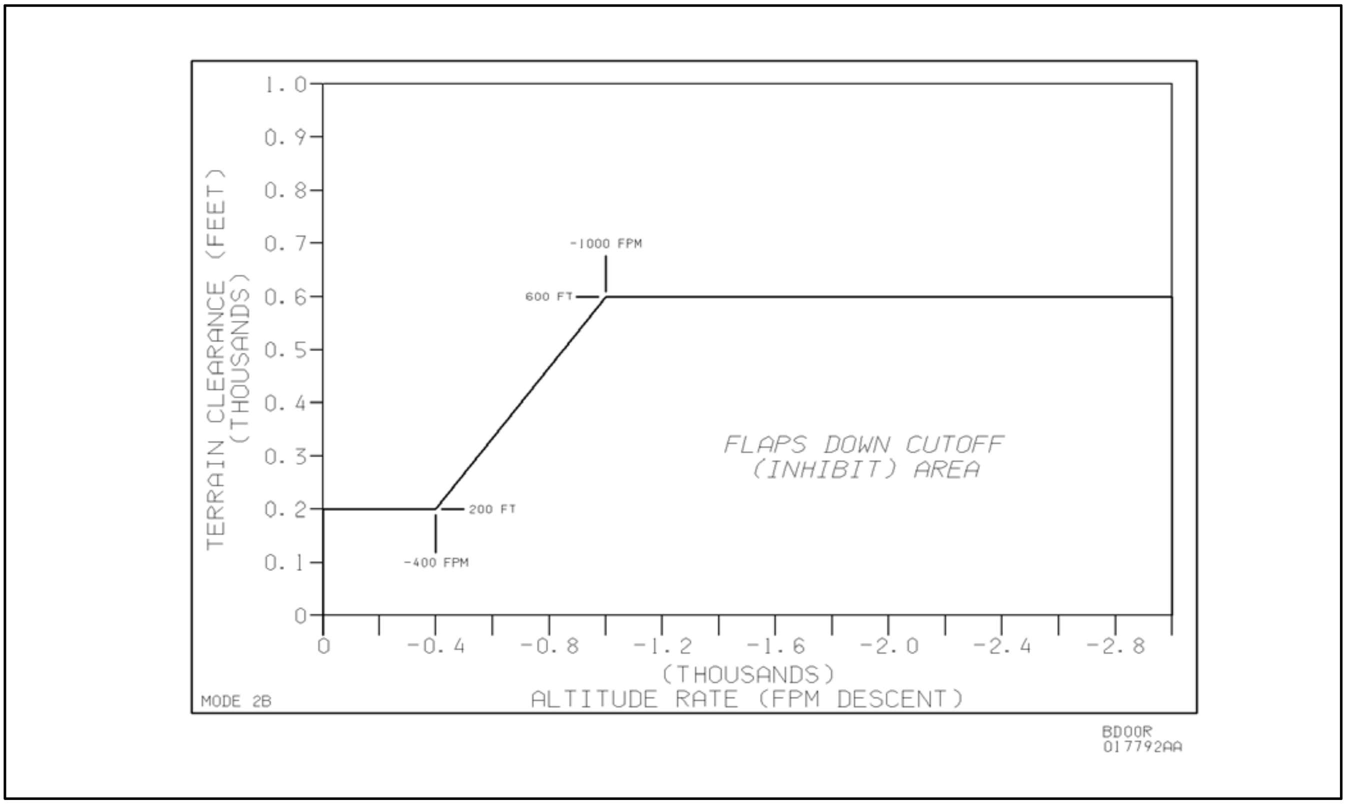


Figure 26-55. Excessive Closure to Terrain — Mode 2B

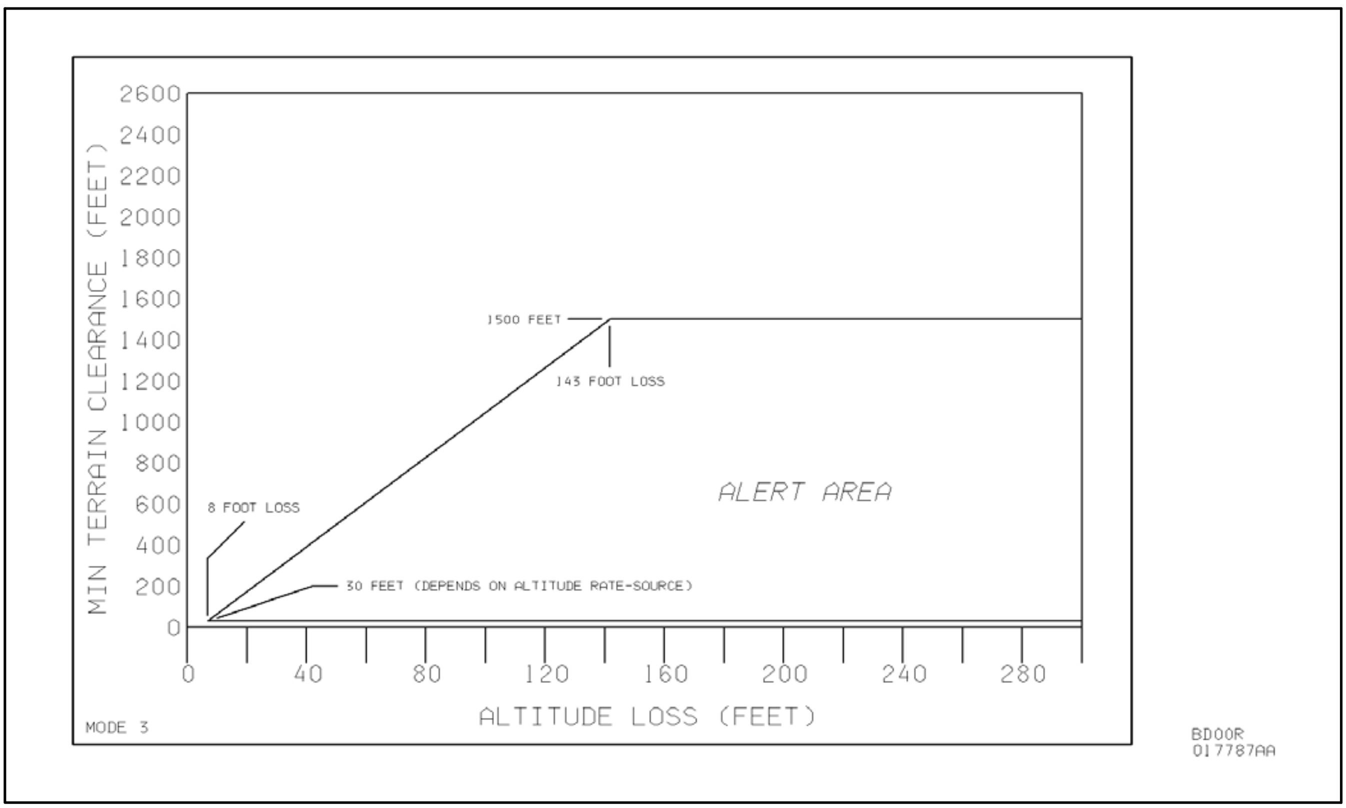


Figure 26-56. Altitude Loss after Takeoff — Mode 3

26.12.4 Mode 4 — Unsafe Terrain Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration, and speed.

Note

- Mode 4 exists in three forms: 4A, 4B and 4C.
- Mode 4A is active during cruise and approach with the gear and flaps not in the landing configuration.
- Mode 4B is active during cruise and approach with the gear in the landing configuration and flaps not in the landing configuration.
- Mode 4C is active during the takeoff phase of flight with either the gear or flaps not in the landing configuration.

26.12.4.1 Mode 4A

Mode 4A is active during cruise and approach with gear and flaps up.

Below 800 feet AGL and above 178 knots airspeed the Mode 4A aural alert is TOO LOW TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 400 feet at 178 knots to 800 feet at 226 knots.

Below 400 feet AGL and less than 178 knots airspeed, the Mode 4A aural alert is TOO LOW GEAR. Refer to Figure 26-57.

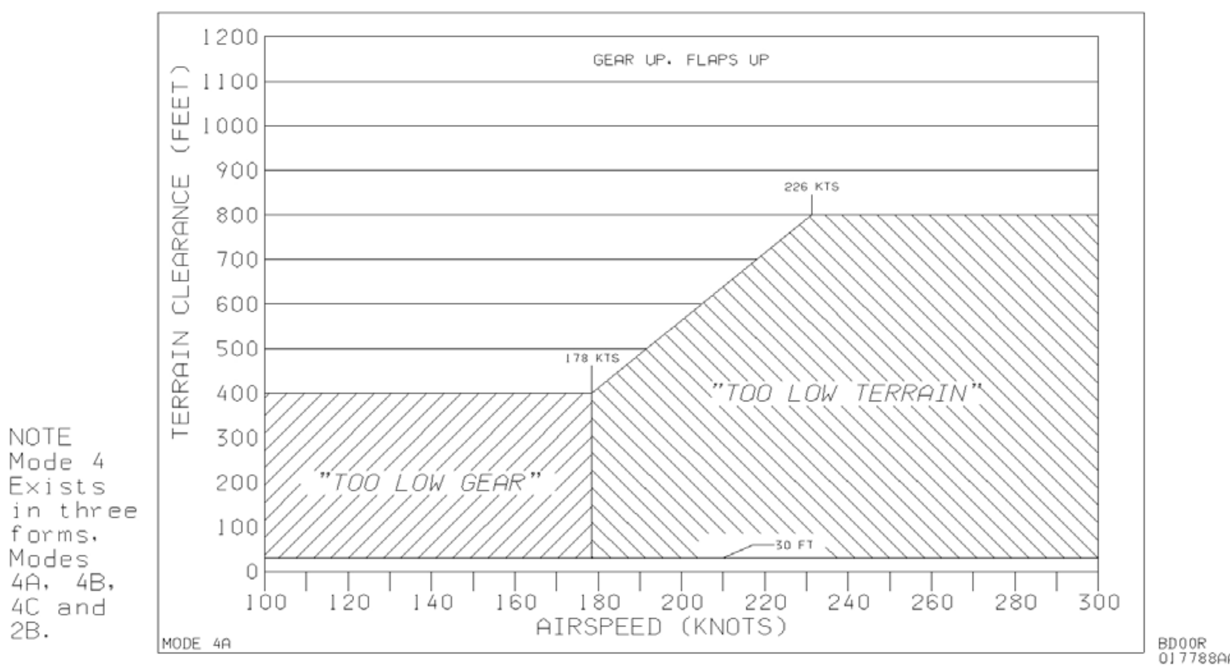


Figure 26-57. Unsafe Terrain Clearance — Mode 4A

26.12.4.2 Mode 4B

Mode 4B is active during cruise and approach, with gear down and flaps not in the landing configuration.

Below 800 feet AGL and above 159 knots airspeed, the Mode 4B aural alert is TOO LOW TERRAIN. This alert is dependent on aircraft speed such that the alert threshold is ramped between 245 feet at 159 knots to 800 feet at 226 knots.

Below 245 feet AGL and less than 159 knots airspeed, the Mode 4B aural alert is TOO LOW FLAPS. If desired the pilot may disable the TOO LOW FLAPS alert by engaging the Flap Override switch. This precludes or silences the Mode 4B flap alert until reset by the pilot. Refer to Figure 26-58.

26.12.5 Mode 4C

The Mode 4C alert is intended to prevent inadvertent controlled flight into the ground during takeoff climb into terrain that produces insufficient closure rate for a Mode 2 alert. After takeoff, Modes 4A and 4B provide this protection.

Mode 4C is based on an EGPWS computed Minimum Terrain Clearance (MTC) floor, which increases with Radio Altitude. It is active after takeoff when the gear or flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

At takeoff the Minimum Terrain Clearance (MTC) is zero feet. As the aircraft ascends the MTC is increased to 75 percent of the aircraft Radio Altitude (averaged over the previous 15 seconds). This value is not allowed to decrease and is limited to 400 feet AGL for airspeed less than 178 knots. Beginning at 178 knots, the MTC increases linearly to the limit of 800 feet at 226 knots.

If the aircraft Radio Altitude decreases to the value of the MTC, the EGPWS caution lights and the aural message TOO LOW TERRAIN are provided. Refer to Figure 26-59.

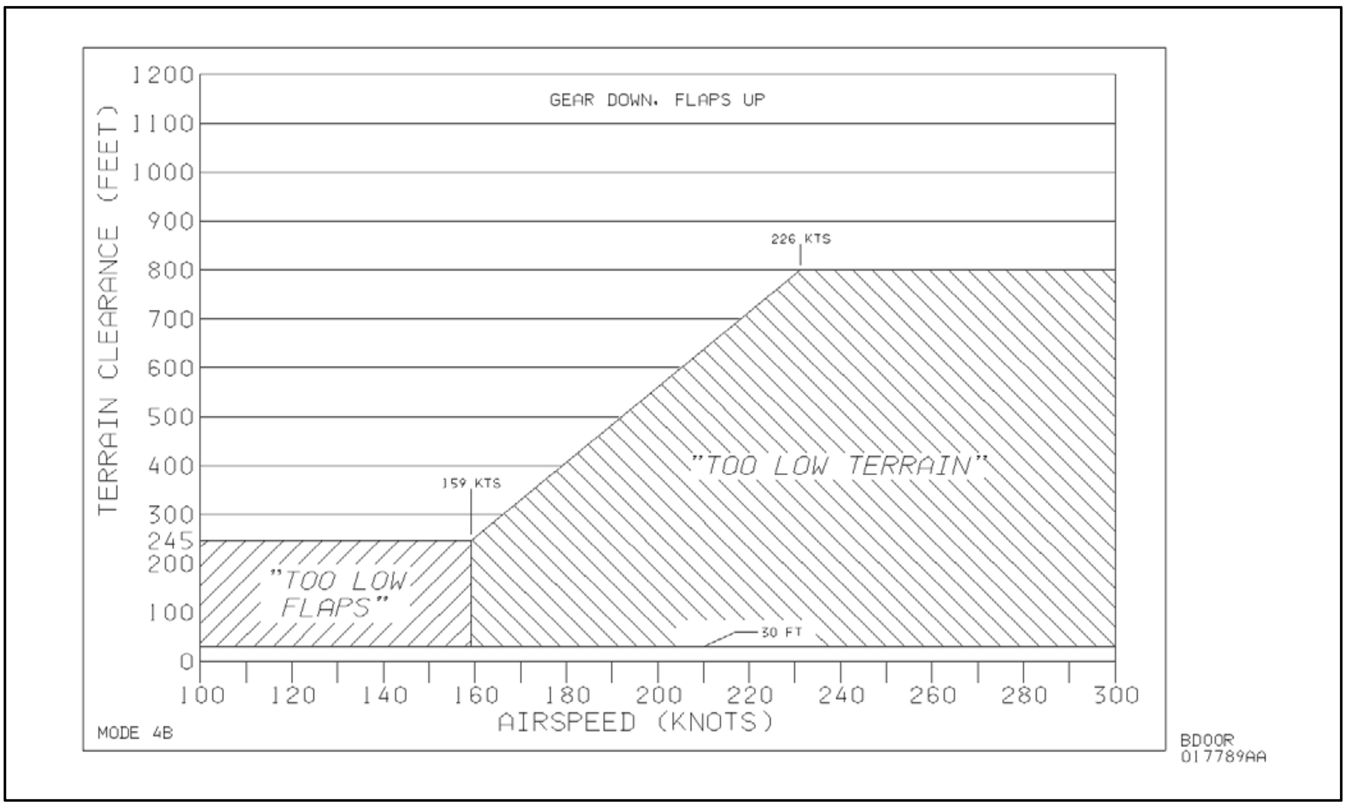


Figure 26-58. Unsafe Terrain Clearance — Mode 4B

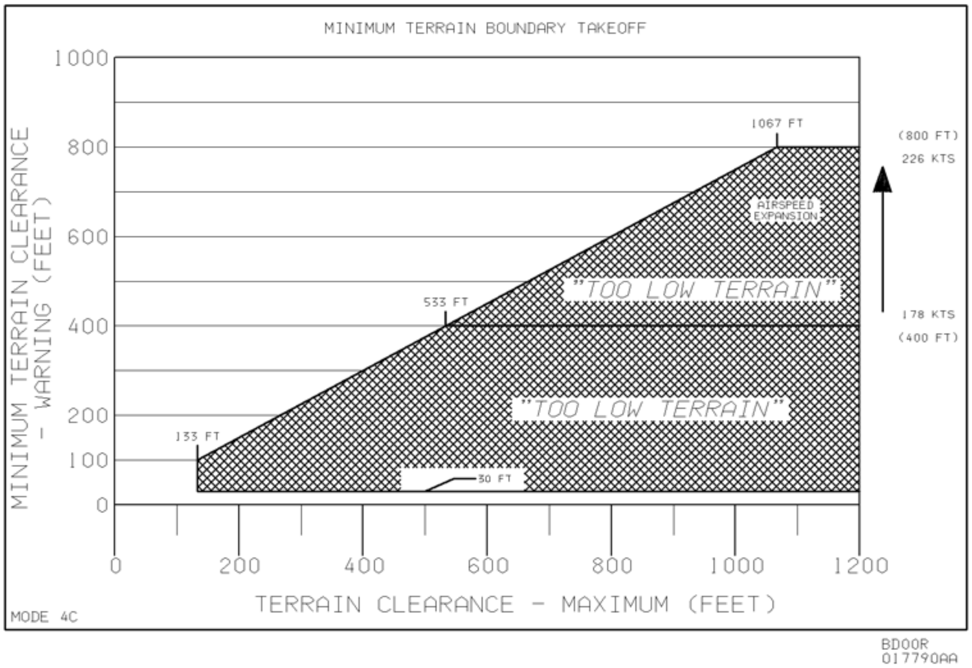


Figure 26-59. Unsafe Terrain Clearance — Mode 4C

26.12.6 Mode 5 — Excessive Deviation Below Glideslope

Mode 5 provides two levels of alerting for when the aircraft descends below glideslope, resulting in activation of EGPWS caution lights and aural messages.

The first level alert occurs when below 1,000 feet Radio Altitude and the aircraft gets 1.3 dots or greater below the beam. This turns on the caution lights and is called a “soft” alert because the audio message GLIDESLOPE is enunciated at half volume. Twenty percent increases in the glideslope deviation cause additional GLIDESLOPE messages enunciated at a progressively faster rate.

The second level alert occurs when below 300 feet Radio Altitude with 2 dots or greater glideslope deviation. This is called a “hard” alert because a louder GLIDESLOPE, GLIDESLOPE message is enunciated every 3 seconds continuing until the “hard” envelope is exited. The caution lights remain on until a glideslope deviation less than 1.3 dots is achieved. To avoid unwanted Below Glideslope alerts when capturing the localizer between 500 feet and 1,000 feet AGL, alerting is varied in the following ways:

> Below Glideslope alerts are enabled only if the localizer is within 2 dots and landing gear and flaps are selected. Glideslope Cancel is not active, and a front course approach is determined.
>
> The upper altitude limit for the alert is modulated with vertical speed. For descent rates above 500 fpm, the upper limit is set to the normal 1,000 feet AGL. For descent rates lower than 500 fpm, the upper limit is desensitized (reduced) to a minimum of 500 feet AGL.

EGPWS Mode 5 alerts are inhibited during backcourse approaches to prevent nuisance alerts due to false fly up lobes from the Glideslope. Refer to Figure 26-60.

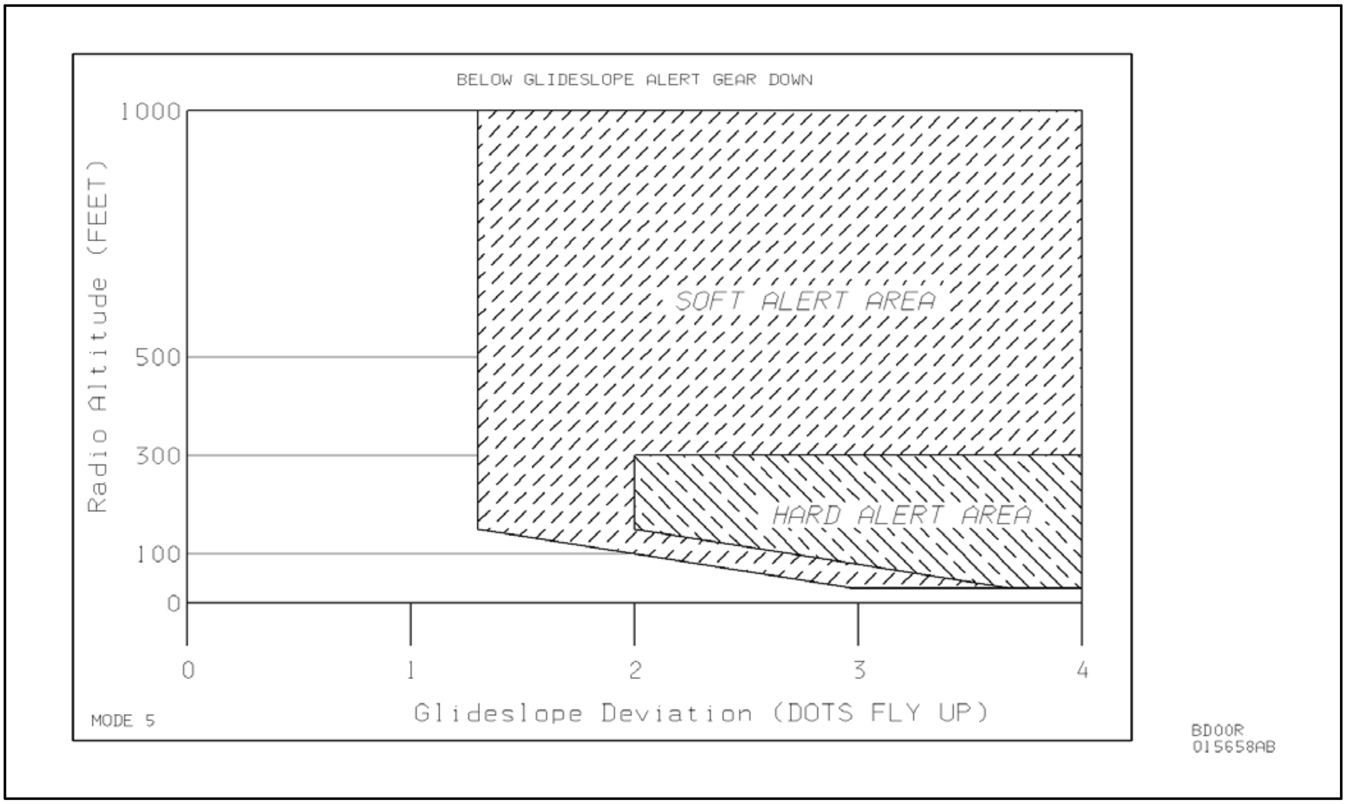


Figure 26-60. Excessive Deviation Below Glideslope — Mode 5

26.12.7 Mode 6 — Altitude Advisory Callouts

Mode 6 provides EGPWS advisory callouts based on the menu-selected option established at installation. These callouts consist of predefined Radio Altitude based voice callouts or tones and an excessive bank angle warning. There is no visual alerting provided with these callouts. The altitude callouts are:

ONE THOUSAND	1,000*
FIVE HUNDREDS	500*
MINIMUMS, MINIMUMS	DH

* May be Barometric Altitude above the field elevation.

Decision Height (DH) based callouts (Minimums) require the landing gear to be DOWN and occur when descending through the Radio Altitude corresponding to the selected DH.

The “500” callout is intended to assist pilots during a nonprecision approach by enunciating FIVE HUNDRED feet independent of the altitude callout menu selection discussed above. The EGPWS determines a nonprecision approach when Localizer or Glideslope are greater than 2 dots deviation (valid or not) or a back-course approach is detected.

The callout BANK ANGLE, BANK ANGLE advises of an excessive roll angle.

The envelope provides bank angle advisory (shaded area). Bank angle advisories are inhibited below 10 feet. Refer to Figure 26-51.

$\pm 10^\circ$ between 10 and 30 feet.
± 10 to 58° between 30 and 130 feet.
$\pm 58^\circ$ above 130 feet.

26.12.8 Limitations

Pilots are authorized to deviate from their current Air Traffic Control (ATC) clearance to the extent necessary to comply with an EGPWS warning.

Navigation must not be predicated upon the use of the Terrain (or Obstacle) Alerting and Display (TAD). The terrain display is intended to serve as a situational awareness tool only and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.

In order to avoid giving unwanted alerts, TAD must be inhibited when within 15 nm of a departure or arrival airport not contained in the EGPWS airport database.

In order to avoid unwanted alerts, TAD must be inhibited when the GPS is either degraded or inoperative.

The copilot altimeter provides barometric altitude input to the EGPWS. Hence, when using the EGPWS, the copilot altimeter must be set to the current barometric setting.

26.12.9 Normal Procedures

An EGPWS self-test should be performed prior to flight to make sure of proper operation.

26.12.9.1 Preflight Self-Test

26.12.9.1.1 Before Takeoff (Runup)

1. Assure the G/S INHBT and GPWS TERR INHBT functions are not engaged.

2. Select the MFD to MAP mode.

3. Press the PULL UP/GPWS TEST button for less than 2 seconds and verify the following:

   a. The amber GPWS INOP and GPWS TERR N/A annunciators illuminate then extinguish.

   b. Amber GPWS annunciator illuminates.

   c. The aural GLIDESLOPE message is announced.

   d. The amber GPWS annunciators extinguish.

   e. The red PULL UP annunciators illuminate.

   f. The aural PULL UP message is announced.

   g. The red PULL UP annunciators extinguish.

   h. The MFD “pops up” the ARC map mode and the terrain display test pattern is displayed.

   i. The red PULL UP annunciators illuminate.

   j. The aural TERRAIN, TERRAIN, PULL UP message is announced.

   k. The red PULL UP annunciators extinguish.

   l. The amber GPWS annunciators momentarily illuminate.

m. The terrain display test pattern is removed from the MFD after several sweeps.

26.12.9.1.2 Before Takeoff (Final Items)

EGPWS — On as required.

Note

Activation of the EGPWS by selecting TERR ON enables the EGPWS display on the MFD and disables the weather radar display on the MFD.

26.12.10 Abnormal Procedures

26.12.10.1 Landing

26.12.10.1.1 Landing with Flaps Up or Flaps Approach

GPWS FLAP ORIDE — Select.

When a procedure specifies landing with flap settings not normally used for landing, the GPWS FLAP ORIDE switch/annunciator can be used to simulate landing flaps. This will prevent the aural alert TOO LOW, FLAPS.

26.12.10.2 EGPWS Caution (GPWS Caution Annunciator Illuminated)

Any activation of aural alerts SINK RATE; TERRAIN, TOO LOW TERRAIN; DON'T SINK; TOO LOW, GEAR; TOO LOW, FLAPS; GLIDESLOPE; CAUTION TERRAIN or CAUTION OBSTACLE, perform one of the following according to the CAUTION received in Figure 26-61:

SINK RATE	Monitor terrain clearance visually, or with terrain display and reduce sink rate as necessary.
TERRAIN, TOO LOW TERRAIN; CAUTION TERRAIN or CAUTION OBSTACLE	Monitor terrain or obstacle clearance visually, or with terrain awareness display and reduce or stop sink rate or climb as necessary.
DON'T SINK	Correct sink rate and continue takeoff climb as required.
TOO LOW, GEAR TOO LOW, FLAPS	Extend landing gear or execute a go-around. Extend flaps or execute a go-around or select GPWS FLAP ORIDE for abnormal configuration landing.
GLIDESLOPE	Correct flight path back to glideslope or select G/S INHBT.

Figure 26-61. EGPWS Caution Annunciators

26.12.11 Emergency Procedures

26.12.11.1 Landing

For off-airport landing, the Terrain (or Obstacle) Alerting and Display (TAD) and Terrain Clearance Floor (TCF) functions should be inhibited by selecting the GPWS TERR INHBT annunciator/switch.

The GPWS circuit breaker may be used to deactivate the EGPWS for ditching, landing with an unsafe gear indication or landing with the gear up.

26.12.11.2 EGPWS Warning (GPWS Warning Annunciator Illuminated)

Any/or activation of the aural warning PULL UP; TERRAIN, TERRAIN, PULL UP; or OBSTACLE, OBSTACLE, PULL UP, perform the following action (refer to Figure 26-62).

1. Autopilot — Disconnect.
2. Propeller levers — Full forward.
3. Throttles — Takeoff power.
4. Pitch attitude — Increase and climb as required to avoid terrain.
5. Flaps — Up.
6. Landing gear — Up.
7. Pitch attitude — Maintain until warning ceases.
8. ATC — Notify (if required).

Mode	Indication		
	Visual Alert	**Audio Alert**	**Warning**
1. Excessive sink rate	PULL UP Indicator	SINK RATE	WHOOP WHOOP PULL UP
2. Excessive terrain closure	PULL UP Indicator	TERRAIN TERRAIN	WHOOP WHOOP PULL UP
3. Descent after takeoff	PULL UP Indicator	DON'T SINK	
4. Inadvertent proximity to terrain			
a. Gear up	PULL UP Indicator	TOO LOW GEAR	
	PULL UP Indicator	TOO LOW TERRAIN	
b. Flaps up	PULL UP Indicator	TOO LOW FLAPS	
	PULL UP Indicator	TOO LOW TERRAIN	
5. Descent below glideslope	G/S Indicator	GLIDESLOPE	
6. Descent below minimums	None	MINIMUMS MINIMUMS	None

Figure 26-62. GPWS Visual/Aural Alerts and Warnings

CHAPTER 27

UC-12B Radar Systems

27.1 TCAS 2000 TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

27.1.1 System Description

The TCAS 2000 system consists of a TCAS 2000 Computer Unit (CU), dual Honeywell Sextant Vertical Speed Indicators/Traffic Advisory Displays (VSI/TRA), and TCAS/transponder control panel. TCAS targets can also be displayed on the ED 551A Multi-Function Display (MFD) mounted on the center instrument panel.

The TCAS 2000 system receives input from the Mode S transponder and TCAS directional antennas and determines target aircraft location and flight path. The CU interprets these inputs and displays traffic targets on the MFD and the VSI/TRA displays located on the pilot and copilot panels. When the traffic is of close enough proximity, the TCAS system will issue traffic resolution target climb or descent rates on the VSI/TRAs that direct the pilot to avoid the approaching threat. Aural warnings of threat traffic are also provided through the flight compartment speakers and headsets.

The Honeywell XS-950 Mode S transponder system consists of a single XS-950 Receiver/Transmitter unit, TCAS/transponder control panel (shared with the TCAS 2000 system), and both top and belly mounted L-band antennas.

The control panel for the Mode S TCAS/transponder is located on the center pedestal and is used to control operating modes for the TCAS and transponder. The panel controls VSI/TRA display range, TCAS Above/Normal/Below mode, Squawk Code selection, Ident button, Flight Level display mode selection, and TCAS/transponder mode selection (STBY, OFF, ALT REPORTING, TA, TA/RA).Refer to Figure 27-1.

Two externally mounted antennas feed information directly to the TCAS CU. The TCAS top mounted antenna is a directional antenna and the belly-mounted antenna is an omnidirectional antenna.

The circuit breaker for the TCAS system is located on the copilot circuit breaker panel and is labeled TCAS. The circuit breakers for the pilot and copilot VSI/TRAs are located on the copilot circuit breaker panel and are labeled No. 1 and No. 2 VSI/TRA. The circuit breaker for the transponder system is located on the copilot circuit breaker panel and is labeled No. 1 XPONDER.

The lighting control knobs for the VSI/TRAs are located on the pilot and copilot instrument panels in close proximity to each VSI/TRA display. The lighting control for the MFD is located on the MFD control panel. The TCAS/transponder control head lighting is controlled with the PEDESTAL lighting control knob on the overhead panel.

27.1.1.1 TCAS/XPDR Control Panel Mode Selector

27.1.1.1.1 Five-Position Switch

The computer unit has a five-position switch to select the Mode S transponder and/or TCAS 2000 mode and a pushbutton for checking TCAS (TA/RA, TA, XPDR, ALT RPTG OFF, STBY, TEST). The button functions are as follows:

TA/RA — The TA/RA mode is the normal TCAS operating mode. In this mode, TCAS 2000 provides both TAs (Traffic Advisories) and RAs (Resolution Advisories). No mode annunciations displayed on the VSI/TRA indicate a fully operational TCAS and Mode S transponder. TA/RA is annunciated on the MFD.

TA — In this position, TCAS 2000 provides TAs only. No RAs are issued. This mode prevents TCAS 2000 from issuing RAs when the TCAS 2000 aircraft is intentionally flying close to another aircraft, such as on a closely spaced parallel approach. TA is annunciated on the VSI/TRA.

XPDR — The XPDR position activates the Mode S transponder function only. TCAS 2000 is disabled and TCAS OFF is annunciated on the VSI/TRA and TCAS STBY is annunciated on the MFD. The Mode S transponder operates in Mode S.

ALT RPTG OFF — This position turns the Mode S transponder altitude-reporting functions off. TCAS 2000 is disabled and TCAS OFF is annunciated on the VSI/TRA and TCAS STBY is annunciated on the MFD.

STBY — The Mode S transponder is set to standby mode and TCAS 2000 is disabled. TCAS OFF is annunciated on the VSI/TRA and TCAS STBY is annunciated on the MFD.

TEST — Momentarily pressing this button activates the TCAS 2000 self-test feature. The voice announcement TCAS TEST will be heard. XPDR FAIL indicator illuminates momentarily and PASS is displayed on the TCAS/transponder control panel. The VSI/TRA displays the standard pattern of intruders along with the TCAS TEST annunciation. The MFD does not display RA information. At the conclusion of the test, TCAS PASS or TCAS FAIL will be annunciated on the VSI/TRA and either the voice announcement, TCAS TEST PASS or TCAS TEST FAIL will be heard.

Note

Pressing and holding the TEST pushbutton for more than 8 seconds when on the ground and in standby mode will activate the extended test function.

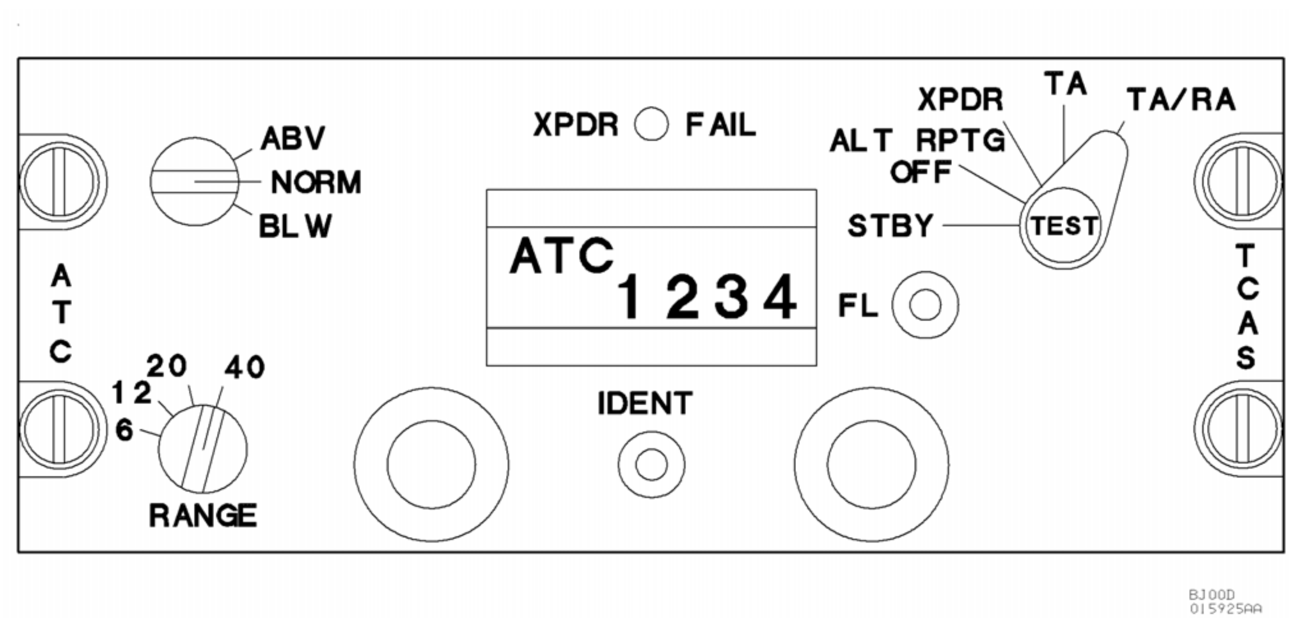


Figure 27-1. TCAS/XPDR Control Panel

27.1.1.1.2 FL Pushbutton

Pushing and holding this pushbutton causes the aircraft altitude to be displayed as a flight level in the right center of the VSI/TRA and in the lower right corner of the MFD. It also changes the separation altitude of target aircraft to a flight level altitude on the VSI/TRA and MFD. When the button is released, the displays return to normal depiction mode.

27.1.1.1.3 Transponder Code Selector Knobs

Dual, concentric rotary knobs are used to enter Air Traffic Control (ATC) Mode S transponder display codes. The large knobs control the outermost digits (thousands and ones), and the small knobs control the middle digits (hundreds and tens). Once a code limit is reached (0 to 7), the display code will not change, even with continued knob rotation in the same direction. Transmitted data will not change until approximately 5 seconds after a new ATC code has been selected.

27.1.1.1.4 Transponder Code Window

Displays the selected four-digit Mode S transponder code for ATC.

27.1.1.1.5 IDENT

Pressing this button initiates the Mode S transponder identification mode of operation. The displayed ATC code and Special Position Identification code are transmitted for a minimum of 18 seconds when IDENT is pressed.

27.1.1.1.6 ABV-NORM-BL W Switch

This switch selects the vertical range for which traffic will be displayed.

ABV (above) — Selects a range from +7,000 feet above the aircraft to -2,700 feet below the aircraft.

NORM (normal) — Selects a range of +2,700 feet above the aircraft to -2,700 feet below the aircraft.

BLW (below) — Selects a range of +2,700 feet above the aircraft to -7,000 feet below the aircraft.

27.1.1.1.7 XPDR FAIL Light

This amber lamp is illuminated when the Mode S transponder system has failed. Loss of valid altitude data from the Barometric Altimeter to the Mode S transponder or an internal failure will also illuminate the XPDR FAIL light and will cause TCAS 2000 to display TCAS OFF on the VSI/TRA.

27.1.1.1.8 RANGE Switch

The RANGE switch allows selection of the scale used for display of traffic on the VSI/TRA. The available selections are 6, 12, 20, or 40 nautical miles.

The RANGE switch indications of the VSI/TRA (Figure 27-2) for each setting is as follows:

VSI/TRA RANGE SETTINGS				
RANGE SETTING	**Ring of Dots**	**Forward** (100% of RANGE Setting)	**Left** or **Right** (70% of RANGE Setting)	**Aft** (42% of RANGE Setting)
6	2 nm	6 nm	4.2 nm	2.5 nm
12	2 nm	12 nm	8.3 nm	5.0 nm
40	—— (See note)	40 nm	28 nm	17 nm

Figure 27-2. VSI/TRA Range Settings

Note

When RANGE is set to 40 nm the ring of dots is removed from the VSI/TRA display.

27.1.1.2 VSI/TRA Indicator

The VSI/TRA display is a color, flat-panel liquid crystal display with two modes of operation: as a normal VSI and as a TRA display. As a VSI, the indicator provides a standard display of vertical speed in feet per minute with a range of plus or minus 6,000 feet per minute. As a TRA display, an aircraft symbol representing the TCAS 2000 aircraft appears in the lower portion of the display surrounded by 12 dots. The dots are located at the clock positions to assist the crew in visually acquiring the traffic. Refer to Figure 27-3.

The data displayed on the VSI/TRA depends on several switch settings as well as the specific status of any intruder.

27.1.1.2.1 Resolution Advisory Vertical Speed Guidance

Red and green arcs show vertical maneuvers recommended by TCAS 2000 to make sure of safe separation.

The TCAS 2000 color-coded visual advisory area for vertical speed guidance is inside, and adjacent to, the vertical speed indicator scale. The red arc indication tells the pilot what vertical speed region is to be avoided. If a change in vertical speed is necessary, a green arc indicates the specific region of vertical speed the pilot is to "fly to."

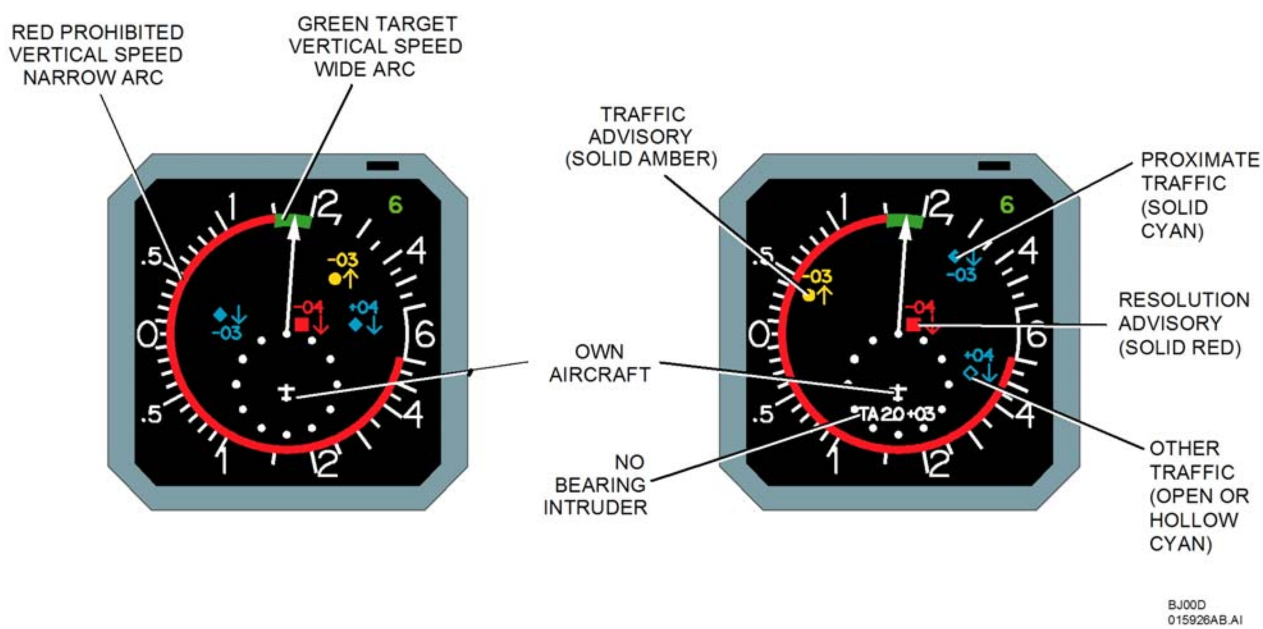


Figure 27-3. VSI/TRA Indicator Display

27.1.1.2.2 Traffic Display Symbology

Aircraft symbology depicted on the VSI/TRA is color-coded. Each color has a distinct shape associated with it. Data Tags have the same color as the symbol they are associated with. Intruders are prioritized and displayed based on their measured range and relative range rate with respect to the TCAS 2000 aircraft. The VSI/TRA can display a maximum of 12 aircraft. The highest priority is given to RAs. The remaining TAs (if present) and Proximate Traffic (if present) are displayed according to their calculated threat assessment based on range, range rate, and whether the intruder has altitude reporting capability.

The displayed traffic will be positioned at its correct range and relative bearing and will move across the display as its range and bearing change.

27.1.1.2.2.1 Solid Red Square

Represents an immediate threat to the TCAS 2000 equipped aircraft. Prompt action must be taken to avoid the intruder. An intruder symbolized in red is entering the warning area and is 15 to 35 seconds from entering the collision area. Red is used only in conjunction with an RA.

27.1.1.2.2.2 Solid Amber Circle

Represents a moderate threat. An intruder symbolized in amber is entering the caution area and is 20 to 48 seconds from entering the collision area. A visual search is recommended for intruder avoidance. Amber is used only in conjunction with a TA.

27.1.1.2.2.3 Solid Cyan Diamond

Represents Proximate Traffic. Proximate Traffic is an aircraft which is within 6 nautical miles or the range capability of the display and within 1,200 feet vertically, but whose path is not predicted to penetrate the collision area. If the range capability of the display is less than 6 nm then the Proximate Traffic will be shown at the edge of the display. Proximate Traffic will not generate a TA or a RA. Proximate Traffic is shown to improve situational awareness in the event of a potential conflict with higher priority RA or TA aircraft.

27.1.1.2.2.4 Open Or Hollow Cyan Diamond

Represents Other Traffic. Other Traffic is any transponder-replying aircraft within the horizontal and vertical range of the display and not classified as Proximate Traffic or as an intruder requiring a TA or a RA. The predicted flight path does not penetrate the collision area. If Other Traffic is being displayed, it will be temporarily removed while a TA or a RA is in progress.

27.1.1.2.2.5 Data Tags

A Data Tag consists of a two-digit number, a plus or minus sign, and possibly an arrow. The Data Tag appears either above or below the intruder aircraft symbol and in the same color. If the intruder is at the same altitude, 00 will be displayed. If the number changes position, from above the aircraft symbol to below or vice versa, the intruder is passing through your altitude.

27.1.1.2.2.5.1 Two-Digit Number

The two digits represent the relative altitude of the intruder aircraft in hundreds of feet above or below the TCAS 2000 aircraft. If the intruder is above the TCAS 2000 aircraft, the Data Tag will be placed above the intruder aircraft symbol; for an intruder below the TCAS 2000 aircraft, the Data Tag will be placed below the intruder aircraft symbol.

CAUTION

The Data Tag on the display shows the separation between aircraft in hundreds of feet.

27.1.1.2.2.5.2 Plus and Minus Signs

A plus or minus sign appears in front of the relative altitude number and indicates whether the displayed aircraft is above (+) or below (-) the TCAS 2000 aircraft.

27.1.1.2.2.5.3 Arrow

A vertical arrow will appear immediately to the right of the aircraft symbol if the intruder is either climbing (up arrow) or descending (down arrow) in excess of 500 feet per minute.

27.1.1.2.2.6 Off Scale Traffic Advisories

If TCAS 2000 is tracking an intruder which is outside of the range of the display but within the caution or warning areas, one half of the appropriate symbol will be positioned at the edge of the display at the appropriate bearing. The Data Tag will be displayed if there is room. The symbol will be in its proper color.

27.1.1.2.2.7 No Bearing Advisories

If and when TCAS 2000 is unable to track the bearing of an intruder, the TA will appear in the lower center of the display just below the host aircraft symbol. The advisory will present appropriate color-coded traffic information. TCAS 2000 may be temporarily unable to determine the bearing of an intruder due to steep bank angles masking the directional antenna. A No Bearing Advisory is most likely the result of the antenna pattern coupled with a steep bank angle. The ability of TCAS 2000 to compute TAs and RAs is not degraded by lack of bearing information and usually a No Bearing Advisory will transform into an advisory with bearing after a few seconds.

27.1.1.2.3 Aural Messages

TCAS 2000 generates 14 aural alerts or messages, excluding the aural test messages that are announced over the flight compartment loudspeaker system. These 14 messages accompany the visual TA and RA displays.

If a logic change occurs before the message is complete and a new alert is initiated, the original alert is terminated and the new alert is announced immediately.

27.1.1.2.3.1 Traffic Advisory

TRAFFIC, TRAFFIC alert occurs when TCAS 2000 predicts an intruder will enter the collision area within 20 to 48 seconds. Simultaneously, the VSI/TRA will display the location of the intruder.

27.1.1.2.3.2 Resolution Advisories

RA messages come in two forms. Corrective Advisories indicate evasive vertical maneuvers are necessary to increase separation between the TCAS 2000 aircraft and the intruder. Preventive Advisories indicate certain changes in vertical speed are not recommended. RA messages consisting of a single word are repeated two times; longer messages may be repeated twice.

27.1.1.2.3.2.1 Preventive or Weakening Advisory

MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED is a Preventive Advisory. The pilot is to monitor the vertical speed of the aircraft, keeping the VSI pointer out of the red area on the VSI scale. The pilot is further expected to minimize the deviation from Air Traffic Control (ATC) clearance to reduce further adverse effects on ATC.

27.1.1.2.3.2.2 Corrective Resolution Advisories

Once these commands are given, the pilot has 5 seconds to make the controlled 0.25g pitch change required. These advisories should be done smoothly to minimize the amount of deviation from the ATC clearance.

1. CLIMB, CLIMB — Climb at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

2. DESCEND, DESCEND — Descend at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

3. CLIMB, CROSSING CLIMB — CLIMB, CROSSING CLIMB — Climb at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

Note

Your own flight path will cross the intruder's altitude.

4. DESCEND, CROSSING DESCEND — DESCEND, CROSSING DESCEND — Descend at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

Note

Your own flight path will cross the intruder's altitude.

27.1.1.2.3.2.3 Increased Strength or Reversed Corrective Advisories

These are Corrective Advisories, which indicate that a previously announced advisory must be increased in strength or reversed. The target vertical speed must be attained within 2.5 seconds of the generation of the corrective RA. The 0.35g maneuver should be a 2 to 3.5° per second pitch change, as smooth and precise as any instrument maneuver.

These advisories are expected to occur only on rare occasions, usually when an intruder suddenly changes its current flight path by maneuvering or when the pilot has chosen to ignore a Corrective/Preventative Advisory.

1. INCREASE CLIMB, INCREASE CLIMB — Increase climb to the rate indicated by the green arc on the VSI/TRA, 2,500 to 3,000 feet per minute.

2. INCREASE DESCENT, INCREASE DESCENT — Increase descent to the rate indicated by the green arc on the VSI/TRA, 2,500 to 3,000 feet per minute.

3. CLIMB, CLIMB NOW! — CLIMB, CLIMB NOW! Follows a descend RA when TCAS 2000 has determined that a reversal of vertical speed is necessary to provide adequate separation. The target vertical speed for this green arc descent is 1,500 to 2,000 feet per minute.

4. DESCEND, DESCEND NOW! DESCEND, DESCEND NOW! — Follows a climb RA when TCAS 2000 has determined that a reversal of vertical speed is necessary to provide adequate separation. The target vertical speed for this green arc descent is 1,500 to 2,000 feet per minute.

27.1.1.2.3.2.4 Corrective, Weakening, or Restrictive Advisories

These Corrective Advisories include a variety of vertical speed commands and guidance intended to minimize or constrain the escape maneuvers or resolve multiple aircraft conflicts in response to an RA.

1. ADJUST VERTICAL SPEED, ADJUST — The target vertical speed for this green arc is a reduction in the current vertical speed.

2. MAINTAIN VERTICAL SPEED, MAINTAIN — The target vertical speed for this green arc is either a 4,400 to 6,000 feet per minute climb or descent dependant on the encounter.

3. MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN — The target vertical speed for this green arc is either a continued climb at 3,200 to 4,000 feet per minute or a descent at 2,600 to 3,300 feet per minute.

Note

Your own flight path will cross the intruder's altitude.

27.1.1.2.3.2.5 Clear of Conflict

Announcement confirms that the encounter has ended and separation is increasing. A return to the original ATC clearance profile is expected.

27.1.2 Limitations

1. When necessary, certain TCAS Resolution Advisory (RA) commands may be limited in order to be compatible with the aircraft climb capabilities.

2. Pilots are authorized to deviate from their current ATC clearance to the extent necessary to comply with a TCAS RA.

3. Maneuvering in response to an RA must be done manually by the pilot flying the aircraft. The pilot must disconnect the autopilot and establish the proper pitch attitude manually.

4. When operating in the restricted category at a gross takeoff weight in excess of 12,500 pounds, operations of the TCAS 2000 are limited to Traffic Advisory (TA) only above FL 250.

5. The TCAS system will comply with the following rules:

   a. No climb commands are issued when the aircraft cannot achieve 1,500 feet per minute.

   b. No increase climb commands are issued when the aircraft cannot achieve 2,500 feet per minute.

   c. No increase descent commands are issued at altitudes less than 1,450 feet above ground level.

   d. No descend commands are issued at altitudes less than 1,000 feet above ground level.

   e. No RAs are issued at altitudes less than 1,000 feet above ground level.

   f. No TAs are issued when the intruder's altitude is less than 380 feet above ground level.

   g. No aural advisories are issued at an altitude below 500 feet above ground level.

6. The TCAS system, when operating, can only detect other aircraft with operating International Civil Aviation Organization (ICAO) compliant transponders.

CAUTION

The TCAS 2000 system will not detect aircraft with inoperative or non-ICAO compliant transponder systems. Do not rely solely on TCAS 2000 or Air Traffic Control (ATC) for collision avoidance.

CAUTION

- TCAS 2000 cannot detect intruding aircraft if the on-board Mode S transponder is OFF or in STBY.
- TCAS 2000 cannot issue an RA for intruding traffic that does not have an operating ICAO transponder with an operational altitude reporting function.
- It is not always possible to inhibit RA when it would be appropriate to do so due to limited inputs to the TCAS 2000. In these cases, TCAS 2000 might command maneuvers that may significantly reduce stall margins. Conditions when this may occur include:

  — Bank angle exceeds 15°.

  — Engine out (pilot should select TA Only).

  — Abnormal configurations (such as an unretracted landing gear which places the aircraft in an inappropriate configuration when the RA occurs, etc.).

  — Operation at temperatures beyond ISA (International Standard Atmosphere) ± 27.8 °C (50 °F).

  — Speeds below normal operating speeds.

  — Buffet margin less than 0.3g.

  — A TCAS to TCAS RA sense reversal.

27.1.3 Normal Procedures

27.1.4 System Self-Test

1. Select TCAS only on the MFD control panel.
2. Set TCAS/XPDR mode selector switch to STBY.
3. The VSI/TRA displays annunciate white TCAS OFF message in the right center of the display.
4. The MFD annunciates cyan TCAS STBY message in the lower right corner of the display.
5. Momentarily depress the system TEST pushbutton on the TCAS control panel.
6. Verify the following:

   a. Aural TCAS TEST message is heard over the cockpit speakers or headsets indicating the start of the self-test.

   b. XPDR FAIL indicator illuminates momentarily and PASS is displayed on TCAS/transponder control panel.

c. VSI/TRA displays depict the standard pattern of intruders and RA arcs along with the white TEST annunciation in the right center of the display.

d. MFD display depicts the standard pattern of intruders and cyan TCAS TEST annunciation in the lower right corner of the display. The MFD does not present RA information.

e. After approximately 8 seconds, the aural TCAS TEST PASS message is heard over the cockpit speakers or headsets indicating the successful completion of the self-test. The VSI/TRA and MFD annunciations revert to previous messages.

Note

- If the TCAS system does not pass the self-test, an aural TCAS TEST FAIL message will be heard. An amber TCAS FAIL message will illuminate on the VSI/TRA and MFD displays.
- Proximate Traffic and Other Traffic are depicted as a solid diamond and a hollow diamond, respectively. On the VSI/TRA displays, the coloration for these symbols is cyan. On the MFD it is white.
- Depressing and holding the TEST button for more than 8 seconds when on the ground and in STBY mode will activate the Extended Test function and VSI/TRA will display maintenance information. To exit this mode, position the mode selector switch out of STBY.

27.1.4.1 System Self Maintenance

Depress the system TEST pushbutton for over eight (8) seconds with the MASTER SYSTEM switch set to STBY mode and gear extended. Make sure of the following:

1. VSI/TRA test pattern is replaced with a display of TCAS maintenance information.
2. Extended test can be exited by switching the TCAS/XPDR mode selector switch to any position other than STBY.

27.1.4.2 TCAS/XPDR Mode Control Panel Test

1. Set the TCAS/XPDR mode selector switch to the STBY mode. Make sure TCAS OFF is displayed on the VSI/TRA. TCAS STBY is displayed on the MFD if TCAS OVERLAY selected.
2. Set the TCAS/XPDR mode selector switch to the ALT RPTG OFF mode. Make sure TCAS OFF is displayed on the VSI/TRA to indicate the altitude-reporting functions are disabled.
3. Set the TCAS/XPDR mode selector switch to the XPDR mode. Make sure TCAS OFF is displayed on the VSI/TRA to indicate the TCAS 2000 is disabled and the Mode S transponder is functional. TCAS STBY is displayed on the MFD if TCAS OVERLAY selected.
4. Set the TCAS/XPDR mode selector switch to the TA mode. Make sure a TA ONLY is visible on the VSI/TRA to indicate that both the TCAS 2000 is operating in the Traffic Advisory mode only, and the Mode S transponder is operational. TCAS STBY is displayed on the MFD if TCAS OVERLAY selected.
5. Set the TCAS/XPDR mode selector switch to the TA/RA mode. Make sure no mode annunciations are visible on the VSI/TRA to indicate a fully operational TCAS 2000 and Mode S transponder. TCAS STBY is displayed on the MFD if TCAS OVERLAY selected.

6. Confirm that the range displays properly on VSI/TRA and MFD.

7. Confirm that the ABV/NORM/BLW displays properly on VSI/TRA and MFD.

27.1.4.3 Annunciations

27.1.4.3.1 Mode Annunciations

The VSI/TRA display provides visual mode and failure annunciations in the upper and lower right corners and in the right center of the display.

The message TA ONLY confirms the selection of traffic alert only mode. This message is also present when RAs are inhibited due to a GPWS alert or when the aircraft is either on the ground or at altitudes less than 1,000 feet Above Ground Level (AGL). The message appears in white in the right center of the display.

The message TCAS OFF appears when the mode selector on the control panel is set to XPDR, STBY, or ALT RPTG OFF. This message also appears if the Mode S transponder fails. The message appears in white in the right center of the display.

Note

A TCAS OFF message is annunciated when one of the two TCAS Mode S antennas fails. Pilot selection of the TA ONLY mode removes the TCAS OFF message and returns TA ONLY capability to the TCAS system, thereby providing situational awareness.

27.1.4.3.2 Failure Annunciations

1. If an in-flight failure of the minimum equipment required for TCAS operation occurs, TCAS FAIL will appear in amber in the right center of the display.

2. RA FAIL appears in amber in the lower right corner when TCAS 2000 cannot display RAs.

3. TD FAIL (traffic display fail) appears in amber in the right center of the display when TCAS 2000 cannot display TAs.

4. Failure or loss of valid vertical speed data input will prevent display of RA information. RA FAIL and VSI FAIL will be annunciated on the indicator in amber in the upper left and upper right corners respectively and the VSI pointer is not displayed.

5. In the case of certain failures of the VSI/TRA display itself, a red X may appear across the display. A two-digit code located at the bottom center is provided for maintenance information. In other cases, the display may appear blank with neither vertical speed nor TA displays visible.

27.1.5 Abnormal Procedures

27.1.5.1 Traffic Advisory

1. Establish visual contact with the intruder aircraft.

2. Reduce vertical speed, if climbing or descending, to less than 1,500 feet per minute (fpm).

3. Maintain or attain safe separation in accordance with good operating practices.

CAUTION

Do not initiate evasive maneuvers using information from the traffic display only, or upon receipt of a Traffic Advisory only, without positive visual identification of the traffic.

27.1.6 Emergency Procedures

27.1.6.1 Engine Failure in Flight

TCAS/XPDR mode selector switch — Select TA.

27.1.6.2 Resolution Advisory

27.1.6.2.1 Climb Resolution Advisory

1. Autopilot — Disconnect.
2. Pitch attitude — As required to achieve green arc.
3. Propeller levers — Full Forward.
4. Throttles — Takeoff power.
5. Flaps — Up.
6. Landing gear — Up.
7. Pitch attitude — Maintain green arc until CLEAR OF CONFLICT.
8. ATC — Notify (if required).

27.1.6.2.2 Descent Resolution Advisory

1. Autopilot — Disconnect.
2. Pitch attitude — As required to achieve and maintain green arc.
3. Throttles — Retard (as required).
4. ATC — Notify (if required).

Note

If necessary to maintain the RA, retract the landing gear and/or flaps if extended. Do not exceed airspeed limitation.

27.2 ENCODING ALTIMETER

The encoding altimeter (Figure 27-4) indicates aircraft altitude above sea level and provides data to the altitude alerter and transponder for mode C operation. The encoding altimeter is powered by the No.1 dual bus and is protected by a circuit breaker placarded PILOT ENCD ALTM located in the FLIGHT group on the copilot right sidewall panel.

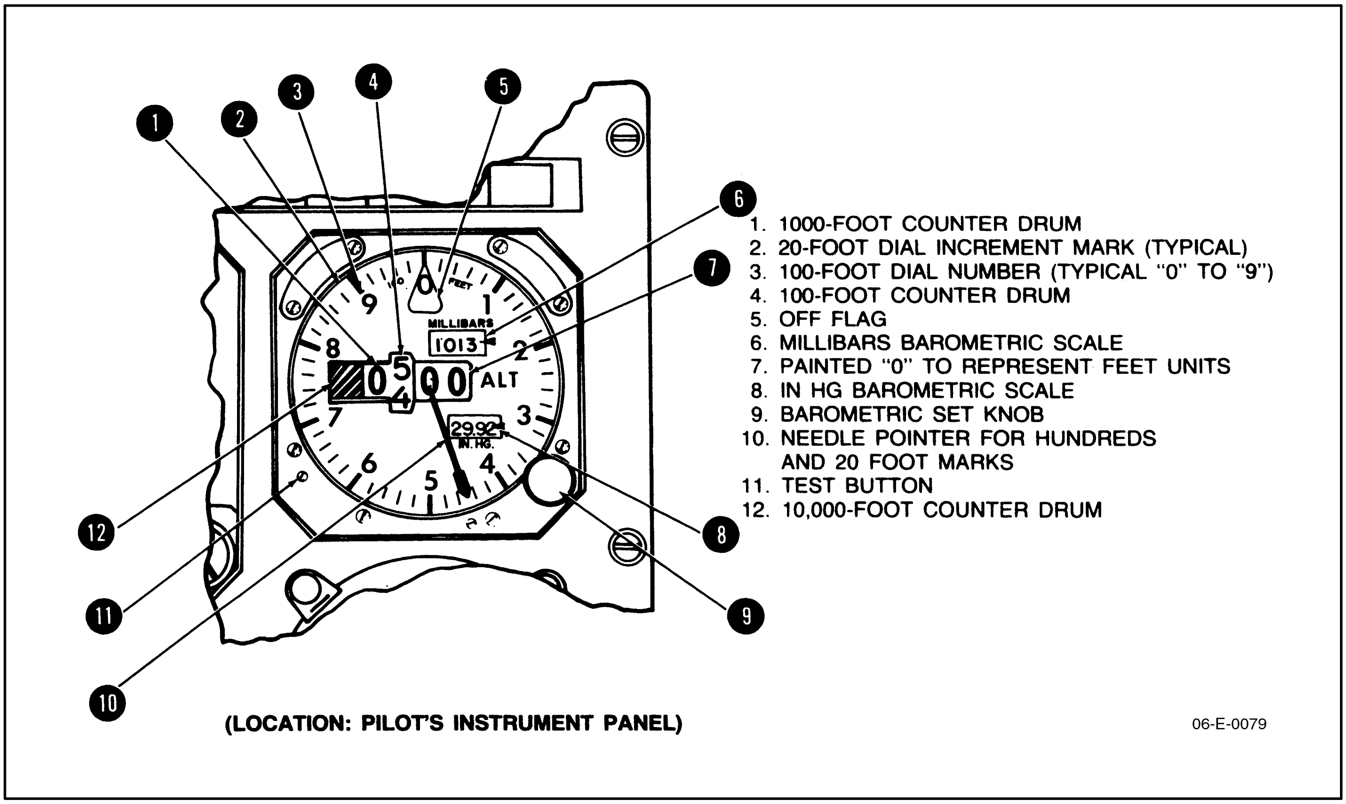


Figure 27-4. Pilot Encoding Altimeter

1. OFF flag — Indicates dc power to altimeter is lost.

Note

If the CODE OFF flag is visible, dc power is off, the circuit breaker is not set, or there is an internal altimeter encoder failure. The CODE OFF flag monitors only the encoder function of the altimeter and not transponder condition. The altitude reporting function may be inoperative without the CODE OFF flag showing. In case of transponder failure or improper control settings, it is also possible to get a good mode C test on the transponder control with the CODE OFF flag showing. If the CODE OFF flag remains visible, radio contact should be made with a ground radar site to determine if the altitude reporting function is operative.

2. TEST button — When depressed, causes a pointer offset to indicate that the servo is operating.

27.3 WEATHER RADAR SYSTEM

27.3.1 System Description

The Honeywell Weather Radar RDR 2000 system is a lightweight, X-band digital radar with alphanumerics designed for weather detection, weather analysis and ground mapping. The RDR 2000 system consists of the Receiver/Transmitter (RT), Radar Computer Unit (RCP), and the Multi-Function Display (MFD). The R/T is composed of the aircraft nose-mounted antenna dish and radar signal processor. The weather presentation is displayed on the MFD and can be superimposed on other MFD displayed data.

The radar is managed through the radar control panel located on the control pedestal extension. The type of Wx (weather) display (ARC, NAV MAP, etc.) and what range is presented is controlled through the MFD control adjacent to the radar control panel. The lighting for the control panels is controlled through the OVHD PED and SUB PANEL control knob located on the overhead panel. The system is protected by the RADAR circuit breaker located on the copilot circuit breaker panel.

The RDR 2000 weather radar system provides weather information and ranging up to 240 nm from the aircraft. The system can detect adverse weather up to 30° in any direction relative to the centerline of the aircraft. The system consists of three pieces of equipment: an antenna, receiver/transmitter and a radar indicator with Vertical Profile (VP) capability and configuration module.

Video display is accomplished by digital techniques, resulting in a continuous bright display of video information. The indicator stores a large amount of video information, which is read out at relatively high rates (60 frames per second). The display continuously updates as the antenna scans.

The indicator mode (Wx, WxA, VP, or GND MAP) is selected by pushbutton on the radar control panel. The function button selects the TST mode. Placing the function button in TST position causes a predetermined test pattern to appear on the MFD. In the TST mode, the transmitter is not operational. Pushbuttons control range and tracking.

A yellow track cursor may be moved either right or left by pressing the track buttons. This assists in determining azimuth bearing of targets. The deviation from the aircraft heading is indicated in the upper left corner of the MFD.

WARNING

- The system performs only the functions of weather detection or ground mapping. It should not be used nor relied upon for proximity warning or anticollision protection.
- The system always transmits in the ON mode. It does not transmit in the OFF, SBY, or TST modes.
- Do not operate during refueling of aircraft or defueling operation within 100 feet (30 meters).
- Do not operate if personnel are standing within 25 feet of the area scanned by radar.

In the weather detection mode, precipitation intensity levels are displayed in four colors, contrasted against a deep black background. Areas of very heavy rainfall will appear in magenta, heavy rainfall in red, less severe in yellow, light rain in green, and little or no rainfall in black (background).

Range marks with identifying numerics, displayed in white, are provided to facilitate evaluation of storm cells.

Selection of the ground mapping (GND MAP) function will cause system parameters to be optimized to improve resolution and enhance identification of small targets at short range. The reflected signal from ground surfaces will be displayed as yellow or cyan (most to least reflective).

27.3.1.1 Radar Control Panel: Controls, Indicators, and Functions

27.3.1.1.1 Radar Mode Selector Switch

The radar mode selector knob, placarded OFF - STBY - TST - ON, is used to select the operating condition of the radar system. Refer to Figure 27-5.

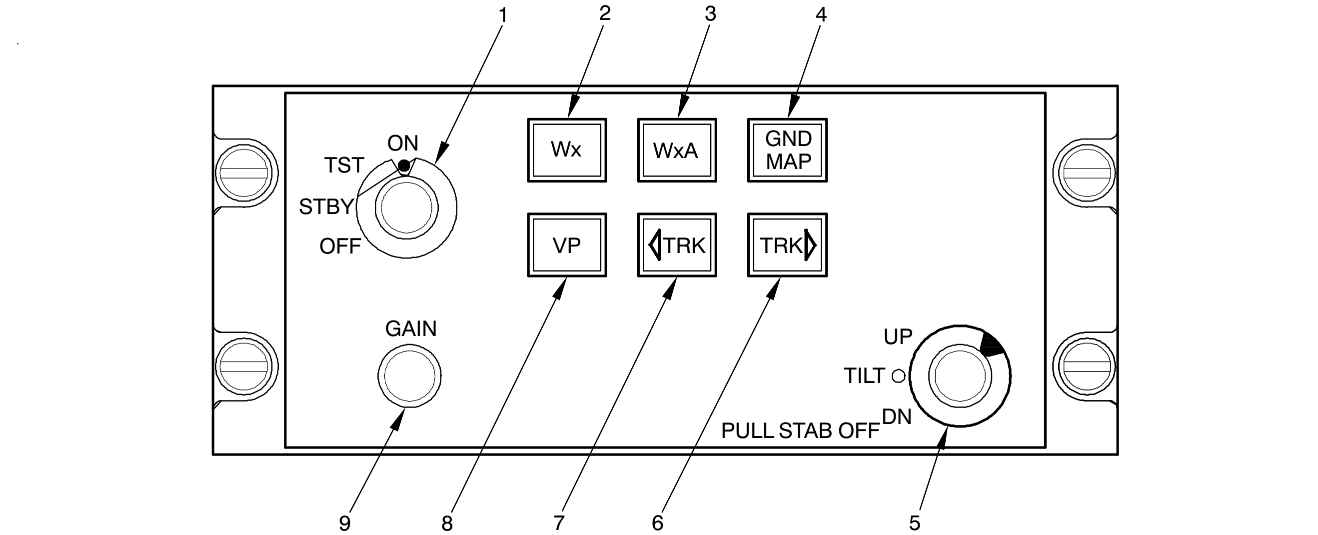


Figure 27-5. Weather Radar Control Panel

1. OFF — The OFF position disables the ART (antenna, receiver, and transmitter) power supply. The radar will remain active with no radar transmissions occurring, for up to a maximum of 30 seconds. This delay allows time to park the antenna at 0° azimuth and 30° tilt down. OFF is displayed on the radar mode line in the lower right corner of the MFD.

2. STBY — After 30 seconds in the standby (STBY) mode the system is in a state of readiness. No radar transmission occurs, and the antenna is parked in the down position. STBY is displayed on the radar mode line if a weather mode is selected.

3. TST — Selecting the test (TST) position causes the test pattern to be displayed on the indicator, if a weather mode is selected. No radar transmissions occur while TST is selected. TEST will be displayed on the radar mode line.

4. ON — Selects the normal condition of operation for weather detection and/or other modes of operation. The system will transmit after a 60-second warmup time is completed. Depending on the selected mode of operation, Wx, WxA, or GND MAP will be displayed on the radar mode line.

27.3.1.1.2 Weather Pushbutton Mode Selector Switch

The weather pushbutton mode selector button, placarded Wx, is used to select the weather mode (Wx) when depressed. Wx will be displayed on the radar mode line if a weather mode is selected.

27.3.1.1.3 Weather Alert Pushbutton Mode Selector Switch

The weather alert pushbutton mode selector button, placarded WxA, is used to select the weather alert mode (WxA) when depressed. WxA will be displayed on the radar mode line if a weather mode is selected.

27.3.1.1.4 Ground Map Pushbutton Mode Selector Switch

The ground map pushbutton mode selector button, placarded GND MAP, is used to select the ground mapping mode when depressed. MAP will be displayed on the radar mode line. The color magenta is not active in the ground mapping mode.

27.3.1.1.5 Tilt/Stabilization Control

The tilt/stabilization control, placarded TILT - UP - DN, PULL STAB OFF, permits manual adjustment of antenna tilt (15° up or down) to enable the pilot to analyze the weather presentation. The tilt angle is displayed on the radar tilt annunciator line in the lower right corner of the MFD.

Pulling out on the tilt selector knob will turn radar stabilization off. STAB OFF will appear on the radar fault/warning line displayed below the antenna tilt annunciation line.

27.3.1.1.6 Right and Left Track Controls

If the weather only mode is selected, depressing the right track (TRK >) or left track (< TRK) button activates and slews a yellow dashed azimuth line. It also activates a digital display showing the number of degrees the azimuth line is located left or right from the nose of the aircraft. In any other map weather presentation, only the yellow dashed line will be displayed.

27.3.1.1.6.1 Track Control Operation in Vertical Profile (VP)

Prior to engaging VP, the appropriate button (left or right) is used to place the track line at the desired azimuth angle to be vertically scanned (sliced). When VP is engaged, the slice will be taken at the last position of the track line, whether it is visible or not. If the track line has not been selected after power has been applied to the system and VP is engaged, the slice will be taken at 0° (directly in front of the aircraft).

When in VP mode, depressing the TRK button will change the selected azimuth 2° left or right, depending upon which button is depressed. Continuously holding the TRK button will result in the track line moving in 2° increments.

27.3.1.1.7 Vertical Profile Pushbutton Mode Selector Switch

Once the desired azimuth has been selected with the TRK button, depressing the VP pushbutton mode selector button, placarded VP, selects the VP mode of operation and causes the VP screen to appear. The weather mode of operation (Wx or WxA) displayed in the lower corner of the display will be the same as existed just prior to selecting VP. To select a different weather mode once in VP, select the desired mode (Wx, WxA, or GND MAP) by depressing the appropriate pushbutton. The operation of scanning the antenna vertically is referred to as taking a vertical slice.

Once VP has been selected, the desired profile azimuth angle may be changed in 2° increments by depressing and holding the appropriate TRK button. If the radar antenna is already profiling, the antenna will move in 2° increments slicing in the direction determined by the TRK button. Or a WAIT annunciation may be displayed indicating that the radar antenna will perform the desired slicing function as soon as the antenna returns to the last selected profiling azimuth angle.

To terminate the VP mode and return to the normal mode (horizontal scan), depress the VP pushbutton. The radar system will retain its existing weather mode and return to horizontal scanning. A track line will be present on the screen for 15 seconds to indicate the location of the last profiling azimuth angle.

27.3.1.1.8 GAIN CONTROL

The manual GAIN control knob becomes active when ground mapping mode (GND MAP) is selected. In all other modes, gain is internally set.

27.3.1.2 Weather Display Calibration

The radar display has been calibrated to show five levels of target intensity. This shows the approximate relationship of aircraft weather radar levels to the Video Integrated Processor (VIP) levels used by the national weather service. These levels are valid only when:

1. Wx or WxA mode is selected.

2. Displayed returns are within the STC range of the radar (approximately 40 miles).

3. The returns are beam filling.

4. There are no intervening radar returns.

27.3.1.3 Tilt Management

Effective antenna tilt management is the single most important key for more informative weather radar displays. Three prime factors must be kept in mind for proper tilt management:

1. The Earth's curvature must be considered in determining the location of the beam at long distances.

2. The center of the radar beam is referenced to the horizon by the aircraft vertical reference system.

3. Adjusting the antenna tilt control will cause the center of the radar beam to scan above or below the plane of the attitude reference system.

A tilt setting that is too low will result in excessive ground or sea return whereas a setting that is too high can result in the radar beam passing above a weather target.

For detecting weather targets at long ranges and to allow adequate time for planning the proper avoidance path, the tilt angle should be set for a sprinkle of ground target returns on the display. By slowly raising the tilt angle, weather targets will emerge from the ground returns because of their height above the ground. In order to minimize ground returns when closely examining weather targets below the aircraft Flight Level, select the shortest range that allows full depiction of the area of interest.

27.3.1.4 En Route Weather Detection Operation

To set the antenna tilt to optimize the radar ability to identify significant weather, follow these steps:

1. Wx pushbutton mode selector switch — Depress.

2. Range button — Select 40 nautical mile range.

3. TILT control — Adjust down until entire display is filled with ground returns. Slowly raise antenna so that ground returns are painted on about the outer one third of the indicator area.

4. Display — Watch strongest returns. If, as they are approached, they become weaker or fade out after working back inside the near limit of the general ground return pattern, they are probably ground returns or insignificant weather. If they continue strong after working down into the lower half of the indicator, you are approaching a hazardous storm or storms and should deviate.

5. Display — Examine the area behind strong targets. If radar shadows are detected, you are approaching a hazardous storm or storms and should deviate. Regardless of the aircraft altitude, if weather is being detected, move the antenna tilt control up and down in small increments until the return object is optimized. At that angle, the most active vertical level of the storm is being displayed.

27.3.1.5 Ground Mapping Mode

Ground mapping mode is selected by depressing the GND MAP pushbutton mode selector button. The TILT control is then used to tilt the antenna down until the desired amount of terrain is displayed. The degree of tilt down will depend upon the aircraft altitude and the selected range.

27.3.1.6 Fault Monitoring

Critical functions in the receiver/transmitter/antenna are continuously monitored.

27.3.2 Limitations

WARNING

Do not operate radar if ground personnel are standing within 25 feet of the area scanned by radar.

CAUTION

If radar system is to be operated in any mode other than standby while the aircraft is on the ground: Direct the nose of the aircraft so that the antenna scan sector is free of large metallic objects such as hangars or other aircraft for a distance of 100 feet (30 meters). Do not operate during refueling or defueling operations within 100 feet (30 meters).

27.3.3 Normal Procedures

27.3.3.1 Preflight

Place the radar controls in the following positions:

1. Radar mode selector to TST.
2. TILT/stabilization control — TILT to UP 7° (as shown on tilt indicator on display). Check for correct test pattern.
3. Radar mode selector in TST or STBY. Taxi to a clear area where there are no people, aircraft, vehicles, or metallic buildings within approximately 100 yards.
4. Radar mode selector to ON. Wx mode will be displayed in the 40 mile range. Any targets (weather or ground) will be displayed in green, yellow, red, or magenta.
5. Press the RANGE DOWN pushbutton on the MFD to display 40 nm as the maximum range.
6. Press the weather alert pushbutton mode selector and observe that the magenta areas (if any) are flashing.
7. Vary the TILT control manually between 0 and UP 15° and 0 and DN 15° and observe that close-in ground clutter appears at lower settings and that any local rain appears at higher settings.
8. Return the radar mode selector to TST or STBY before taxiing.

27.4 ED 551A MULTI-FUNCTION DISPLAY (MFD)

27.4.1 System Description

The ED 551A MFD system consists of a SG 465 symbol generator, a CP 469A MFD control head, and the ED 551A MFD. Weather radar functions, for RDR 2000 color radar, are accessed through the CP 466A control head and displayed on the ED 551A through the symbol generator. Refer to Figure 27-6.

The ED 551A MFD is a single integrated display system capable of providing display of the RDR 2000 color radar, EGPWS, GPS/FMS waypoint mapping, and Horizontal Situation Indicator (HSI) display. The CP 469A MFD control head is located in the center pedestal and is adjacent to the CP 466A RDR 2000 color radar controller.

The CP 469A MFD control head has the control knob for the MFD brightness as well as the selectors for the various operational modes stated above. The lighting for the control panel is controlled through the avionics panel control located on the overhead panel.

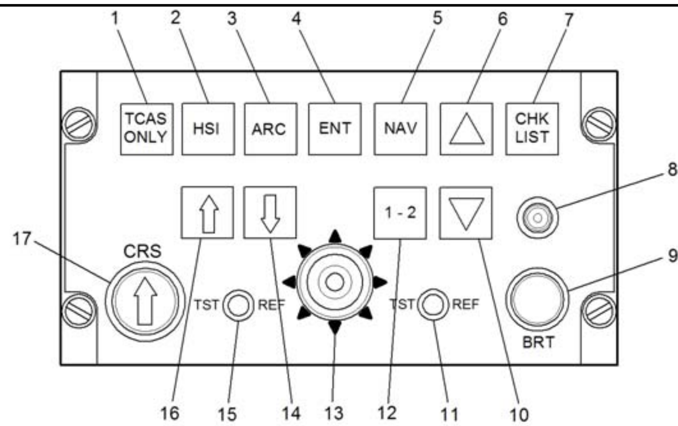
The MFD circuit breaker located on the copilot circuit breaker panel controls aircraft dc electrical power to the ED 551A MFD, SG-465A symbol generator, and CP 469A MFD control panel.

27.4.1.1 MFD Control Panel

The following controls and their functions are provided for operation of the MFD control panel.

27.4.1.1.1 TCAS ONLY Pushbutton Mode Selector Switch

Depressing the TCAS ONLY button will toggle the MFD display between the TCAS ONLY presentation and the previously selected mode.



1. TCAS ONLY PUSHBUTTON MODE SELECTOR SWITCH
2. HSI 360 DEGREDD PUSHBUTTON MODE SELECTOR SWITCH
3. HSI ARC PUSHBUTTON MODE SELECTOR SWITCH
4. ENTER SWITCH
5. NAVIGATION PUSHBUTTON SELECTOR SWITCH
6. RANGE UP SWITCH
7. CHECKLIST PUSTBUTTON SWITCH
8. DATA INPUT JACK
9. BRIGHTNESS CONTROL
10. RANGE DOWN CONTROL
11. SYSTEM/REFERENCE BUTTON TEST SWITCH
12. PIMARY NAVIGATION SENSOR SYSTEM PUSHBUTTON SELECTOR SWITCH
13. JOYSTICK
14. HSI DOUBLE NEEDLE BEARING POINTER SOURCE PUSHBUTTON SELECTOR SWITCH
15. HSI COURSE SELECT KNOB ACTIVATION PUSHBUTTON SWITCH
16. HSI SINGLE NEEDLE BEARING POINTER SOURCE PUSHBUTTON SELECTOR SWITCH
17. HSI COURSE SELECT KNOB

Figure 27-6. MFD Control Panel

27.4.1.1.2 HSI 360° Pushbutton Mode Selector Switch

The HSI mode pushbutton, placarded HSI, allows selection of the various HSI display formats. There are four possible display formats: Standard HSI compass rose, NAV map, NAV map with weather (or EGPWS terrain), and DG mode. Each press of the HSI button sequentially selects the next display format.

27.4.1.1.3 HSI ARC Pushbutton Mode Selector Switch

The ARC pushbutton, placarded ARC, will select a large scale view of the CDI by presenting an approximate 85° sector display of this compass. There are five possible display formats: Standard HSI compass rose, NAV map, NAV map with weather (or EGPWS terrain), HSI compass rose with weather, and weather only.

27.4.1.1.4 Enter Switch

27.4.1.1.4.1 Checklist Operation

In the checklist mode, the ENT button will generally function to check items in the list. The checklist was designed such that the pilot can complete the entire checklist by using only the ENT button. Normally, pressing the ENT button will cause an unchecked checklist line to be checked and the cursor to advance to the next unchecked line. At the end of a page, pressing the ENT button will cause the cursor to advance to the next page (if available) and to check the first unchecked line on that page. If no unchecked items exist between the cursor position and the end of the list, the cursor is placed on the first unchecked page that referenced the specific list.

27.4.1.1.5 Navigation Pushbutton Selector Switch

The NAV pushbutton, placarded NAV, will cause the MFD to display FMS, LOC/ILS/VOR, or ADF data.

27.4.1.1.6 Range Up/Down Switch

The range up button is placarded ▲. The range down button is placarded ▼. A press of the RANGE DOWN button selects the next lower range to be displayed while in the NAV MAP or WEATHER modes of operation. Once the lowest selectable range is reached, the RANGE UP button must be used for a range change. The operation of the RANGE UP button is similar to the RANGE DOWN except it selects the next higher range to be displayed while in the NAV MAP or WEATHER modes of operation.

27.4.1.1.7 Checklist Pushbutton Switch

Pressing the checklist button, placarded CHK LIST, will display the root page of the checklist. If an emergency discrete is active, pressing the checklist button will display the emergency page.

27.4.1.1.8 Data Input Jack

A provision is made for insertion of a customer-defined checklist through a data port on the right center position of the MFD computer unit.

27.4.1.1.9 Brightness Control

The display brightness knob controls brightness of the display.

Note

The display brightness control provides full range dimming to allow night operation in no- or low-light situations. The lower limit of the display brightness may appear as an inoperative tube during normal daylight operation. It is therefore advisable to check the BRT knob setting during preflight test.

27.4.1.1.10 System/Reference Button Test Switch

The TEST/REFERENCE button, placarded TST ● REF, will toggle the MFD map displayed formats in/out of TCAS, airports and NAVAIDs data presentations. With checklist active, this button will cause a checklist “help” page to be displayed on the MFD.

To display the EHSI system SELF-TEST, press and hold the TEST/REFERENCE button for 3 seconds. Upon entering self-test, a test pattern will be displayed. In the center of the test pattern, either a SELF-TEST PASS or SELF-TEST FAIL will be annunciated. The EFS will cancel the test mode and return both the EADI and EHSI to normal operation after 5 seconds.

Note

If the SELF-TEST FAIL message is annunciated, the system should be serviced.

27.4.1.1.11 Primary Navigation Sensor System Pushbutton Selector Switch

The 1-2 pushbutton, placarded 1-2, allows the pilot to select between on side and off side NAV sensors. It selects which side will be displayed until pushed again. A press of the NAV pushbutton will not cause a selected off side sensor to cycle back to an on side sensor.

27.4.1.1.12 Joystick

The joystick is located in the center of the control panel.

27.4.1.1.12.1 Waypoint Entry Operation

The joystick can be used to generate and move single waypoints on the display unit.

With FMS selected for the primary NAV sensor and during display of a NAV MAP on the MFD, initial movement of the joystick will create a waypoint cursor ahead of the aircraft on the half range ring at the current heading. This will be true for both the HSI and ARC display formats.

The cursor will be a standard white waypoint symbol. Movement of the waypoint will be in any of the eight directions commanded by the joystick. The rate of movement will start off slow and increase in speed in two steps. Return of the joystick to its center (off) position at any time will reset the rate of movement to the slowest speed.

When FMS is selected as the primary navigation source, Latitude/Longitude coordinates of the cursor will be displayed in the lower center of the display. The coordinates of the cursor will remain displayed for at least 10 seconds and disappear from the display within 15 seconds.

If the waypoint cursor is not moved for 20 seconds, it will disappear from view. The next time the joystick is moved, the cursor will reappear in the same location on the display screen; however, a change of primary NAV sensor or display modes will reset the invisible cursor location to its initial starting position.

27.4.1.1.12.2 Checklist Operation

In the checklist mode, the joystick commands will be limited to four positions: UP, DOWN, LEFT, and RIGHT. The 45° commands will be ignored.

A down push on the joystick will advance the cursor checklist line. A down push at the bottom of a checklist page will advance the cursor to the next page if available. Continuous downward pushes will wrap the cursor within a checklist level.

A right push on the joystick will move the cursor to the top of the next checklist page. Continuous right pushes will wrap the cursor to the top of the next page within the list.

A left push on the joystick will move the cursor to the top of the previous checklist page. Continuous left pushes will wrap the cursor to the top of the previous page within the list.

27.4.1.1.13 HSI Single and Double Needle Bearing Pointer Source Pushbutton Selector Switch

The ↑ and ⇑ bearing pointer select buttons work in a similar manner as the NAV sensor select button. A press of the bearing pointer button sequentially selects the next available sensor for display. The bearing pointer sensor list contains only those sensors that have bearing information capabilities. If the selected sensor has distance information paired with it, that distance will also be displayed below the sensor annunciation.

Note

The ⇑ button is inoperative when TCAS OVERLAY is selected.

27.4.1.1.14 HSI Course Select Knob Activation Pushbutton Switch

The CRS SEL button is not functional for FMS operations. In checklist mode, pressing the button selects emergency procedure index on MFD.

27.4.1.1.15 HSI Course Select Knob

This provides independent selection of course on the MFD referenced to the selected NAV source.

27.4.2 Limitations

The pilot and copilot vertical gyro and directional gyro source select switches are to be selected to the same source only after failure of one source.

Navigation by reference to MFD or MFD Course Deviation Indicator (CDI) during approach is not authorized.

Note

The ED 551A system in this aircraft has been programmed upon initial installation to provide certain display formats. It is approved for use with this programming only.

27.4.3 Normal Procedures

27.4.3.1 Before Takeoff

27.4.3.1.1 MFD Preflight

Brightness — Adjust brightness of the MFD to desired level.

SYS REF test buttons on MFD computer units — Push and hold (3 seconds minimum).

Test pattern is displayed on MFD.

The MFD will display the following red flags: HDG, SG, RCP, CP, and CCP.

Note

Failure annunciations consist of a displayed message surrounded by a red box, double parallel red lines drawn through alphanumeric readouts, and red crosses through pointers. Cooling fan failure annunciation is displayed as a yellow message surrounded by a yellow box. Any of the following conditions indicate a malfunction of the ED 551A system:

— Absence of a failure or warning annunciation during test.

— TEST IN PROGRESS message remains on MFD. This message should only be displayed for a few seconds at the beginning of the test.

— SELF-TEST FAIL message on MFD.

— SELF-TEST PASS message does not appear on the MFD.

— MFD - SELECT display format as required.

27.4.4 Abnormal Procedures

27.4.4.1 DU — Display Unit Loss of Cooling

A yellow DU enclosed in a yellow box is annunciated on the MFD when insufficient airflow is detected in the display unit. Once annunciated, the faulty display unit will continue to operate for at least 30 minutes if the rated ambient temperature is not exceeded. To extend the operating time, reduce display information and brightness to a minimum.

27.4.4.2 SG — Symbol Generator Loss of Cooling

A yellow SG enclosed by a yellow box is annunciated on the MFD if insufficient airflow is detected in the symbol generator. Once annunciated, the symbol generator will continue to operate for at least 30 minutes if the rated ambient temperature is not exceeded. To extend the operating time, reduce display information and brightness to a minimum.

27.4.4.3 SG — Symbol Generator

A red SG enclosed by a red box is annunciated on the MFD when certain monitored functions are detected invalid. If the red SG annunciation is encountered, extreme caution should be used to validate any data used on the display for navigation. Even after validation and revalidation, the data should only be used as supplementary information.

27.4.4.4 CP — Control Panel

A red CP enclosed by a red box is annunciated on the MFD when a control panel button becomes stuck for greater than 10 seconds. If a button fails, the display should maintain all currently selected conditions. If the button should become functional, the fault annunciation will be removed and normal operation will be restored.

27.4.5 Other Normal Procedures

27.4.5.1 Course Select

A red X will be drawn through the course pointer head and tail if there is a course select knob failure on the ED 551A control panel.

27.4.5.2 RCP — Radar Control Panel

A red RCP enclosed by a red box is annunciated at the lower left center of the EHSI display if a radar control panel failure is detected.

27.4.5.3 RAW Data Deviation Annunciation

Pointer/scale malfunctions are annunciated by removal of the associated pointer/scale and placing a red X drawn in their place. A flag presented on the vertical deviation scale will result in the deviation pointer being removed. On the MFD, the pointer/scale annunciations include L/R deviation and GS.

27.4.5.4 Bearing Pointer Annunciation

Bearing pointer source failure or invalid data reception (no computed data, NCD) causes a red X to be drawn through the source annunciator. The bearing pointer or NAVAID is also removed.

27.4.5.5 Alphanumeric Readout Annunciation

Failures affecting alphanumeric readouts are annunciated by a red X drawn through the readout. On the MFD, the alphanumeric readouts include NAV bearing pointer source and course (DRS) or Desired Track (DTK).

Failures affecting distance information are annunciated by red dashes in the data field. When the distance source is operational but not providing valid distance data (no lock on or NCD), dashes the color of the sensor will be placed in the data field. Speed (KT) and time (MN) annunciation will be removed if valid distance, speed, and time-to-station information are not provided by the primary NAV sensor system.

27.4.5.6 WEATHER RADAR ANNUNCIATION

When a weather radar failure occurs while operating in the Wx mode, a white alphanumeric annunciation appears below the weather mode annunciation.

27.4.5.6.1 WX FLT (Weather Fault)

Displayed when a mismatch of mode, tilt, and gain or range information between the EFIS and radar RT has existed for more than 30 seconds.

27.4.5.6.2 WX OFF (Weather Radar Off)

Displayed when the radar is off.

27.4.5.6.3 Busy VP

Displayed when the radar is in the continuous VP (vertical profile) mode.

27.4.5.6.4 STB LMT (Stabilization Fault)

Displayed when the combination of tilt, roll, roll trim, and pitch exceeds $\pm 30°$.

27.4.5.6.5 429 FLT (429 Data Fault)

Displayed when 429 control data is missing or incorrect at the radar RT.

27.4.5.6.6 ANT FLT (Antenna Fault)

Displayed when the measured antenna tilt does not match the requested tilt angle.

27.4.5.6.7 TX FLX (TRANSMITTER FAULT)

Displayed when a fault is detected in the radar transmitter.

27.4.5.6.8 Range

Displayed when the pilot has selected the 1,000 miles range on the MFD. The radar is unable to operate at this range and is placed in standby.

27.4.5.6.9 STB OFF (Stabilization Off)

Displayed when stabilization off has been selected or when the stabilization reference is not present at the radar.

27.4.5.6.10 Wait

Displayed when in VP mode and one of the TRACK buttons is pressed, indicating the radar will perform the desired slicing function as soon as the antenna returns to the last selected profiling azimuth angle.

27.4.5.6.11 Heading

Once a heading failure is detected, the MFD lubber line and course pointer head and tail are removed. The lubber line is replaced by a red box with a red HDG inside it.

CHAPTER 28

UC-12F Radar Systems

28.1 TRANSPONDER

28.1.1 Introduction

The transponder system is an identification, position tracking, altitude reporting, and emergency tracking device. This set receives, decodes, and responds to interrogations by search radar. Range of the set is normally limited to line of sight.

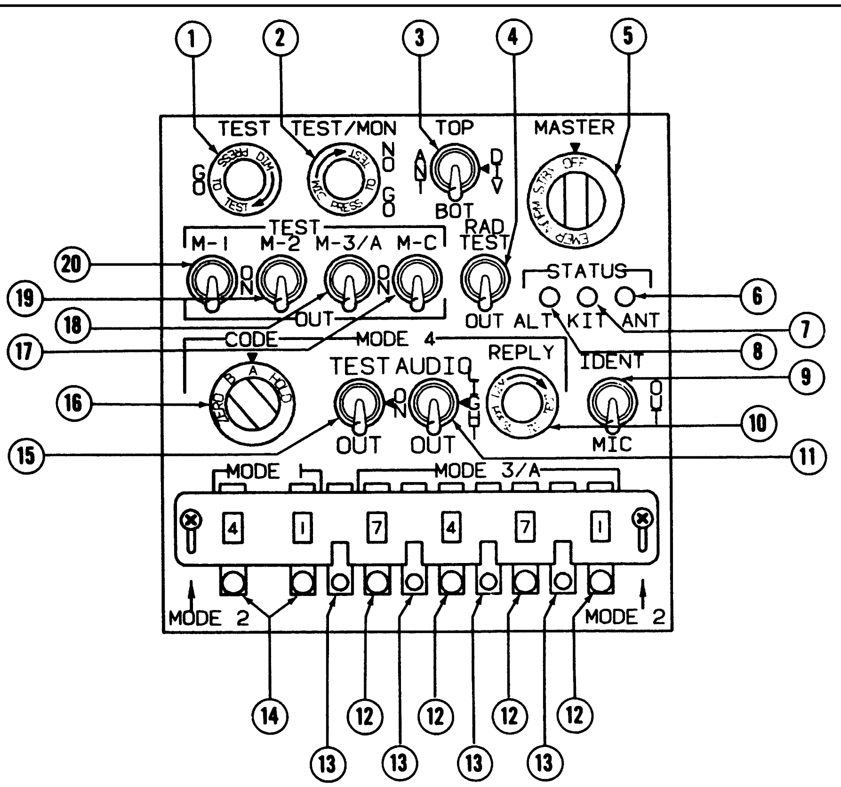
28.1.2 Operating Controls

The following controls (Figure 28-1) are provided for operation of the set.

28.1.2.1 Transponder Control Panel

1. TEST-GO indicator — Illumination indicates successful completion of built-in test.

2. TEST/MON indicator — Illumination indicates unit has malfunctioned.



1. TEST-GO Indicator
2. TEST/MON-NO GO Indicator
3. ANT Switch
4. RAD TEST-OUT Switch
5. MASTER Control
6. STATUS ANT Indicator
7. STATUS KIT Indicator
8. STATUS ALT Indicator
9. IDENT-MIC Switch
10. MODE 4 REPLY Indicator
11. MODE 4 AUDIO-LIGHT-OUT Switch
12. MODE 3/A Code Selectors
13. MODE 2 Code Selectors
14. MODE 1 Code Selectors
15. MODE 4 TEST-ON-OUT Switch
16. MODE 4 CODE Control
17. M-C TEST Switch
18. M-3/A TEST Switch
19. M-2 TEST Switch
20. M-1 TEST Switch

Figure 28-1. Transponder Control Panel

28.1.2.1.1 ANT TOP/DIV/BOT Switch

1. TOP — Selects use of top antenna.
2. DIV — Selects diversity operation using both antennas.
3. BOT — Selects use of bottom antenna.
4. RAD TEST/OUT switch — Enables an appropriately equipped transponder to reply to TEST mode interrogations from an AN/UPM-92 or similar test set.

28.1.2.1.2 MASTER OFF/STBY/NORM/EMER Control

1. OFF — Turns set off.
2. STBY — Places set in warmup (standby) condition. Red NO- GO light is on in standby position.
3. NORM — Operates set at normal sensitivity.
4. EMER — Transmits emergency reply code.

28.1.2.1.3 STATUS ANT Indicator

Illumination indicates the BIT or MON failure of Vertical Scan Weather Radar (VSWR) antenna.

28.1.2.1.4 STATUS KIT Indicator

Illumination indicates the BIT or MON failure is due to external computer.

28.1.2.1.5 STATUS ALT Indicator

Illumination indicates the BIT or MON failure is due to altitude digitizer.

28.1.2.1.6 IDENT/MIC Switch

1. IDENT — Activates transmission of identification (IP) pulse.
2. MIC — Enables either control wheel POS IDENT button to activate transmission of IDENT signal from transponder.

Note

The MIC feature is inoperative on the UC-12F.

28.1.2.1.7 MODE 4 REPLY Indicator

Illumination indicates that a reply has been made to a valid MODE 4 interrogation or will flash when in standby position and interrogated for MODE 4.

28.1.2.1.8 MODE 4 AUDIO/LIGHT/OUT Switch

1. AUDIO — Permits aural and reply light monitoring of valid mode 4 interrogations and replies.
2. LIGHT — Permits REPLY indicator only monitoring.
3. OUT — Disables monitoring capability.

28.1.2.1.9 Mode 3A Code Selectors

Selects the desired reply codes for mode 3A.

28.1.2.1.10 Mode 1 Code Selectors

Selects the desired reply code for mode 1.

28.1.2.1.11 Mode 4 TEST/ON/OUT Switch

1. TEST — Initiates BIT of mode 4 operation.
2. ON — Enables mode 4 operation.
3. OUT — Disables mode 4 operation.

28.1.2.1.12 Mode 4 Code Control

Selects dialed-in mode 4 code of the day.

28.1.2.1.13 M-C, M-3/A, M-2, and M-1 Switches

1. TEST — Permits self-test in the selected mode.
2. ON — Permits set to reply in the selected mode.
3. OUT — Disables replies.

28.1.2.1.14 Mode 2 Code Selectors

These select the desired reply codes for mode 2.

Note

The cover over the mode select switches must be slid forward to display the selected mode 2 code.

28.1.3 Transponder Operations

28.1.3.1 Activation/Test Procedure

Perform the following setup/test procedures each time the transponder is activated:

1. Place the MASTER switch in the NORM position.
2. Allow transponder to warm up for 2 minutes before operation.
3. Operate the press-to-test feature of the TEST indicator light to ensure light illuminates.
4. Test each mode (M-1, M-2, M-3/A, and M-C) individually by momentarily holding each mode switch in the TEST position. The green TEST indicator light should illuminate each time.
5. Return all switches to the normal operating position.

Note

Make no checks with the master switch in EMER or with M-3/A code 7500, 7600, or 7700 without first obtaining authorization from the interrogating station(s).

28.1.3.2 Operating Procedures

The activation test procedures will leave the transponder in an operating condition. The following additional steps may be required, depending upon mission instructions:

Note

If the external security computer is not installed in the aircraft, a NO-GO light will illuminate any time the MODE 4 switch is moved out of the OFF position.

1. Change the MODE 4 CODE rotary switch from A to B.
2. If it is desired to retain the code in the external computer during a temporary shutdown for passenger discharge or refueling, rotate the MODE 4 CODE switch to HOLD prior to touchdown and then release it. Wait 15 seconds before turning the MASTER rotary switch to OFF.
3. Dumping the code in the external computer is accomplished by turning the MODE 4 CODE switch to ZERO.
4. Set any of the M-1, M-2, M-3/A, M-C, or MODE 4 switches to OUT in order to inhibit transmission of replies in the undesired modes.
5. Set the IDENT/OUT/MIC switch momentarily to IDENT in order to transmit the identification of position (I/P) pulses.

28.1.3.3 Shutdown Procedures

Rotate the MASTER switch to OFF. This will automatically zero the external computer codes unless they have been retained as in step 2 of Operating Procedures. Refer to paragraph 28.1.3.2.

28.2 RADAR SYSTEM

28.2.1 Description

The color radar system is a lightweight, X-band digital radar with alphanumerics designed for weather detection and analysis and ground mapping (Figure 28-2).

The primary purpose of the system is to detect storms along the flight path and give the pilot a visual indication in color of the rainfall intensity. After proper evaluation, the pilot can chart a course to avoid these storm areas.

WARNING

The system performs only the function of weather detection or ground mapping. It should not be used nor relied upon for proximity warning or anticollision protection.

CAUTION

Do not operate radar system, even in STANDBY mode, without 115 Vac, 400 Hz power applied to the system. Without ac power, the receiver/transmitter cooling blower will not operate, which could result in circuit damage and/or automatic shutdown.

In weather detection mode, storm intensity levels are displayed in three bright colors contrasted against a deep black background. Areas of heaviest rainfall will appear in red, less severe rainfall in yellow, moderate rainfall in green, and little or no rainfall in black (background).

Range marks and identifying numerics, displayed in cyan, are provided to facilitate evaluation of storm cells. The cyclic function further emphasizes the heavy rainfall areas (red) of the weather display by flashing them approximately once per second.

Selection of the map function causes system parameters to be optimized on the three lowest ranges to improve resolution and identification of small targets at short ranges. The reflected signal from various ground surfaces is displayed as magenta, yellow, or cyan (most to least reflective).

The radar system consists of three units: indicator (Figure 28-2), receiver/transmitter, and antenna. The indicator is mounted in the cockpit and contains all the controls used to operate the radar. The receiver/transmitter is located on the radio rack. The antenna, which is fully stabilized for aircraft pitch and roll, is in the avionics compartment in the nose of the aircraft.

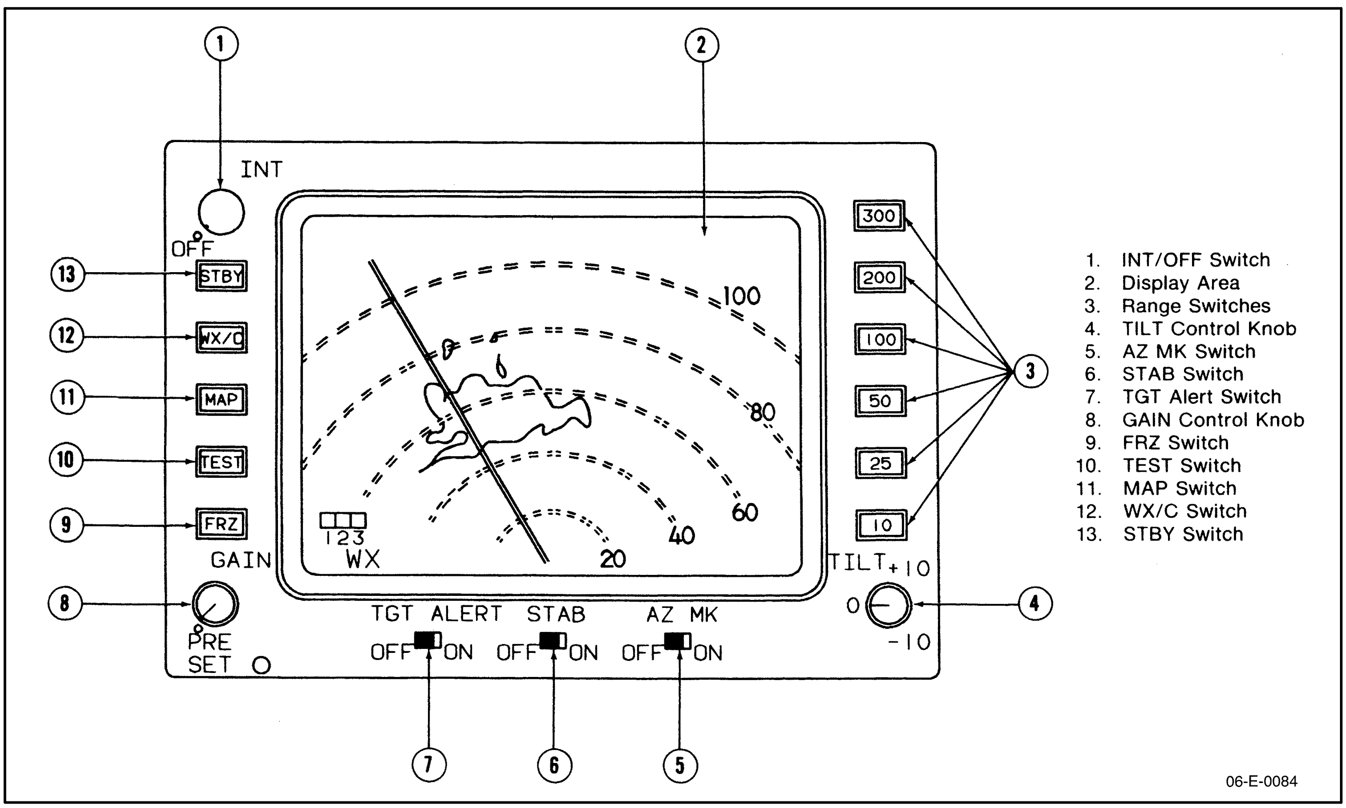


Figure 28-2. Color Radar Indicator

28.2.2 Radar System Switches

1. INT/OFF — Rotary control used to turn system on and off and to adjust intensity of display. Turn on, STBY, and 100 will be displayed.

2. STBY — Momentary pushbutton used to select standby after radar has been used in an operating mode (e.g., WX or TEST). Standby is useful for keeping radar in ready state while taxiing, loading, etc. In standby, antenna does not scan, transmitter is not enabled, and display memory is erased. STBY is displayed in mode field, and 100 is displayed as the selected range numeric.

3. WX/C — Alternate action momentary pushbutton used to select weather detection operation. If WX/C or MAP is selected prior to end of warmup period, WAIT will be displayed until R/T warms up (approximately 60 seconds). After initial turn-on and warmup, first depression of WX/C selects weather operation; WX is displayed. Second depression of pushbutton selects cyclic weather display; CYC is displayed. Displayed red targets flash on and off once per second; gain is automatically set to preset level.

4. MAP — Momentary pushbutton used to select ground mapping display; MAP is displayed.

5. TEST — Momentary pushbutton used to select a special test pattern to allow verification of system operation. In TEST position, transmitter is not enabled, 100- mile range and preset range gain are automatically selected, and TEST is displayed.

6. FRZ — Momentary pushbutton used to turn freeze function on or off with alternate depressions. When freeze is selected, display is not updated with incoming target return data. To alert pilot, FRZ label is displayed and is flashed on and off once each second. FRZ is automatically deactivated whenever selection of different control settings dictates a change in displayed data. At system turn-on, FRZ is automatically off.

7. GAIN — Rotary control with one fixed-gain detented position PRESET. Used to adjust sensitivity of radar receiver, primarily to resolve nearby strong target signals while ground mapping. Sensitivity increases with clockwise rotation. Full counterclockwise rotation to detent sets gain at preset level. When control is not in detented position, VAR is displayed unless preset gain has been automatically selected.

8. TGT ALERT — Slide control used to turn target alert function on or off. When enabled, letter T in red rectangle is displayed to identify that target alert function is active. Target alert is active only when radar gain is calibrated (i.e., in WX with GAIN PRESET and in CYC or TEST). The symbol TGT in a red rectangle is displayed and flashes once each second whenever a red-level target is detected within the target alert section (range from 60 to 160 nm and within $\pm 7.5°$ of aircraft heading). Target alert is deactivated automatically if MAP is selected or if variable GAIN is used, but is reactivated automatically when operating controls are restored to valid alert settings.

9. STAB — Slide control used to turn antenna stabilization on or off.

10. AZ MK — Slide control used to either display or not display azimuth markers at 30° intervals.

11. TILT — Rotary control used to select tilt angle of antenna beam with relation to earth (with stabilization on) or with relation to airframe (with stabilization off). Clockwise rotation tilts beam upward 0° to 10°; counterclockwise rotation tilts beam downward 0° to 10°.

12. 10/25/50/100/200/300 — Momentary pushbuttons used to select one of six ranges. For each selected range, five range marks are displayed. At system turn-on, l00-mile range is automatically selected. Internal memory for range pushbuttons is always active.

28.2.3 Display Area

28.2.3.1 Mode Field

Selected function is displayed as STBY, WX, CYC, MAP, or TEST.

WAIT is displayed until the initial R/T warmup period has expired and the indicator and antenna are synchronized.

28.2.3.2 Auxiliary Field

Color bar relates displayed colors to signal reflectivity levels 1, 2, 3 displayed beneath color bar.

For WX, CYC, and TEST, color bar is green, yellow, and red. For MAP, color bar is cyan, yellow, and magenta.

VAR replaces 1, 2, 3 in WX and MAP when GAIN control is not in detented PRESET position.

FRZ is displayed as a blinking word when freeze function is selected.

28.2.3.3 Target Field

Blank unless target alert is enabled, causing letter T in red rectangle to be displayed. Flashing alert symbol TGT in a red rectangle is displayed when red-level target is detected within the target alert sector.

28.2.3.4 Range Mark Numerics

Five labeled range marks are displayed on each range. The fifth range mark label is larger, serving to identify the selected range. Range and azimuth marks and numerics are displayed in cyan for WX, CYC, and TEST and in green for MAP.

28.2.4 Operation

CAUTION

Do not operate radar system, even in STANDBY mode, without 115- Vac, 400- Hz power applied to the system. Without power, the receiver/transmitter cooling blower will not operate, which could result in circuit damage and/or automatic shutdown.

28.2.4.1 Before Turn-On

Place the system controls in the following positions before applying power from the aircraft electrical system.

1. INT/OFF — OFF (fully counterclockwise in detent).
2. GAIN — PRESET (fully counterclockwise in detent).
3. TILT — +10 (fully clockwise).

4. STAB — ON.

5. TGT ALRT — OFF.

6. AZ MK — OFF.

28.2.4.2 Precautionary Procedures

If the radar system is to be operated in any mode other than STBY or TEST while the aircraft is on the ground:

1. Direct nose of aircraft such that antenna scan sector is free of large metallic objects such as hangars or other aircraft for a distance of 100 feet (30 meters) and tilt antenna fully upward.

2. Avoid operation during refueling operations within 100 feet (30 meters).

3. Avoid operation if personnel are standing too close in the 270° forward sector of the aircraft (refer to paragraph 28.2.4.9).

WARNING

To prevent electromagnetic radiation in ramp, terminal, taxiway, or other areas occupied by personnel, operate radar only in STANDBY mode.

28.2.4.3 Self-T est Displays

A distinctive test pattern is displayed when the TEST function is selected. The following procedures should be performed to verify the operational status of the radar:

Note

The MODE field will not be visible with NAV 1 and NAV 2 selected on the DATA NAV control panel.

1. Verify that the preliminary control settings have been made, then rotate INT/OFF control to midpoint to turn system on. Verify that STBY is displayed in mode field and 100 is displayed as selected range.

2. Press WX/C pushbutton and verify that WAIT is displayed in mode field.

Note

- A time-delay circuit prevents the transmitter from operating and maintains the display blanked until the magnetron has warmed up. When the radar is turned on by pressing the WX/C or MAP pushbuttons, it will display WAIT and will be in standby for the 1 minute warmup period, then automatically become operational in the selected mode.

- If none of the pushbutton switches are depressed, the radar will display STBY and be in the standby mode.

3. Press the TEST pushbutton and, when the test pattern appears, verify operation of the intensity control and adjust to desired viewing level.

4. Observe the display; verify that TEST is displayed in the mode field and test pattern exhibits the following characteristics:

   a. Range marks and alphanumerics are displayed in cyan.

   b. Color bar and 1 2 3 are displayed in auxiliary field.

   c. The colors of the first three target bands are green, yellow, and red.

   d. The color of the fourth target band (65 to 76 nm) is red.

   e. The two red target bands flash on and off approximately once each second.

5. Momentarily press WX/C pushbutton and slide TGT ALERT control to ON. Verify that the letter T in a red box appears in the target alert field.

6. Press TEST pushbutton and observe that the test pattern display crosses the centerline and the T is replaced by a flashing TGT label. Slide TGT ALERT control to OFF to disable the function.

7. Verify that 100 (nm) is displayed in the upper right-hand corner and the first four range marks are labeled with the correct numerics.

8. Slide AZ MK control to ON and verify that azimuth marks are displayed in cyan at 30° intervals. Slide AZ MK control to OFF to remove azimuth marks.

9. Momentarily press WX/C pushbutton to erase display, then press TEST pushbutton. After approximately 2 seconds, momentarily press FRZ and verify that the 1 2 3 display beneath the color bar is replaced by a flashing FRZ label. Verify that only a portion of the test pattern is displayed and there is no further updating. Momentarily press FRZ pushbutton and verify that the display begins updating, starting at the current scan position.

10. Press 10 (nm) range pushbutton and verify that the test pattern is momentarily blanked and then restored to the previous display.

11. Momentarily press WX/C pushbutton and verify that WX appears in the mode field and 10 appears as the selected range. Verify correct range numerics.

12. Press each range pushbutton in succession (25/50/100/200/300) and verify that range numerics change appropriately with each selection.

13. Momentarily press WX/C pushbutton and verify that CYC is displayed in the mode field.

14. Rotate GAIN control just out of PRESET and verify that 1 2 3 remains in the auxiliary field.

15. Momentarily press WX/C pushbutton and verify that WX is displayed in the mode field and that VAR replaces 1 2 3 in the auxiliary field.

16. Momentarily press MAP pushbutton and verify that MAP is displayed in the mode field. Verify that the color of the range marks and alphanumerics is green.

17. Momentarily press STBY pushbutton to return radar to nontransmitting state. Return GAIN control to PRESET.

28.2.4.4 Fault Displays

Display colors are continuously monitored by the color bar and 1 2 3 legend in the auxiliary field. If a fault causes change to unfamiliar colors, the severity level denoted by the faulty color(s) is directly coded by the 1 2 3 legend.

Other circuits continuously monitor performance and loading of system power supplies. A fault resulting in power supply operation outside of preset limits will cause the system to shut down and the display will be blank. Should this occur, use the following procedure to recycle the system:

1. Rotate INT/OFF control to OFF.

2. Verify aircraft radar circuit breaker is set.

3. After a few seconds, rotate INT/OFF control to midpoint and press TEST pushbutton.

If the fault was of transient nature, the system may operate satisfactorily.

28.2.4.5 Ground Mapping

Ground mapping operation is selected by pressing the MAP pushbutton. Turn the TILT control down until the desired amount of terrain is displayed. The degree of down tilt will depend upon the type of terrain, aircraft altitude, and selected range.

For the low ranges (10, 25, and 50 nm), the transmitter pulse width is narrowed and the receiver bandwidth is widened to enhance the identification of small targets.

28.2.4.6 Radar Stabilization

The radar stabilization system is designed to maintain the antenna beam at the selected tilt angle relative to the Earth's surface. The stabilization system uses the aircraft vertical gyros as a reference and is comprised of electronic amplifiers in the receiver/transmitter interconnected with electromechanical components in the antenna.

28.2.4.7 Level Flight

Trim aircraft for straight-and-level flight in smooth, clear air over level terrain. Select a 50-mile range and set STAB to OFF.

Rotate tilt control upward until all ground returns disappear. Then rotate tilt downward until ground returns just begin to appear. After several antenna sweeps, check to see that ground returns are equally displayed. If returns are only on one side of the radar screen or uneven across the radar screen, this indicates a misalignment of the radar antenna mounting and should be corrected before proceeding. Repeat this procedure until a balanced display is achieved.

Once the radar display is correct with stabilization off, select stabilization ON and tilt upward once again to remove all returns. Rotate tilt downward and check for even displays of ground returns. If this test indicates improper display, possible errors in the radar stabilization circuits or aircraft gyro exist.

Note

It is typical of a precessing aircraft gyro to cause ground returns to first appear on one side of the display, then have them shift to the opposite side of the display. This precession may not be readily apparent with respect to flight control instruments.

28.2.4.8 Turns

Once proper operation is established in level flight, rotate the TILT control upward in 1° increments until ground returns just disappear, then rotate an additional 2° upward.

Place the aircraft in a standard rate turn to the right. Note the radar display. It should be free of returns throughout the turn, indicating proper stabilization alignment.

If returns display on the right side of radar indicator, the radar system is understabilizing. Targets on the left side of radar display indicate the system is overstabilizing.

In prolonged turns, gyro precession may occur, which will be tracked by the stabilization system and appear as undesirable ground targets on the indicator.

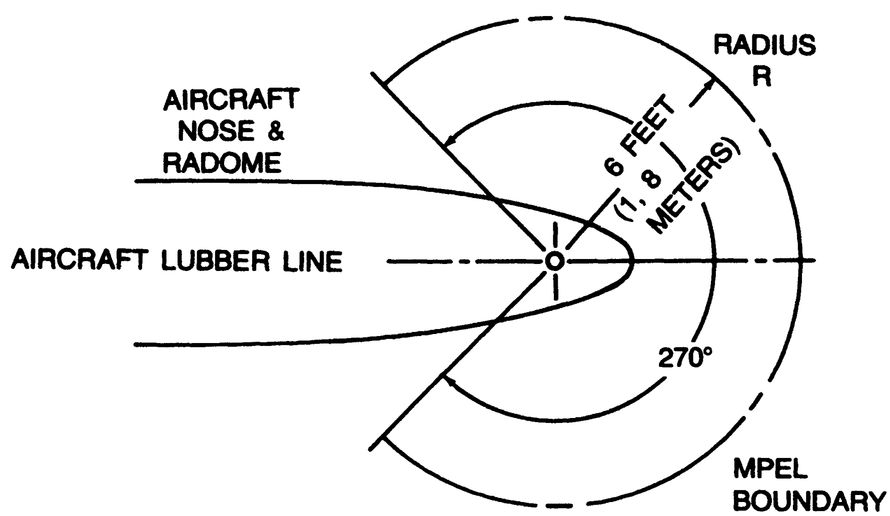
28.2.4.9 Maximum Permissible Exposure Level

Heating and radiation effects of weather radar can be hazardous. Personnel should remain at a distance greater than "R" (Figure 28-3) from the radiating antenna in order to be outside of the radiation envelope.

28.3 WEATHER RADAR SYSTEM

28.3.1 Description

The weather radar system detects storms and gives the pilot a visual indication of storm intensities. The presentation on the indicator shows the location, distance, and azimuth of potentially dangerous areas. In addition to its primary purpose of weather mapping, the system can be used for ground mapping also.



WARNING

NEVER RELY UPON WEATHER RADAR FOR PROXIMITY WARNING OR FOR ANTICOLLISION PROTECTION OR WARNING

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Figure 28-3. Maximum Permissible Radar Exposure Level Boundary

WARNING

The radar system performs only weather detection and ground mapping functions. It should not be used nor relied upon for proximity warning or anticollision protection.

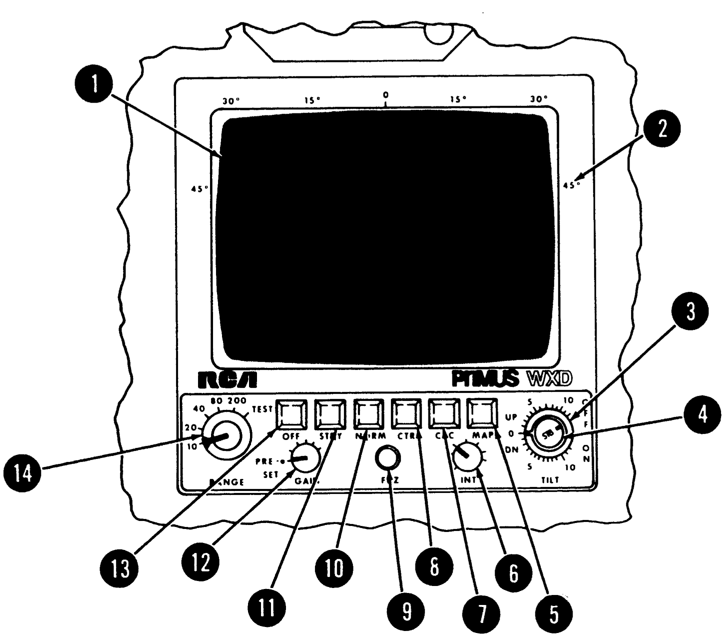
The radar system consists of three units: the receiver/transmitter, the antenna, and the indicator. The radar indicator (Figure 28-4) is mounted in the cockpit instrument panel and contains all controls used to operate the radar. The antenna is located in a radome in the nose of the aircraft (Figure 20-1), and the receiver/transmitter is located in a fuselage radio compartment. System circuits are protected by a RADAR circuit breaker on the copilot right sidewall panel.

1. Tilt selector control — Rotary control enables pilot to select angles of antenna beam tilt with relation to earth plane (with stabilization on) or in relation to airframe (with stabilization off). Rotating control clockwise tilts beam upward; counterclockwise rotation tilts beam downward. Control indexes increments of tilt in degrees from 0° to 12° up or down.

2. Stabilization (STAB) ON/OFF control — Two-position switch concentric with tilt control used to turn stabilization ON or OFF.

3. Mapping mode pushswitch — Pushbutton switch used to select ground mapping mode.

4. Intensity (INT) control — Rotary control used to regulate brightness (intensity) of display. Display retains distinguishable illumination levels over entire range of control.



1. DISPLAY AREA
2. AZIMUTH 15-DEGREE INCREMENT (TYP)
3. TILT SELECT CONTROL
4. STABILIZATION ON/OFF CONTROL
5. MAPPING MODE PUSHSWITCH
6. INTENSITY RHEOSTAT
7. CYCLICAL MODE PUSHSWITCH
8. CONTOUR MODE PUSHSWITCH
9. FREEZE (DISPLAY) PUSHSWITCH
10. NORMAL MODE PUSHSWITCH
11. STANDBY MODE PUSHSWITCH
12. GAIN/PRESET RHEOSTAT
13. OFF PUSHSWITCH
14. RANGE SELECT CONTROL

06-E-0080

Figure 28-4. Radar Control Panel

5. Cyclical (CYC) mode pushswitch — Pushbutton switch used to select cyclical operation between normal and contour modes. Automatically selects preset gain.

6. Contour (CTR) mode pushswitch — Pushbutton switch used to select contour mode. Contoured data is delineated by border and automatically selects preset gain.

7. Freeze (FRZ) mode pushswitch — Pushbutton switch used to stop data update. When pushed, switch illuminates and last updated picture is continuously displayed. When pushed again, freeze mode is terminated and light mode extinguishes.

8. Normal (NORM) mode pushswitch — Pushbutton switch used to place radar in normal mode of operation for weather detection.

9. Standby (STBY) mode pushswitch — Pushbutton switch that activates radar. Upon turn-on, radar begins warmup period of about 4-1/2 minutes, after which it is ready to operate in any selected mode. Radar can also be turned on by pressing any other mode selection switch, and it will automatically go into operation at end of warmup period. Standby is useful for keeping radar in ready state while taxiing, loading, etc. In standby, antenna does not scan and transmitter does not transmit.

10. GAIN/PRESET control — Variable gain rotary control with one fixed gain position (RESET). Gain increases as the control knob is rotated clockwise. Variable gain is used to adjust sensitivity of receiver, primarily to resolve nearby strong target signals, and is available in the NORM and MAP modes only. The full counterclockwise rotation (DETENT) sets gain at PRESET (maximum) level.

11. OFF pushswitch — Pushbutton switch used to turn system OFF.

Note

If none of the mode selection switches (OFF, STBY, NORM, CTR, or MAP) is depressed, the radar will be in the standby mode.

12. Range select control RANGE: 10, 20, 40, 80, 200, TEST CONTROL — Rotary switch with six detent positions used to select one of five ranges or TEST mode. Range settings are: 10, 20, 40, 80, and 200 nm. TEST mode provides special test pattern in which all illumination levels can be seen. Test pattern cycles alternate between normal and contour mode of operation. In TEST mode, transmitter does not transmit and range selection is automatically 80 nm.

28.3.2 Operation

28.3.2.1 Before Turn-On

Place controls on the radar control panel (Figure 28-4) in the following positions before applying power from the aircraft electrical system:

1. OFF pushbutton — Depressed.

2. GAIN/PRESET control — Fully counterclockwise at PRESET.

3. INT control — Midpoint.

4. TILT control — Fully upward.

5. RANGE control — TEST.

28.3.2.2 Precautionary Procedures

If the radar system is to be operated in the NORM, CTR, CYC, or MAP mode while the aircraft is on the ground, proceed as follows:

1. Direct nose of aircraft so that antenna scan sector is free of large metallic objects (hangars, other aircraft, etc.) for distance of 100 yards (90 meters), and tilt antenna fully upward.

2. Avoid operation during refueling operations within 100 yards (90 meters).

3. Prevent personnel from standing too close to radiating antenna. Refer to Figure 28-3.

28.3.2.3 Turn-On

1. RADAR circuit breaker — Set.

2. RANGE control — Verify in TEST position.

3. STBY pushbutton — Depress; allow 4- 1/2 minute warmup.

Note

A time-delay circuit prevents the transmitter from operating until the magnetron has warmed up. If the radar is switched directly from OFF to NORM, CTR, CYC, or MAP, it will not operate until the warmup period has expired.

4. NORM pushbutton — Depress after warmup.

5. Rotate intensity control in increments until display brightness is at desired level. After each adjustment of intensity, wait for several scan periods before judging effect. Once established, setting seldom needs adjustment.

6. Observe test display cycling between those shown in Figures 28-5 and 28-6.Verify three-level pattern and alphanumerical indication of mode, maximum range, and range markers.

7. Press CTR pushbutton and observe continuous test display as shown in Figure 28-6. Verify that dark upper bar is bordered.

28.3.2.4 Operation

28.3.2.4.1 Weather Detection

It may be necessary to tilt the antenna up slightly to avoid ground clutter during weather detection. The exact amount of up tilt will depend on the aircraft altitude and the selected operating range. After each adjustment of tilt, wait for two or three scans before judging the effect.

The normal mode is usually selected for weather detection. When the radar is in the contour or cyclic mode, the variable control of the gain is disabled and the gain preset condition is automatically substituted. The cyclic mode presents the display in the normal and contour modes on alternate left and right scans.

28.3.2.4.2 Ground Mapping

For ground mapping, turn the TILT control down until the desired amount of terrain is displayed. The degree of down tilt will depend on the aircraft altitude and the selected range.

If insufficient detail appears, rotate the GAIN control from the PRESET position and adjust the gain manually.

28.3.2.4.3 Weather Recognition and Avoidance

Experience will teach the pilot to detect and evaluate the various types of storm displays. To avoid turbulent weather, the pilot should evaluate the storm display and then determine the approximate heading change required to bypass the storm or to navigate between storm cells. When the aircraft has been established on its new heading, the pilot should monitor the radar display to see if further correction is needed.

Turbulence and hail are chief weather conditions that detract from the comfort and safety of flight. These conditions are associated with thunderstorms and, more specifically, with sharp rainfall gradients. Isocontour circuits in the radar make possible the display of such a gradient, provided that it is steep enough and close enough to the aircraft.

Note

Use of radar for weather penetration closer than 10 miles is not recommended.

28.3.2.4.4 Maximum Permissible Exposure Level

The heating and radiating effects of weather radar can be hazardous to life. Personnel should remain 6 feet (1.8 meters) or more from the radiating antenna to be outside the envelope in which the radiation exposure levels equal or exceed 10 milliwatts per square centimeter. The 6-foot (1.8-meter) radius is calculated on the basis of the rated peak power output and duty cycle of the transmitter and an antenna radiator 18 inches (45.7 centimeters) in diameter. This is a far field distance calculation. The near field to far field intersection distances are less than the 6-foot (1.8-meter) distance shown in Figure 28-3.

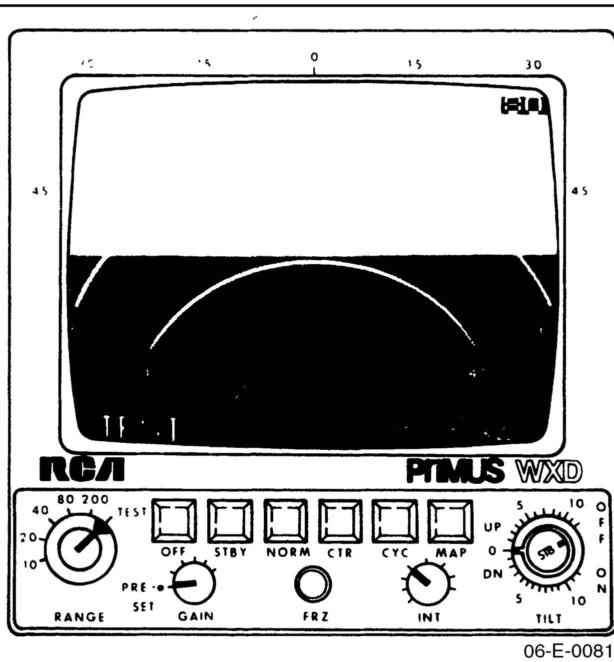
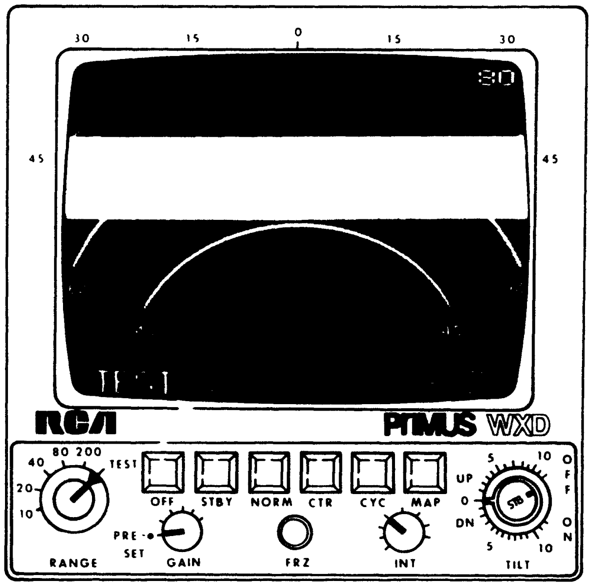


Figure 28-5. Radar Test Display — Normal Presentation



06-E-0082

Figure 28-6. Radar Test Display — Contour Presentation

CHAPTER 29

UC-12M Radar Systems

29.1 TCAS 2000 TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

29.1.1 System Description

The TCAS 2000 system consists of a TCAS 2000 Computer Unit (CU), dual Sextant Vertical Speed Indicators/Traffic Advisory Displays (VSI/TRA), and TCAS/transponder control panel. TCAS targets can also be displayed on the ED 551A Multi-Function Display (MFD) mounted on the center instrument panel.

The TCAS 2000 system receives input from the Mode S/IFF transponder and TCAS directional antennas and determines target aircraft location and flight path. The CU interprets these inputs and displays traffic targets on the MFD and the VSI/TRA displays located on the pilot and copilot panels. When the traffic is of close enough proximity, the TCAS system will issue traffic resolution target climb or descent rates on the VSI/TRAs that direct the pilot to avoid the approaching threat. Aural warnings of threat traffic are also provided through the flight compartment speakers and headsets.

The Honeywell XS-950SI Mode S/IFF transponder system consists of a single XS-950SI Receiver/Transmitter unit, TCAS/transponder control panel (shared with the TCAS 2000 system), and both top and belly mounted L-band antennas.

The control panel for the Mode S/IFF TCAS/transponder is located on the center pedestal and is used to control operating modes for the TCAS and transponder. The panel controls the standard mode 3A 4096 code related selections including LOAD pushbutton, Ident (IDNT) pushbutton, TCAS Above/Normal/Below mode, VSI/TRA display range, TCAS/transponder mode select switch, MASTER SYSTEM switch, SYSTEM TEST pushbutton, GO and NOGO annunciators, and Display Select switch.

Two externally mounted antennas feed information directly to the TCAS CU. The TCAS top mounted antenna is a directional antenna and the belly-mounted antenna is an omnidirectional antenna.

The circuit breaker for the TCAS system is located on the overhead circuit breaker panel and is labeled TCAS. The circuit breakers for the pilot and copilot VSI/TRAs are located on the circuit breaker panel and are labeled No. 1 and No. 2 VSI/TRA (AC). The circuit breaker for the transponder system is located on the overhead circuit breaker panel and is labeled TRANSPONDER.

The lighting control knobs for the VSI/TRAs are located on the pilot and copilot instrument panels in close proximity to each VSI/TRA display. The lighting control for the MFD is located on the MFD control panel. The TCAS/transponder control head lighting is controlled with the CONSOLE LIGHTS control knob on the overhead panel. Refer to Figure 29-1.

29.1.1.1 TCAS/XPDR/IFF Control Panel

29.1.1.1.1 Mode Select/TCAS Enable Switch

Selects the transponder and TCAS modes. Switch has six positions (TCAS: TA/RA, TA and MODE: S, C, 3/A and OFF). The switch position functions are as follows:

1. TA/RA (Traffic Advisory/Resolution Advisory) — The TA/RA switch position is the normal, TCAS operating mode. In this mode, TCAS provides both TAs and generates RAs. Configures the transponder for modes 3/A, C and S operations and enables altitude reporting. Periodic mode S squitters are transmitted from the aircraft.

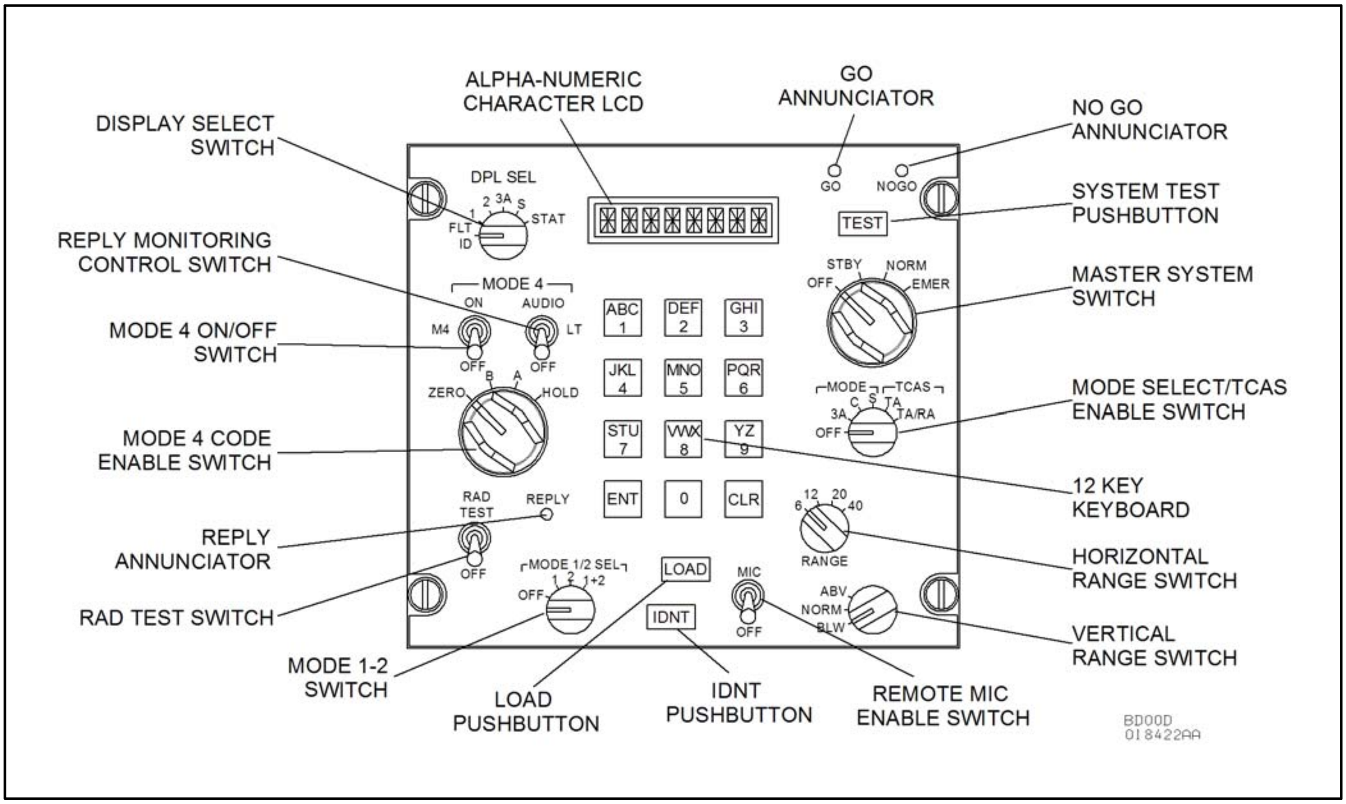


Figure 29-1. TCAS/XPDR/IFF

2. TA — In this position, TCAS provides TAs only. No RAs are issued. This mode prevents TCAS from issuing RAs when the TCAS aircraft is intentionally flying close to another aircraft, such as on a closely spaced parallel approach. TA ONLY is annunciated on the VSI/TRA display. The TA mode configures the transponder for modes 3/A, C, and S operations and enables altitude reporting. Periodic mode S squitters are transmitted from the aircraft.

3. S — Configures the transponder for modes 3/A, C, and S operations and enables altitude reporting. Periodic mode S squitters are transmitted from the aircraft.

4. C — This position configures the transponder for modes 3/A and C operations and enables altitude reporting. Periodic mode S squitters are transmitted from the aircraft.

5. 3A — Configures the transponder for mode 3/A operations.

6. OFF — Turns off all functions of the transponder.

29.1.1.1.2 MASTER SYSTEM Switch

A four-position switch (STBY, NORM, EMER, and OFF). The switch position functions are as follows:

1. STBY (Standby) — This position puts the transponder in standby mode. The transponder receives interrogations but does not reply. This position inhibits TCAS interrogations when the Mode Select/TCAS Enable switch is set in the TA/RA or TA mode. TCAS OFF is displayed on the TCAS VSI/TRA display.

2. NORM (Normal) — This position enables TCAS/Transponder interrogations and transponder mode replies to air and ground interrogations. This position enables transponder Mode 4 replies to IFF interrogations when MODE 4 ON/OFF switch is in the ON position.

3. EMER (Emergency) — This position configures the transponder for emergency operation. The EMER switch position enables transponder modes 1, 2, 3/A ,and S to reply with an emergency transponder code automatically irrespective of the Mode Select/TCAS Enable switch settings, MODE 1-2 switch settings, or MODE 4 ON/OFF switch settings.

4. OFF — Turns the power off the TCAS/transponder/IFF control panel.

Note

When the MASTER SYSTEM switch is in the STBY or NORM position, the control panel LCD display should read SYS GO.

29.1.1.1.3 System Test (TEST) Pushbutton

With the MASTER SYSTEM switch set to NORM, pushing the TEST pushbutton initiates the mode S/IFF transponder self-test. Control panel and transponder status messages are displayed on the control panel LCD display. Select STAT on the Display Select switch to view system status.

Self-test only tests enabled transponder modes.

During self-test, the control panel first conducts a lamp test, turning all LCD segments on, front panel indicators on, and turning the caution light on for 5 seconds.

Next, the control panel performs an internal test and will display CP FAIL if there is an internal failure of the control panel. If the control panel self-test passes, CP PASS is displayed for 5 seconds.

29.1.1.1.4 NOGO Annunciator

Annunciator lamp indicates transponder operational system status. A NOGO indication means the transponder is partially or completely inoperative. Select STAT on the Display Select switch to view fault messages. More than one fault message may exist. Push ENT to scroll through all fault messages.

29.1.1.1.5 GO Annunciator

Annunciator lamp indicates transponder operational system status. A GO indication means the mode S/IFF is operational for the transponder modes selected. The GO lamp will illuminate for approximately 5 seconds and the control panel LCD STAT display will read SYS GO.

29.1.1.1.6 Display Select (DPL SEL) Switch

A six-position switch (STAT, S, 3A, 2, 1, and FLT ID).

1. STAT (Status) — When selected, will give the status of the control panel and transponder on the LCD display. When the MASTER SYSTEM switch is in the OFF position and the DPL SEL switch is in the STAT position, power is removed from the transponder and the control panel LCD display reads XPDR OFF.

2. S — Select this position in order to enter the eight-digit Mode S address. Does not function when the Mode 1-2 switch is selected, Mode 4 ON/OFF switch is on, or when the Mode Select/TCAS Enable switch is in the C or 3A position.

3. 3A — Select the position in order to enter the four-digit Air Traffic Control (ATC) address. Does not function when the Mode 1-2 switch is selected or the Mode 4 ON/OFF switch selection is in the ON position.

4. 2 — 4096 code selection. Select this position to enter the four-digit 4096 ATC address. Works only with the Mode 1-2 switch selection.

5. 1 — 32 code selection. Select this position and enter the two-digit 32 response code. Works only with the Mode 1-2 switch selection.

6. Flt ID (Flight Identification) — Select this position to enter the flight identification character string (maximum of eight alphanumeric characters). Works only when the Mode Select/TCAS Enable switch is in the TA/RA, TA, or Mode S position.

29.1.1.1.7 LOAD Pushbutton

Press the LOAD pushbutton to activate the DPL SEL selection when entered. The LOAD pushbutton must be pushed within 5 seconds after entering the code address or the control panel reverts back to the previous code.

29.1.1.1.8 IDNT (Ident) Pushbutton

The transponder Ident (IDNT) function can be initiated from the control panel IDNT pushbutton if the Remote MIC Enable switch is in the OFF position. When the Remote MIC Enable switch is in the MIC position, IDNT is initiated from a remote PUSH-TO-TALK switch on the pilot control wheel.

29.1.1.1.9 Remote MIC Enable Switch

Enables pilot to use the remote transponder Ident button on the pilot control wheel.

29.1.1.1.10 Vertical Range Switch (ABV-NORM-BLW)

This switch selects the vertical range for which traffic will be displayed.

1. ABV (above) — TCAS displays traffic within the selected range that is located between +9,900 feet above the aircraft to -2,700 feet below the aircraft. The ABV selection is displayed on the TCAS VSI/TRA display.

2. NORM (normal) — TCAS displays traffic within the selected range that is located between +2,700 feet above the aircraft to -2,700 feet below the aircraft.

3. BLW (Below) — TCAS displays traffic within the selected range that is located between +2,700 feet above the aircraft to -9,900 feet below the aircraft. The BLW selection is displayed on the TCAS VSI/TRA display.

29.1.1.1.11 Horizontal RANGE Switch

The RANGE switch allows selection of the scale used for display of traffic on the VSI/TRA. The available selections are 6, 12, 20, or 40 nautical miles.

VSI/TRA RANGE SETTINGS				
RANGE SETTING	Ring of Dots	Forward (100% of RANGE Setting)	Left or Right (70% of RANGE Setting)	Aft (42% of RANGE Setting)
6	2 nm	6 nm	4.2 nm	2.5 nm
12	2 nm	12 nm	8.3 nm	5.0 nm
40	--- (see note)	40 nm	28 nm	17 nm

Note

When RANGE is set to 40 nautical miles, the ring of cyan dots is removed from the VSI/TRA display.

29.1.1.1.12 Mode 1-2 Switch (MODE 1/2 SEL)

This switch is a four-position switch (OFF, 1, 2, and 1+2). The switch positions are as follows:

1. OFF — Turns off Modes 1 and 2 transponders.
2. 1 — Configures the transponder for Mode 1 operations.
3. 2 — Configures the transponder for Mode 2 operations.
4. 1+2 — Configures the transponder for both Modes 1 and Mode 2 operations.

29.1.1.2 Continuous Fault Detection

The Mode S/IFF transponder continuously monitors and tests itself. If the NOGO annunciator lamp illuminates, select STAT (Display Select switch) to determine the cause of the failure.

29.1.1.3 Mode 4 Identification Friend/Foe Transponder Operations

29.1.1.3.1 Mode 4 ON/OFF Switch

Mode 4 is the Identification Friend/Foe (IFF) interrogation/reply mode. It configures the transponder for Mode 4 operations.

29.1.1.3.2 Mode 4 Code Enable Switch

To operate the Mode 4 Code Enable switch, push and turn the control knob to the desired position. This switch is a four-position switch (A, B, HOLD, and ZERO).

29.1.1.3.2.1 Code A

Transponder replies to Code A encrypted interrogations.

29.1.1.3.2.2 Code B

Transponder replies to Code B encrypted interrogations.

29.1.1.3.2.3 HOLD

The spring-loaded HOLD switch retains the Mode 4 crypto computer codes A and B when electrical power is removed from the transponder. The Mode 4 Code Enable switch returns (springs back) to the Code A position after HOLD is enabled. The HOLD function only works when the aircraft is on the ground and is typically enabled prior to refueling the aircraft.

29.1.1.3.2.4 ZERO

This switch position erases Mode 4 crypto computer codes A and B.

29.1.1.3.3 REPLY Monitoring Control Switch

This is a three-position switch (AUDIO, LT, and OFF).

29.1.1.3.3.1 AUDIO

An audio Mode 4 warning tone is annunciated in the pilot headset when the transponder receives a valid Mode 4 interrogation but it does not reply.

29.1.1.3.3.2 LT

The LT position enables REPLY annunciator lamp only monitoring; Mode 4 audio warning tones are disabled.

29.1.1.3.3.3 OFF

The AUDIO and REPLY annunciator lamp functions are disabled.

29.1.1.3.4 REPLY Annunciator

REPLAY annunciator lamp illuminates when the transponder replies to Mode 4 interrogations.

29.1.1.3.5 RAD Test Switch

Permits in-flight monitoring or ground testing of the entire IFF system usually conducted by a ground ramp test unit prior to takeoff.

Note

- The RAD TEST switch is a momentary position switch which is enabled when manual pressure is applied and returns to the OFF position when manual pressure is removed.
- Make sure the MASTER SYSTEM switch is in the NORM position.

29.1.1.4 VSI/TRA Indicator

The VSI/TRA display is a color, flat-panel liquid crystal display with two modes of operation: as a normal VSI and as a TRA display. As a VSI, the indicator provides a standard display of vertical speed in feet per minute with a range of plus or minus 6,000 feet per minute. As a TRA display, an aircraft symbol representing the TCAS 2000 aircraft appears in the lower portion of the display surrounded by 12 dots. The dots are located at the clock positions to assist the crew in visually acquiring the traffic. Refer to Figure 29-2.

The data displayed on the VSI/TRA depends on several switch settings as well as the specific status of any intruder.

29.1.1.4.1 Resolution Advisory Vertical Speed Guidance

Red and green arcs show vertical maneuvers recommended by TCAS 2000 to make sure of safe separation.

The TCAS 2000 color-coded visual advisory area for vertical speed guidance is inside, and adjacent to, the vertical speed indicator scale. The red arc indication tells the pilot what vertical speed region is to be avoided. If a change in vertical speed is necessary, a green arc indicates the specific region of vertical speed the pilot is to “fly to.”

29.1.1.4.2 Traffic Display Symbology

Aircraft symbology depicted on the VSI/TRA is color-coded. Each color has a distinct shape associated with it. Data Tags have the same color as the symbol they are associated with. Intruders are prioritized and displayed based on their measured range and relative range rate with respect to the TCAS 2000 aircraft. The VSI/TRA can display a maximum of 12 aircraft. The highest priority is given to RAs. The remaining TAs (if present) and Proximate Traffic (if present) are displayed according to their calculated threat assessment based on range, range rate, and whether the intruder has altitude reporting capability.

The displayed traffic will be positioned at its correct range and relative bearing and will move across the display as its range and bearing change.

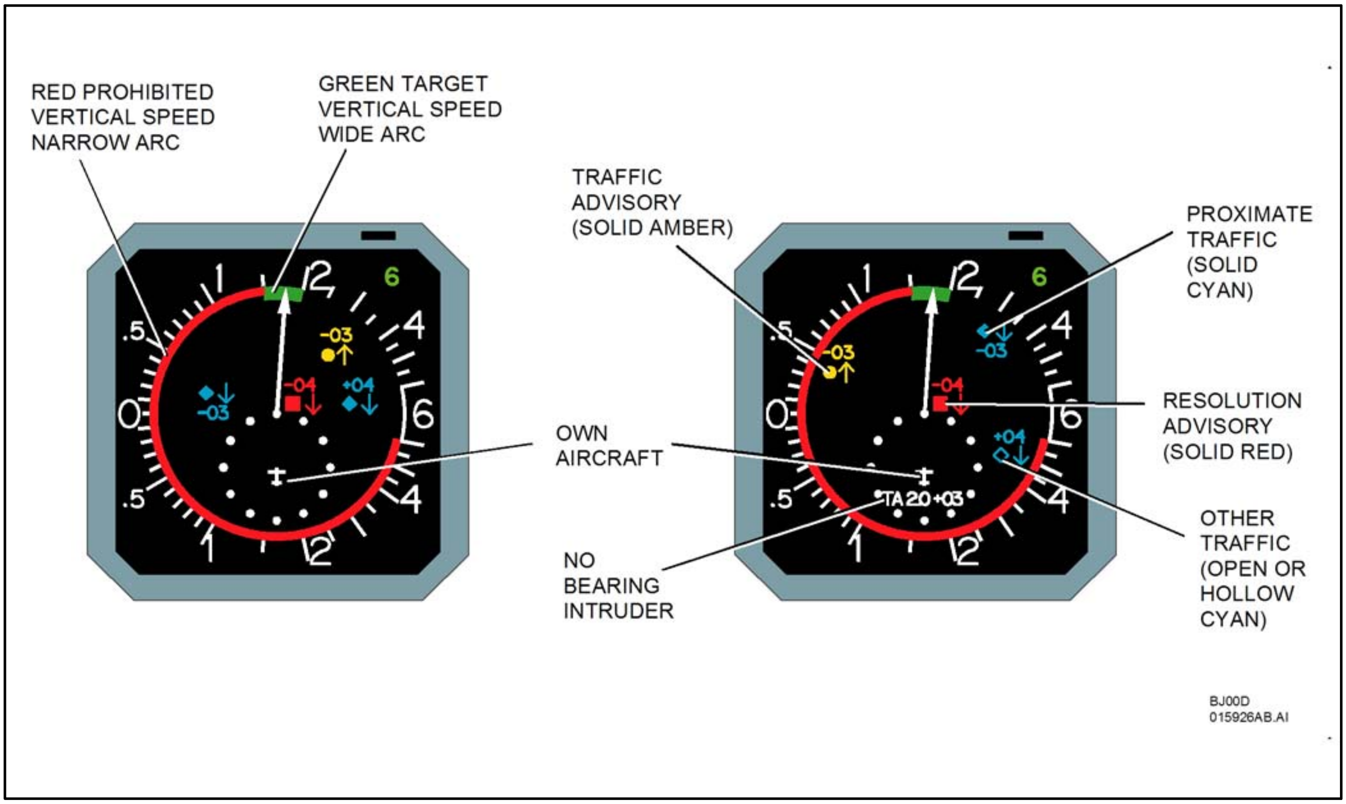


Figure 29-2. VSI/TRA Indicator Display

29.1.1.4.2.1 Solid Red Square

Represents an immediate threat to the TCAS 2000 equipped aircraft. Prompt action must be taken to avoid the intruder. An intruder symbolized in red is entering the warning area and is 15 to 35 seconds from entering the collision area. Red is used only in conjunction with an RA.

29.1.1.4.2.2 Solid Amber Circle

Represents a moderate threat. An intruder symbolized in amber is entering the caution area and is 20 to 48 seconds from entering the collision area. A visual search is recommended for intruder avoidance. Amber is used only in conjunction with a TA.

29.1.1.4.2.3 Solid Cyan Diamond

Represents Proximate Traffic. Proximate Traffic is an aircraft that is within 6 nautical miles or the range capability of the display and within 1,200 feet vertically, but whose path is not predicted to penetrate the collision area. If the range capability of the display is less than 6 nautical miles, then the Proximate Traffic will be shown at the edge of the display. Proximate Traffic will not generate a TA or an RA. Proximate Traffic is shown to improve situational awareness in the event of a potential conflict with higher priority RA or TA aircraft.

29.1.1.4.2.4 Open or Hollow Cyan Diamond

Represents Other Traffic. Other Traffic is any transponder-replying aircraft within the horizontal and vertical range of the display and not classified as Proximate Traffic or as an intruder requiring a TA or an RA. The predicted flight path does not penetrate the collision area. If Other Traffic is being displayed, it will be temporarily removed while a TA or an RA is in progress.

29.1.1.4.2.5 Data Tags

A Data Tag consists of a two-digit number, a plus or minus sign, and possibly an arrow. The Data Tag appears either above or below the intruder aircraft symbol and in the same color. If the intruder is at the same altitude, 00 will be displayed. If the number changes position, from above the aircraft symbol to below or vice versa, the intruder is passing through your altitude.

29.1.1.4.2.5.1 Two-Digit Number

The two digits represent the relative altitude of the intruder aircraft in hundreds of feet above or below the TCAS 2000 aircraft. If the intruder is above the TCAS 2000 aircraft, the Data Tag will be placed above the intruder aircraft symbol; for an intruder below the TCAS 2000 aircraft, the Data Tag will be placed below the intruder aircraft symbol.

CAUTION

The Data Tag on the display shows the separation between aircraft in hundreds of feet.

29.1.1.4.2.5.2 Plus and Minus Signs

A plus or minus sign appears in front of the relative altitude number and indicates whether the displayed aircraft is above (+) or below (-) the TCAS 2000 aircraft.

29.1.1.4.2.5.3 Arrow

A vertical arrow will appear immediately to the right of the aircraft symbol if the intruder is either climbing (up arrow) or descending (down arrow) in excess of 500 feet per minute.

29.1.1.4.2.6 Off Scale Traffic Advisories

If TCAS 2000 is tracking an intruder that is outside of the range of the display but within the caution or warning areas, one half of the appropriate symbol will be positioned at the edge of the display at the appropriate bearing. The Data Tag will be displayed if there is room. The symbol will be in its proper color.

29.1.1.4.2.7 No Bearing Advisories

If and when TCAS 2000 is unable to track the bearing of an intruder, the TA will appear in the lower center of the display just below the host aircraft symbol. The advisory will present appropriate color-coded traffic information. TCAS 2000 may be temporarily unable to determine the bearing of an intruder due to steep bank angles masking the directional antenna. A No Bearing Advisory is most likely the result of the antenna pattern coupled with a steep bank angle. The ability of TCAS 2000 to compute TAs and RAs is not degraded by lack of bearing information and usually a No Bearing Advisory will transform into an advisory with bearing after a few seconds.

29.1.1.4.3 Aural Messages

TCAS 2000 generates 14 aural alerts or messages, excluding the aural test messages that are announced over the flight compartment loudspeaker system. These 14 messages accompany the visual TA and RA displays.

If a logic change occurs before the message is complete and a new alert is initiated, the original alert is terminated and the new alert is announced immediately.

29.1.1.4.3.1 Traffic Advisory

TRAFFIC, TRAFFIC alert occurs when TCAS 2000 predicts an intruder will enter the collision area within 20 to 48 seconds. Simultaneously, the VSI/TRA will display the location of the intruder.

29.1.1.4.3.2 Resolution Advisories

RA messages come in two forms. Corrective Advisories indicate evasive vertical maneuvers are necessary to increase separation between the TCAS 2000 aircraft and the intruder. Preventive Advisories indicate certain changes in vertical speed are not recommended. RA messages consisting of a single word are repeated two times; longer messages may be repeated twice.

29.1.1.4.3.2.1 Preventive or Weakening Advisory

MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED is a Preventive Advisory. The pilot is to monitor the vertical speed of the aircraft, keeping the VSI pointer out of the red area on the VSI scale. The pilot is further expected to minimize the deviation from Air Traffic Control (ATC) clearance to reduce further adverse effects on ATC.

29.1.1.4.3.2.2 Corrective Resolution Advisories

Once these commands are given, the pilot has 5 seconds to make the controlled 0.25g pitch change required. These advisories should be done smoothly to minimize the amount of deviation from the ATC clearance.

1. CLIMB, CLIMB — Climb at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

2. DESCEND, DESCEND — Descend at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

3. CLIMB, CROSSING CLIMB — CLIMB, CROSSING CLIMB — Climb at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

Note

Your own flight path will cross the intruder’s altitude.

4. DESCEND, CROSSING DESCEND — DESCEND, CROSSING DESCEND — Descend at the rate indicated by the green arc on the VSI/TRA, 1,500 to 2,000 feet per minute.

Note

Your own flight path will cross the intruder’s altitude.

29.1.1.4.3.2.3 Increased Strength or Reversed Corrective Advisories

These are Corrective Advisories, which indicate that a previously announced advisory must be increased in strength or reversed. The target vertical speed must be attained within 2.5 seconds of the generation of the corrective RA. The 0.35g maneuver should be a 2 to 3.5-degree per second pitch change, as smooth and precise as any instrument maneuver.

These advisories are expected to occur only on rare occasions, usually when an intruder suddenly changes its current flight path by maneuvering or when the pilot has chosen to ignore a Corrective/Preventative Advisory.

1. INCREASE CLIMB, INCREASE CLIMB — Increase climb to the rate indicated by the green arc on the VSI/TRA, 2,500 to 3,000 feet per minute.

2. INCREASE DESCENT, INCREASE DESCENT — Increase descent to the rate indicated by the green arc on the VSI/TRA, 2,500 to 3,000 feet per minute.

3. CLIMB, CLIMB NOW! — CLIMB, CLIMB NOW! Follows a descend RA when TCAS 2000 has determined that a reversal of vertical speed is necessary to provide adequate separation. The target vertical speed for this green arc descent is 1,500 to 2,000 feet per minute.

4. DESCEND, DESCEND NOW! DESCEND, DESCEND NOW! — Follows a climb RA when TCAS 2000 has determined that a reversal of vertical speed is necessary to provide adequate separation. The target vertical speed for this green arc descent is 1,500 to 2,000 feet per minute.

29.1.1.4.3.2.4 Corrective, Weakening or Restrictive Advisories

These Corrective Advisories include a variety of vertical speed commands and guidance intended to minimize or constrain the escape maneuvers or resolve multiple aircraft conflicts in response to a RA.

1. ADJUST VERTICAL SPEED, ADJUST — The target vertical speed for this green arc is a reduction in the current vertical speed.

2. MAINTAIN VERTICAL SPEED, MAINTAIN — The target vertical speed for this green arc is either a 4,400 to 6,000 feet per minute climb or descent dependant on the encounter.

3. MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN — The target vertical speed for this green arc is either a continued climb at 3,200 to 4,000 feet per minute or a descent at 2,600 to 3,300 feet per minute.

Note

Your own flight path will cross the intruder’s altitude.

29.1.1.4.3.2.5 Clear of Conflict

Announcement confirms that the encounter has ended and separation is increasing. A return to the original ATC clearance profile is expected.

29.1.2 Limitations

1. When necessary, certain TCAS Resolution Advisory (RA) commands may be limited in order to be compatible with the aircraft climb capabilities.

2. Pilots are authorized to deviate from their current ATC clearance to the extent necessary to comply with a TCAS RA.

3. Maneuvering in response to an RA must be done manually by the pilot flying the aircraft. The pilot must disconnect the autopilot and establish the proper pitch attitude manually.

4. The transponder Ident (IDNT) function is initiated through the pilot control wheel pushbutton when TCAS/transponder control panel MIC/OFF switch is placed in the MIC position. To initiate the Ident (IDNT) function from the control panel, the MIC/OFF switch must be in the OFF position.

5. The TCAS/transponder control panel Display Select switch (DPL SEL) must be in the 3A mode to display standard ATC 4096 codes.

CAUTION

- The TCAS system, when operating, can only detect other aircraft with operating International Civil Aviation Organization (ICAO) compliant transponders.
- The TCAS 2000 system will not detect aircraft with inoperative or non-ICAO compliant transponder systems. Do not rely solely on TCAS 2000 or Air Traffic Control (ATC) for collision avoidance.
- TCAS 2000 cannot detect intruding aircraft if the on-board Mode S transponder is OFF or in STBY.
- TCAS 2000 cannot issue an RA for intruding traffic that does not have an operating ICAO transponder with an operational altitude reporting function.
- It is not always possible to inhibit RA when it would be appropriate to do so due to limited inputs to the TCAS 2000. In these cases, TCAS 2000 might command maneuvers that may significantly reduce stall margins. Conditions when this may occur include:

  — Bank angle exceeds 15°.

  — Engine out (pilot should select TA Only).

  — Abnormal configurations (such as an unretracted landing gear that places the aircraft in an inappropriate configuration when the RA occurs, etc.).

  — Operation at temperatures beyond ISA (International Standard Atmosphere) 27.8 °C (82 °F).

  — Speeds below normal operating speeds.

  — Buffet margin less than 0.3g.

  — A TCAS to TCAS RA sense reversal.

29.1.3 Normal Procedures

29.1.3.1 System Self-Test

1. Select TCAS ONLY on the MFD control panel.
2. Select MASTER SYSTEM selector switch to STBY and DPL SEL knob to 3A.
3. The VSI/TRA displays annunciate white TCAS OFF message in the right center of the display.
4. The MFD annunciates cyan TCAS STBY message in the lower right corner of the display.

5. Momentarily depress the system TEST pushbutton on the TCAS/transponder control panel.

6. Verify the following:

   a. GO, NOGO, and REPLY lights illuminate and control panel display shows a row of eight test characters.

   b. Aural TCAS TEST message is heard over the cockpit speakers or headsets, indicating the start of the self-test.

   c. VSI/TRA displays depict the standard pattern of intruders and RA arcs along with the white TEST annunciation in the right center of the display. The standard test arc on the VSI/TRA includes a green arc from 0 to +300 fpm and red arc starting at 0 and going counterclockwise to +2,000 fpm.

   d. GO indicator illuminates momentarily on the TCAS/transponder control panel.

   e. MFD display depicts the standard pattern of intruders and cyan TCAS TEST annunciation in the lower right corner of the display. The MFD does not present RA information.

   f. After approximately 8 seconds, the aural TCAS TEST PASS message is heard over the cockpit speakers or headsets, indicating the successful completion of the self-test. The VSI/TRA and MFD annunciations revert to previous messages.

Note

- If the TCAS system does not pass the self-test, an aural TCAS TEST FAIL message will be heard. An amber TCAS FAIL message will illuminate on the VSI/TRA and NO TCAS displayed on MFD. Select STAT on the Display Select switch to view fault messages.

- Proximate Traffic and Other Traffic are depicted as a solid diamond and a hollow diamond, respectively. The symbols are cyan on the VSI/TRA displays and white on the MFD.

- Depressing and holding the TEST button for more than 8 seconds when on the ground and in STBY mode will activate the Extended Test function and VSI/TRA will display maintenance information. To exit this mode, position the mode selector switch out of STBY.

29.1.3.2 Before Takeoff

MASTER SYSTEM Selector switch — NORM.

Mode Select/TCAS Enable switch — Select TA/RA.

29.1.3.3 System Self Maintenance

Depress the system TEST pushbutton for more than 8 seconds with the MASTER SYSTEM switch set to STBY mode and gear extended. Make sure of the following:

1. VSI/TRA test pattern is replaced with a display of TCAS maintenance information.

2. Extended test can be exited by switching the TCAS/XPDR mode selector switch to any position other than STBY.

29.1.3.4 Annunciations

29.1.3.4.1 Mode Annunciations

The VSI/TRA display provides visual mode and failure annunciations in the upper and lower right corners and in the right center of the display.

The message TA ONLY confirms the selection of traffic alert only mode. This message is also present when RAs are inhibited due to a GPWS alert or when the aircraft is either on the ground or at altitudes less than 1,000 feet Above Ground Level (AGL). The message appears in white in the right center of the display.

The message TCAS OFF appears when the mode selector on the control panel is set to STBY.

29.1.3.4.2 Failure Annunciations

1. If an in-flight failure of the minimum equipment required for TCAS operation occurs, TCAS FAIL will appear in amber in the right center of the display.

2. RA FAIL appears in amber in the lower right corner when TCAS 2000 cannot display RAs.

3. TD FAIL (traffic display fail) appears in amber in the right center of the display when TCAS 2000 cannot display TAs.

4. Failure or loss of valid vertical speed data input will prevent display of RA information. RA FAIL and VSI FAIL will be annunciated on the indicator in amber in the upper left and upper right corners respectively and the VSI pointer is not displayed.

5. In the case of certain failures of the VSI/TRA display itself, a red X may appear across the display. A two-digit code located at the bottom center is provided for maintenance information. In other cases, the display may appear blank with neither vertical speed nor TA displays visible.

29.1.4 Abnormal Procedures

29.1.4.1 Traffic Advisory

1. Establish visual contact with the intruder aircraft.

2. Reduce vertical speed, if climbing or descending, to less than 1,500 feet per minute (fpm).

3. Maintain or attain safe separation in accordance with good operating practices.

CAUTION

Do not initiate evasive maneuvers using information from the traffic display only, or upon receipt of a Traffic Advisory only, without positive visual identification of the traffic.

29.1.5 Emergency Procedures

29.1.5.1 Engine Failure in Flight

TCAS/XPDR mode selector switch — Select TA.

29.1.5.2 Resolution Advisory

29.1.5.2.1 Climb Resolution Advisory

1. Autopilot — Disconnect.
2. Pitch attitude — As required to achieve green arc.
3. Propeller levers — Full forward.
4. Throttles — Takeoff power.
5. Flaps — Up.
6. Landing gear — Up.
7. Pitch attitude — Maintain green arc until CLEAR OF CONFLICT.
8. ATC — Notify (if required).

29.1.5.2.2 Descent Resolution Advisory

1. Autopilot — Disconnect.
2. Pitch attitude — As required to achieve and maintain green arc.
3. Throttles — Retard (as required).
4. ATC — Notify (if required).

Note

If necessary to maintain the RA, retract the landing gear and/or flaps if extended. Do not exceed airspeed limitation.

29.2 EMERGENCY LOCATOR TRANSMITTER (ELT)

29.2.1 Description

An automatic or manually activated Emergency Locator Transmitter (ELT) is located in the right side of the fuselage at approximately FS-369.00. The associated antenna is mounted on top of the aft fuselage at approximately the same location. An access hole with spring-loaded cover is located in the fuselage adjacent to the transmitter, enabling a pilot to manually initiate/terminate operation, or reset the ELT to an armed mode. There is also a remote switch with a yellow transmit light located on the left cockpit sidewall next to the OAT gage. The remote switch is lever-locked in the ARM and the ON positions. The transmitter contains an impact G switch that will automatically activate the transmitter following a 10 ±1g impact from any direction. Neither the remote switch nor the switch on the transmitter can be positioned to prevent the automatic activation of the transmitter. When activated, the ELT simultaneously radiates omnidirectional RF signals on the international distress frequencies of 121.5 and 243.0 MHz. The radiated signals are modulated with an audio swept tone. An internal battery will provide continuous transmitter operation for 48 hours.

29.2.2 RESET-AUTO-XMIT Switch

1. AUTO — Establishes a readiness state to start automatic emergency signal transmission when the force of impact exceeds the 10 ±1g threshold.
2. XMIT — Turns set on, manually initiating emergency signal transmissions.
3. RESET — Deactivates signals and resets transmitter.

29.2.3 Remote Switch

1. ON — Turns set on, manually initiating emergency signal transmissions.
2. ARM — Deactivates signals and resets transmitter.

29.3 WEATHER RADAR SYSTEM

29.3.1 System Description

The Honeywell Weather Radar RDR 2000 system is a lightweight, X-band digital radar with alphanumerics designed for weather detection, weather analysis, and ground mapping. The RDR 2000 system consists of the Receiver/Transmitter (RT), Radar Computer Unit (RCP), and the Multi-Function Display (MFD). The R/T is composed of the aircraft nose-mounted antenna dish and radar signal processor. The weather presentation is displayed on the MFD and can be superimposed on other MFD displayed data.

The radar is managed through the radar control panel located on the control pedestal extension. The type of Wx (weather) display (ARC, NAV MAP, etc.) and what range is presented is controlled through the MFD control adjacent to the radar control panel. The lighting for the control panels is controlled through the OVHD PED and SUB PANEL control knob located on the overhead panel. The system is protected by the RADAR circuit breaker located on the copilot circuit breaker panel.

The RDR 2000 weather radar system provides weather information and ranging up to 240 nm from the aircraft. The system can detect adverse weather up to 30° in any direction relative to the centerline of the aircraft. The system consists of three pieces of equipment: an antenna, receiver/transmitter, and a radar indicator with Vertical Profile (VP) capability and configuration module.

Video display is accomplished by digital techniques, resulting in a continuous bright display of video information. The indicator stores a large amount of video information, which is read out at relatively high rates (60 frames per second). The display continuously updates as the antenna scans.

The indicator mode (Wx, WxA, VP, or GND MAP) is selected by pushbutton on the radar control panel. The function button selects the TST mode. Placing the function button in TST position causes a predetermined test pattern to appear on the MFD. In the TST mode, the transmitter is not operational. Pushbuttons control range and tracking.

A yellow track cursor may be moved either right or left by pressing the track buttons. This assists in determining azimuth bearing of targets. The deviation from the aircraft heading is indicated in the upper left corner of the MFD.

WARNING

- The system performs only the functions of weather detection or ground mapping. It should not be used nor relied upon for proximity warning or anticollision protection.
- The system always transmits in the ON mode. It does not transmit in the OFF, STBY, or TST modes.

WARNING

- Do not operate during refueling of aircraft or defueling operation within 100 feet (30 meters).
- Do not operate if personnel are standing within 25 feet of the area scanned by radar.

In the weather detection mode, precipitation intensity levels are displayed in four colors, contrasted against a deep black background. Areas of very heavy rainfall will appear in magenta, heavy rainfall in red, less severe in yellow, light rain in green, and little or no rainfall in black (background).

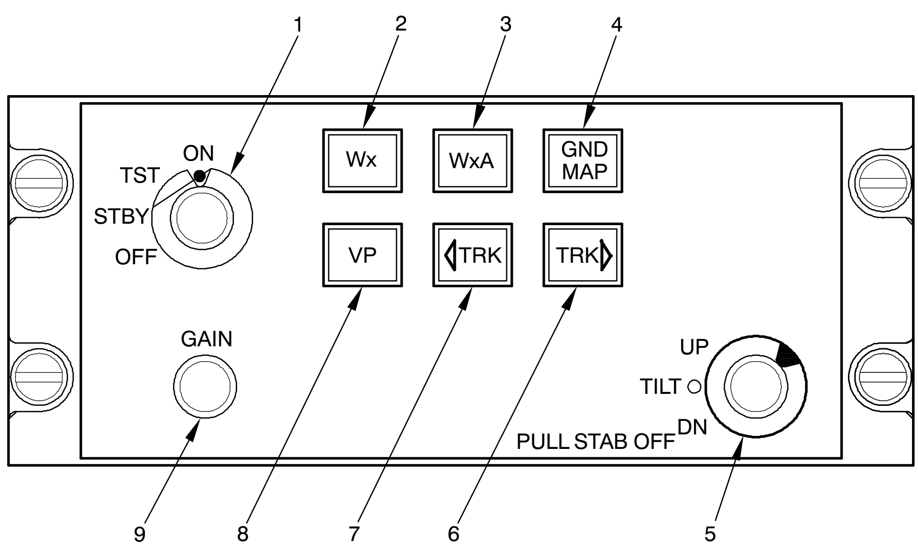
Range marks with identifying numerics, displayed in white, are provided to facilitate evaluation of storm cells.

Selection of the ground mapping (GND MAP) function will cause system parameters to be optimized to improve resolution and enhance identification of small targets at short range. The reflected signal from ground surfaces will be displayed as yellow or cyan (most to least reflective).

29.3.1.1 Radar Control Panel: Controls, Indicators, and Functions

29.3.1.1.1 Radar Mode Selector Switch

The radar mode selector knob, placarded OFF — STBY — TST — ON, is used to select the operating condition of the radar system. Refer to Figure 29-3.



1. RADAR MODE SELECTOR
2. WEATHER PUSHBUTTON MODE SELECTOR
3. WEATHER ALERT PUSHBUTTOM MODE SELECTOR
4. GND MAP PUSHBUTTON MODE SELECTOR
5. TILT/STABILIZATION CONTROL
6. RIGHT TRACK CONTROL
7. LEFT TRACK CONTROL
8. VERTICAL PROFILE PUSHBUTTON MODE SELECTOR
9. GAIN CONTROL

Figure 29-3. Weather Radar Control Panel

1. OFF — The OFF position disables the ART (antenna, receiver, and transmitter) power supply. The radar will remain active, with no radar transmissions occurring, for up to a maximum of 30 seconds. This delay allows time to park the antenna at 0° azimuth and 30° tilt down. OFF is displayed on the radar mode line in the lower right corner of the MFD.

2. STBY — After 30 seconds in the standby (STBY) mode, the system is in a state of readiness. No radar transmission occurs, and the antenna is parked in the down position. STBY is displayed on the radar mode line if a weather mode is selected.

3. TST — Selecting the test (TST) position causes the test pattern to be displayed on the indicator if a weather mode is selected. No radar transmissions occur while TST is selected. TEST will be displayed on the radar mode line.

4. ON — Selects the normal condition of operation for weather detection and/or other modes of operation. The system will transmit after a 60-second warmup time is completed. Depending on the selected mode of operation, Wx, WxA, or GND MAP will be displayed on the radar mode line.

29.3.1.1.2 Weather Pushbutton Mode Selector Switch

The weather pushbutton mode selector button, placarded Wx, is used to select the weather mode (Wx) when depressed. Wx will be displayed on the radar mode line if a weather mode is selected.

29.3.1.1.3 Weather Alert Pushbutton Mode Selector Switch

The weather alert pushbutton mode selector button, placarded WxA, is used to select the weather alert mode (WxA) when depressed. WxA will be displayed on the radar mode line if a weather mode is selected.

29.3.1.1.4 Ground Map Pushbutton Mode Selector Switch

The ground map pushbutton mode selector button, placarded GND MAP, is used to select the ground mapping mode when depressed. MAP will be displayed on the radar mode line. The color magenta is not active in the ground mapping mode.

29.3.1.1.5 Tilt/Stabilization Control

The tilt/stabilization control, placarded TILT - UP - DN, PULL STAB OFF, permits manual adjustment of antenna tilt (15° up or down) to enable the pilot to analyze the weather presentation. The tilt angle is displayed on the radar tilt annunciator line in the lower right corner of the MFD.

Pulling out on the tilt selector knob will turn radar stabilization off. STAB OFF will appear on the radar fault/warning line displayed below the antenna tilt annunciation line.

29.3.1.1.6 Right and Left Track Controls

If the weather only mode is selected, depressing the right track (TRK >) or left track (< TRK) button activates and slews a yellow dashed azimuth line. It also activates a digital display showing the number of degrees the azimuth line is located left or right from the nose of the aircraft. In any other map weather presentation, only the yellow dashed line will be displayed.

29.3.1.1.6.1 Track Control Operation In Vertical Profile (VP)

Prior to engaging VP, the appropriate button (left or right) is used to place the track line at the desired azimuth angle to be vertically scanned (sliced). When VP is engaged, the slice will be taken at the last position of the track line, whether it is visible or not. If the track line has not been selected after power has been applied to the system and VP is engaged, the slice will be taken at 0° (directly in front of the aircraft).

When in VP mode, depressing the TRK button will change the selected azimuth 2° left or right, depending upon which button is depressed. Continuously holding the TRK button will result in the track line moving in 2-degree increments.

29.3.1.1.7 Vertical Profile Pushbutton Mode Selector Switch

Once the desired azimuth has been selected with the TRK button, depressing the VP pushbutton mode selector button, placarded VP, selects the VP mode of operation, and causes the VP screen to appear. The weather mode of operation (Wx or WxA) displayed in the lower corner of the display will be the same as existed just prior to selecting VP. To select a different weather mode once in VP, select the desired mode (Wx, WxA, or GND MAP) by depressing the appropriate pushbutton. The operation of scanning the antenna vertically is referred to as taking a vertical slice.

Once VP has been selected, the desired profile azimuth angle may be changed in 2-degree increments by depressing and holding the appropriate TRK button. If the radar antenna is already profiling, the antenna will move in 2-degree increments slicing in the direction determined by the TRK button or a WAIT annunciation may be displayed, indicating that the radar antenna will perform the desired slicing function as soon as the antenna returns to the last selected profiling azimuth angle.

To terminate the VP mode and return to the normal mode (horizontal scan), depress the VP pushbutton. The radar system will retain its existing weather mode and return to horizontal scanning. A track line will be present on the screen for 15 seconds to indicate the location of the last profiling azimuth angle.

29.3.1.1.8 Gain Control

The manual GAIN control knob becomes active when ground mapping mode (GND MAP) is selected. In all other modes, gain is internally set.

29.3.1.2 Weather Display Calibration

The radar display has been calibrated to show five levels of target intensity. This shows the approximate relationship of aircraft weather radar levels to the Video Integrated Processor (VIP) levels used by the national weather service. These levels are valid only when:

1. Wx or WxA mode is selected.

2. Displayed returns are within the STC range of the radar (approximately 40 miles).

3. The returns are beam filling.

4. There are no intervening radar returns.

29.3.1.3 Tilt Management

Effective antenna tilt management is the single most important key for more informative weather radar displays. Three prime factors must be kept in mind for proper tilt management:

1. The Earth's curvature must be considered in determining the location of the beam at long distances.

2. The center of the radar beam is referenced to the horizon by the aircraft vertical reference system.

3. Adjusting the antenna tilt control will cause the center of the radar beam to scan above or below the plane of the attitude reference system.

A tilt setting that is too low will result in excessive ground or sea return whereas a setting that is too high can result in the radar beam passing above a weather target.

For detecting weather targets at long ranges and to allow adequate time for planning the proper avoidance path, the tilt angle should be set for a sprinkle of ground target returns on the display. By slowly raising the tilt angle, weather targets will emerge from the ground returns because of their height above the ground. In order to minimize ground returns when closely examining weather targets below the aircraft Flight Level, select the shortest range that allows full depiction of the area of interest.

29.3.1.4 En Route Weather Detection Operation

To set the antenna tilt to optimize the radar ability to identify significant weather, follow these steps:

1. Wx pushbutton mode selector switch — Depress.
2. Range button — Select 40 nautical mile range.
3. TILT control — Adjust down until entire display is filled with ground returns. Slowly raise antenna so that ground returns are painted on about the outer one-third of the indicator area.
4. Display — Watch strongest returns. If, as they are approached, they become weaker or fade out after working back inside the near limit of the general ground return pattern, they are probably ground returns or insignificant weather. If they continue strong after working down into the lower half of the indicator, you are approaching a hazardous storm or storms and should deviate.
5. Display — Examine the area behind strong targets. If radar shadows are detected, you are approaching a hazardous storm or storms and should deviate. Regardless of the aircraft altitude, if weather is being detected, move the antenna tilt control up and down in small increments until the return object is optimized. At that angle, the most active vertical level of the storm is being displayed.

29.3.1.5 Ground Mapping Mode

Ground mapping mode is selected by depressing the GND MAP pushbutton mode selector button. The TILT control is then used to tilt the antenna down until the desired amount of terrain is displayed. The degree of tilt down will depend upon the aircraft altitude and the selected range.

29.3.1.6 Fault Monitoring

Critical functions in the receiver/transmitter/antenna are continuously monitored.

29.3.2 Limitations

WARNING

Do not operate radar if ground personnel are standing within 25 feet of the area scanned by radar.

CAUTION

If radar system is to be operated in any mode other than standby while the aircraft is on the ground: Direct the nose of the aircraft so that the antenna scan sector is free of large metallic objects such as hangars or other aircraft for a distance of 100 feet (30 meters). Do not operate during refueling or defueling operations within 100 feet (30 meters).

29.3.3 Normal Procedures

29.3.3.1 Preflight

Place the radar controls in the following positions:

1. Radar mode selector to TST.
2. TILT/stabilization control — TILT to UP 7° (as shown on tilt indicator on display). Check for correct test pattern.
3. Radar mode selector in TST or STBY. Taxi to a clear area where there are no people, aircraft, vehicles, or metallic buildings within approximately 100 yards.
4. Radar mode selector to ON. Wx mode will be displayed in the 40 nm range. Any targets (weather or ground) will be displayed in green, yellow, red, or magenta.
5. Press the RANGE DOWN pushbutton on the MFD to display 40 nm as the maximum range.
6. Press the weather alert pushbutton mode selector and observe that the magenta areas (if any) are flashing.
7. Vary the TILT control manually between 0 and UP 15° and 0 and DN 15° and observe that close-in ground clutter appears at lower settings and that any local rain appears at higher settings.
8. Return the radar mode selector to TST or STBY before taxiing.

29.4 ED 551A MULTI-FUNCTION DISPLAY (MFD)

29.4.1 System Description

The ED 551A MFD system consists of a SG 465 symbol generator, a CP 469A MFD control head, and the ED 551A MFD. Refer to Figure 29-4. Weather radar functions, for RDR 2000 color radar, are accessed through the CP 466A control head and displayed on the ED 551A through the symbol generator.

The ED 551A MFD is a single integrated display system capable of providing display of the RDR 2000 color radar, EGPWS, GPS/FMS waypoint mapping, and Horizontal Situation Indicator (HSI) display. The CP 469A MFD control head is located in the center pedestal and is adjacent to the CP 466A RDR 2000 color radar controller.

The CP 469A MFD control head has the control knob for the MFD brightness as well as the selectors for the various operational modes stated above. The lighting for the control panel is controlled through the avionics panel control located on the overhead panel.

The MFD circuit breaker located on the copilot circuit breaker panel controls aircraft dc electrical power to the ED 551A MFD, SG-465A symbol generator, and CP 469A MFD control panel.

29.4.1.1 MFD Control Panel

The following controls and their functions are provided for operation of the MFD control panel.

29.4.1.1.1 TCAS ONLY Pushbutton Mode Selector Switch

Depressing the TCAS ONLY pushbutton will toggle the MFD display between the TCAS ONLY presentation and the previously selected mode.

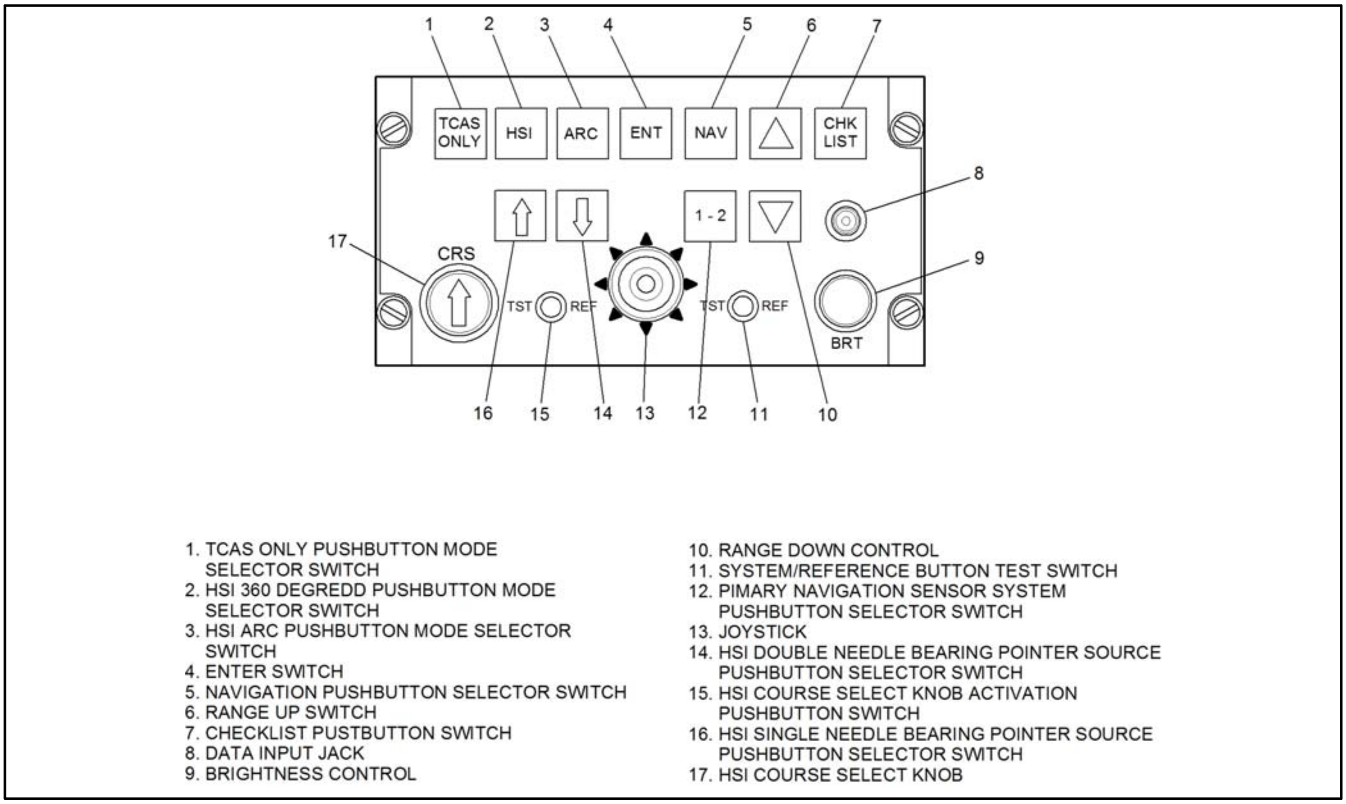


Figure 29-4. MFD Control Panel

29.4.1.1.2 HSI 360° Pushbutton Mode Selector Switch

The HSI mode pushbutton, placarded HSI, allows selection of the various HSI display formats. There are four possible display formats: Standard HSI compass rose, NAV map, NAV map with weather (or EGPWS terrain), and DG mode. Each press of the HSI button sequentially selects the next display format.

29.4.1.1.3 HSI ARC Pushbutton Mode Selector Switch

The ARC pushbutton, placarded ARC, will select a large-scale view of the CDI by presenting an approximately 85-degree sector display of this compass. There are five possible display formats: Standard HSI compass rose, NAV map, NAV map with weather (or EGPWS terrain), HSI compass rose with weather, and weather only.

29.4.1.1.4 Enter Switch

29.4.1.1.4.1 Checklist Operation

In the checklist mode, the ENT button will generally function to check items in the list. The checklist was designed such that the pilot can complete the entire checklist by using only the ENT button. Normally, pressing the ENT button will cause an unchecked checklist line to be checked and the cursor to advance to the next unchecked line. At the end of a page, pressing the ENT button will cause the cursor to advance to the next page (if available) and to check the first unchecked line on that page. If no unchecked items exist between the cursor position and the end of the list, the cursor is placed on the first unchecked page that referenced the specific list.

29.4.1.1.5 Navigation Pushbutton Selector Switch

The NAV pushbutton, placarded NAV, will cause the MFD to display FMS, LOC/ILS/VOR, or ADF data.

29.4.1.1.6 Range Up/Down Switch

The range up button is placarded ▲. The range down button is placarded ▼. A press of the RANGE DOWN button selects the next lower range to be displayed while in the NAV MAP or WEATHER modes of operation. Once the lowest selectable range is reached, the RANGE UP button must be used for a range change. The operation of the RANGE UP button is similar to the RANGE DOWN except it selects the next higher range to be displayed while in the NAV MAP or WEATHER modes of operation.

29.4.1.1.7 Checklist Pushbutton Switch

Pressing the checklist button, placarded CHK LIST, will display the root page of the checklist. If an emergency discrete is active, pressing the checklist button will display the emergency page.

29.4.1.1.8 Data Input Jack

A provision is made for insertion of a customer-defined checklist through a data port on the right center position of the MFD computer unit.

29.4.1.1.9 Brightness Control

The display brightness knob controls brightness of the display.

Note

The display brightness control provides full range dimming to allow night operation in no- or low-light situations. The lower limit of the display brightness may appear as an inoperative tube during normal daylight operation. It is therefore advisable to check the BRT knob setting during preflight test.

29.4.1.1.10 System/Reference Button Test Switch

The TEST/REFERENCE button, placarded TST ●REF, will toggle the MFD map displayed formats in/out of TCAS, airports and NAVAIDs data presentations. With checklist active, this button will cause a checklist 'help' page to be displayed on the MFD.

To display the EHSI system SELF-TEST, press and hold the TEST/REFERENCE button for 3 seconds. Upon entering self-test, a test pattern will be displayed. In the center of the test pattern, either a SELF-TEST PASS or SELF-TEST FAIL will be annunciated. The EFS will cancel the test mode and return both the EADI and EHSI to normal operation after 5 seconds.

Note

If the SELF-TEST FAIL message is annunciated, the system should be serviced.

29.4.1.1.11 Primary Navigation Sensor System Pushbutton Selector Switch

The 1-2 pushbutton, placarded 1-2, allows the pilot to select between on side and off side NAV sensors. It selects which side will be displayed until pushed again. A press of the NAV pushbutton will not cause a selected off side sensor to cycle back to an on side sensor.

29.4.1.1.12 Joystick

The joystick is located in the center of the control panel.

29.4.1.1.12.1 Waypoint Operation

The joystick can be used to generate and move single waypoints on the display unit.

With FMS selected for the primary NAV sensor and during display of a NAV MAP on the MFD, initial movement of the joystick will create a waypoint cursor ahead of the aircraft on the half range ring at the current heading. This will be true for both the HSI and ARC display formats.

The cursor will be a standard white waypoint symbol. Movement of the waypoint will be in any of the eight directions commanded by the joystick. The rate of movement will start off slow and increase in speed in two steps. Return of the joystick to its center (off) position at any time will reset the rate of movement to the slowest speed.

When FMS is selected as the primary navigation source, Latitude/Longitude coordinates of the cursor will be displayed in the lower center of the display. The coordinates of the cursor will remain displayed for at least 10 seconds and disappear from the display within 15 seconds.

If the waypoint cursor is not moved for 20 seconds, it will disappear from view. The next time the joystick is moved, the cursor will reappear in the same location on the display screen; however, a change of primary NAV sensor or display modes will reset the invisible cursor location to its initial starting position.

29.4.1.1.12.2 Checklist Operation

In the checklist mode, the joystick commands will be limited to four positions: UP, DOWN, LEFT, and RIGHT. The 45-degree commands will be ignored.

A down push on the joystick will advance the cursor checklist line. A down push at the bottom of a checklist page will advance the cursor to the next page if available. Continuous downward pushes will wrap the cursor within a checklist level.

A right push on the joystick will move the cursor to the top of the next checklist page. Continuous right pushes will wrap the cursor to the top of the next page within the list.

A left push on the joystick will move the cursor to the top of the previous checklist page. Continuous left pushes will wrap the cursor to the top of the previous page within the list.

29.4.1.1.13 HSI Single and Double Needle Bearing Pointer Source Pushbutton Selector Switch

The ↑ and ⇈ bearing pointer select buttons work in a similar manner as the NAV sensor select button. A press of the bearing pointer button sequentially selects the next available sensor for display. The bearing pointer sensor list contains only those sensors that have bearing information capabilities. If the selected sensor has distance information paired with it, that distance will also be displayed below the sensor annunciation.

Note

The ⇈ button is inoperative when TCAS OVERLAY is selected.

29.4.1.1.14 HSI Course Select Knob Activation Pushbutton Switch

The CRS SEL button is not functional for FMS operations. In checklist mode, pressing the button selects emergency procedure index on MFD.

29.4.1.1.15 HSI Course Select Knob

This provides independent selection of course on the MFD referenced to the selected NAV source.

29.4.2 Limitations

The pilot and copilot vertical gyro and directional gyro source select switches are to be selected to the same source only after failure of one source.

Navigation by reference to MFD or MFD Course Deviation Indicator (CDI) during approach is not authorized.

Note

The ED 551A system in this aircraft has been programmed upon initial installation to provide certain display formats. It is approved for use with this programming only.

29.4.3 Normal Procedures

29.4.3.1 Before Takeoff

29.4.3.1.1 MFD Preflight

Brightness — Adjust brightness of the MFD to desired level.

SYS REF test buttons on MFD computer units — Push and hold (3 seconds minimum).

Test pattern is displayed on MFD.

The MFD will display the following red flags: HDG, SG, RCP, CP, and CCP.

Note

Failure annunciations consist of a displayed message surrounded by a red box, double parallel red lines drawn through alphanumeric readouts, and red crosses through pointers. Cooling fan failure annunciation is displayed as a yellow message surrounded by a yellow box. Any of the following conditions indicate a malfunction of the ED 551A system:

— Absence of a failure or warning annunciation during test.

— TEST IN PROGRESS message remains on MFD. This message should only be displayed for a few seconds at the beginning of the test.

— SELF-TEST FAIL message on MFD.

— SELF-TEST PASS message does not appear on the MFD.

— MFD - SELECT display format as required.

29.4.4 Abnormal Procedures

29.4.4.1 DU — Display Unit Loss of Cooling

A yellow DU enclosed in a yellow box is annunciated on the MFD when insufficient airflow is detected in the display unit. Once annunciated, the faulty display unit will continue to operate for at least 30 minutes if the rated ambient temperature is not exceeded. To extend the operating time, reduce display information and brightness to a minimum.

29.4.4.2 SG — Symbol Generator Loss of Cooling

A yellow SG enclosed by a yellow box is annunciated on the MFD if insufficient airflow is detected in the symbol generator. Once annunciated, the symbol generator will continue to operate for at least 30 minutes if the rated ambient temperature is not exceeded. To extend the operating time, reduce display information and brightness to a minimum.

29.4.4.3 SG — Symbol Generator

A red SG enclosed by a red box is annunciated on the MFD when certain monitored functions are detected invalid. If the red SG annunciation is encountered, extreme caution should be used to validate any data used on the display for navigation. Even after validation and revalidation, the data should only be used as supplementary information.

29.4.4.4 CP — Control Panel

A red CP enclosed by a red box is annunciated on the MFD when a control panel button becomes stuck for greater than 10 seconds. If a button fails, the display should maintain all currently selected conditions. If the button should become functional, the fault annunciation will be removed and normal operation will be restored.

29.4.5 Other Normal Procedures

29.4.5.1 Course Select

A red X will be drawn through the course pointer head and tail if there is a course select knob failure on the ED 551A control panel.

29.4.5.2 RCP — Radar Control Panel

A red RCP enclosed by a red box is annunciated at the lower left center of the EHSI display if a radar control panel failure is detected.

29.4.5.3 Raw Data Deviation Annunciation

Pointer/scale malfunctions are annunciated by removal of the associated pointer/scale and placing a red X drawn in their place. A flag presented on the vertical deviation scale will result in the deviation pointer being removed. On the MFD, the pointer/scale annunciations include L/R deviation and GS.

29.4.5.4 Bearing Pointer Annunciation

Bearing pointer source failure or invalid data reception (No Computed Data, NCD) causes a red X to be drawn through the source annunciator. The bearing pointer or NAVAID is also removed.

29.4.5.5 Alphanumeric Readout Annunciation

Failures affecting alphanumeric readouts are annunciated by a red X drawn through the readout. On the MFD, the alphanumeric readouts include NAV bearing pointer source and course (DRS) or desired track (DTK).

Failures affecting distance information are annunciated by red dashes in the data field. When the distance source is operational but not providing valid distance data (no lock on or NCD), dashes the color of the sensor will be placed in the data field. Speed (KT) and time (MN) annunciation will be removed if valid distance, speed, and time-to-station information are not provided by the primary NAV sensor system.

29.4.5.6 Weather Radar Annunciation

29.4.5.6.1 Wx FLT (Weather Fault)

When a weather radar failure occurs while operating in the Wx mode, a white alphanumeric annunciation appears below the weather mode annunciation.

29.4.5.6.2 Wx OFF (Weather Radar Off)

Displayed when a mismatch of mode, tilt, and gain or range information between the EFIS and radar RT has existed for more than 30 seconds.

29.4.5.6.3 Busy VP

Displayed when the radar is off.

29.4.5.6.4 STB LMT (Stabilization Fault)

Displayed when the radar is in the continuous VP (vertical profile) mode.

29.4.5.6.5 429 FLT (429 Data Fault)

Displayed when 429 control data is missing or incorrect at the radar RT.

29.4.5.6.6 ANT FLT (Antenna Fault)

Displayed when the measured antenna tilt does not match the requested tilt angle.

29.4.5.6.7 TX FLX (Transmitter)

Displayed when a fault is detected in the radar transmitter.

29.4.5.6.8 Range

Displayed when the pilot has selected the 1,000 miles range on the MFD. The radar is unable to operate at this range and is placed in standby.

29.4.5.6.9 STB OFF (Stabilization Off)

Displayed when stabilization off has been selected or when the stabilization reference is not present at the radar.

29.4.5.6.10 Wait

Displayed when in VP mode and one of the TRACK buttons is pressed, indicating the radar will perform the desired slicing function as soon as the antenna returns to the last selected profiling azimuth angle.

29.4.5.6.11 Heading

Once a heading failure is detected, the MFD lubber line and course pointer head and tail are removed. The lubber line is replaced by a red box with a red HDG inside it.

PART VIII

Cargo Loading/Weight Balance

CHAPTER 30

Cargo (General)

30.1 EXTENT OF COVERAGE

Sufficient data has been provided so that, knowing the basic weight and moment of the aircraft, any combination of weight and balance can be computed in accordance with the mission configuration.

30.2 AIRCRAFT SECTIONS AND COMPARTMENTS

The aircraft is separated into four basic sections, consisting of nose, flight compartment, cabin, and tail sections. The pressurized part of the fuselage is subdivided into three compartments, consisting of the flight compartment (pilot and copilot), the passenger/cargo compartment, and a utility compartment for baggage and/or limited cargo. Provisions within the cabin compartment may be changed to suit mission requirements.

30.3 ILLUSTRATIONS

To facilitate proper loading and assist weight and balance computations, the following illustrations are provided:

Figure 4-5. Center of Gravity Limits.

Figure 30-1. Aircraft Compartment and Station Diagram.

Figure 32-1. Compartment Layout — Aeromedical Cargo.

Figure 32-2. Litter Tiedown Method.

(**B**) Figure 32-3. Cargo Loading Sections.

(**F/M**) Figure 32-4. Cargo Loading Sections.

Figure 32-5. Compartment Layout — Air Cargo.

Figure 32-6. Typical Cargo Restraint and Tiedown Method.

(**B**) Figure 34-1. Weight and Balance Clearance Form F.

(**F/M**) Figure 34-2. Weight and Balance Clearance Form F.

Figure 34-3. Useful Load Weight and Moment — Occupants.

(**B**) Figure 34-4. Useful Load Weight and Moment — Baggage and Cargo.

(**F/M**) Figure 34-5. Useful Load Weights and Moments — Baggage and Cargo.

Figure 34-6. Useful Load Weights and Moments — Usable Fuel (JP-4).

Figure 34-7. Useful Load Weights and Moments — Usable Fuel (JP-5/8).

Figure 34-8. Center of Gravity Moment.

Figure 34-9. Typical Service Load Conditions.

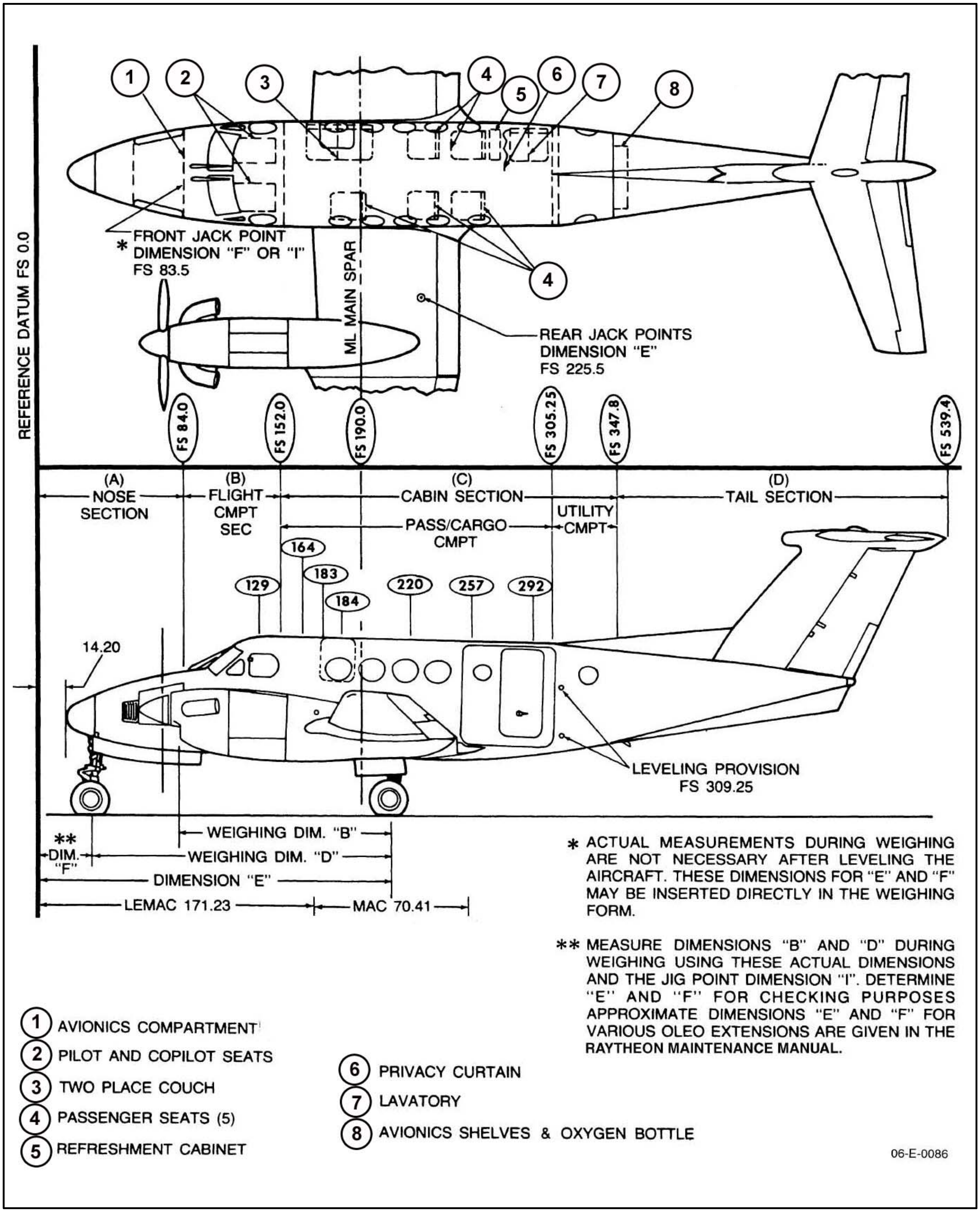


Figure 30-1. Aircraft Compartment and Station Diagram

CHAPTER 31

Cargo Provisions

31.1 PERSONNEL

31.1.1 Passenger Transport Provisions

The cabin compartment will accommodate removable provisions for eight passengers. Provisions (Figure 30-1) consist of five passenger seats, a two-place couch, a liquid container (refreshment cabinet), and a belted lavatory (passenger seat) shielded by a privacy curtain. Floor supported provisions attach to permanent seat tracks. Refer to Figure 34-3 for passenger and (**B**) Figures 34-4/(**F/M**) 34-5 for baggage and cargo weight and moment data.

31.1.2 Aeromedical Litter Provisions

The content and arrangement of the cabin section may be changed to serve an aeromedical mission. Tracks are provided to support two litters and two attendant chairs, or three litters and one attendant chair (Figure 32-1). The recommended litter tiedown method is detailed in Figure 32-2.

31.2 CARGO

31.2.1 Cabin Provisions

The cabin section may be readied for air cargo missions (Figures (**B**) 32-3 and (**F/M**) 32-4) by removing accommodations from the seat tracks and walls to clear a storage area. A usable flat floor space about 4 feet wide by 12 feet long is thereby readied for cargo items that are secured to the seat tracks. Usable height will vary from about 40 inches at the fuselage walls to about 54 inches at aircraft centerline. The cabin section flooring will withstand a loading of 200 pounds per square foot supported on the seat tracks. Floor areas where seat tracks are not present (walkways and aft baggage/utility area) will support 100 pound per square foot loads.

CHAPTER 32

Cargo Loading

32.1 GENERAL

The Aircraft Commander shall ensure proper loading of the aircraft before each flight. At the time of delivery, the aircraft manufacturer provides the necessary weight and balance data to compute individual loadings.

The useful load weights and moments tables (Figures 34-3, 34-4, 34-5, 34-6, and 34-7) are provided to compute weight and balance for occupants, baggage, cargo, and usable fuel. Figure 34-8 provides center of gravity moments tables, Figure 4-5 provides center of gravity limits tables, and Figure 34-9 provides a typical service load conditions table. All moments are divided by 100 to simplify computation.

32.2 LOADING FUNDAMENTALS

The three elements of proper aircraft loading are weight, balance, and restraint. Cargo must be loaded so that the weight of the cargo is within the carrying capacity of the aircraft, the balance of the aircraft is within the operating limits specified, and the cargo is prevented from shifting during flight. Refer to Figures 32-1, 32-2, 32-3, 32-4, 32-5, and 32-6.

32.2.1 Weight

Each aircraft has a basic weight. The maximum allowable cargo weight is determined by subtracting the crew weight and the basic aircraft weight from the maximum zero fuel weight. Any weight between maximum zero fuel weight and maximum takeoff weight (normal or restricted category) must consist of fuel. The weight of cargo that can be carried also depends upon the location of cargo within the aircraft and the strength of seat tracks and floor structure. Refer to paragraph 4.4.1 for aircraft weight limitations.

32.2.2 Balance

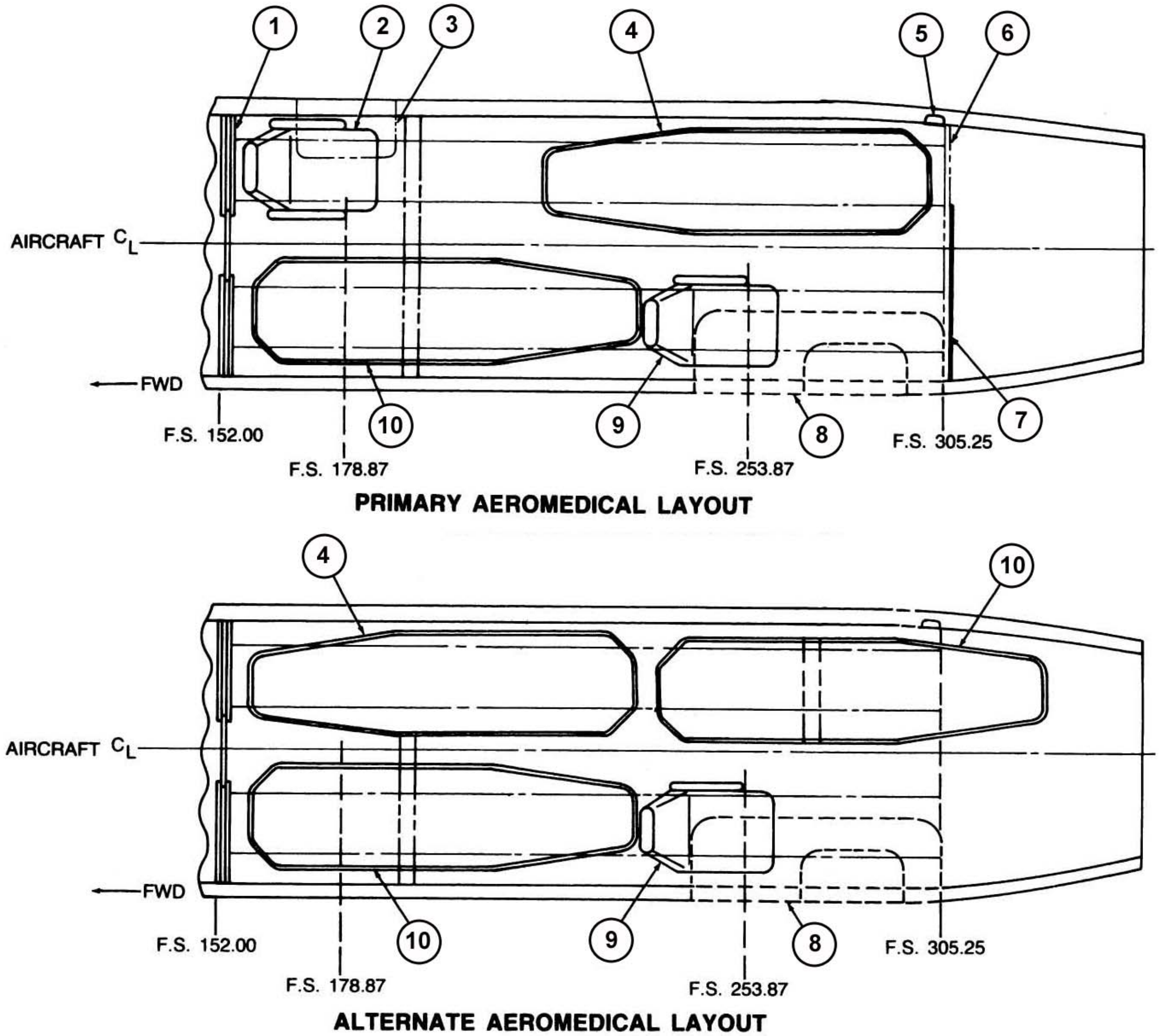
Every aircraft has a point about which it will balance. This point is known as its cg. Any item that is added to or removed from the aircraft will cause a change in the balance of the aircraft and cause the cg of the aircraft to shift. If the cg shifts too far forward or too far aft, the aircraft will be unsafe in flight. Cargo must be loaded so that the cg of the loaded aircraft is within the range specified.

32.2.3 Restraint

Cargo carried in an aircraft is subject to forces resulting from such factors as turbulence, acceleration, and rough or crash landings. Unless cargo is tied down or restrained, these forces will cause the cargo to shift. Cargo must be prevented from shifting in order to preserve the balance of the aircraft during flight and prevent injury to passengers and crew.

WARNING

Unrestrained cargo may shift aft during normal takeoff and climb, resulting in a tail-heavy condition that could lead to a stall on takeoff.



1. CREW COMPARTMENT SEPARATION PARTITION
2. ATTENDANT CHAIR
3. EMERGENCY EXIT OPENING
4. RIGID LITTER STRAPPED TO SEAT TRACKS (HEAD AFT)
5. SIDEWALL MOUNTED RELIEF TUBE
6. AFT COMPARTMENT BAGGAGE PARTITION
7. BAGGAGE WEBBING
8. CARGO DOOR OPENING
9. ATTENDANT CHAIR (NO OUTBOARD ARM REST)
10. RIGID LITTER STRAPPED TO SEAT TRACKS (HEAD FWD)

Figure 32-1. Compartment Layout — Aeromedical Cargo

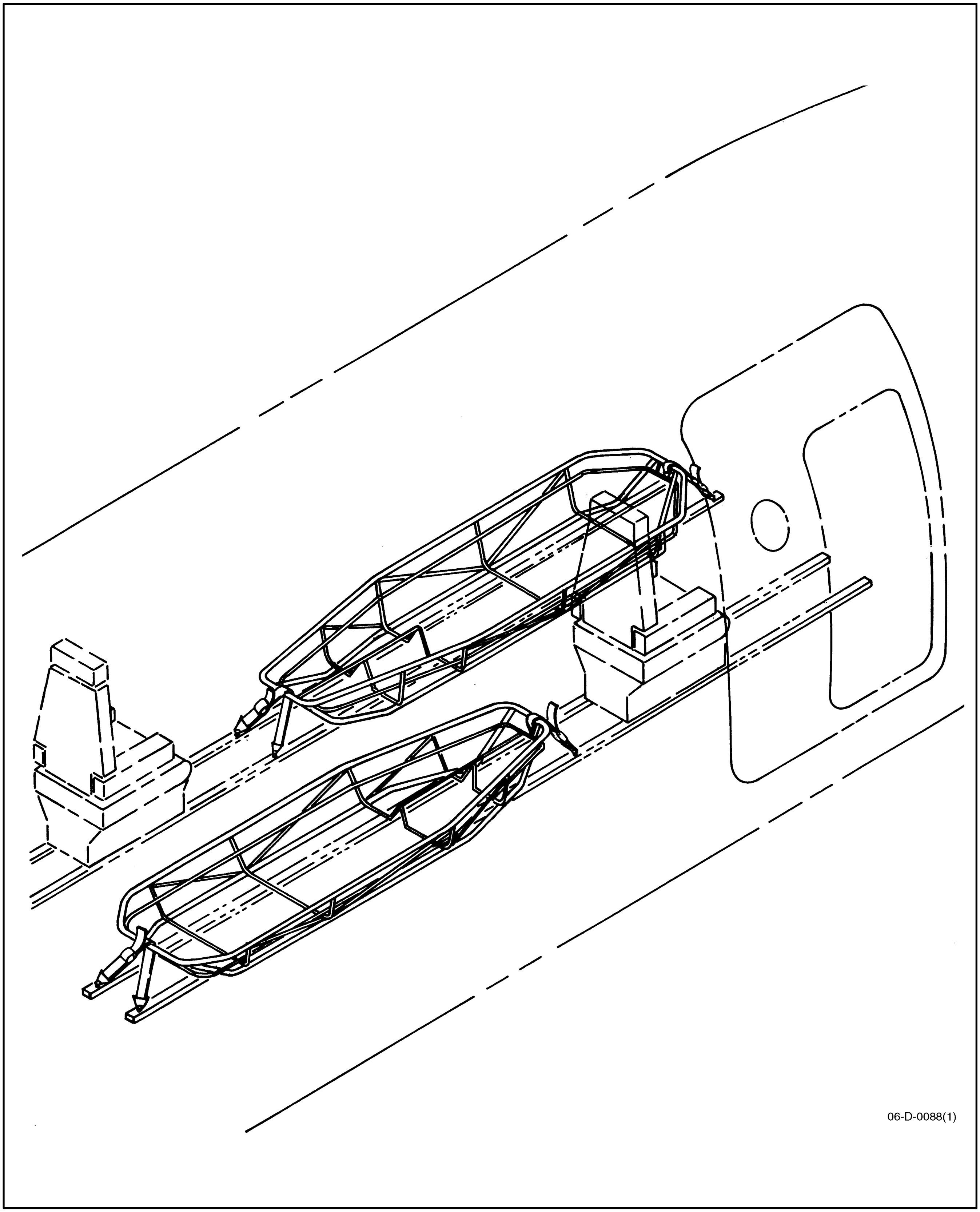
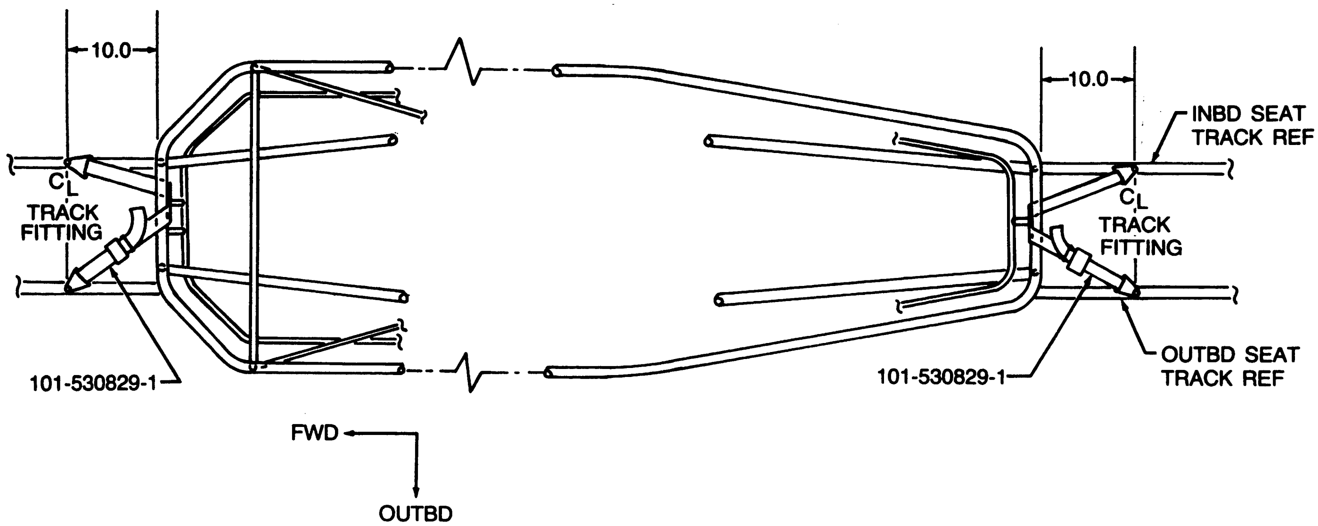


Figure 32-2. Litter Tiedown Method (Sheet 1 of 2)



NOTE

LOOP 101-530829-1 STRAP ASSY AROUND BOTH ENDS OF LITTER. ENSURE LITTER VERTICAL BRACE IS OUTBOARD OF STRAP ON THE BOTTOM SIDE OF THE LOOP AS SHOWN. PULL ADJUSTMENT STRAP AS TIGHT AS POSSIBLE.

06-D-0088(2)

Figure 32-2. Litter Tiedown Method (Sheet 2 of 2)

32.3 CARGO LOAD PLANNING

Placement of cargo, method of cargo loading, and method of cargo restraint should all be planned in advance. Cargo loading shall comply with the following: cargo shall be loaded without damaging or exceeding the strength of the seat tracks or floor. Cargo weight shall be distributed so that the center of gravity of the loaded aircraft is within the limits specified. Cargo shall be arranged to permit free access to all exits and emergency exits. The cargo shall be arranged to permit secure tiedown of all items. Bulk cargo shall be properly arranged to prevent damage to fragile items. Cargo destination should be considered when applicable. If part of the cargo is to be removed at an intermediate stop, the cargo should be arranged accordingly.

32.3.1 Cargo Placement Planning

The cg of the loaded aircraft shall always be within the operating limits specified in this NATOPS flight manual. Prior to actual loading, the location of each individual item of cargo within the aircraft should be planned and a check made to determine if the arrangement is satisfactory. The planning procedure consists of two steps. The first step is to select locations for items within the aircraft, and the technique by which the cg of the load will be determined. If the cg of the load is to be determined by the compartment method, the selection of locations consists of deciding into which of the (**B**) five (**F/M**) four compartments each item will be placed. If the balance station method is to be used, specific locations must be assigned to each item of cargo. The second step is to determine the cg of the cargo load. If the load consists of only a few items, the station method should be used. Final weight and balance of the loaded aircraft must always be determined in accordance with this section.

32.3.2 Center of Gravity by Compartments

Cargo center of gravity by compartments provides a rapid means of computing the cg of a load and should be used when the cargo consists of a number of items. (**B**) The aircraft is divided into five compartments as shown in Figure 32-3. The center of balance of each compartment, or the centroid, is located at fuselage stations 171, 210, 250, 290, and 325 respectively. (**F/M**) The aircraft is divided into four compartments as shown in Figure 32-4. The center of balance of each compartment, or the centroid, is located at fuselage stations 170, 218, 276, and 325 respectively. When using this method, it is assumed the weight of all the cargo in each compartment is concentrated at the centroid of the compartment and is within weight limitations shown in (**B**) Figures 32-3/(**F/M**) 32-4. If an item is placed so that it is in two or more compartments, the weight of the item should be proportionally distributed to each compartment. The cg of the cargo load is calculated as follows:

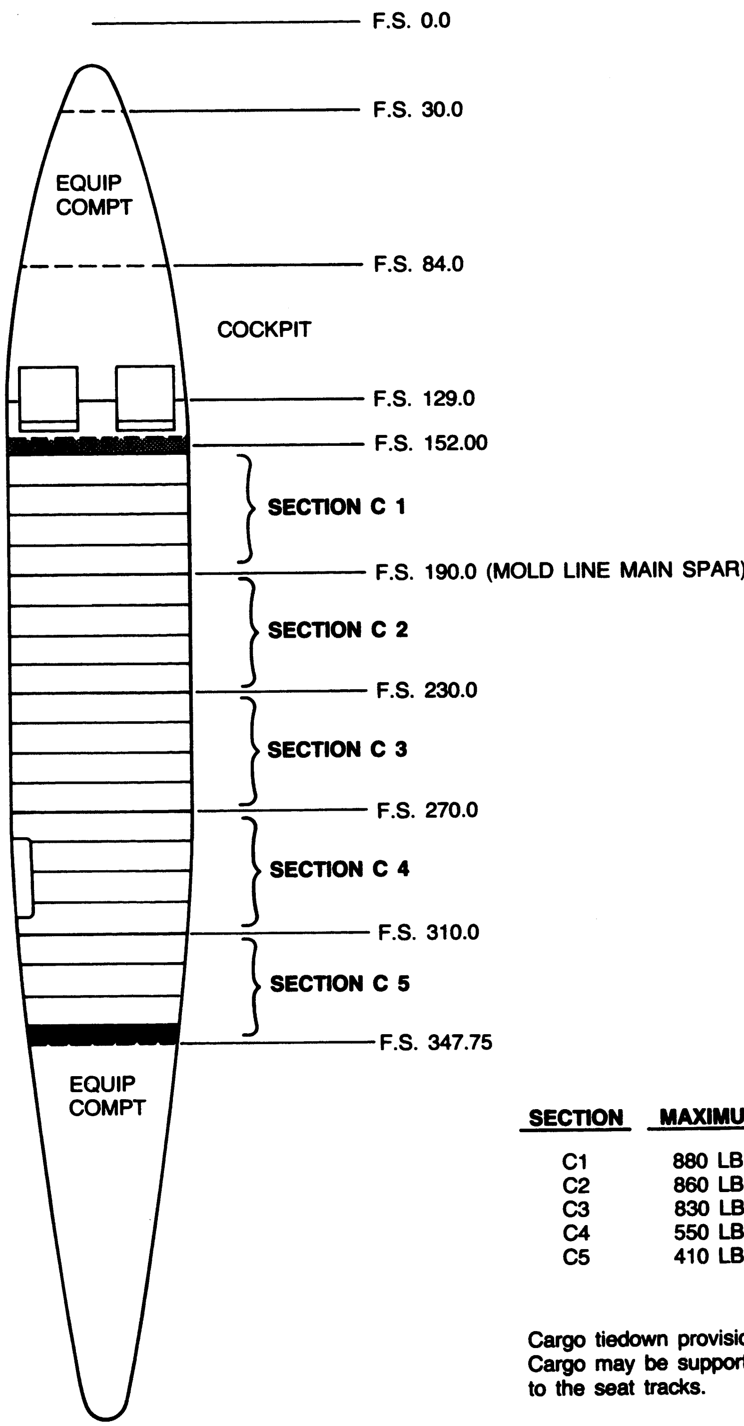
1. Record the weight of cargo in each compartment.
2. Multiply the total weight in each compartment by the station number of the centroid. The result is the compartment moment.
3. Add the (**B**) five (**F/M**) four compartment moments.
4. Add the weight of all compartments.
5. Divide the sum of the compartment moments by the total weight. The result is the location of the cg of the load.

32.3.3 Cargo Center of Gravity by Stations

Cargo cg by stations provides a method of computing the precise cg of a load and should be used when the load consists of only a few items of cargo.

In order to use this method, the cg of each item of cargo must be known. The cg of each item in the aircraft will coincide with the fuselage station number. The cg of the load is then calculated as follows:

1. Set up a table and record the weight and station number of the cg of each item.

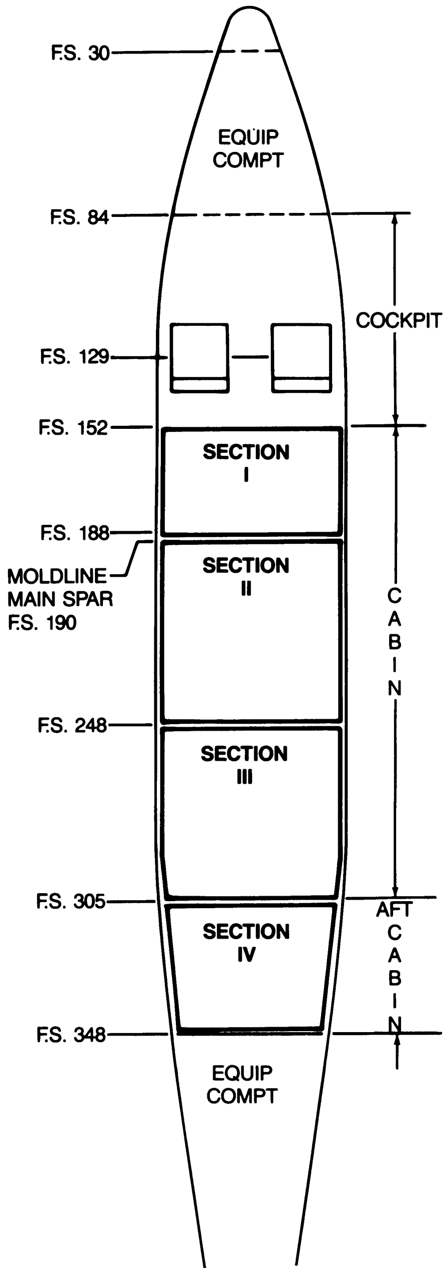


SECTION	MAXIMUM	CENTROID ARM
C1	880 LB.	F.S. 171
C2	860 LB.	F.S. 210
C3	830 LB.	F.S. 250
C4	550 LB.	F.S. 290
C5	410 LB.	F.S. 325

Cargo tiedown provisions are not provided. Cargo may be supported upon and tied down to the seat tracks.

06-D-0089

Figure 32-3. (**B**) Cargo Loading Sections



SECTION	MAXIMUM STRUCTURAL CAPACITY	CENTROID ARM
I	800 LBS	F.S. 170
II	1300 LBS	F.S. 218
III	1370 LBS	F.S. 276
IV	550 LBS	F.S. 325

NOTES:

1. All cargo in Sections I, II & III must be supported on and secured to the seat tracks.
2. Concentrated cargo loads in Sections I, II & III must not exceed 200 lbs. per square foot & must be supported on the seat rails.
3. Cargo in Section IV is to be secured by Beech furnished baggage net, webbing, or straps.
4. Footman loops in Section IV are to be used to secure cargo/baggage in that area only.
5. Concentrated floor loadings of cargo or baggage in Section IV must not exceed 100 lbs. per square foot.

CARGO LOADING

The method of loading cargo, its placement in the airplane and the method of restraint should each be determined before starting the actual loading.

For loads that are evenly distributed in a given section the useful Load Table under the heading of Cargo Compartment should be used. For any load that cannot be located at the centroid of a section or that extends over more than one section, it will be necessary to determine its own CG and its location in the airplane. Determine the CG arm (Fuselage Station) by measuring in inches, from a known location in the cabin to the CG of the load. Determine the "moment" for the load by multiplying the weight by the CG arm (Fuselage Station). This resultant should be divided by 100 to be compatible with other loading data.

06-D-0090

Figure 32-4. (**F/M**) Cargo Loading Sections

2. Calculate the moment of each item by multiplying the weight of the item by the fuselage station number of its cg.

3. Add the moments to obtain the total load moment.

4. Add the weights to obtain the total load weight.

5. Divide the total load moment by the total load weight to obtain the cg of the load.

32.4 SECURING CARGO

32.4.1 Load Factors

Cargo may be subjected to forces resulting from such factors as turbulence, acceleration, and rough or crash landings. These forces are more pronounced in some directions than in others and will shift the cargo unless it is properly restrained. Since the aircraft and cargo both move forward in flight, sudden deceleration could cause the cargo to continue forward movement. This forward force is likely to be the strongest force that will act on the cargo, but the cargo must also be secured against the forces acting on it laterally, vertically, or in an aft direction. The amount of restraint that must be used to prevent cargo movement in any direction equals the weight of the item times the load factor for that direction. Load factors are expressed in units of gravity, or g forces. Experience has shown that aircraft cargo must be secured to withstand the following load factors:

1. Forward — 9.0g's.

2. Up — 3.0g's.

3. Lateral — 1.5g's.

4. Down — 3.0g's.

For example, adequate cargo restraint must withstand a forward force of nine times the weight of the cargo (9g's).

32.4.2 Restraint Devices

The aircraft is equipped with full-length seat tracks that are used to support the cargo and provide attachment points for the cargo tiedown devices. When cargo is properly secured by tiedown devices, it will be restrained from moving in any direction within the aircraft.

32.4.3 Cargo Restraining Method

Cargo is restrained by passing tiedown devices over and around the cargo and attaching the ends of the tiedown device to the seat tracks as shown in Figure 32-6. The number of tiedown devices required to restrain a given weight of cargo may vary.

32.5 PASSENGER AND CARGO DOORS

A top-hinged cargo door (Figures 2-37 and 32-5), with an opening 52 inches wide by 52 inches high, is provided on the left side of the fuselage to accommodate bulk cargo. An airstair door, with an opening 21.5 inches wide by 50 inches high, is contained within the cargo door for crew and passenger entry and exit. Refer to Chapter 2 for detailed coverage.

32.6 LOADING PROCEDURE

The loading and unloading of cargo is accomplished through the main cabin entrance (airstair) door and cargo door. Caution should be exercised to prevent damaging wing flaps, doors, floorboards, seat tracks, and other aircraft structures. Personnel shall observe NO STEP areas. The aircraft should be checked for possible damage after a loading or unloading operation.

CAUTION

The airstair door is weight limited to 300 pounds to prevent possible structural damage.

32.7 HAZARDOUS MATERIALS

It is essential to prevent the escape of residual fluid from hydraulic actuators, pumps, fuel control units, etc. Aircrew shall ensure all fluid ports, vents, and lines are sealed with plugs or caps as appropriate before air shipments.

Note

Handling and transporting of chemicals, explosives, and other types of dangerous cargo in military aircraft requires special instructions. These specialized instructions are contained in NAVSUPPUB 505, Preparation of Hazardous Materials for Military Air Shipment. Handling of dangerous cargo identified in NAVSUPPUB 505 shall be rigidly enforced.

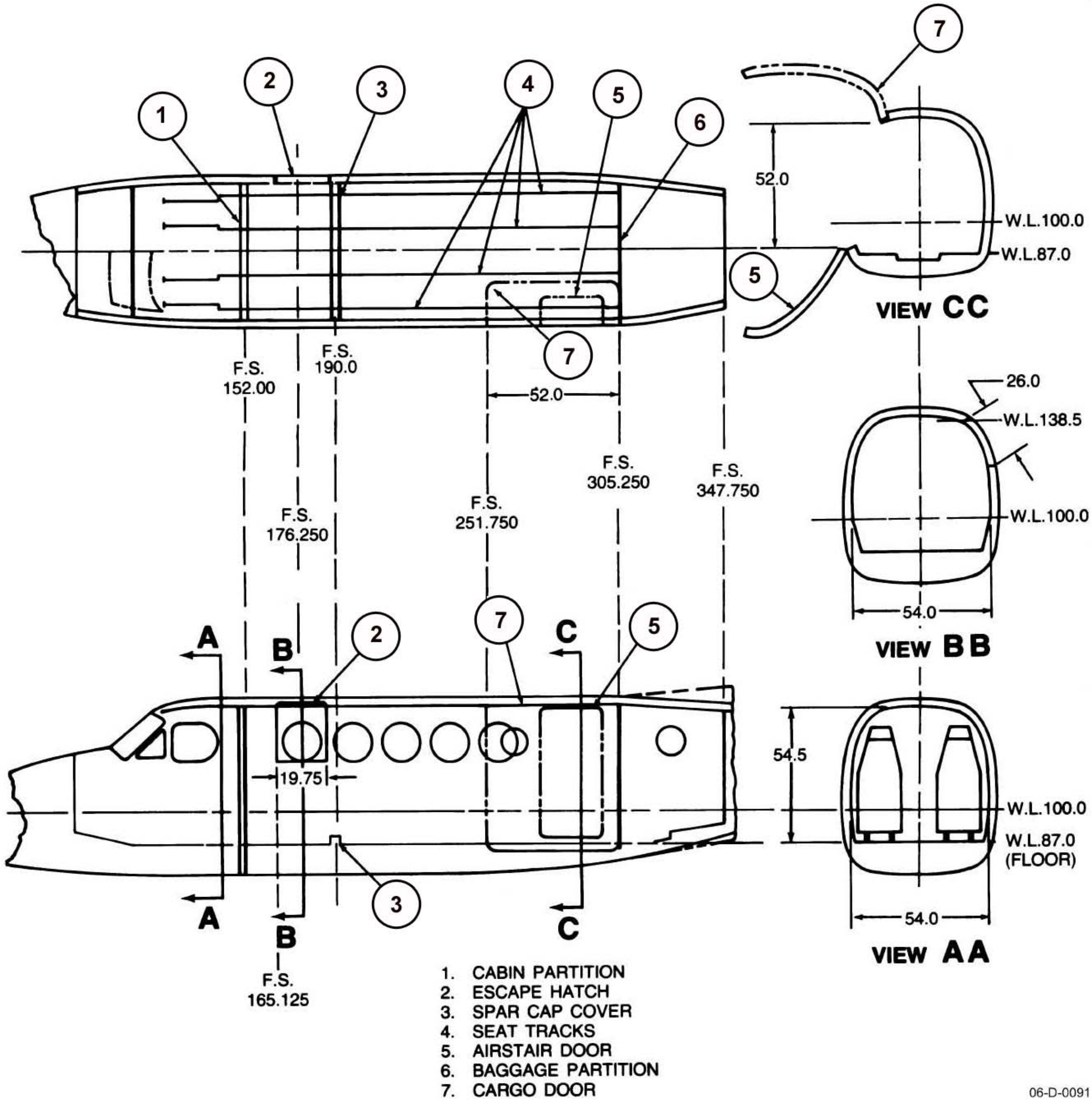


Figure 32-5. Compartment Layout — Air Cargo

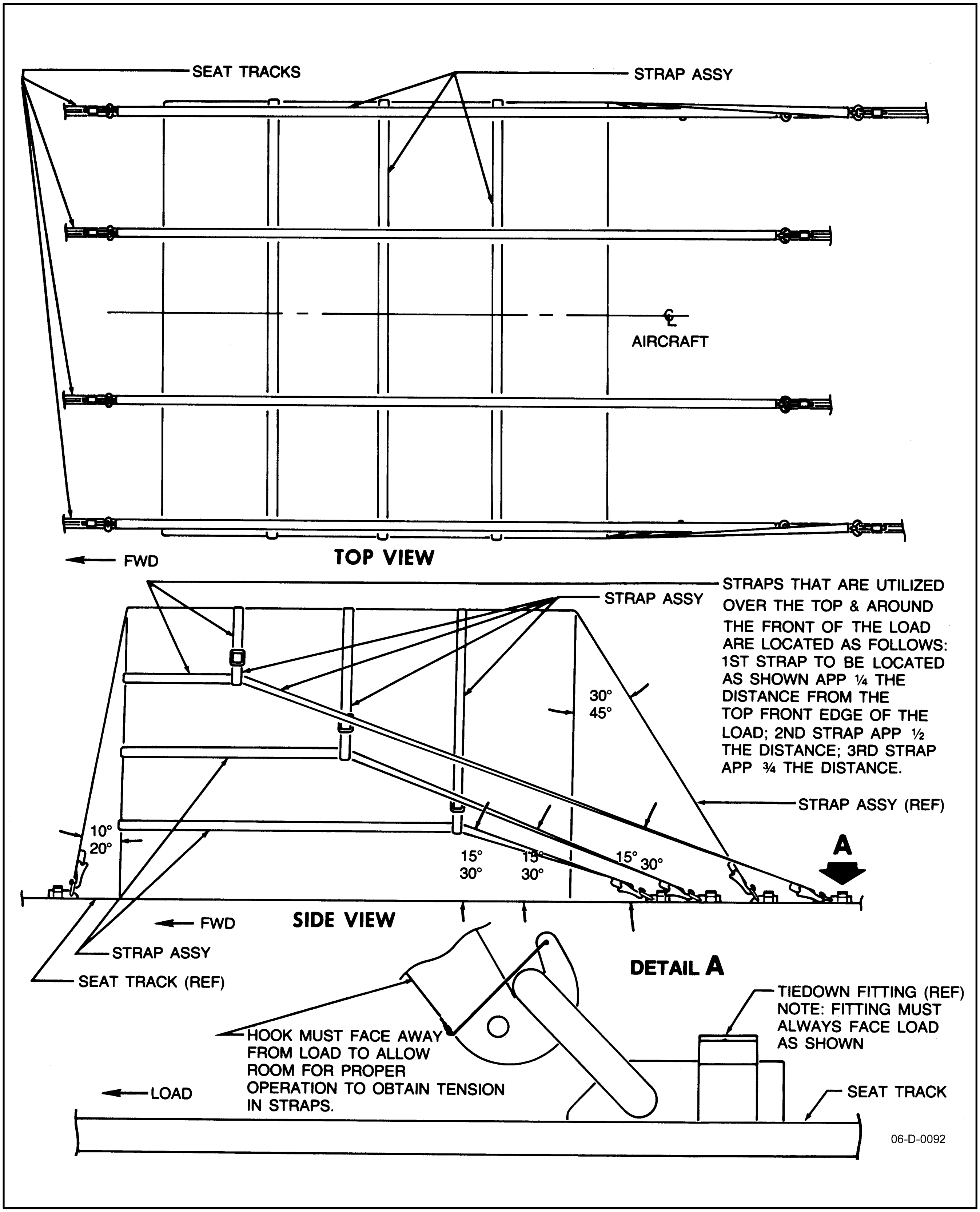


Figure 32-6. Typical Cargo Restraint and Tiedown Method

CHAPTER 33

Fuel

33.1 FUEL LOAD

Fuel loading may restrict the number of passengers or the weight of cargo that can be carried. The weight of the required fuel must be determined, and that weight subtracted from the total weight of cargo and fuel. As the fuel load is increased, the cargo capacity is reduced. Cargo may also be restricted by maximum zero fuel weight discussed in paragraph 32.2.

33.2 FUEL DATA

(**B**) Figures 34-6/(**F/M**) 34-7 provide weight and moment data for JP-4 and JP-5 fuel. Temperature effect on fuel density and weight can be determined by use of A1-C12BM-NFM-200 Performance Charts.

CHAPTER 34

Weight and Balance

34.1 PURPOSE

Data inserted on the weight and balance charts and forms are applicable only to an individual aircraft. That aircraft serial number appears on the title page of the booklet WEIGHT AND BALANCE DATA supplied by the aircraft manufacturer and on forms and charts that remain with the aircraft.

34.2 RESPONSIBILITY

The aircraft manufacturer inserts aircraft identifying data on the title page of the booklet entitled WEIGHT AND BALANCE DATA and on the various charts and forms. All charts, including one sample Weight and Balance Clearance Form F ((**B**) Figures 34-1/(**F**/**M**) 34-2), if applicable, are completed at the time of delivery. This record is the basic weight and balance data of the aircraft at delivery. Changes in weight and balance are the Navy's responsibility thereafter.

34.3 AIRCRAFT WEIGHINGS

Periodic weighing of the aircraft may be required to keep the basic empty weight current. The frequency of weighing is to be determined by the Navy and will normally be conducted in accordance with directives or when:

1. The pilot reports unsatisfactory flight characteristics (nose or tail heaviness).

2. Major modifications or repairs are made.

3. The basic weight data contained in the records are suspected to be in error.

34.3.1 Weight Definitions

34.3.1.1 Basic Weight

The basic weight of an aircraft is that weight that includes all fixed operating equipment, unusable fuel, and engine oil. It is necessary to add variable or expendable load items for various missions. The basic weight of an aircraft varies with structural modifications and changes in fixed operating equipment. The term "basic weight" when qualified with a word indicating the type of mission, such as basic weight for personnel transport, basic weight for ferry, etc., may be used in conjunction with directives stating what the equipment shall be for these missions. For example, extra fuel tanks and various items of equipment installed for long-range ferry flight that are not normally carried on personnel transport missions will be included in basic weight for ferry but not in basic weight for personnel transport.

34.3.1.2 Operating Weight

The operating weight is the basic weight of the aircraft, plus the weight of the crew and all equipment required for the mission, excluding the weight of the fuel or payload.

34.3.1.3 Gross Weight

The gross weight is the total weight of an aircraft and its content.

1. The takeoff gross weight is the operating weight plus the variable and expendable load items that vary with the mission.

2. The landing gross weight is the takeoff gross weight minus the expended load items.

WEIGHT AND BALANCE CLEARANCE FORM F - TRANSPORT
(Use reverse for tactical missions)

FOR USE WITH T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM-55-1500-342-23

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

DATE *(YYMMDD)*	AIRCRAFT TYPE UC-12B	FROM	HOME STATION
MISSION	SERIAL NO.	TO	PILOT

REMARKS

Initial Fuel 386 gallons of JP-5

-90 pounds taxi and engine burn

*** Cargo sample (restricted category)

LOAD ADJUSTER NUMBER

REF	ITEM	WEIGHT	INDEX OR MOM/ 100
1	BASIC AIRCRAFT *(From Chart C)*	7943	14693
2			
3	CREW *(No.)* 2(129)	380	490
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT (325)	73	238
7	EXTRA EQUIPMENT		
8	A/C (292)	200	584
9	OPERATING WEIGHT	8596	16005
10	TAKEOFF FUEL (373 *Gal.)*	2535	4678
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	11131	20683

CORRECTION / MOST FWD / MOST AFT

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	INDEX OR MOM/
TOTAL WEIGHT REMOVED			
TOTAL WEIGHT ADDED			
NET DIFFERENCE			

13 DISTRIBUTION OF ALLOWABLE LOAD *(PAYLOAD)*

14 ZERO FUEL WT 10396

ZERO FUEL WT INDEX OR MOM 19907

ZERO FUEL % M.A.C. 191.5 in

PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM/
		G-1	Cargo		171	700	1197
		G-2	Cargo		210	500	1050
		G-3	Cargo		250	300	750
		G-4	Cargo		290	200	580
		G-5	Cargo		325	100	325

SAMPLE

LIMITATIONS

CONDITION	TAKEOFF	LANDING	[1]FUEL
ALLOWABLE GROSS WEIGHT	13500	12500	11000
TOTAL AIRCRAFT WT. *(Ref. 12)*	11131		
(Ref. 9) + (Ref. 23)		9096	
OPERATING WT. *(Ref. 9)*			8596
ALLOWABLE LOAD *(Ref. 13) (use smallest figure)*	2369	3404	2404

[1]*Zero Fuel or Limiting Wing Fuel.*

	FORWARD	AFT
PERMISSIBLE C.G. TAKEOFF	188.3	196.4
PERMISSIBLE C.G. LANDING	181.0	196.4
PERMISSIBLE C.G. ZERO FUEL WT.	181.0	196.4

COMPUTED BY SIGNATURE

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/
15		1800	3902
16	TAKEOFF CONDITION *(Uncorrected)*	12931	24585
17	TAKEOFF C.G. IN % M.A.C. OR IN	190.1 in	
18	CORRECTIONS *(If required)*		
19	TAKEOFF CONDITION *(Corrected)*	12931	24585
20	TAKEOFF C.G. IN % M.A.C. OR IN	190.1 in	
21	ZERO FUEL WT *(Ref. 14)*	10396	19907
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	500	876
24	ESTIMATED LANDING CONDITION	10896	20783
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	190.7 in	

DD Form 365-4, APR 89 *Previous editions are obsolete.* **S/N 0102-LF-008-8700**

06-C-0094(1)

Figure 34-1. (**B**) Weight and Balance Clearance Form F (Sheet 1 of 2)

WEIGHT AND BALANCE CLEARANCE FORM F - TRANSPORT (Use reverse for tactical missions)	FOR USE WITH T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM-55-1500-342-23	Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 10 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

DATE (YYMMDD)	AIRCRAFT TYPE UC-12B	FROM	HOME STATION
MISSION	SERIAL NO.	TO	PILOT

REMARKS

Initial 329 gallons of JP-5
-90 pounds taxi and engine burn

***Passenger sample (normal category)

LOAD ADJUSTER NUMBER

REF	ITEM	WEIGHT	INDEX OR MOM/
1	BASIC AIRCRAFT (From Chart C)	8241	15400
2			
3	CREW (No.) 2 (129)	380	490
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT	73	230
7	EXTRA EQUIPMENT		
8	A/C (164)	170	279
9	OPERATING WEIGHT	8864	16399
10	TAKEOFF FUEL 315.5 Gal.)	2146	3938
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	11010	20337

CORRECTION / MOST FWD / MOST AFT

13 DISTRIBUTION OF ALLOWABLE LOAD (PAYLOAD)

14 ZERO FUEL WT 10354
ZERO FUEL WT INDEX OR MOM 20116
ZERO FUEL % M.A.C. 194.3

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	INDEX OR MOM/	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM/
				1	170	183				170	311
				1	170	184				170	313
				2	340	220				340	748
				2	340	257				340	874
				1	170	292				170	496
							Baggage		325	300	975
TOTAL WEIGHT REMOVED											
TOTAL WEIGHT ADDED											
NET DIFFERENCE											

SAMPLE

LIMITATIONS CONDITION	TAKEOFF	LANDING	[1]FUEL
ALLOWABLE GROSS WEIGHT	12500	12500	11000
TOTAL AIRCRAFT WT. (Ref. 12)	11010		
(Ref. 9) + (Ref. 23)		9364	
OPERATING WT. (Ref. 9)			8864
ALLOWABLE LOAD (Ref. 13) (use smallest figure)	1490	3136	2136

[1]Zero Fuel or Limiting Wing Fuel.

	FORWARD	AFT
PERMISSIBLE C.G TAKEOFF	185.0	196.4
PERMISSIBLE C.G. LANDING	181.0	196.4
PERMISSIBLE C.G. ZERO FUEL WT.	181.0	196.4

COMPUTED BY SIGNATURE

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/
15		1490	3717
16	TAKEOFF CONDITION (Uncorrected)		
17	TAKEOFF C.G. IN % M.A.C. OR IN	192.4	
18	CORRECTIONS (If required)		
19	TAKEOFF CONDITION (Corrected)	12500	24054
20	TAKEOFF C.G. IN % M.A.C. OR IN	192.4	
21	ZERO FUEL WT (Ref. 14)	10354	20116
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	500	882
24	ESTIMATED LANDING CONDITION	10854	20998
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	193.4	

DD Form 365-4, APR 89 — Previous editions are obsolete. — S/N 0102-LF-008-8700

06-C-0094(2)

Figure 34-1. (**B**) Weight and Balance Clearance Form F (Sheet 2 of 2)

WEIGHT AND BALANCE CLEARANCE FORM F - TRANSPORT
(Use reverse for tactical missions)

FOR USE WITH T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM-55-1500-342-23

Form Approved OMB No. 0704-0188

DATE (YYMMDD)	AIRCRAFT TYPE UC-12F/M	FROM	HOME STATION
MISSION	SERIAL NO.	TO	PILOT

REMARKS

INITIAL FUEL: 350 gallons of JP-5 — 95 lb for taxi and engine burn

***PASSENGER SAMPLE (normal category)

REF	ITEM	WEIGHT	INDEX OR MOM/ 100
1	BASIC AIRCRAFT *(From Chart C)*	8316	15616
2			
3	CREW *(No.)* 2 (129)	360	464
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT	77	243
7	EXTRA EQUIPMENT		
8	A/C (164)	170	279
9	OPERATING WEIGHT	8923	16602
10	TAKEOFF FUEL (336 *Gal.)*	2187	4019
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	11110	20621

LOAD ADJUSTER NUMBER

14 ZERO FUEL WT 10313
ZERO FUEL WT INDEX OR MOM 19994
ZERO FUEL % M.A.C. 193.9 in

CORRECTION / MOST FWD / MOST AFT — 13 DISTRIBUTION OF ALLOWABLE LOAD *(PAYLOAD)*

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	INDEX OR MOM/	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM/
				1	170	183				170	311
				1	170	184				170	313
				2	340	220				340	748
				2	340	257				340	874
				1	170	292				170	496
						325	BAGGAGE			200	650
TOTAL WT GROSS WEIGHT											
TOTAL ADDED WEIGHT											
NET DIFFERENCE											

SAMPLE

LIMITATIONS

CONDITION	TAKEOFF	LANDING	[1]FUEL
ALLOWABLE GROSS WEIGHT	12500	12500	11000
TOTAL AIRCRAFT WT. *(Ref. 12)*	11110		
(Ref. 9) + (Ref. 23)		9638	
OPERATING WT. *(Ref. 9)*			8923
ALLOWABLE LOAD *(Ref. 13) (use smallest figure)*	1390	2862	2077

[1]*Zero Fuel or Limiting Wing Fuel.*

	FORWARD	AFT
PERMISSIBLE C.G TAKEOFF	185.0	196.4
PERMISSIBLE C.G. LANDING	181.0	196.4
PERMISSIBLE C.G. ZERO FUEL WT.	181.0	196.4

COMPUTED BY SIGNATURE

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/
15		1390	3392
16	TAKEOFF CONDITION *(Uncorrected)*	12500	24013
17	TAKEOFF C.G. IN % M.A.C. OR IN	192.1 in	
18	CORRECTIONS *(If required)*		
19	TAKEOFF CONDITION *(Corrected)*	12500	24013
20	TAKEOFF C.G. IN % M.A.C. OR IN	192.1 in	
21	ZERO FUEL WT *(Ref. 14)*	10313	19994
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	715	1280
24	ESTIMATED LANDING CONDITION	11028	21274
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	192.9 in	

DD Form 365-4, MAR 88 *Previous editions are obsolete.* **S/N 0102-LF-002-9900**

06-C-0095(1)

Figure 34-2. (**F/M**) Weight and Balance Clearance Form F (Sheet 1 of 2)

WEIGHT AND BALANCE CLEARANCE FORM F - TRANSPORT
(Use reverse for tactical missions)

FOR USE WITH T.O. 1-1B-40, NAVAIR 01-1B-40, AND TM-55-1500-342-23

Form Approved OMB No. 0704-0188

DATE *(YYMMDD)*	AIRCRAFT TYPE UC-12F/M.	FROM	HOME STATION
MISSION	SERIAL NO.	TO	PILOT

REMARKS

INITIAL FUEL: 405 gallons of JP-5 –
95 lb for taxi and engine burn

LOAD ADJUSTER NUMBER

REF	ITEM	WEIGHT	INDEX OR MOM/ 100
1	BASIC AIRCRAFT *(From Chart C)*	8316	15616
2			
3	CREW *(No.)* 2 (129)	360	464
4	CREW'S BAGGAGE		
5	STEWARD'S EQUIPMENT		
6	EMERGENCY EQUIPMENT	77	243
7	EXTRA EQUIPMENT		
8	A/C (292)	190	555
9	OPERATING WEIGHT	8943	16878
10	TAKEOFF FUEL (391 *Gal.)*	2659	4924
11	WATER INJ.		
12	TOTAL AIRCRAFT WEIGHT	11602	21802

14 ZERO FUEL WT 10753
ZERO FUEL WT INDEX OR MOM 21115
ZERO FUEL % M.A.C. 196.3

CORRECTION / MOST FWD / MOST AFT

13 DISTRIBUTION OF ALLOWABLE LOAD *(PAYLOAD)*

COMPT OR ARM	ITEM	CHANGES (+ or -) WEIGHT	INDEX OR MOM/	PASSENGERS NO.	PASSENGERS WEIGHT	COMPT OR ARM	CARGO	CARGO	COMPT OR ARM	WEIGHT	INDEX OR MOM/
						C-1		500	170	500	850
						C-2		600	218	600	1308
						C-3		400	276	400	1104
						C-4		300	325	300	975
TOTAL WT GROSS WEIGHT											
TOTAL ADDED WEIGHT											
NET DIFFERENCE											

SAMPLE

LIMITATIONS			
CONDITION	TAKEOFF	LANDING	[1]FUEL
ALLOWABLE GROSS WEIGHT	13500	12500	11000
TOTAL AIRCRAFT WT. *(Ref. 12)*	11602		
(Ref. 9) + (Ref. 23)		9658	
OPERATING WT. *(Ref. 9)*			8943
ALLOWABLE LOAD *(Ref. 13) (use smallest figure)*	1898	2842	2057

[1]*Zero Fuel or Limiting Wing Fuel.*

	FORWARD	AFT
PERMISSIBLE C.G TAKEOFF	188.3	196.4
PERMISSIBLE C.G. LANDING	181.0	196.4
PERMISSIBLE C.G. ZERO FUEL WT.	181.0	196.4

COMPUTED BY SIGNATURE

WEIGHT AND BALANCE AUTHORITY SIGNATURE

PILOT SIGNATURE

REF	ITEM	WEIGHT	INDEX OR MOM/
15		1810	4237
16	TAKEOFF CONDITION *(Uncorrected)*	13412	26039
17	TAKEOFF C.G. IN % M.A.C. OR IN	194.1 in	
18	CORRECTIONS *(If required)*		
19	TAKEOFF CONDITION *(Corrected)*	13412	26039
20	TAKEOFF C.G. IN % M.A.C. OR IN	194.2 in	
21	ZERO FUEL WT *(Ref. 14)*	10753	21115
22	LESS AIR DROP LOAD		
23	ESTIMATED LANDING FUEL	715	1280
24	ESTIMATED LANDING CONDITION	11468	22395
25	ESTIMATED LANDING C.G. IN % M.A.C. OR IN	195.2 in	

DD Form 365-4, MAR 88 — *Previous editions are obsolete.* — S/N 0102-LF-002-9900

06-C-0095(2)

Figure 34-2. (**F/M**) Weight and Balance Clearance Form F (Sheet 2 of 2)

34.3.2 Balance Definitions

34.3.2.1 Reference Datum

The reference datum is an imaginary vertical plane at or forward of the nose of the aircraft from which all horizontal distances are measured for balance purposes. The aircraft diagram shows this reference datum as balance station zero. Refer to Figure 30-1.

34.3.2.2 Arm

Arm is the horizontal distance in inches from the reference datum to the cg of the item. Arm may be determined from Figure 30-1.

34.3.2.3 Moment

Moment is the weight of an item multiplied by its arm. Moment divided by a constant is generally used to simplify balance calculations by reducing the number of digits. For this aircraft, inches and moment/100 have been used. Refer to Figures 34-3, 34-4, 34-5, 34-6, 34-7, 34-8, and 34-9.

WEIGHT	CREW	TWO PLACE COUCH		PASSENGER SEATS			LAVATORY
	F.S. 129	F.S. 164	F.S. 184	F.S. 183	F.S. 220	F.S. 257	F.S. 292
	MOMENT/100						
80	103	131	147	146	176	206	234
90	116	148	166	165	198	231	263
100	129	164	184	183	220	257	292
110	142	181	202	201	242	283	321
120	155	197	221	220	264	308	350
130	168	213	239	238	286	334	380
140	181	230	258	256	308	360	409
150	194	246	276	275	330	386	438
160	206	262	294	293	352	411	467
170	219	279	313	311	374	437	496
180	232	295	331	329	396	463	526
190	245	312	350	348	418	488	555
200	258	328	368	366	440	514	584
210	271	344	386	384	462	540	613
220	284	361	405	403	484	565	642
230	297	377	423	421	506	591	672
240	310	394	442	439	528	617	701
250	323	410	460	458	550	643	730

Figure 34-3. Useful Load Weight and Moment — Occupants

34.3.2.4 Average Arm

Average arm is the arm obtained by adding the weights and adding the moments of a number of items and dividing the total moment by the total weight.

34.3.2.5 Basic Moment

Basic moment is the sum of moments of all items making up the basic weight. When using data from an actual weighing of an aircraft, the basic moment is the total moment of the basic aircraft with respect to the reference datum.

34.3.2.6 Center of Gravity

Cg is the point about which an aircraft would balance if suspended. Its distance from the reference datum is found by dividing the total moment by the gross weight of the aircraft.

34.3.2.7 Cg Limits

Cg limits are the extremes of acceptable forward or aft cg location. The cg of the loaded aircraft must be within these limits at takeoff, in the air, and on landing.

34.4 BALANCE COMPUTER DESCRIPTION

The computer used with this aircraft is a precision device enabling a pilot or crewmember to easily determine the cg of the aircraft prior to and during all phases of a properly planned flight and to make accurate loading adjustments as required. The fuselage diagram on the back of the balance computer will be of assistance in deciding where to place load items since it provides information concerning the station locations for occupants, baggage, and lettered compartments for cargo. The station numbers and compartment letters correspond with the appropriate scale on the slide of the computer. The appropriate scale must be used for each item and location. The colored top strip of the balance computer is the guide to safe loading. The white section indicates the safe loading limits range. The sloping lines define limits according to the gross weight of the loaded aircraft. The note to CHECK LANDING CONDITION is an important part of this strip. The use of fuel load changes the balance position and, unless the loading is arranged to allow for this movement of cg, it is possible the allowable limits will be exceeded as expendable load is consumed. The movement of the cursor or hairline indicator shows the change in balance position as load is added or expended in terms of INDEX units that appears on the bottom of the rule. The index scale is a simple reference that is mathematically related to the cg grid, or balance diagram, that appears on the inner recess of the computer. The colored areas and limit lines are the same as those shown at the top strip except for an enlarged vertical weight scale. The cg grid forward and aft RED sections show the cg limits in terms of inches from the reference datum that may be read directly from the grid using the indicator (cursor) hairline. The cg limits are also shown in percent of the mean aerodynamic chord, and it is from these limits that the top strip of the computer is derived.

34.5 PREPARATION

The first step is to translate the basic empty weight and cg kept in the aircraft records into balance computer index units. The basic empty weight, empty cg, and, when computed, empty index should be entered in the appropriate place on the face. Once entered, they need not be changed until the aircraft is reweighed and/or the equipment is changed, which might affect the empty cg.

The following is a sample determination of the index formula:

Basic empty weight — 7,500 pounds.

Empty cg (arm) — 190.5 inches.

INDEX = 100 - Weight (196.4 - Arm)/2,000.

= 100 - 7,500 (196.4 - 190.5)/2,000.

= 100 - 22.1 = 77.9.

	COMPARTMENT				
	C-1 F.S. 152-190	C-2 F.S. 190-230	C-3 F.S. 230-270	C-4 F.S. 270-310	C-5 F.S. 310-348
	CENTROID				
	F.S. 171	F.S. 210	F.S. 250	F.S. 290	F.S. 325
WEIGHT	MOMENT/100				
10	17	21	25	29	33
20	34	42	50	58	65
30	51	63	75	87	98
40	68	84	100	116	130
50	86	105	125	145	163
60	103	126	150	174	195
70	120	147	175	203	228
80	137	168	200	232	260
90	154	189	225	261	293
100	171	210	250	290	325
200	342	420	500	580	650
300	513	630	750	870	975
400	684	840	1000	1160	1300
410					1333
500	855	1050	1250	1450	
550				1595	
600	1026	1260	1500		
700	1197	1470	1750		
800	1368	1680	2000		
830			2075		
860		1806			
880	1505				

Figure 34-4. (**B**) Useful Load Weight and Moment — Baggage and Cargo

Weight	F.S. 152-188	CABIN F.S. 188-248	CABIN F.S. 248-305	F.S. 305-348
		CENTROID		
	F.S. 170	F.S. 218	F.S. 276	F.S. 325
		MOMENT/100		
10	17	22	28	33
20	34	44	55	65
30	51	65	83	98
40	68	87	110	130
50	85	109	138	163
60	102	131	166	195
70	119	153	193	228
80	136	174	221	260
90	153	196	248	293
100	170	218	276	325
200	340	436	552	650
300	510	654	828	975
400	680	872	1104	1300
500	850	1090	1380	1625
510	867	1112	1408	1658
550	935	1199	1518	1788
600	1020	1308	1656	—
700	1190	1526	1932	—
800	1360	1744	2208	—
900	—	1962	2484	—
1000	—	2180	2760	—
1100	—	2398	3036	—
1200	—	2616	3312	—
1300	—	2834	3588	—
1370	—	—	3781	—

NOTE:

All cargo must be supported by the seat tracks in a uniform distribution and tied down to the tracks by an approved method.

Figure 34-5. **(F/M)** Useful Load Weights and Moments — Baggage and Cargo

GALLONS	JP-4 FUEL 6.5 LB/GAL		GALLONS	JP-4 FUEL 6.5 LB/GAL	
	WEIGHT	MOMENT/100		WEIGHT	MOMENT/100
10	65	100	310	2015	3698
20	130	200	320	2080	3819
30	195	310	330	2145	3940
40	260	430	340	2210	4062
50	325	550	350	2275	4184
60	390	672	360	2340	4310
70	455	794	370	2405	4434
80	520	918	380	2470	4560
90	585	1039	386	2509	4634
100	650	1160	400	2600	4815
110	715	1280	410	2665	4945
120	780	1400	420	2730	5075
130	845	1519	430	2795	5206
140	910	1640	440	2860	5337
150	975	1761	450	2925	5470
160	1040	1881	460	2990	5600
170	1105	2002	470	3055	5733
180	1170	2122	480	3120	5866
190	1235	2244	490	3185	5999
200	1300	2365	500	3250	6134
210	1365	2486	510	3315	6269
220	1430	2607	520	3380	6405
230	1495	2728	530	3445	6542
240	1560	2850	540	3510	6676
250	1625	2971	544	3536	6729
260	1690	3093			
270	1755	3213			
280	1820	3334			
290	1885	3455			
300	1950	3576			

Figure 34-6. Useful Load Weights and Moment — Usable Fuel (JP-4)

GALLONS	JP-5/8 FUEL 6.8 LB/GAL WEIGHT	MOMENT/100	GALLONS	JP-5/8 FUEL 6.8 LB/GAL WEIGHT	MOMENT/100
10	68	105	310	2108	3868
20	136	209	320	2176	3995
30	204	324	330	2244	4123
40	272	450	340	2312	4249
50	340	575	350	2380	4376
60	408	703	360	2448	4509
70	476	831	370	2516	4638
80	544	960	380	2584	4770
90	612	1087	386	2625	4848
100	680	1214	400	2720	5037
110	748	1339	410	2788	5173
120	816	1465	420	2856	5309
130	884	1589	430	2924	5446
140	952	1715	440	2992	5583
150	1020	1842	450	3060	5722
160	1088	1968	460	3128	5859
170	1156	2095	470	3196	5997
180	1224	2221	480	3264	6136
190	1292	2348	490	3332	6276
200	1360	2473	500	3400	6418
210	1428	2600	510	3468	6558
220	1496	2727	520	3536	6700
230	1564	2854	530	3604	6844
240	1632	2982	540	3672	6984
250	1700	3109	544	3699	7039
260	1768	3236			
270	1836	3361			
280	1904	3488			
290	1972	3615			
300	2040	3741			

Figure 34-7. Useful Load Weights and Moments — Usable Fuel (JP-5/8)

GROSS WEIGHT POUNDS	FWD LIMIT % MAC MOM/100	% MAC							
		13.9	17.3	19.6	24.2	27.0	30.0	33.0	35.7
		ARM							
		181.0	183.4	185.0	188.3	190.3	192.4	194.5	196.4
7200		13032	13205	13320	13558	13702	13853	14004	14141
7250		13123	13297	13413	13652	13797	13949	14101	14239
7300		13213	13388	13505	13746	13892	14045	14199	14337
7350		13304	13480	13598	13840	13987	14141	14296	14435
7400		13394	13572	13690	13934	14082	14238	14393	14534
7450		13485	13663	13783	14028	14177	14334	14490	14632
7500		13575	13755	13875	14123	14272	14430	14588	14730
7550		13666	13847	13968	14217	14368	14526	14685	14828
7600		13756	13938	14060	14311	14463	14622	14782	14926
7650		13847	14030	14153	14405	14558	14719	14879	15025
7700		13937	14122	14245	14499	14653	14815	14977	15123
7750		14028	14214	14338	14593	14748	14911	15074	15221
7800		14118	14305	14430	14678	14843	15007	15171	15319
7850		14209	14397	14523	14782	14939	15103	15268	15417
7900		14299	14489	14615	14876	15034	15200	15366	15516
7950		14390	14580	14708	14970	15129	15296	15463	15614
8000		14480	14672	14800	15064	15224	15392	15560	15712
8050		14571	14764	14893	15158	15319	15488	15657	15810
8100		14661	14855	14985	15252	15414	15584	15755	15908
8150		14752	14947	15078	15346	15509	15681	15852	16007
8200		14842	15039	15170	15441	15605	15777	15949	16105
8250		14933	15131	15263	15535	15700	15873	16046	16203
8300		15023	15222	15355	15629	15795	15969	16144	16301
8350		15114	15314	15448	15723	15890	16065	16241	16399
8400		15204	15406	15540	15817	15985	16162	16338	18498
8450		15295	15497	15633	15911	16080	16258	16435	16536
8500		15385	15589	15725	16006	16175	16354	16533	16694
8550		15476	15681	15818	16100	16271	16450	16630	16792
8600		15566	15772	15910	16194	16366	16546	16727	16890
8650		15657	15864	16003	16288	16461	16643	16824	16989
8700		15747	15956	16095	16382	16556	16739	16922	17087
8750		15838	16048	16188	16476	16651	16835	17019	17185
8800		15928	16139	16280	16570	16746	16931	17116	17283
8850		16019	16231	16373	16665	16842	17027	17213	17381
8900		16109	16323	16465	16759	16937	17124	17311	17480

Figure 34-8. Center of Gravity Moment (Sheet 1 of 4)

GROSS WEIGHT POUNDS	FWD LIMIT % MAC MOM/100	% MAC							
		13.9	17.3	19.6	24.2	27.0	30.0	33.0	35.7
		ARM							
		181.0	183.4	185.0	188.3	190.3	192.4	194.5	196.4
8950		16200	16414	16558	16853	17032	17220	17408	17578
9000		16290	16506	16650	16947	17127	17316	17505	17676
9050		16381	16598	16743	17041	17222	17412	17602	17774
9100		16471	16689	16835	17135	17317	17508	17700	17872
9150		16562	16781	16928	17229	17412	17605	17797	17971
9200		16652	16873	17020	17324	17508	17701	17894	18069
9250		16743	16965	17113	17418	17603	17797	17991	18167
9300		16833	17056	17205	17512	17698	17893	18089	18265
9350		16924	17148	17298	17606	17793	17989	18186	18363
9400		17014	17240	17390	17700	17888	18086	18283	18462
9450		17105	17331	17483	17794	17983	18182	18380	18560
9500		17195	17423	17575	17889	18078	18278	18478	18658
9550		17286	17515	17668	17983	18174	18374	18575	18756
9600		17376	17606	17760	18077	18269	18470	18672	18854
9650		17467	17698	17853	18171	18364	18567	18769	18953
9700		17557	17790	17945	18265	18459	18663	18867	19051
9750		17648	17882	18038	18359	18554	18759	18964	19149
9800		17738	17973	18130	18453	18649	18855	19061	19247
9850		17829	18065	18223	18548	18745	18951	19158	19345
9900		17919	18157	18315	18642	18840	19048	19256	19444
9950		18010	18248	18408	18736	18935	19144	19353	19542
10000		18100	18340	18500	18830	19030	19240	19450	19640
10050		18191	18432	18593	18924	19125	19336	19547	19738
10100		18281	18523	18685	19018	19220	19432	19645	19836
10150		18372	18615	18778	19112	19315	19529	19742	19935
10200		18462	18707	18870	19207	19411	19625	19839	20030
10250		18552	18799	18963	19301	19506	19721	19936	20131
10300		18643	18890	19055	19395	19601	19817	20034	20229
10350		18734	18982	19148	19489	19696	19913	20131	20327
10400		18824	19074	19240	19583	19791	20010	20228	20426
10450		18915	19165	19333	19677	19886	20106	20325	20524
10500		19005	19257	19425	19772	19981	20202	20423	20622
10550		19096	19349	19518	19866	20077	20298	20520	20720

Figure 34-8. Center of Gravity Moment (Sheet 2 of 4)

GROSS WEIGHT POUNDS	FWD LIMIT % MAC MOM/100	% MAC							
		13.9	17.3	19.6	24.2	27.0	30.0	33.0	35.7
		ARM							
		181.0	183.4	185.0	188.3	190.3	192.4	194.5	196.4
10600		19186	19440	19610	19960	20172	20394	20617	20818
10650		19277	19532	19703	20054	20267	20491	20714	20917
10700		19367	19624	19795	20148	20362	20587	20812	21015
10750		19458	19716	19888	20242	20457	20683	20909	21113
10800		19548	19807	19980	20336	20552	20779	21006	21211
10850		19639	19899	20073	20431	20648	20875	21103	21309
10900		19729	19991	20165	20525	20743	20972	21201	21408
10950		19820	20082	20258	20619	20838	21068	21298	21506
11000	MAX ZERO FUEL WEIGHT	19910	20174	20350	20713	20933	21164	21395	21604
11050		20001	20266	20443	20807	21028	21260	21492	21702
11100		20091	20357	20535	20901	21123	21356	21590	21800
11150		20182	20449	20628	20995	21218	21453	21687	21899
11200		20272	20541	20720	21090	21314	21549	21784	21997
11250		20363	20633	20813	21184	21409	21645	21881	22095
11300	14.0	20461	20724	20905	21278	21504	21741	21979	22193
11350	14.2	20570	20816	20998	21372	21599	21837	22076	22291
11400	14.4	20679	20908	21090	21466	21694	21934	22173	22390
11450	14.7	20789	20999	21183	21560	21789	22030	22270	22488
11500	14.9	20899	21091	21275	21655	21884	22126	22368	22586
11550	15.1	21008	21183	21368	21749	21980	22222	22465	22684
11600	15.4	21113	21274	21460	21843	22075	22318	22562	22782
11650	15.6	21229	21366	21553	21937	22170	22415	22659	22881
11700	15.8	21339	21458	21645	22031	22265	22511	22757	22979
11750	16.1	21449	21550	21738	22125	22360	22607	22854	23077
11800	16.3	21560	21641	21830	22219	22455	22703	22951	23175
11850	16.5	21671	21733	21923	22314	22551	22799	23048	23273
11900	16.8	21782	21825	22015	22408	22646	22896	23146	23372
11950		17.0	21916	22108	22502	22741	22992	23243	23470
12000		17.2	22008	22200	22596	22836	23088	23340	23568
12050		17.5	22119	22293	22690	22931	23184	23437	23666
12100		17.7	22231	22385	22784	23026	23280	23535	23764
12150		18.0	22343	22478	22878	23121	23377	23632	23863

Figure 34-8. Center of Gravity Moment (Sheet 3 of 4)

GROSS WEIGHT POUNDS	FWD LIMIT % MAC MOM/100	% MAC							
		13.9	17.3	19.6	24.2	27.0	30.0	33.0	35.7
		ARM							
		181.0	183.4	185.0	188.3	190.3	192.4	194.5	196.4
12200		18.2	22455	22570	22973	23217	23473	23729	23961
12250		18.4	22567	22663	23067	23312	23569	23826	24059
12300		18.7	22679	22755	23161	23407	23665	23924	24157
12350		18.9	22792	22848	23255	23502	23761	24021	24255
12400		19.1	22904	22940	23349	23597	23858	24118	24354
12450		19.4	23017	23033	23443	23692	23954	24215	24452
12500			19.6	23125	23538	23787	24050	24313	24550
12550			19.8	23238	23632	23883	24146	24410	24848
12600			20.0	23352	23726	23978	24242	24507	24746
12650			20.3	23465	23820	24073	24339	24804	24845
12700			20.5	23579	23814	24168	24435	24702	24943
12750			20.7	23693	24008	24283	24531	24799	25041
12800			21.0	23807	24102	24358	24627	24896	25139
12850			21.2	23921	24197	24484	24723	24993	25237
12900			21.4	24035	24291	24549	24820	25091	25336
12950			21.7	24150	24385	24644	24916	25188	25434
13000			21.9	24265	24479	24739	25012	25285	25532
13050			22.1	24379	24573	24834	25108	25382	25630
13100			22.4	24494	24667	24929	25204	25480	25728
13150			22.6	24610	24761	25024	25301	25577	25827
13200			22.8	24725	24856	25120	25397	25674	25925
13250			23.1	24840	24950	25215	25493	25771	26023
13300			23.3	24956	25044	25310	25589	25869	26121
13350			23.5	25072	25138	25405	25685	25966	26219
13400			23.8	25183	25232	25500	25782	26063	26318
13450			24.0	25304	25326	25595	25878	26160	26416
13500					25421	25691	25974	26258	26514

Figure 34-8. Center of Gravity Moment (Sheet 4 of 4)

34.5.1 Balance Calculations

All loading calculations start by setting the cursor hairline on the empty index number as determined previously. From there, only two operations are required to “load” each of the items shown on the loading form (see sample problem). These items are presented on the slide of the computer.

Note

Keep a separate tally of loading items in pounds for gross weight limit.

1. Leaving the cursor in place, shift the slide to bring the “0” of the loading scale to be used under the hairline. Shift the cursor to the weight of the load item (fuel, passengers, cargo, etc.). The new index is then read under the hairline on the index scale at the bottom of the rule.

2. Repeat step 1 for all items of loading. For each step, move the slide first to “0” position, then shift the cursor to the appropriate weight. After the final item is loaded, the cg is found by the hairline position over the loading range where the hairline intersects the horizontal gross weight line (from the weight tally).

The effect of the removal or redistribution of load is determined by following the same two steps above except that the weight to be removed is initially set under the hairline and the cursor is then moved to the “0” line of the scale, or some intermediate point, and the new index read.

34.6 SAMPLE PROBLEM

Basic empty weight — 7,500 pounds.

Empty cg (arm) — 190.5 inches.

Resulting empty index — 77.9.

LOAD ITEM	ARM	WEIGHT	INDEX
Basic Empty	190.5	7,500	77.9
Crew	129	380	65.0
Passenger	164	170	62.3
Passenger	183	170	61.1
Passenger	184	170	60.1
Passengers (2)	220	340	64.1
Passengers (2)	257	340	74.4
Baggage	325	300	93.7
Zero Fuel Weight		9,370	
JP-4 Fuel	190.3	3,536	83.0
Totals		12,906	83.0

Index must fall between 45 to 100 units at gross weight.

34.7 WEIGHING INSTRUCTIONS

1. The aircraft may be weighed on wheels or jack points. Three jack points are provided: one on the nose section of the fuselage at station 83.5 and two on the wing center section rear spar at station 225.5. Wheel reaction locations should be measured as described in step 6.

2. Fuel should be drained before weighing. Tanks are drained from the regular ports with the aircraft in static ground attitude. When tanks are drained, 10 pounds of unusable fuel remain in the aircraft at an arm of 188.0 inches. The remainder of the unusable fuel to be added to a drained system is 34 pounds at station 164.0. If the aircraft is weighed with full fuel, the fuel specific weight (pounds/gallon) should be determined by using a hydrometer. Compute total fuel weight and moment using fuel tables.

3. Engine oil must be at the full level in each tank.

   Total engine oil aboard when both tanks are full is 62 pounds at an arm of 131 inches.

4. To determine aircraft configuration at time of weighing, installed equipment is checked against the aircraft equipment list or superseding forms. All equipment must be in its proper place during weighing.

5. The aircraft is placed on the scales in level attitude. Leveling screws are located on the fuselage cargo door frame. Leveling is accomplished with a plumb bob. Jack pad leveling may require the nosegear shock to be secured in the static position to prevent its extension. Wheel weighings can be leveled by varying the amounts of air in the shocks and tires.

6. Measurement of the reaction arms for a wheel weighing is made using the nose jacking point for a reference. Using a steel measuring tape, measurements are taken with the aircraft level on the scales from the reference (a plumb bob hung from the center of the nose jacking point) to the axle centerline of the nosegear and then from the nosegear axle centerline to the main wheel axle centerline. The main wheel axle centerline is best located by stretching a string across from one main wheel to the other. All measurements are to be taken with the tape level with the hangar floor and parallel to the fuselage centerline. The locations of the wheel reactions will be approximately at an arm of 209 inches for main wheels and 30 inches for the nosewheel.

7. The basic empty weight and moment are determined from the scale readings. Items weighed that are not part of the empty aircraft (e.g., usable fuel) are subtracted. Unusable fuel and engine oil are added if not already in the aircraft.

8. Weighing should always be made in an enclosed area that is free from air currents. The scales used should be properly calibrated and certified.

34.8 WEIGHT AND BALANCE CLEARANCE FORM F (DD FORM 365-4)

34.8.1 General

Form F ((**B**) Figures 34-1/(**F/M**) 34-2) is the summary of the actual disposition of load in the aircraft for a particular flight. It records the weight and balance status of the aircraft step by step throughout the flight. It serves as a worksheet on which the weight and balance technician records the calculations and any corrections that must be made to ensure the aircraft will be within weight and cg limits throughout the flight. It also serves as the record that weight and balance were determined to be acceptable for the flight. It is necessary to complete Form F prior to flight whenever an aircraft is loaded in a manner for which no previous valid Form F is available.

Form F is expendable and can be replaced when exhausted. An original and copy are prepared for each loading. The original sheets, carrying the signature of responsibility, should remain at the point of departure to serve as certificates of proper weight and balance as required by existing clearance directives. The duplicate copy must remain in the manual for the duration of the flight. On a cross-country flight, this form aids the weight and balance technician at refueling bases and stopover stations.

ITEM	ARM	NORMAL			
		PASSENGER		CARGO	
		WEIGHT	MOM/100	WEIGHT	MOM/100
Pilot and/or Copilot	129	380	490	380	490
Passenger — Couch, FWD	164	170	279		
— Chair, FWD	183	170	311		
— Couch, AFT	184	170	313		
— Chair — Mid	220	340	748		
— Chair — AFT	257	340	874		
— Lavatory	292	170	496		
Baggage	325	300	975		
Cargo — Section C-1	171			300	513
Cargo — Section C-2	210			500	1050
Cargo — Section C-3	250			500	1250
Cargo — Section C-4	290			500	1450
Cargo — Section C-5	325			200	650
Fuel (6.5 Lb/Gals.)					
Main & Aux. 544 Gals.	190.3	3536	6729	3536	6729
Total		5576	11215	5916	13132

Figure 34-9. Typical Service Load Conditions

There are two versions of Form F, transport and tactical, designed to provide for loading arrangements of these aircraft. The general use of either version is the same, although specific instructions for filling out the transport version are given herein.

34.8.2 Use of Form F (DD Form 365-4)

1. Insert the necessary information at the top of the form. In the blank spaces of the LIMITATIONS table, enter the gross weight and cg restrictions obtained from the NATOPS flight manual. Use inches as applicable for cg limits.
2. REF 1. Enter the aircraft basic weight and moment/100.
3. REF 3. Enter the number, weight, and moment/100 of crew (use actual crew weight if available).
4. REF 4. Enter the weight and moment/100 of the crew baggage.
5. REF 5. Not applicable.
6. REF 6. Enter the weight and moment/l00 of emergency equipment.
7. REF 7. Not applicable.
8. REF 8. Enter aircrewman weight and moment/100.
9. REF 9. Enter the sums of the weights and moment/100 for REF 1 through REF 8 inclusive to obtain the OPERATING WEIGHT and moment/100.

10. REF 10. Enter the number of gallons and weight and moment/100 of the takeoff fuel. The weight of fuel to be used in warmup and/or taxi should not be included. Refer to (**B**) Figures 34-6/(**F**/**M**) 34-7 for weight and moment. If actual fuel load differs from a charted value, use NEXT CLOSEST MOMENT/NEXT CLOSEST WEIGHT X ACTUAL FUEL WEIGHT.

Note

List under remarks the fuel tanks to be used, including auxiliary, and the amount of fuel in each tank and the amount of fuel used for engine ground burn.

11. REF 11. Not applicable.

12. REF 12. Enter the sum of weights and moment/100 for REF 9 through 11 inclusive to obtain TOTAL AIRCRAFT WEIGHT.

13. Determine the ALLOWABLE LOAD based on takeoff, landing, or limiting wing fuel restrictions by use of the LIMITATIONS table in the lower left-hand corner of the form as follows:

    a. Enter the ALLOWABLE GROSS WEIGHT for TAKEOFF and LANDING. For aircraft that have a gross weight restriction above which all weight must be fuel in the wings (i.e., maximum zero fuel weight), enter ALLOWABLE GROSS WEIGHT for LIMITING WING FUEL in the last column of the LIMITATIONS table.

    b. Enter the TOTAL AIRCRAFT WEIGHT (REF 12) in the first column. Estimate the fuel to be aboard at the time of landing (see REF 23) and enter the operating weight plus estimated landing fuel weight (REF 9 plus REF 23) in the second column. Enter the OPERATING WEIGHT (REF 9) in the third column.

    c. Subtract the above weights from the respective allowable loads. The smallest of these figures is the allowable load and represents the maximum amount of payload that may be distributed throughout the aircraft in various compartments without exceeding the limiting gross weights of the aircraft.

14. REF 13. Enter the number and weight of passengers, cargo, and other payload items. Use actual passenger weights if available. Enter the total for each compartment/flight station in the WEIGHT column. Enter corresponding moment/l00. Weight X Arm = Moment; then divide by 100.

Note

The compartment totals must not exceed the compartment weight limits. The sum of the compartment totals must not exceed the ALLOWABLE LOAD determined in the LIMITATIONS table.

15. REF 14. Add REF 9 weight and moment/100 and REF 15 weight and moment/100.

16. REF 15. Enter the sums of the payload weights and moment/100. Check the payload weight against the ALLOWABLE LOAD values in the LIMITATIONS table.

17. REF 16. Enter the sums of REF 12 and REF 15. Check against the TAKEOFF GROSS WEIGHT in the LIMITATIONS table.

18. REF 17. Check this value against the permissible TAKEOFF CG limitations in the LIMITATIONS table. Moment/Weight X 100.

19. REF 18. If changes in amount or distribution of loads are required, indicate necessary adjustments by proper entries in the CORRECTION table on left side of the form. Enter a brief description of the adjustment made in the column marked ITEM. Add all the weight and moment decreases and insert the totals in the space opposite TOTAL REMOVED WEIGHT. Add all the weight and moment increases and insert the totals in the space opposite TOTAL ADDED WEIGHT. Subtract the smaller from the larger of the two totals and enter the difference (with applicable + or – sign) opposite NET DIFFERENCE. Transfer the NET DIFFERENCE figures to the spaces opposite REF 18.

20. REF 19. Enter the sum of or the difference between REF 16 and REF 18. Recheck to ensure that the weight does not exceed the ALLOWABLE TAKEOFF GROSS WEIGHT.

21. REF 20. Determine the takeoff cg position. Enter this value in the space provided opposite TAKEOFF CG. Recheck to ensure that this value does not exceed the permissible TAKEOFF CG limitations. Moment/Weight X 100.

22. REF 21. Enter the difference between REF 19 and REF 10 for both weight and moment/100. This is the ZERO FUEL WEIGHT. Post these values to REF 14. If applicable, check to ensure that these figures do not exceed allowable values for zero fuel weight and cg and make loading changes if necessary.

23. REF 22. Not applicable.

24. REF 23. Enter estimated LANDING FUEL weight and moment/100. Use chart and formula: Closest Moment/Closest Weight X Actual Weight.

25. REF 24. Enter the weight and moment/100 (REF 21 plus REF 23). Check the weight against the allowable landing gross weight.

26. REF 25. Determine the estimated landing cg position. Enter this value opposite ESTIMATED LANDING CG. Check against PERMISSIBLE CG LANDING limits and make loading changes if necessary.

27. The necessary signatures must appear at the bottom of the form.

PART IX

Flightcrew Coordination

CHAPTER 35

Flightcrew Coordination

35.1 INTRODUCTION

Crew resource management is the responsibility of the AC. In this chapter, specific responsibilities are delineated by crew position and by phase of flight. The structure of these responsibilities mandates good communication between each member of the aircrew team. The aircrewman is an integral part of the aircrew team and should be utilized to the fullest extent possible. As always, the AC is responsible for the successful completion of any assigned mission. All crewmembers must be familiar with the concept and requirements of this chapter. Utilizing each crewmember to his/her full capability ensures good crew resource management.

35.1.1 Crew Resource Management (CRM)

The program is described in full in OPNAV 3710.7 and is intended to improve safety and mission effectiveness throughout the aviation community by enhancing crew coordination and communication. The seven critical behavioral skills are:

1. Decision Making — Gather data, identify alternatives, provide rationale, and make an informed decision based on the information available.

2. Assertiveness — Advocate a specific course of action, maintain position when challenged, and maintain position until convinced by facts presented that position is wrong.

3. Mission Analysis — Define tasks, question data to devise a plan, critique existing plan, create contingency plans, and coordinate, allocate, and monitor crew and aircraft resources.

4. Communication — Use standard terminology, exercise two-way communication: receive communication, verify accuracy of statement, request clarification if necessary, and provide feedback.

5. Leadership — Direct and coordinate tasks to be completed, ask for input, assign tasks to crew, provide feedback, and encourage crew to act as a team.

6. Adaptability/Flexibility — Alter course of action and/or behavior to meet situational demands and maintain constructive behavior under pressure.

7. Situational Awareness — Aware of mission status, navigational requirements, and aircraft/systems performance and how they relate to what is supposed to be happening.

Practicing CRM principles will improve mission effectiveness and reduce mishaps resulting from poor crew coordination.

35.1.2 Checklist Usage

Flow patterns for the UC-12 series aircraft are an integral part of good operating procedures. Configuring the aircraft for a phase of flight should be accomplished in a logical sequence on an as-needed basis, then confirmed by use of the challenge and response checklists. Use of normal checklists is for validation that tasks have been accomplished and that the cockpit and aircraft are properly configured for the next phase of flight.

A flow pattern for the UC-12 is included in this chapter. It is a disciplined procedure. It requires that pilots know their aircraft and systems and that they accomplish its configuration methodically.

Checklists shall be initiated by command from the PF. Good airmanship requires that if, in the opinion of the PNF, initiation of the checklist has been overlooked, the PNF inquire of the PF if the checklist should be started. Such prompting is appropriate in a professional cockpit in any flight situation (e.g., training, operations, or checkrides).

In execution of the checklist, the PNF reads each checklist item aloud. Items that are the responsibility of the PF are validated as accomplished and the PF verbally responds (CHALLENGE — RESPONSE). The items that are PNF responsibility are validated as having been accomplished and the PNF verbally confirms this (CHALLENGE — RESPONSE).

Effective checklists are pertinent and concise. Use them verbatim, smartly, and professionally. The pilot designated to fly the aircraft (PF) does not perform tasks that compromise this responsibility.

35.2 DEFINITIONS

The following definitions are provided for a better understanding of flightcrew coordination:

1. Aircraft Commander (AC) — The pilot assigned responsibility for safe and orderly conduct of the aircraft.
2. Pilot Flying (PF) — The pilot responsible for controlling the flight of the aircraft.
3. Pilot Not Flying (PNF).
4. Left Seat/Right Seat (LS/RS) pilot station — Designation of seat position for accomplishing a given task because of proximity to the respective control/indicator. Regardless of PF or PNF role, the pilot in that seat position performs tasks and responds to checklist challenges accordingly.
5. Transport Aircrewman (TA) — A designated Naval Aircrewman who is NATOPS qualified in model. Specific responsibilities are detailed in paragraph 35.3.3.

35.2.1 Challenge No Response

If a flight deviation or critical situation is observed by the PNF and there is no response by the PF to his/her challenge, a second challenge must be made. Response, as used herein, means verbal response as well as appropriate action.

35.2.2 Time Critical Situation

A malfunction during a critical phase of flight (i.e., requiring immediate action tasks by recall) should be positively announced by the observing crewmember. As time permits, the other crewmember should make every effort to confirm/identify the malfunction before initiating emergency action. On takeoff, for example, the PNF usually is the first to observe any indication of a critical failure. Upon observing such indication, the PNF announces it and simultaneously verifies the malfunction graphically to the PF (pointing to the indicator/annunciator).

On verification of malfunction, the PF announces his/her decision and commands accomplishment of recall action items, monitoring the PNF in those tasks accomplished by the PNF.

35.2.3 Emergency/Abnormal Procedures (Checklist Utilization)

Emergency situations requiring immediate corrective actions, identified in the respective checklist as memory or recall items, are accomplished without reference to the checklist. All other emergency and abnormal procedures should be accomplished by reference to the printed checklist; however, pilots are expected to be thoroughly familiar with each checklist procedure.

Emergency and abnormal checklists should be accomplished so that the pilot reading the checklist states both the CHALLENGE and the RESPONSE when the item has been accomplished. When a checklist procedure calls for the movement or manipulation of controls or switches critical to flight safety (e.g., power levers, propeller levers), the pilot performing the action obtains verification from the other pilot that he/she is moving the correct control or switch prior to initiating the action.

Any checklist action pertaining to a specific control switch or equipment that is duplicated in the cockpit is read to include its relative position stated left or right (e.g., right condition lever, left boost pump). The planned route of flight may influence the designation of takeoff abort “trigger” malfunctions. When departing a coastal airport for a long overwater leg, for instance, a prudent course might be to abort the takeoff for any annunciated malfunction or for others in addition to those listed above. If such a preflight decision is made, it must be included in the before takeoff briefing.

35.2.4 Nonrecall Procedures

Recognition and verification of a malfunction or impending malfunction during noncritical phases of flight require the same positive verbal and graphic communication; however, time is not as critical and allows more deliberated and positive consensus of the malfunction. Corrective action always is accomplished utilizing the appropriate checklist.

35.2.5 Sterile Cockpit

A sterile cockpit is a concept whereby cockpit activity and communications below 10,000 feet Mean Sea Level (MSL) should relate to the tasks at hand. Nonessential and potentially distracting conversations in this critical phase of flight should be avoided. A sterile cockpit is not meant to preclude normal cockpit interaction below 10,000 feet MSL.

35.3 CREW RESPONSIBILITIES

35.3.1 Aircraft Commander

The aircraft commander shall be in command of the aircraft and is responsible for the safe and orderly conduct of the flight. His/her responsibility exists from the time he/she accepts the flight and the crew has reported to him/her for such flight until the flight is completed and/or he/she is relieved from duty by proper authority. The authority and responsibility of the aircraft commander for the flight are independent of the presence of other persons senior to him/her in the crew or among the passengers except as stated in Article 0823 U.S. Navy Regulations, herein quoted in part: “The Commanding Officer of a ship or aircraft, not a flagship with a flag officer eligible for command at sea embarked as a passenger by due authority, shall be subject to the orders of such flag officer; other officers embarked as passengers, senior to the Commanding Officer, shall have no authority over him.”

The aircraft commander will be thoroughly familiar with this manual, squadron manuals and directives, and all other pertinent directives from higher authority.

At the discretion of the aircraft commander, the crew duties and responsibilities outlined in the following paragraphs may be reassigned as appropriate within the crew. The aircraft commander has the authority to delay or discontinue a flight when, in his/her opinion, conditions are unsafe starting or continuing a flight.

35.3.2 Copilot

The copilot is second in command and is responsible for assisting the aircraft commander in the performance of his/her duties and such other duties as may be assigned. When a qualified NFO is assigned as copilot, his/her duties are the same as listed below except he/she shall not assume physical control of the aircraft.

The copilot may control the aircraft without special weather restrictions and may make instrument climbs, descents, landings, and takeoffs, day or night, consistent with his/her instrument qualifications.

The aircraft commander shall use his/her discretion in each case of adverse weather or emergencies encountered when deciding if the copilot is capable of executing a safe departure or approach.

When in control of the aircraft, in the absence of the aircraft commander from the cockpit, the copilot shall ensure the safe conduct of the flight and shall notify the aircraft commander immediately of any unusual events or circumstances.

In the event of disability of the aircraft commander during flight, the copilot with the highest designation shall take command of the flight and assume the authority, duties, and responsibilities of the aircraft commander to the next en route station or to a closer alternate, as the situation warrants.

The copilot shall constantly monitor all maneuvers being performed by the pilot, bringing to his/her attention any deviations from normal operations. When, in his/her opinion, the flight is bordering on unsafe conditions, it is the copilot's responsibility to prompt the pilot, regardless of designation or rank.

35.3.3 Transport Aircrewman

The transport aircrewman shall:

1. Verify the fuel load and obtain any special instructions from the aircraft commander before flight.
2. Perform preflight inspection in accordance with paragraph 7.2.
3. Prepare a DD 365-4 (Form F).
4. Provision the aircraft with water, coffee, box lunches, etc., as required.
5. Configure aircraft for appropriate load. Load and secure cargo and/or passengers.
6. Give normal and emergency instructions to the passengers in accordance with paragraph 7.2.4.
7. Ensure passenger comfort during flight.
8. Maintain cleanliness within the aircraft during flight.
9. Prepare manifest, customs forms, etc.
10. Ensure aircraft is properly secured after flight, including chocks, tiedowns, propeller restraints, pitot covers, and intake covers as appropriate.

In the event a transport aircrewman is not assigned, the copilot will assume duties at the discretion of the aircraft commander.

35.4 SPECIFIC RESPONSIBILITIES

35.4.1 Flightcrew

This section provides for mandatory briefs, duties, and voice calls to be made during a specified flight phase. Development of good cockpit resource management shall be the goal of all UC-12 aircrew. Briefs should be succinct. The following recommendations are outlines that should be used to ensure successful completion of the mission. Additional items may be employed to brief the crew at the discretion of the AC.

35.4.2 General

Prior to conducting a flight, the AC shall ensure the following responsibilities and procedures are understood.

35.4.2.1 Pilot Flying

The PF shall:

1. Fly the aircraft.
2. Call for checklists.
3. Back up the PNF.

35.4.2.2 Pilot Not Flying

The PNF shall:

1. Read the checklists.
2. Assist the PF as required.
3. Communicate with ATC and record clearances.
4. Tune, ID, and set all radios and NAVAIDs.
5. Call 1,000 feet prior to assigned altitude.
6. Call airspeed deviations as required.
7. Call altitude deviations.
8. Call one dot deviation off course or glideslope.
9. Call abnormal pitch, roll, and sink rates.

35.4.3 Preflight

The AC shall brief all aircrew on duties, route, weather, passengers, cargo load, and any unusual requirements or conditions.

35.4.4 Engine Start

Prior to engine start, the PF shall conduct a brief that includes the start sequence and procedures to be used.

35.4.5 Takeoff

The PF shall conduct a takeoff brief that shall include the following:

1. Voice callouts.
2. Abort criteria.
3. Emergency return.
4. Normal departure.

35.4.6 Departure

1. The climb checklist shall be called for above 1,000 feet AGL.

35.4.7 Approach

The PF shall conduct an approach brief that shall include the following:

1. Weather.
2. Airfield and runway.
3. Type of approach and landing.
4. Missed approach.
5. Voice callouts.

35.4.7.1 Instrument Approach

When conducting an instrument approach, the following items should be briefed:

1. Name of approach.
2. Automatic Terminal Information System (ATIS) information and current weather.
3. NAVAIDs and frequencies.
4. Minimum sector altitudes.
5. Inbound leg to FAF, procedure turn, and altitudes.
6. Final approach course and altitude.
7. Timing (as required).
8. DH, MDA, and Visual Descent Point (VDP).
9. Height above touchdown (set on radio altimeter).
10. Missed approach point.
11. Runway elevation, length, and width.
12. Terrain and obstacles near field.
13. Airfield lighting.
14. Calling field in sight.
15. Missed approach procedures.

PART X

NATOPS Evaluation

CHAPTER 36

NATOPS Evaluation

36.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating UC-12 aircraft. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS program is achieved only through vigorous support of the program by commanding officers as well as flightcrewmembers.

36.2 APPLICABILITY

The NATOPS evaluation shall be administered annually to pilots, naval flight officers, and transport aircrewmen.

36.3 DEFINITIONS

The following terms used throughout this chapter are defined as to their specific meaning within the NATOPS program:

1. NATOPS evaluation — A periodic evaluation of individual flightcrewmember standardization consisting of an open-book examination, a closed-book examination, an oral examination, and a flight evaluation.

2. NATOPS reevaluation — A partial NATOPS evaluation administered to a flightcrewmember who has been placed in an Unqualified status by receiving an Unqualified grade for any of his/her ground examinations or the flight evaluation. Only those areas in which an unsatisfactory level was noted need be observed during a reevaluation.

3. Minor discrepancies and/or omissions — Minor discrepancies and/or omissions, as may be referred to in the grading criteria, are defined as those that would not adversely affect the successful completion of the mission or jeopardize the safety of the crew and/or equipment.

4. Momentary deviations — Very brief deviations from the tolerances set forth in the grading criteria will not be considered in marking, provided the evaluee is alert in applying corrective action and the deviation does not jeopardize the safety of the aircraft or crew and does not exceed the limitations prescribed for the Conditionally Qualified grade. Cumulative momentary deviations, however, will result in downgrading.

5. Qualified (Q) — That degree of standardization demonstrated by a very reliable flightcrewmember who has a good knowledge of standard operating procedures and a thorough understanding of aircraft capabilities and limitations.

6. Conditionally Qualified (CQ) — That degree of standardization demonstrated by a flightcrewmember who meets the minimum acceptable standards. He/she is considered safe enough to fly as an Aircraft Commander or to perform normal duties without supervision, but more practice is needed to become Qualified.

7. Unqualified (U) — That degree of standardization demonstrated by a flightcrewmember who fails to meet minimum acceptable criteria. He/she should receive supervised instruction until he/she has achieved a grade of Qualified or Conditionally Qualified.

8. Area — A routine of preflight, flight, or postflight.

9. Subarea — A performance subdivision within an area that is observed and evaluated during an evaluation flight.

10. 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.

11. Emergency — An aircraft component system failure or condition that requires instantaneous recognition, analysis, and proper action.

12. Malfunction — An aircraft component or system failure or condition that requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

36.4 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. The various categories of flightcrewmembers desiring to attain/retain qualifications in the UC-12 shall be evaluated in accordance with the current OPNAVINST 3710.7. Individual and unit NATOPS evaluations will be conducted periodically; however, instruction in the observation of adherence to NATOPS procedures will 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 the current OPNAVINST 3710.7 series. Evaluees who receive a grade of Unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date the initial ground evaluation was commenced and the date the flight evaluation is satisfactorily completed.

36.5 GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a grade of Qualified on the open- and closed-book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To ensure a degree of standardization between units, the NATOPS instructors may use the bank of questions contained in this chapter in preparing portions of the written examinations.

36.5.1 Open-Book Examination

Up to 50 percent of the questions used may be taken from the question bank. The number of questions on the examination will not exceed 40 or be fewer than 20. The purpose of the open-book examination portion of the written examination is to evaluate pilot knowledge of appropriate publications and the aircraft.

36.5.2 Closed-Book Examination

Up to 50 percent of the closed-book examination may be taken from the question bank and shall include questions concerning normal procedures, emergency procedures, and aircraft limitations. The number of questions on the examination will not exceed 40 or be fewer than 20. Questions designated critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of Unqualified being assigned to the examination.

36.5.3 Oral Examination

The questions may be taken from this manual and drawn from the experience of the instructor/evaluator. Such questions should be direct and positive and should in no way be opinionated.

36.5.4 Grading Instructions

Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of Qualified or Unqualified.

36.5.4.1 Open-Book Examination

To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.5.

36.5.4.2 Closed-Book Examination

To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.3.

36.5.4.3 Oral Examination

A grade of Qualified or Unqualified shall be assigned by the instructor/evaluator.

36.6 FLIGHT EVALUATION

The flight evaluation is designed to measure with maximum objectivity the degree of standardization demonstrated by pilots and crewmembers. It is not intended to measure the proficiency and/or ability of those evaluated beyond a point necessary to ensure safety of flight. Within reasonable limits, any individual evaluated should be able to attain a Qualified grade based upon demonstrated knowledge without regard to special proficiency or ability.

Note

All critical items must be covered on all checkflights. Other items may be covered at the discretion of the evaluator.

The process uses three integrated parts: the NATOPS evaluation worksheet (Figures 36-1, 36-2, or 36-3), flight evaluation criteria (paragraphs 36.7, 36.8, or 36.9), and the evaluation report OPNAV Form 3710/7 (Figure 36-4).

The flight evaluation worksheet is designed to enable the instructor/evaluator to record pertinent information for the purpose of a comprehensive postflight reconstruction and critique. Following completion of the evaluation, data from the worksheet is compared with the grading criteria to determine the numerical/adjectival equivalent for entry on the evaluation report form.

36.6.1 Flight Evaluation Grade Determination

36.6.1.1 Flight Evaluation Grading Criteria

Only those subareas observed or required will be graded. The grade assigned for a subarea shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings listed below. Momentary deviations from standard operating procedures should not be considered as unqualifying, provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

The following procedure shall be used in determining the flight evaluation grade. A grade of Unqualified in any critical area/subarea will result in an overall grade of Unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical evaluation to the objective grade of each subarea. Only the numerals 0, 2, or 4 will be assigned to subareas without interpolation.

Unqualified — 0.0.

Conditionally Qualified — 2.0.

Qualified — 4.0.

To determine the numerical grade for an area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The objective grade shall then be determined on the basis of the following scale:

0.0 to 2.10 — Unqualified.

3.0 to 4.0 — Qualified.

2.2 to 2.99 — Conditionally Qualified.

PILOT NATOPS EVALUATION WORKSHEET

Name ______________________ Date ____________

SSN ______________________________________

Position __________________ Prev Eval ____________

Total Hrs _________________ Hrs in Model ____________

Open Book Date ______________ Grade ____________

Closed Book Date ____________ Grade ____________

Aircraft BUNO ______________ Flt Time ____________

NI Rank/Name _____________________________

Overall Grade Computation

Preflight	☐
Pretakeoff	☐
Takeoff, Climb, and Cruise	☐
Landings	☐
Instrument Approaches	☐
Emergencies/Malfunctions	☐
Postflight Procedures	☐
	7
Evaluation Grade	☐

Evaluation Writeup

Page 1

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Figure 36-1. Pilot NATOPS Evaluation Worksheet (Sheet 1 of 4)

ADMINISTRATIVE COMMENTS

1. No interpolation is allowed grading subareas. The only grades assigned are 4 for no errors (Q), 2 for minor errors (but not safety related — CQ), or 0 for major/safety errors (U).

2. Subareas marked with an asterisk (*) are critical. An Unsatisfactory in a critical subarea is Unsatisfactory for the entire area.

3. To compute the final grade, the areas are averaged. 3.0 to 4.0 is Qualified; 2.2 to 2.99 is Conditionally Qualified; 0.0 to 2.10 is Unqualified.

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Figure 36-1. Pilot NATOPS Evaluation Worksheet (Sheet 2 of 4)

EMERGENCIES/MALFUNCTIONS

*1. Aircraft handling (BAW)
*2. Engine Fire
*3. Landing gear emergencies
*4. Brake Malfunction
*5. Loss of ac/dc power source
*6. Electrical fire
*7. Pressurization loss
*8. Emergency descent
9. Icing system malfunction
*10. Ditching drill
11. Propeller malfunction
*12. Airstart procedures
13. Flight control malfunction

Grade 13

Comments

POSTFLIGHT PROCEDURES

Grade

Comments

Page 6

PREFLIGHT

1. Flight planning
2. Crew/passenger briefing
3. Aircraft inspection
*4. Pilot safety and survival equipment

Grade 4

Comments

PRETAKEOFF

1. Prestart
2. Start
3. Taxi
4. Before takeoff

Grade 4

Comments

Page 3

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Figure 36-1. Pilot NATOPS Evaluation Worksheet (Sheet 3 of 4)

TAKEOFF, CLIMB, AND CRUISE

*1. Normal takeoff ☐
*2. Normal transition ☐
*3. Malfunctions before lift-off ☐
*4. Malfunctions after lift-off ☐
5. Climb and departure ☐
6. Level off and cruise ☐

Grade ☐ (6)

Comments

Page 4

LANDINGS

1. Normal pattern ☐
*2. Normal approach ☐
*3. Normal landings ☐
*4. Single-engine approach ☐
*5. Single-engine landing ☐
6. No-flap approach ☐
7. No-flap landing ☐
*8. Waveoff ☐

Grade ☐ (8)

Comments

INSTRUMENT APPROACHES

1. Holding procedures ☐
2. Bearing interception ☐
3. Approach airspeed control ☐
4. DME arcing ☐
5. Approach altitude control ☐
6. Approach course control ☐
7. Approach engine operation ☐
8. Use of checklists ☐
9. Missed approach ☐
10. GCA/ILS airspeed control ☐
11. GCA/ILS altitude control ☐
12. GCA/ILS heading/course control ☐
13. GCA/ILS glideslope ☐
14. GCA/ILS use of checklists ☐
15. GCA/ILS missed approach ☐

Grade ☐ (15)

Comments

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Figure 36-1. Pilot NATOPS Evaluation Worksheet (Sheet 4 of 4)

NFO/OBSERVER NATOPS EVALUATION WORKSHEET

Name ____________ Date ____________

SSN ____________

Position ____________ Prev Eval ____________

Total Hrs ____________ Hrs in Model ____________

Open Book Date ____________ Grade ____________

Closed Book Date ____________ Grade ____________

Aircraft BUNO ____________ Flt Time ____________

NI Rank/Name ____________

Overall Grade Computation

Preflight	☐
Pretakeoff	☐
Takeoff, Climb, and Cruise	☐
Landings	☐
Instrument Approach	☐
Emergencies/Malfunctions	☐
Postflight Procedures	☐
	7
Evaluation Grade	☐

Evaluation Writeup

Page 1

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Figure 36-2. NFO/Observer NATOPS Evaluation Worksheet (Sheet 1 of 4)

ADMINISTRATIVE COMMENTS

1. No interpolation is allowed grading subareas. The only grades assigned are 4 for no errors (Q), 2 for minor errors (but not safety related — CQ), or 0 for major/safety errors (U).

2. Subareas marked with an asterisk (*) are critical. An Unsatisfactory in a critical subarea is Unsatisfactory for the entire area.

3. To compute the final grade, the areas are averaged. 3.0 to 4.0 is Qualified; 2.2 to 2.99 is Conditionally Qualified; 0.0 to 2.10 is Unqualified.

Page 2

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Figure 36-2. NFO/Observer NATOPS Evaluation Worksheet (Sheet 2 of 4)

EMERGENCIES/MALFUNCTIONS

*1. Checklist/procedures
*2. Loss of ac/dc power source
*3. Electrical fire
*4. Pressurization loss
*5. Emergency descent
6. Icing system malfunction
*7. Ditching drill
8. Propeller malfunction
*9. Airstart procedures

Grade 10

Comments

POSTFLIGHT PROCEDURES

Grade

Comments

Page 6

PREFLIGHT

1. Flight planning
2. Crew/passenger briefing
3. Aircraft inspection
*4. Pilot safety and survival equipment

Grade 4

Comments

PRETAKEOFF

1. Prestart
2. Start
3. Before takeoff

Grade 3

Comments

Page 3

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Figure 36-2. NFO/Observer NATOPS Evaluation Worksheet (Sheet 3 of 4)

TAKEOFF, CLIMB, AND CRUISE

*1. Normal takeoff
*2. Malfunctions before lift-off
*3. Malfunctions after lift-off
4. Climb and departure
5. Level-off and cruise

Grade 5

Comments

LANDINGS

1. Normal landing pattern
2. Approach
*3. Waveoff

Grade 3

Comments

Page 4

INSTRUMENT APPROACH

1. Holding procedures
2. Bearing interception
3. Use of checklists
4. Missed approach

Grade 4

Comments

Page 5

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Figure 36-2. NFO/Observer NATOPS Evaluation Worksheet (Sheet 4 of 4)

FLIGHT

1. Care of passengers ☐
*2. In-flight emergency procedures ☐
*3. Ditching ☐
4. Care and use of equipment ☐
*5. Location and use of survival equipment ☐
6. Forms used ☐
7. Aircraft cleanliness ☐

Grade ☐ 7

Comments

POSTFLIGHT

1. Servicing and securing ☐
2. Offloading procedure ☐
3. Aircraft secured as required ☐
4. Security compliance ☐
5. Crew coordination ☐
6. Knowledge of aircraft ☐
7. Military courtesy ☐
8. Knowledge of first-aid ☐

Grade ☐ 8

Comments

06-C-0099(1)

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TAC NATOPS EVALUATION WORKSHEET

Name ____________________ Date ____________

SSN ________________________________

Position ________________ Prev Eval ____________

Total Hrs ______________ Hrs in Model ____________

Open Book Date ______________ Grade ____________

Closed Book Date ______________ Grade ____________

Aircraft BUNO ______________ Flt Time ____________

NI Rank/Name ________________________________

Overall Grade Computation

Flight Planning Preparation ☐
Preflight ☐
Flight ☐
Postflight ☐

4

Evaluation Grade ☐

Evaluation Writeup

Page 1

Figure 36-3. TA NATOPS Evaluation Worksheet (Sheet 1 of 2)

ADMINISTRATIVE COMMENTS

1. No interpolation is allowed grading subareas. The only grades assigned are 4 for no errors (Q), 2 for minor errors (but not safety related — CQ), or 0 for major/safety errors (U).

2. Subareas marked with an asterisk (*) are critical. An Unsatisfactory in a critical subarea is Unsatisfactory for the entire area.

3. To compute the final grade, the areas are averaged. 3.0 to 4.0 is Qualified; 2.2 to 2.99 is Conditionally Qualified; 0.0 to 2.10 is Unqualified.

Page 2

FLIGHT PLANNING AND PREPARATION

1. Professional equipment ☐
2. Preflight inspection duties ☐
3. Preflight inspection paperwork ☐

Grade ☐ 3

Comments

PREFLIGHT

1. Aircraft servicing ☐
2. Ensure all survival and flight attendant equipment aboard ☐
*3. Knowledge of weight and balance ☐
*4. Baggage handling ☐
*5. Cargo loading and tiedown ☐
6. Briefing ☐

Grade ☐ 6

Comments

Page 3

06-C-0099(2)

Figure 36-3. TA NATOPS Evaluation Worksheet (Sheet 2 of 2)

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)

06-C-0096

Figure 36-4. NATOPS Evaluation Report (OPNAV 3710/7)

36.6.1.2 Final Grade Determination

The final NATOPS evaluation grade shall be the same as the grade assigned to the evaluation flight. An evaluee who receives an unqualified on any ground examination or the flight evaluation shall be placed in an Unqualified status until he/she achieves a grade of Conditionally Qualified on a reevaluation.

Note

Asterisked (*) areas and subareas are critical.

36.6.1.3 Critique

The critique is the terminal point in the NATOPS evaluation and will be given by the instructor/evaluator administering the check. The critique involves processing data collected and oral presentation of the Evaluation Worksheet. Deviations from standard operating procedures will be covered in detail, using all collected data and the Evaluation Worksheet.

36.6.1.4 Records and Reports

A NATOPS evaluation report (OPNAV Form 3710/7) (Figure 36-4) shall be completed for each evaluation and forwarded to the evaluee's commanding officer. This report shall be filed in the individual flight training record and retained therein.

36.7 PILOT NATOPS EVALUATION GRADING CRITERIA

36.7.1 Preflight

1. Flight planning.

   Qualified — Properly prepared for the assigned flight. Familiar with all aspects pertinent to the flight proposed, including en route instrument publications. Had prepared all the necessary flight logs, forms, etc., as appropriate to ensure successful completion of the flight.

   Conditionally Qualified — Limited preparation made for assigned flight. Certain important aspects lacking to ensure the total success of the flight. Flight planning, however, would not jeopardize the safe conduct of the flight.

   Unqualified — Failed to meet the minimum standards of Conditionally Qualified.

2. Crew/passenger briefing.

   Qualified — Conducted a thorough, detailed, and professional briefing for the crew and/or passengers, covering route, altitude, destination, weather factors, use of personal and emergency equipment, emergency procedures, smoking privileges, etc., in accordance with current directives.

   Unqualified — Conducted no briefing or failed to cover emergency procedures to the extent necessary to ensure effective action during emergencies.

3. Aircraft inspection.

Qualified — Ensured thorough aircraft inspection. Inspected data sheets of previous discrepancies and preflight inspection form.

Conditionally Qualified — Completed aircraft inspection with omissions in minor areas that did not affect the safety of the proposed flight. Did not check previous discrepancy sheets.

Unqualified — Failed to conduct aircraft inspection properly and omitted important items that affected the safety of the proposed flight. Overlooked equipment adrift in the aircraft.

*4. Pilot safety and survival equipment.

Qualified — Safety and survival equipment complete. Demonstrated thorough knowledge and utilization of required equipment.

Unqualified — Any omission of safety or survival equipment that would preclude a successful ditching or jeopardize safety or survival. Unfamiliar with the use of required equipment, lack of knowledge of fire extinguishers, oxygen equipment, aircraft exits, liferafts, or other pertinent equipment.

36.7.2 Pretakeoff

1. Prestart.

Qualified — Executed NATOPS checklist properly. Demonstrated a thorough knowledge of all items.

Conditionally Qualified — Completed checklist satisfactorily. Minor omissions that did not jeopardize flight or system operation. Adequate understanding of all items.

Unqualified — Failed to complete checklist properly, thereby affecting safe flight operations. Knowledge of items not adequate to ensure safe and successful operation.

2. Start.

Qualified — Knew limitations and ensured execution of proper procedures.

Conditionally Qualified — Adequate knowledge of limitations and procedures or slow to recognize a start malfunction.

Unqualified — Did not know limitations or did not follow standard start procedure.

3. Taxi procedures.

Qualified — Procedures required by the NATOPS flight manual complied with. Taxi signalmen were utilized, power and speeds regulated closely, all lights and taxi aids were utilized as necessary. Checklists were accomplished without omission or discrepancy. Judicious use of power levers.

Conditionally Qualified — Procedures required by the NATOPS flight manual accomplished with omissions, deviations, or discrepancies that did not adversely affect successful completion of the mission, jeopardize safety, or cause undue delay.

Unqualified — Any omission or discrepancy that precluded successful completion of the mission, jeopardized safety, or caused excessive delay. Excessive use of reverse in areas of loose dirt or stones.

4. Before Takeoff.

Qualified — Executed checklists properly. Ensured deicing, anti-icing, and engine checks completed without omissions and in proper sequence. Set up radios in accordance with those facilities needed for initial climbout and on-course navigation. Checked all communication/navigation equipment in accordance with the best means available. Operated equipment in accordance with appropriate directives. Fully utilized available radios and NAVAIDs. Conducted proper briefing for the takeoff.

Conditionally Qualified — Completed all of above, but with minor discrepancies or omissions or not in proper sequence.

Unqualified — Failed to satisfy Conditionally Qualified or any item jeopardizing safe operation.

36.7.3 Takeoff, Climb, and Cruise

*1. Normal takeoff.

Qualified — Aircraft aligned with runway, initial power application smooth, directional control maintained with nosewheel until rudder effective and then with rudder.

Conditionally Qualified — Aircraft not aligned with runway, discrepancies in power applications. Abrupt or excessive usage of nosewheel steering. Discrepancies in any of the foregoing to an extent not jeopardizing safe operations.

Unqualified — Failed to satisfy Conditionally Qualified or any item jeopardizing safe operation.

*2. Normal transition.

Qualified — Rotated aircraft smoothly within 0 to +5 knots of rotation speed. Maintained balanced flight and correct takeoff pitch attitude until power reduction. Gear retracted without delay after establishing positive rate of climb.

Conditionally Qualified — Nosewheel skip or nose-high takeoff. Rotation airspeed within 0 to +10 knots of rotation speed. Aircraft in unbalanced flight; did not maintain takeoff attitude until power reduction.

Unqualified — Poor handling technique after liftoff, positive rate of climb not established or maintained. Gear retracted prematurely. Any other failure to satisfy Conditionally Qualified or any item jeopardizing safe operations.

*3. Malfunctions before liftoff.

Qualified — Used proper abort procedures. Maintained directional control and minimized swerve of aircraft. Announced intentions to abort the takeoff.

Conditionally Qualified — Slow in initiating correct abort procedures. Minor difficulty maintaining directional control of the aircraft, but not sufficient to jeopardize safety. Did not announce intentions to abort.

Unqualified — Did not use proper abort procedures. Serious difficulty maintaining directional control after executing abort.

*4. Malfunctions after liftoff.

Qualified — Correctly diagnosed malfunction and completed appropriate procedures while maintaining positive control of the aircraft.

Conditionally Qualified — Failed to meet the requirements for a grade of Qualified, but did not jeopardize safety. Did not maintain positive control of the aircraft.

Unqualified — Failed to satisfy Conditionally Qualified or any item jeopardizing safe operation.

5. Climb and departure.

Qualified — Proper use of Climb Checklist. Maintained correct climb power setting. Climb airspeed maintained within ±5 knots. Prescribed headings within ±5°. Did not exceed the limits of assigned departure altitudes and proper execution of the SID (when applicable).

Conditionally Qualified — Established, but did not maintain correct climb power setting. Climb airspeed maintained within ±10 knots. Prescribed headings within 10°.

Unqualified — Failed to complete Climb Checklist. Did not establish correct climb power. Failed to satisfy requirements listed under Conditionally Qualified.

6. Level-off and cruise.

Qualified — Appropriate power and altitude selection. Demonstrated knowledge of proper operation of anti-icing and deicing systems. Adequate knowledge of engine and airframe operating limitations and fuel management procedures. Leveled off and maintained assigned altitude within +100 feet. Prompt, correct altitude changes as required.

Conditionally Qualified — Incorrect procedures or questionable knowledge, but not considered to be of sufficient magnitude to jeopardize safe operation.

Unqualified — Failed to satisfy above requirements or any action or omission jeopardizing safety of flight. Leveled off or maintained assigned altitude in excess of ±150 feet. Excessive delay in executing assigned altitude changes.

36.7.4 Landings

1. Normal landing pattern.

Qualified — Entered and flew traffic pattern in accordance with the appropriate governing directives. Proper execution of descent and Landing Checklists. Flew the traffic pattern within ±100 feet altitude and ±5 knots airspeed.

Conditionally Qualified — Entered and flew traffic pattern in accordance with appropriate directives, but with deviations that did not interfere with traffic or jeopardize safety. Late calling for or completing checklists. Flew traffic pattern within ±150 feet altitude and ±10 knots of airspeed.

Unqualified — Deviated from prescribed pattern and interfered with other traffic or jeopardized safety. Failed to complete checklists. Exceeded limits of Conditionally Qualified.

*2. Normal approach.

Qualified — Established and executed pattern in accordance with NATOPS flight manual. Proper use of power. Landing Checklist completed. Airspeed ± 5 knots.

Conditionally Qualified — Deviation in approach not sufficient to jeopardize safety. Excessive power changes or rough use. Held airspeeds within ±l0 knots. Landing Checklist completed.

Unqualified — Deviation in approach that interfered with normal traffic or other deviations that jeopardized flight safety. Airspeed not held within above limits. Safe completion of approach was questionable and pilot did not attempt waveoff. Failed to complete Landing Checklist.

*3. Normal landings.

Qualified — Maintained positive control of speed, power, and rate of descent. Aircraft aligned within runway limits throughout final approach. Maintained aircraft in trim. Nose-high touchdown in first third of runway. Maintained directional control during rollout. Positive control of reverse. Smooth, effective use of brakes and nosewheel steering.

Conditionally Qualified — Had minor difficulty with transition. Handled aircraft roughly and used poor technique in flare, landing, or rollout. Flat touchdown in first third of runway.

Unqualified — Had serious difficulty with transition. Failed to maintain positive control of aircraft during flare, landing, or rollout. Did not touch down in first third of runway. Hard landing. Jeopardized safety.

*4. Single-engine approach.

Qualified — Normal airspeeds within ±5 knots (not safe below 120 knots until landing assured). Maintained trim and balanced flight. Checklists properly utilized and copilot briefed.

Conditionally Qualified — Deviations in approach in excess of Qualified that did not jeopardize safe completion. +10 and -5 knots, Landing Checklist completed.

Unqualified — Deviation in approach that interfered with normal traffic or other deviations that jeopardized flight safety. Safe completion of approach was questionable and pilot did not attempt waveoff. Failed to complete Landing Checklist.

*5. Single-engine landing.

Qualified — Maintained positive control of speed, power, and rate of descent to touchdown. Nose-high touchdown in first third of runway. Maintained directional control through rollout. Smooth, effective use of brakes and nosewheel steering.

Conditionally Qualified — Had minor difficulty with transition. Handled aircraft roughly and used poor technique in flare, landing, or rollout. Hard or flat touchdown in first third of runway.

Unqualified — Had serious difficulty with transition. Failed to maintain positive control of aircraft during flare, landing, or rollout. Did not touch down in first third of runway. Jeopardized safety or otherwise failed to satisfy requirements of Conditionally Qualified.

6. No-flap approach.

Qualified — Same criteria as for a normal landing. Airspeed within ±5 knots of prescribed. Landing Checklist completed.

Conditionally Qualified — Deviations in approach in excess of above, but did not jeopardize approach. Landing Checklist completed.

Unqualified — Deviation in approach that interfered with normal traffic or other deviations that jeopardized flight safety. Airspeed not held within above limits. Safe completion of approach was questionable and pilot did not attempt waveoff. Failed to complete Landing Checklist.

7. No-flap landing.

Qualified — Well-controlled, gradual power-on descent to landing. Proper trim. Touchdown in first third of runway. Well-controlled and proper use of reversing and brakes on rollout.

Conditionally Qualified — Excessive rate of descent or excessive flare on landing. Hard or flat touchdown in first third of runway. Rough usage or poor technique that did not jeopardize safety.

Unqualified — Failure to satisfy requirements of Conditionally Qualified.

*8. Waveoff.

Qualified — Executed waveoff with proper use of power. Executed smooth transition to climb attitude, retracted gear, raised flaps, and established positive rate of climb. Maintained smooth acceleration to climb airspeed.

Unqualified — Slow or incomplete power application, failed to retract gear, raise flaps, or to achieve positive rate of climb. Followed incorrect sequence or utilized other unsafe actions.

36.7.5 Instrument Approach

1. Holding procedures.

   Qualified — Entered holding in accordance with existing FAA requirements and used correct voice reports. Obtained expected approach or further clearance time. Maintained assigned holding pattern and altitude within ±100 feet.

   Conditionally Qualified — Entered holding pattern erratically. Failed to obtain expected approach or further clearance time. Varied pattern in excess of 30 seconds, altitude ±200 feet.

   Unqualified — Exceeded any requirement set forth under Conditionally Qualified.

2. Bearing interception.

   Qualified — Demonstrated effective interception procedures by the most direct and acceptable methods. Understood the use of bearing equipment in establishing interception.

   Conditionally Qualified — Effective bearing interception with some delay. Unsure of procedures and equipment, but performed interception without exceeding clearance limits.

   Unqualified — Became disoriented. Experienced decided amount of difficulty in effecting interception. Failed to understand equipment and clearance limits.

3. Approach airspeed control.

   Qualified — Maintained prescribed speed ranges and ±5 knots of specific airspeeds as published in NATOPS Flight Manual (Part III).

   Conditionally Qualified — Maintained airspeeds within ±10 knots of prescribed speed ranges.

   Unqualified — Exceeded the preceding limits.

4. DME ARC.

   Qualified — Maintained specified distance from station within ±1 mile.

   Conditionally Qualified — Maintained specified distance within ±2 miles.

   Unqualified — Failed to meet the requirements for Conditionally Qualified.

5. Approach altitude control.

   Qualified — Did not exceed limits of assigned or published altitudes. Maintained positive control of aircraft and situation during climb and descents.

   Conditionally Qualified — Did not exceed limits of assigned or published altitudes. Had minor difficulty maintaining positive control of aircraft and situation during climbs and descents. Did not jeopardize safety of flight.

   Unqualified — Exceeded the limits of assigned or published altitudes. Handled aircraft poorly. Did not maintain positive control of the situation.

6. Approach course control.

   Qualified — Maintained course within ±5°, effectively correcting for drift.

   Conditionally Qualified — Maintained course within ±10°. Had difficulty correcting for drift.

   Unqualified — Failed to maintain course within ±10°. Did not hold correction for drift.

7. Approach engine operation.

   Qualified — Did not exceed maximum ITT/TGT or TORQUE.

   Unqualified — Failed to observe ITT/TGT or TORQUE maximum.

8. Use of checklists.

   Qualified — Properly used checklists, with no omissions or incorrect responses.

   Conditionally Qualified — Late in calling for checklists, no serious omissions or incorrect responses.

   Unqualified — Failed to use checklists, serious omissions or incorrect responses.

9. Missed approach.

   Qualified — Prepared for missed approach. Timely and correct power application. Raised gear and flaps in accordance with waveoff procedure following power applications. Did not descend below minimums. No deviations from published procedures.

   Conditionally Qualified — Not adequately prepared for missed approach. Incorrect power application. Improper sequence of power, flaps, and gear. Did not descend below minimums. Satisfactorily carried out published procedure.

   Unqualified — Descended below minimums. Unsafe use of power. Unsatisfactory completion of published procedure.

10. Ground Control Approach (GCA)/ILS airspeed control.

    Qualified — Maintained airspeeds within prescribed speed range and/or ±5 knots of specified airspeeds.

    Conditionally Qualified — Maintained airspeeds within ±l0 knots of prescribed speed.

    Unqualified — Failed to remain within limits of Conditionally Qualified.

11. GCA/ILS altitude control.

    Qualified — Leveled off and maintained assigned altitudes within ±50 feet. Prompt, correct altitude changes.

    Conditionally Qualified — Leveled off and maintained assigned altitudes within ±100 feet. Delay in altitude changes.

    Unqualified — Failure to remain within limits of Conditionally Qualified.

12. GCA/ILS heading/course control.

    Qualified — Prompt response to heading instructions or course deviation; maintained assigned heading or course prior to final within ±5° and on final within ±3°; balanced flight standard rate turns except during small heading changes.

    Conditionally Qualified — Heading changes or course corrections late; maintained heading or course prior to final within ±8° and on final within ±5°; unbalanced flight, turning rates excessively fast or slow.

    Unqualified — Heading control not meeting requirements of Conditionally Qualified or resulting in waveoff or no gyro instructions.

13. GCA/ILS glideslope.

    Qualified — Prompt and adequate glideslope corrections.

    Conditionally Qualified — Maintained ILS glideslope within ±1 dot deviation. Adjustments late or excessive, but deviations within scale.

    Unqualified — Glideslope control inadequate or resulted in waveoff because of poor procedures.

14. GCA/ILS use of checklists.

    Qualified — Prompt and timely completion of required checklists.

    Conditionally Qualified — Delay or omissions in execution of checklists that did not affect safety of flight.

    Unqualified — Delays or omissions in execution of checklists that affect safety of flight.

15. GCA/ILS missed approach.

    Qualified — Properly carried out missed approach instructions. Power application, gear, flaps, and climb in accordance with NATOPS waveoff procedure.

    Conditionally Qualified — Minor discrepancies in above not affecting safety of flight.

    Unqualified — Not in conformance with the above.

36.7.6 Emergencies/Malfunctions

*1. Aircraft handling.

Qualified — Maintained or established desired heading within ±10°, altitude within ±150 feet. Minimal airspeed loss. Raised flaps and gear if required.

Conditionally Qualified — Maintained or established desired heading within ±20°, altitude within ±200 feet. Excessive airspeed loss. Delayed gear and flap retraction if required. Did not jeopardize flight safety.

Unqualified — Failure to satisfy criteria for Conditionally Qualified, loss of control or orientation, unsafe airspeed loss, or other unsafe actions. Failed to raise flaps and gear if required.

*2. Engine fire.

Qualified — Initiated first steps of checklist immediately and ensured remainder of checklist is accomplished.

Unqualified — Did not initiate or complete checklist. Performed any action detrimental to safety of flight.

*3. Landing gear emergencies.

Qualified — Correctly demonstrated emergency landing gear extension and had an understanding of significance of pulling the landing gear circuit breaker. Had a knowledge of landing gear airspeed limitations.

Unqualified — Failed to execute proper procedures.

*4. Brake malfunction.

Qualified — Promptly executed proper procedures and maintained positive control of aircraft.

Unqualified — Took excessive amount of time in stopping aircraft.

*5. Loss of ac or dc power source.

Qualified — Correctly diagnosed malfunction and followed procedures in Part V.

Unqualified — Inadequate knowledge of system or procedures. Any action affecting safety of flight.

*6. Electrical fire.

Qualified — Initiated first step of checklist if source unknown and ensured remainder of checklist was accomplished.

Unqualified — Did not initiate checklist and/or did not follow up on remainder of checklist. Failed to execute proper procedures.

*7. Loss of pressurization.

Qualified — Correctly diagnosed cause of pressurization loss and took appropriate action.

Unqualified — Failed to recognize pressurization loss or take corrective action. Performed any action detrimental to safety of flight.

*8. Emergency descent.

Qualified — Demonstrated knowledge and executed correct procedures.

Conditionally Qualified — Excessive delay in accomplishing emergency descent.

Unqualified — Inadequate knowledge of procedures. Other acts that resulted in unsafe operation.

9. Icing system malfunction.

Qualified — Correctly diagnosed malfunction and followed procedures outlined in Part V.

Conditionally Qualified — Correctly diagnosed malfunction, but made minor procedural errors that did not jeopardize safety.

Unqualified — Incorrectly diagnosed malfunction or made errors affecting safety of flight.

10. Ditching drill.

Qualified — Promptly and correctly assessed wind, sea, weather, and aircraft conditions. Maintained positive control of the aircraft and crew throughout the emergency. Executed proper procedures and accomplished the simulated water entry in such a way as to make successful ditching probable.

Conditionally Qualified — Minor omissions or errors in judgment that did not jeopardize the probability of crew survival.

Unqualified — Excessive rate of descent, slow airspeed, excessively fast airspeed, or improper flap setting or water entry speed. Other deficiencies or procedural omissions that would jeopardize the probability of crew survival.

11. Propeller malfunction.

Qualified — Demonstrated knowledge of procedures to follow with overspeeding propeller. Knowledge of protective devices in propeller autofeather and primary and overspeed governors.

Conditionally Qualified — Minor discrepancies in procedures. Knowledge of backup systems weak.

Unqualified — Did not know procedures to be followed with overspeeding propeller. Knowledge of protective systems limited to extent that safe operating procedures are jeopardized.

*12. Airstart procedures.

Qualified — Properly executed starter-assisted and/or windmilling airstart procedures without exceeding engine or airframe limitations. Correctly executed procedures in outline in Part V.

Unqualified — Any procedure causing a hazard to aircraft or safety of flight. Did not execute correct airstart procedures.

13. Flight control malfunction.

Qualified — Correctly diagnosed malfunction and followed procedures in accordance with Part V.

Conditionally Qualified — Correctly diagnosed malfunction. Made minor errors following procedures outlined in Part V that did not jeopardize safety.

Unqualified — Incorrectly diagnosed malfunction or made errors that affected safety of flight.

36.7.7 Postflight Procedures

Qualified — Handled aircraft safely. Executed checklists. Taxied and parked aircraft in a safe manner. Completed all safety items without omissions.

Conditionally Qualified — Poor handling technique, failed to complete checklists, and allowed minor omissions in securing aircraft. Completed all safety items without omissions.

Unqualified — Handled aircraft in a hazardous manner, failed to request checklists. Any act, performance, or omission that could result in an unsafe condition.

36.8 NAVAL FLIGHT OFFICER (NFO)/OBSERVER NATOPS EVALUATION GRADING CRITERIA

36.8.1 Preflight

1. Flight planning.

Qualified — Properly prepared for the assigned flight. Familiar with all aspects pertinent to the flight proposed, including en route instrument publications. Had prepared all the necessary flight logs, forms, etc., as appropriate to ensure successful completion of the flight.

Conditionally Qualified — Limited preparation made for assigned flight. Certain important aspects lacking to ensure the total success of the flight. Flight planning, however, would not jeopardize the safe conduct of the flight.

Unqualified — Failed to meet the minimum standards of Conditionally Qualified.

2. Crew/passenger briefing.

Qualified — Conducted a thorough, detailed, and professional briefing for the crew and/or passengers, covering route, altitude, destination, weather factors, use of personal and emergency equipment, emergency procedures, smoking privileges, etc., in accordance with current directives.

Unqualified — Conducted no briefing or failed to cover emergency procedures to the extent necessary to ensure effective action during emergencies.

3. Aircraft inspection.

Qualified — Ensured thorough aircraft inspection. Inspected data sheets of previous discrepancies and preflight inspection form.

Conditionally Qualified — Completed aircraft inspection with omissions in minor areas that did not affect the safety of the proposed flight. Did not check previous discrepancy sheets.

Unqualified — Failed to conduct aircraft inspection properly and omitted important items that affected the safety of the proposed flight. Overlooked equipment adrift in the aircraft.

*4. Pilot safety and survival equipment.

Qualified — Safety and survival equipment complete. Demonstrated thorough knowledge and utilization of required equipment.

Unqualified — Any omission of safety or survival equipment that would preclude a successful ditching or jeopardize safety or survival. Unfamiliar with the use of required equipment.

36.8.2 Pretakeoff

1. Prestart.

Qualified — Executed NATOPS checklist properly. Demonstrated a thorough knowledge of all items.

Conditionally Qualified — Completed checklist satisfactorily. Minor omissions that did not jeopardize flight or system operation. Adequate understanding of all items.

Unqualified — Failed to complete checklist properly, thereby affecting safe flight operations. Knowledge of items not adequate to ensure safe and successful operation.

2. Start.

Qualified — Knew limitations and ensured execution of proper procedures.

Conditionally Qualified — Adequate knowledge of limitations and procedures or slow to recognize a start malfunction.

Unqualified — Did not know limitations or did not follow standard start procedure.

3. Before takeoff.

Qualified — Executed checklists properly. Ensured deicing, anti-icing, and engine checks completed without omissions and in proper sequence. Set up radios in accordance with those facilities needed for initial climbout and on-course navigation. Checked all communication/navigation equipment in accordance with the best means available. Operated equipment in accordance with appropriate directives. Fully utilized available radios and NAVAIDs. Conducted proper briefing for the takeoff.

Conditionally Qualified — Completed all of above, but with minor discrepancies or omissions or not in proper sequence.

Unqualified — Failed to satisfy Conditionally Qualified or any item jeopardizing safe operation.

36.8.3 Takeoff, Climb, and Cruise

*1. Normal takeoff.

Qualified — Backed pilot up on instruments, ensured power set to predicted value, called V_r and V_2.

Unqualified — Failure to satisfy requirements for Qualified or any item jeopardizing safe operation.

*2. Malfunctions before liftoff.

Qualified — Correctly diagnosed malfunction and advised pilot. Demonstrated a thorough knowledge of appropriate procedures.

Conditionally Qualified — Incorrect procedures or questionable knowledge not considered to be of sufficient magnitude to jeopardize safe operation.

Unqualified — Failure to satisfy Conditionally Qualified or any item jeopardizing safe operation.

*3. Malfunctions after liftoff.

Qualified — Correctly diagnosed malfunction and advised pilot. Demonstrated a thorough knowledge of appropriate procedures.

Unqualified — Did not recognize malfunction. Did not advise pilot. Incorrect procedures or any item affecting safe operation.

4. Climb and departure.

Qualified — Proper use of climb checklist. Backed up pilot on departure. Proper utilization of NAVAIDs and ATC procedures.

Conditionally Qualified — Incorrect procedures or questionable knowledge not sufficient to jeopardize safe operation.

Unqualified — Failure to satisfy above requirements or any action affecting safety of flight.

5. Level-off and cruise.

Qualified — Appropriate power and altitude selection. Demonstrated knowledge of proper operation of anti-icing and deicing systems. Adequate knowledge of engine and airframe operating limitations and fuel management procedures.

Conditionally Qualified — Incorrect procedures or questionable knowledge not considered to be of sufficient magnitude to jeopardize safety of flight.

Unqualified — Failure to satisfy above requirements or an action or omission jeopardizing safety of flight.

36.8.4 Landings

1. Normal landing pattern.

Qualified — Proper execution of descent and prelanding checklists.

Conditionally Qualified — Late calling for or completing checklists.

Unqualified — Failed to complete checklists. Exceeded limits of Conditionally Qualified.

2. Approach.

Qualified — Correctly computed approach speed. Proper utilization of checklist. Correctly backed pilot up on attitude, heading, airspeed, and altitude. Correct utilization of NAVAIDs and voice procedures.

Conditionally Qualified — Any deviation in above not sufficient to jeopardize safety.

Unqualified — Any action or omission jeopardizing safety of flight.

*3. Waveoff.

Qualified — Backed up pilot, knowledgeable of correct waveoff procedures.

Unqualified — Any action or omission jeopardizing safety of flight.

36.8.5 Instrument Approach

1. Holding procedures.

Qualified — Computed holding entry in accordance with existing FAA requirements and used correct voice reports. Obtained expected approach or further clearance time.

Unqualified — Computed holding pattern incorrectly. Failed to obtain expected approach or further clearance time.

2. Bearing interception.

   Qualified — Computed effective interception procedures by the most direct and acceptable methods. Understood the use of bearing equipment in establishing interception.

   Conditionally Qualified — Computed bearing interception with some delay. Unsure of procedures and equipment, but computed interception without exceeding clearance limits.

   Unqualified — Became disoriented. Experienced decided amount of difficulty in computed interception. Failed to understand equipment and clearance limits.

3. Use of checklists.

   Qualified — Properly utilized checklists with no omissions or incorrect responses.

   Conditionally Qualified — Late in completing checklists but no serious omissions or incorrect responses.

   Unqualified — Failed to complete checklists, serious omissions or incorrect responses.

4. Missed approach.

   Qualified — Prepared for missed approach. Correctly backed up pilot on missed approach procedure. Correct voice reports.

   Conditionally Qualified — Not adequately prepared for missed approach. No action or omission affecting safety of flight.

   Unqualified — Unsatisfactory pilot backup. Any action or omission affecting safety of flight.

36.8.6 Emergencies/Malfunctions

*1. Checklist/procedures.

   Qualified — Initiated proper checklist. Ensured checklist was accomplished. Correct knowledge of procedures.

   Unqualified — Inadequate knowledge of procedures. Performed any actions affecting safety of flight.

*2. Loss of ac or dc power source.

   Qualified — Correctly diagnosed malfunction and followed procedures in Part V.

   Conditionally Qualified — Correctly diagnosed malfunction, but made minor procedural errors. Showed minor lack of understanding of electrical system.

   Unqualified — Failure to execute proper procedures.

*3. Electrical fire.

   Qualified — Proper utilization of checklist. Correct knowledge of proper procedures. Ensured checklist was accomplished.

   Conditionally Qualified — Made minor procedural errors not affecting safety of flight.

   Unqualified — Failed to execute proper procedures.

*4. Loss of pressurization.

Qualified — Correctly diagnosed cause of pressurization loss and took appropriate action.

Conditionally Qualified — Showed minor lack of understanding of pressurization system, but took corrective action to ensure safety of flight.

Unqualified — Failed to recognize pressurization loss or take corrective action.

*5. Emergency descent.

Qualified — Demonstrated knowledge of correct procedures.

Unqualified — Inadequate knowledge of procedures. Other acts that resulted in unsafe operation.

6. Icing system malfunction.

Qualified — Correctly diagnosed malfunction and followed procedures outlined in Part V.

Conditionally Qualified — Correctly diagnosed malfunction, but made minor procedural errors that did not jeopardize safety.

Unqualified — Incorrectly diagnosed malfunction or made errors affecting safety of flight.

*7. Ditching drill.

Qualified — Knowledgeable of correct procedures. Ensured passengers briefed. Correctly assessed wind, sea, weather, and aircraft conditions. Ensured pilot executed proper procedures.

Conditionally Qualified — Minor omissions or errors in judgment that did not jeopardize the probability of crew survival.

Unqualified — Deficiencies or procedural omissions that would jeopardize the probability of crew survival.

8. Propeller malfunction.

Qualified — Demonstrated knowledge of procedures to follow with overspeeding propeller. Knowledge of protective devices in propeller autofeather and primary and overspeed governors.

Conditionally Qualified — Minor discrepancies in procedures. Knowledge of backup systems weak.

Unqualified — Did not know procedures to be followed with overspeeding propeller. Knowledge of protective systems limited to extent that safe operating procedures were jeopardized.

*9. Airstart procedures.

Qualified — Properly executed starter-assisted and/or windmilling airstart checklists without exceeding engine or airframe limitations.

Unqualified — Any procedure causing a hazard to safety.

36.8.7 Postflight Procedures

Qualified — Executed checklists. Completed all safety items without omissions.

Conditionally Qualified — Failed to complete checklists and allowed minor omissions in securing aircraft. Completed all safety items without omissions.

Unqualified — Any act, performance, or omission that could result in an unsafe condition.

36.9 TRANSPORT AIRCREWMAN NATOPS EVALUATION GRADING CRITERIA

36.9.1 Flight Planning and Preparation

1. Professional equipment.

   Qualified — Had all necessary personal and professional equipment. Displayed positive knowledge of the proper use, care, and operation of such equipment.

   Conditionally Qualified — Marginal knowledge of the proper use, care, and operation of personal and professional equipment.

   Unqualified — Did not have required personal or professional equipment. The lack of this gear and proper knowledge of its use could cause compromise of safe operation. Successful survival in an emergency was doubtful.

2. Preflight inspection duties.

   Qualified — Reported sufficiently in advance of flight to complete preflight inspection/duties, precluding delay of flight. Completed thorough preflight inspection in compliance with standard forms. Ascertained that all required equipment was aboard.

   Conditionally Qualified — Completed aircraft inspection/duties with omission in minor areas that did not cause delay or affect the safety of the proposed flight.

   Unqualified — Failed to conduct proper aircraft inspection and/or omitted important items that would affect the safety of flight. Failed to have all required equipment on board.

3. Preflight inspection paperwork.

   Qualified — Accomplished all necessary paperwork.

   Conditionally Qualified — Completed necessary paperwork, but with minor deviations from established procedures.

   Unqualified — Did not accomplish required paperwork.

36.9.2 Preflight

1. Aircraft servicing.

   Qualified — Displayed positive knowledge of requirements and proficiency in servicing of engine oil, fuel, oxygen, and hydraulic system components as outlined in approved manual and directives. All safety precautions were heeded.

   Conditionally Qualified — Servicing of oxygen, engine oil, fuel, and hydraulic system components was accomplished with minor deviations of approved manuals and directives. Deviations did not compromise safety.

   Unqualified — Servicing of engine oil, fuel, oxygen, and hydraulic system components was not accomplished in an approved manner. Safety precautions were partially or completely disregarded, thereby endangering aircraft and/or personnel.

2. Ensure all survival and flight attendant equipment aboard.

   Qualified — Inspected aircraft to ensure adequate survival and flight attendant equipment aboard to accomplish mission. Knew procedures to procure additional equipment.

   Conditionally Qualified — Completed inspection with minor omissions not affecting safety of flight.

   Unqualified — Failed to ensure adequate survival equipment was aboard to accomplish mission.

*3. Knowledge of weight and balance.

Qualified — Properly completed weight and balance clearance Form F (DD 365-4) to ensure aircraft was within allowable operating limits.

Unqualified — Made errors in computations, resulting in improper cabin load or exceeding allowable limits of aircraft.

*4. Baggage handling.

Qualified — Loaded passenger baggage in proper sequence according to offloading points. Ensured proper stowage and securing of baggage in designated compartments.

Unqualified — Exceeded weight limits of compartments. Unnecessarily rough in handling.

*5. Cargo loading and tiedown.

Qualified — Loaded aircraft within allowable cabin load or compartment limits.

Unqualified — Exceeded allowable cabin load or compartment limits. Failed to load within allowable cg limits. Failed to apply proper restraint to cargo.

6. Briefing.

Qualified — Briefed the passengers completely concerning the use of seatbelts, the observance of the no smoking and seatbelt signs, the availability of coffee and water aboard, safety regulations, and ditching procedures.

Conditionally Qualified — Same as Qualified, but omitted some items or incompletely briefed on any one item.

Unqualified — Gave incomplete briefing. Omitted most items that should have been covered.

36.9.3 Flight

1. Care of passengers.

Qualified — Courteous in meeting the needs and requests of passengers. Conformed to high standards of personal service and passenger comfort at all times. Anticipated needs and took initiative to convenience. Ensured that all requirements and requests were handled expeditiously and correctly. Consistently polite and attentive in dealing with passengers, assisting them whenever possible.

Conditionally Qualified — Possessed all the attributes of Qualified, but with occasional minor oversights.

Unqualified — Impolite in dealing with passengers. Lacked initiative in assisting passengers and failed to comply with requests. Disregarded standards of comfort desired and required for passengers.

*2. In-flight emergency procedures.

Qualified — Exhibited complete understanding of the corrective actions required for various in-flight emergencies. Knew the emergency checklist thoroughly. On drills, conducted corrective measures in a highly professional manner.

Unqualified — Unsatisfactory knowledge of emergency procedures or corrective actions required. Attempted to perform an unsafe action during emergency drill conducted by the aircraft commander.

*3. Ditching.

Qualified — Demonstrated a thorough knowledge of ditching procedures. Explained, in detail, all actions required for ditching in the proper sequence. Was able to execute the ditching expeditiously, safely, and correctly, requiring a minimum of supervision.

Unqualified — Did not know ditching procedures or left doubt that he/she would survive ditching or bailout if left to his/her own devices.

4. Care and use of equipment.

Qualified — Demonstrated correct use of all equipment applicable to his/her duties. Took care not to abuse or misuse equipment.

Conditionally Qualified — Same as Qualified, but could be more careful in handling of equipment.

Unqualified — Inadequate knowledge or improper utilization of equipment.

*5. Location and use of survival equipment.

Qualified — Demonstrated a complete knowledge of all survival equipment normally carried in the aircraft, its use, care, and stowage locations. Thorough knowledge of how and when to launch, properly inflate, and board rafts.

Unqualified — Demonstrated lack of knowledge of survival equipment.

6. Forms used.

Qualified — Completed all required forms expeditiously and accurately. Specifically checked passenger/cargo manifests and completed flight summary for given leg of the flight. All required forms for specific stations completed prior to arrival.

Conditionally Qualified — Completed all required forms but with minor omissions that did not adversely affect the flight.

Unqualified — Failed to satisfactorily complete necessary forms.

7. Aircraft cleanliness.

Qualified — Maintained a maximum standard of cleanliness and neatness at all times. Ensured that the cabin was cleaned thoroughly at regular intervals and that all waste receptacles were serviced at each stop en route. Displayed initiative in maintaining a high degree of aircraft cleanliness at all times.

Conditionally Qualified — Same as Qualified, but with minor deviations.

Unqualified — Neglected to empty waste receptacles at en route stops. Lack of concern and effort to keep the cabin spaces neat and clean. Failure to inspect the aircraft for cleanliness, or to correct discrepancies that exist.

36.9.4 Postflight

1. Servicing and securing.

Qualified — Displayed professional knowledge of requirements and proficiency in refueling and securing aircraft. All requirements, as outlined in approved manuals and directives, were accomplished in a professional manner. All safety precautions were heeded.

Conditionally Qualified — Refueling and securing were accomplished in accordance with approved manual and directives, but with minor deviations. Deviations did not compromise safety. Aircraft considered not completely secured, but not endangered.

Unqualified — Refueling and securing were not accomplished or were not accomplished in approved manner. Safety precautions were partially or completely disregarded, thereby endangering aircraft and/or personnel. Required supervision and/or further instruction.

2. Offloading procedure.

   Qualified — Observed safe practices in cargo handling. Ensured compliance with load limits of aircraft and cargo handling equipment. Provided proper safeguards where appropriate.

   Conditionally Qualified — Same as Qualified except for minor deviations.

   Unqualified — Used unsafe procedure in offloading. Exceeded allowable limits of aircraft or equipment. Failed to provide proper safeguards.

3. Aircraft secured as required.

   Qualified — Ensured aircraft entry doors and hatches were secured.

   Conditionally Qualified — Same as Qualified except for minor deviations.

   Unqualified — Made little effort to ensure aircraft was properly secured.

4. Security compliance.

   Qualified — Ensured compliance with security regulations concerning special mail and/or cargo.

   Conditionally Qualified — Same as Qualified except for minor deviations.

   Unqualified — Failed to provide proper security as required.

5. Crew coordination.

   Qualified — Coordinated action/requirements smoothly and effectively with all crewmembers. Anticipated demands upon crew position. The overall performance of the crew was enhanced by his/her critical decisions to the needs of others in the performance of their assigned duties.

   Conditionally Qualified — Attempted to coordinate action/requirements, but lacked the desired effect. Intercommunication discipline at times interfered with crew. Responses to checklist were made with only minor deviations. Did not jeopardize mission.

   Unqualified — Displayed undesirable traits related to crew coordination. Intercommunication discipline was nonexistent. Responses to checklist were vague or improper. Performance impaired the smooth accomplishment of the mission.

6. Knowledge of aircraft.

   Qualified — Possessed a complete knowledge of the equipment and systems of the aircraft related to the performance of duties and execution of emergency procedures. Demonstrated the ability to properly operate all related equipment in an efficient manner. Knew the various aircraft configurations and understood the limitations and procedures involved in each case.

   Conditionally Qualified — Displayed a general knowledge of equipment and systems related to performance of duties. Needs instruction and training in different configurations and related equipment.

   Unqualified — Unfamiliar with necessary systems and equipment. Lacked knowledge of limitations or operation of equipment essential to performance of duties and/or safety.

7. Military courtesy.

   Qualified — Rendered proper military courtesy to crew, passengers, and ground personnel. Polite and cheerful in dealing with all passengers.

   Conditionally Qualified — Occasionally neglected to render proper courtesies.

   Unqualified — Consistently lacking in military courtesy. Disagreeable or rude to officers, crew, passengers, or ground personnel.

8. Knowledge of first aid.

   Qualified — Possessed an excellent knowledge of the fundamentals of first aid. Knew the location and use of all first aid equipment aboard.

   Conditionally Qualified — Same as Qualified, but with minor discrepancies.

   Unqualified — Little or no knowledge of the fundamentals of first aid. Did not know the location or use of the first aid equipment.

36.10 NATOPS EVALUATION QUESTION BANK

1. A “WARNING” is defined in NATOPS as:

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

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

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

   d. An operating procedure, practice, or condition, etc., that must be followed.

2. A “CAUTION” is defined in NATOPS as:

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

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

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

   d. An operating procedure, practice, or condition, etc., that must be followed.

3. A “NOTE” is defined in NATOPS as:

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

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

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

   d. An operating procedure, practice, or condition, etc., that must be followed.

4. Starter use is time-limited to ________ on,________off,________on,________off,________on, ________off.

5. The pilot and copilot turn and slip indicators are powered

   a. Both electrically by 28 Vdc.

   b. Both electrically by 115 Vac.

   c. The pilot’s by 28 Vdc and the copilot’s by vacuum.

   d. The pilot’s by vacuum and the copilot’s by 28 Vdc.

6. Propeller speeds above ____________ rpm indicate failure of the primary and overspeed governors.

   a. 2,000; 2,080.

   b. 2,080; 2,120.

   c. 2,000; 2,120.

   d. None of the above.

7. Total fuel capacity is _________ gallons, of which ________ gallons are usable.

   a. 549; 544.

   b. 195; 193.

   c. 79.5; 79.

   d. 390; 384.

8. True or False: Under normal conditions the transfer of fuel from the auxiliary tank is automatic.

9. With the loss of the right 325 ampere current limiter (isolation limiter), what equipment is lost (assume no other failure)?

   a. All electrical equipment on the right generator bus.

   b. No. 1 and No. 3 dual fed bus.

   c. Landing gear motor.

   d. None of the above.

10. While securing the aircraft, failure to turn off ________ will discharge the battery overnight.

    a. Standby boost pumps (**B** only).

    b. Emergency lights.

    c. Entry lights.

    d. A and C only.

    e. All of the above.

11. True or False: Connecting a GPU and charging a weak battery (below 20 volts) is permitted since a relay will not allow excessively weak batteries to accept a charge, thus preventing battery damage.

12. Mark the true statements regarding the use of external power on the UC-12B/F:

    a. The battery switch must be on.

    b. One or both generators should be on.

    c. The receptacle is located outboard of the left engine nacelle.

    d. All of the above.

    e. A and C only.

13. The emergency lighting will be actuated by:

    a. Hard landings.

    b. 2g acceleration along the longitudinal axis.

    c. Activation of the switch in the cockpit.

    d. B and C.

    e. All of the above.

14. True or False: The stall warning system (horn) is accurate during icing conditions provided stall warning heat and wing deice are utilized properly.

15. True or False: The airstair door may be opened for ease in closing the cargo door.

16. The maximum operating cabin differential pressure is:

    a. 4.6 psi.

    b. (**B**) 6.1 (**F/M**) 6.6 inches Hg.

    c. (**B**) 6.1 (**F/M**) 6.6 psid.

    d. 4.6 inches Hg.

17. Minimum N_1 on the right engine to operate the air-conditioner is:

    a. 0 percent. The air conditioner compressor is on the left engine.

    b. 61 percent.

    c. 70 percent.

    d. None of the above.

18. Compute how many minutes of oxygen are available under the following conditions:

    O_2 pressure — 1,500 psig.

    Crew — Two (both using 100 percent).

    Passengers — Five.

    Cabin Altitude — 20,000 feet.

19. Mark all true statements regarding the passenger seats and headrests.

    a. All seatbacks must be upright and headrest properly positioned for all takeoffs and landings.

    b. All seatbacks must be upright, but only rear-facing seats must have their headrests properly positioned for all takeoffs and landings.

    c. Only rear-facing seats must have their seatbacks upright and headrests properly positioned for takeoffs and landings.

    d. All forward-facing seats must have shoulder harness installed and in use for all takeoffs and landings.

20. V_{FE} for 100 percent in the UC-12 is:

    a. 144 KIAS.

    b. 155 KIAS.

    c. 157 KIAS.

    d. 182 KIAS.

    e. 200 KIAS.

21. V_{YSE} for the UC-12 is:

    a. 86 KIAS.

    b. 104 KIAS.

    c. 115 KIAS.

    d. 121 KIAS.

22. V_{MCA} is:

    a. 86 KIAS.

    b. 9l KIAS.

    c. 104 KIAS.

    d. 121 KIAS.

23. True or False: Takeoff is permitted with either fuel quantity gauge indicating in the yellow arc.

24. True or False: During engine start, a maximum ITT/TGT of 1,000 °C for 10 seconds is allowable.

25. During ground operations in low idle, the following engine operating limits must be observed:

    ITT/TGT _____.

    N_1 rpm _____ (min).

    Oil pressure ______ (min).

    Oil temperature ______ (min).

26. Normal oil pressure limit for flight above 21,000 feet is _______ psi.

    a. 85 to 135.

    b. 60 to 135.

    c. 60 to 105.

    d. None of the above.

27. At maximum allowable power, the following engine operating limits must be observed:

    ITT/TGT __________.

    Torque _________.

    Propeller rpm __________.

    N_1 rpm __________.

    Oil pressure _________ above 21,000 feet.

    Oil temperature __________.

28. Maximum ITT/TGT during high-altitude performance cruise is:

    a. 700/790 °C.

    b. 725/770 °C.

    c. 750/800 °C.

    d. No limit; usually the engine is torque unlimited above 18,000 feet.

29. During normal cruise climb, the following limits on engine operation are imposed:

    ITT/TGT _________.

    Oil temperature _________.

30. The following engine operating limits must be observed in maximum reverse:

    ITT/TGT _________.

    Propeller rpm _________.

    N_1 rpm __________.

    All of these limits are time-limited to________.

31. The following transient limits on engine operation must be observed:

    ITT/TGT ____ for ______ seconds.

    Torque ____ for ____ seconds.

    Propeller rpm for____ seconds.

    N_1 rpm ______ percent for ___ seconds.

    Oil temperature___ for ______.

32. True or False: During ground operation (low idle), you notice that ITT/TGT on the left engine is 660 °C and that the left generator load is 60 percent. You should immediately increase N_1 rpm or reduce the electrical load.

33. During ground operation at high idle, maximum generator load should not exceed:

    a. 70 percent.

    b. 80 percent.

    c. 85 percent.

    d. 100 percent.

34. You plan to take off from Podunk Airport (sea level field elevation) and the only jet fuel available contains no anti-icing additive. The OAT is –10 °F. At oil temperatures below ____ , icing at the fuel control may occur.

    a. –14 °F.

    b. –14 °C.

    c. –27 °C.

    d. None of the above.

35. The maximum zero fuel weight of the UC-12 is:

    a. 12,500 pounds.

    b. 10,400 pounds.

    c. 11,000 pounds.

    d. Approximately 8,000 pounds (each aircraft is different depending on equipment installed).

    e. 3,699 pounds (using JP-5).

36. Maximum gross weight for takeoff is:

    a. 13,590 pounds.

    b. 12,590 pounds.

    c. 13,500 pounds.

    d. 12,500 pounds.

37. Maximum landing weight for the UC-12B is:

    a. 13,590 pounds.

    b. 12,590 pounds.

    c. 12,500 pounds.

    d. 10,400 pounds.

38. True or False: The V_{MO} is 245/259 KIAS for all Navy UC-12.

39. In the UC-12, the maximum speeds for landing gear retraction and extension are:

   a. 155 KIAS; 200 KIAS.

   b. 164 KIAS; 182 KIAS.

   c. 182 KIAS for both.

   d. 163 KIAS; 181 KIAS.

40. For the UC-12, V_{SSE} is:

   a. 86 KIAS.

   b. 91 KIAS.

   c. 104 KIAS.

   d. 121 KIAS.

41. The yaw damper is required:

   a. For flight.

   b. Above 140 KIAS.

   c. Above 17,000 feet.

   d. B and C.

42. The minimum crew required for flight is:

   a. Two: a designated T2P and a designated trainee (PUI).

   b. Three: a designated TPC, a designated trainee (PUI), and a designated aircrewman.

   c. Two: two designated T2Ps.

   d. Two: a designated T2P and a designated Transport Third Pilot (T3P).

43. If a cold oil check indicates more than 3 quarts low, you should:

   a. Start the engine and run it until oil temperature is a minimum of 30 °C, then shut down and recheck the oil level.

   b. Motor the engine for 15 to 20 seconds, then recheck the oil level.

   c. Add enough oil to bring the level back to between zero and 1 quart low.

   d. Call maintenance.

44. Before fuel is introduced during a ground start, N_1 must rise at or above:

   a. 16 percent.

   b. 12 percent.

   c. 10 percent.

   d. None of the above.

45. True or False: When using a GPU for start, it is recommended to start the left engine first.

46. If no ITT/TGT rise is observed within _______ seconds after moving the condition lever to LOW IDLE, you should _______.

   a. 10; discontinue the start by moving the condition lever to FUEL CUTOFF and turning starter OFF.

   b. 10; discontinue the start by moving the condition lever to FUEL CUTOFF, moving the starter switch to STARTER ONLY for 15 to 40 seconds, then to OFF.

   c. 20; discontinue the start by moving the condition lever to FUEL CUTOFF and turning starter OFF.

   d. 20; discontinue the start by moving the condition lever to FUEL CUTOFF, moving the start switch to STARTER ONLY for 15 to 40 seconds, then to OFF.

47. Engine clearing procedures call for the starter (only) to be selected for:

   a. 15 to 20 seconds.

   b. 15 to 40 seconds.

   c. 20 seconds.

   d. 40 seconds.

48. When conducting the autoignition/autofeather check on the left engine in the Engine Runup Checklist, normal indications are:

   a. The right autofeather annunciator extinguishes and the left ignition annunciator comes on below 410 (±50) foot-pounds/18 ±2 percent torque on the left engine.

   b. The left autofeather annunciator extinguishes and the left ignition annunciator comes on below 410 (±50) foot-pounds/18 ±2 percent torque on the left engine.

   c. The left autofeather light flashes below 260 (±50) foot-pounds/11 ±2 percent torque on the left engine.

   d. A and C only.

   e. B and C only.

49. Under normal conditions, it is recommended that taxi speed be controlled with the use of:

   a. Brakes.

   b. Beta range.

   c. Aerodynamic braking.

   d. All of the above.

50. During the overspeed governor check in the Engine Runup Checklist, the propeller rpm should stabilize at:

   a. 2,080 (±40 rpm).

   b. l,600 to l,640 rpm.

   c. l,830 to 1,9l0 rpm.

   d. None of the above.

51. During the primary governor check, propeller rpm should stabilize at ________ when the propeller levers are pulled to the aft detent.

    a. 0 to 300 (feather).

    b. l,600 to l,640.

    c. 2,000.

    d. None of the above.

52. Autoignition should be armed _______ and dearmed _______.

    a. During icing flights and at night above 14,000 feet; at all other times.

    b. Before takeoff; after landing.

    c. After engine start; before engine shutdown.

    d. A and B above.

53. Normal climb schedule airspeeds are:
______________KIAS up to ___________ feet ____________KIAS from _________ feet to _________ feet ____________KIAS from _________ feet to _________ feet ____________KIAS from _________ feet to _________ feet.

54. In order to maintain the proper pressurization schedule during a descent, _______N_1 rpm is required for two-engine operation and _______ N_1 rpm for single-engine operation.

    a. 52 to 55 percent, 61 percent.

    b. 75 percent, 85 percent.

    c. 85 percent, 75 percent.

    d. None of the above.

55. During an ILS approach, propeller settings between ______ rpm and ______ rpm should be avoided.

56. The propeller controls should be set to high rpm during a reverse thrust landing in order to:

    a. Ensure constant reversing characteristics.

    b. Prevent the primary governor from influencing propeller reversal.

    c. Shorten the landing distance.

    d. A and C.

    e. All of the above.

57. During a reverse thrust landing, the propellers should be moved out of the reverse range above ______ knots, if possible, to minimize propeller blade erosion.

    a. 40.

    b. 50.

    c. 60.

    d. Prior to coming to a complete stop.

58. True or False: Approach flaps are normally selected during a waveoff.

59. The procedures for a two-engine waveoff (in order) are:

    a. ______________________________.

    b. ______________________________.

    c. ______________________________.

    d. ______________________________.

60. What is the stall speed at 40 percent flaps, gear down, 30° angle of bank, and 12,500 pounds gross weight?

61. To simulate zero thrust:

    a. Set power lever to IDLE, propeller lever to FEATHER.

    b. Zero thrust should not be set below 4,000 feet AGL.

    c. Set 120 foot-pounds of thrust, 1,100 rpm.

    d. Set 120 foot-pounds of torque, 1,600 rpm at lower altitudes at airspeeds between 105 and 120 knots.

62. List in order the procedures for engine fire on the deck:

    a. ______________________________.

    b. ______________________________.

    c. ______________________________.

    d. ______________________________.

    e. ______________________________.

63. At 65 KIAS during takeoff roll, you experience a left engine chip light. With 6,000 feet of runway remaining, what steps should you take (in order)?

    a. ______________________________.

    b. ______________________________.

    c. ______________________________.

    d. ______________________________.

    e. ______________________________.

64. Immediately after liftoff at 105 KIAS, you experience a complete failure of the left engine; only 500 feet of runway remain. List, in order, the steps to be taken immediately.

    a. ______________________________.

    b. ______________________________.

    c. ______________________________.

    d. ______________________________.

    e. ______________________________.

    f. ______________________________.

    g. ______________________________.

65. When flying in cruise flight, the left chip light illuminates. What should you do?

   a. Check for secondary indications; if normal, continue operation at a reduced power setting (1,100 foot-pounds or less of torque).

   b. Check for secondary indications. If abnormal or fluctuation indications are found, secure the engine using the Emergency Shutdown Checklist.

   c. Secure the engine using Emergency Shutdown Checklist.

   d. A and B only.

66. List the steps in the Emergency Shutdown Checklist in order:

   a. ______________________________.

   b. ______________________________.

   c. ______________________________.

   d. ______________________________.

67. List the steps, in order, for an engine failure of the second engine:

   a. ______________________________.

   b. ______________________________.

68. A cross-generator airstart generally increases ITT/TGT on the operative engine:

   a. Very little. It is necessary to consider it as a factor prior to conducting the airstart.

   b. 20 °C.

   c. 50 °C.

   d. 30 °C.

69. When conducting a starter-assisted airstart, N_1 rpm should be above _____ prior to selecting LOW IDLE with the condition lever.

   a. 16 percent.

   b. l2 percent.

   c. 10 percent.

   d. None of the above.

70. True or False: The propeller on the dead engine should not be feathered prior to conducting a windmilling airstart.

71. What are the limits on windmilling airstarts?

   a. Airspeed above 140 KIAS, altitude below 20,000 feet.

   b. Airspeed above 140 KIAS, altitude below 21,000 feet.

   c. Airspeed above 130 KIAS, altitude below 20,000 feet.

   d. None of the above.

72. True or False: Before the cabin fire extinguisher is operated, the cabin should be depressurized and the pilot and copilot storm windows opened.

73. True or False: Failure of the primary (engine-driven) fuel pump will result in engine flameout.

74. Engine operation with the FUEL PRESS light illuminated is limited to:

    a. 150 hours between the engine overhaul and replacement.

    b. 10 hours between engine-driven fuel pump overhaul or replacement.

    c. Replacement of the engine-driven fuel pump upon next landing.

    d. No specific limits. The engine will flame out. Refer to single-engine operation.

75. Illumination of the BATTERY CHG annunciator indicates:

    a. The battery is charging at an excessive rate.

    b. A normal condition after a battery start.

    c. That you should execute the Battery Charge Light Illuminated procedure if it illuminates in flight.

    d. All of the above.

    e. A and C only.

76. True or False: Crossfeed may be used in normal operation to correct fuel imbalances of greater than 500 pounds.

77. What are the procedures and requirements for crossfeed (L to R) operation?

    a. Used only for single-engine operation.

    b. Recommended for two-engine operation only when a fuel imbalance of 500 pounds or greater exists.

    c. AUX TRANSFER switches — both AUTO, STANDBY PUMP switches — both OFF.

    d. AUX TRANSFER switches: left — OVERRIDE, right — AUTO (if fuel in left auxiliary tanks).

    e. CROSSFEED switch to right, FUEL CROSSFEED annunciator extinguishes.

    f. CROSSFEED switch to right, FUEL CROSSFEED annunciator on.

       (1) A, C, F.

       (2) A, B, C, F.

       (3) A, C, E.

       (4) A, B, D, F.

78. True or False: A tripped subpanel feeder circuit breaker should not be reset in flight.

79. When should the propeller failure or overspeed procedures be performed?

    a. After a propeller autofeather.

    b. Any time the propeller rpm exceeds 2,000 rpm for more than 5 seconds.

    c. If the propeller feathers (engine running normally).

    d. If an overspeed condition occurs not controlled by the governors, power lever, or propeller lever.

    e. B and C only.

80. List the steps in order for an emergency descent:

a. ________________________________.

b. ________________________________.

c. ________________________________.

d. ________________________________.

e. ________________________________.

81. Mark the true answers regarding the engine anti-ice protection (inertial separators):

a. Airspeed must be below 160 KIAS for manual extension.

b. Airspeed must be below 200 KIAS for electrical extension.

c. They can be electrically retracted after manual extension.

d. They should be extended when in visible moisture when OAT is +5 °C.

e. They should be extended when in visible moisture when OAT is +15 °C.

f. They should be retracted above +15 °C.

(1) A, B, D, F.

(2) A, B, C, D.

(3) A, D, F.

(4) A, B, E, F.

82. List six ways the autopilot may be intentionally disengaged:

a. ________________________________.

b. ________________________________.

c. ________________________________.

d. ________________________________.

e. ________________________________.

f. ________________________________.

83. True or False: With the CABIN DOOR annunciator illuminated, the cabin door should be visually checked for security prior to landing.

84. With cracked outer windshield panel, what action should be taken?

a. No immediate action required.

b. Depressurized to a maximum of 4.0 psig within 10 minutes.

c. Descent below 25,000 feet and depressurized to 4.6 psig or less.

d. Dump pressurization, land as soon as possible.

85. List the procedures to follow prior to manually extending the gear if one or more of the landing gear fails to extend or to indicate safe:

a. ______________________.

b. ______________________.

c. ______________________.

d. ______________________.

e. ______________________.

86. True or False: Before executing an intentional wheels-up landing, all field arresting cables should be removed.

87. During sustained icing conditions, a minimum of_______ should be maintained to prevent ice accumulation on unprotected surfaces of the wing.

a. 170 KIAS.

b. 140 KIAS.

c. 170 KIAS.

d. 155 KIAS.

88. Surface deicers should be actuated only after _____of ice have accumulated on wing surfaces.

a. l/2 to l inch.

b. l to 2 inches.

c. 1 to 1 1/2 inches.

d. Over 2 inches.

89. The UC-12 is approved for flight into known icing conditions provided the following equipment is operable:

a. ______________________.

b. ______________________.

c. ______________________.

d. ______________________.

e. ______________________.

f. ______________________.

g. ______________________.

h. ______________________.

i. ______________________.

j. ______________________.

90. Turbulent air penetration speed for the UC-12 is:

  a. 115 KIAS.

  b. 12l KIAS.

  c. 170 KIAS.

  d. 245 KIAS.

  e. LUDICROUS.

91. Regarding loading of the aircraft, mark all true answers:

  a. The baggage compartment is limited to (**B**) 410 pounds (**F/M**) 550 pounds (not counting the liferaft and other survival equipment) and floor loading throughout the cabin is limited to 100 pounds per square foot for cargo supported by seat tracks and 200 pounds per square foot for unsupported areas including the baggage compartment.

  b. The baggage compartment is limited to (**B**) 410 pounds (**F/M**) 550 pounds and floor loading throughout the cabin is limited to 200 pounds per square foot for cargo supported by seat tracks and 100 pounds per square foot for unsupported areas including the baggage compartment.

  c. No passengers are permitted to be seated forward of any cargo.

  d. The UC-12 can be loaded without regard to the emergency exit if no passengers are embarked and free access is provided for the pilots to the main cabin door.

92. The maximum aft cg at all gross weights is:

  a. 196.4 inches.

  b. 35.7 percent MAC.

  c. Moved aft as gross weight is increased (**B**) 410 pounds and (**F/M**) 550 pounds.

  d. A and B are correct.

93. At 1,000 foot pressure altitude and 120 KIAS, selection of alternate static will:

  a. Raise indications on both the pilot and copilot altimeters 50 feet and airspeed indicators 4 KIAS (fly high and fast).

  b. Lower indications on both the pilot and copilot altimeters 50 feet and airspeed indicators 4 KIAS (fly low and slow).

  c. Raise indications only on pilot altimeter 50 feet and airspeed indicators 4 KIAS (fly high and fast).

  d. Lower indications only on pilot altimeter 50 feet and airspeed indicators 4 KIAS (fly low and slow).

94. What is the minimum acceptable takeoff power under the following conditions?

    6,000 feet pressure altitude _________.

    +30 °C OAT _________.

    65 KIAS _________.

    Ice vanes retracted _________.

95. What is the accelerate-go distance and accelerate-stop distance for flaps 0 percent and 40 percent under the following conditions?

    12,000-pound gross weight _________.

    10-knot headwind component _________.

    2,000-foot pressure altitude _________.

    +30 °C OAT _________.

96. What is the V_r, V_x, takeoff ground roll distance, and distance to clear a 50-foot obstacle under the following conditions?

    +30 °C OAT _________.

    Flaps 0 percent _________.

    2,000-foot pressure altitude _________.

    13,400-pound gross weight _________.

    5-knot headwind component _________.

97. What is the two-engine rate of climb and target speed with flaps at 0 percent and at 40 percent under the following conditions?

    2,000-foot pressure altitude _________.

    +30 °C OAT _________.

    12,000-pound gross weight _________.

98. What is the single-engine rate of climb and target speed under the following conditions?

    Flaps 0 percent _________.

    2,000-foot pressure altitude _________.

    0 °C OAT, ice vanes extended _________.

    12,000-pound gross weight _________.

99. What is the performance cruise power torque, total fuel flow, and TAS under the following conditions?

    26,000-foot pressure altitude _________.

    –24 °C OAT _________.

    12,000-pound gross weight _________.

100. What is the approach speed, landing ground roll, and distance to clear a 50-foot obstacle under the following conditions?

    Flaps 0 percent _________.

    Propeller reversing used _________.

    Wet runway _________.

    2,000-foot pressure altitude _________.

    10 °C OAT, 10-knot headwind component _________.

    11,500-pound gross weight _________.

PART XI

NATOPS Performance Charts

Refer to A1-C12BM-NFM-200 NATOPS Flight Manual Performance Charts for Navy Series UC-12 Aircraft.

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