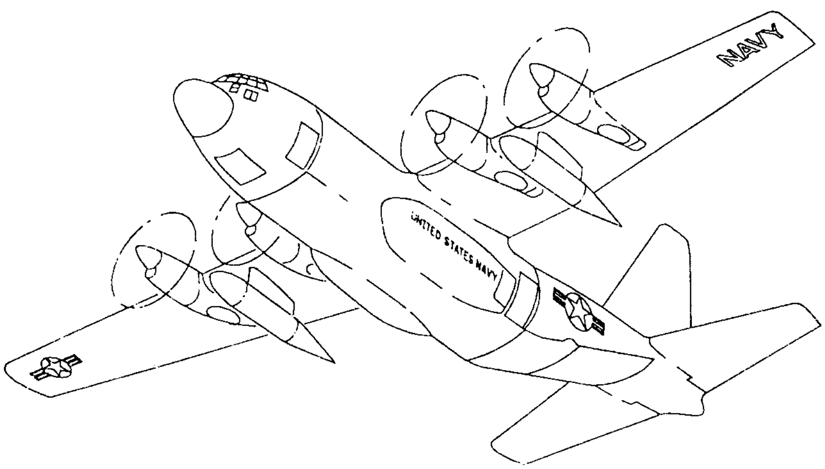
NATOPS FLIGHT MANUAL NAVY MODEL C-130T AIRCRAFT

THIS PUBLICATION IS INCOMPLETE WITHOUT NAVAIR 01-75GAI-1.1



C130-F01

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

1 OCTOBER 2001

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

1 October 2001

LETTER OF PROMULGATION

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

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

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

M.J. McCABE
Rear Admiral, U.S. Navy
Director, Air Warfare

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1	Overheat Detection System
2	Minimum Currency Requirements

Interim Changes Outstanding — To be maintained by the custodian of this manual.

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

Summary of Applicable Technical Directives

Information relating to the following recent technical directives has been incorporated into 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

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

NATOPS Flight Manual Navy Model C-130T Aircraft

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FOLDOUTS

LIST OF ABBREVIATIONS/ACRONYMS

A

AAPS. Altitude alerter/preselect system.

ac. Alternating current.

ACN. Aircraft classification number.

ACU. Antenna coupler unit.

ADF. Automatic direction finder.

ADI. Attitude director indicator.

ADIZ. Air defense identification zone.

ADS. Air delivery system.

AGL. Above ground level.

AIMS. Airborne identification mobile system.

AME. Amplitude modulation equivalent.

AP. Autopilot.

APU. Auxiliary power unit.

ATCRBS. Air traffic control beacon system.

ATO. Assisted takeoff.

B

BAROSET. Barometric pressure setting.

BDHI. Bearing distance heading indicator.

BFO. Beat frequency oscillator.

BIT. Built-in-test.

BITE. Built-in-test equipment.

BSU. Bus switching unit.

BT. Bromotrifluoromethane.

BTU. British thermal unit.

C

°C. Temperature in degrees Centrigrade.

CARA. Combined altitude radar altimeter.

CAS. Calibrated airspeed.

CBR. California bearing ratio.

CDU. Control display unit.

CG. Center of gravity.

CI. Control indicator.

CP. Copilot.

CPS. Control power supply.

CU. Control unit.

CW. Continuous wave.

D

dc. Direct current.

DF. Direction finder.

DG. Directional gyro.

DH. Decision height.

DME. Distance measuring equipment.

DR. Dead reckoning.

E

EGT. Exhaust gas temperature.

EID. Emitter identification data.

ESWL. Equivalent single-wheel load.

ETA. Estimated time of arrival.

ETD. Estimated time of departure.

ETP. Equivalent time point.

F

°F. Temperature in degrees Fahrenheit.

FAA. Federal Aviation Administration.

Fc. Climb factor.

FE. Flight engineer.

FLLP. Flight information publication.

FOD. Foreign object damage.

fpm. Feet per minute.

FS. Fuselage station.

$f_{t.}$o. Takeoff factor.

G

G/A. Go-around.

GCA. Ground controlled approach.

GI. Ground idle.

GMT. Greenwich mean time.

gpm. Gallons per minute.

GPS. Global positioning system.

GPWS. Ground proximity warning system.

GS. Groundspeed.

GSI. Glideslope indicator.

GTP. Grid transport procession.

GW. Gross weight.

H

Hd. Density altitude.

Hp. Pressure altitude.

hp. Horsepower.

HF. High frequency.

HSI. Horizontal situation indicator.

Hz. Hertz.

I

IAS. Indicated airspeed.

ICAO. International Civil Aviation Organization.

ICS. Intercommunications system.

IFF. Identification friend or foe.

ILS. Instrument landing system.

INS. Inertial navigation system.

INU. Inertial navigation unit.

IOAT. Indicated outside air temperature.

K

KHz. Kilohertz.

KIAS. Knots indicated airspeed.

kVA. kilovolt-ampere.

L

LCN. Load classification number.

LED. Light emitting diode.

LM. Loadmaster.

LOC. Line of communication.

LOP. Line of position.

LSB. Lower sideband.

M

MAC. Mean aerodynamic chord.

MAF. Maintenance action form.

MDA. Minimum descent altitude.

MHz. Megahertz.

MLG. Main landing gear.

MLS. Microwave landing system.

MRC. Maintenance requirement card.

MSU. Mode selector unit.

N

NLG. Nose landing gear.

nm. Nautical miles.

NOTAM. Notice to airmen.

NTS. Negative torque signal.

O

OALS. Optimum approach line space.

OAT. Outside air temperature.

ODS. Overheat detection system.

OFP. Operational flight program.

ONS. Omega navigation system.

P

PA. Public address system.

PAR. Precision approach radar.

PCN. Pavement classification number.

PIC. Pilot in command.

pph. Pounds per hour.

PPI. Planned position indicator.

ppm. Pounds per minute.

psi. Pressure in pounds per square inch.

psig. Gauge pressure, pounds per square inch.

PSR. Point of safe return.

Q

QNH. Station pressure.

R

R/C. Rate of climb.

RCR. Runway condition reading.

R/D. Rate of descent.

RMI. Radio magnetic indicator.

RON. Remain overnight.

rpm. Revolutions per minute.

RPU. Receiver-processor unit.

RSC. Runway surface condition.

RT. Receiver transmitter.

S

STC. Sensitivity time control.

T

TAS True airspeed.

TCAS. Traffic alert and collision avoidance system.

TD. Temperature datum.

TIT. Turbine inlet temperature.

U

UCI. Unit construction index.

UDM. User data module.

USB. Upper sideband.

V

V_{CEF}. Critical engine failure speed.

V_D. Maximum permissible speed.

V_{MCA}. Air minimum control speed.

V_{MCG}. Minimum control speed on ground.

V_R. Refusal speed.

V_S. Power-off stall speed.

V_T/W_F. Nautical miles per pound of fuel.

VALI. Variable altitude limit index.

VFR. Visual flight rules.

VLF. Very low frequency.

VOR. VHF omnidirectional range.

Vs. Stall speed.

VSI/TRA. Vertical speed indicator/traffic and resolution advisory.

Y

YD. Yaw damper.

PREFACE

SCOPE

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

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-75GAL-1C (Normal/Emergency Card Checklist)

NAVAIR 01-75GAL-1F (Functional Checkflight Checklist)

NAVAIR 01-75GAA-9 (Cargo Loading)

NAVAIR 00-80T-112 (Instrument Flight Manual)

NAVAIR 00-80V-49 (Air Navigation Manual)

NAVAIR 01-75GAI-1.1 (Combined Performance Data Manual)

HOW TO GET COPIES

Note

Distribution of this manual is controlled by Commander Fleet Logistics Support Wing. All distribution requests will be reviewed by him.

One-Time Orders

If this publication is needed on a one-time basis (without future updates), order it from stock by sending an electronic DD 1348 requisition in accordance with NPFC Publication 2002 found on NAVSUP Publication 600 (Naval Logistics Library) CD-ROM disc.

Automatic Distribution (with Updates)

This publication and changes to it are automatically sent to activities that are established on the Automatic Distribution Requirements List (ADRL) maintained by Naval Air Technical Data and Engineering Service Command, in San Diego, CA. If there is a continuing need for this publication, each activity's Central Technical Publication Librarian must send a revised ADRL report on floppy disk to Naval Air Technical Data and Engineering Service Command. If an activity does not have a library, then send a letter to the Commanding Officer, Naval Air Technical Data and Engineering Service Command, Naval Aviation Depot North Island, Bldg 90, Code 3.3A, P.O. Box 357031, San Diego, CA 92135-7031, requesting assignment of a distribution account number (if necessary) and automatic mailing of future issues of the publications needed.

Note

The ADRL floppy disk can be used only to place an activity on the mailing list for automatic distribution of *future* issues of the publication. *It cannot be used to make one-time orders of publications from current stock.* To get publications from current stock, see One-Time Orders above.

Once established on automatic distribution for this or any other NAVAIR technical publication, an activity must submit an ADRL report on floppy disk at least once every 12 months to update or confirm their automatic distribution requirements.

Note

Activities not submitting an ADRL report on floppy disk for more than 12 months may be dropped from distribution of all NAVAIR technical publications.

UPDATING THE MANUAL

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

CHANGE RECOMMENDATIONS

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

Routine change recommendations are submitted directly to the model manager on OPNAV 3710/6 shown on the next page. The address of the model manager of this aircraft is:

Commander
Fleet Logistics Support Wing
1049 Boyington Drive
Naval Air Station Joint Reserve Base
Fort Worth, Texas 76127-1049

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

YOUR RESPONSIBILITY

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

NATOPS FLIGHT MANUAL INTERIM CHANGES

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

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, adjacent to the affected text, like the one printed next to this paragraph. The change identifies the addition of either new information, a changed procedure, the correction of an error, or a rephrasing of the previous material.

WARNINGS, CAUTIONS, AND NOTES

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

WARNING

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

CAUTION

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

Note

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

WORDING

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

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

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

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

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

Use of commas (,) and virgules (/) in crew responses and positions in checklist: A comma between crew positions or responses indicates that both will be applicable. A virgule (/) between positions or responses indicates either one or the other will apply.

EFFECTIVITY

This manual is applicable to the C-130T aircraft. Where appropriate, effectivity is provided by bureau numbers/system. When information applies to a specific model or models, model numbers are used to indicate effectivity.

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

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

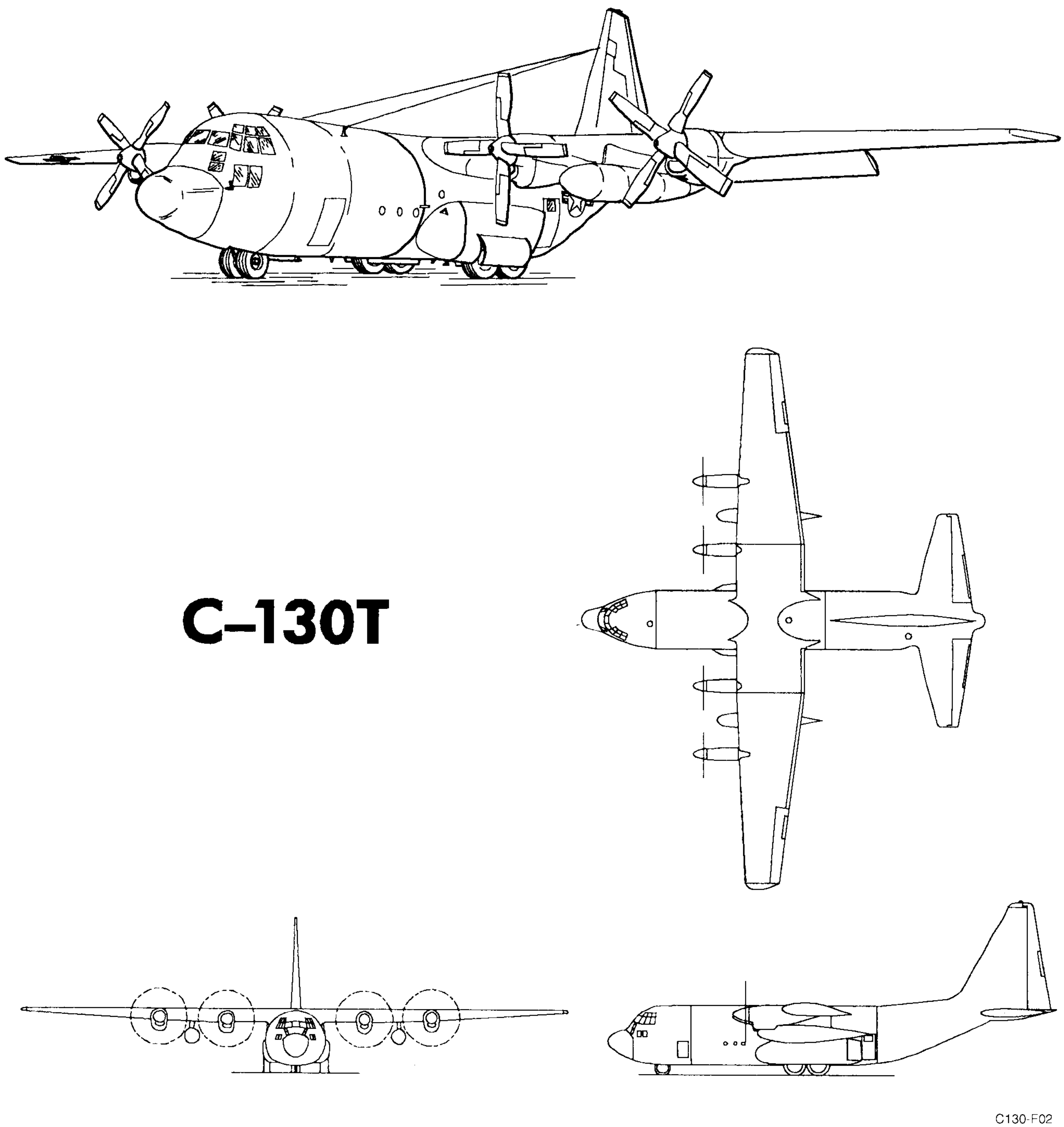
FROM	DATE
TO	

REFERENCE
(a) Your Change Recommendation Dated ____________________

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

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

/S/ ____________________ MODEL MANAGER | ____________________ AIRCRAFT


C–130T
C130-F02

PART I

The Aircraft

CHAPTER 1

General Description

1.1 THE AIRCRAFT

The Lockheed C-130T is a high-wing, all-metal, long-range, land-based monoplane. The mission of this aircraft is to provide rapid transportation of personnel or cargo for delivery by parachute or landing. The aircraft can be used as tactical transports and can be converted readily for ambulance or aerial delivery missions. The aircraft can land and take off on short runways and can be used on landing strips such as those found in advance base operation.

1.1.1 Accommodations

1. Ground troops — 78.
2. Ground troops (including wheelwell seats) — 92.
3. Paratroops — 64.
4. Litters/attendants — 70/6.
5. Litters/attendants — 74/2.

1.1.2 Propulsion. Power is supplied by four Allison T56-A-16, turboprop, constant-speed engines. There are provisions for externally mounted ATO units to provide additional thrust for takeoff. Each engine drives a four-blade Hamilton Standard Hydromatic, constant-speed propeller with full feathering and reversible pitch.

1.1.3 Aircraft Dimensions. The principal dimensions of the C-130T aircraft are:

1. Wing span — 132 feet 7 inches.
2. Length — 99 feet 5 inches.
3. Height — 38 feet 4 inches.
4. Stabilizer span — 52 feet 8 inches.
5. Cargo compartment:
   a. Length — 40 feet.
   b. Width (minimum) — 10 feet 3 inches.
   c. Height (minimum) — 9 feet.

1.1.4 Crew Stations. Crew stations are provided for a pilot, copilot, flight engineer, two loadmasters, or one loadmaster and one second loadmaster. The pilot and copilot are seated on the left and right sides, respectively, of the control pedestal in the forward section of the flight station. The flight engineer is seated in the center of the flight station, behind the pilot and copilot.

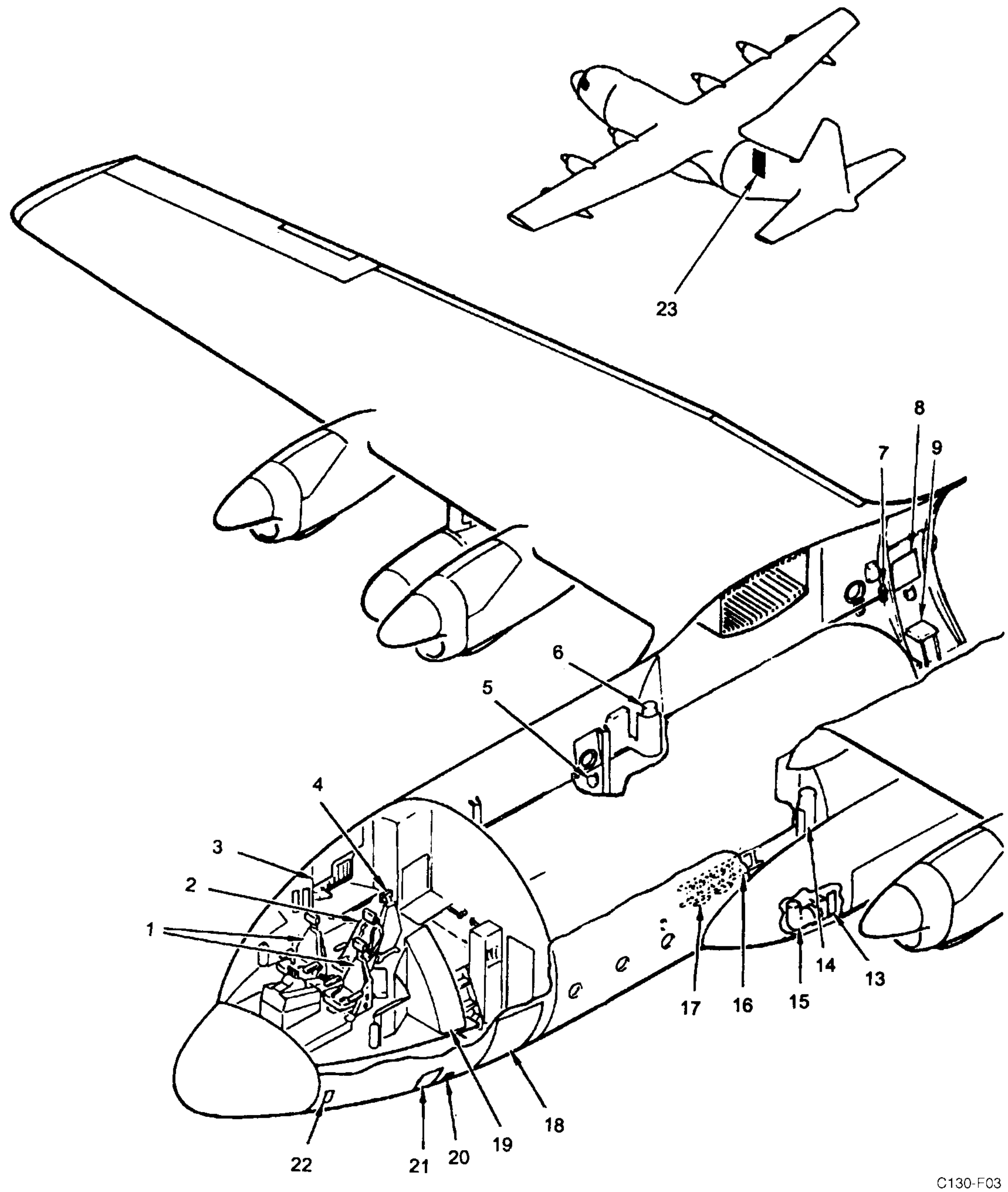


Figure 1-1. General Arrangement (Sheet 1 of 2)

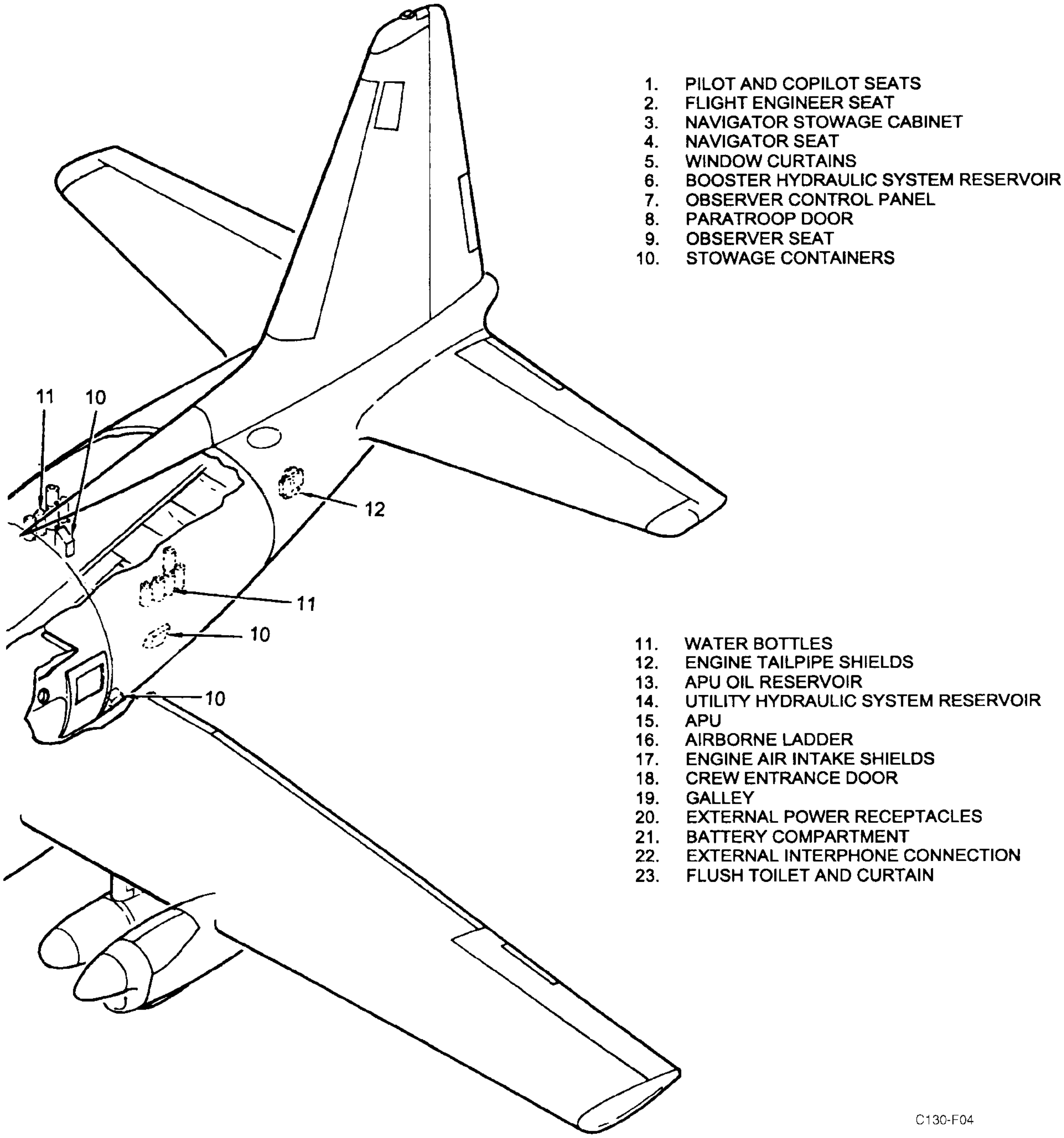


Figure 1-1. General Arrangement (Sheet 2)

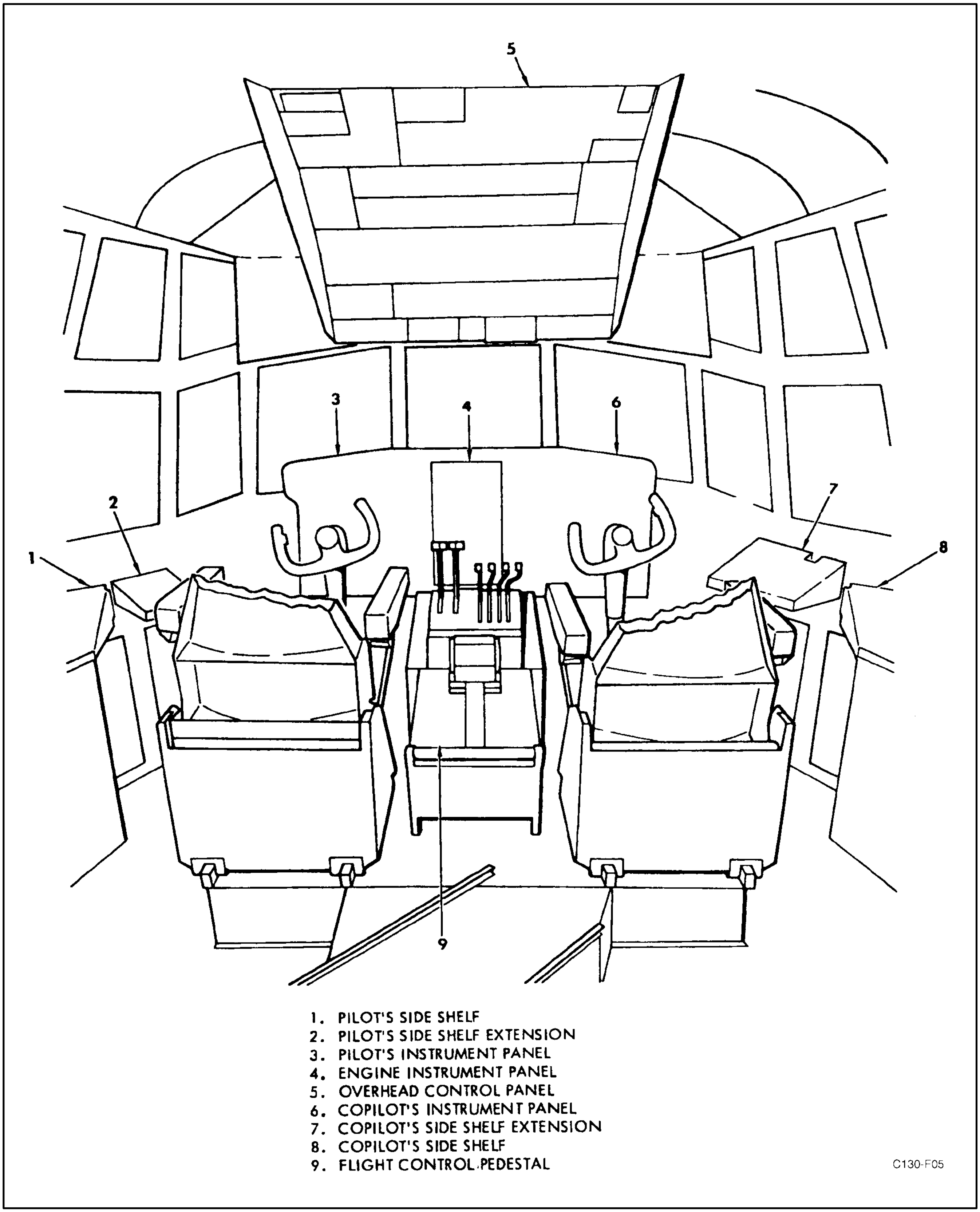
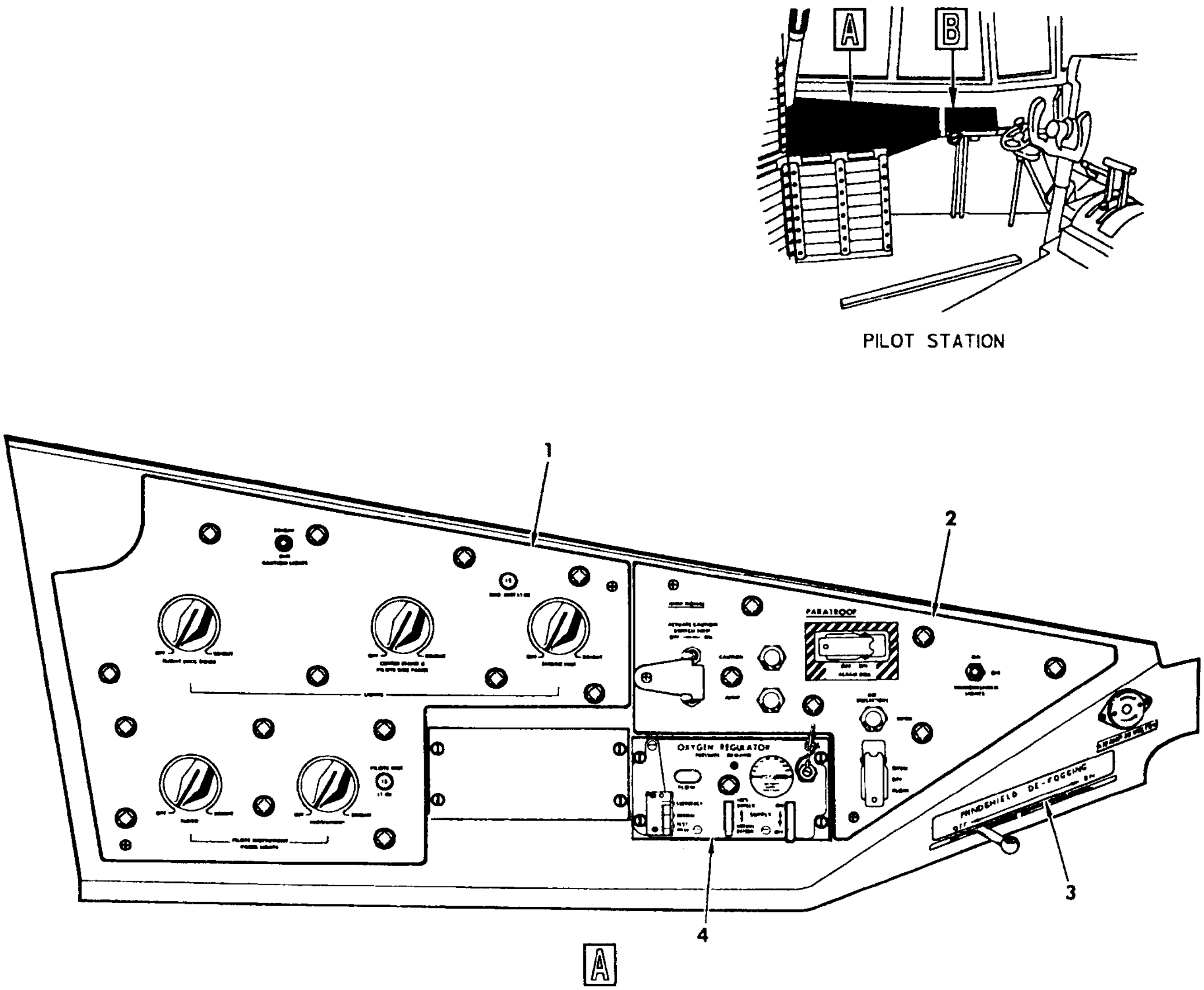


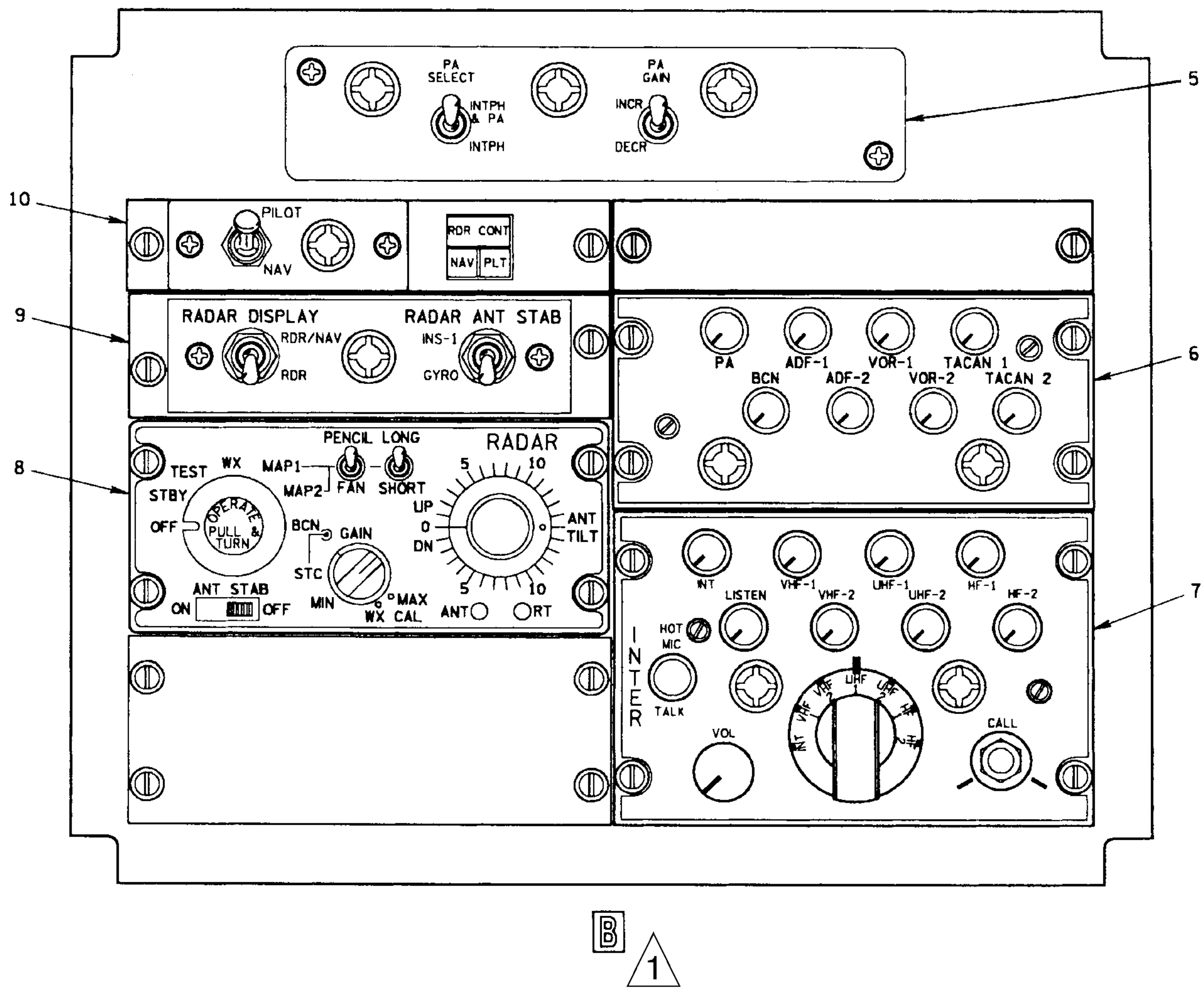
Figure 1-2. Flight Station Forward



1. INTERIOR LIGHTING CONTROLS
2. PARATROOP PANEL
3. WINDSHIELD DE-FOGGING CONTROL
4. PILOT'S OXYGEN REGULATOR

C130-F06

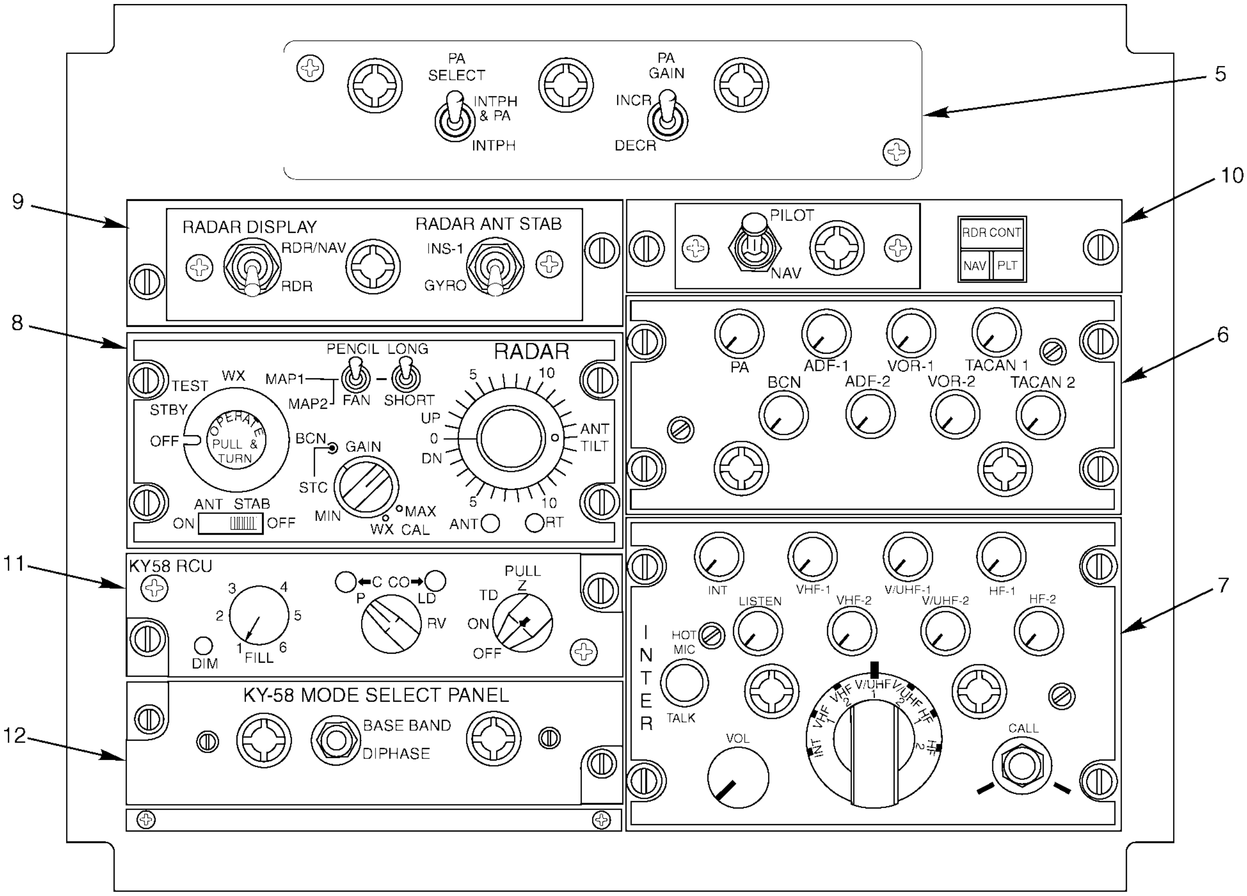
Figure 1-3. Pilot Side Shelf and Extension (Sheet 1 of 3)



5. PA/RADOME ANTI-ICING CONTROL PANEL
6. PILOT'S INTERCOMMUNICATION MONITOR PANEL
7. PILOT'S INTERCOMMUNICATION CONTROL PANEL
8. RADAR CONTROL PANEL (MULTI-MODE)
9. RADAR SELECT SWITCH PANEL
10. RADAR CONTROL SELECTOR ANNUNCIATOR PANEL

C130-F07

Figure 1-3. Pilot Side Shelf and Extension (Sheet 2)



2 B

5. PA/RADOME ANTI-ICING CONTROL PANEL
6. PILOT'S INTERCOMMUNICATION MONITOR PANEL
7. PILOT'S INTERCOMMUNICATION CONTROL PANEL
8. RADAR CONTROL PANEL (MULTI-MODE)
9. RADAR SELECT SWITCH PANEL
10. RADAR CONTROL SELECTOR ANNUNCIATOR PANEL
11. NO. 1 V/UHF KY-58 CONTROL UNIT
12. NO. 1 V/UHF KY-58 MODE SELECT PANEL

1 AIRCRAFT NOT MODIFIED BY AFC-338

2 AIRCRAFT MODIFIED BY AFC-338

C130-F0277

Figure 1-3. Pilot Side Shelf and Extension (Sheet 3)

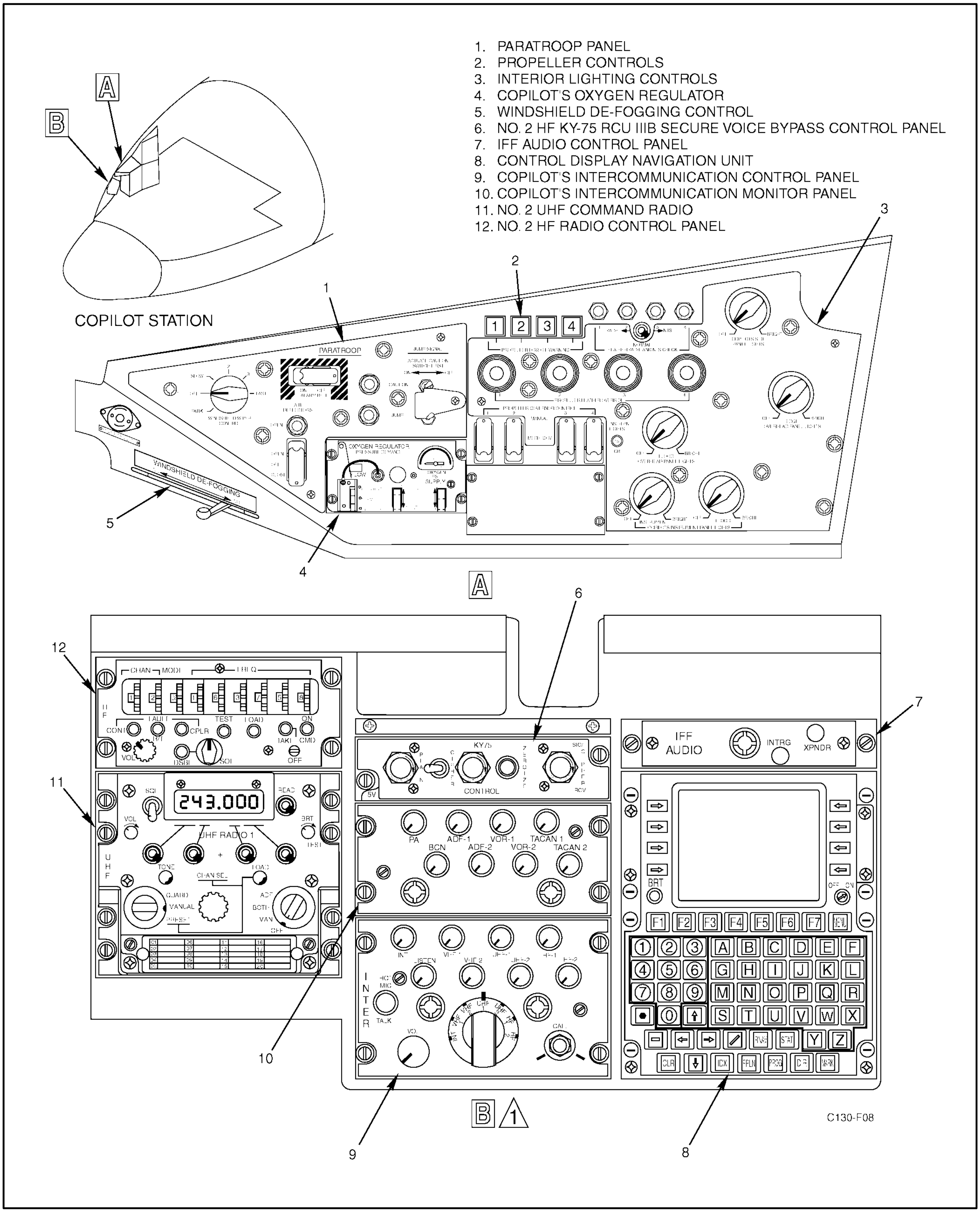


Figure 1-4. Copilot Side Shelf and Extension (Sheet 1 of 2)

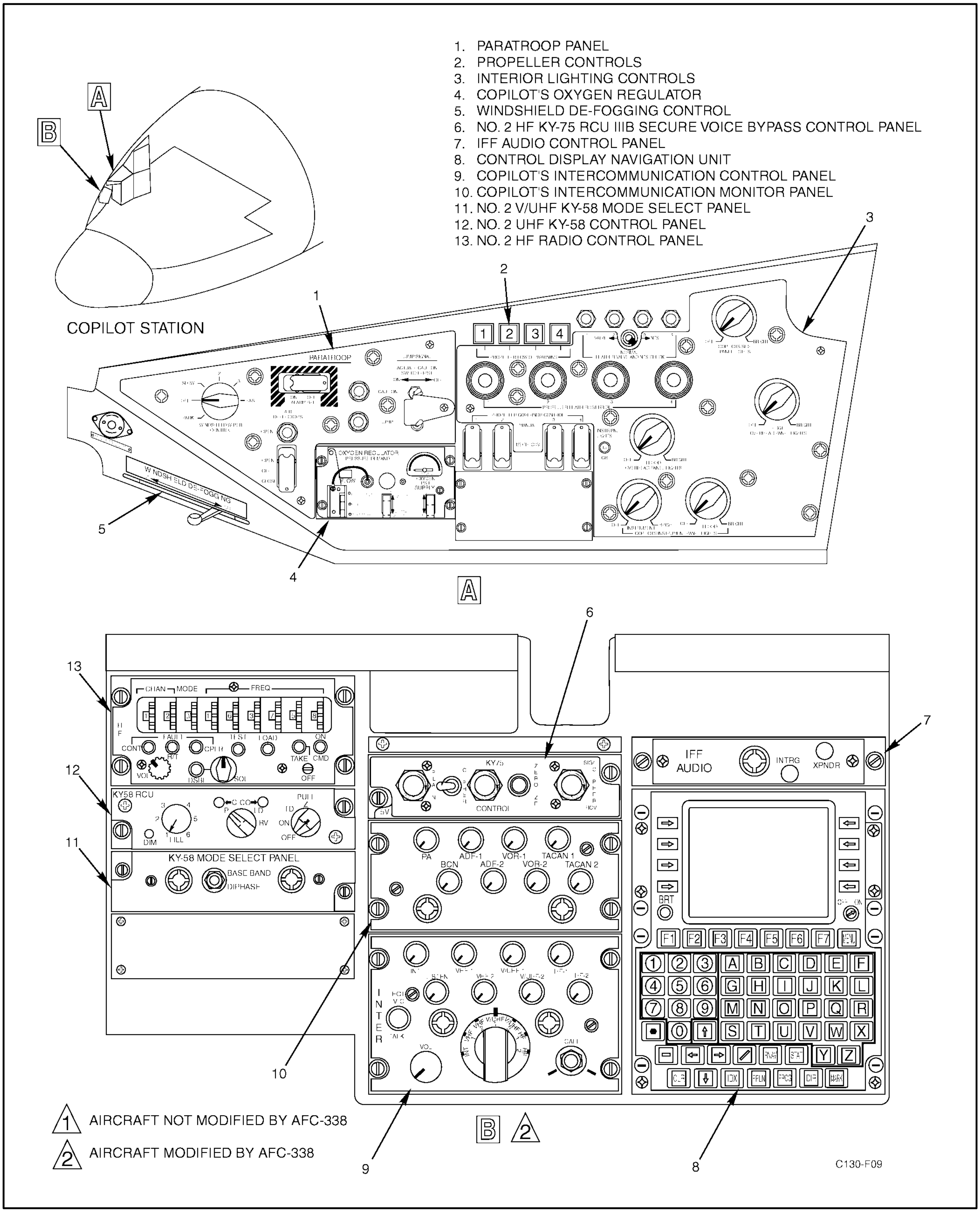
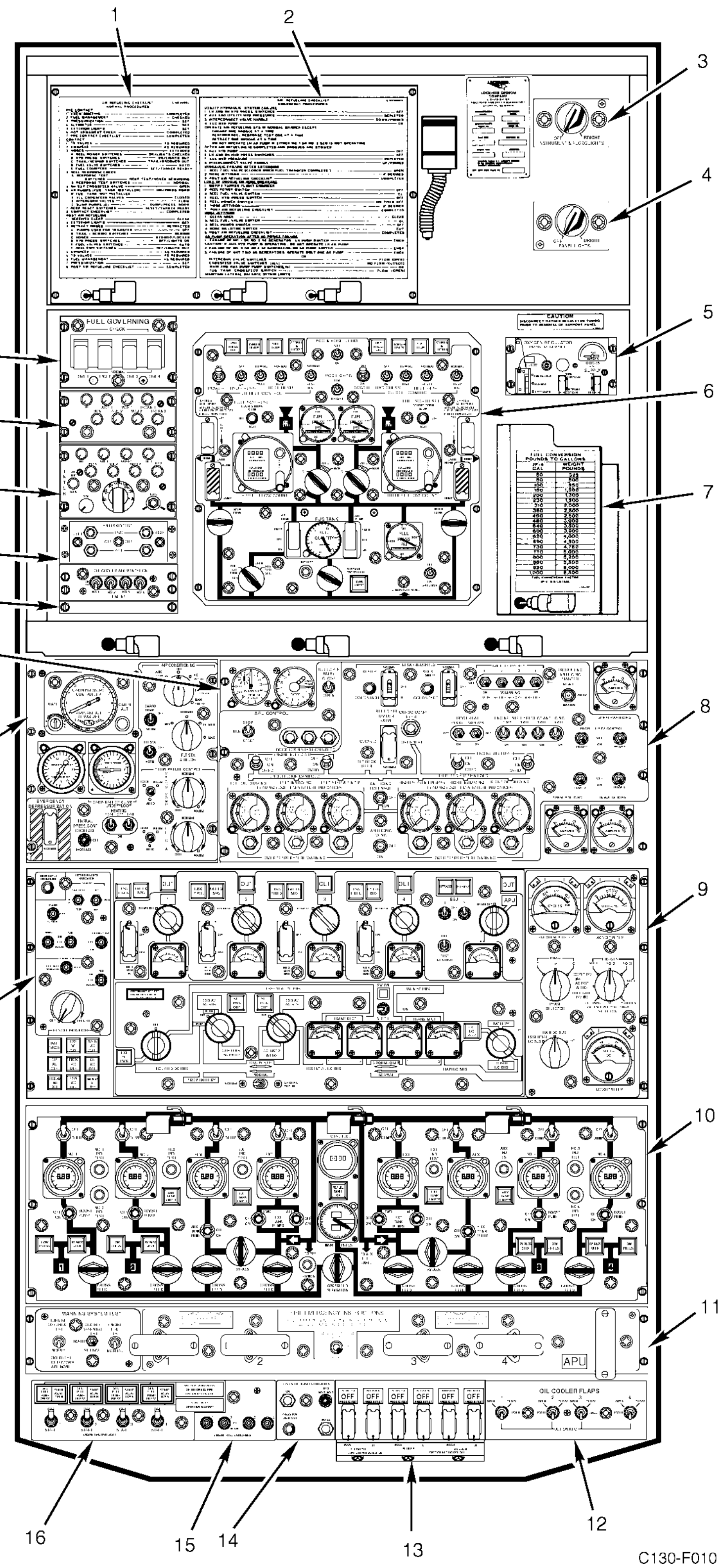


Figure 1-4. Copilot Side Shelf and Extension (Sheet 2)



1. AIR REFUELING NORMAL CHECKLIST
2. AIR REFUELING EMERGENCY CHECKLIST
3. AIR REFUELING INSTRUMENT LIGHTS SWITCH
4. AIR REFUELING PANEL LIGHTS SWITCH
5. OXYGEN REGULATOR
6. AUXILIARY FUEL CONTROL PANEL
7. FUEL CONVERSION CHART
8. ANTI-ICING SYSTEMS CONTROL PANEL
9. ELECTRICAL CONTROL PANEL
10. FUEL CONTROL PANEL
11. FIRE EMERGENCY CONTROL PANEL
12. OIL COOLER FLAPS CONTROL PANEL
13. CONTROL BOOST SWITCH PANEL
14. ICE DETECTION PANEL
15. ENGINE STARTING CONTROL PANEL
16. ENGINE WARNING SYSTEM TEST PANEL
17. EXTERIOR LIGHTS CONTROL PANEL
18. AIR-CONDITIONING AND PRESSURIZATION CONTROL PANEL
19. APU CONTROL PANEL
20. OIL COOLER AUGMENTATION CONTROL PANEL
21. ANTI-SKID TEST PANEL
22. INTERCOMMUNICATION CONTROL PANEL
23. INTERCOMMUNICATION MONITOR PANEL
24. FUEL GOVERNING CHECK SWITCHES

Figure 1-5. Overhead Control Panel (Typical)

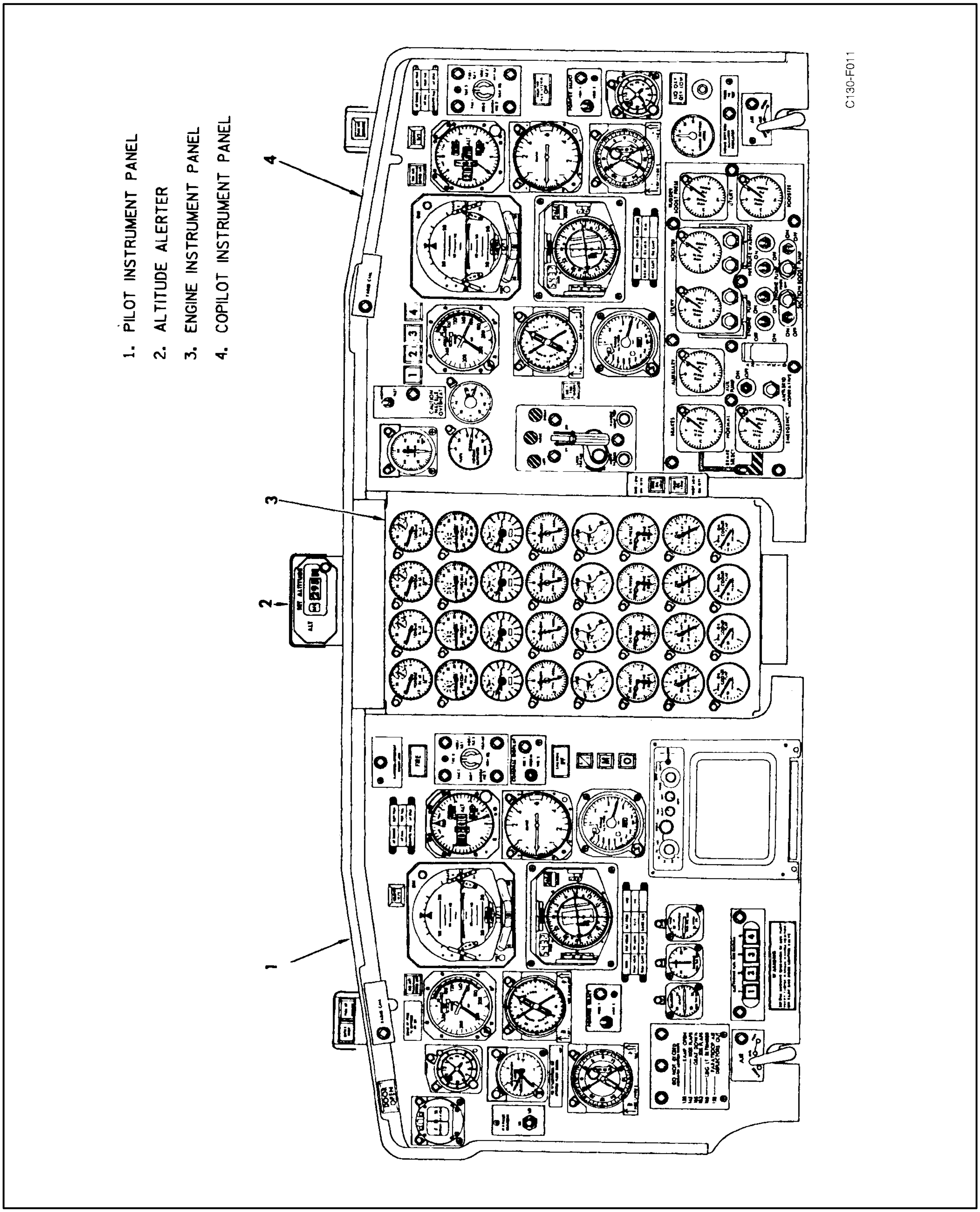


Figure 1-6. Main Instrument Panel (Typical)

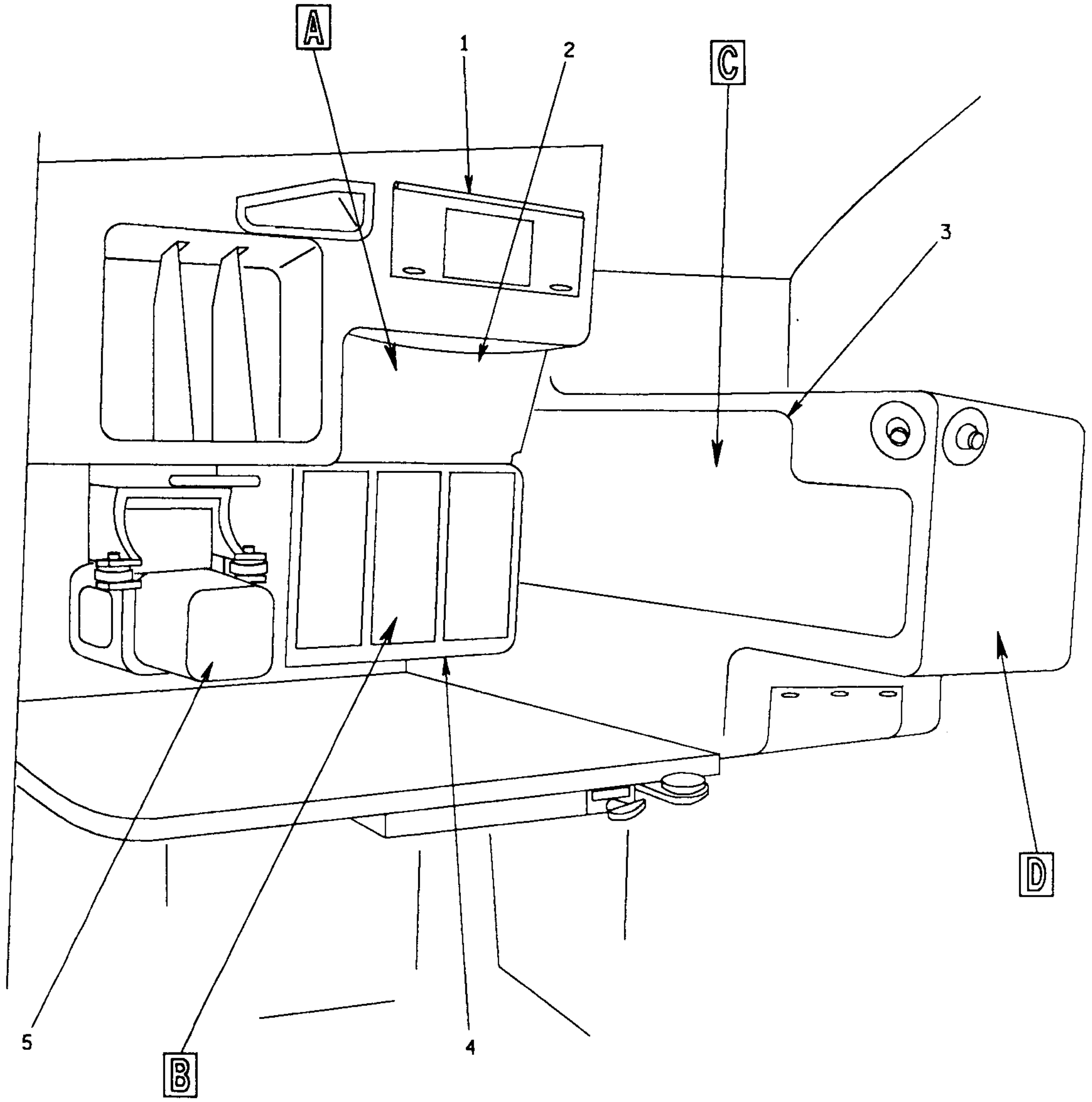
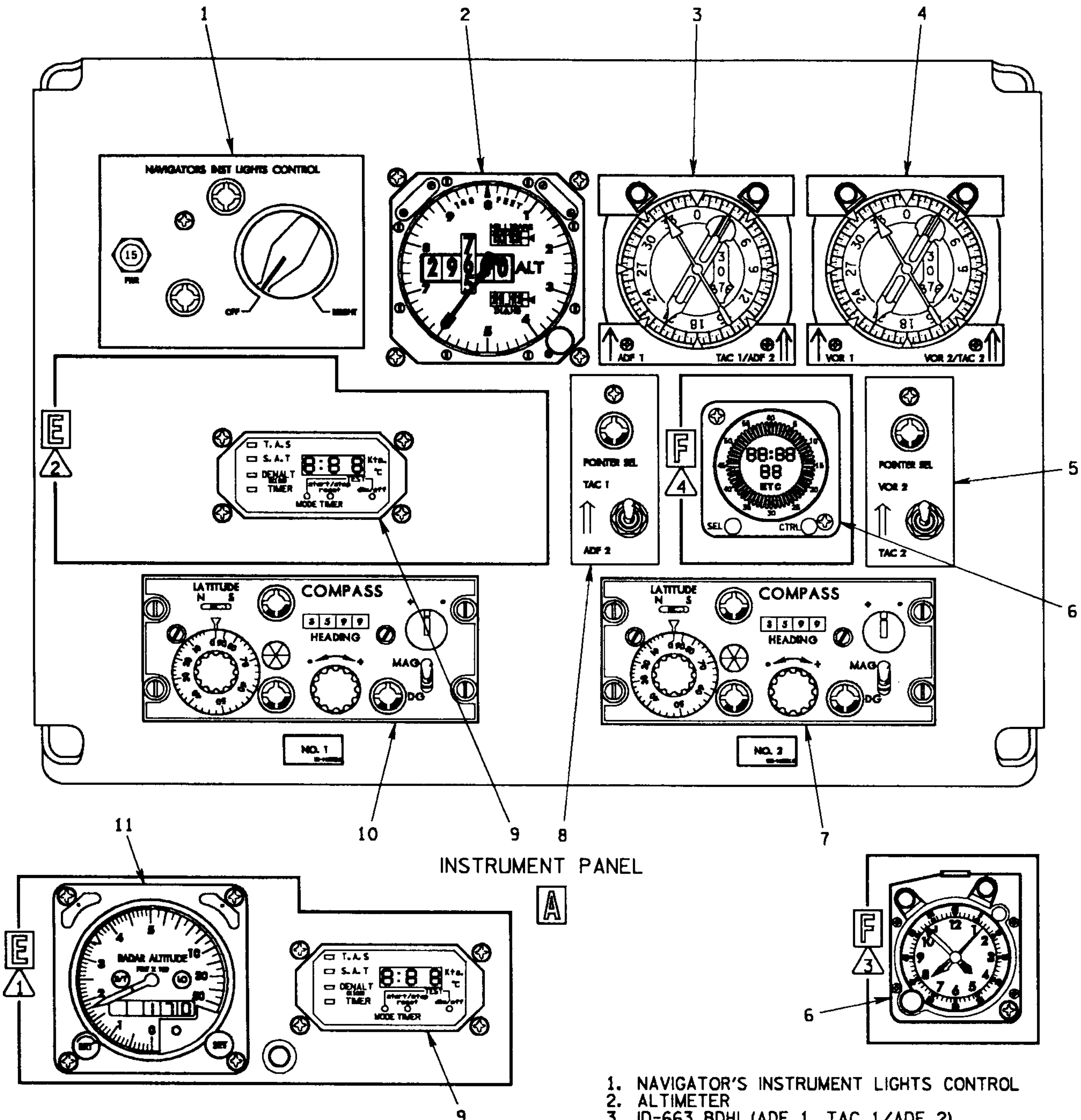


Figure 1-7. Navigator Station (Typical) (Sheet 1 of 5)



Note

⚠1 C-130T AIRCRAFT PRIOR TO 164993.

⚠2 C-130T AIRCRAFT 164993 AND UP.

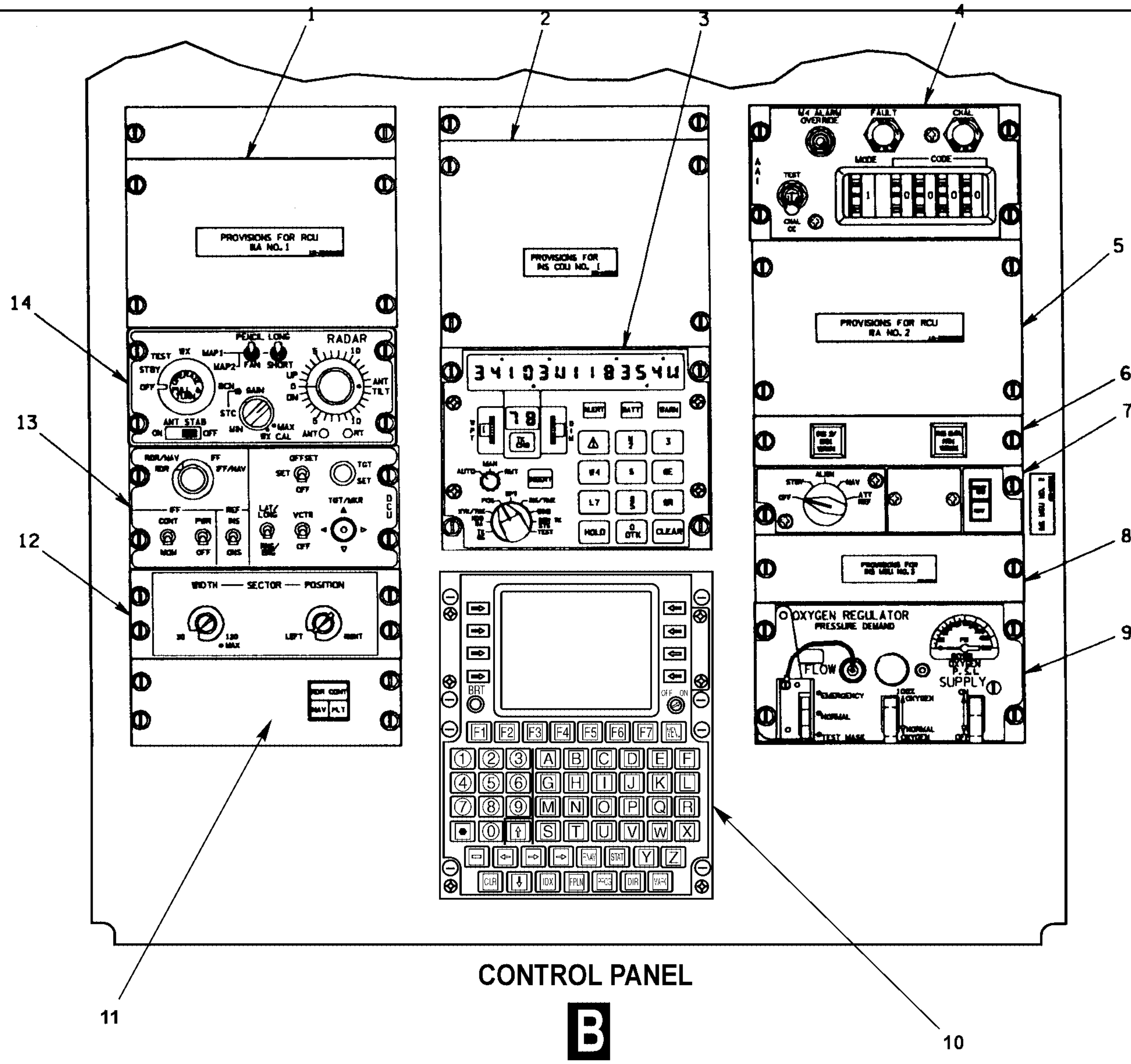
⚠3 AIRCRAFT PRIOR TO 165313.

⚠4 AIRCRAFT 165313 AND UP.

1. NAVIGATOR'S INSTRUMENT LIGHTS CONTROL
2. ALTIMETER
3. ID-663 BDHI (ADF 1, TAC 1/ADF 2)
4. ID-663 BDHI (VOR 1, VOR 2/TAC 2)
5. SELECTOR SWITCH NO. 2 POINTER (VOR 2, TAC 2)
6. CLOCK
7. NO. 2 C-12 COMPASS CONTROLLER
8. SELECTOR SWITCH NO. 2 POINTER (TAC 1, ADF 2)
9. TRUE AIRSPEED INDICATOR
10. NO. 1 C-12 COMPASS CONTROLLER
11. CARA INDICATOR ⚠1
12. ALTITUDE LOW INDICATOR LIGHT

C130-F013

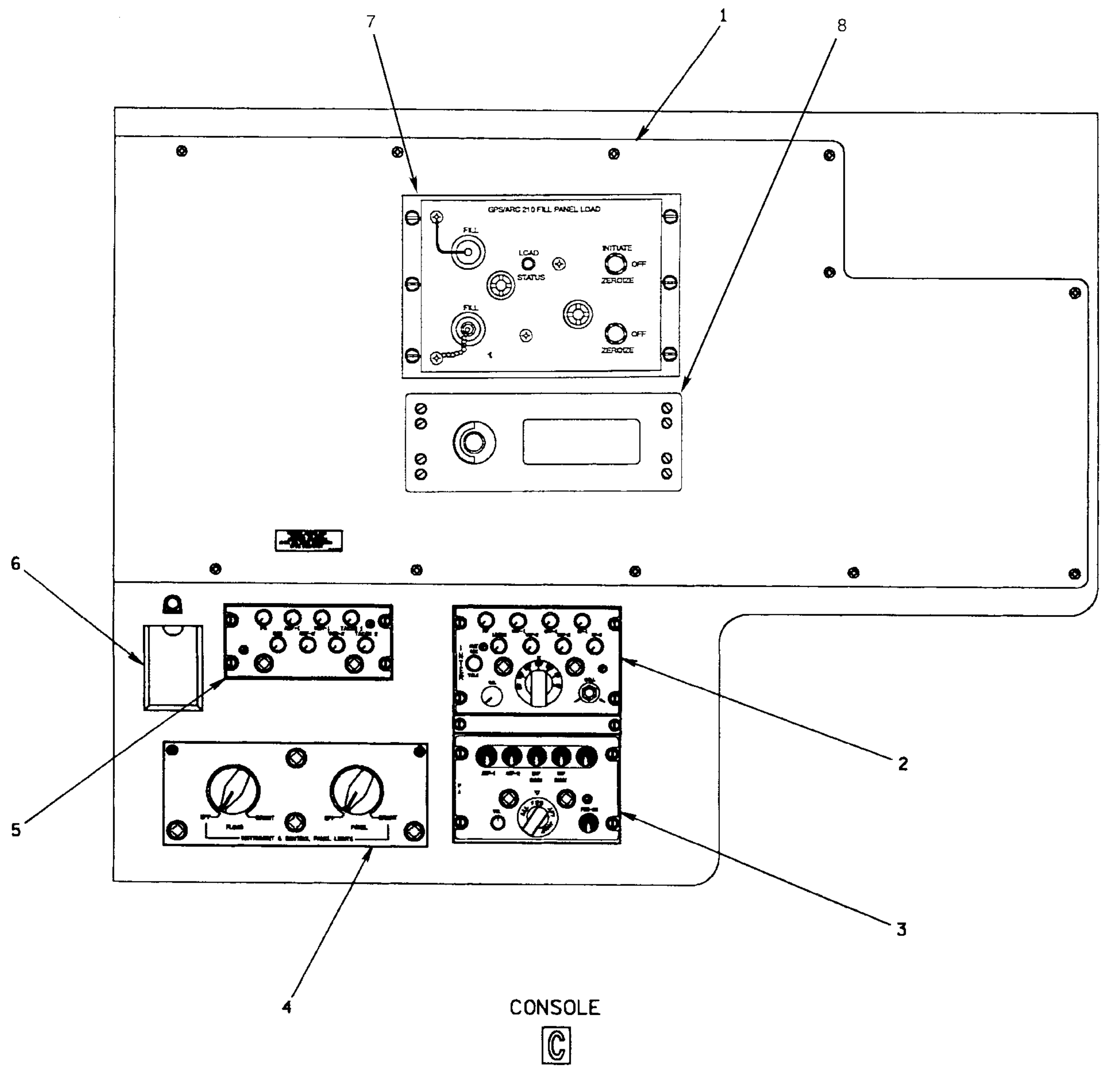
Figure 1-7. Navigator Station (Typical) (Sheet 2)



1. PROVISIONS FOR NO. 1 HF KY-75 RCU IIIA SECURE VOICE CONTROL PANEL
2. PROVISIONS FOR NO. 1 INS CONTROL DISPLAY UNIT
3. NO. 2 INS CONTROL DISPLAY UNIT
4. IFF INTERROGATOR CONTROL PANEL
5. PROVISIONS FOR NO. 2 HF KY-75 RCU IIIA SECURE VOICE CONTROL PANEL
6. NO. 2 INS AND NO. 3 INS/OMEGA FAN WARN INDICATORS
7. NO. 2 INS MODE SELECTOR UNIT
8. PROVISIONS FOR NO. 3 INS MODE SELECTOR UNIT
9. OXYGEN REGULATOR
10. CONTROL DISPLAY NAVIGATION UNIT
11. PILOT/NAV RADAR CONTROL INDICATOR
12. RADAR SELECTOR SCAN CONTROL PANEL
13. RADAR DISPLAY CONTROL UNIT
14. RADAR CONTROL PANEL

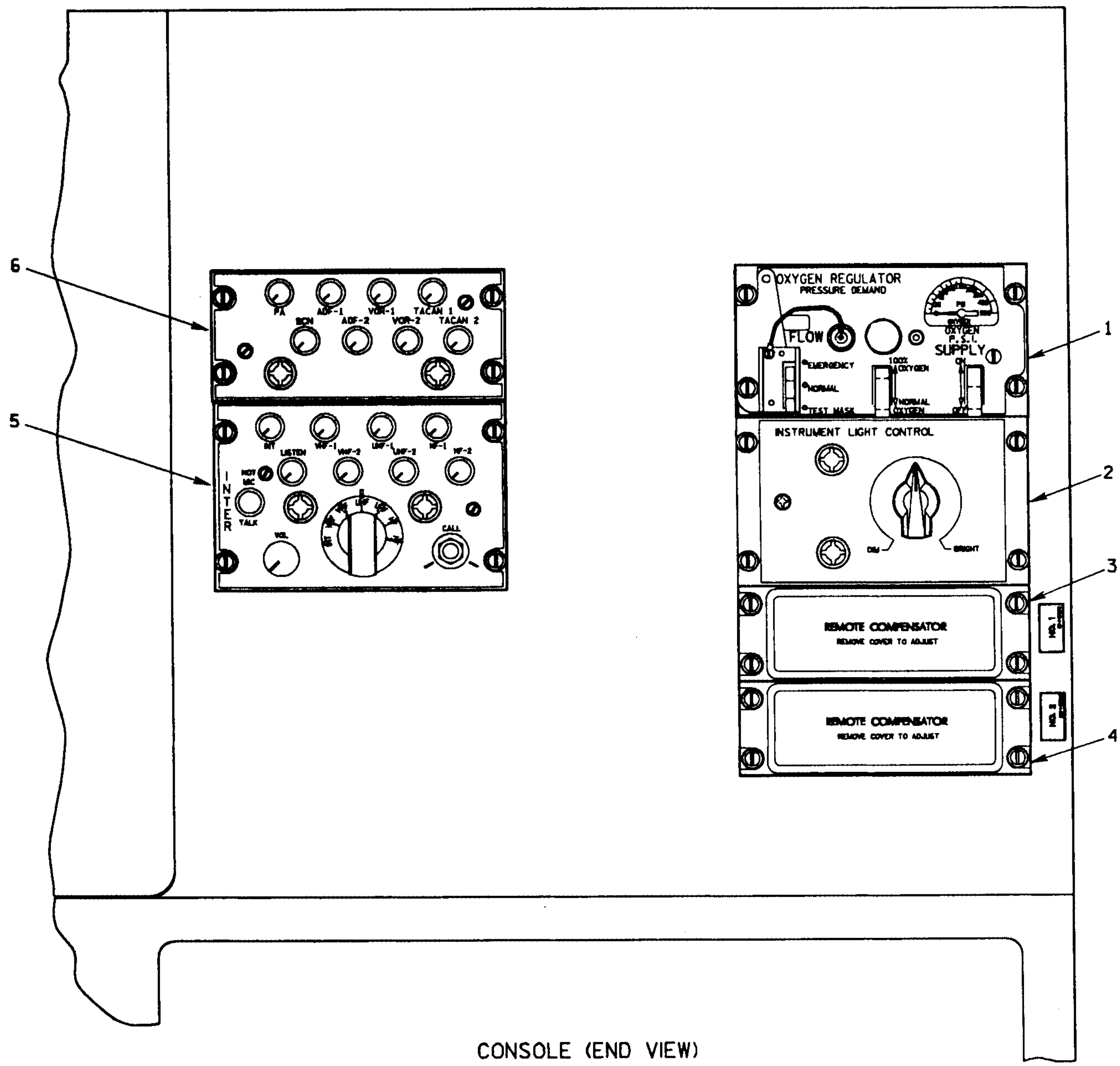
C130-F014

Figure 1-7. Navigator Station (Typical) (Sheet 3)



1. COVER PLATE
2. NAVIGATOR'S INTERCOMMUNICATION CONTROL PANEL
3. PA SYSTEM CONTROL PANEL
4. NAVIGATOR'S LIGHTING CONTROL
5. NAVIGATOR'S INTERCOMMUNICATION MONITOR PANEL
6. COMPASS CORRECTION CARD HOLDER
7. GPS/ARC-210 FILL PANEL
8. MISSION DATA LOADER

Figure 1-7. Navigator Station (Typical) (Sheet 4)



CONSOLE (END VIEW)

D

1. OXYGEN REGULATOR
2. NAVIGATOR'S CONSOLE INSTRUMENT LIGHT CONTROL
3. NO. 1 C-12 COMPASS COMPENSATOR
4. NO. 2 C-12 COMPASS COMPENSATOR
5. INTERCOMMUNICATION CONTROL PANEL
6. INTERCOMMUNICATION MONITOR PANEL

C130-F016

Figure 1-7. Navigator Station (Typical) (Sheet 5)

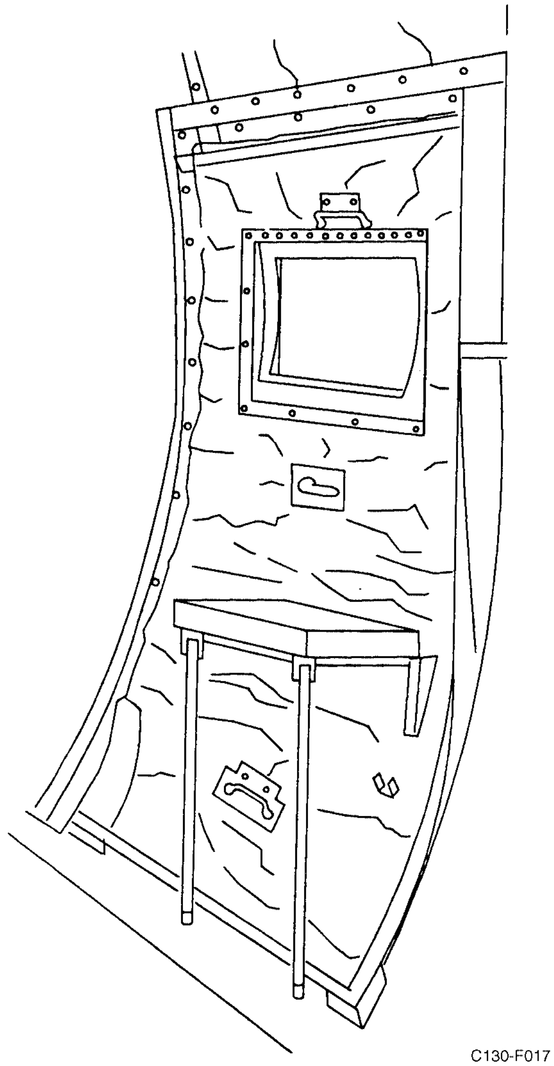


Figure 1-8. Observer Station

CHAPTER 2

Systems and Equipment

2.1 ENGINES

The aircraft is powered by four Allison T56-A-16 turboprop engines (see Figure 2-1). The basic engine consists of two major assemblies, a power section, and a reduction gear assembly, which are attached to each other by an extension shaft assembly and two supporting struts. The engine is provided with fuel, oil, starting, ignition, and control systems. The engine operates at a constant speed; therefore, engine power is related to TIT, which varies according to the rate of fuel flow. An increase in fuel flow causes an increase in TIT and a corresponding increase in energy available at the turbine. The turbine then absorbs more energy and transmits it to the propeller in the form of torque. In order to absorb the increased torque, the propeller increases blade angle to maintain constant engine rpm. A decrease in torque results in a decrease in propeller blade angle to maintain engine speed. Thrust is obtained from the propeller, and a small amount of additional thrust (approximately 10 percent at takeoff) is created by the tailpipe exhaust.

2.1.1 Power Section. The power section of the engine is composed of a single-entry, 14-stage, axial-flow compressor; a set of six combustion chambers of the through-flow type; and a 4-stage turbine. Mounted on the power section are an accessories drive assembly and components of the engine fuel, ignition, and control systems. Acceleration bleed valves are installed at the 5th and 10th compressor stages. A manifold is installed at the diffuser to bleed air from the compressor for aircraft pneumatic systems. Anti-icing systems are provided to prevent accumulation of ice in the engine inlet air duct and the oil cooler scoop. Inlet air enters the compressor through a scoop and duct below the compressor and is progressively compressed through the 14 stages of compression. The compressed air (at approximately 125 psi and 600 °F) flows through a diffuser into the combustion section. Fuel is introduced into the combustion chambers and burned to increase the temperature and, thereby, the energy of the gases. The gases pass through the turbine causing it to rotate and drive the compressor, the propeller, and accessories. The gases, after expanding through the turbine, flow out through a tailpipe.

2.1.2 Extension Shaft Assembly. The extension shaft assembly consists of two concentric shafts and torquemeter components. The inner shaft transmits power from the power section to the reduction gear. The outer shaft serves as a reference so that the torsional deflection of the loaded inner shaft can be detected by the magnetic pickups of the torque indicating system. Torquemeter amplifiers are provided with adjustment screws for calibration purposes.

2.1.3 Reduction Gear Assembly. The reduction gear assembly contains a reduction gear train, a propeller brake, a NTS system, and a safety coupling. Mounted on the accessory drive pads are the engine starter, an ac generator, a hydraulic pump, an oil pump, and a tachometer generator. The reduction gear has an independent dry-sump oil system. The reduction gear train is in two stages, providing an overall reduction of 13.54 to 1 between engine speed (13,820 rpm) and propeller shaft speed (1,021 rpm). The propeller brake, NTS system, and safety coupling are described in the following paragraphs.

2.1.3.1 Propeller Brake. The cone-type propeller brake acts on the first stage of reduction gearing. During engine operation, it is held disengaged by gearbox oil pressure when rpm exceeds 23 percent and is engaged below this speed. As engine speed is reduced and oil pressure drops, the braking surfaces are brought into contact by spring force to help slow the propeller to a stop. Helical splines between the starter shaft and the starter gear on the outer brake member cause the brake to disengage when starting torque is applied during starting. The brake also engages to stop reverse rotation of the propeller.

2.1.3.2 Negative Torque Protective Devices. Very high windmilling drag upon sudden loss of turbine power is a problem in propeller-jet aircraft operation. High windmilling drag results when the compressor absorbs a great amount of power. If a power failure is experienced in flight at high speed, the engine starts to

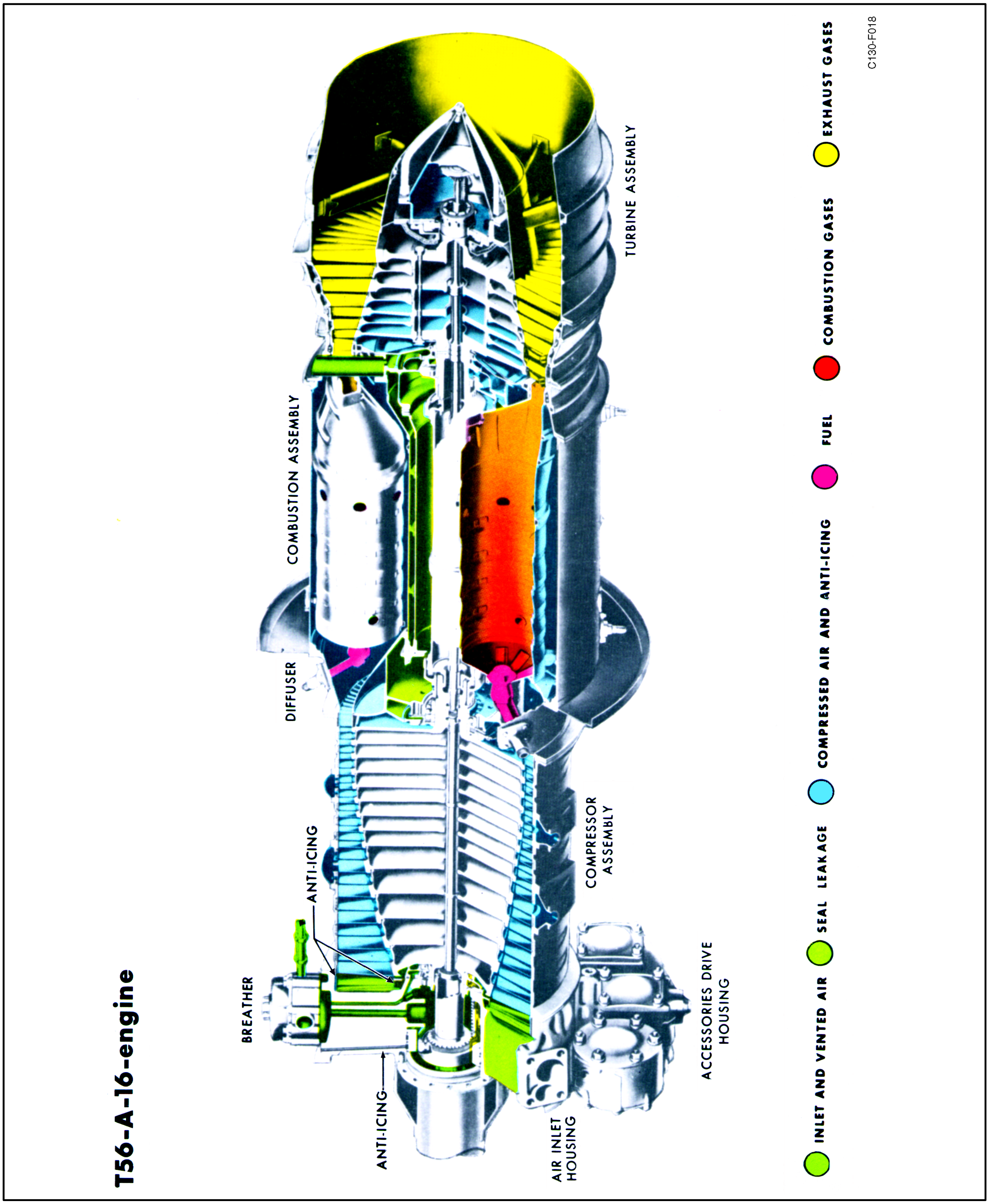


Figure 2-1. T56-A-16 Engine (Sheet 1 of 2)

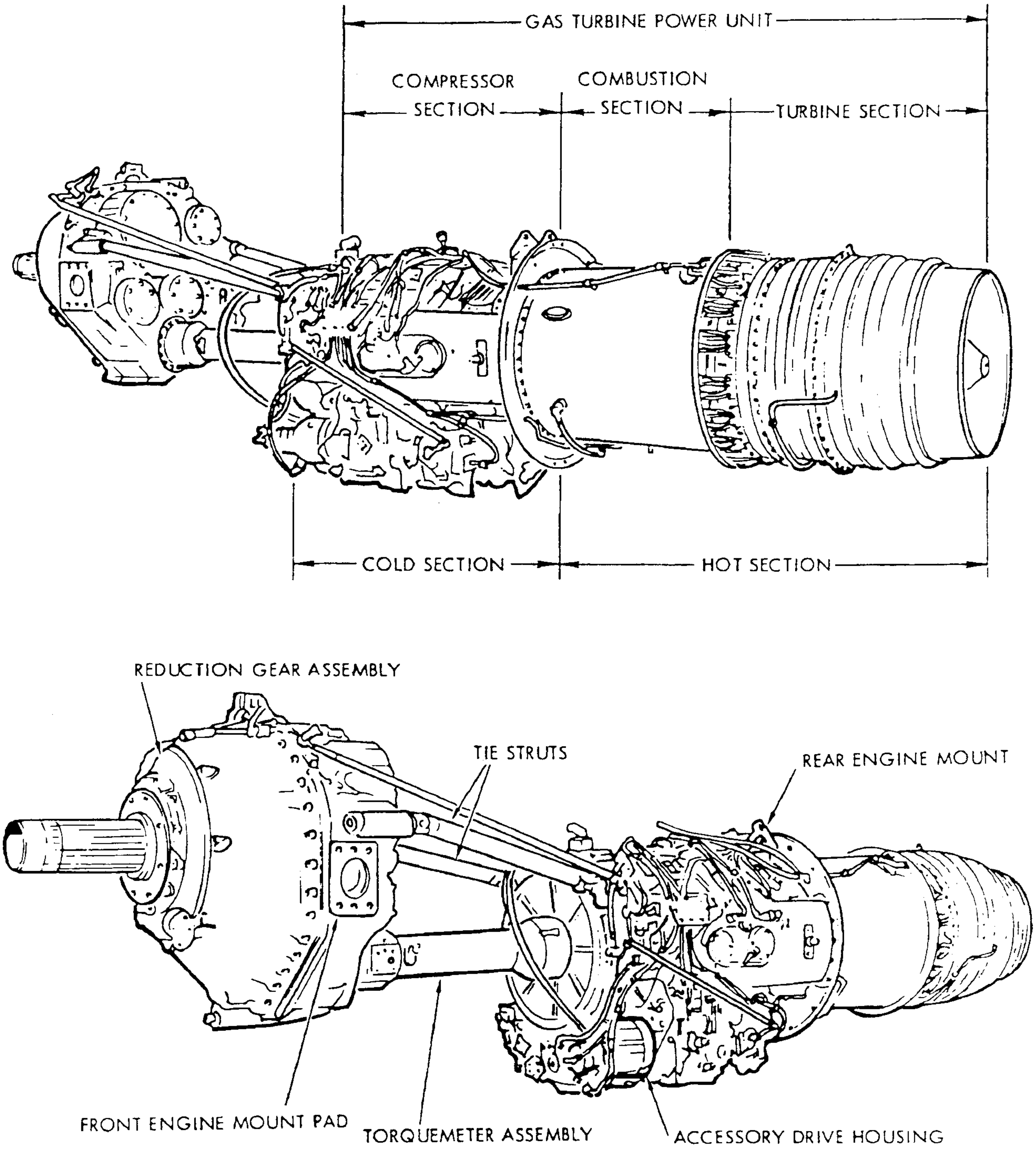


Figure 2-1. T56-A-16 Engine (Sheet 2)

slow down; the propeller, sensing rpm, reduces blade angle and drives the compressor, trying to bring it up to speed. Two safety devices are provided to prevent a sudden increase in windmilling drag that could result in high structural loads on the tail of the aircraft and loss of directional control. These devices are the NTS system, which increases blade angle of the propeller, and the safety coupling, which can decouple the propeller and reduction gear from the power section of the engine upon failure of the power section.

2.1.3.3 Negative Torque Signal System. The NTS system provides a mechanical signal to limit negative torque. Negative torque is encountered when the propeller attempts to drive the engine. If not relieved, this condition creates a great amount of drag, causing the aircraft to yaw. The NTS system consists of an actuating mechanism housed partly within the reduction gear assembly and partly in the propeller control assembly. It operates when negative torque applied to the reduction gear exceeds approximately 1,260 ±600 inch-pounds. A ring gear is then moved forward against springs as a result of torque reaction generated through helical splines. In moving forward, the ring gear actuates a plunger extending through the nose of the gearbox. The plunger pushes against a cam in the control assembly to actuate control linkage connected to the propeller feather valve. When a NTS is transmitted to the propeller, the propeller increases blade angle to relieve the condition, except when the throttles are below the FLIGHT IDLE position. When the throttles are below FLIGHT IDLE, a cam moves the actuator away from the NTS plunger and renders the system inoperative. This is necessary to prevent a propeller from receiving a possible NTS at high landing speeds when the throttles are moved toward reverse. If the negative torque is sufficiently reduced, the signal mechanism returns to normal by springs acting on the ring gear.

Note

Properly adjusted, the NTS will not commit the propeller to feather. An improperly adjusted or malfunctioning NTS system receiving continual NTSs will cause a propeller to move to a high blade angle. The resultant load may cause an engine stall and flameout.

2.1.3.4 Safety Coupling. The safety coupling is provided to decouple the power section from the reduction gear if negative torque applied to the reduction gear exceeds approximately 6,000 inch-pounds, a value much higher than that required to operate the NTS system. Because of its higher setting, the safety coupling backs up the NTS system to reduce drag until the propeller can be feathered. The safety coupling connects the engine extension shaft to the pinion of the first stage of reduction gears. It consists of three members: an outer member is attached to the extension shaft; an inner member is attached to the pinion; and an intermediate member is engaged to the outer member by straight teeth and to the inner member by helical teeth. Reaction of the helical teeth tends to force the intermediate member aft out of engagement when negative torque is applied, and the members disengage if approximately 6,000 inch-pounds of negative torque is reached. While disengaged, the two members are forced together by springs so that the teeth will ratchet. The teeth can thus be damaged; therefore, the engine should not be continued in operation after a decoupling. Before restarting the engine, the coupling must be replaced.

2.1.4 Engine Fuel and Control System. In flight, the engine operates at a constant speed that is maintained by the governing action of the propeller. Power changes are made by changing fuel flow and propeller blade angle rather than engine speed. An increase in fuel flow causes an increase in TIT and a corresponding increase in energy available at the turbine. The turbine absorbs more energy and transmits it to the propeller in the form of torque. The propeller, in order to maintain governing speed, increases blade angle to absorb the increased torque. TIT is a very important factor in the control of the engine. It is directly related to fuel flow and consequently to power produced. It is also limited because of the strength and durability of the combustion and turbine section materials. The fuel control system schedules fuel flow (see Figure 2-2) to produce specific TITs and to limit those temperatures so that the temperature tolerances of combustion and turbine section materials are not exceeded. Changes in power settings are effected by the throttle, which is connected to the fuel control and the propeller through a mechanical coordinator. During ground operation, changes in throttle position mechanically affect both the fuel flow and the propeller blade angle. In flight, changes in throttle position

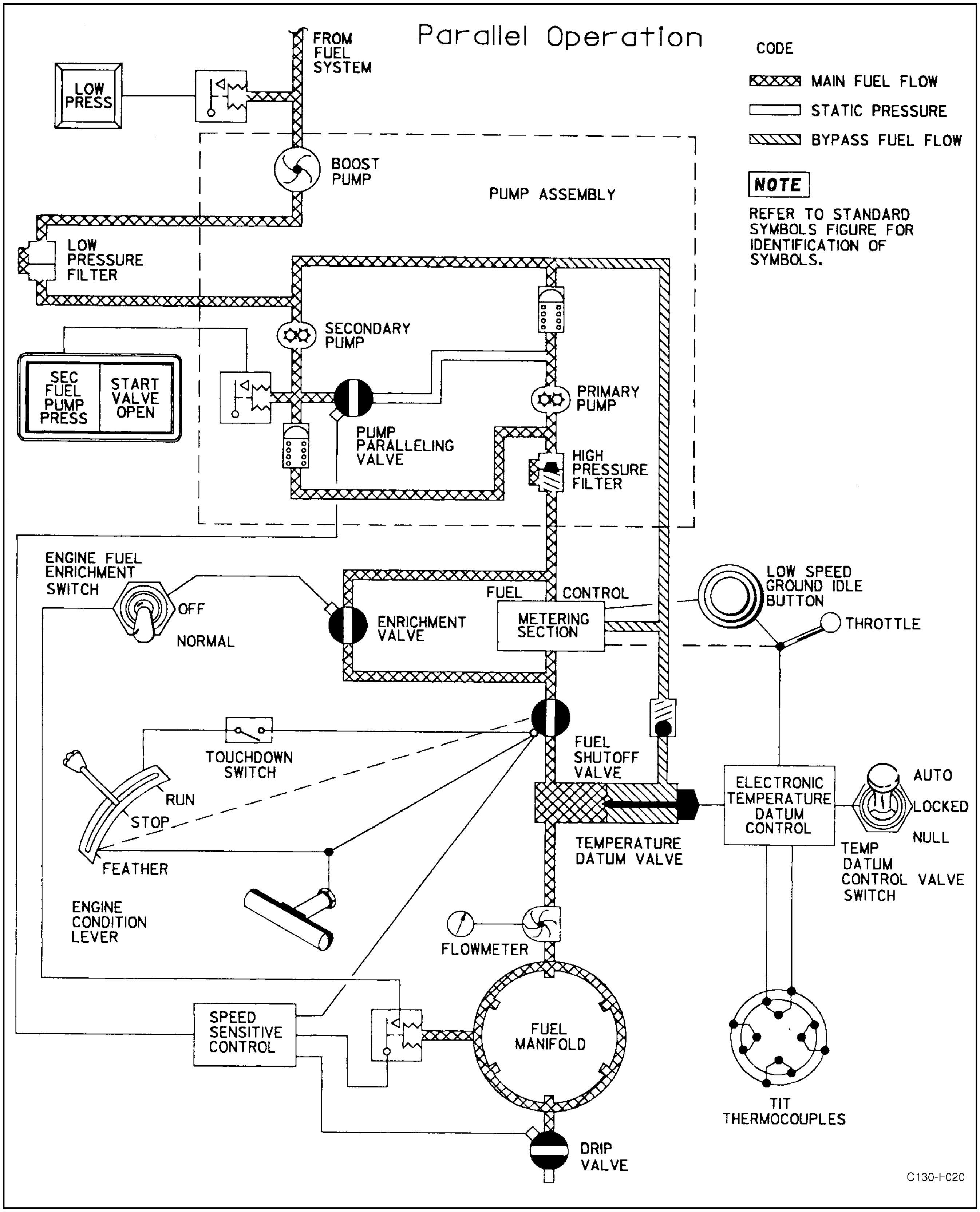


Figure 2-2. Engine Fuel Flow (Sheet 1 of 2)

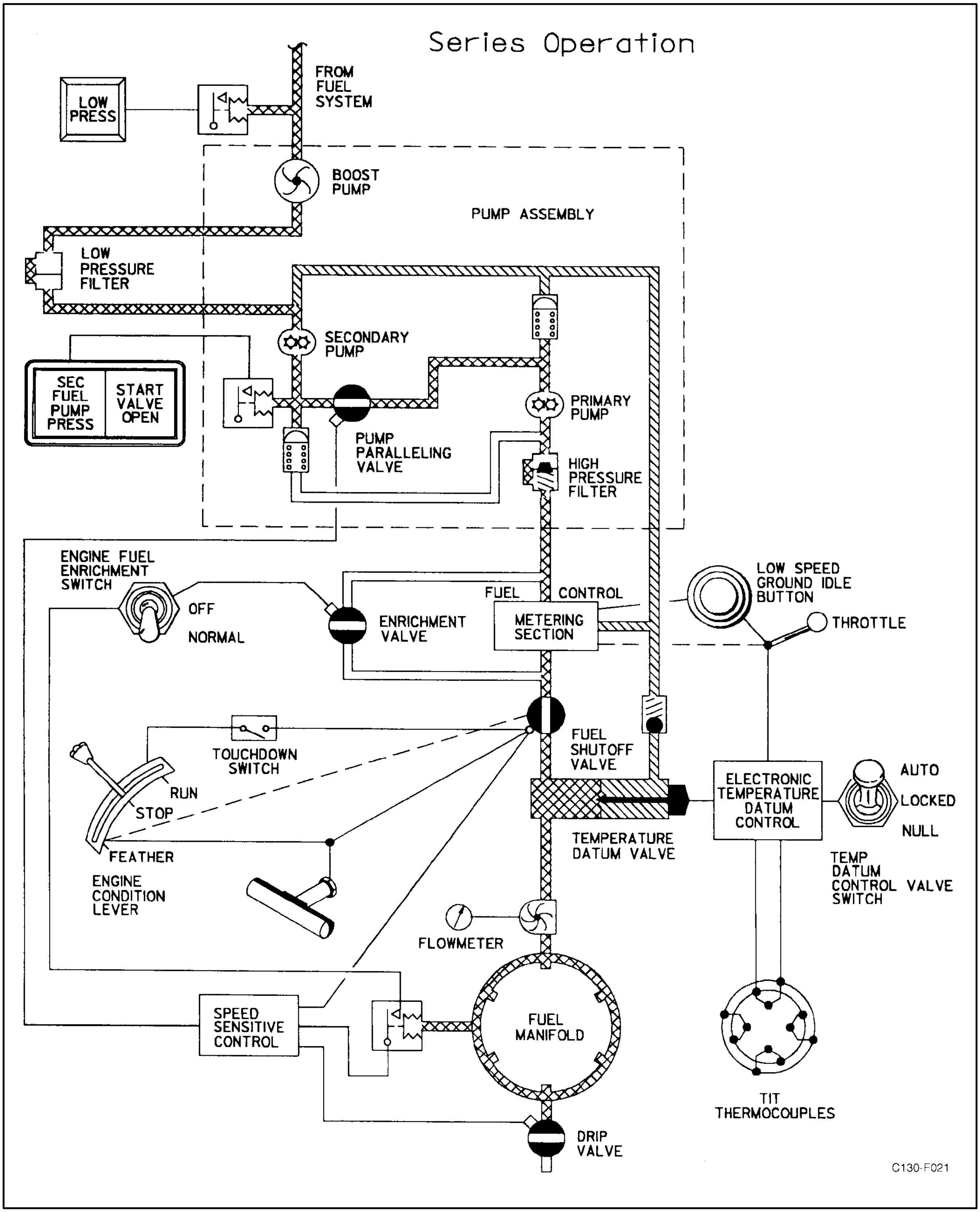


Figure 2-2. Engine Fuel Flow (Sheet 2)

mechanically affect fuel flow, and the propeller governor regulates blade angle, maintaining constant engine speed. The hydromechanical fuel control, which is part of the basic fuel system, senses engine inlet air temperature and pressure, rpm, and throttle position, and varies fuel flow accordingly. The electronic TD control system senses TIT and throttle position and makes any necessary changes in the fuel flow from the fuel control before it reaches the fuel nozzles. The TD system compensates for minor variables not sensed by the hydromechanical fuel control and for mechanical tolerances within the fuel control itself. By means of switches, the TD system can be turned off (NULL position) and the engine will operate on the basic hydromechanical system alone. With the TD system in AUTO, temperature protection is provided through the entire throttle range and automatic temperature scheduling is provided when the throttle is in the range of 65° to 90°. When the TD system is in NULL, the functions of temperature limiting and temperature scheduling must be accomplished manually by adjustment of the throttle.

2.1.4.1 Basic Hydromechanical Fuel System. The basic hydromechanical fuel system consists of a throttle, a coordinator, a low-pressure fuel filter, a high-pressure fuel filter, a dual-element fuel pump, a hydromechanical fuel control, and six fuel nozzles.

2.1.4.2 Throttle, Coordinator, and Propeller Control Linkage. The coordinator is a mechanical discriminating device that coordinates the throttle, the propeller, the fuel control, and the electronic TD system. Movements of the throttle are transmitted to the coordinator and, in turn, to the fuel control and the propeller by a series of levers and rods. A potentiometer in the coordinator provides signals to the TD system. Propeller blade angle is scheduled by throttle position from MAXIMUM REVERSE to FLIGHT IDLE. For throttle settings between FLIGHT IDLE and TAKE-OFF, the propeller is governing. Throttle movement in this range serves primarily to change fuel flow and also to change propeller hydraulic pitch stop (beta followup) settings.

2.1.4.3 Fuel Control. Fuel flows from the fuel pump to the hydromechanical fuel control. The control is sensitive to throttle position, air temperature and pressure at the engine inlet, and engine speed. The engine speed function of the fuel control maintains engine speed in the taxi range and limits engine speed in the flight range if the propeller governor fails. Governor action is controlled by flyweights that respond to engine rpm.

The control will start to reduce fuel to the engine at approximately 103.5 percent at a rate of 900 pounds per 1-percent rpm. A speed servo system provides for speed acceleration during engine start and underspeed control during normal engine operation. Fuel metered by the control is equal to engine requirements plus an additional 20 percent, which is for the use of the TD valve. With the TD system in NULL, the excess fuel provided by the fuel control is constantly bypassed by the TD valve back to the fuel pump, and fuel metering is accomplished by the fuel control alone. The required fuel flow passes on through the TD valve to the fuel nozzles and into the combustion liners, where it is burned.

2.1.4.4 Fuel Pump and Filter Assembly. The pump and filter assembly contains a centrifugal boost pump, a primary and a secondary gear pump, high-pressure filter, pressure switch, pump paralleling valve, and bypass and check valves. After engine start, the primary and secondary gear pumps operate in series; that is, the secondary pump receives fuel from the centrifugal pump and directs its output to the primary pump, which supplies fuel to the engine. If either pump fails, the operating pump will bypass the failed pump and supply sufficient fuel to sustain normal full-power engine operation. During engine starting, the solenoid-operated pump paralleling valve is energized closed by the speed-sensitive control through the ignition relay to block flow from the secondary to the primary pump. The centrifugal boost pump then feeds both gear pumps, and the combined output of the pumps operating in parallel is fed to the engine to provide increased fuel flow capacity during the start cycle. The pressure switch is closed to turn on the secondary pump pressure light while the pump paralleling valve is closed, or when the primary pump has failed.

2.1.4.5 Low-Pressure Filter. A low-pressure, paper-element filter assembly is installed between the centrifugal boost pump and the two gear pumps to remove contamination from the incoming fuel. This filter assembly is mounted externally from the fuel pump and filter assembly.

2.1.4.6 Acceleration Bleed-Air Valves. The bleed-air valves on the 5th and 10th stages of the compressor are provided for compressor unloading during starting and while the engine is operating in the low-speed, ground-idle range. These bleed valves remain open only when engine speed is below 94-percent rpm. The 5th- and 10th-stage bleed-air valves are automatic in operation and are actuated by 14th-stage compressor air pressure through an engine-driven, speed-sensitive valve assembly.

2.1.4.7 Starting Fuel Enrichment System. The enrichment system consists of a bypass line in which is mounted a solenoid valve, a pressure switch, and the engine fuel-enrichment selector switch. The valve is opened by the speed-sensitive control through the ignition relay when engine speed reaches 16-percent rpm during starting when the engine fuel enrichment switch is in NORM. While open, it allows pump discharge fuel to flow around the metering section of the fuel control to add to the metered flow from the fuel control. After fuel pressure in the manifold reaches approximately 50 psi (gauge), the manifold pressure switch opens to deenergize the valve, which then closes.

2.1.4.8 Fuel Nozzles. Six duplex fuel nozzles are used. The small slots of the nozzles open when manifold pressure is low during engine starting. Both small and large slots open when manifold pressure increases to 65 psi as the engine accelerates to normal speed.

2.1.4.9 Burner Drain Valves. Two burner drain valves are provided to drain fuel from the combustion section of the engine when it is stopped. They are spring-loaded and operate automatically to close when internal combustion pressure exceeds external pressure.

2.1.4.10 Drip Valves. The purpose of the drip valve is to drain the fuel manifold to minimize the amount of fuel dripping into the combustion chambers and causing fire at shutdown. The valve is closed by a solenoid that is controlled by the speed-sensitive control through the ignition relay when engine speed reaches approximately 16-percent rpm during starting. It is held against a spring by pressure in the fuel manifold after the engine is started. When fuel pressure in the manifold drops to approximately 9 psi during engine shutdown, the valve opens and drains the manifold.

2.1.5 Starting System. An air turbine starter unit drives the engine for ground starts. This starter unit consists of an air-driven turbine section, a clutch, and a reduction gear section that is splined to the reduction gear assembly of the engine. Air for driving the starter can be supplied by the auxiliary power unit, by an operating engine, or by an external air source. The air is routed through the bleed-air system and the engine bleed-air regulators.

When the respective bleed-air regulator is opened, air is supplied to the starter regulator valve. When the ENGINE GROUND START switch is placed to START, the starter regulator valve opens (when its solenoid is energized) and allows airflow into the starter turbine section. Releasing the ENGINE GROUND START switch to OFF will deenergize the regulator valve. Within approximately 15 seconds the START VALVE OPEN light will extinguish, indicating that the starter valve is closed. Each engine starting circuit is electrically interlocked with the corresponding engine oil fire shutoff valve control circuit. This renders the starting circuit inoperative unless the fire emergency control handle is pushed in and the FIRE SHUTOFF VALVE-OIL circuit breaker is engaged.

2.1.5.1 Starting Control System. The starting control system automatically controls fuel flow and ignition during ground and air starts. Electrical power for the control circuits is supplied from the essential dc bus through the START CONTROL circuit breakers and the IGNITION CONTROL circuit breakers on the copilot side circuit breaker panel. The automatic control of the starting control system has a speed-sensitive control and a speed-sensitive valve, which are engine-driven. The speed-sensitive control performs the following functions:

1. At 16-percent rpm — The fuel shutoff valve in the engine fuel control is opened, the ignition relay is energized completing circuit to the ignition exciter, the engine fuel pump paralleling valve closes, the fuel enrichment valve opens if selected, and the manifold drip valve closes.
2. At 65-percent rpm — Ignition system is deenergized, fuel pump paralleling valve is opened to return pumps to series operation, manifold drip valve is deenergized (it is then held closed by pressure).
3. At 94 percent rpm — Electronic TD control system is switched from start limiting to normal

limiting, and the speed-sensitive valve opens to allow 14th-stage bleed air to force the 5th- and 10th-stage acceleration bleed valves closed.

2.1.6 Ignition System. The ignition system is a high-voltage, condenser-discharge type, consisting of an exciter, two igniters, and control components. The system is controlled by the speed-sensitive control through the ignition relay, which turns it on at 16-percent engine rpm and off at 65-percent engine rpm during starting.

2.1.6.1 Electronic Temperature Datum Control System. The electronic TD control, together with the coordinator potentiometer, temperature adjustment network, a TIT measurement system, and the temperature datum valve make up the electronic temperature datum system. The system compensates for variations in fuel heat value and density, engines, and control system characteristics. The TD control is furnished actual TIT signals from a set of thermocouples, and is furnished desired TIT signals by the throttle through the coordinator potentiometer and the temperature adjustment network. The control compares the actual and the desired TIT signals. In the temperature controlling range (65° to 90° throttle movement), if there is a difference, the TD control signals the temperature datum valve to increase or decrease fuel flow to bring the temperature back on schedule. In the temperature limiting range (0° to 65° throttle movement), the TD control acts only when the limiting temperature is exceeded, at which time, it signals the TD valve to decrease fuel flow. The TD valve is located between the fuel control and the fuel nozzles. It is a motor-operated bypass valve that responds to signals received from the TD control. In throttle positions between 0° and 65°, the valve remains in a 20-percent bypass or null position and the engine operates on the fuel flow scheduled by the fuel control. The valve remains in the null position unless it is signaled by the TD control to limit TIT. The valve then reduces the fuel flow (up to 50 percent during starting, 20 percent above 94-percent rpm) to the nozzles by returning the excess to the fuel pump. When the TIT lowers to the desired level, the TD control signals the valve to return to the null position. In throttle positions between 0° and 65°, the control system is in the temperature limiting range. In throttle positions between 65° and 90°, the TD valve acts to control TIT to a preselected schedule corresponding to throttle position; this is the temperature controlling range. In this range the valve may be signaled by the TD control to allow more (higher temperature desired) or allow less (lower temperature desired) of the fuel to flow to the fuel nozzles. Any specific fuel flow trim correction applied in the 65° to 90° throttle range can be locked into the TD valve while above 65° and will be maintained in the 0° to 65° range by the use of the TEMP DATUM CONTROL VALVE switch located at the flight station. Also, the TD system can be returned to null at any time by the use of the TEMP DATUM CONTROL VALVE switch. When the switch is in NULL, automatic temperature-limiting circuits are inoperative, the TD valve remains in the null (20-percent bypass) position, and all fuel metering is then accomplished by the fuel control. Temperature limiting then must be accomplished by throttle adjustment.

2.1.7 Engine Controls and Control Systems. Engine control in the flight range of operation is based on regulation of engine speed by propeller constant-speed governing and control of torque through regulation of fuel flow. Note that the throttle acts only as a power control. It exercises no direct control over the propeller, which is controlled entirely by the propeller regulator to regulate engine speed and to limit the low blade angle. The fuel control regulates the rate of increase and decrease of fuel metering for acceleration and deceleration. The TD control system functions at all throttle positions (MAXIMUM REVERSE through TAKE-OFF) either as a temperature-limiting or a temperature-controlling system. When performing temperature limiting, the system operates to prevent overtemperatures by “taking” a portion of fuel flow when maximum allowable TIT is exceeded. When performing temperature controlling (past 65° of throttle travel, fuel correction lights out), it adjusts fuel flow to obtain the desired temperature. This is accomplished by using a voltage signal from a potentiometer, positioned by the throttle, as a reference for desired TIT. The system compares this reference with actual TIT and adjusts fuel flow to obtain the desired temperature. The TD control system may be operated to provide a fixed correction of fuel flow. By positioning the TEMP DATUM CONTROL VALVE switches in LOCKED while the throttles are in the temperature-controlling range, all of the TD control valves are locked in the position in which they have been set by the temperature-controlling systems. When the TEMP DATUM CONTROL VALVE switches are positioned in LOCKED, the electronic fuel correction warning lights should remain out through all throttle movements. Should an overtemperature condition occur, the light, or lights, will come on indicating that a “take” signal has been initiated, that the TD valve brake has been released, and that fuel correction has been lost. The light will stay on until the TD system is reset. In throttle positions below FLIGHT IDLE, the throttle selects propeller blade angle as well as fuel flow. The TD control system still functions to limit TIT.

An engine is stopped by closing a fuel shutoff valve on the fuel control. The valve is closed electrically when the condition lever is at GROUND STOP if the control circuit is completed through a landing gear touchdown switch, when the condition lever is pulled to FEATHER, or when the fire emergency handle is pulled. The valve is also closed mechanically when the condition lever is pulled to FEATHER. Propeller feathering can be accomplished by pulling the condition lever to FEATHER, or by pulling the fire emergency handle.

For starting an engine, a speed-sensitive valve and a speed-sensitive control, which contains three speed-sensitive microswitches, provide automatic control of all functions involved in the starting cycle. The speed-sensitive switches turn on the fuel, control ignition, parallel fuel pump elements, initiate starting fuel enrichment, close a manifold drip valve, and switch the electronic datum control system from starting limiting to normal limiting. The speed-sensitive valve controls the compressor bleed valves. These operations are timed according to engine speed to ensure that the proper sequence of starting operations is followed. For airstarts, the engine condition lever operates switches that start the propeller feather pump motor to provide pressure to decrease the propeller blade angle and to apply power to the speed-sensitive control, energizing fuel and ignition control circuits.

2.1.7.1 Throttles. The throttles (see Figures 2-3 and 2-4) are quadrant mounted on the flight control pedestal. Throttle movements are transmitted through mechanical linkage to an engine-mounted coordinator. The coordinator transmits the movements through mechanical linkage to the propeller and to the engine fuel control, and it also actuates switches and a potentiometer that affect electronic TD control system operation. Each throttle has two distinct ranges of movement, taxi and flight, that are separated by a stop (see Figure 2-3). Both ranges are used for ground operation, but the taxi range must not be used in flight. In the taxi range, the throttle position selects a propeller blade angle and a corresponding rate of fuel flow. In the flight (governing) range, throttle position selects a rate of fuel flow and the propeller governor controls propeller blade angle. The throttles have four placarded positions as follows:

1. MAXIMUM REVERSE (0° travel) gives maximum reverse thrust with engine power approximately 40 percent of takeoff power.

2. GROUND IDLE (approximately 18° travel) is a detent position. This is the ground-starting position at which blade angle is set for minimum thrust.

Note

Throttles must not be moved out of GROUND IDLE detent during ground starting because the resultant increase in propeller blade angle might overload the starter, reducing the rate of engine acceleration.

3. FLIGHT IDLE (34° travel) is the transition point between the taxi and flight (governing) ranges. A step in the quadrant limits aft travel of the throttle at this position until the throttle is lifted.

4. TAKE-OFF (90° travel) is the maximum power position.

The throttle quadrant is also divided into two unmarked ranges with respect to control of the electronic TD control system. The crossover point is at 65° throttle travel, at which point the switches in the coordinator are actuated. Below this point, the electronic TD control system is limiting TIT. Above this point, it is controlling TIT if the TD valve switches are in the AUTO position.

2.1.7.2 LOW SPEED GROUND IDLE Control Buttons. Four LOW SPEED GROUND IDLE control buttons (see Figure 2-5) on the control pedestal may be pushed in to reduce engine rpm to approximately 72 percent at any time the throttles are in the range between 9° and 30°. The low speed ground idle buttons send a signal to the fuel topping governor on the fuel control, to reduce fuel flow to the engine. This allows the fuel nozzles to cool down and extends engine life. In addition, this allows the aircraft to taxi at a slower speed without having to use excess braking. Moving the throttles out of this range will automatically disengage the LOW SPEED GROUND IDLE buttons. Power is

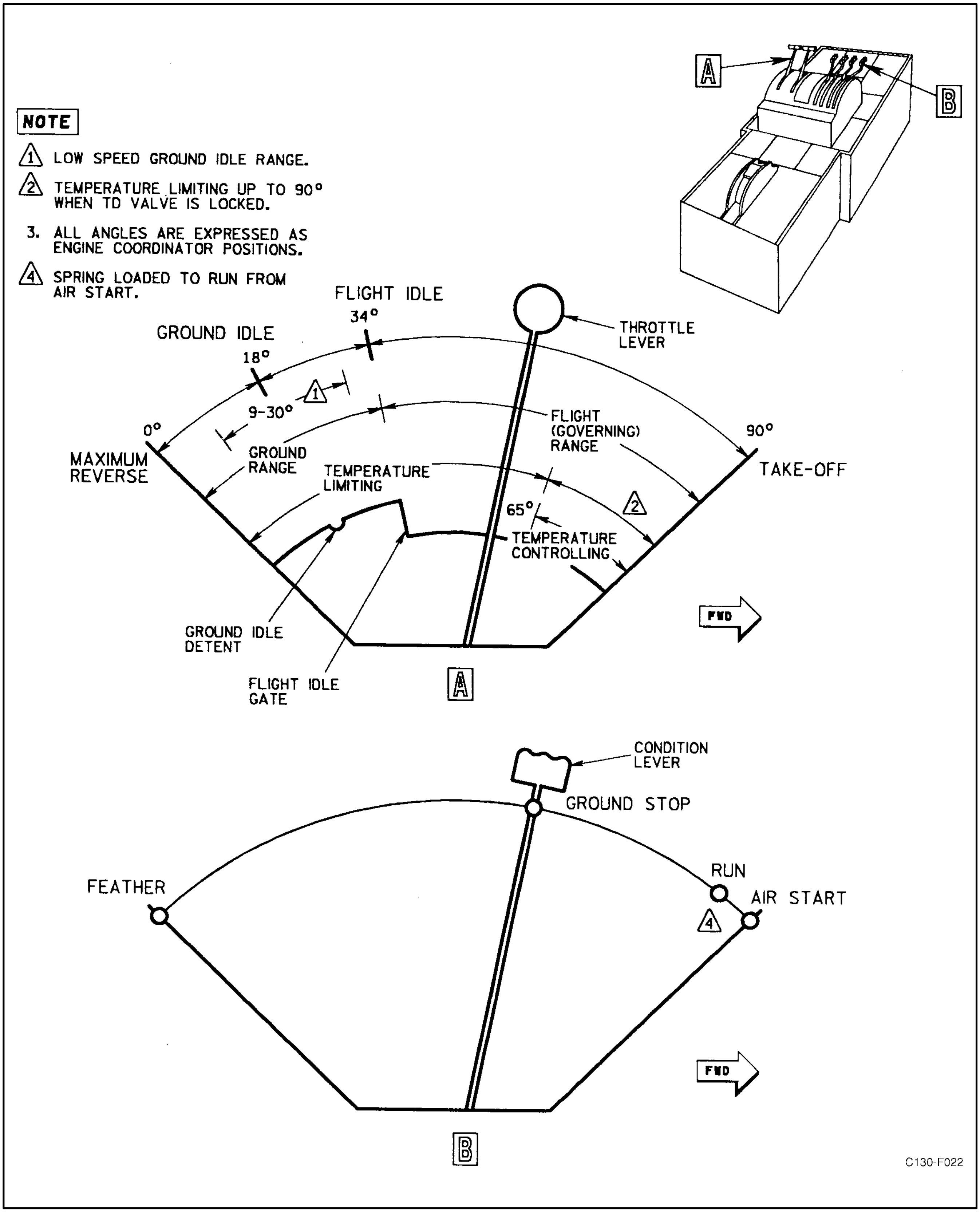


Figure 2-3. Engine Control Quadrant

1. NO. 1 AND NO. 2 ADF RADIO CONTROL PANEL
2. NO. 1 INS MODE SELECTOR UNIT (MSU)
3. UHF/VHF EMERGENCY SELECT SWITCH
4. NO. 1 INS CONTROL DISPLAY UNIT (CDU)
5. NO. 1 HF KY-75 RCU IIIB SECURE VOICE CONTROL PANEL
6. ASH 37 CONTROL UNIT
7. NO. 2 VHF KY-58 CONTROL PANEL
8. ENGINE CONTROL QUADRANT
9. LANDING AND TAXI LIGHTS CONTROL PANEL
10. NO. 2 UHF ANTENNA SELECTOR PANEL
11. LOW SPEED GROUND IDLE AND ASSISTED TAKE-OFF CONTROL PANEL
12. FCS ANNUNCIATOR LIGHTS CONTROL PANEL
13. AUTOPILOT CONTROLLER
14. NO. 2 FCS REMOTE HEADING AND COURSE SELECTOR
15. NO. 2 FCS FLIGHT SELECTOR PANEL
16. GPWS FLAP OVERRIDE/RADAR ALT MONITOR CONTROL PANEL
17. AERIAL DELIVERY SYSTEM (ADS) CONTROL PANEL
18. IFF SYSTEM CONTROL PANEL
19. FLAP CONTROL QUADRANT
20. NO. 1 HF RADIO CONTROL PANEL
21. NO. 1 UHF COMMAND RADIO
22. NO. 1 FCS FLIGHT SELECTOR PANEL
23. NO. 1 FCS REMOTE HEADING AND COURSE SELECTOR
24. TRIM TAB CONTROL PANEL
25. ELEVATOR TRIM TAB POWER SELECTOR SWITCH
26. NO. 1 UHF ANTENNA SELECTOR PANEL
27. NO. 1 UHF KY-58 CONTROL PANEL
28. NO. 1 VHF KY-58 CONTROL PANEL
29. RECEIVING DECODING GROUP CONTROL PANEL
30. CONTROL DISPLAY NAVIGATION UNIT
31. NO. 2 UHF KY-58 CONTROL UNIT
32. NO. 1 V/UHF CONTROL UNIT
33. NO. 1 V/UHF ANTENNA SELECTOR PANEL
34. NO. 2 V/UHF ANTENNA SELECTOR PANEL
35. IFF/TCAS SYSTEM CONTROL PANEL

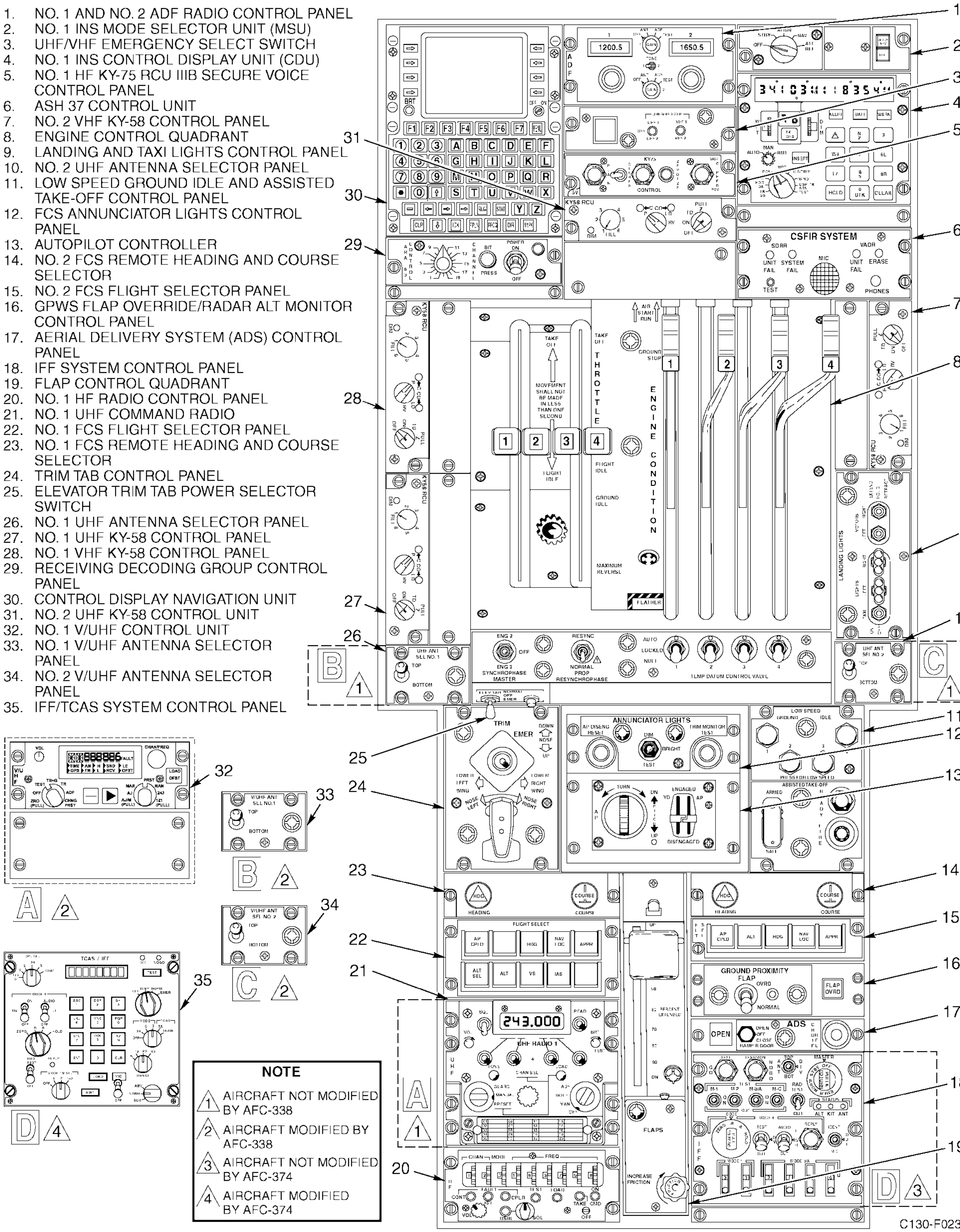


Figure 2-4. Flight Control Pedestal

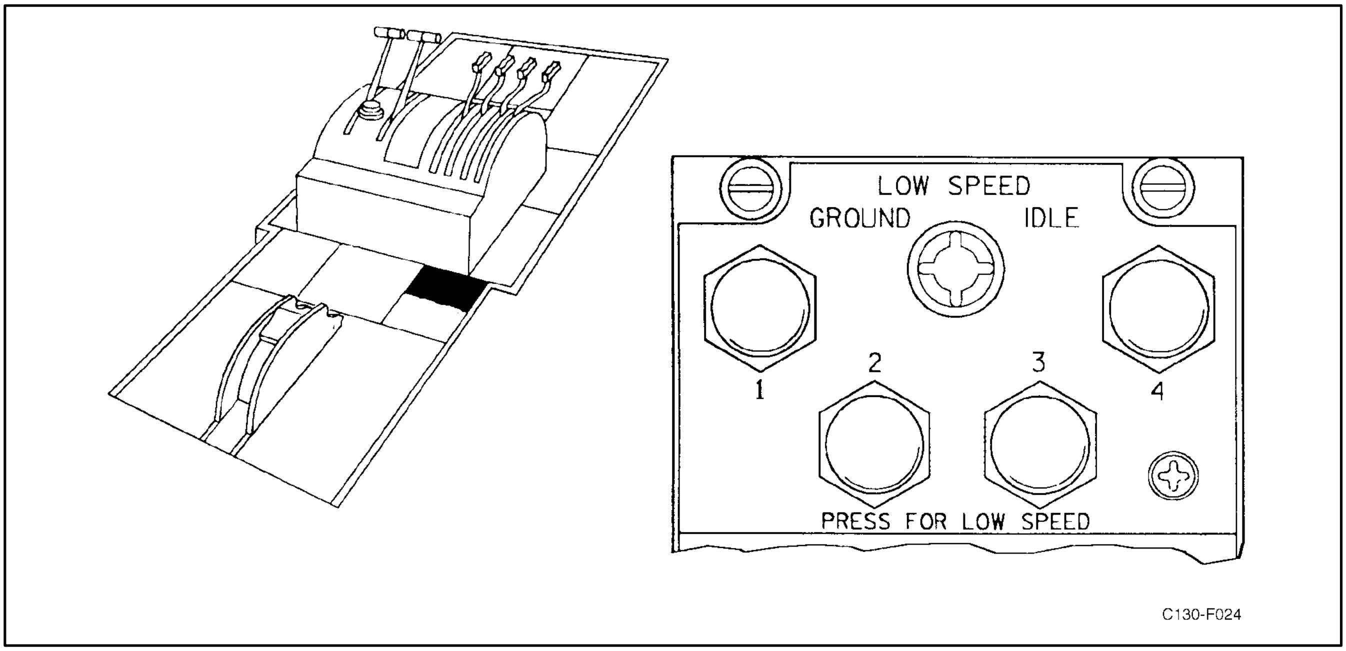


Figure 2-5. Low-Speed Ground Idle Buttons

supplied from the essential dc bus through the LOW SPEED GND IDLE circuit breakers on the copilot side circuit breaker panel.

CAUTION

- With engines in low-speed ground idle, movement of throttles beyond the limits of 9° to 30° (coordinator angle) at ambient temperatures above 80 °F may cause engine stall and overtemperature. Therefore, the recommended procedure for coming out of low-speed ground idle is to disengage the buttons manually with the throttles in GROUND IDLE detent.
- If all four engines are operated at low-speed ground idle, the APU generator must be on since the engine-driven ac generators will not supply ac power. If the APU generator fails and the BUS TIE switch is in the TIED position, the LOW SPEED GROUND IDLE buttons must be disengaged manually in order to restore ac power and to prevent a drain on the battery. If the BUS TIE switch is not in the TIED position, the LOW SPEED GROUND IDLE buttons will disengage automatically.

2.1.7.3 Throttle Friction Knob. A friction knob (see Figure 2-4) on the throttle quadrant adjusts the amount of friction applied to the throttles to prevent creeping or accidental movement.

2.1.7.4 ENGINE CONDITION Levers. Four pedestal-mounted condition levers (see Figure 2-4) are primarily controls for engine starting and stopping and propeller feathering and unfeathering. They actuate both mechanical linkages and switches that provide electrical control. Each lever has four placarded positions as follows:

1. RUN is a detent position. At this position, the lever closes a switch that places engine fuel and ignition systems under control of the speed-sensitive control. For engines No. 2 and No. 3, the ice-detection system is energized.

2. AIRSTART is a position attained by holding the lever forward against spring tension. In this position, the lever closes the same switch closed by placing the lever at RUN and, in addition, closes a switch that causes the propeller feathering pump to operate.

3. GROUND STOP is a detent position. In this position, the lever actuates a switch that causes the electrical fuel shutoff valve on the engine fuel

control to close only if the landing gear touchdown switches are closed. The switch also closes the nacelle preheat control circuit making this system operable, if installed.

4. FEATHER is a detent position. When the lever is pulled toward this position, mechanical linkages transmit the motion to the engine-mounted coordinator and from the coordinator to the propeller and to the shutoff valve on the engine fuel control. Switches are also actuated by the lever as it is pulled aft. The results of moving the lever to FEATHER are the following:

   a. The propeller receives a feather signal and mechanically and electrically energizes the feather solenoid valve.

   b. The fuel shutoff valve on the engine fuel control is closed both mechanically and electrically.

   c. The propeller feathering pump is turned on.

   d. The nacelle preheat system remains operable only when the aircraft is on the ground (if installed).

CAUTION

When pulling a condition lever to FEATHER, pull it all the way to the detent to ensure that the propeller is fully feathered when the engine fuel is shut off. If the lever is left at midposition and the NTS is inoperative, an engine decoupling is possible.

2.1.7.5 TEMP DATUM CONTROL VALVE Switches. Four temperature datum control valve switches (see Figure 2-6) are mounted on a control panel on the flight control pedestal. Each switch has AUTO, LOCKED, and NULL positions. The switch positions are used as follows.

The AUTO position permits normal operation of the electronic TD control system by applying single-phase, ac power to the amplifier through a FUEL & TEMPERATURE CONTROL circuit breaker on the pilot lower circuit breaker panel.

The LOCKED position may be set when the throttles are in temperature-controlling range, to provide a fixed-percentage correction on the metered fuel flow throughout the engine operating range and will permit the fuel control to compensate for changes in

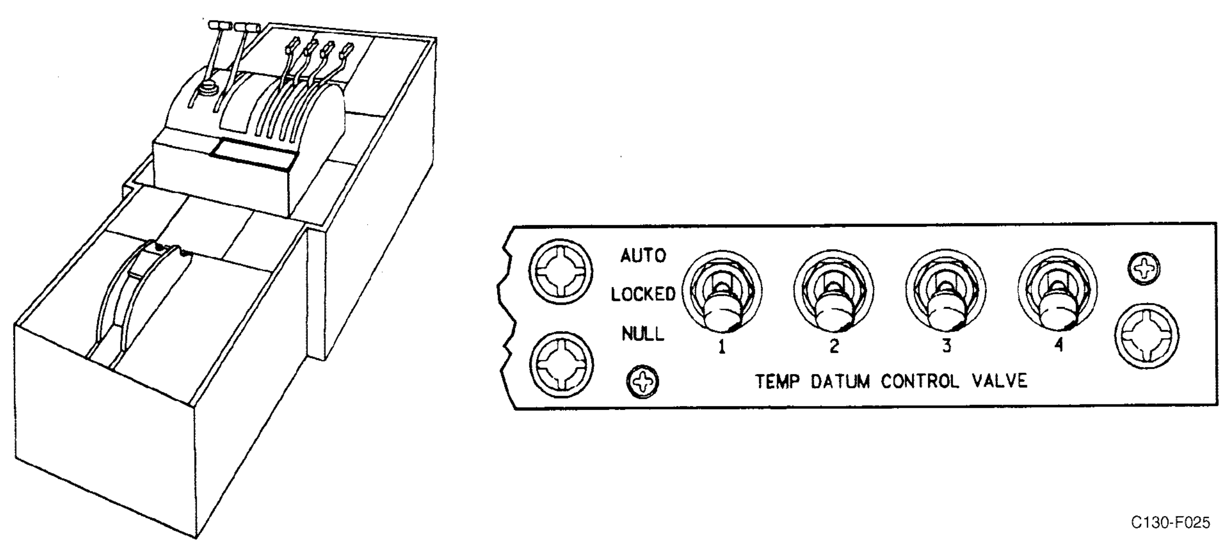


Figure 2-6. Temperature Datum Control Valve Panel

ambient temperatures in order to maintain a symmetrical shaft horse-power at flight idle. If the TD control valve switch is then positioned at LOCKED, the TD valve is locked at whatever position it is in at the time. The TD valves remain locked and the fuel correction lights remain out through all throttle movements, unless an overtemperature condition is sensed by the amplifier. When the switch is in the AUTO or LOCKED position, the TD valve for an engine is unlocked and set to a “take” position if TIT for the engine exceeds approximately 1,083 °C. If a valve is unlocked by its control system to correct an overtemperature condition, the fuel correction light for that engine comes on to indicate that the valve is unlocked.

Note

The switches lock the TD valves only when they are positioned at LOCKED while the throttle is in temperature-controlling range and the fuel correction light is out.

The NULL position removes ac power from the control system amplifier; the TD valve, receiving no control signals, returns to its null position so that it does not correct the fuel flow according to TIT. The TD valve brake is released by dc power supplied through a FUEL & TEMPERATURE CONTROL circuit breaker on the pilot lower circuit breaker panel.

The NULL position of these switches is used to deactivate the control systems when erratic fuel scheduling is suspected or when the engines are not operating.

2.1.7.6 Electronic Fuel Correction Lights. The four amber press-to-test ELECTRONIC FUEL CORRECTION lights (see Figure 2-7) are located on the pilot instrument panel. The lights are illuminated in the temperature-limiting range (throttles below 65°) and extinguished in the temperature-controlling range (throttles above 65°), if the TEMP DATUM CONTROL VALVE switches (see Figure 2-6) are in the AUTO position. The lights will be illuminated below 65° throttle and extinguished above 65° throttle, but will illuminate again if temperature limit is reached when the TEMP DATUM CONTROL VALVE switches are in the LOCKED position.

2.1.7.7 Starting Control System. The starting control system (Figure 2-8) automatically controls fuel flow and ignition during ground and air starts. Electrical power for the control circuits is supplied from the essential dc bus through engine START CONTROL circuit breakers and the IGNITION CONTROL circuit breakers on the copilot side circuit breaker panel. The automatic control of the starting control system has a

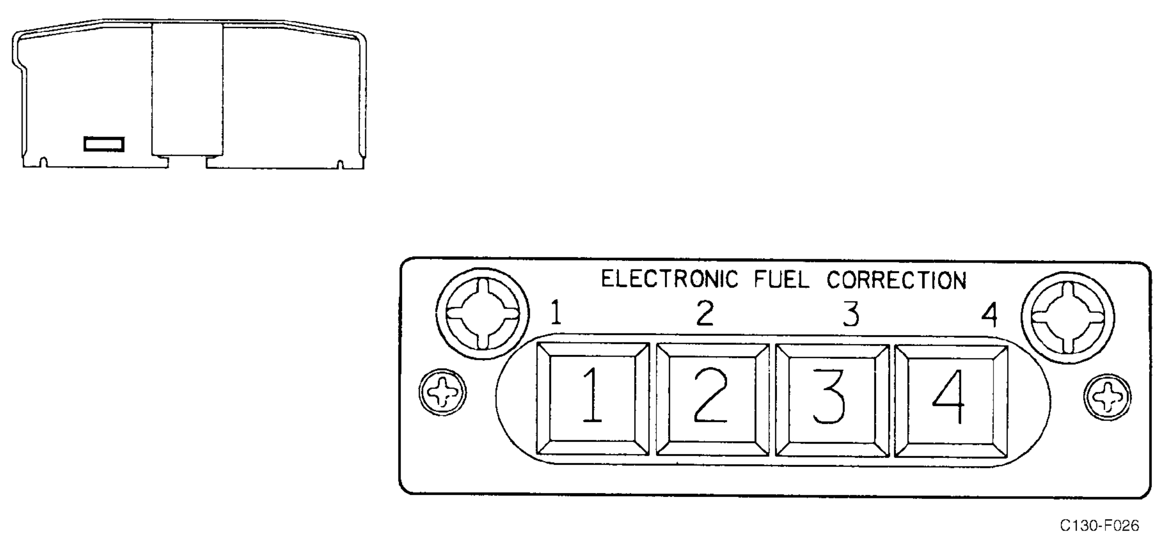


Figure 2-7. Electronic Fuel Correction Lights

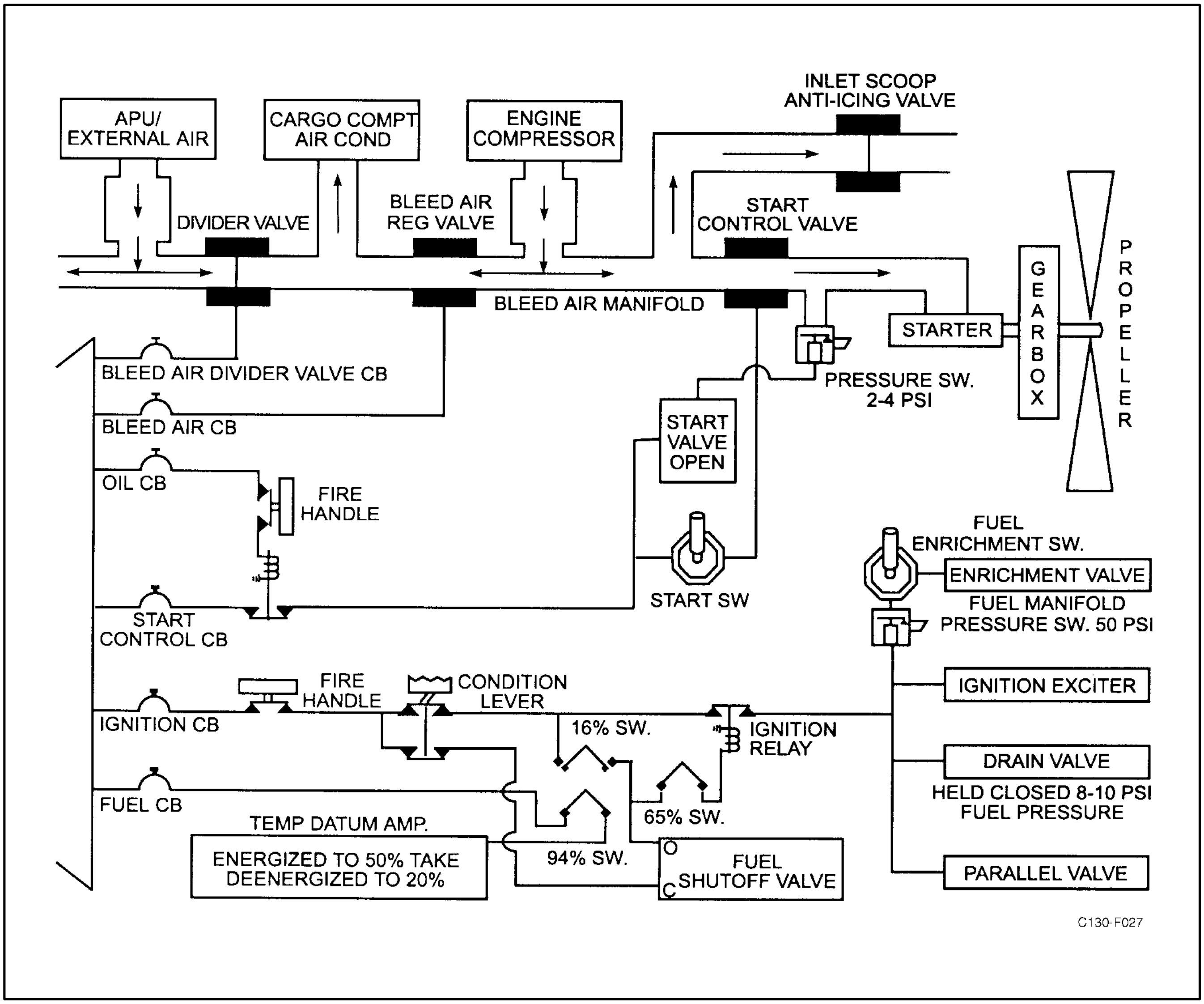


Figure 2-8. Engine Start Control System (Simplified Diagram)

speed-sensitive control and a speed-sensitive valve, which is engine-driven and performs the following functions:

1. On acceleration to 16-percent rpm — The fuel shutoff valve in the engine fuel control is opened, the ignition relay is energized completing circuits to the ignition exciter, the engine fuel pump paralleling valve closes, the fuel enrichment valve opens, and the manifold drip valve closes.

2. On acceleration to 65-percent rpm — Ignition system is deenergized, fuel pump paralleling valve is opened to return pumps to series operation, manifold drip valve is deenergized (it is then held closed by pressure).

3. On acceleration to 94-percent rpm — Electronic TD control system is switched from start limiting to normal limiting, and the speed-sensitive valve opens to allow 14th-stage bleed air to force the 5th- and 10th-stage compressor bleed valves closed.

2.1.7.8 Normal Engine Starting Sequence. During a normal start, the following actions take place automatically (provided Chapter 8 checklist procedures have been followed) as listed in Figure 2-9. An examination of the sequence will be helpful in understanding the overall operation of any start.

PERCENT ENGINE RPM (approximate)	ACTION	CONTROLLED BY
0 to 94	TIT limited to 830° by TD control	Speed-sensitive switch
0 to 94	5th- and 10th-stage compressor bleeds open	Speed-sensitive valve
—	Electronic fuel correction light on	Throttle and electronic fuel correction switch
16	Fuel shutoff opened	Speed-sensitive switch
16	Fuel enrichment on	Speed-sensitive switch and fuel enrichment switch
16	Fuel pumps in parallel operation	Speed-sensitive switch
16 and up	Drip valve closed	Speed-sensitive switch and pressure
16	Ignition on	Speed-sensitive switch
50 PSIG fuel manifold pressure	Fuel enrichment off	Manifold pressure switch
60	Starter switch released	Pilot
65	Fuel pumps in series operation	Speed-sensitive switch
65	Ignition off	Speed-sensitive switch
94	5th- and 10th-stage compressor bleeds closed	Speed-sensitive valve
94	TIT limited by TD	Speed-sensitive switch

Figure 2-9. Normal Engine Starting Sequence

2.1.7.9 Compressor Unloading. Bleed valves are located in the 5th and 10th stages of the compressor to allow more rapid acceleration of the turbine during starting and to minimize compressor surge or stall problems. The opening and closing of the 5th- and 10th-stage bleed valves is controlled by an engine-driven centrifugally actuated valve. On acceleration, the bleed valves are open from 0 to 94 percent at which point the engine-driven speed-sensitive valve opens to allow control air pressure flow from the 14th stage to close the bleed valves. The bleed valves remain closed until engine speed decelerates below 94 percent.

2.1.7.10 ENGINE GROUND START Switches. Four spring-loaded ENGINE GROUND START switches are located on the overhead control panel (see Figure 2-10). Holding the ENGINE GROUND START switch to the START position opens the starter regulator valve to permit bleed air from the bleed air manifold to drive the engine starter turbine. The ENGINE GROUND START switch should be released to OFF at 60-percent engine rpm.

2.1.7.11 Engine Fuel Enrichment Switches. The ENGINE FUEL ENRICHMENT switches are located on the engine starting panel (see Figure 2-10). They are toggle switches with NORM and OFF positions. In NORM, each switch allows the engine fuel enrichment valve to be controlled by the speed-sensitive control and manifold pressure switch during starting. The OFF position is provided to permit deactivating the fuel enrichment system for any engine. During the engine starting cycle the fuel enrichment system furnishes unmetered fuel to the TD valve to supplement normal flow through the fuel control. This enriching starts at 16 percent rpm and lasts only until fuel manifold pressure reaches approximately 50 psi.

Note

If fuel enrichment is used and the engine does not start, the drip valve should drain all excess fuel in the engine overboard when the start is discontinued. If the drip valve fails to drain the excess fuel, it is advisable to place the ENGINE FUEL ENRICHMENT switch to OFF for the next starting attempt and motor the engine, with the condition lever in GROUND STOP, to eliminate the accumulated fuel from the engine to preclude a hot start or torching.

Characteristics of the starts will vary during extreme cold weather. With fuel enrichment off, light-off occurs between 22.0- and 26.5-percent rpm and several seconds may elapse between maximum turbine-starter-driven rpm and light-off. Torching may occur also. Starting with fuel enrichment normal produces light-off between 19.0- and 27.0-percent rpm with rapid engine acceleration. If a stalled start takes place, it can be noted by rpm lag at about 40-percent rpm and a sharp TIT increase. When the engine is still hot from previous operation, stalled starts are more likely to occur with fuel enrichment on. After an unsuccessful attempt to start the engine with fuel enrichment OFF, the next attempt should be made with fuel enrichment normal.

2.1.7.12 ENGINE BLEED AIR Switches. The ENGINE BLEED AIR switches, located on the anti-icing and deicing control panel, are three-position (OFF, ON, OVRD) toggle switches. Each switch controls a pressure-actuated, dual solenoid-controlled pressure regulator. When the bleed-air switch is in OFF, the regulator shuts off all airflow to or from the engine. When the switch is in the ON position, the regulator regulates airflow from the engine to the bleed-air manifold to approximately 50 psi and prevents airflow into the engine nacelle if the bleed-air manifold pressure is above approximately 50 psi. Low bleed-air manifold pressure will allow airflow into an engine nacelle. When the switch is in OVRD (override), the regulator is fully open and permits air flow in either direction. It is necessary to use the OVRD position during engine starting, nacelle preheating (if installed), and for engine inlet air scoop anti-icing with the engine not running. A check valve is provided to prevent backflow into the engine diffuser. The bleed-air regulators receive 28-Vdc

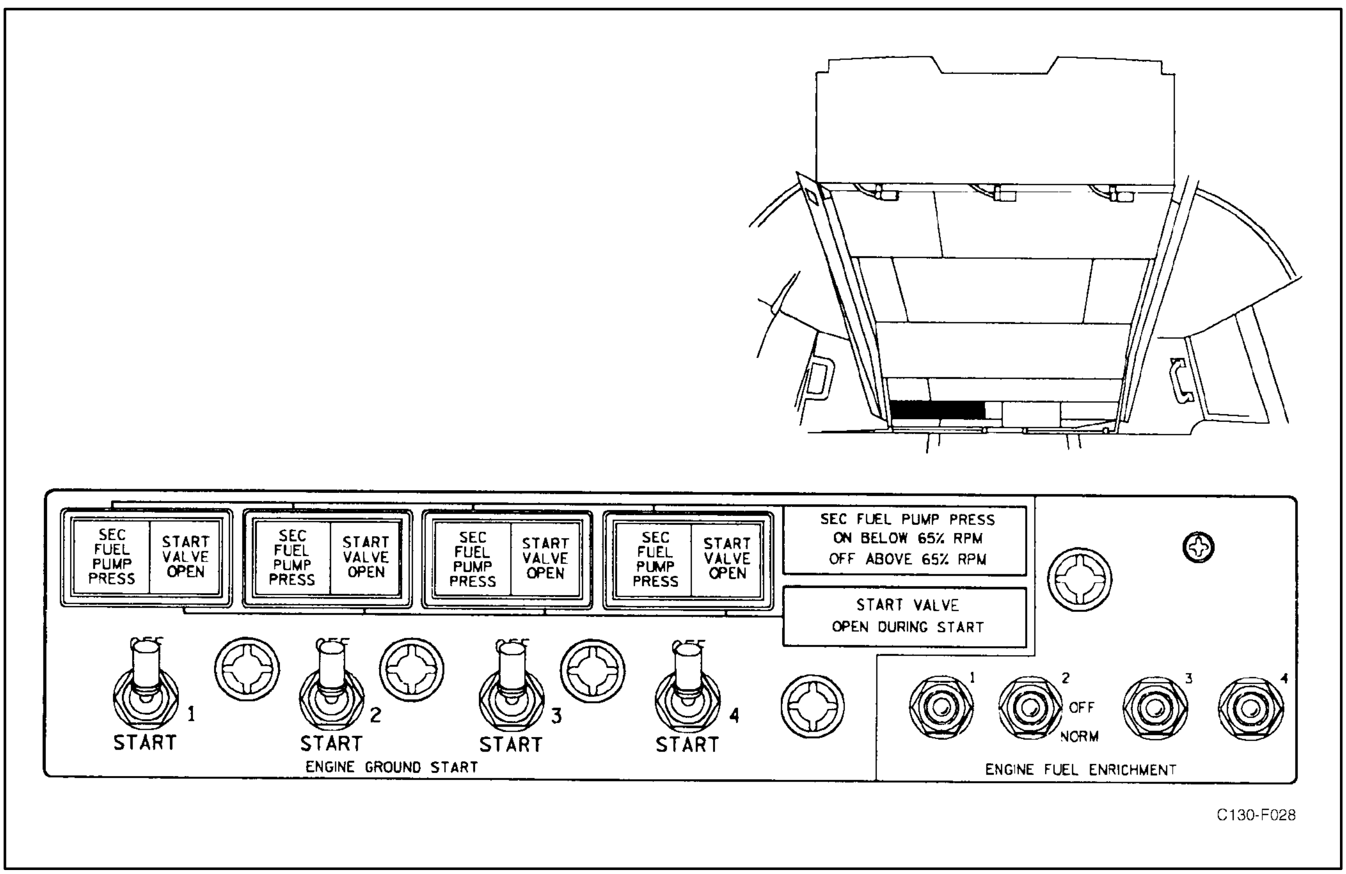


Figure 2-10. Engine Starting and Fuel Enrichment Panel

power from the essential dc bus through the BLEED AIR FIRE SHUTOFF VALVES circuit breakers on the copilot side circuit breaker panel. The regulators go to the closed position when deenergized.

2.1.7.13 Feather Valve and NTS Test Switch and Lights. The feather valve and NTS check system (see Figure 2-18) consist of a FEATHER VALVE AND NTS CHECK switch, four indicator lights (one for each engine), four NTS check relays (one for each engine), and a feather valve switch and an NTS switch in each propeller control assembly. When the FEATHER VALVE AND NTS CHECK switch is in the VALVE position, it completes the light circuits from the essential dc bus through the lights and contacts of each NTS check relay to the feather valve switch in each propeller control assembly. If the feather valve is positioned by the condition lever for feathering the propeller, it completes a circuit to ground for the corresponding indicator light. The light will come on to indicate that the feather valve is in position to feather the propeller. When a propeller is feathered by a fire emergency control handle, the corresponding light will not come on, although the feather valve is in the feather position. When the FEATHER VALVE AND NTS CHECK switch is in the NTS position, it completes two circuits. One circuit is completed from the essential dc bus through each indicator light to a set of contacts in each NTS check relay. The other circuit is completed from the essential dc bus through the coil of each NTS check relay to the NTS check switch in the propeller control assembly. When a negative torque condition exists, the engine NTS plunger actuates a linkage that closes the NTS switch. The NTS switch completes a circuit to ground for the NTS check relay coil and energizes the relay. The relay actuates to provide a ground path for the light circuit and the relay coil. The relay will remain energized, and the indicator light will glow as long as the FEATHER VALVE AND NTS CHECK switch is in the NTS position.

2.1.8 Engine Instruments. The engine instruments are located on a panel at the center of the main instrument panel. Indicator lights for fuel pressure warning are on the overhead control panel. For additional information on fuel flow gauges and pressure warning lights, refer to Fuel System Indicators, paragraph 2.6.11.

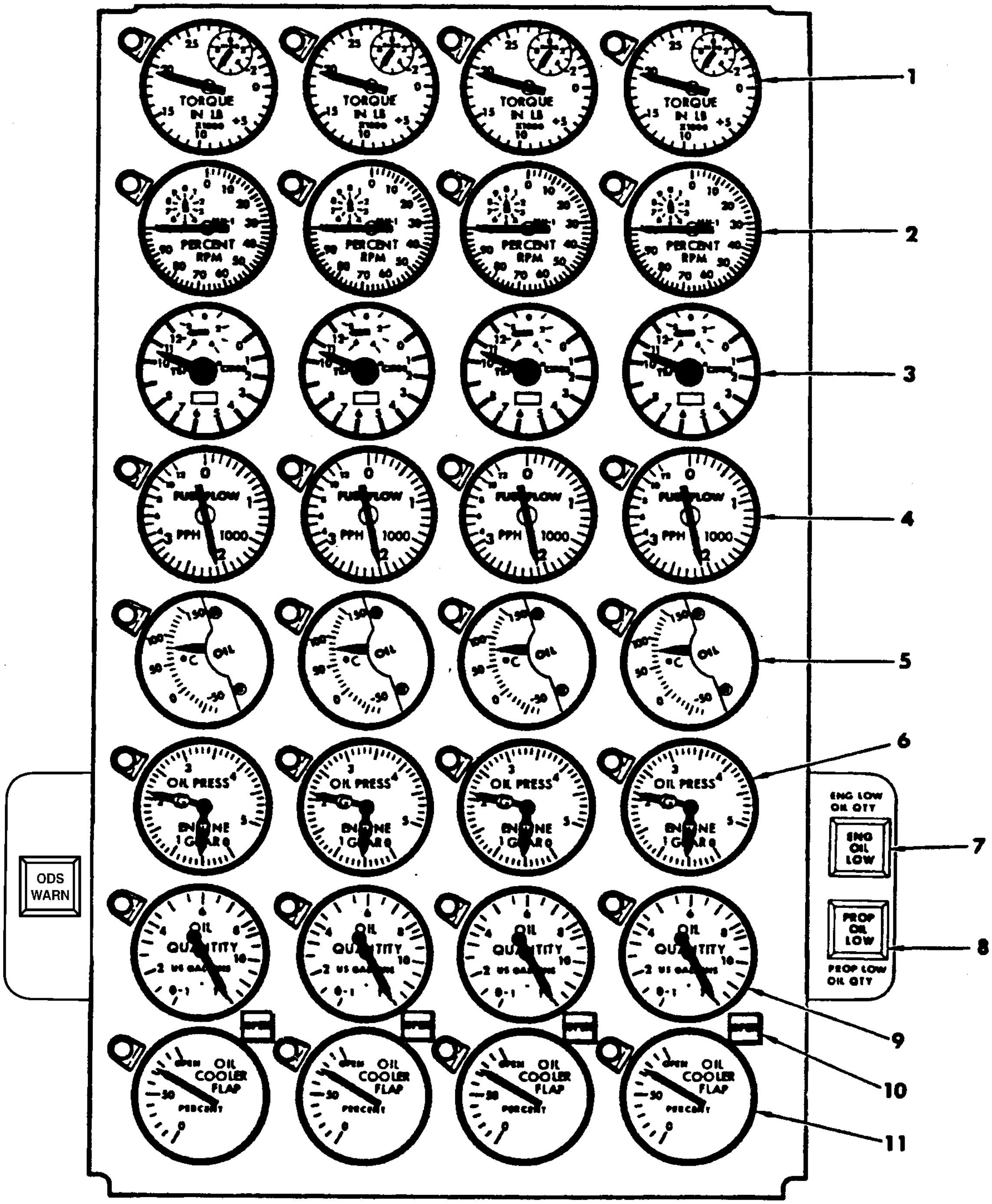
2.1.8.1 Torquemeters. Each of the four torquemeters (see Figure 2-11) indicates positive and negative torque in inch-pounds. The indicated torque is detected at the extension shaft between the engine power section and reduction gear assembly. The torquemeter system uses 115-volt, single-phase, ac power from the ac instrument and engine fuel control bus through the ENGINE TORQUEMETER circuit breakers on the pilot lower circuit breaker panel.

2.1.8.2 Tachometers. Each of the four tachometers (see Figure 2-11) indicates engine speed in percent of normal engine rpm. A vernier dial on each indicator makes it possible to read to the nearest percent. The tachometer system uses a separate engine-driven tachometer generator, mounted on each engine, that is not dependent upon the aircraft electrical system for operation.

2.1.8.3 Turbine Inlet Temperature Indicators. Each of the TIT indicators (see Figure 2-11) indicates temperature sensed by thermocouples in the engine turbine inlet casing. Each indicator registers temperature in degrees Centigrade and contains a vernier scale graduated in degrees. The indicator system uses 115-volt, single-phase, ac power from the ac instrument and engine fuel control bus through the TURBINE INLET TEMPERATURE circuit breakers on the pilot lower circuit breaker panel.

2.1.8.4 Fuel Flow Gauges. Each of the four fuel flow gauges (see Figure 2-11) indicates flow in pounds per hour. Flow is measured at the point where fuel enters the manifold on the engine. The indicating system receives single-phase, 115-Vac power from the ac instrument and engine fuel control bus through the FUEL FLOW circuit breakers on the pilot lower circuit breaker panel, and it receives 28-Vdc power from the essential dc bus through the FUEL FLOW circuit breaker on the copilot lower circuit breaker panel.

2.1.8.5 Secondary Fuel Pump Pressure Lights. Four press-to-test secondary fuel pump pressure lights are located on the engine starting and fuel enrichment panel (see Figure 2-10). Each light is controlled by a pressure switch on the engine fuel pump and filter assembly. The light is normally on while the two gear pumps in the assembly are operating in parallel during engine starting (prior to 65-percent rpm). The



1. TORQUEMETER
2. TACHOMETER
3. TURBINE INLET TEMPERATURE
4. FUEL FLOW
5. OIL TEMPERATURE
6. OIL PRESSURE
7. ENGINE LOW OIL QUANTITY WARNING LIGHT
8. PROP LOW OIL QUANTITY MASTER WARNING LIGHT
9. OIL QUANTITY
10. OIL COOLER AUGMENTATION VALVE POSITION INDICATOR
11. OIL COOLER FLAP POSITION

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Figure 2-11. Engine Instrument Panel

light also illuminates at any other time if the pump paralleling valve is closed or if the primary gear pump fails. If the light does not illuminate during starting, either the pump paralleling valve is open or the secondary pump has failed. The lights are energized by 28-Vdc power from the essential dc bus through the SEC PUMP IND LIGHT circuit breaker on the copilot side circuit breaker panel.

2.1.8.6 Oil Temperature Gauges. The four oil temperature gauges (see Figure 2-11) indicate oil temperature in the oil inlet lines in degrees Centigrade. The electrical-resistance-type indicators receive 28-Vdc power from the essential dc bus through the ENGINE OIL TEMP INDICATOR circuit breaker on the copilot side circuit breaker panel.

2.1.8.7 Oil Pressure Gauges. Four dual oil pressure gages (see Figure 2-11) register oil pressure for both the engine power sections and reduction gears. The rear needle marked “G” on each indicator shows reduction gear oil pressure, and the front needle marked “E” indicates power section oil pressure. The oil pressure gauges receive 26-Vac power from the instrument transformers through engine Nos. 1, 2, 3, and 4 GEAR BOX IND OIL PRESSURE and IND ENGINE OIL PRESSURE fuses on the pilot lower circuit breaker panel.

2.2 FIRE AND OVERHEAT DETECTION SYSTEMS

A fire detection system is provided for each engine and the APU. An overheat detection system is provided for the engine turbine and nacelle, anti-icing, and air-conditioning. The engine and nacelle fire and overheat detection systems are described below. Refer to the appropriate system for description of other detection systems.

2.2.1 Fire Detection System. The fire detection system for each engine and APU consists of a continuous loop detector, an amplifier, and warning lights in the flight station. When a high temperature is detected, the amplifier unit initiates a signal to the warning lights. These lights give a steady red glow when activated. The fire detection system receives 28-Vdc power from the essential dc bus through the FIRE DETECTOR circuit breakers on the copilot side circuit breaker panel.

2.2.1.1 Fire Detection System Test Switch. The fire detection test switch labeled ENGINE FIRE is located on the warning system test panel (see Figure 2-12) on the overhead control panel. The test system is provided to test the operation of the detectors and the warning lights. When the switch is placed in the TEST position, all five fire detection systems are

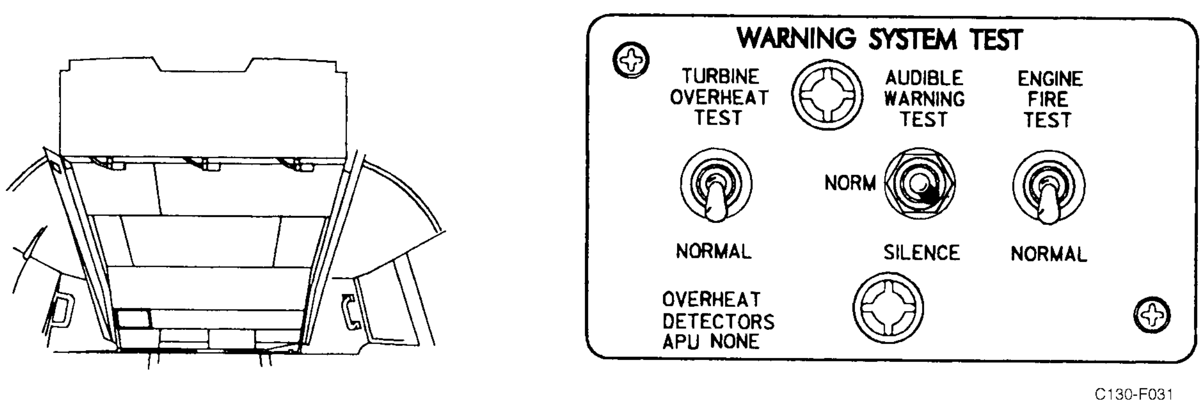


Figure 2-12. Warning System Test Panel

activated and the warning lights will go on. Failure of a warning light to go on indicates a break in continuity in the warning circuit.

2.2.1.2 Fire Detection System Warning Lights. The fire detection system warning lights consist of the master fire warning light and the lights in the fire emergency control handles.

2.2.1.2.1 Master Fire Warning Light. A red master fire warning light and an edge-lighted panel are located on the pilot instrument panel (see Figure 2-13). If a fire is detected by any one of the detection systems, the warning light and panel light will glow steadily. The steady light distinguishes the signal from an overheat warning indication, which is a flashing of the same light. When the master light indicates a fire, the lights in one of the fire emergency control handles will be on also to indicate the location of the fire. The master fire warning light receives power from the essential dc bus through the MASTER FIRE WARNING circuit breaker on the copilot side circuit breaker panel.

2.2.1.2.2 Fire Emergency Control Handle Lights. Each emergency control handle (see Figure 2-17) contains four indicator lights. The top two lights in the handle flash indicating a turbine overheat, while the two lower lights glow steady when a fire is detected in the corresponding engine.

2.2.2 Turbine Overheat Warning Systems. An overheat warning system is provided for each engine turbine. Each system consists of four thermal-switch detector units mounted in the “hot section” of the nacelle aft of the firewall, a flasher, and indicator lights. These components are interconnected so that an overheat condition sensed by any one of the detectors causes the lights to flash. The detectors are connected in parallel to a loop; and if part of the detectors is inoperable, the remaining detectors can still close the circuit to turn on the lights. A test switch permits testing all four systems at the same time. The fenwal setting at which the detector lights will give an overheat warning is approximately 700 °F. The 28-Vdc power for energizing the system is supplied from the essential dc bus through OVERHEAT DETECTORS TAILPIPE circuit breakers on the copilot side circuit breaker panel.

2.2.2.1 Turbine Overheat Warning Lights. Overheat warning of the engine turbine is indicated by flashing of the master fire warning light and the lights in the fire emergency control handles.

2.2.2.1.1 Master Fire Warning Light. A red master fire warning light and an edge-lighted panel are located on the pilot instrument panel (Figure 2-13). The master fire warning light and the panel light flash when any one of the engine overheat warning systems senses an overheat condition. The lights in the fire emergency control handle for the overheated engine will flash also. The master fire warning light receives power from the essential dc bus through the MASTER FIRE WARNING circuit breaker on the copilot side circuit breaker panel.

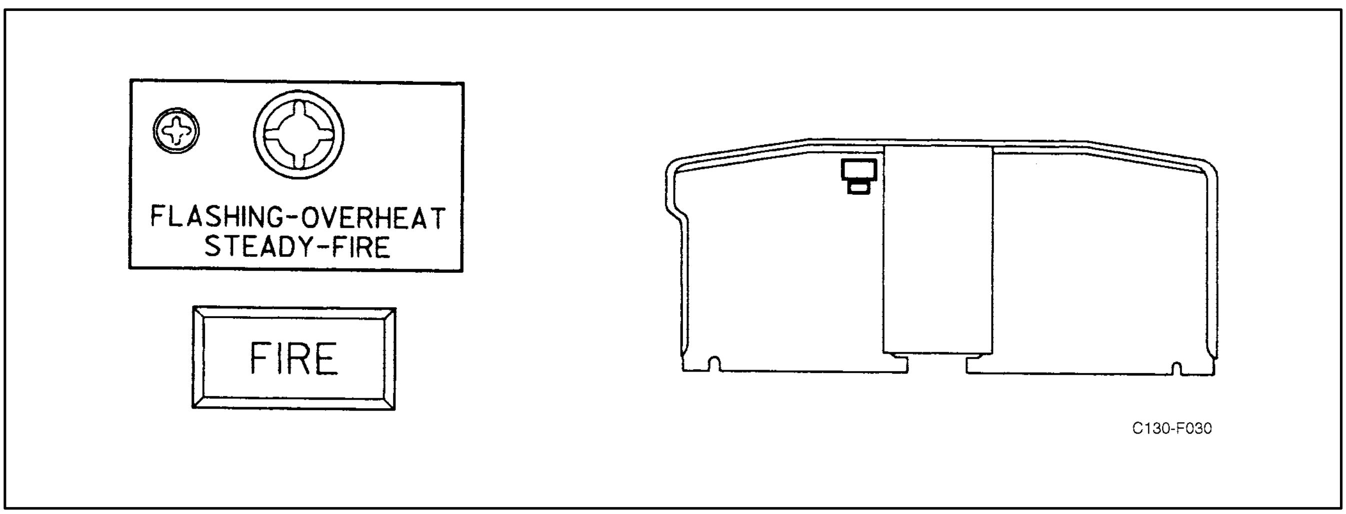


Figure 2-13. Master Fire Warning Light

2.2.2.1.2 Fire Emergency Control Handle Lights. Each fire emergency control handle (see Figure 2-17) contains two red indicator lights that flash when an overheat condition is sensed in its respective engine.

2.2.2.2 Turbine Overheat Detector Test Switch. The overheat detection test switch labeled TURBINE OVERHEAT (see Figure 2-12) is located on the warning system test panel on the overhead control panel. The switch has NORMAL and TEST positions. When positioned at TEST, it closes all four of the overheat warning system circuits in the same manner as if they were closed by detectors sensing an overheat condition. If the indicator lights all come on and flash when the switch is operated, circuit continuity and flasher operation are satisfactory.

Note

The test switch will only check circuit continuity and that the switch is functioning properly. Even though all indicator lights come on and flash, this does not indicate the detectors are properly set or even operating.

2.2.2.3 Audible Warning Test Switch. The AUDIBLE WARNING test switch (see Figure 2-12) is a three-position (TEST, NORM, SILENCE), spring-loaded toggle switch, located on the warning system test panel. The TEST and SILENCE positions of the switch are both test positions. Holding the switch to TEST while visually monitoring the master fire warning light and No. 1 fire emergency control handle light provides a check of the continuity of the fire warning system. The master fire warning light panel and the No. 1 fire emergency control handle light should illuminate with a steady glow. When the switch is released, it should return to NORM. Holding the switch to SILENCE while simultaneously holding the engine test switch to TEST and repeating both monitoring operations provides a check on the current operational status of a holding relay in the system. If the master fire warning light and all fire emergency control handle lights glow, the relay is functioning as desired. Releasing the switch from the SILENCE position should cause it to return to NORM. Electrical power for the system is furnished from the essential dc bus through an AUDIO WARNING circuit breaker located on the copilot side circuit breaker panel.

Note

There is no audible fire warning on any Navy C-130T aircraft. This switch only tests a holding relay.

2.2.3 Nacelle Overheat Warning Systems. An overheat warning system is provided for each nacelle. Each system consists of eight thermal-switch detector units, seven mounted in the nacelle area forward of the firewall, one mounted in the horse collar area, and a warning light on the copilot instrument panel. A test switch is provided for testing all four warning systems simultaneously. The purpose of each system is to warn of an overheat condition in the area around the engine compressor section. Overheat in this area can result from the nacelle preheat valve being opened or a rupture occurring in the bleed-air system ducts. The overheat condition could also result from fire. The overheat condition can be detected by any one of the detectors, which are connected in parallel to a loop. The fenwal setting at which the detector lights will give an overheat warning is approximately 300 °F.

2.2.3.1 Indicator Lights. Four numbered nacelle overheat warning lights and a test panel (see Figure 2-14) are located on the copilot instrument panel. If overheat is detected in any nacelle, the corresponding overheat warning light and the light on the test panel will go on. Power for the overheat warning lights comes from the essential dc bus through the OVERHEAT DETECTORS NACELLE TAILPIPE circuit breakers on the copilot side circuit breaker panel. The indicator lights receive 28-Vdc power from the essential dc bus through the NACELLE OVERHEAT NAMEPLATE and OVERHEAT DETECTORS NACELLE circuit breakers on the copilot side circuit breaker panel.

2.2.3.2 Nacelle Overheat Test Switch. A nacelle overheat test switch is located on the copilot instrument panel next to the warning lights (see Figure 2-14). Operation of the test switch closes all four nacelle overheat warning circuits simultaneously, causing all four warning lights and the panel lights to glow as long as the switch is held in TEST. Failure of a light to go on indicates a break in continuity in the warning circuit.

Note

The test switch will check only circuit continuity and that the switch is functioning properly. Even though all indicator lights go

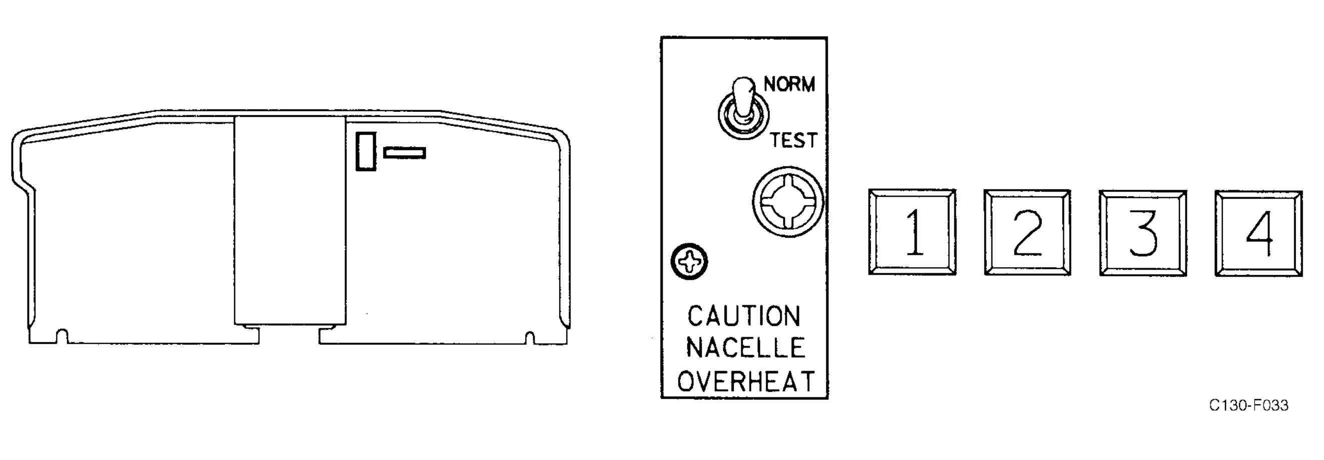


Figure 2-14. Nacelle Overheat Control Panel and Lights

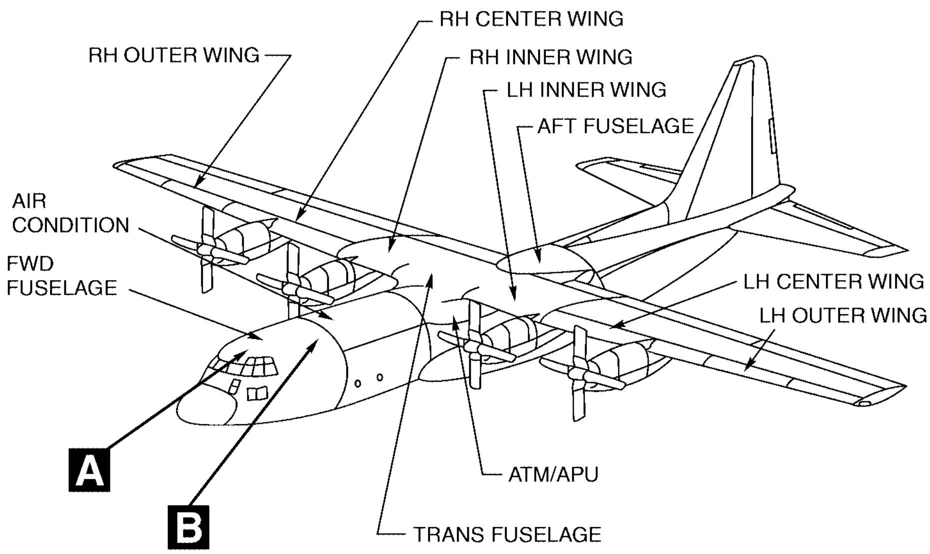
on, this does not indicate that the detectors are properly set or even that they are operating.

2.2.4 Bleed Air Duct Overheat Detection System (ODS). An overheat warning system is provided for the aircraft's high-pressure bleed air ducts. The system will provide warnings upon detection of small leaks in the bleed air duct system, which if left undetected could cause extensive collateral damage to other aircraft systems and structures. The system consists of a control unit, a relay panel, an ODS control panel, and several continuous discrete sensing elements divided into 11 zones. The sensing elements will detect a rise in temperature and are set to provide visual and audible warnings at temperatures of 310° F for elements located outside the aircraft and 255° F for elements within the fuselage compartment (see Figure 2-15). If an overheat condition is detected, warning lights in the flight station will illuminate and the landing gear warning horn will pulse at 90 cycles per minute. The control unit in the cargo compartment will also display a code that can be used for further troubleshooting. When the overheat condition diminishes, the system will reset and the sensing elements return to their original condition with no external action required. A broken sensing element will continue to function on either side of the break; however, the system will not properly test. The system receives 115-Vac power from the essential ac bus through the LHS SENSORS and RHS SENSORS circuit breakers and 28-Vdc power from the essential dc bus through the ODS ALARM and ODS CONTROL circuit breakers located on the pilot's lower circuit breaker panel.

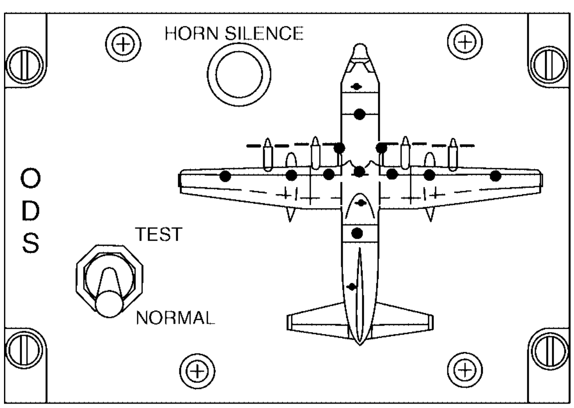
2.2.4.1 ODS Control Panel. The ODS control panel is located on the flight engineer's overhead panel (Figure 2-15). The control panel provides visual indications of an ODS warning and incorporates a warning horn silence button and system test switch. Eleven NVIS red indicator lights correspond to the 11 zones of the sensor elements and are grouped into six output alarms. Alarm signal 1 illuminates all three indicator lights in the left wing. Alarm signal 2 illuminates all three indicator lights in the right wing. Alarm signal 3 illuminates both the transfuselage and forward fuselage indicator lights. Alarm signal 4 illuminates the aft fuselage indicator light. Alarm signal 5 illuminates the APU indicator light. Alarm signal 6 illuminates the air conditioning indicator light.

2.2.4.1.1 ODS Test Switch. A lever locked NORMAL/TEST toggle switch located on the ODS control panel allows the operator to activate a system self-test. The switch is spring-loaded to the NORMAL position. Placing the switch to the test position will illuminate the 11 indicator lights, the ODS master warning light, and cause the landing gear warning horn to sound in pulsing mode (90 cycles per minute).

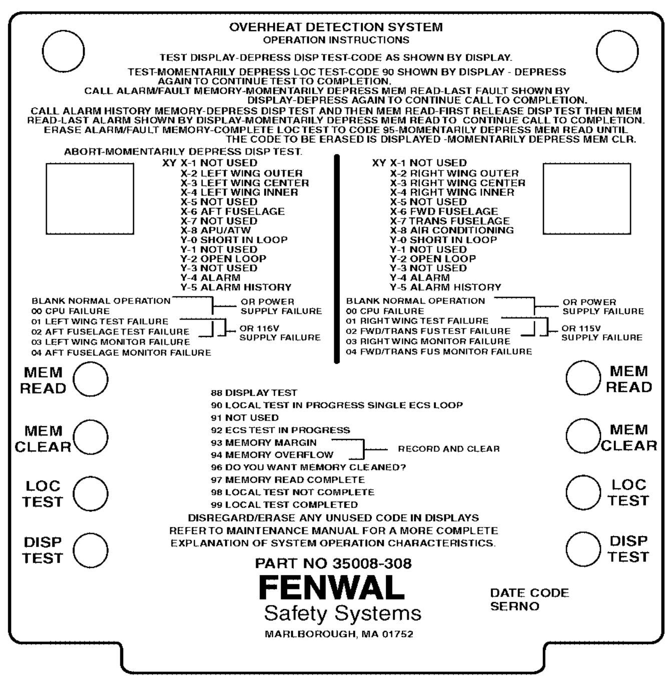
2.2.4.1.2 ODS Horn Silence Switch. A HORN SILENCE switch is located on the ODS control panel and allows the ODS warning horn to be silenced during an alarm condition or self-test.



ALARM SIGNAL	GEOGRAPHICAL ZONES
1	LH OUTER, LH CENTER, LH INNER WING
2	RH OUTER, RH CENTER, RH INNER WING
3	TRANSFUSELAGE, FORWARD FUSELAGE
4	AFT FUSELAGE
5	APU
6	CARGO AIR CONDITIONING PACKAGE



A ODS CONTROL PANEL



B ODS CONTROL UNIT

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Figure 2-15. Bleed Air Overheat Detection System (ODS)

2.2.4.2 ODS Master Warning Light. An amber ODS master warning light is located on the lower left side of the engine instrument panel (Figure 2-11). If an overheat condition is detected, the master warning light will illuminate steady along with the pulsing landing gear warning horn and corresponding alarm indicator lights on the overhead control panel.

2.2.4.3 ODS Control Unit. The ODS control unit is located on the starboard side of the cargo compartment. The control unit monitors sensing elements mounted in 11 zones throughout the aircraft and groups them into 6 alarm zones. The control unit's monitoring circuits record any alarm condition and transmit signals to the control panel in the flight station to indicate where the overheat condition exists. Specific alarm and malfunction codes are displayed on LED readouts on the face panel of the control unit. All malfunction and alarm codes are stored in memory for maintenance and repair purposes.

2.3 FIRE EXTINGUISHING SYSTEM

A two-shot bromotrifluoromethane (BT) fire extinguishing system (see Figure 2-16) is connected through a series of directional-flow valves to each of the four engine nacelles and to the APU compartment. The extinguishing agent is contained in two bottles mounted in the left wheelwell. Each bottle contains approximately 27 pounds of agent. One bottle is discharged each time the system is actuated. A check valve prevents a discharged bottle from being recharged when a fresh bottle is fired. Each bottle is charged to approximately 600 psi with nitrogen, the nitrogen acting as a propellant for the BT. Individual pressure gauges on each bottle show charged pressure.

WARNING

Repeated or prolonged exposure to high concentrations of BT or decomposition products should be avoided. BT is a narcotic agent of moderate intensity but of prolonged duration. It is considered to be less toxic than carbon tetrachloride, methyl bromide, or the usual products of combustion. BT is safer to use than these fire extinguishing agents. However, normal precautions should be taken, including the use of oxygen when available.

2.3.1 Fire Extinguishing System Controls. The fire extinguishing system controls are located on the fire emergency control panel (see Figure 2-17) forward of the overhead electrical control panel. The fire extinguishing system control circuits use dc power supplied from the battery bus through three FIRE EXT circuit breakers on the pilot side circuit breaker panel. One circuit breaker labeled FIRE EXT is in the control circuit and the other two labeled FIRE EXT NO. 1 and NO. 2 are in the squib firing circuits (one for each squib).

2.3.1.1 AGENT DISCHARGE Switch. A three-position (NO. 1, OFF, NO. 2) toggle switch located on the fire emergency control panel (see Figure 2-17) controls the discharge of the bottles. The AGENT DISCHARGE switch is spring-loaded to the OFF position. The agent will not discharge unless a fire emergency control handle is pulled. The fire emergency handle circuit powers the correct sequence of solenoid directional control valves in the system to direct flow of agent to the selected engine when one of the bottles is fired. The directional flow valves move in the same order as the handles are pulled. If two fire emergency control handles are pulled, the agent will be routed to the engine for the last handle pulled. In order to route agent to the engine for the first handle pulled, the first handle must be pushed in and pulled again.

2.3.1.2 Fire Emergency Control Handles. The five plastic fire emergency control handles are mounted on the fire emergency control panel (see Figure 2-17). They operate emergency shutdown switches for the APU and the four engines. When an engine handle is pulled out, it closes dc circuits to operate valves that isolate the engine as follows:

1. The shutoff valve on the engine fuel control is closed.
2. The engine oil shutoff valve is closed.
3. The firewall fuel shutoff valve is closed.
4. The firewall hydraulic shutoff valves are closed.
5. The engine bleed-air regulator is closed.
6. Engine starting control circuits are deenergized.
7. The propeller is feathered.
8. The fire extinguisher system directional flow valves are positioned for routing agent to the engine. The extinguishing AGENT DISCHARGE switch is armed.

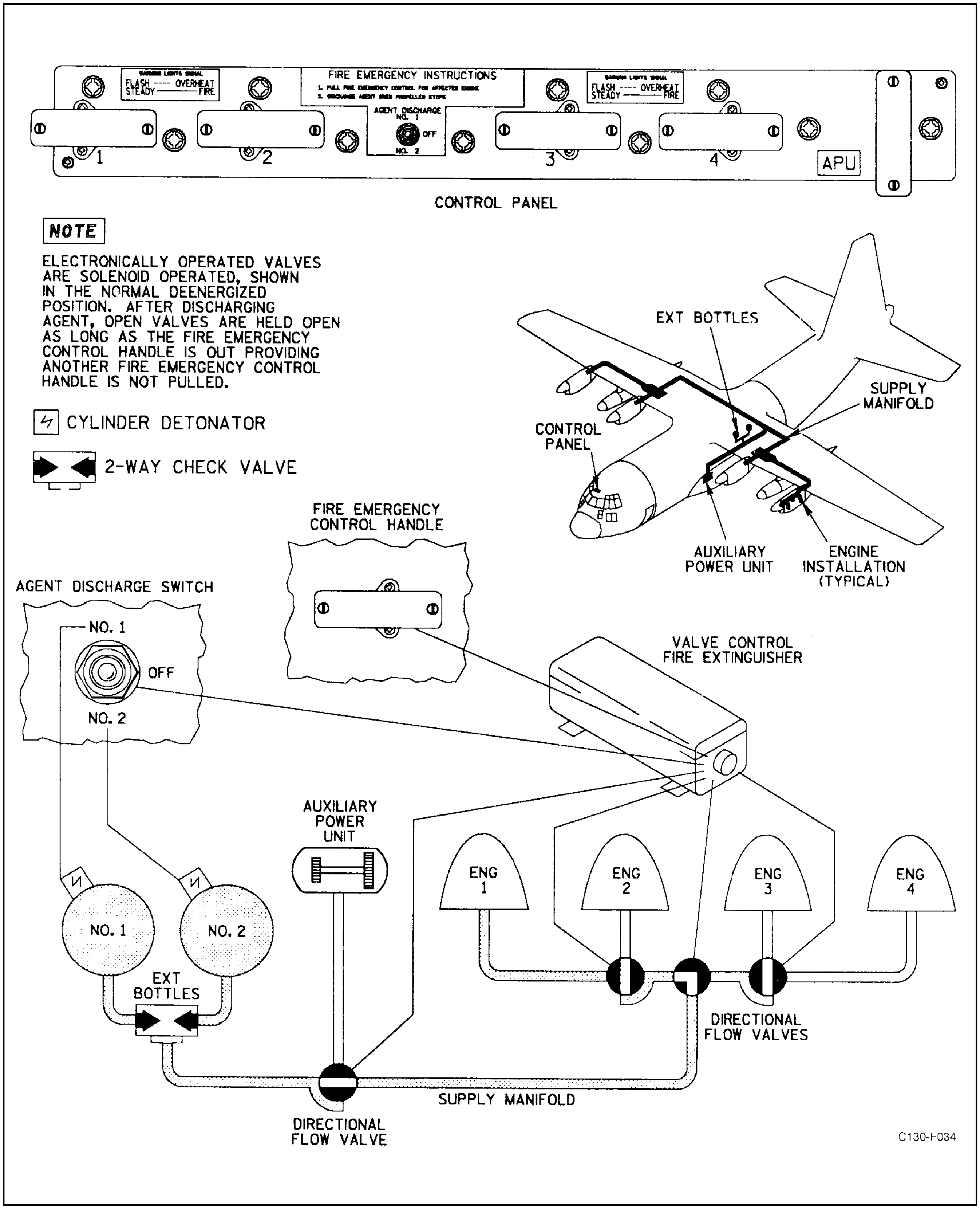


Figure 2-16. Fire Extinguishing System

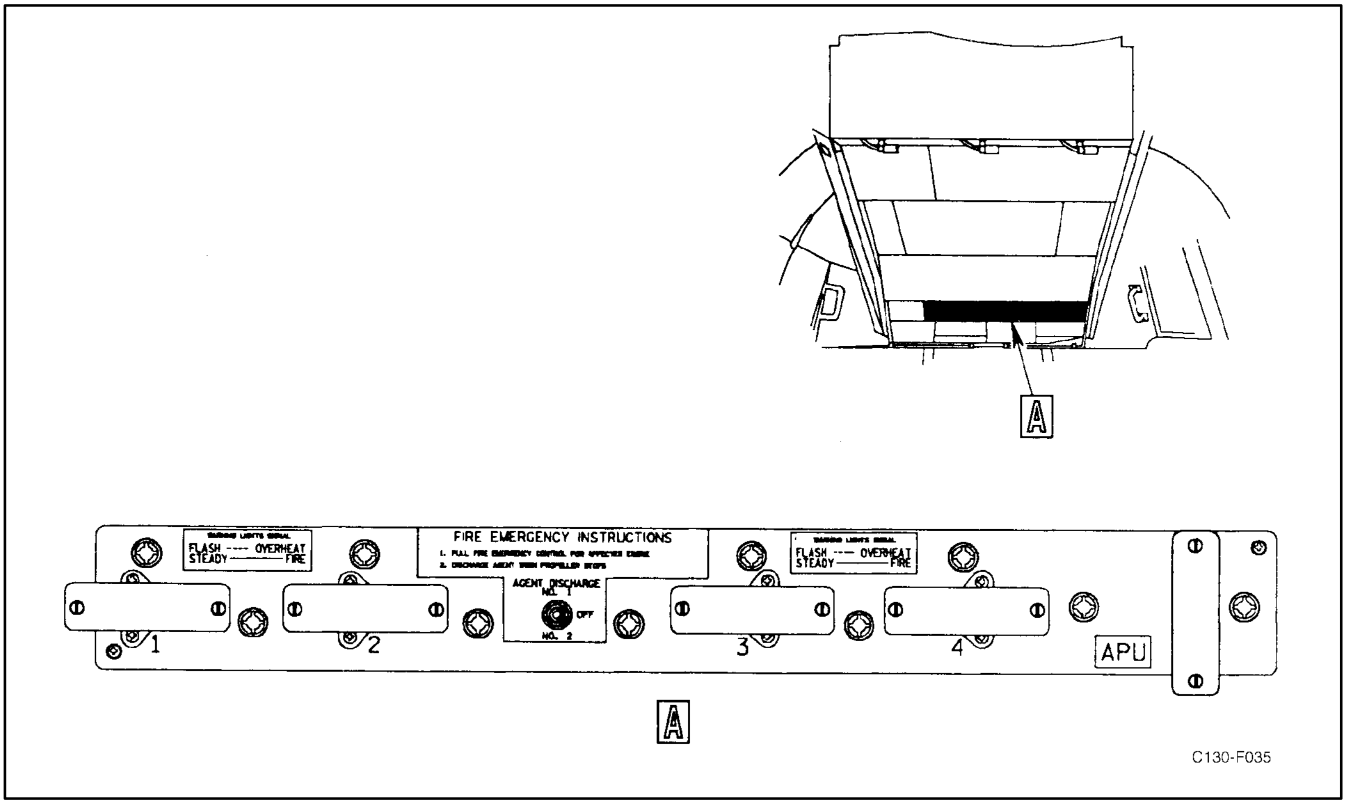


Figure 2-17. Fire Emergency Control Panel

When the APU handle is pulled, the APU is isolated as follows:

1. The fuel shutoff valve is closed.
2. The bleed-air valve is closed.
3. The fire extinguisher system directional flow valve is positioned for routing agent to the APU.
4. The extinguisher AGENT DISCHARGE switch is armed. The APU door closes.

2.4 PROPELLERS

Each engine is equipped with a Hamilton Standard, four-blade, electro-hydromatic, full-feathering, reversible-pitch propeller. The propeller operates as a controllable-pitch propeller for throttle settings below flight idle and as a constant-speed propeller for throttle settings of flight idle or above. The major components of the propeller system are the propeller assembly, the synchrophasing system, the control system, and the anti-icing and deicing system.

2.4.1 Propeller Assembly. The propeller assembly is made up of the propeller blades, barrel assembly, dome assembly, spinner assembly, control assembly, and the anti-icing and deicing assembly.

2.4.1.1 Propeller Blades. The propeller blades are solid aluminum alloy with hollow shanks for weight reduction. On the mounting end of the blades are located the blade gear segments, thrust bearings, oil seals, and deicing rings.

2.4.1.2 Barrel Assembly. The principal functions of the barrel assembly are to retain the blades within the propeller assembly, to provide the necessary means of attaching the propeller to the engine shaft, and to transmit engine torque to the blades. The barrel assembly is made in two sections that are bolted together to retain the propeller blades. An extension on the rear half of the assembly is machined to fit over the splined engine shaft. The pitchlock assembly, located inside the barrel assembly, consists of a stationary pitchlock ratchet ring, a pitchlock rotating ratchet, a pitchlock valve, and fly-weight assembly. The pitchlock prevents the blades from decreasing pitch if hydraulic pressure is lost, and it locks the blades at a fixed pitch angle if overspeeding occurs. The stationary and rotating pitchlock ratchet rings are held disengaged by propeller oil pressure and are spring loaded to engage when pressure is lost. When the ratchet rings are engaged, the propeller can increase pitch to allow feathering. In an overspeed condition, the flyweight assembly will remove oil pressure and allow the pitchlock to engage and prevent a decrease in blade angle. When the overspeed condition is corrected, oil pressure is restored to release the pitchlock.

2.4.1.3 Dome Assembly. The dome assembly is mounted on the forward section of the barrel assembly. It contains the pitch changing mechanism and the low-pitch stop assembly. The pitch changing mechanism converts hydraulic pressure into mechanical torque. Its main parts are a piston assembly, a stationary cam, a rotating cam, and the dome shell. The piston is a double-walled assembly that fits over the two cams and inside the dome shell. The piston is held in place by rollers that ride in the cam tracks of both cams. The rear of the rotating cam is connected by beveled gears to the propeller blades. As hydraulic pressure is applied to the piston, causing it to move, the rollers riding in the cam tracks turn the rotating cam, changing the blade angle. The low-pitch stop in the dome mechanically stops the piston from decreasing blade angle below the flight range. The low-pitch stop is retracted to allow lower blade angles during ground operation.

2.4.1.4 Control Assembly. The propeller control assembly is mounted on the aft extension of the propeller barrel but does not rotate. It contains the oil reservoir, pumps, valves, and control components that supply the pitch changing mechanism with hydraulic pressure of the proper magnitude and direction to vary the propeller blade angle as required for the selected operating condition. The valve housing assembly section of the control assembly contains the flyweight speed-sensing pilot valve, feather valve, feather solenoid valve, and feather actuating valve. The pump housing assembly contains a scavenge, main, and standby pump, and an electrically driven, double-element, auxiliary pump. The flow of fluid from these pumps is controlled by the valves in the valve housing assembly to accomplish the desired propeller operation. All mechanical and electrical connections necessary for propeller operation are made through the control assembly.

The mechanical connections are linkages from the engine control system and the NTS system. The electrical connections are for oil level indication, pulse generator coil, auxiliary pump motor, synchrophasing system, anti-icing and deicing systems, and the electrical feathering system.

2.4.1.5 Spinner Assembly. The spinner assembly, which improves the aerodynamic characteristics of the propeller assembly, encloses the dome, barrel, and control assemblies. It consists of a front section, a rear section, and a nonrotating afterbody assembly. Cooling air is admitted through an air inlet at the front of the spinner and passes over the dome assembly, barrel assembly, and control assembly fins, and exhausts through vents in the engine nacelle.

2.4.1.6 Anti-Icing and Deicing Assembly. The anti-icing and deicing assembly is made up of stationary and moveable contacts for conducting electrical power to the resistance-type heating elements on the leading edge and shank of each blade and the entire spinner assembly. Continuous anti-icing heaters cover the spinner front section and the afterbody assembly. Cyclic deicing heaters cover the remainder of the spinner front section, the spinner rear section, the blade shanks, and part of each blade's leading edge. The contact ring holder assembly mounted on the aft end of the barrel assembly contains four sliprings and four contact brush housing assemblies. Power from the aircraft electrical system is transmitted through the brushes and sliprings to the spinner anti-icing and deicing elements and the blade's deicing elements.

2.4.1.7 Propeller Low Oil Level Warning Lights. A PROPELLER LOW OIL WARNING light for each propeller is located on the copilot side shelf (see Figure 2-18); a PROP LOW OIL quantity light, which acts as a master warning light, is located on the engine instrument panel (see Figure 2-11). The propeller low oil warning system is controlled by a float-actuated switch in each propeller control assembly. When the oil quantity for each propeller drops approximately 2 quarts below normal, the float-actuated switch closes and illuminates the PROPELLER LOW OIL WARNING light for that engine and the PROP LOW OIL quantity light. If the oil quantity

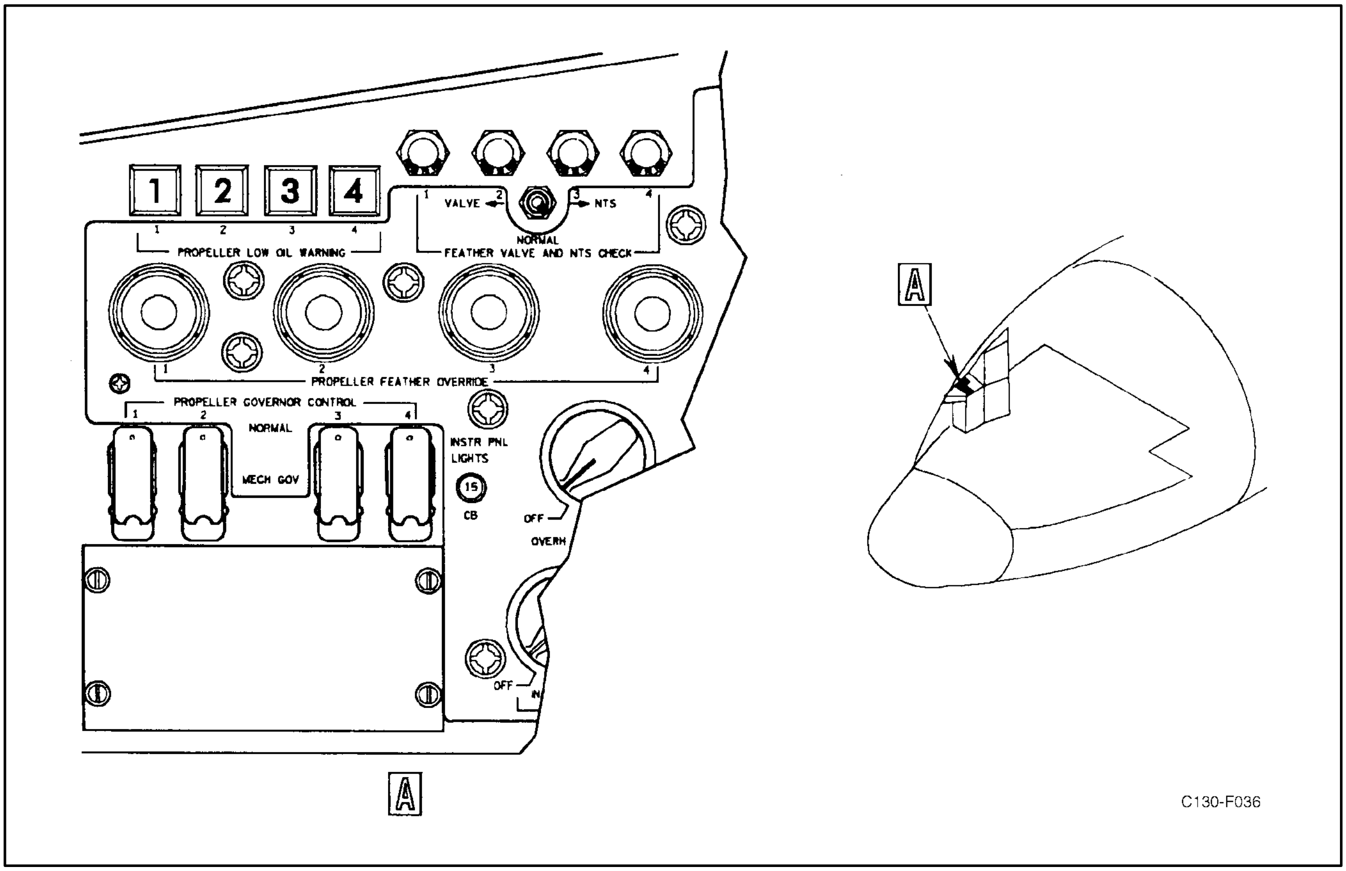


Figure 2-18. Propeller Controls

becomes low for another propeller, the only indication will be from the PROPELLER LOW OIL WARNING light for that engine. The low oil warning lights receive 28-Vdc power from the essential dc bus through the PROP LOW OIL LEVEL circuit breaker on the copilot side circuit breaker panel.

2.4.2 Propeller Speed Control System. The speed of the propeller is controlled by the propeller governing system and the synchrophasing system.

2.4.2.1 Propeller Governing System. The principal function of the propeller governing system is to maintain constant engine operating rpm. Propeller governing is accomplished by the action of the flyweight speed-sensing pilot valve. This valve is controlled by the mechanical action of the flyweight opposing the tension of the speeder spring. When the propeller is in an on-speed condition, the pilot valve meters sufficient fluid to the increased pitch or forward side of the dome assembly piston to overcome twisting movement and maintain the required blade angle. When an overspeed condition occurs, the flyweight force overcomes the speeder spring force, and the pilot valve moves to increase the flow to the increased-pitch side of the piston. If the propeller slows below governed speed, the force of the speeder spring overcomes the force exerted by the flyweights, and the pilot valve meters fluid to the aft side of the dome assembly piston to decrease blade angle and allow the propeller to increase speed. The low-pitch stop prevents the propellers from decreasing blade angle below the flight range while the throttles are in the flight range.

2.4.2.2 Synchrophasing System/Electronic Governing. The synchrophaser electronic unit provides circuits for the following governing functions: speed stabilization (derivative), throttle anticipation, and synchrophasing. The propeller mechanical governor will hold a constant speed in the flight range but throttle changes will cause the governor to overspeed or underspeed while trying to compensate for the change in power. A stabilization circuit stabilizes the mechanical governor during these changes when the propeller governor control switch is in the NORMAL/NORM position by sending a signal to the speed bias servo control motor to change the speeder spring compression. The throttle anticipation circuit stabilizes the propeller speed during rapid movement of the throttle when the propeller governor control switch is in the NORMAL position. Throttle movement rotates the anticipation potentiometer in the propeller control assembly sending a signal to the anticipation circuit which sends an amplified signal to the speed bias servo control motor to change the speeder spring compression. The synchrophasing system acts to keep all the propellers turning at the same speed, and it maintains a constant blade rotational position relationship to decrease vibration and to lower the noise level. The system uses either No. 2 or No. 3 engine as the master engine, and it relates the blade position of the other three engines to the master. The blade position of a slave engine is changed by moving the pilot valve to increase or decrease the speed of that engine. The synchrophasing circuit determines the blade position by comparing an electrical pulse generated by each slave propeller to a modified pulse from the master propeller. If the blades are in the correct position, the resultant voltage of the slave and master pulse will be zero. Any deviation in blade position will produce a positive or negative voltage from the two compared pulses. This voltage drives the speed bias servo control motor to change the speeder spring compression, correcting the blade position. If propeller operation is erratic, see paragraph 11.4.2, Propeller Malfunctions. The electronic propeller governing system is powered by the essential dc bus through the SYNCHROPHASER circuit breaker on the copilot side circuit breaker panel.

2.4.3 Negative Torque Signal Lockout System. The propeller is equipped with a lockout system to deactivate the NTS system for throttle settings below FLIGHT IDLE. When the throttle is moved below FLIGHT IDLE, a cam moves the actuator away from the NTS plunger and renders the system inoperative. This is necessary to prevent a propeller from receiving a possible negative torque signal at high landing speeds when the throttles are moved toward reverse, with resultant asymmetrical power problems.

2.4.4 Propeller Controls. Propeller controls include the throttles, condition levers, SYNCHROPHASE MASTER switch, PROP RESYNCHROPHASE switch, PROPELLER GOVERNOR CONTROL switches, fuel governor check switches, and feather override buttons.

2.4.4.1 Throttles. Each throttle (see Figure 2-4) is mechanically linked through the engine coordinator to an input shaft on the propeller control assembly. When the throttle is in the governing range, between FLIGHT IDLE and TAKE-OFF positions, the input shaft rotates with throttle movement but has no effect on propeller speed. When the throttle is in the range below FLIGHT IDLE, any movement of the throttle is transmitted to the speed-sensing pilot valve to increase or decrease blade angle. The maximum negative blade angle is obtained when the throttle is at MAXIMUM REVERSE. Approximate minimum thrust angle is obtained when the throttle is at GROUND IDLE. When the throttle is moved below FLIGHT IDLE, a cam locks out the NTS system and a switch interrupts synchrophaser signals to the propeller.

2.4.4.2 Engine Condition Levers. The engine condition levers (see Figure 2-4) serve primarily as feathering and unfeathering controls. Each lever is mechanically linked to the engine coordinator, which transmits the motion of the lever to the propeller linkage only when it is moved to the FEATHER position. When pulled to FEATHER, the condition lever also actuates switches to turn on the electrically-driven auxiliary pump in the propeller control assembly and the propeller blades are moved to the feather angle. For unfeathering, the engine condition lever is held in the AIRSTART position. A switch is actuated to turn on the propeller auxiliary pump, and the pump continues to operate as long as the lever is held in this position. When the engine condition lever is in the AIRSTART position and the auxiliary pump is operating, fluid is routed to the aft side of the dome assembly piston to move the blades to low-pitch angle. When the condition lever is in GROUND STOP or RUN positions, the propeller is controlled normally and the lever has no effect on its operation.

2.4.4.3 SYNCHROPHASE MASTER Switch. The SYNCHROPHASE MASTER switch (see Figure 2-19) is located on the flight control pedestal. This three-position (ENG 2, OFF, ENG 3) toggle switch controls the operation of the synchrophase system and selects the engine to be used as the master. When the switch is in the ENG 2 position, the No. 2 engine is selected as the master and the other propeller phase angles are referenced to this engine. When the switch is in the OFF position and the propeller governor control switches are in the NORMAL position, the synchrophasing system is turned off and the propellers operate

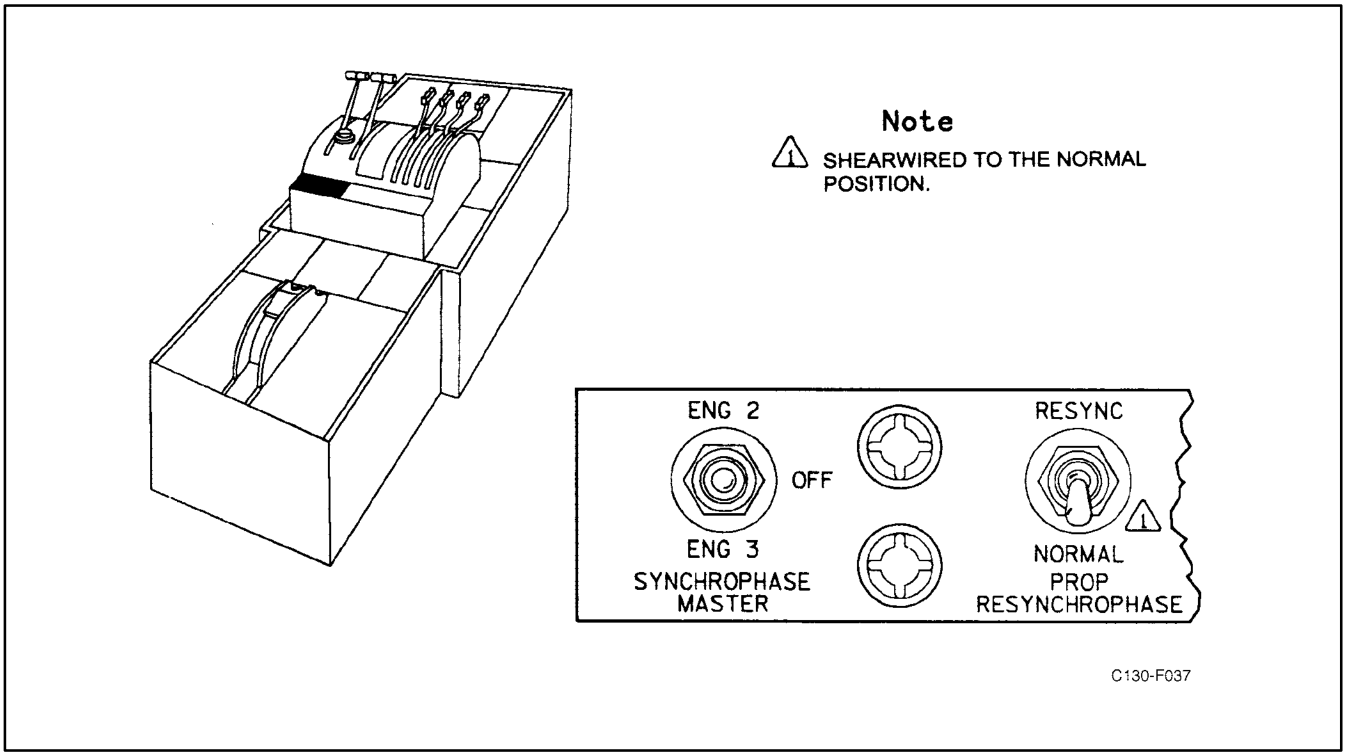


Figure 2-19. Synchrophaser Control Switch Panel

in normal governing. If the propeller governor control switches are in the MECH GOV position, the propellers operate in mechanical governing. When the switch is in the ENG 3 position, the No. 3 engine is the master and the other propeller phase angles are referenced to this engine.

2.4.4.4 Prop Resynchrophase Switch. The prop resynchrophase switch (see Figure 2-19) is a two-position (NORMAL, RESYNC) toggle switch located on the flight control pedestal. The switch is spring-loaded and shear-wired to the NORMAL position. The prop resynchrophase switch shall not be positioned to RESYNC except when performing the propeller re-indexing procedure and should be used only for correcting an out-of-sync or off-speed condition by performing the complete re-indexing procedure. These airplanes will have a decal installed above the prop resynchrophase switch on the flight control pedestal stating SOLID STATE SYNCHROPHASER INSTALLED. REFER TO APPROVED FLIGHT MANUAL FOR OPERATION. Power is supplied through the SYNCHROPHASER 28V essential dc circuit breaker located on the copilot side circuit breaker panel.

CAUTION

The PROP RESYNCHROPHASE switch shall not be positioned to RESYNC except when performing the propeller reindexing procedure and should be used only for correcting an out-of-sync or off-speed condition by performing the complete reindexing procedure.

2.4.4.5 Propeller Governor Control Switches. The four PROPELLER GOVERNOR CONTROL switches are two-position (NORMAL, MECH GOV) guarded toggle switches located on the copilot side shelf (see Figure 2-18). When the switches are in the NORMAL position, the throttle anticipation and speed stabilization (derivative) circuits are operative, and if the SYNCHROPHASE MASTER switch is positioned to either master engine, the blade rotational position of the slave engines is related to the master by the synchrophasing system. Placing a switch in the MECH GOV position disconnects the electrical speed control to that propeller and the speed of the propeller is controlled by basic mechanical governing.

2.4.4.6 Fuel Governing Check Switches. The four FUEL GOVERNING check switches located on the aft end of the overhead control panel, provide a means of checking the operation of the propeller pitch-lock mechanism and the engine fuel control governor.

CAUTION

The fuel governing check switches must never be used in flight.

2.4.4.7 Feather Override Buttons. Four FEATHER OVERRIDE buttons are located on the copilot side shelf (see Figure 2-18) to provide a means of manually stopping the propeller auxiliary pump. When a condition lever is moved to FEATHER, electrical circuits are completed to the feather solenoid valve, propeller auxiliary pump, pressure cutout switch, and a holding circuit to the feather override button. If a FEATHER OVERRIDE button is manually pulled after a condition lever is placed in FEATHER, the electrical circuits for propeller feathering are interrupted. If a FEATHER OVERRIDE button does not pop out after the feather cycle is complete, it should be pulled manually to prevent damage to the propeller auxiliary pump. The holding coil of the override button receives 28-Vdc power from the essential dc bus through the FEATHER & AIRSTART or EMER FEATHER circuit breaker on the copilot side circuit breaker panel.

2.5 OIL SYSTEM

Independent oil systems, one for each engine, supply lubrication to the engine power section and the reduction gear assembly. An oil tank with a 12-gallon usable oil capacity is located in each nacelle above the engine. The oil tanks are provided with a pendulum-tube oil pickup to prevent loss of oil pressure under negative-g conditions. The pendulum will accompany the oil in a negative-g condition, assuring positive oil pressure. Oil from the tank enters the power section and the reduction gear assembly, where it is circulated and returned by scavenger pumps through a heat exchanger and oil cooler back into the oil tank. Hot oil passing through the heat exchanger heats the engine fuel and prevents ice from forming in the fuel filter. Air flowing through an oil cooler duct and over the coils of the oil cooler absorbs excess heat from the oil. A bleed-air ejector, located in the oil cooler air exit duct, provides additional airflow through the oil cooler for ground operations. A thermostatic element in the oil tank return line controls the oil temperature by regulating the amount of air flowing through the oil cooler duct. Four motor-operated valves provide an emergency means of shutting off oil flow to the engines when the fire emergency control handles are pulled. Oil used in the aircraft must conform to the specification and grade listed in the servicing diagram (see Figure 3-1).

2.5.1 Oil System Controls. Oil system controls available to the flightcrew are the oil cooler flap switches and the fire emergency control handles.

2.5.1.1 Oil Cooler Flap Switches. Airflow through the oil cooler is governed by a controllable oil cooler flap which restricts the opening of the oil cooler air exit duct, and by an oil cooler augmentation valve which controls the flow of fourteenth stage compressor bleed air to an ejector assembly in the oil cooler exit duct. Four, four-position (AUTOMATIC, OPEN, CLOSE, FIXED) oil cooling toggle switches are located on the oil cooling control panel on the overhead control panel (see Figure 2-20). These switches control the electrical circuits of the oil cooler flap actuators and the oil cooler augmentation valves. In the AUTOMATIC position, the oil cooler flap position is regulated by a thermostatic unit to maintain an oil temperature of approximately 80 °C. In the OPEN or CLOSE positions (spring-loaded) the thermostat is excluded from the circuit and the actuator is directly energized to open or close the oil cooler flap. When the switch is moved to FIXED, the actuator is deenergized and the flap will remain in the position it was in prior to moving the switch. The OPEN, CLOSE, and FIXED positions are used to control the oil cooler flap actuator manually if the thermostatic control unit fails. The oil cooler flap actuators receive 28-volt, dc power from the essential dc bus through OIL COOLER FLAPS circuit breakers on the copilot side circuit breaker panel.

2.5.1.2 Oil Cooler Augmentation Switches. Oil cooler airflow augmentation is provided by a high-pressure bleed-air ejector located in the oil cooler air exit duct. Four two-position (ON, OFF) toggle switches on the overhead control panel operate oil cooler augmentation valves that control the flow of 14th-stage compressor bleed air to the ejectors (see Figure 2-21). The oil cooler flap must be at least 90-percent open, the throttle must be in the ground operating range, and the ENGINE GROUND START switch must be in the OFF position before power is

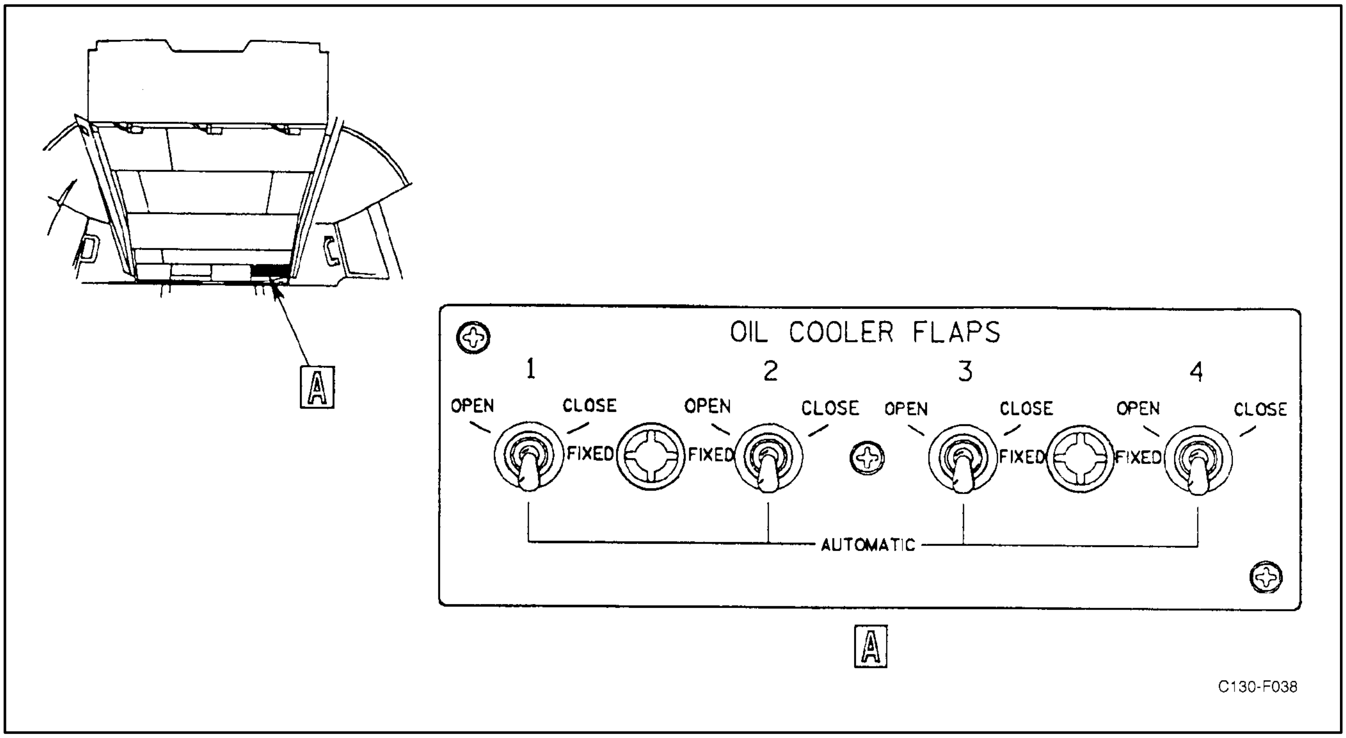


Figure 2-20. Oil Cooler Flap Control Panel

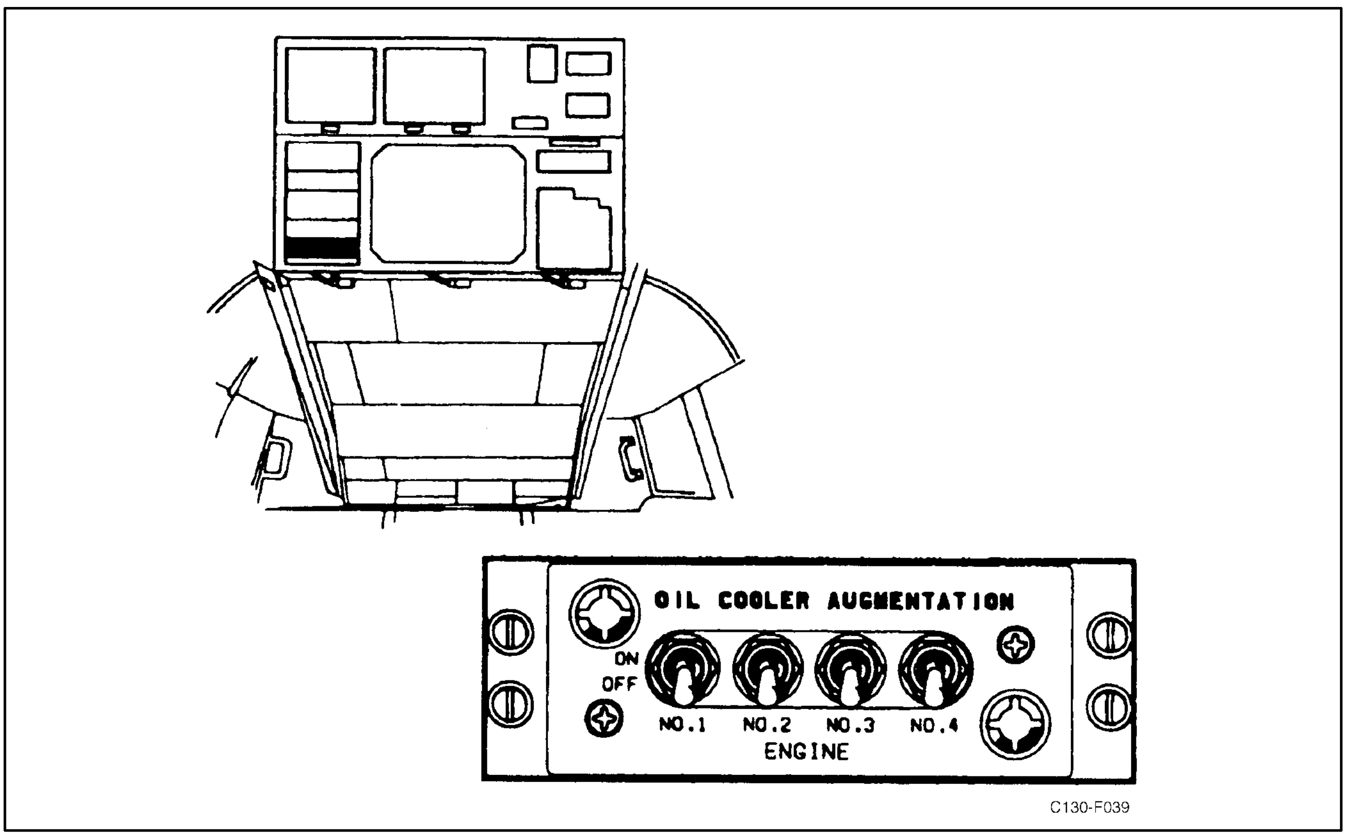


Figure 2-21. Oil Cooler Augmentation Control Panel

available to the OIL COOLER AUGMENTATION switch. The oil cooler augmentation valves are energized through the OIL COOLER AUGMENTATION switches by 28-Vdc power from the essential dc bus, through the START CONTROL circuit breakers on the copilot side circuit breaker panel.

2.5.1.3 Fire Emergency Control Handles. Motor-operated shutoff valves, energized by 28-volt essential dc power and controlled by the fire emergency control handles (see Figure 2-17), are installed in the engine oil systems to shut off the flow of oil to the engine during an emergency. See paragraph 2.3.1.2 for other functions of the fire emergency control handles.

2.5.2 Oil System Indicators. The oil system indicators are an oil quantity gauge for each engine, a low-oil-quantity warning light, and an oil cooler flap position indicator for each engine. All of the indicators are located on the engine instrument panel (see Figure 2-11).

2.5.2.1 OIL QUANTITY Gauges. Four OIL QUANTITY gauges (see Figure 2-11), one for each engine oil system, are located on the engine instrument panel. Each indicator is calibrated from 0 to 1 (empty) to F (full) in increments of 1 gallon. The indicators are energized by 28-Vdc power from the essential dc bus through the OIL QUANTITY INDICATOR circuit breakers on the copilot side circuit breaker panel.

2.5.2.2 Low Oil Quantity Warning Light. A low-oil-quantity warning light (see Figure 2-11) is located on the engine instrument panel. A microswitch in each engine oil tank quantity transmitter, actuated by the tank float arm, will cause the light to illuminate when any oil tank level drops to 4 gallons. Operation of the light is independent of quantity indicators; however, no additional warning is supplied should a second tank reach a low level. The warning light receives 28-Vdc power from the essential dc bus through the engine oil quantity light circuit breaker on the copilot side circuit breaker panel.

2.5.2.3 Oil Cooler Augmentation Valve Position Indicators. Four oil cooler augmentation valve position indicators, one for each valve, are located on the engine instrument panel (see Figure 2-11). The press-to-test indicators are connected electrically to pressure switches in the ejector bleed-air duct downstream of the augmentation valves and illuminate (OPEN) when the pressure switch closes. The lights are energized by 28-Vdc power from the essential dc bus through the OIL COOLER VALVE OPEN IND circuit breaker on the copilot lower circuit breaker panel.

2.5.2.4 OIL COOLER FLAP Position Indicators. Four OIL COOLER FLAP position indicators (see Figure 2-11), one for each engine oil system, are located on the engine instrument panel. The indicators are electrically connected to position transmitters geared to the oil cooler flap actuators. The indicator dials, calibrated from 0 to OPEN in increments of 10 percent, indicate the percentage that the oil cooler flaps have opened. The indicators are energized by 28-Vdc power from the essential dc bus through the OIL COOLER FLAPS circuit breakers on the copilot side circuit breaker panel.

2.6 FUEL SYSTEMS

The fuel system is a modified manifold-flow-type, incorporating a fuel crossfeed system, a single-point refueling and defueling system, and a fuel dump system. The system provides fuel supply for the four engines and the auxiliary power unit. It is adaptable to a number of flow arrangements (see FO-1). For systems diagrams, see FO-1. Fuel specifications and grades are listed in Figure 3-1. Total usable capacity of the fuel tanks is shown in Figure 2-22. For system management, refer to paragraph 8.28. Aircraft limitations resulting from use of emergency fuels are discussed in Chapter 4.

2.6.1 Fuel Flow. Each engine may be supplied fuel either directly from the main respective fuel tank or through the crossfeed manifold system from any tank. Fuel for the APU is routed directly from the No. 2 fuel tank.

2.6.2 Refueling and Defueling. All wing tanks and the fuselage tank (if installed) may be refueled or defueled from the single-point ground refueling and defueling receptacle located in the right main landing gear fairing. When refueling, fuel is routed from the single-point receptacle through the refueling manifold to each tank through separate supply lines from the manifold. Fuel level in the tanks is controlled by float shutoff valves. All tanks except No. 1 and 4 contain one shutoff valve that allows the tanks to be filled to their maximum capacity, maintaining a minimum of 3-percent expansion space. Two shutoff valves in both the No. 1 and 4 tanks are located at different levels. These valves are controlled by the refueling pod disconnects.

TANK	USABLE FUEL BOOST PUMP ON			UNUSABLE FUEL (JP-4) BOOST PUMP ON			UNUSABLE FUEL (JP-4) BOOST PUMP OFF		
	GAL	LB		LB	GAL	GAGE READING	LB	GAL.	GAGE READING
		JP-4	JP-5/JP-8						
No. 1	1288	8372	8758	78	12	0	475	73	397
No. 2	1186	7709	8065	91	14	0	592	91	501
Left Ext (3)	1379	8964	9377	137	21	0	(1) 137	21	0
Left Aux	901	5857	6127	59	9	0	(2)	(2)	(2)
Right Ext (3)	1379	8964	9377	137	21	0	(1) 137	21	0
Right Aux	901	5857	6127	59	9	0	(2)	(2)	(2)
No. 3	1186	7709	8065	91	14	0	592	91	501
No. 4	1288	8372	8758	78	12	0	475	73	397
Lines				39	6				
TOTALS									
Main Tanks Only	4948	32162	33646	377	58				
Main and Aux Tanks	6750	43876	45900	495	76				
Main and Ext Tanks (3)	7706	50090	52400	651	100				
Main, Aux, and Ext Tanks	9508	61804	64654	769	118				

Note

(1) The external tanks are equipped with dual pumps and a single pump off will not affect the unusable fuel quantity in these tanks.

(2) The unusable fuel for an auxiliary tank is the quantity in the tank at the time the boost pump becomes inoperative.

(3) External tank installation (Lear Siegler part no. 305J001).

4. Fuel quantities based on 6.5 pounds per U.S. gallon for JP-4 and 6.8 pounds per U.S. gallon for JP-5.

5. Pounds (LB) and gallons (Gal) are rounded off to the nearest whole number.

Figure 2-22. Fuel Quantity Data Table

The low-level valves operate when the refueling pods are installed and allow the tanks to become only partially full. When the pods are removed, the high-level valves operate and allow the tanks to fill completely. Refueling and defueling are controlled at the single-point refueling control panel located in the right landing gear fairing. As an alternate method of refueling, the main and external tanks may be fueled separately through a filler opening in the top of each tank. The fuselage tank does not incorporate a manual filler opening, but it can be refueled by transferring fuel from the wing tanks, or from the single-point refueling control panel, and selecting the OPEN position of the fuselage tank fill switch on the auxiliary fuel control panel. In defueling the wing tanks, fuel flows into the crossfeed manifold through the refueling manifold, and overboard through the single-point refueling receptacle. Defueling flow from the fuselage tank is into the refueling manifold and overboard through the single-point refueling receptacle.

2.6.3 Internal Tanks. Six fuel tanks are located within the wing (see FO-1). The No. 1, 2, 3, and 4 tanks are integral and use sealed wing structure for tank walls. The left and right auxiliary fuel tanks are each comprised of units of three bladder cells. The three cells are interconnected to form one assembly and are laced within the center wing section. Each of the six tanks has a three-phase, ac-powered boost pump to ensure fuel flow. The water removal system, located in each main tank, maintains the fuel level around the boost pump when the aircraft is in a nosedown attitude with low fuel level in the tank. The No. 1, 2, 3, and 4 tanks have, in addition, a dump pump that is used for fuel dumping and transfer.

2.6.4 Water Removal System. The water removal system provides continual water removal from the tank low points during boost pump operation. The system consists of two ejectors, a check valve, a strainer, and associated plumbing in each main tank. The ejectors are connected by plumbing to the boost pump discharge line, and a part of the boost pump fuel flow is routed through each ejector housing and discharged through its nozzle. This fuel flow through the ejectors causes a differential pressure, and additional fuel is drawn from between the lower wing panel risers and is ejected into the surge box. Anytime the fuel boost pump is operating, the fuel will be continually stirred to prevent water from settling in the bottom of the tank.

2.6.5 Vent System. All of the six wing fuel tanks are vented to the atmosphere to equalize pressure at all times. Tank Nos. 2 and 3, and the left and right auxiliary tanks have a wraparound vent system. The wraparound system permits venting for these tanks even though the aircraft is not in a wings-level attitude. The outboard tanks (Nos. 1 and 4) are vented by a float-controlled vent valve to prevent fuel loss overboard on the ground when the aircraft is not in a wings-level attitude and in flight when the wings deflect upward. Vent air leaving the tank passes through a drainbox on its way overboard. Any fuel entering the vent lines because of an aircraft change of attitude collects in the drainbox and is returned to the tank continuously by the water removal system in the inboard and outboard tanks and by the jet pump eductors in the auxiliary tanks. Boost pump pressure is necessary for the water removal system and jet pump eductors to operate. The No. 1 and 4 tanks also contain a pressure-relief valve that vents tank pressure directly to the jettison manifold, downstream of the dump mast shutoff valve.

The external tanks are vented through the spaces at the top of the bulkheads separating the tank compartments and through the fuel vent line. The vent line runs from the forward compartment of each tank through the pylon and up into the wing trailing edge, where it vents to the atmosphere. Fuel will not fill the vent line because each tank is separated by compartments. The vent line is at the top of the tanks and runs upward to the wing.

2.6.6 Crossfeed Primer System. A press-to-actuate CROSSFEED PRIMER VALVE button is located on the fuel control panel (see Figure 2-23). This button, when pressed, moves the motor-operated crossfeed fuel primer valve to the open position and opens the motor-driven crossfeed separation valve. This allows fuel to flow through the manifold into the No. 2 fuel tank to remove any trapped air. Releasing the button actuates the primer valve to the closed position and closes the crossfeed separation valve. Power for the system comes through the ENGINE CROSSFEED VALVES PRIME circuit breaker on the copilot side circuit breaker panel.

2.6.7 External Tanks. Two all-metal external fuel tanks are mounted under the wings on pylons between the inboard and outboard engines. The tanks are partially compartmented for center-of-gravity control. All fuel flows into the center compartment through check valves. A surge box in the tank center compartment contains a forward and an aft boost pump, providing dual reliability and an increased fuel dumping rate if both pumps are operated during fuel dumping. Both pumps have overriding output pressures that, under normal operation, ensure depletion of fuel from the external tanks before the main tanks are affected.

2.6.8 Fuel Dump System. A fuel dump system is provided to enable all fuel, except approximately 1,600 pounds each from the No. 1 and 4 wing tanks, 1,500 pounds each from the No. 2 and 3 wing tanks, and 65 pounds from each external tank, to be dumped overboard. Eight two-position (OFF, DUMP) toggle switches for the wing tanks are located on the engine fuel control panel. Two-position (NORM, DUMP) guarded toggle switches and two rotary interconnect switches are located on the auxiliary fuel control panel (Figure 2-24). The dump rate is approximately 3,900 pounds per minute from the wing tanks with all pumps operating. All tanks feed into a common manifold in the wing, then to a dump mast in each wingtip. Check valves at each tank dump outlet prevent reverse flow. The four main wing tanks have individual integral pumps specifically for fuel dumping. The two auxiliary and two external tanks use the same pumps for dumping that are used for normal boost operation. Actuation of the tank dump switch will open the tank dump valve and turn the pump on for the selected tank (see FO-1). To complete the dump operation, the interconnect switches on the auxiliary fuel panel are turned to the flow condition and the two guarded dump switches on the auxiliary fuel control panel are placed in the DUMP position. When the auxiliary tank dump switches are actuated, the auxiliary tank crossfeed valves will close. Refer to Chapter 11 for operation of

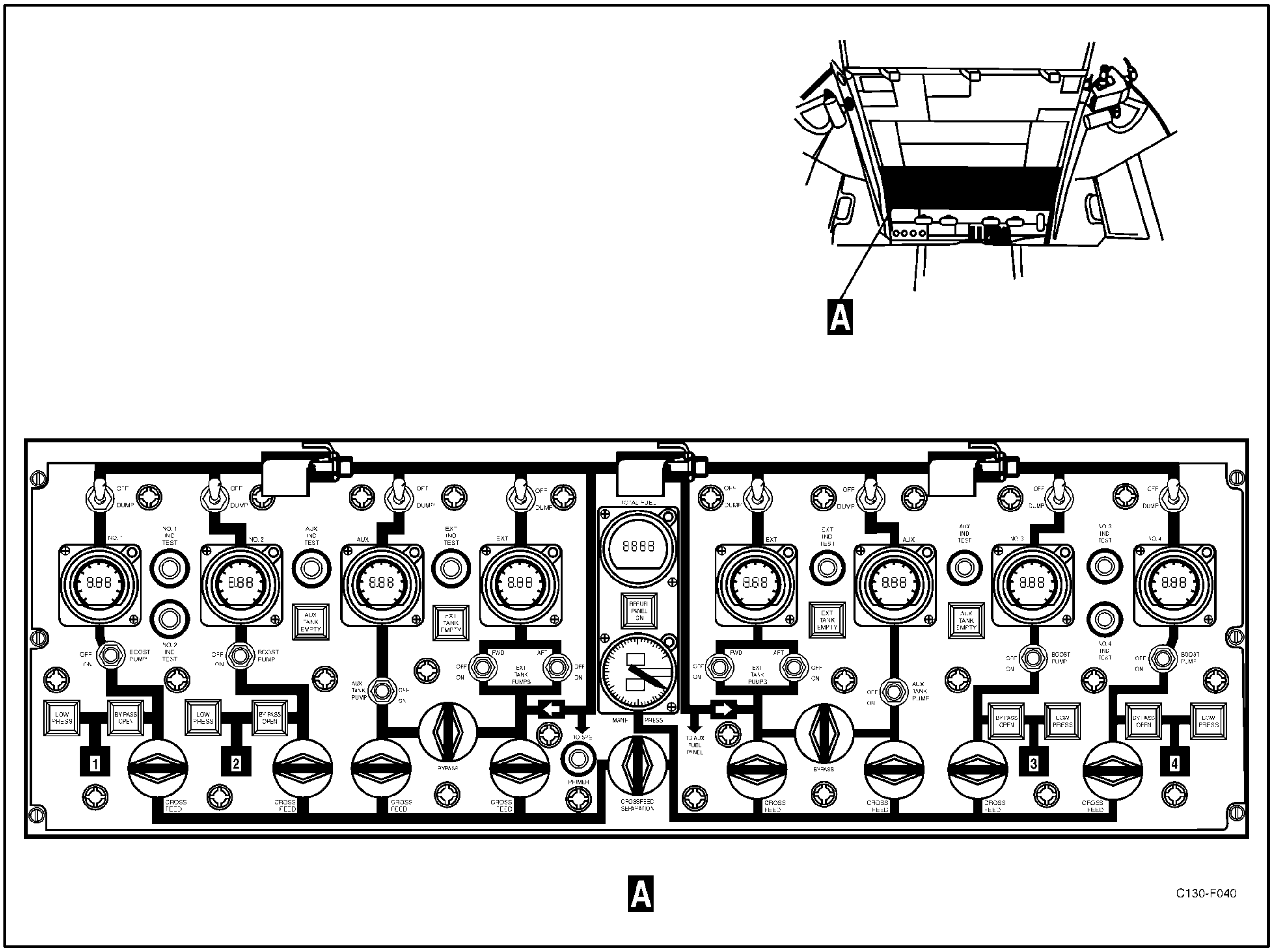


Figure 2-23. Fuel Control Panel

the wing tank fuel dump system and to Part VIII for operation of the fuselage tank dump system. All pumps are powered by three-phase, 200/115-volt, 400-Hz ac. Power for the motor-operated dump valves is supplied from the essential dc bus through the LH and RH FUEL DUMP VALVES circuit breakers on the copilot side circuit breaker panel. The dump pumps in the four main wing tanks are supplied power from the main ac bus through the DUMP PUMPS circuit breakers on the copilot upper circuit breaker panel.

2.6.9 Fuel Strainer and Heater Unit. A combination fuel strainer and heater is located in the right side of each nacelle. Heat is transferred from engine oil to the fuel in the heater unit, and the temperature is controlled thermostatically.

2.6.10 Fuel System Controls. Controls for normal in-flight management of engine fuel are located on the fuel control panel (see Figure 2-23).

2.6.10.1 BOOST PUMP Switches. Ten BOOST PUMP switches are located on the fuel control panel. The No. 1, 2, 3, and 4 fuel tank boost switches control the internal boost pumps for their respective tanks. The left and right AUX TANK PUMP switches control the pump in each of the auxiliary tanks. Four BOOST PUMP switches, one forward and one aft for each external tank, control the pumps in the external tanks. All of the boost pumps are powered by three-phase, 115/200volt, 400-Hz ac. The No. 1 tank pump is supplied power through the FUEL BOOST PUMP TANK NO. 1 circuit breakers on the pilot upper circuit breaker panel left-hand ac bus. The No. 2 tank pump is supplied power through the FUEL BOOST PUMP TANK NO. 2 circuit breakers on the pilot side circuit breaker panel essential ac bus. The No. 3 tank pump is supplied power through the FUEL BOOST PUMP TANK NO. 3 circuit breakers on the copilot upper circuit breaker panel main ac bus. The No. 4 tank pump

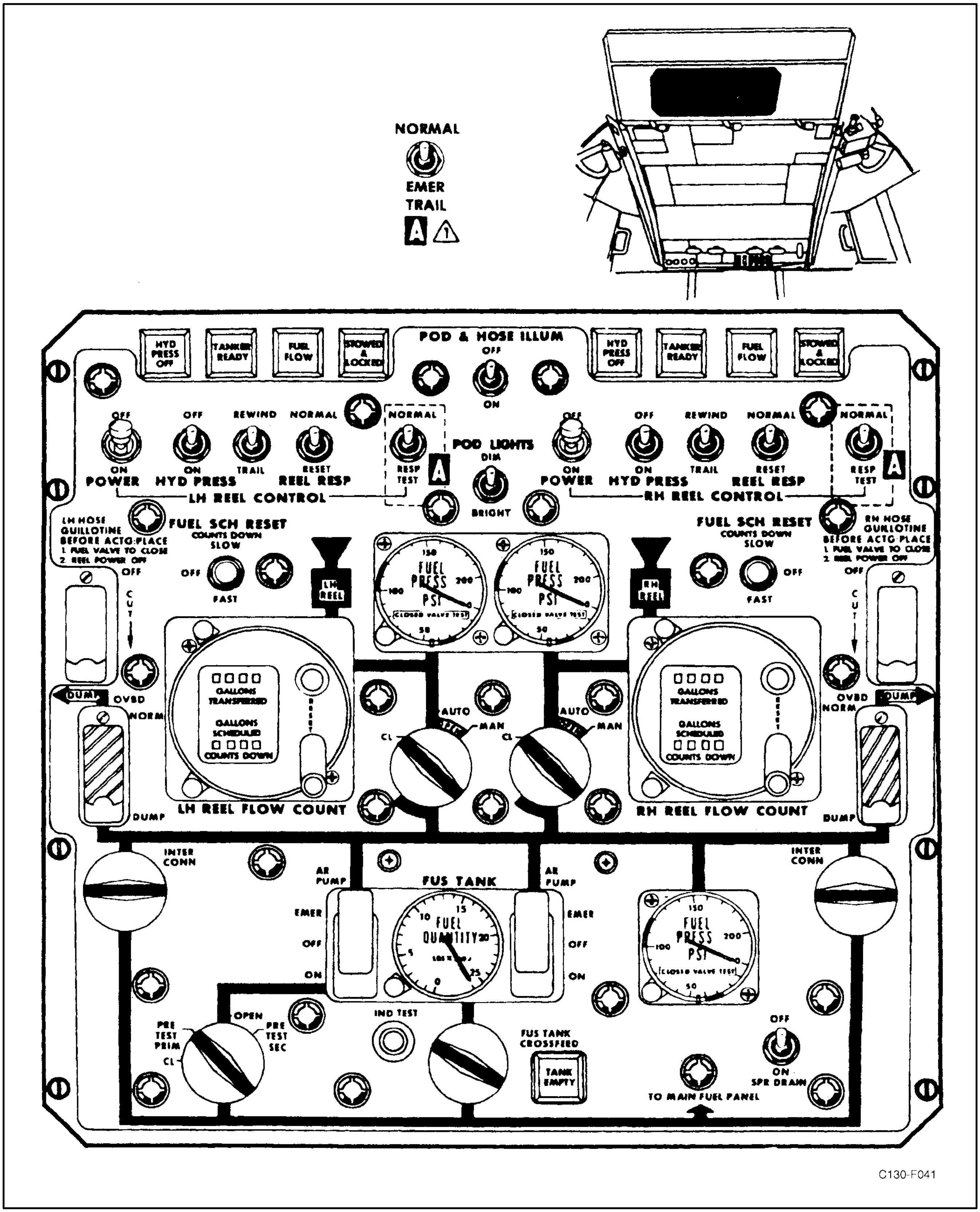


Figure 2-24. Auxiliary Fuel Control Panel

is supplied power through the FUEL BOOST PUMP TANK NO. 4 circuit breakers on the pilot upper circuit breaker panel right-hand ac bus. The left- and right-hand auxiliary fuel tank boost pumps are supplied power through the AUXILIARY TANK LH and RH circuit breakers on the copilot upper circuit breaker panel main ac bus. The right- and left-hand external fuel tank forward boost pumps are supplied power through the RH and LH EXT PUMP (FWD) circuit breakers on the pilot upper circuit breaker panel from the RH and LH ac buses respectively. The right- and left-hand external fuel tank aft boost pumps are supplied main ac power through the RH and LH EXT TANK PUMP (AFT) circuit breakers on the copilot upper circuit breaker panel.

2.6.10.2 CROSSFEED VALVE Switches. Eight CROSSFEED VALVE switches are located on the fuel control panel (see Figure 2-23). These two-position rotary switches route 28-Vdc through the ENGINE CROSSFEED VALVES circuit breakers on the copilot side circuit breaker panel to the motor-operated cross-feed valves. When the switches are placed in the flow position (switch markings aligned with the fuel control panel markings), the valve motors are energized to open the valves. When the switches are placed in the no-flow position (switch markings at right angles to the panel markings), the valve motors are energized to close the valves. In case of power failure, the valves hold the last energized position.

2.6.10.3 Bypass Valve Switches. Two bypass valve switches are located on the fuel control panel to permit an alternate path for fuel from the left and right auxiliary and external fuel tanks if crossfeed valves fail to open. These two-position rotary switches route power to motor-operated bypass valves. When the switches are placed in bypass position (switch markings aligned with fuel control panel markings), valve motors are energized to open the valves and allow external tank fuel to be crossfed or jettisoned through the auxiliary tank crossfeed or jettison valves, and vice versa. The bypass valves may be used to jettison main tank fuel in the event of main tank dump valve/pump failure. When switches are placed in the off position (switch markings at right angles to panel markings), valve motors are energized to close the valves. In case of power failure, the valves hold the last energized position. The bypass valve switch receive power from the essential dc bus through the FUEL MANAGEMENT ENGINE CROSSFEED VALVES 1 & 4 (LEFT VALVE) and 2 & 3 (RIGHT VALVE) circuit breakers located on the pilot side circuit breaker panel.

2.6.10.4 Crossfeed Separation Valve Switch. The CROSSFEED separation switch is located on the fuel control panel (see Figure 2-23). The crossfeed separation valve is provided in the crossfeed manifold system to permit additional control on fuel routing. With the crossfeed separation valve closed, the left wing tanks supply fuel to engine Nos. 1 and 2, while the right wing tanks supply fuel to engine Nos. 3 and 4. This procedure ensures a more even fuel consumption when operating from the auxiliary tanks through the crossfeed manifold. Since there may be a slight variation in boost pump pressure and if both pumps were supplying the manifold, the pump operating at the highest pressure would feed the manifold if not prevented by the separation valve. However, the crossfeed separation valve is used primarily for fuel balancing between the left- and right-hand fuel tanks and when crossfeeding from the fuselage tank. The crossfeed separation valve is electrically actuated by 28-Vdc power received from the essential dc bus through the ENGINE CROSS-FEED VALVES PRIME circuit breaker, located on the copilot side circuit breaker panel.

2.6.10.5 Fire Emergency Control Handles. Five fire emergency control handles, one for each engine and one for the auxiliary power unit, are mounted on the fire emergency control panel (see Figure 2-17). These control handles route 28-Vdc power to the motor-operated, engine firewall fuel shutoff valves and to the motor-operated, auxiliary power unit fuel supply shutoff valve. In case of power failure, valves hold the last energized position. Circuit protection is provided by the FIRE SHUTOFF VALVES circuit breakers on the copilot side circuit breaker panel and the APU CONTROL circuit breaker on the pilot side circuit breaker panel. Other functions of the handles are described under paragraph 2.3.1.2.

2.6.11 Fuel System Indicators. Quantity gauges and warning lights are located on the fuel control panel (see Figure 2-23) and on the auxiliary fuel control panel (see Figure 2-24) to give the crew a continuous, visual indication of the status of the fuel system. For additional information on fuel indicators, refer to paragraph 2.1.8.

2.6.11.1 TOTAL FUEL QUANTITY Indicator. A TOTAL FUEL QUANTITY indicator is located in the center of the fuel control panel (see Figure 2-23). The indicator continuously shows the total fuel quantity (in pounds) in the fuel tanks when the single-point refueling master switch is in the OFF position. When the master switch is in any position other than OFF, the TOTAL FUEL QUANTITY indicator is deenergized. The indicator is tested when an individual tank quantity indicator is tested as described in paragraph 2.6.11.2. The TOTAL FUEL QUANTITY indicator receives single-phase, 115-volt, ac power from the ac instruments and fuel control bus through the FUEL QUANTITY TOTALIZER circuit breaker on the pilot lower circuit breaker panel.

2.6.11.2 FUEL QUANTITY Indicators and Test Switches

Note

On aircraft 165313 and up there is no analog bar graph on the flight station indicators.

FUEL QUANTITY indicators are located on the fuel control panel (see Figure 2-23). Each tank indicator provides a continuous visual display of the pounds of fuel contained in that tank. A liquid crystal display shows fuel quantity in both digital and analog format. A three-digit numeric readout shows fuel quantity in thousands of pounds. An analog bar display around the periphery of the dial shows the percentage of total fuel capacity of that tank. Each illuminated small mark represents 2 percent of tank capacity. The major marks for each 10 percent of tank capacity are always illuminated. Separate conductors in the aircraft wiring harness provide a binary code that tells the individual indicator computer to which tank it is connected. The indicator is then properly scaled for that tank. A letter (M, E, A) and a number (1, 2, 3, 4) appear at the bottom of the indicator display that identifies the tank. The main tanks are identified as M1, M2, M3, and M4; the auxiliary tanks are identified as Al and A2, and the external tanks are identified as El and E2. All eight indicators on the fuel control panel are interchangeable. Each indicator has computerized built-in-test equipment. The BITE is designed to test the entire fuel quantity indicating system, not just the indicator. The BITE functions are continually processed during normal system operation. Additional test functions are performed at power-up and when the IND TEST pushbutton is depressed. The results of the BITE test are displayed in numerical code by the indicator. Pressing the IND TEST pushbutton on the fuel control panel adjacent to the indicator causes the display reading to decrease toward zero. Releasing the IND TEST pushbutton causes all segments of the digital display, analog display, tank identification and error code to illuminate for approximately 4 seconds, after which all segments will extinguish for approximately 4 seconds. Then any error code that has been detected since power-up will be displayed for approximately 4 seconds until all errors found by the bite test are displayed. During normal operation, all fault conditions are detected within 10 seconds after occurrence, and the error code is displayed on the indicator. If the detected fault condition should return to normal, the error code will be removed and the normal fuel quantity display will automatically resume. The following error codes may be displayed:

ERROR CODE	DESCRIPTION	FUEL QUANTITY INDICATION
E0	Open or missing tank unit	Zero
E1	Tank unit leakage	Displayed at reduced accuracy
E2	Tank unit Hi-Z fault	Zero
E3	Compensator Lo-Z fault	Displayed at reduced accuracy
E4	Tank unit Lo-Z fault	Zero
E5	Compensator fault	Normal display at reduced accuracy
E6	Shorted tank unit	Zero
E7	Compensator leakage or out of range	Displayed at reduced accuracy
E8	Indicator internal failure	Zero or blank
E9	Internal calibration failure	Zero
Blank Display	Indicator failure	Blank

The BITE for the TOTAL FUEL QUANTITY indicator is continually processed during normal operation of the system. The indicator displays error codes that are either detected within the indicator itself or received from any of the eight fuel quantity indicators. The TOTAL FUEL QUANTITY indicator is tested when the IND TEST pushbutton for any individual fuel quantity indicator is depressed. When an IND TEST pushbutton is depressed, the TOTAL FUEL QUANTITY indicator reading will decrease in response to the decrease in the individual tank fuel quantity indicator. The fuel quantity indication will continue to decrease to zero until the IND TEST pushbutton is released. When the pushbutton is released, all segments of the total fuel quantity indicator display will illuminate for approximately 4 seconds. Then all segments will be extinguished for 4 seconds. When the TOTAL FUEL QUANTITY indicator is in the BITE mode, it will not display any type of error code. If an individual tank fuel quantity indicator has more than one error code to display during the BITE test, the total fuel quantity indicator will return to normal fuel quantity display. The error codes are continuously displayed whenever the fault is present. If more than one fault is present, each fault will be sequentially displayed for 1 second.

Note

Tank indicator error codes indicate an error in the individual fuel tank quantity indicator. A communications error code is displayed when no data or invalid data is received from a tank indicator. The number appearing after the first letter identifies the tank. For example, M2E0 indicates No. 2 main tank communications error.

The following error codes are detected by the TOTAL FUEL QUANTITY indicator and the repeater indicators.

ERROR CODE	DESCRIPTION
M — E	Main tank indicator error
A — E	Auxiliary tank indicator error
E — E	External tank indicator error
M — E0	Main tank indicator communication error
A — E0	Auxiliary tank indicator communication error
E — E0	External tank indicator communication error
Blank Display	Total fuel quantity indicator failure
E8	Display is blank with error code; indicator internal failure
E9	Display shows zero with error code; calibration failure

The fuel quantity indicating system receives 115-Vac power from the ac instrument and engine fuel control bus. Circuit protection is provided by the FUEL QUANTITY circuit breakers on the pilot lower circuit breaker panel.

2.6.11.3 Auxiliary Fuel Tank Magnetic Sight Gauge. An auxiliary fuel tank magnetic sight gauge is located on the underside of the wing center section for each auxiliary fuel tank. The magnetic sight gauge consists of three components: a mounting base and outer tube, a float, and a gauge stick. The mounting base is attached to the lower surface of the auxiliary fuel tank with the outer tube secured to the mounting base. The float rides on the outside of the tube and has magnets in its inner diameter. The gauge stick is contained within the outer tube, has magnets on its upper end, markings to indicate fuel quantity, and latches on the lower end that latch into the mounting base. The gauge stick markings indicate fuel quantity and are marked from 5 to 59 in 500-pound increments.

2.6.11.4 AUX and EXT TANK EMPTY Lights. Two AUX TANK EMPTY lights and two EXT TANK EMPTY lights are located on the fuel control panel (see Figure 2-23), in the flight station. If the BOOST PUMP switch associated with a given auxiliary or external tank is positioned to ON and there is no source of higher pressure to that side of the manifold, the associated tank empty light will be illuminated whenever output flow pressure is below approximately 23 psi. Illumination of the light indicates either depleted tank quantity or an inoperative boost pump or (in the case of the external tanks only) failure of the fuel level control valve in the open position. The tank empty lights receive 28-Vdc power from the essential dc bus through the respective FUEL DUMP VALVES AUX or EXT circuit breakers on the copilot side circuit breaker panel. Refer to Part VIII for discussion of the fuselage tank empty light.

2.6.11.5 REFUEL PANEL ON Light. A REFUEL PANEL ON light is located on the fuel control panel (see Figure 2-23). This press-to-test light will come on anytime the single-point refueling MASTER switch is in any position other than OFF. Power for the REFUEL PANEL ON light is supplied from the essential dc bus through the WARNING LIGHTS TEST circuit breaker on the copilot lower circuit breaker panel.

2.6.11.6 Fuel STRAINER BYPASS OPEN Light. A fuel STRAINER BYPASS OPEN light is located on the fuel control panel (see Figure 2-23). A pressure switch on the strainer unit actuates the light when the pressure drop across the strainer exceeds approximately 4 PSID. Power for the bypass light is supplied from the essential dc bus through the ENG FUEL STRAINER BYPASS INDICATOR circuit breaker on the copilot side circuit breaker panel.

2.6.11.7 Fuel LOW PRESS Warning Lights. Four fuel LOW PRESS warning lights are located on the fuel control panel (see Figure 2-23). Each light goes on when pressure in the fuel supply line to the engine pump drops below approximately 8.5 psi. When a light goes on, it indicates a possible booster pump failure, valve failure, fuel line failure, or a malfunctioning pressure switch. The lights are energized by 28-Vdc power from the essential dc bus through the LOW PRESSURE LIGHTS circuit breaker on the copilot side circuit breaker panel.

2.6.11.8 MANF PRESS Indicator. A MANF PRESS indicator, located on the fuel control panel (see Figure 2-23), indicates fuel pressure in the crossfeed manifold. The indicator is used to check fuel boost pumps before starting engines and used during flight only to determine if a pump is operating. This indicator is electrically connected to a fuel pressure transmitter. The transmitter measures the pressures of the crossfeed manifold. Thus, when the fuel boost pumps are turned on individually, the pressure supplied the crossfeed system by any pump is measured by the transmitter and shown by the indicator. Single-phase, 26-Vac to operate the pressure indication system is supplied by the No. 1 instrument transformer. Circuit protection is provided by the FUEL PRESSURE INDICATOR fuse on the pilot lower circuit breaker panel.

2.6.12 Single-Point Refueling and Defueling System. A single-point refueling and defueling system enables all normal refueling and defueling operations to be accomplished through a single receptacle located in the aft end of the right wheelwell fairing. Controls and indicators for all tanks except the fuselage tank are installed on the single-point refueling control panel located immediately above the receptacle (see Figure 2-25). Controls and indicators for the fuselage tank are mounted on the auxiliary fuel control panel (see Figure 2-24). When refueling, fuel enters the tanks by way of the refueling manifold. A dual float valve in each tank shuts off the flow when the tank is filled to its single-point refueling capacity. Defueling can be accomplished by using the tank boost pumps or the dump pumps. When using the boost pumps, the fuel flow is through the crossfeed manifold, through the ground transfer valve to the refueling manifold, and out the refueling receptacles. Defueling flow, when using the dump pumps, is through the dump line to the refueling manifold and out the refueling receptacles. Fuel can be transferred between fuel tanks when the aircraft is on the ground by using the tank boost pumps or dump pumps and single-point refueling controls. A surge suppressor is located in the refueling line to absorb pressure surges during offloading. A surge suppressor pressure gauge is located on the surge suppressor and may be observed through the starboard air deflector door.

2.6.12.1 Single-Point Refueling and Defueling System Controls and Indicators

2.6.12.1.1 MASTER Switch. A master switch for the single-point refueling system is located on the single-point refueling control panel (see Figure 2-25). The switch is a six-position (DRAIN, DEFUEL, OFF, PRE-CHKSEC, REFUEL & GRD TRANS, PRE-CHK PRIM) rotary-type by which the system function is selected. Placing the MASTER switch in the REFUEL & GRD TRANS position supplies power to the tank selector switches and the ground transfer switch, permitting selective (OPEN, CLOSE) operation of the tank fill valves and the ground transfer valve. Placing the MASTER switch in the DEFUEL position supplies power to operate the ground transfer valve only. The tank fill valves cannot be opened when the MASTER switch is in the DEFUEL position. Placing the switch in either the PRE-CHK PRIM position or the PRE-CHK SEC position interrupts power to the corresponding solenoid in the tank fill valves, closing the fill valves and simulating a tank-full condition, thus providing a check on the automatic operation of the tank fill valves. In both the PRE-CHK PRIM and the PRE-CHK SEC positions, power is supplied to the ground transfer switch, permitting operation of the ground transfer valve. In the DRAIN position, power is supplied to open the drain valve and to operate the drain pump. Power is also supplied directly to the offload valve, bypassing the OFFLOAD VALVE switch (closing the valve), and power is removed from the tank selector switches (rendering the switches inoperative). In all positions except OFF, the single-point refueling panel fuel quantity gauges are energized. The refueling system receives 28 Vdc from the main dc bus through the REFUELING PANEL circuit breakers on the copilot lower circuit breaker panel.

2.6.12.1.2 Tank Selector Switches. Each of the selector switches, one for each tank, located on the single-point refueling control panel (see Figure 2-25), is a two-position (OPEN, CLOSE), rotary-type switch through which power is supplied to the solenoids of the associated tank fill valve. The switches can operate the valves only while the fueling control MASTER switch is in REFUEL & GRD TRANS.

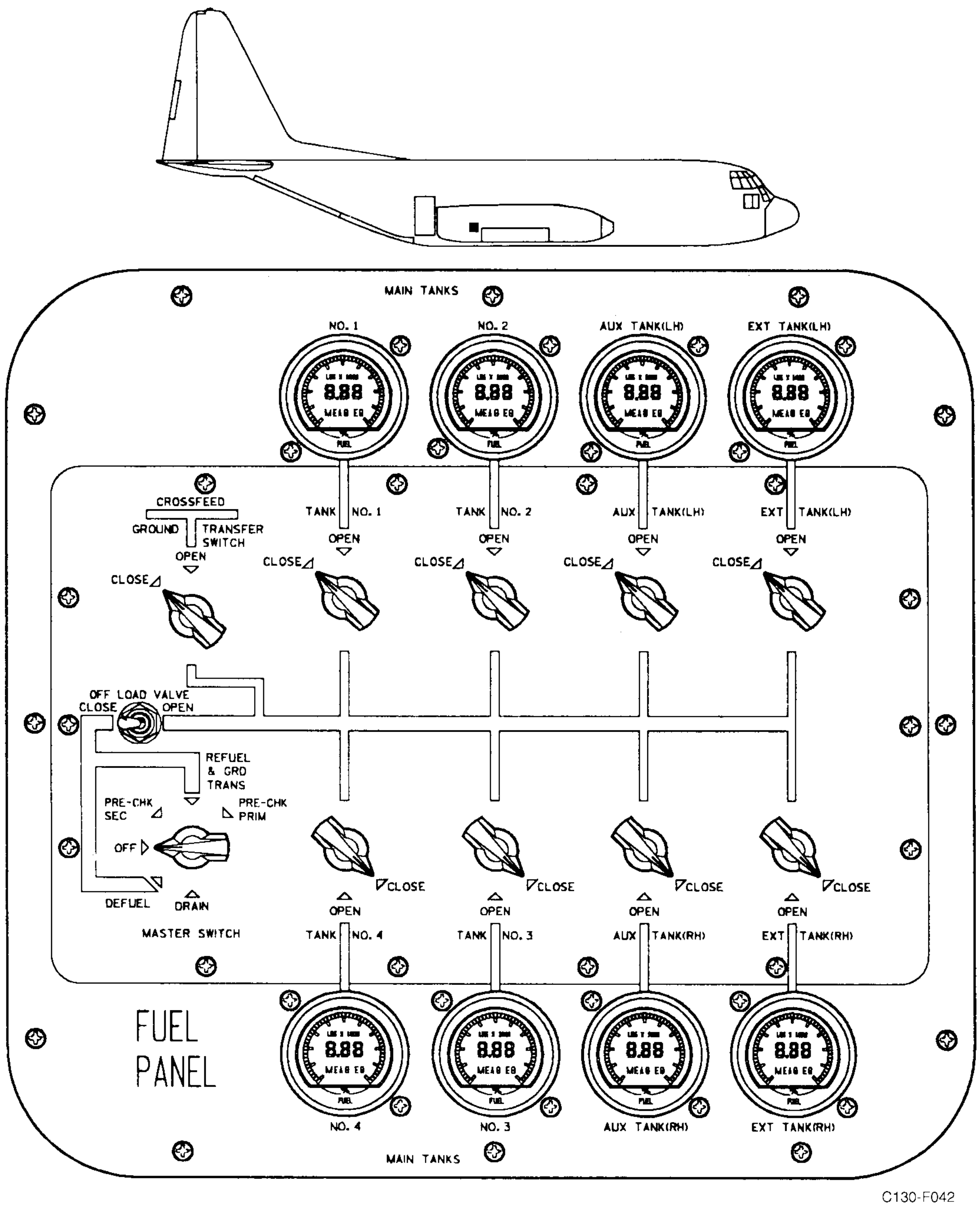


Figure 2-25. Single-Point Refueling Control Panel

2.6.12.1.3 GROUND TRANSFER Switch. The GROUND TRANSFER switch, located on the single-point refueling control panel (see Figure 2-25), is a two-position (OPEN, CLOSE), rotary-type switch, used to control the ground transfer valve. The MASTER switch must be in the DEFUEL, PRE-CHK SEC, REFUEL & GRD TRANS, or PRE-CHK PRIM position before the ground transfer valve will operate. When the master switch is in the OFF or DRAIN position, the GROUND TRANSFER switch is bypassed, and the valve is energized to the closed position.

2.6.12.1.4 OFF-LOAD VALVE Switch. The OFF-LOAD VALVE switch, located on the single-point refueling control panel (see Figure 2-25), is a two-position (CLOSE, OPEN), toggle-type switch used to control the offload valve when the MASTER switch is in any position except OFF or DRAIN. When the MASTER switch is in the OFF or DRAIN position, the OFF-LOAD VALVE SWITCH is bypassed and the offload valve is energized to the closed position. The OFF-LOAD VALVE switch must be in the OPEN position to refuel and defuel.

2.6.12.1.5 FUEL QUANTITY Indicators. One FUEL QUANTITY indicator for each fuel tank is located on the single-point refueling control panel (see Figure 2-25). All the indicators register tank fuel quantity in pounds and are energized when the MASTER switch is at any setting other than OFF. The fuel quantity indicators have a liquid crystal display that shows fuel quantity in pounds on a digital display and the percentage of total fuel capacity on an analog display. The single-point refueling control panel indicators are similar to those installed on the flight station fuel control panel except for a zero adjustment screw located on the aft end of the flight station indicators. The single-point refueling control panel repeater indicators are tested by depressing the corresponding flight station fuel control panel IND TEST pushbutton with the single point refueling system MASTER switch in any position other than OFF. An E0 error code on the repeater indicator indicates that no signal is being supplied from the primary indicator in the flight station. An E-error code on the repeater indicator indicates that the primary indicator is presently displaying an error code. The repeater indicator error codes are the same as the total fuel quantity indicator error codes. With an IND TEST pushbutton depressed, both primary and repeater indicator numeric readouts count down to zero. When the IND TEST pushbutton is released, the LCD segments illuminate for 4 seconds, then go blank for 4 seconds. The repeater indicator then displays fuel quantity. The indicators receive single-phase, 115-Vac power from the ac instruments and fuel control bus through the FUEL QUANTITY TOTALIZER circuit breaker on the pilot lower circuit breaker panel.

2.6.12.1.6 INTER CONN Switches. Two rotary, two-position (flow, no-flow) interconnect valve switches are provided on the auxiliary fuel control panel. The switches enable dumping to be accomplished from the wing tanks and external tanks. When the switch is in the FLOW position, fuel is supplied from the wing, external and fuselage tanks; however, the fuel supplied from the fuselage tank must be by the FUS TANK CROSSFEED switch. Power for operation of the interconnect valves is supplied from the essential dc bus through the INTERCONNECT VALVE RH and LH circuit breakers on the copilot side circuit breaker panel. Power for operation of the interconnect valve relay is supplied from the essential dc bus through the INTERCONNECT VALVE CONTROL circuit breaker on the copilot side circuit breaker panel. The interconnect valves must be open for dumping fuel from the wing and external tanks.

2.6.12.1.7 Fuel Dump Switches. Two two-position (NORM, DUMP) fuel dump switches are provided on the auxiliary fuel control panel for dumping fuel from the wing tanks. When the switches are placed in DUMP (unguarded) position, the dump valves will open. Wing tank fuel can be dumped by placing the desired wing tank dump switch to the DUMP position and turning the interconnect switches to the FLOW position. Power to the dump switches is supplied from the essential dc bus through the FUEL DUMP VALVES LH and RH circuit breakers on the copilot side circuit breaker panel.

2.6.12.2 Refueling Procedure. Refer to Chapter 3.

2.7 ELECTRICAL POWER SUPPLY SYSTEMS

Note

Never use circuit breakers as switches. Circuit breakers should be pulled only during emergencies or maintenance. (See Figures 2-33 through 2-40 for circuit breaker panels.)

All internal electrical power for aircraft use comes from five ac generators (see Figure 2-26), or from the battery. Each engine drives one 40-Kva, ac generator, and a 40-Kva generator is driven by the APU. The APU-driven generator is the same type as the engine-driven generator. Power from these ac generators is used to provide electrical power for aircraft use: 28-Vdc; 200/115-volt, 400-Hz, 3-phase primary ac; and 115-volt, 400-Hz, single-phase, secondary and primary ac. The four engine-driven ac generators are connected through transfer contactors (relays) to four ac buses: the left-hand ac bus, the essential ac bus, the main ac bus, and the right-hand ac bus. The transfer system operates in such a manner that any combination of two or more of the engine-driven ac generators will power all four of the buses. On aircraft 165313 and up, two bus switching units conduct ac power from the unregulated ac buses to two additional (essential and main) avionics ac buses. (See Figure 2-29 for a distribution schematic of these buses.) The bus switching units provide uninterrupted ac power to critical avionics components through the avionics buses by monitoring the various sources and switching rapidly between these sources as required. The BSUs are controlled by BSU 1 and BSU 2, two-position (OFF, ON) toggle switches on the overhead electrical control panel. (See Figure 2-28.) If only one generator is operating, it will power only the essential ac bus and the main ac bus. Placing the APU generator control switch in the APU position energizes the APU generator contactor, which connects the APU generator to the essential ac bus. The APU-driven ac generator normally will power only the essential ac bus. The APU generator will also power the main ac bus provided there are no engine-driven generators supplying power and the AC BUS TIE switch is placed to the ON position. This feature is for ground use only. The APU generator, voltage regulator, and generator control are the same as the engine-driven generator, voltage regulator, and generator control. (Refer to paragraph 2.19.) Combinations of operating generators and the buses that they power are shown on the ac bus power sources chart (see Figure 2-31). All in-flight controls for operation of the electrical system are located on the overhead electrical control panel (see Figure 2-28). Circuit breakers are shown in Figures 2-33 through 2-40.

2.7.1 Bus Switching Units (Aircraft 165313 and Up). Two bus switching units (BSU 1 and BSU 2) provide continuous no-break power to the essential and main avionics ac buses for critical avionics systems. BSU No. 1 supplies the essential avionics ac bus, and BSU No. 2 supplies the main avionics ac bus. During normal operation with generator power, BSU No. 1 and No. 2 both receive power from the essential and main ac buses. For BSU No. 1, the essential ac bus is the primary source and the main ac bus is the alternate source. For BSU No. 2, the main ac bus is the primary source and the essential ac bus the alternate source. When external ac power is being used, BSU No. 1 receives power from the left-hand ac bus only and BSU No. 2 receives power from the right-hand ac bus only. When the BSU switches are OFF or the BSUs are in the bypass mode, the essential and main avionics buses are powered directly from their respective primary source. Each BSU receives logic inputs that provide electrical system status. It monitors the engine generator line contactors, the APU generator contactor, and the ac external power contactor, thus receiving advance information of impending bus transfers. It also monitors voltage, frequency and current, and selects the best source of power for output to the respective avionics bus. During normal stable operations, BSU No. 1 selects power from the essential ac bus and BSU No. 2 selects power from the main ac bus.

Note

With the APU generator connected to the essential ac bus, programmed logic in BSU No.1 does not recognize the APU on status. Simultaneous disconnecting or reconnecting engine generator Nos. 2 and 3 when in this configuration will cause momentary interruption of power to the essential ac avionics bus.

When ac power is first applied to the aircraft with the BSU switches OFF, the BSUs are in the bypass mode with the BSU BYPASS lights illuminated. When the BSU switches are placed to ON, the BSUs each perform a 5-second BIT check. After a successful BIT check, the BSU BYPASS lights will extinguish and the BSUs will connect the avionics buses to the primary or alternate source, as available, if on generator power, or to the left-hand and right-hand ac buses if external ac power is selected. With external ac power selected, when the first generator is placed on line, external ac power is removed from the essential and main ac buses as their load is assumed by the generator. External power is then removed from the left- and right-hand ac buses after a delay of 0.5 seconds, and the BSUs then transfer to the primary or alternate sources, as available. As additional

Note

1. AIRCRAFT PRIOR TO 165313.

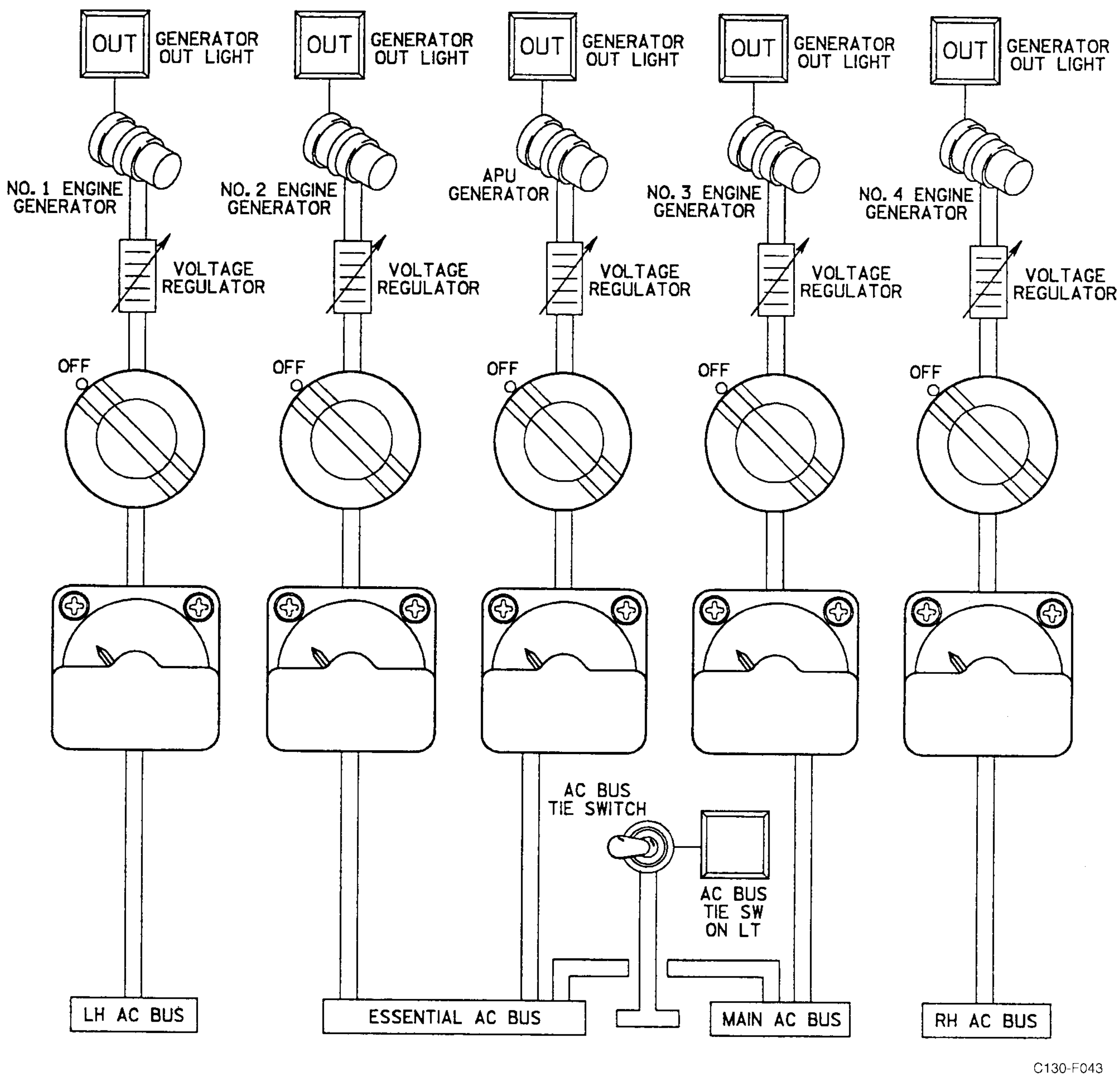


Figure 2-26. Ac Primary Power Supply (Sheet 1 of 2)

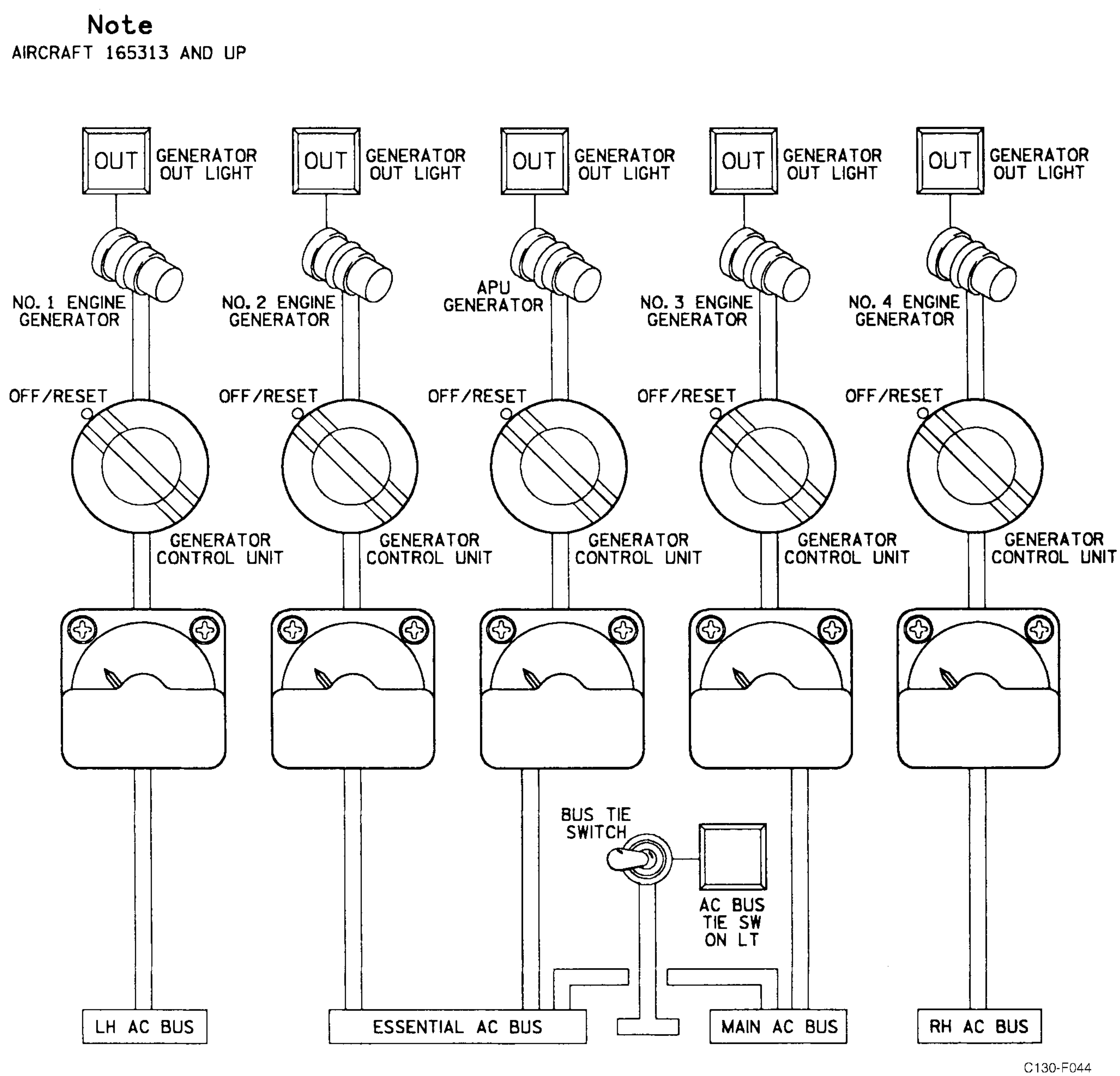


Figure 2-26. Ac Primary Power Supply (Sheet 2)

generators are brought on line, if the BSU detects a power interruption or a condition that would cause a degradation in output power quality, it will transfer the output to the alternate source until the primary source stabilizes. After a 7-second delay, the BSU will switch back to the primary source, provided it is stable.

Note

In order to ensure a smooth transition of power to the main avionics ac bus, place the AC BUS TIE switch to ON prior to switching from external ac power to APU generator power.

The BSUs receive 28-Vdc control power through BSU 1 and BSU 2 two-position (OFF/ON) toggle switches on the overhead electrical control panel. When placed in the OFF position, the BSU reverts to a bypass condition that supplies power to the respective avionics bus from its primary ac bus. During normal operation, the BSU may automatically go into the bypass mode if it fails to pass BIT. Two advisory lights illuminate to indicate the BSUs are in the bypass mode either because the BSU has failed BIT or the BSU switch has been placed to OFF. In the event of an overload condition on an avionics bus, the affected BSU will go into bypass mode and the respective BSU 1 or 2 BYPASS light will illuminate if the overload is not cleared in a specified time. The specific time varies from 5 minutes at 150-percent BSU overload, to 5 seconds at 200-percent overload, to 2 Hz for a short to ground. The delay allows time for circuit protection devices to trip or open to relieve the overload. These switches can also be used at any time to try to reset the BSU if it should automatically go into the BYPASS or OFF mode. It takes approximately 10 seconds for the BSU to reset. The BSU will remain in the bypass mode and will not reset until all power to the BSU has been removed and reapplied.

2.7.2 External Power Provisions

Note

The 200/115-volt, three-phase, 400-Hz ac external source should have a capacity of 40 Kva; its phase rotation must be A-B-C. The 28-Vdc external source should have a capacity of 400 amperes.

Both dc and ac external power receptacles are located on the left side of the fuselage just aft of the battery compartment. Dc power from the external source is supplied through two current limiters to the main dc bus. Any dc electrically operated equipment on the aircraft, except equipment connected to the battery bus, can be supplied from an external dc power source. The battery is disconnected from all dc buses except the battery bus when external dc power is being used. When an external ac power source is connected to the aircraft, power is supplied to all ac buses, to the dc buses through transformer-rectifier units, and to the battery bus to charge the battery if the DC POWER switch is in the BATTERY position.

Note

The APU generator switch must be in the OFF position before external ac power can be fed into the aircraft system.

2.7.3 Primary Ac System. Power for the primary ac system is supplied by five ac generators (see Figure 2-26). This power supply is also used to operate the secondary ac systems and the dc system.

2.7.4 Primary Ac System Controls. The ac system controls, with the exception of a manual reset lever on each generator control panel, are located aft of the overhead electrical control panel (see Figure 2-28) in the flight station. The generator control panels are located in racks under the flight station and are accessible from the cargo compartment.

2.7.4.1 Generator Switches. The generator switches consist of five four-position rotary-type switches. When a switch is in the ON position (knob stripe aligned with panel stripe), a relay closes contacts to connect the generator to the buses if the generator is operating normally. The distribution of generated power to the various buses under all conditions of generator operation is shown in Figures 2-27 and 2-32. All engine generators are off the line when the low-speed ground idle buttons are engaged; therefore, the APU generator must be used to provide power to the essential ac bus, which is the only bus it supplies. The APU generator may also supply the main ac bus, provided there are no engine-driven generators supplying power and the ac BUS TIE switch is placed in the ON position. This feature is for ground use only. When a generator switch is placed in the OFF or (for aircraft 165313 and up) OFF/RESET position, the relay disconnects the generator from the system. If the switch is turned to TRIP, the field circuit of the generator is opened by a field relay to remove generator excitation.

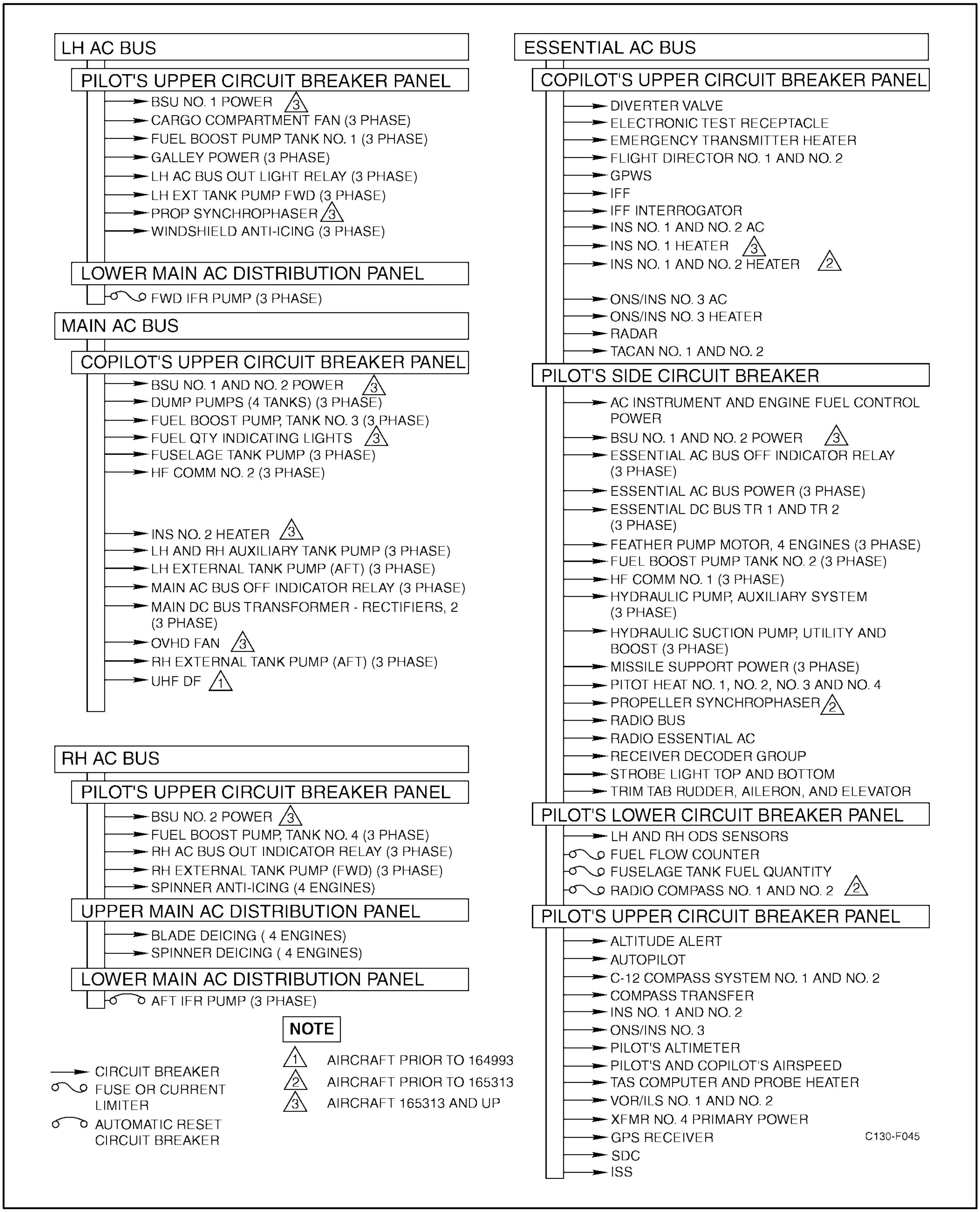


Figure 2-27. Ac Primary Power Distribution (Sheet 1 of 2)

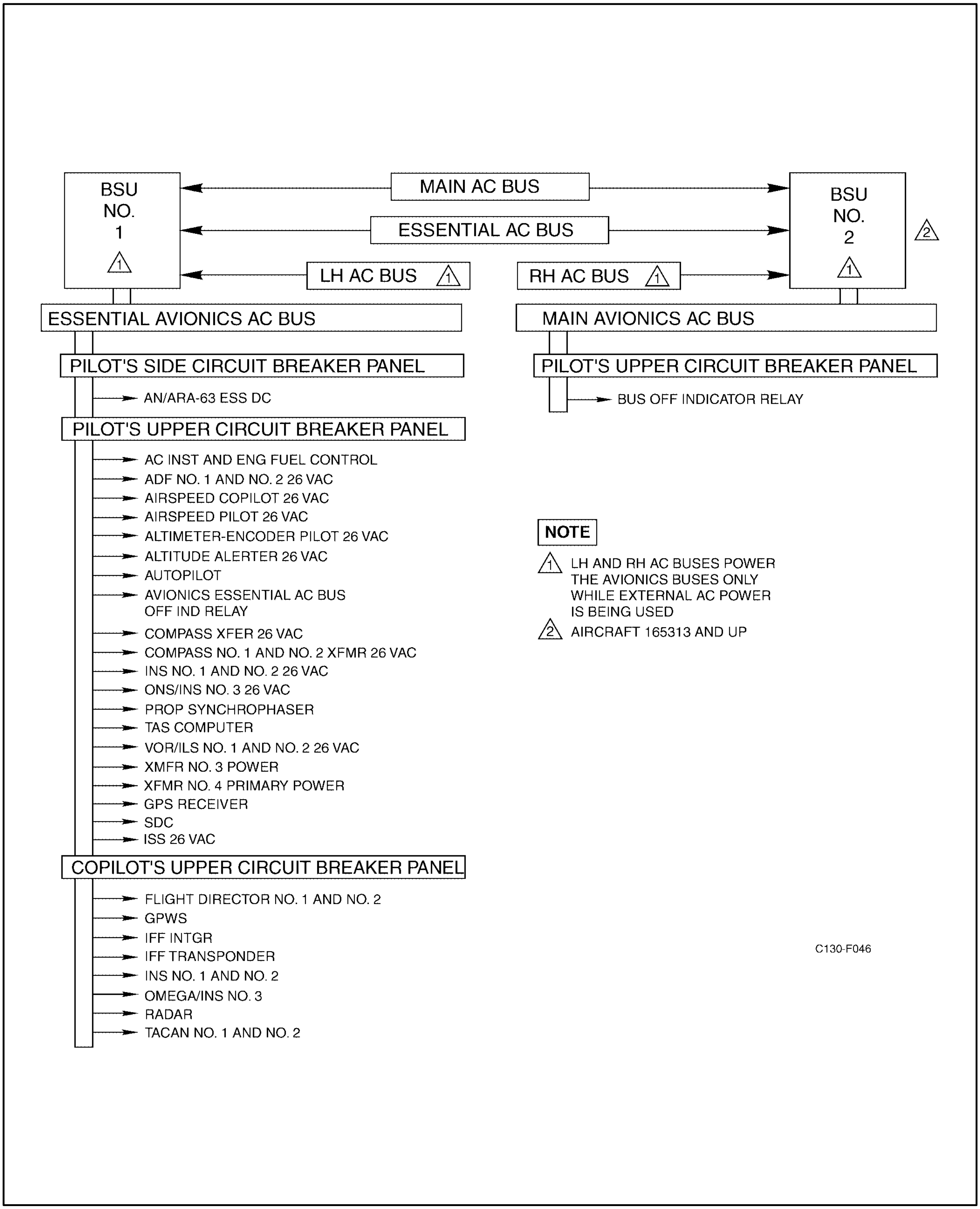


Figure 2-27. Ac Primary Power Distribution (Sheet 2)

No voltage is then produced by the generator. The RESET position of the switch is used to operate the field relay to its reset position after it has been tripped. The relay then closes the generator field circuit to allow the generator to build up voltage. On aircraft prior to 165313, the RESET position of the generator switch knob is spring loaded. The generator switch knob must be pulled out to move it to the TRIP position.

2.7.4.2 Generator Disconnect Switches. Each engine-driven generator is provided with a spring-loaded, two-position (OFF, DISC) guarded switch. When the switch is held in the DISC position (approximately 2 seconds), a direct short in the firing mechanism causes the fused portion of the plunger to burn through and be actuated by spring tension. As the plunger of the firing mechanism passes over the generator disconnect fired light switch, the generator DISC FIRED light will illuminate, indicating the firing mechanism has been fired. The plunger then engages a wing on the generator stub shaft causing it to shear. The generator cannot be reconnected in flight since a new stub shaft must be installed. Power to the switches is supplied from the essential dc bus through the four GENERATOR DISCONNECT PWR circuit breakers on the pilot upper circuit breaker panel.

2.7.4.3 Generator Disconnect Test Switch. A spring-loaded, two-position OFF, TEST GEN DISC switch is provided to check the continuity of the firing mechanism. If the continuity check is good, the generator DISC FIRED lights will illuminate. Power to the switch is supplied from the essential dc bus through the GENERATOR DISCONNECT PWR circuit breaker on the pilot upper circuit breaker panel.

2.7.4.4 Ac BUS TIE Switch. A two-position (OFF, ON) ac BUS TIE switch on the overhead electrical control panel provides a means for powering the main ac bus from the APU generator during ground operation with no engine-driven generators supplying power. The switch receives 28-Vdc power from the essential dc bus through the APU GEN ESS TO MAIN 53K circuit breaker in the main ac distribution panel.

2.7.4.5 Ac External Power Switch. A two-position, ac external power switch is located immediately below the LH ac bus loadmeter on the overhead electrical control panel. The OFF position of the switch disconnects external power from the ac distribution system. The external power position (stripe on knob aligned with stripe on panel) connects external power to the ac distribution system. The ac external power switch receives 28-Vdc control power from the ac external power source through the aircraft external ac power unit, or 24-Vdc control power directly from the ac external power cart dc battery through the aircraft ac EXT PWR CONTROL circuit breaker in the aircraft battery compartment.

Note

An override solenoid in the system is powered from the battery and will turn the switch off if the APU generator control switch is on, if the ac power is not in the correct phase sequence, if any engine generator is on the line, or if the external power plug is not in the receptacle.

2.7.4.6 VOLTAGE & FREQUENCY SELECTOR Switch. A seven-position (ENG GEN NO. 1, ENG GEN NO. 2, ENG GEN NO. 3, ENG GEN NO. 4, APU GEN, EXT PWR, COPLT INV ϕA AC INST & ENG FUEL CONT INV ϕC) rotary switch is used to isolate a chosen source of ac power for measurement.

2.7.4.7 PHASE SELECTOR Switch. A three-position PHASE SELECTOR switch selects one of the three phases of ac generator output to be measured by the ac meters on the panel. Placing the switch in a given position determines which phase is measured by the five ac loadmeters, the ac voltmeter, and the frequency meter on the overhead electrical control panel. The switch can be used in conjunction with the VOLTAGE & FREQUENCY SELECTOR switch to test a given ac power source.

2.7.4.8 Primary Ac System Indicators. Indicators for the primary ac power system are located in the overhead electrical control panel (see Figure 2-28) in the flight station.

2.7.4.9 Generator-Out Indicator Lights. Each generator is provided with a generator-out press-to-test indicator light. This light will illuminate when the generator control switch is in the ON position and one or more of the following conditions exist: the generator is not developing sufficient voltage, the generator output is below proper frequency, or the field-trip relay has opened the field circuit of the generator. The field relay will trip when the generator switch is turned to the TRIP position, when the generator output voltage is too high, or when a fault exists in the generator output circuit.

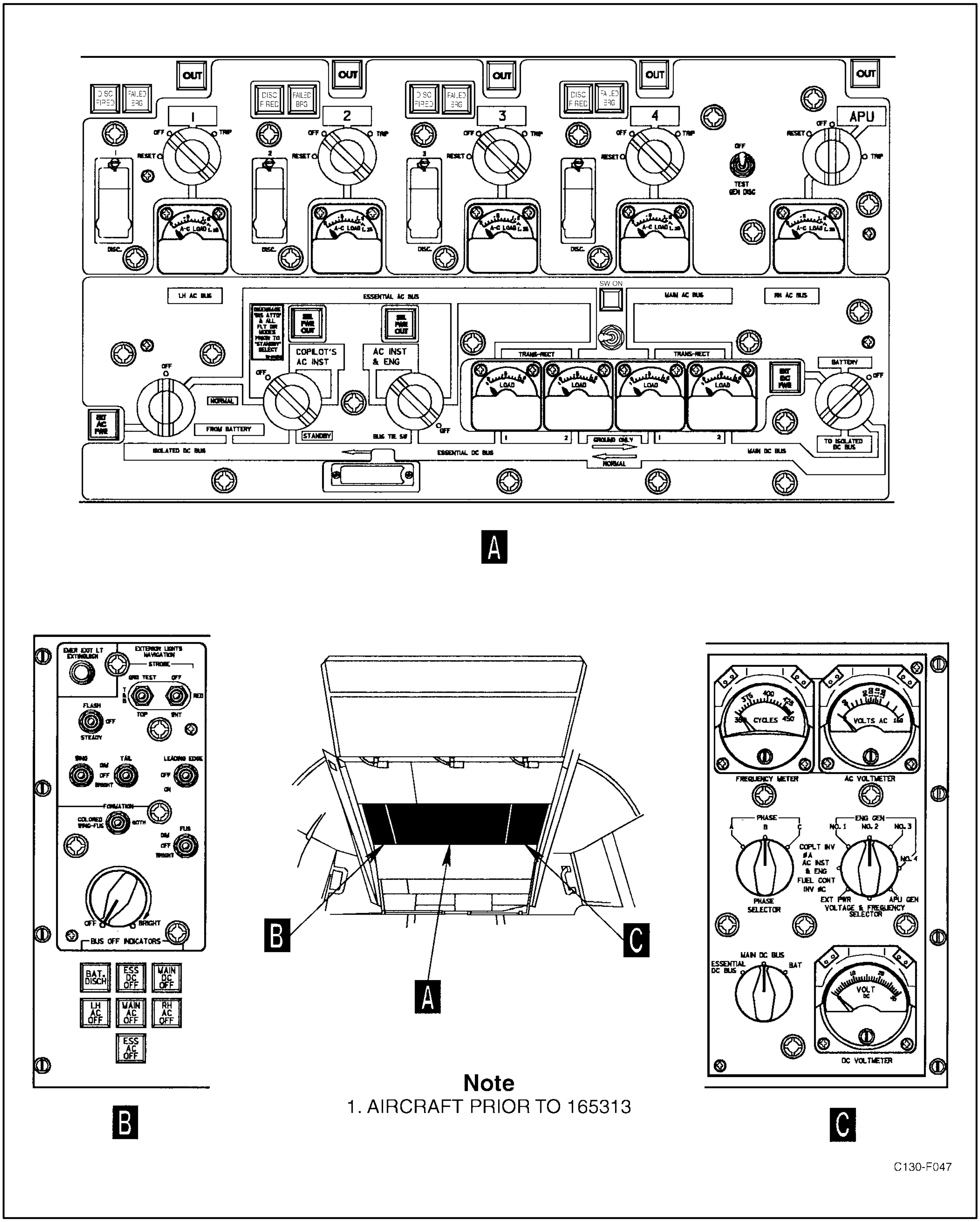


Figure 2-28. Overhead Electrical Panel (Sheet 1 of 2)

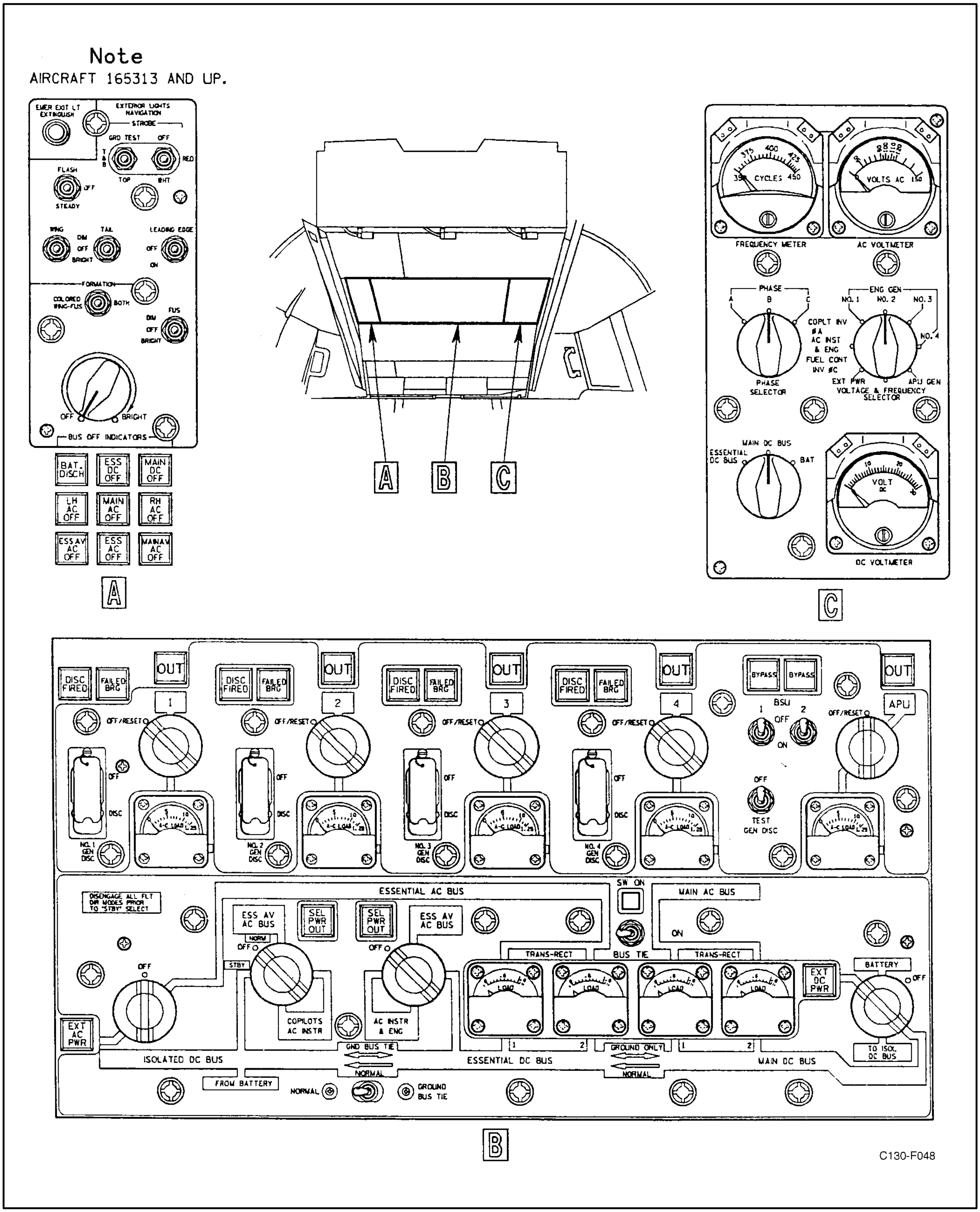


Figure 2-28. Overhead Electrical Panel (Sheet 2)

2.7.4.10 Ac Loadmeters. Five ac loadmeters, one for each generator, give a continuous indication of the percent of rated current flow of any one PHASE SELECTOR switch from their respective generators.

2.7.4.11 AC BUS OFF Indicators. The AC BUS OFF warning system consists of four red press-to-test warning lights and four indicator relays. The warning lights are located on the flight station overhead electrical control panel and the relays are located behind the LH and RH distribution panels. The lights are labeled ESS AC OFF, MAIN AC OFF, LH AC OFF, and RH AC OFF. On aircraft 165313 and up there are six red press-to-test warning lights and six indicator relays. Labeled ESS AC OFF, MAIN AC OFF, LH AC OFF, RH AC OFF, ESS AV AC OFF, and MAIN AV AC OFF. The indicator relays receive power from their respective ac bus. The warning lights receive 28-Vdc power from the isolated dc bus through the AC BUS OFF IND circuit breaker on the pilot side circuit breaker panel.

2.7.4.12 AC VOLTMETER. The AC VOLTMETER can be used to measure the output voltage of the generator or inverter that has been selected with the VOLTAGE & FREQUENCY SELECTOR switch. Each of the three phases of generator output, or the appropriate phase of inverter output, can be measured by selectively positioning the PHASE SELECTOR switch.

2.7.4.13 Frequency Meter. A frequency meter permits measuring the frequency of the output power of the generator selected with the VOLTAGE & FREQUENCY SELECTOR switch. Each of the three phases of the generator output power can be measured by selecting the appropriate position on the PHASE SELECTOR switch.

2.7.4.14 Ac External Power-On Indicator Light. An ac external power-on (EXT AC PWR) press-to-test indicator light is energized by dc power through small pins in the ac external power receptacle and through the closed contacts of a phase sequence relay on the lower main ac distribution panel when the relay is energized. The phase sequence relay is energized when three-phase external ac power with correct phase sequence and no open phases is connected to the aircraft.

2.7.4.15 Generator Disconnect Fired Indicator Lights. Each engine-driven generator is provided with a generator disconnect fired (DISC FIRED) indicator light that will illuminate when one of the following conditions exists: a generator disconnect switch is held in the DISC position and the firing mechanism is fired, or when the generator disconnect test switch is held in the TEST GEN DISC position. Power to the lights is supplied from the essential dc bus through the GENERATOR DISCONNECT circuit breaker on the pilot upper circuit breaker panel.

2.7.4.16 Generator Bearing-Failure Indicator Lights. Each engine-driven generator is provided with a generator bearing failure (FAILED BRG) warning indicator light. Each generator stator contains a soft wire winding that grounds out the stator when contact is made with the rotor. When this occurs, a circuit is completed for illumination of the generator bearing-failure indicator light. Once the indicator light is illuminated, it will remain illuminated until dc power to the circuit is removed. The power for the lights and holding circuit is supplied from the essential dc bus through two GEN BRG FAIL circuit breakers on the pilot upper circuit breaker panel.

2.7.4.17 Ac BUS TIE Switch On Light. An amber SW ON light, located adjacent to the ac BUS TIE switch, illuminates when the ac BUS TIE switch is in the ON position. The light receives 28-Vdc power from the essential dc bus through the GEN OUT LIGHT APU circuit breaker on the copilot lower circuit breaker panel.

2.7.5 Secondary Ac System. The secondary ac power is comprised of two systems: the copilot ac instrument system, and the ac instrument and engine fuel control system (see Figure 2-29).

2.7.5.1 Copilot Ac Instrument Power System. On aircraft prior to 165313, a single 250-volt-ampere inverter supplies 115-volt, 400-Hz, three-phase power. The inverter draws dc power from the isolated bus; therefore, it can be operated from the battery during emergency conditions of flight. Power can also be supplied from the essential ac bus to operate the pilot and copilot ac instruments.

On aircraft 165313 and up, a 250-volt-ampere solid-state inverter supplies 115-volt, 400 Hz, single-phase ac power. The inverters are operated by dc power

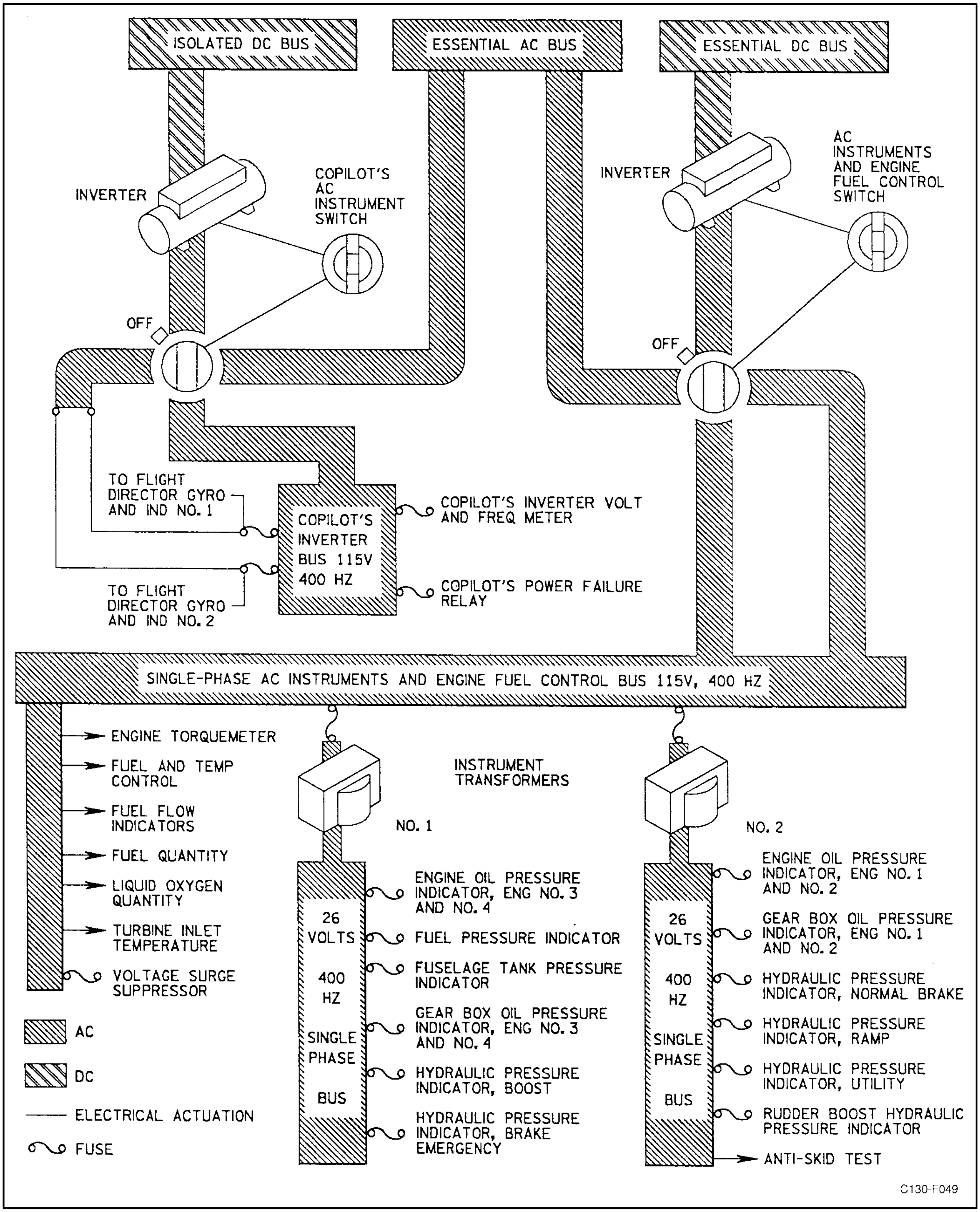


Figure 2-29. Ac Secondary Power System (Aircraft prior to 165313) (Sheet 1 of 2)

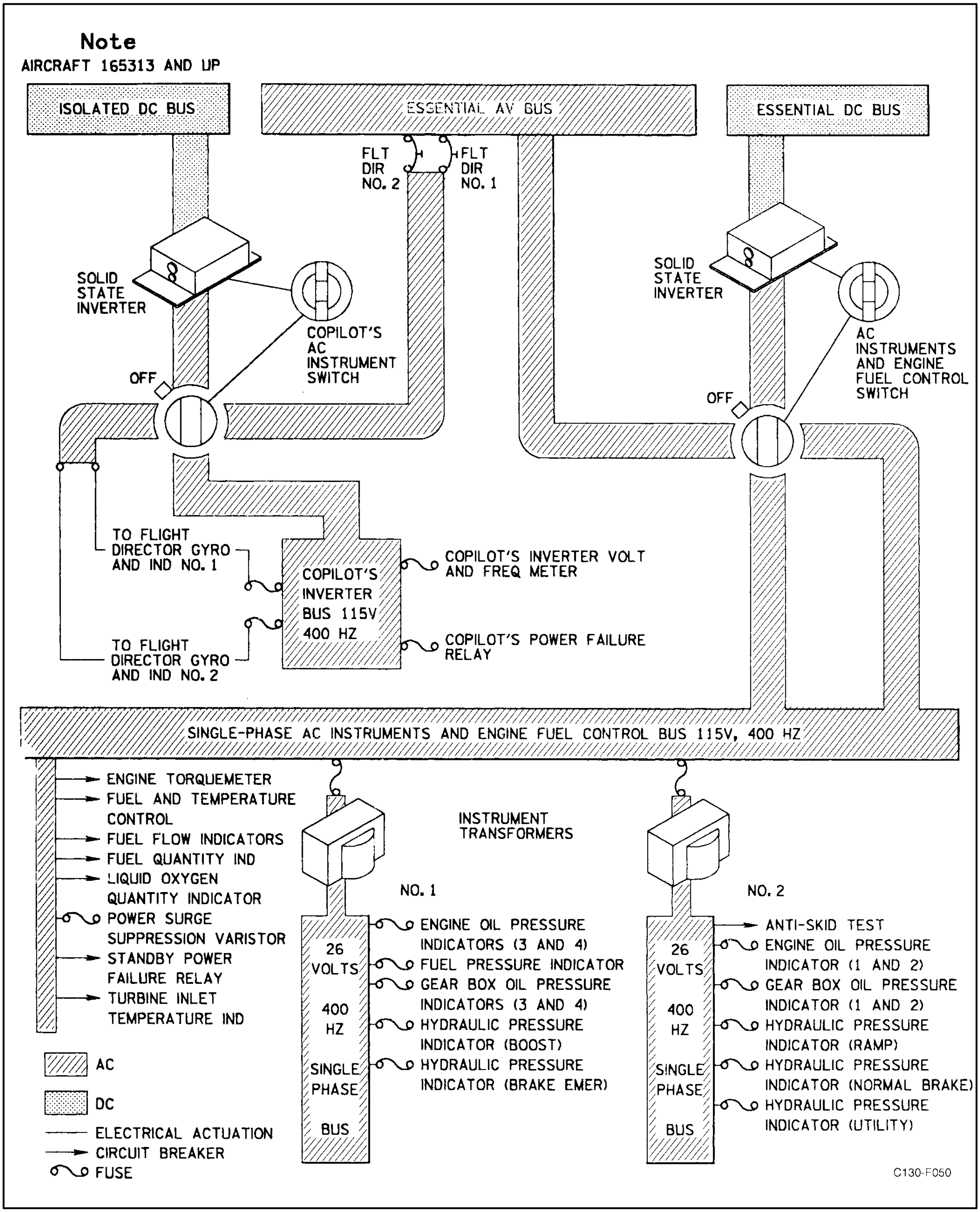


Figure 2-29. Ac Secondary Power System (Aircraft prior to 165313) (Sheet 2)

from the isolated bus, and, therefore, can be operated from the battery during emergency conditions. During normal operations, power is supplied from the essential avionics ac bus to operate the pilot and copilot instruments.

2.7.5.2 Ac Instrument and Engine Fuel Control System. On aircraft prior to 165313, the ac instruments and engine fuel control system are powered by a 115-volt, 400-Hz, single-phase ac bus. One source of power is a 2,500-volt-ampere, single-phase inverter powered from the essential dc bus through a current limiter located in the right-hand distribution box. Inverter control power is provided through the AC INST & ENG FUEL CONT INVERTER circuit breaker on the copilot lower circuit breaker panel from the essential dc bus. Power can also be supplied from phase A of the essential ac bus through the AC INST & ENG FUEL CONT PWR circuit breaker on the pilot side circuit breaker panel. The ac instruments and engine fuel control bus circuits are protected from voltage spiking by a voltage surge suppressor (varistor) through the SURGE SUPPR PROT DEV fuse on the pilot lower circuit breaker panel. Two instrument transformers are powered from the 115-volt, 400-Hz, single-phase bus, and provide 26-volt, single-phase, ac power for instrument use.

On aircraft 165313 and up, the ac instruments and engine fuel control system are powered by a 115-volt, 400-Hz, single-phase, ac instrument and engine fuel control bus. Power for the bus is supplied from one of two sources. One source of power is a solid-state 1,000-volt-ampere inverter. Inverter control power is provided through the AC INST & ENG FUEL CONT INVERTER circuit breaker on the copilot lower circuit breaker panel from the essential dc bus. Power can also be supplied from Phase A of the essential avionics bus through the AC INST & ENG FUEL CONT PWR circuit breaker on the pilot side circuit breaker panel. The ac instruments and engine fuel control bus circuits are protected from voltage spiking by a voltage surge suppressor (varistor) through the SURGE SUPPR PROT DEV fuse on the pilot lower circuit breaker panel. Two instrument transformers are powered from the 115-volt, 400-Hz, single-phase bus and provide 26-volt, single-phase, ac power for instrument use.

2.7.5.3 Secondary Ac System Controls. Controls for the secondary ac power system are located on the overhead electrical control panel (see Figure 2-28).

2.7.5.4 Copilot Ac Instruments Switch. The COPILOT AC INST switch is a three-position (STANDBY, OFF, NORMAL) rotary switch. In the STANDBY position, power is routed from the isolated dc bus to operate the copilot instrument inverter for the copilot instrument power supply system. In the NORMAL position, the inverter is turned off and power for the copilot instrument power system is taken from the essential ac bus. In the OFF position, no power is supplied to the system.

On aircraft 165313 and up, the COPILOTS AC INSTR switch is a three-position, rotary-type switch. In the STBY (horizontal) position, dc power is routed from the isolated dc bus to operate the copilot instrument inverter for the copilot instrument power supply system. In the ESS AV AC BUS position, the inverter is turned off and power for the copilot instrument power supply system is supplied from the essential avionics ac bus. In the OFF position, no power is supplied to the system.

2.7.5.5 Ac Instrument and Engine Switch. The AC INST & ENG switch is a three-position rotary switch. In the horizontal position, power is supplied to the 115-volt, 400-Hz, single-phase bus from phase A of the essential ac bus. In the vertical position, power is supplied to the ac instruments and engine fuel control inverter, which will then power the system. If the inverter output voltage is insufficient, the power supply is automatically switched from the essential dc bus to the essential ac bus. In the OFF position, no power is supplied to the system.

On aircraft 165313 and up, the AC INSTR & ENG switch is a three-position rotary switch. In the ESS AV AC BUS position, power is supplied to the ac instrument and engine fuel control bus from phase A of the essential avionics ac bus. In the normal (horizontal) position, essential dc bus power energizes the ac instruments and engine fuel inverter, which will then power the bus. If the inverter output voltage is insufficient, the power supply is automatically switched from the inverter to the essential ac bus. In the OFF position, no power is supplied to the system.

2.7.5.6 VOLTAGE & FREQUENCY SELECTOR Switch. The VOLTAGE & FREQUENCY SELECTOR switch has seven positions for measuring the output voltage and frequency of the ac power supply sources. Placing the switch in the COPLT INV ϕA AC INST & ENG FUEL CONT INV ϕC position, while simultaneously placing the PHASE SELECTOR switch in the PHASE A position, provides an indication of the frequency and voltage of the copilot inverter on the frequency meter and the ac voltmeter, respectively. Positioning the PHASE SELECTOR switch to PHASE C provides an indication of the output frequency and voltage of the ac instrument and engine fuel control inverter. If the switch is at the COPLT INV ϕA AC INST & ENG FUEL CONT INV ϕC position and essential ac power is being used in place of the inverter, the frequency meter and the ac voltmeter will not indicate output frequency.

2.7.5.7 PHASE SELECTOR Switch. A three-position PHASE SELECTOR switch permits selection of the appropriate phase of electrical power when measuring the output voltage and frequency of either of the inverters.

2.7.6 Secondary Ac System Indicators. Indicators for the secondary ac power system are located on the overhead electrical control panel (see Figure 2-28).

2.7.6.1 Ac Voltmeter. An ac voltmeter permits measuring the output voltage of that phase of inverter power selected with the PHASE SELECTOR switch. In order for the voltmeter to measure inverter output voltage, the VOLTAGE & FREQUENCY SELECTOR switch must be in the COPLT INV ϕA AC INST & ENG FUEL CONT INV ϕC position. If the switch is at either position and a bus source of power is being used in place of the inverter, however, the voltmeter will not indicate output voltage.

2.7.6.2 Frequency Meter. A frequency meter permits measuring the frequency of the output power of that phase of inverter output selected with the PHASE SELECTOR switch. In order for the frequency meter to measure the frequency of the inverter output power, the VOLTAGE & FREQUENCY SELECTOR switch must be in the COPLT INV ϕA AC INST & ENG FUEL CONT INV ϕC position. If the switch is at either position and a bus source of power is being used in place of the inverter, however, the frequency meter will not indicate output frequency.

2.7.6.3 Selected Power OUT Lights. Two selected power OUT press-to-test lights are located on the electrical control panel. If the copilot ac instrument SEL PWR OUT light comes on, it indicates that no power is being supplied to the pilot and copilot ac instruments. When the AC INST & ENG switch is in the vertical position and its SEL PWR OUT light glows, the inverter has failed; however, the 115-Vac instrument and engine bus is then automatically connected to the standby power source (the essential/essential avionics ac bus). The light does not glow when the corresponding selector switch is OFF.

2.7.7 Dc Power System. Power from the essential ac bus and the main ac bus operates four transformer-rectifier units (two from each ac bus) to provide dc power to the respective dc buses for the aircraft (see Figure 2-30). The four transformer-rectifier units, mounted on the electronic control and supply rack, convert the power from the ac buses to 28-Vdc. Both the essential ac bus and the main ac bus may be powered by any of the engine-driven generators (refer to Figure 2-31).

The essential ac bus is powered from the APU generator also, so it may be used as a source of dc power for ground operation. The transformer-rectifier units feed current through reverse-current relays to the main dc bus and the essential dc bus.

2.7.7.1 Dc System Buses. There are four buses in the DC POWER system: essential dc bus, battery bus, main dc bus, and isolated dc bus (see Figure 2-32). The main and essential buses are connected through a reverse-current relay, which, in flight, allows current to flow from the main bus to the essential bus but limits current flow in the opposite direction. When the aircraft is on the ground, a touchdown switch is actuated to complete a circuit that overrides the reverse-current limiting features of the reverse-current relay and permits current flow in either direction between the main and essential buses. The essential and isolated buses are similarly connected through another reverse-current relay that limits current flow from the isolated bus to the essential bus in flight. When the aircraft is on the ground, the touchdown switch completes a circuit so that manual positioning of the dc BUS TIE switch overrides the reverse-current limiting features of the reverse-current relay and permits current flow in either direction between the isolated and essential buses.

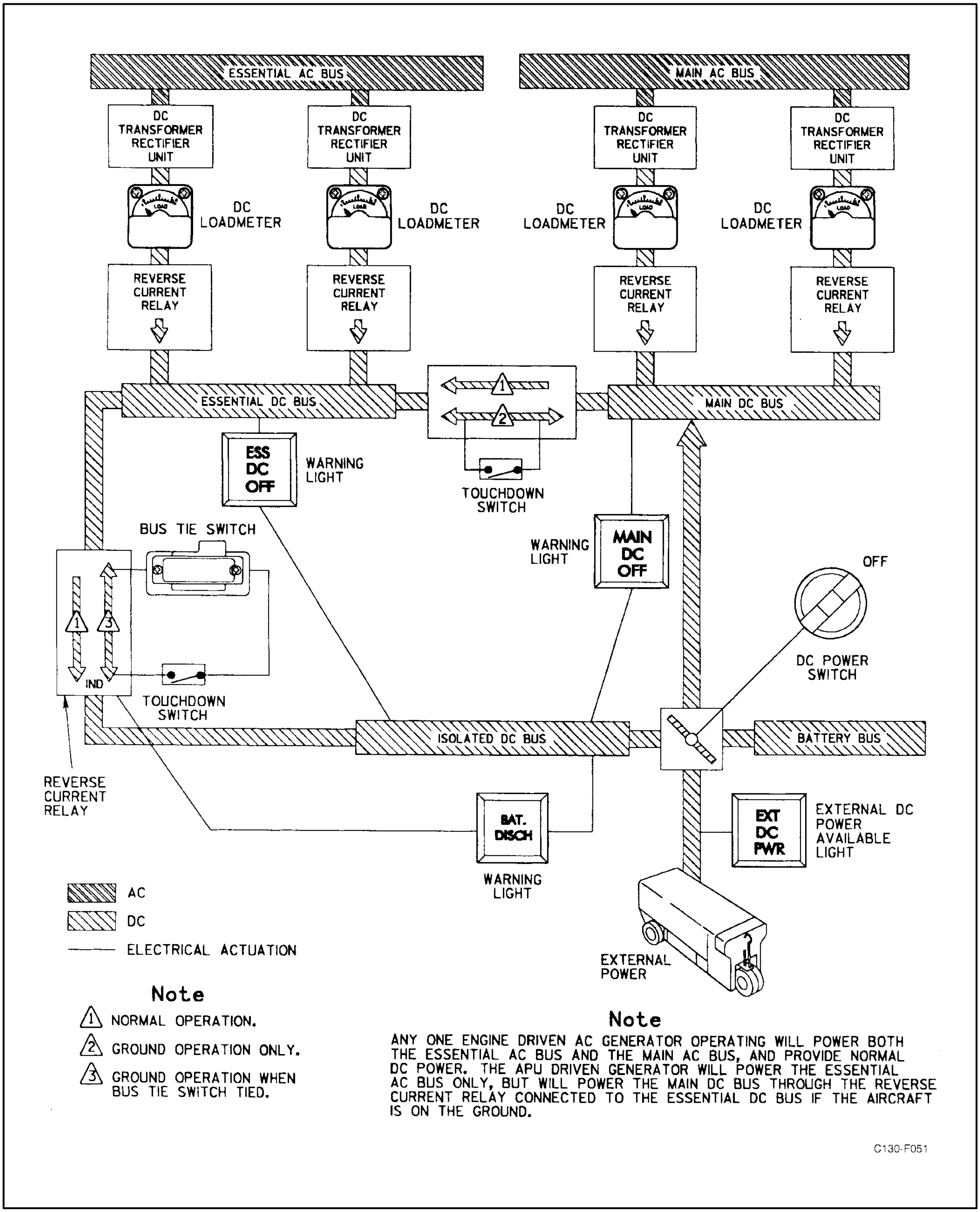


Figure 2-30. Dc Power Supply

ENGINE DRIVEN GENERATORS				AC GENERATOR POWER SOURCE				AC BUS POWER SOURCE (2)			
								ESSENTIAL AVIONICS BUS		MAIN AVIONICS BUS	
NO. 1	NO. 2	NO. 3	NO. 4	LH AC BUS	ESSENTIAL AC BUS	MAIN AC BUS	RH AC BUS	PRI	ALT	PRI	ALT
On	On	On	On	1	2	3	4	ESS	MAIN	MAIN	ESS
Out	On	On	On	2	2	3	4	ESS	MAIN	MAIN	ESS
On	Out	On	On	1	1	3	4	ESS	MAIN	MAIN	ESS
On	On	Out	On	1	2	4	4	ESS	MAIN	MAIN	ESS
On	On	On	Out	1	2	3	3	ESS	MAIN	MAIN	ESS
Out	Out	On	On	4	3	3	4	ESS	MAIN	MAIN	ESS
On	Out	Out	On	1	1	4	4	ESS	MAIN	MAIN	ESS
On	On	Out	Out	1	2	2	1	ESS	MAIN	MAIN	ESS
Out	On	On	Out	2	2	3	3	ESS	MAIN	MAIN	ESS
Out	On	Out	On	2	2	4	4	ESS	MAIN	MAIN	ESS
On	Out	On	Out	1	1	3	3	ESS	MAIN	MAIN	ESS
Out	Out	Out	On		4	4		ESS		MAIN	
Out	Out	On	Out		3	3		ESS		MAIN	
Out	On	Out	Out		2	2		ESS		MAIN	
On	Out	Out	Out		1	1		ESS		MAIN	
Out	Out	Out	Out		APU Gen	APU Gen		ESS		(3)	ESS
Out	Out	Out	Out	Ext	Ext	Ext	Ext		LH		RH

Generator Out

Generator On

Note

1. The APU generator will power the main ac bus when the ac bus tie switch is placed in the on position. This function is for ground checks only.

(2) Aircraft 165313 and up.

(3) If the ac bus tie switch is on, bus no. 2 will select the main ac bus to power the main avionics bus.

4. Example:
   No. 2 and No. 3 engine-driven generators out.
   LH ac bus supplied by No. 1 generator.
   Essential ac bus supplied by No. 1 generator.
   Main ac bus supplied by No. 4 generator.
   RH ac bus supplied by No. 4 generator.

5. If generator frequency drops below 368 Hz, the respective bus should transfer automatically.

Figure 2-31. Ac Bus Power Sources

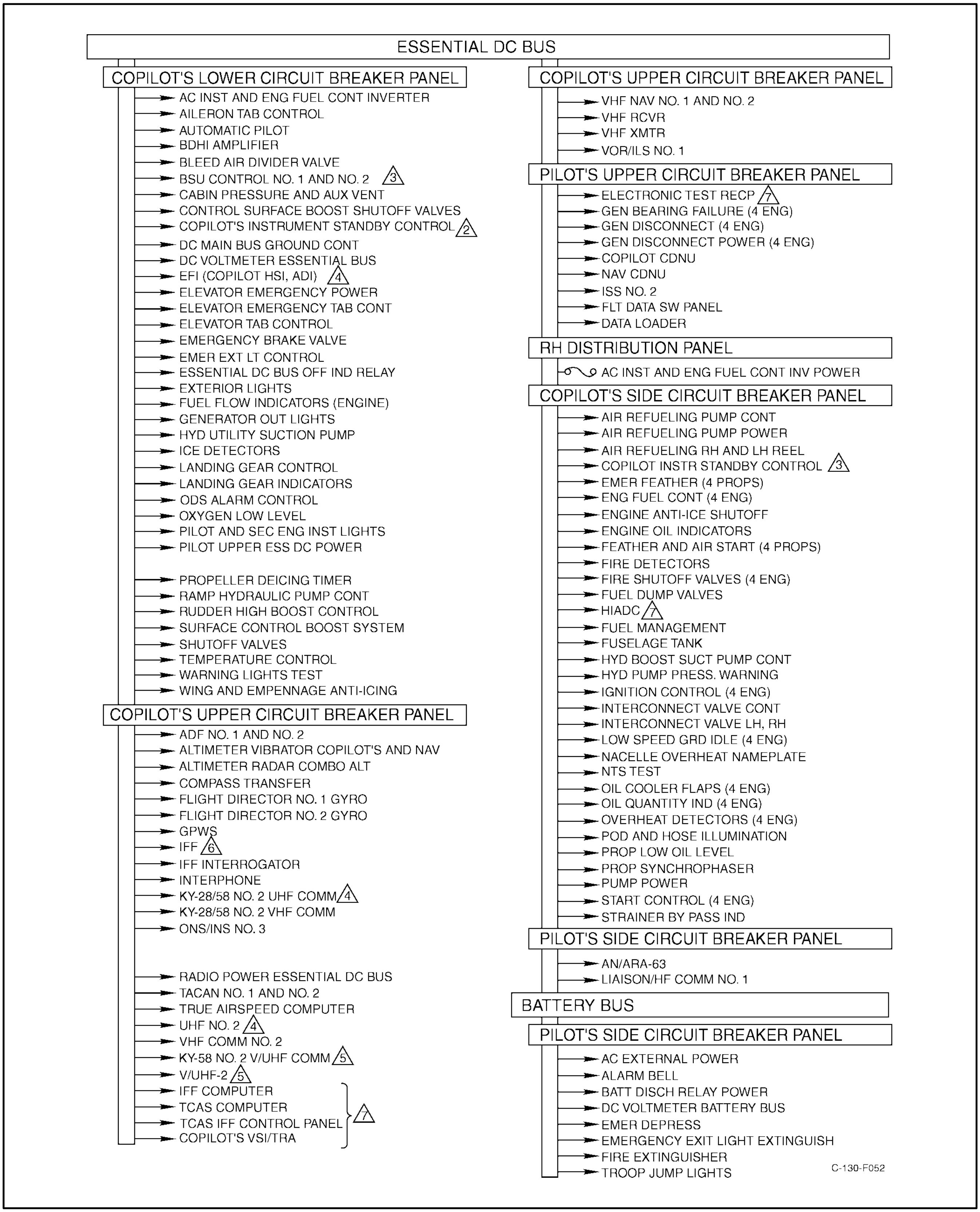


Figure 2-32. Dc Power Distribution (Sheet 1 of 2)

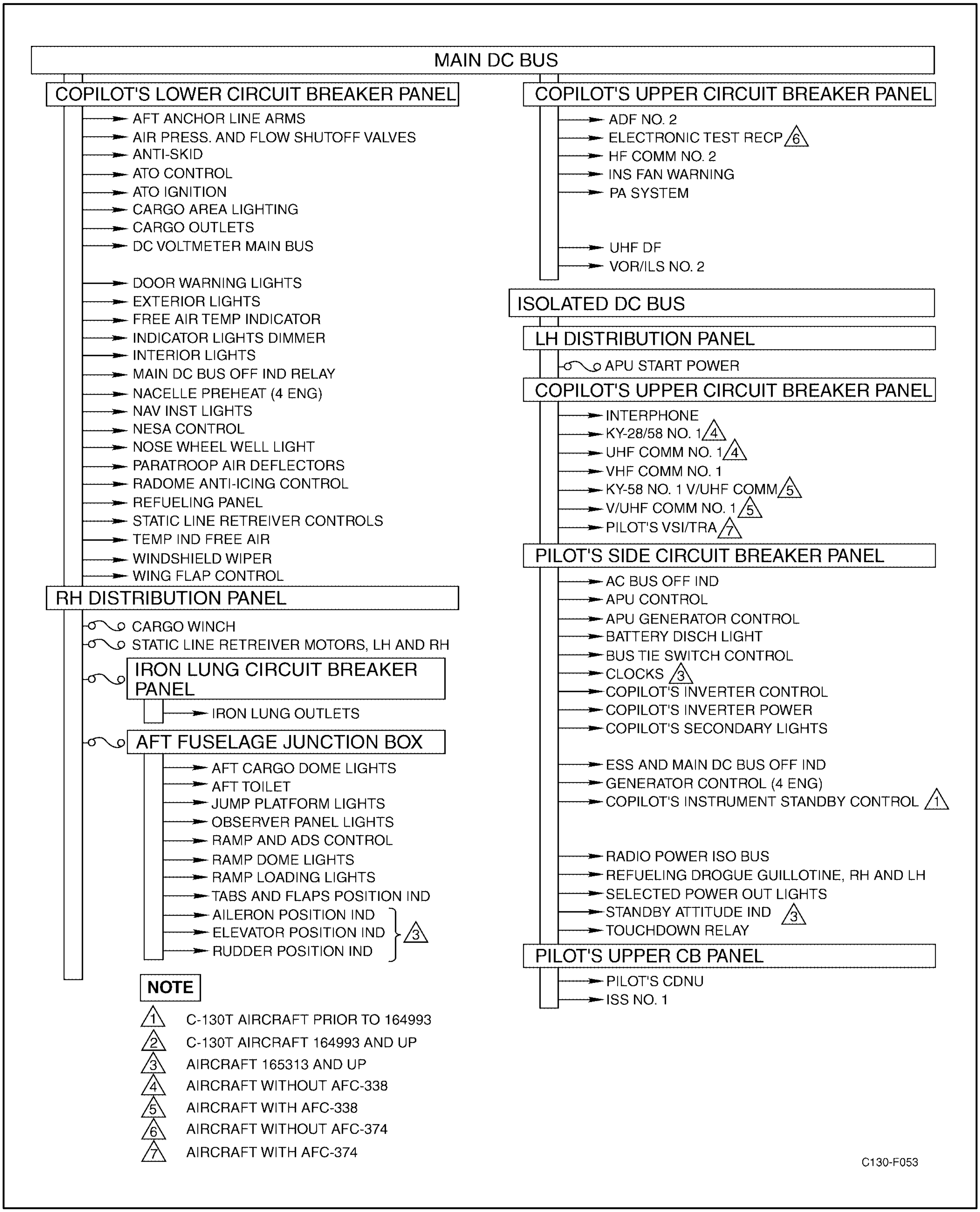


Figure 2-32. Dc Power Distribution (Sheet 2)

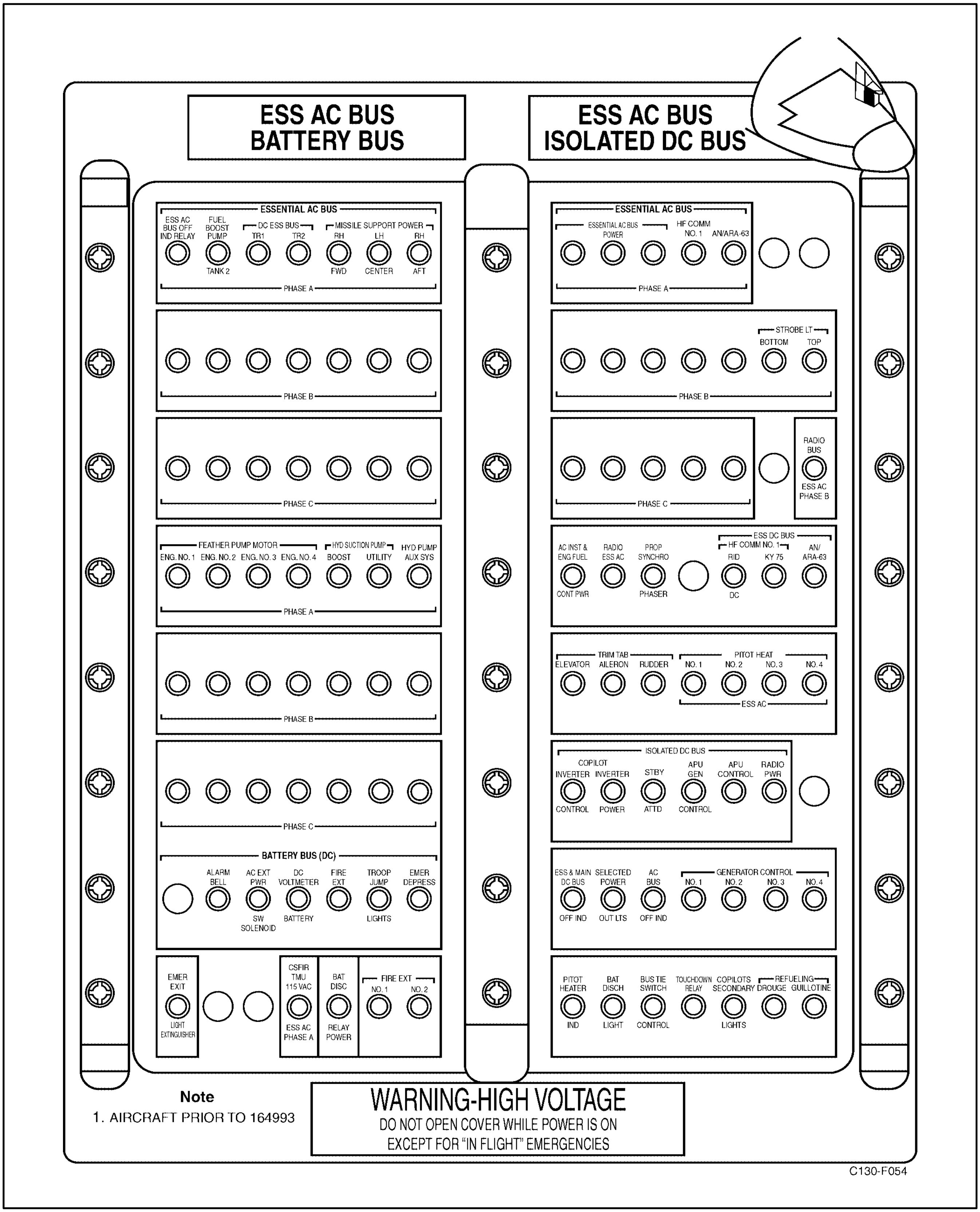


Figure 2-33. Pilot Side Circuit Breaker Panel (Sheet 1 of 3)

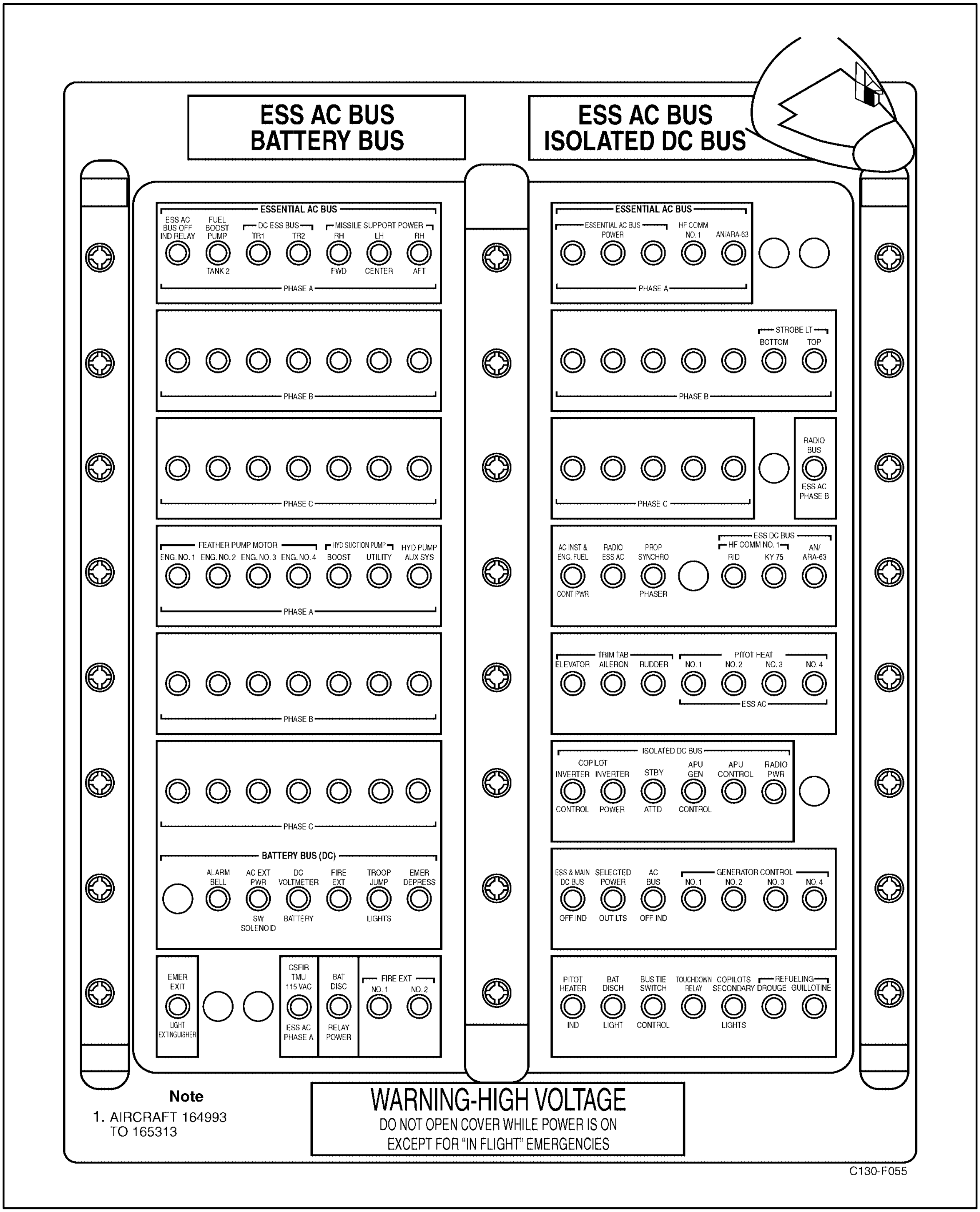


Figure 2-33. Pilot Side Circuit Breaker Panel (Sheet 2)

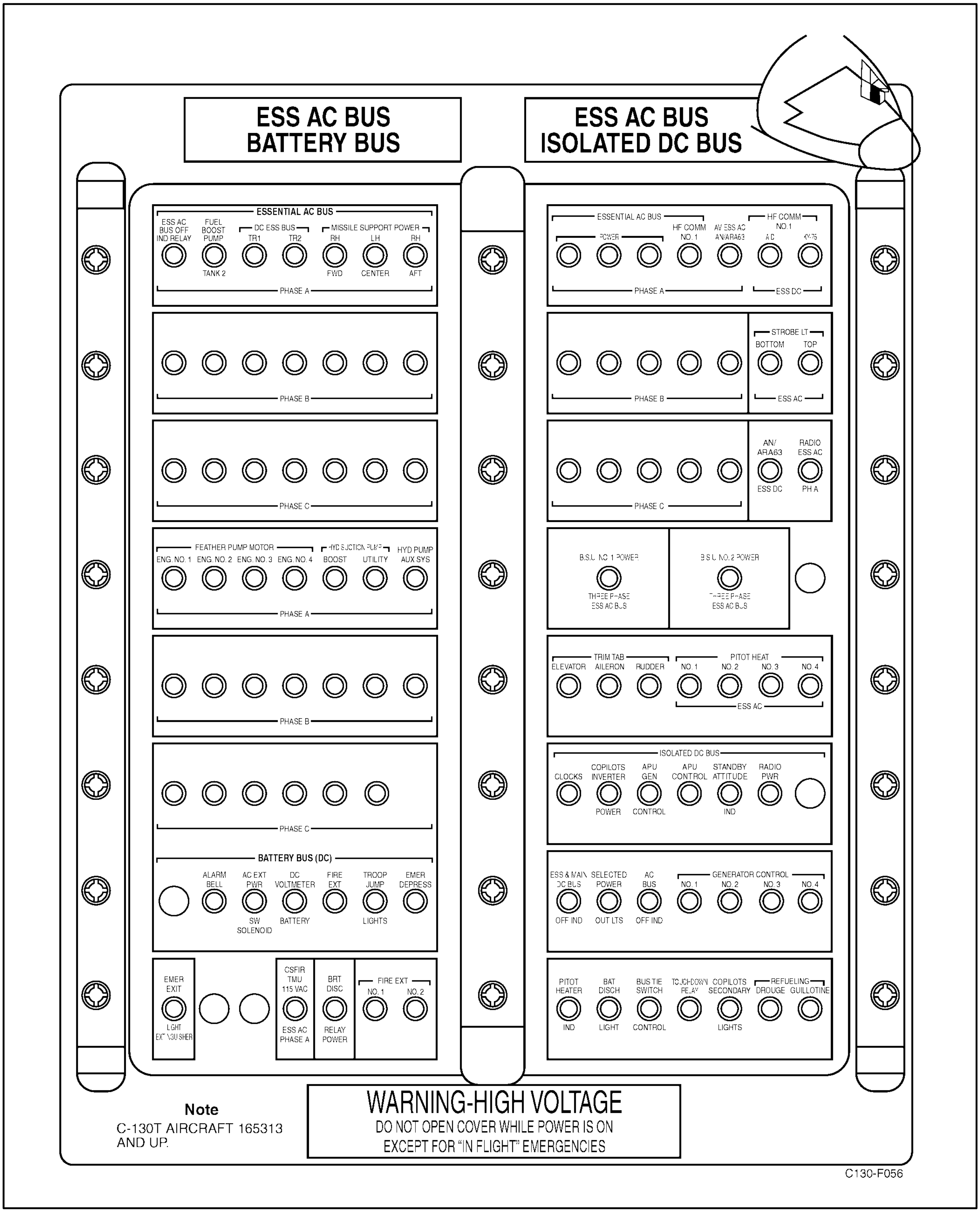


Figure 2-33. Pilot Side Circuit Breaker Panel (Sheet 3)

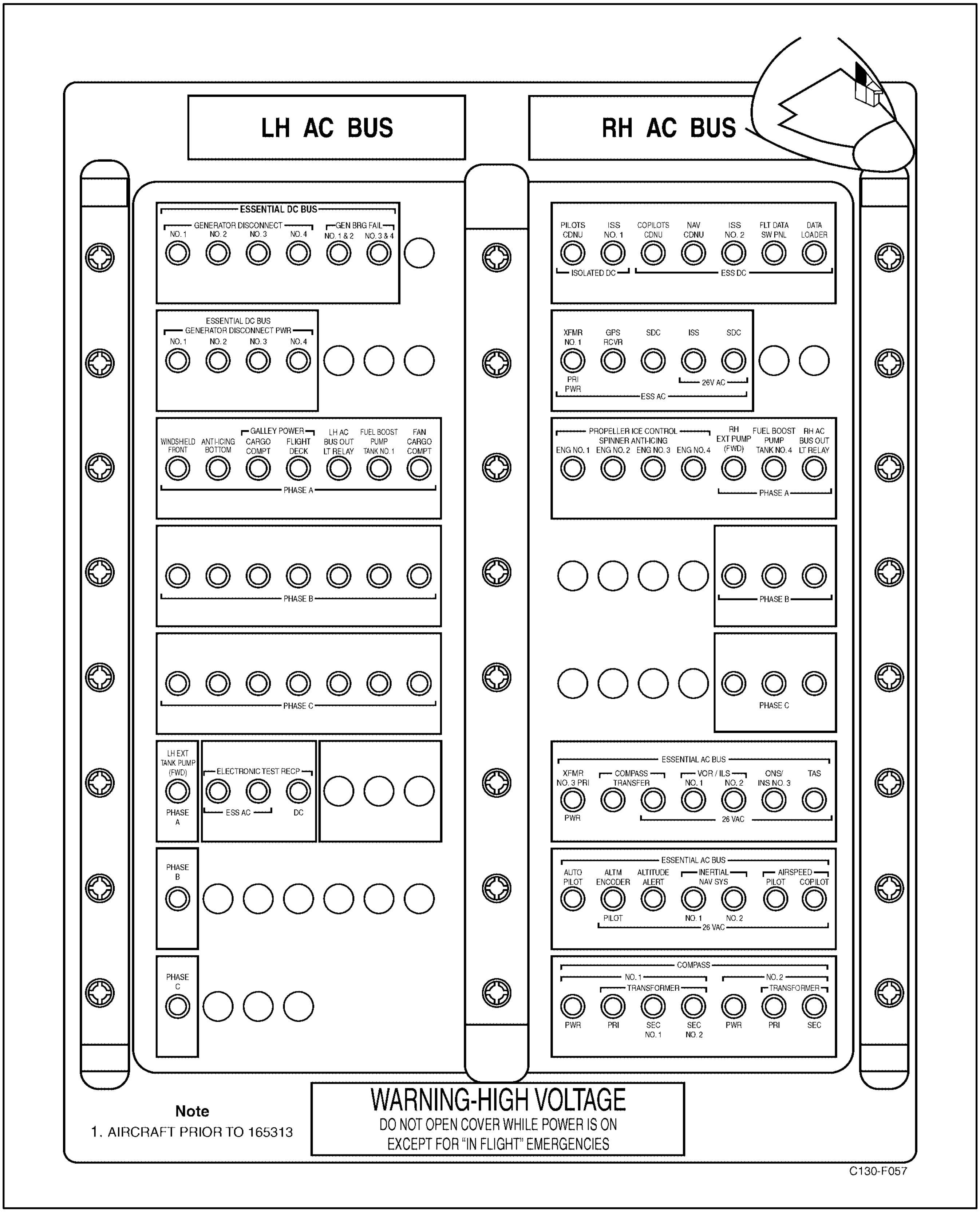


Figure 2-34. Pilot Upper Circuit Breaker Panel (Sheet 1 of 2)

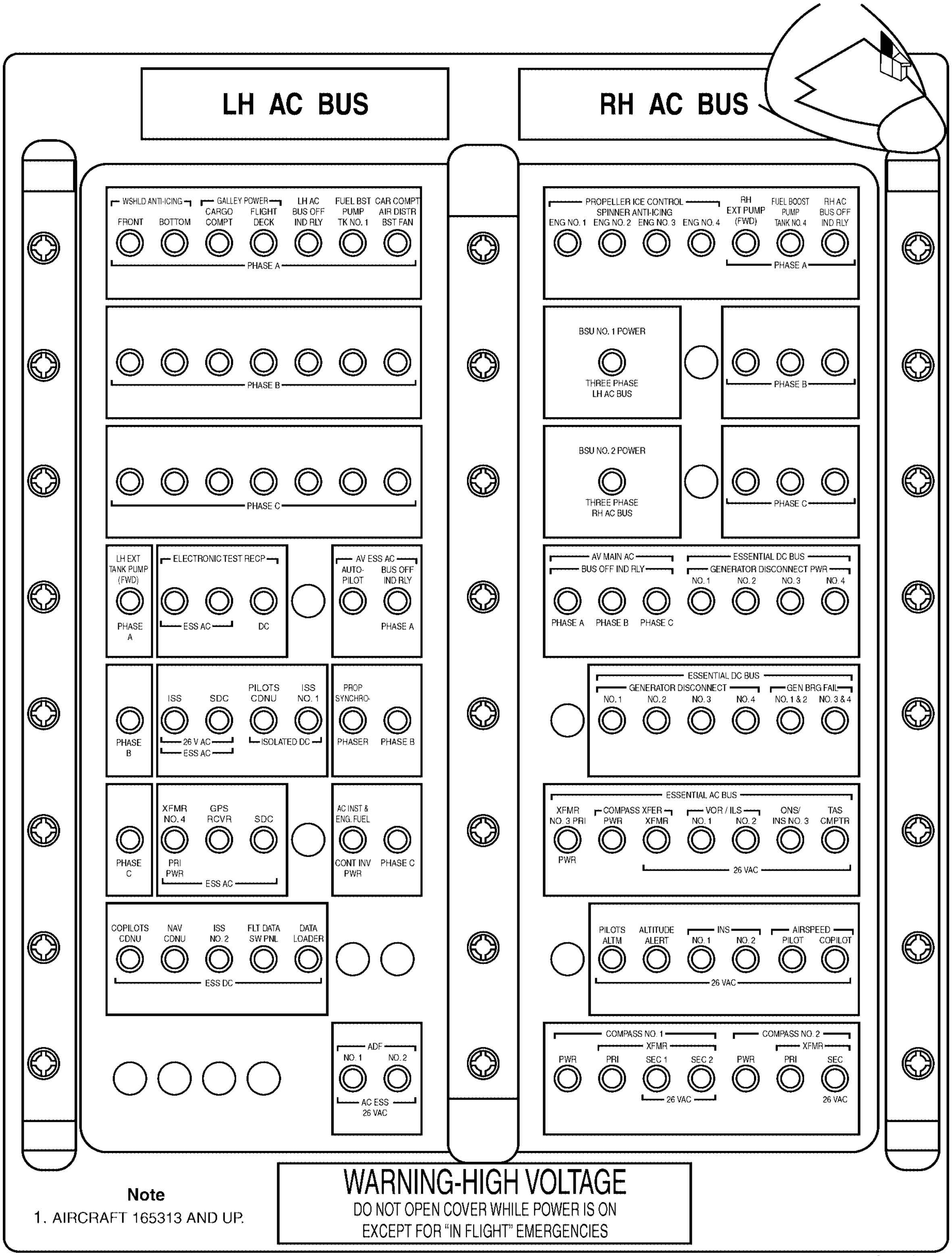


Figure 2-34. Pilot Upper Circuit Breaker Panel (Sheet 2)

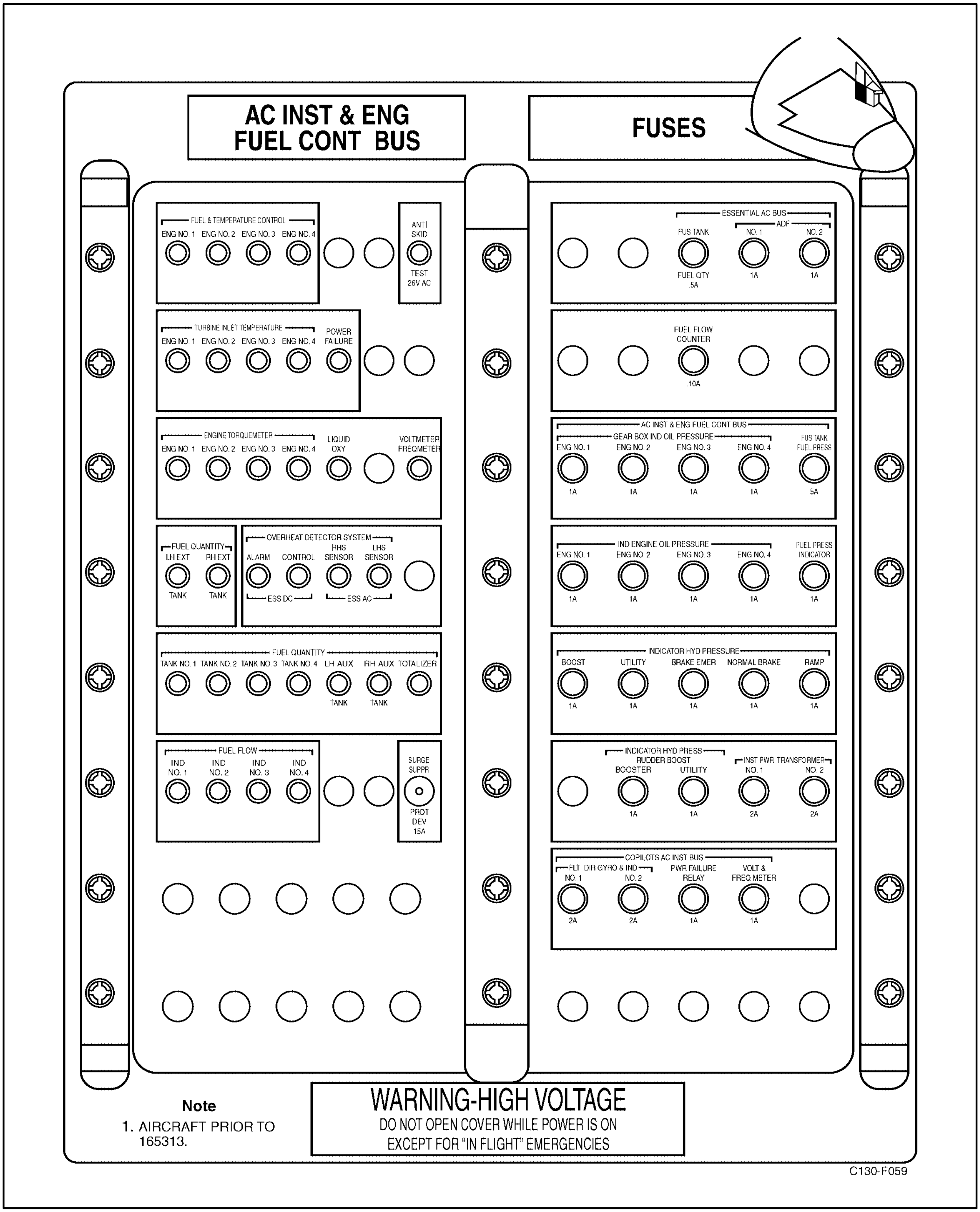


Figure 2-35. Pilot Lower Circuit Breaker Panel (Sheet 1 of 2)

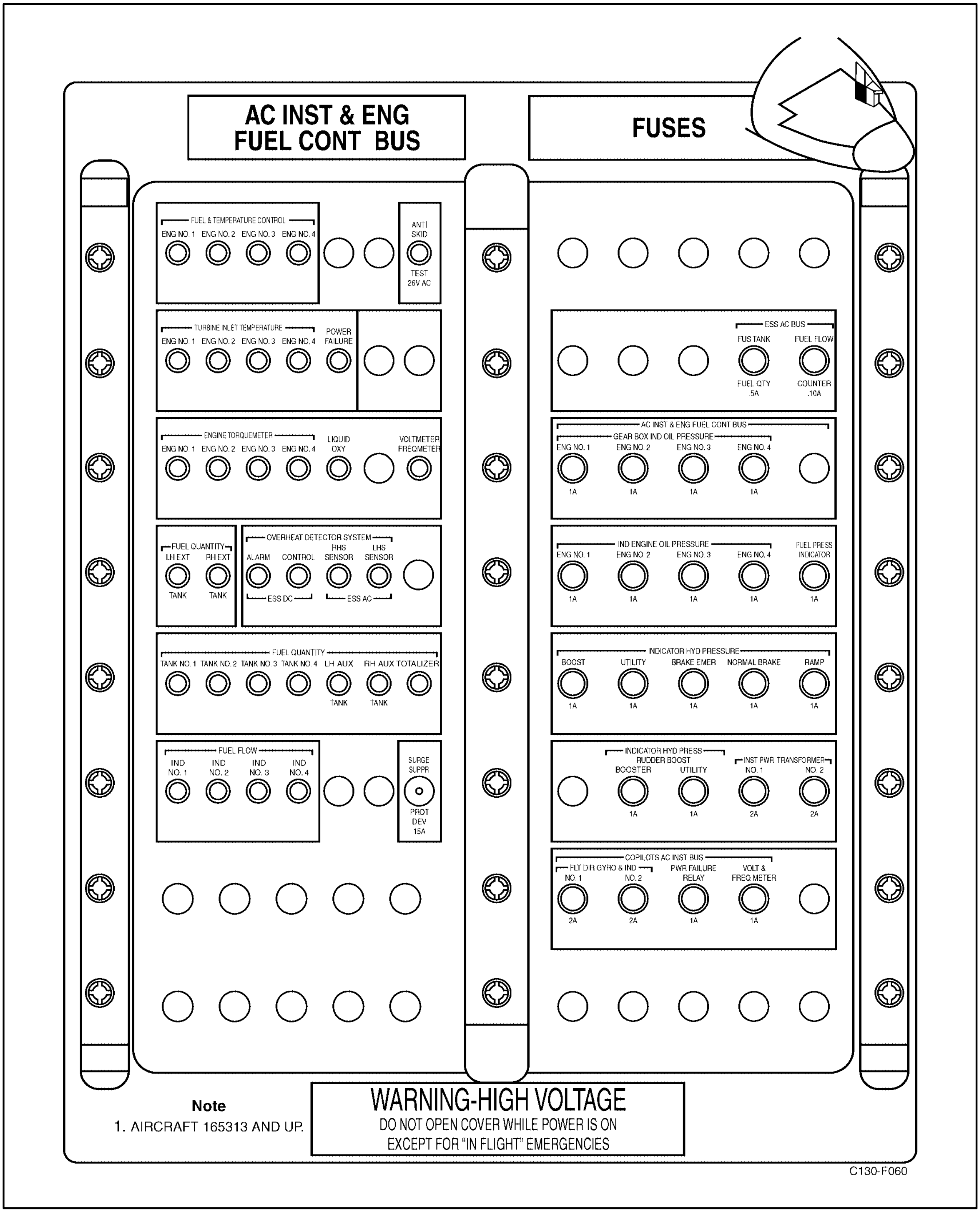


Figure 2-35. Pilot Lower Circuit Breaker Panel (Sheet 2)

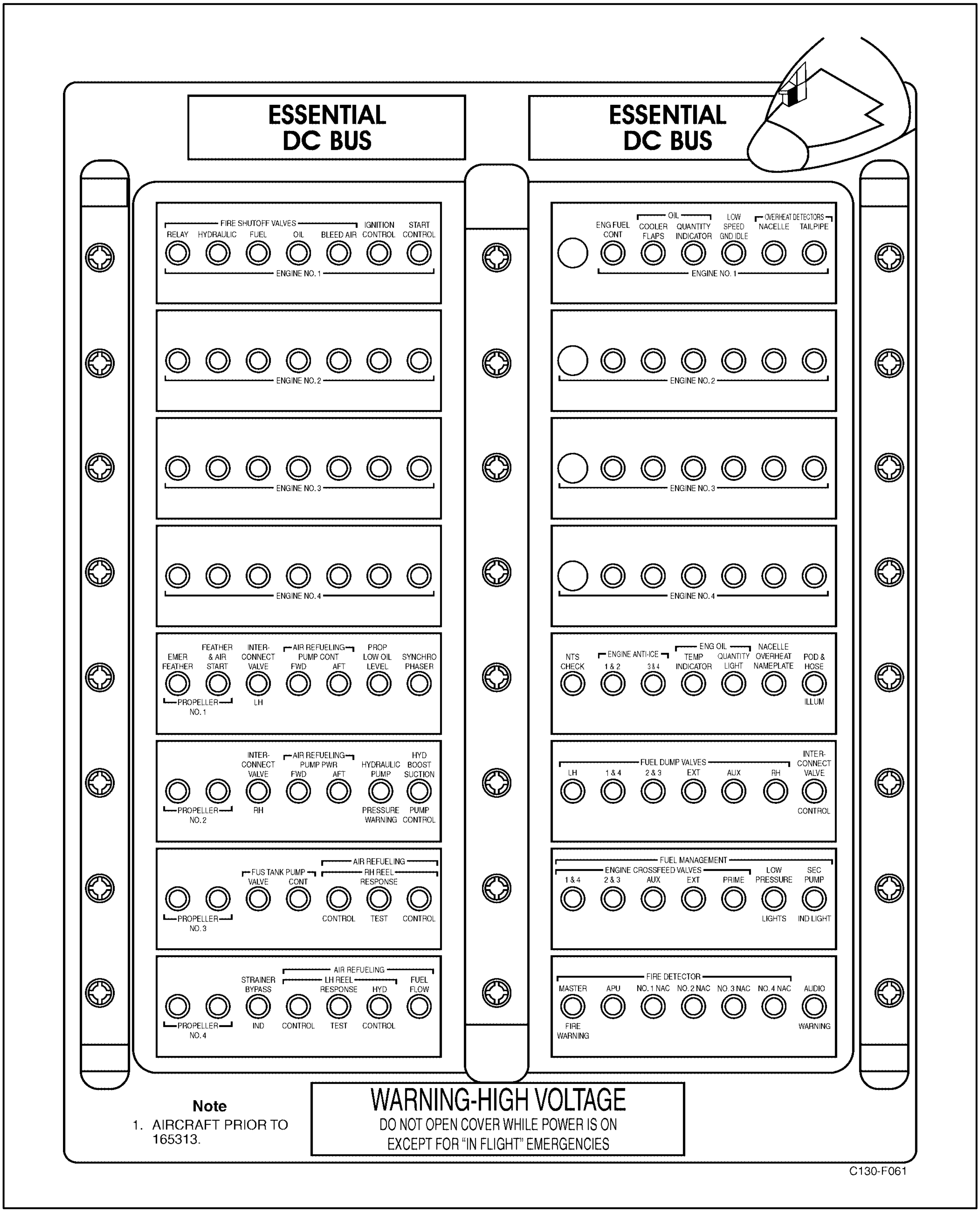


Figure 2-36. Copilot Side Circuit Breaker Panel (Sheet 1 of 2)

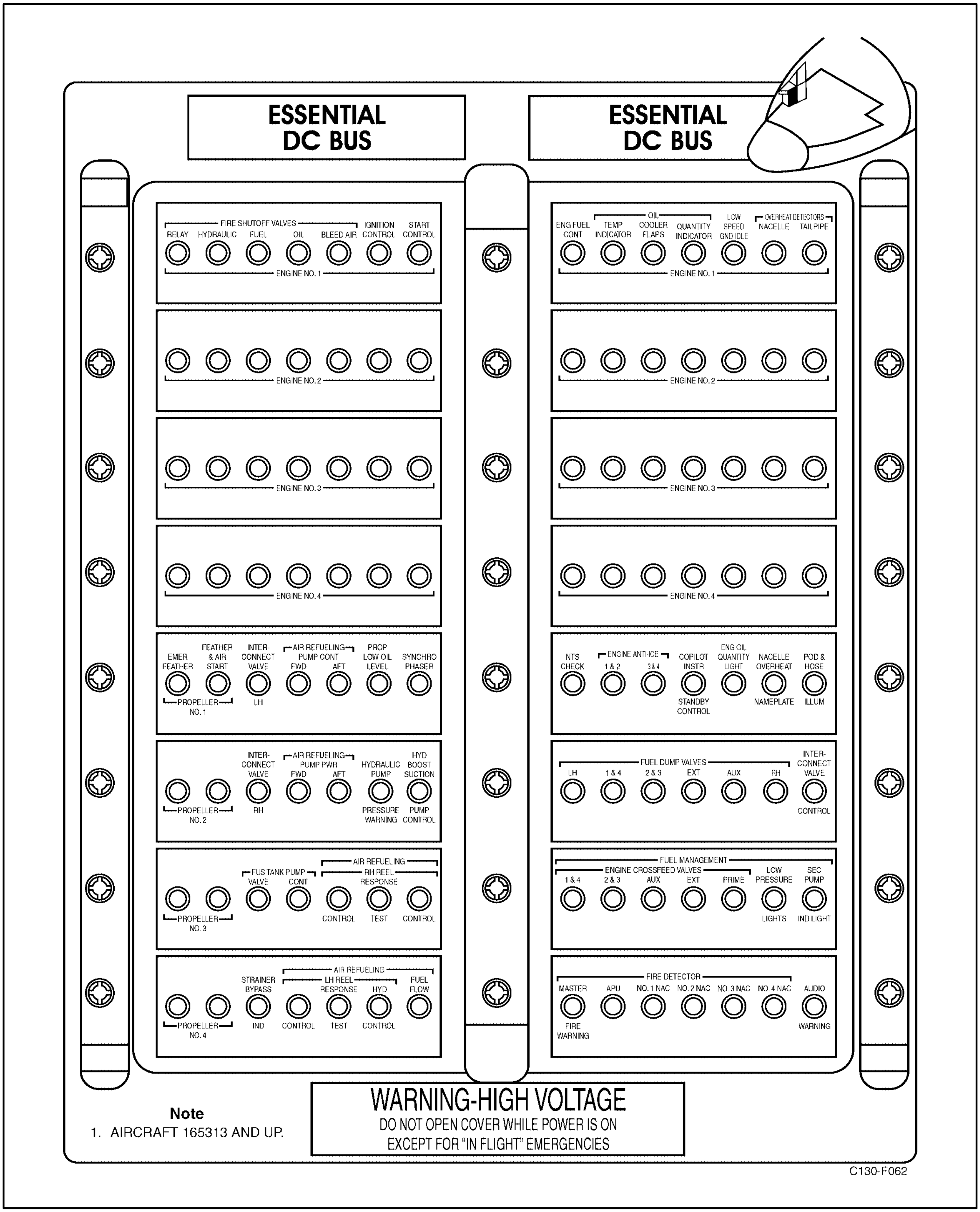


Figure 2-36. Copilot Side Circuit Breaker Panel (Sheet 2)

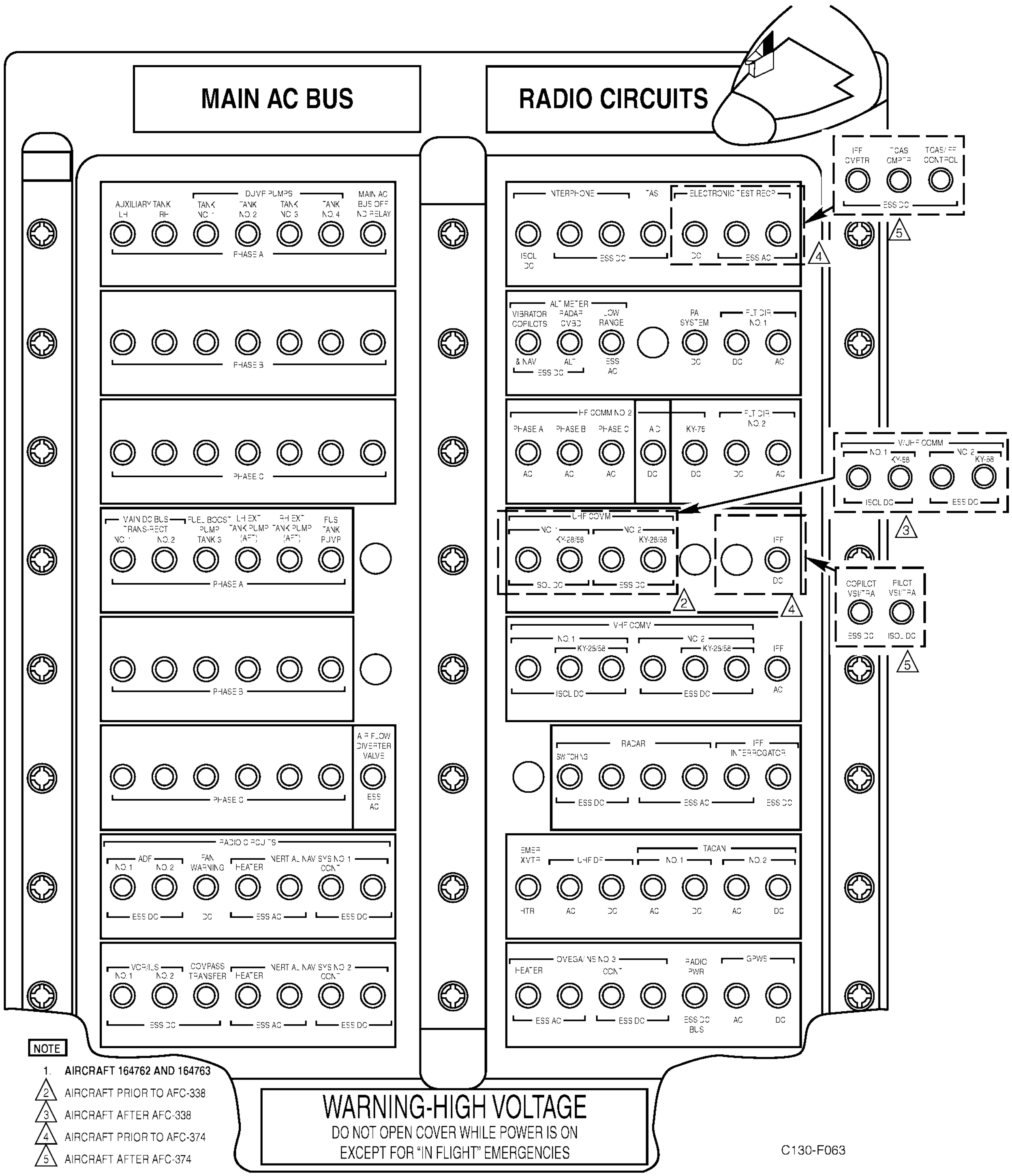


Figure 2-37. Copilot Upper Circuit Breaker Panel (Sheet 1 of 3)

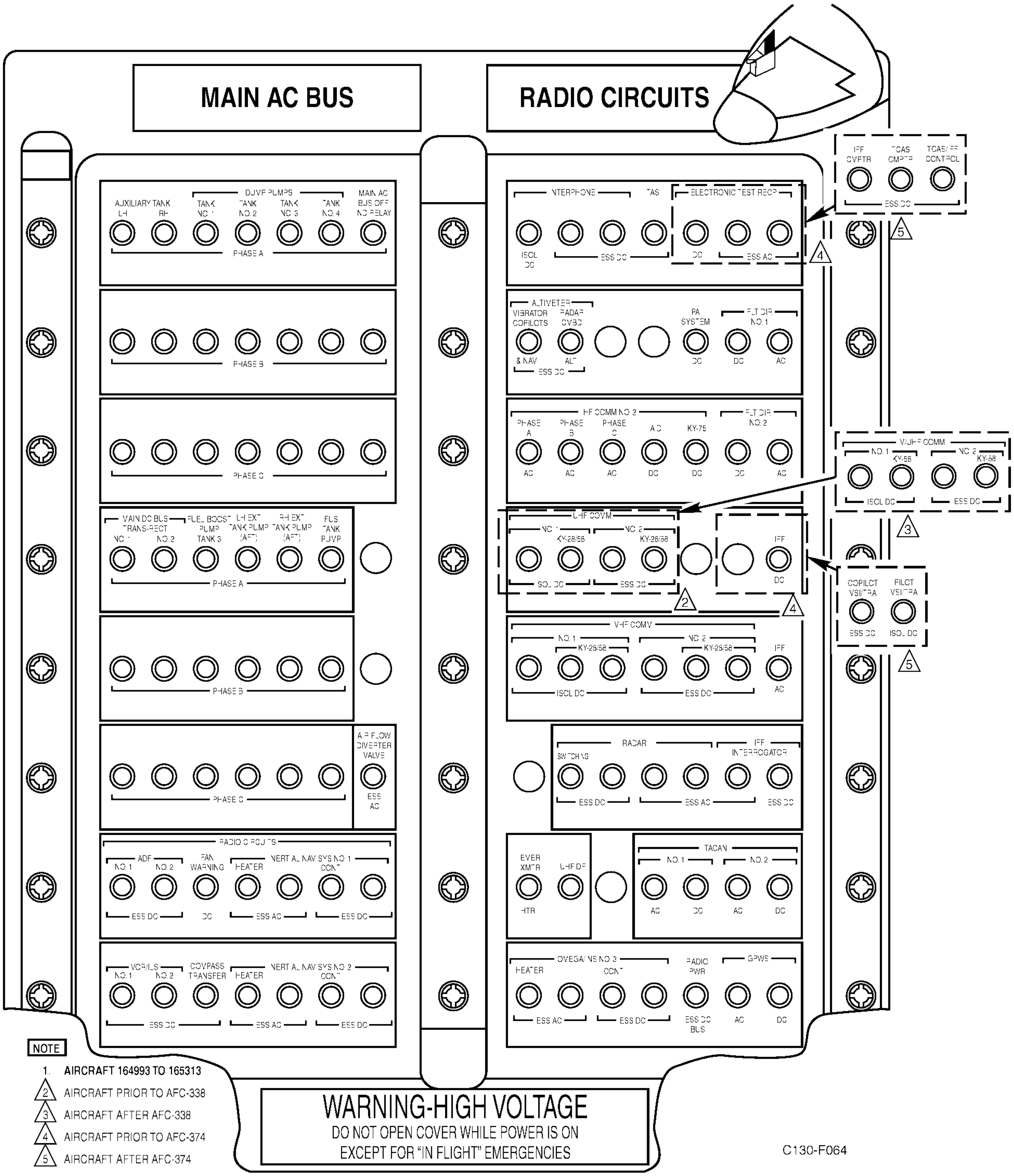


Figure 2-37. Copilot Upper Circuit Breaker Panel (Sheet 2)

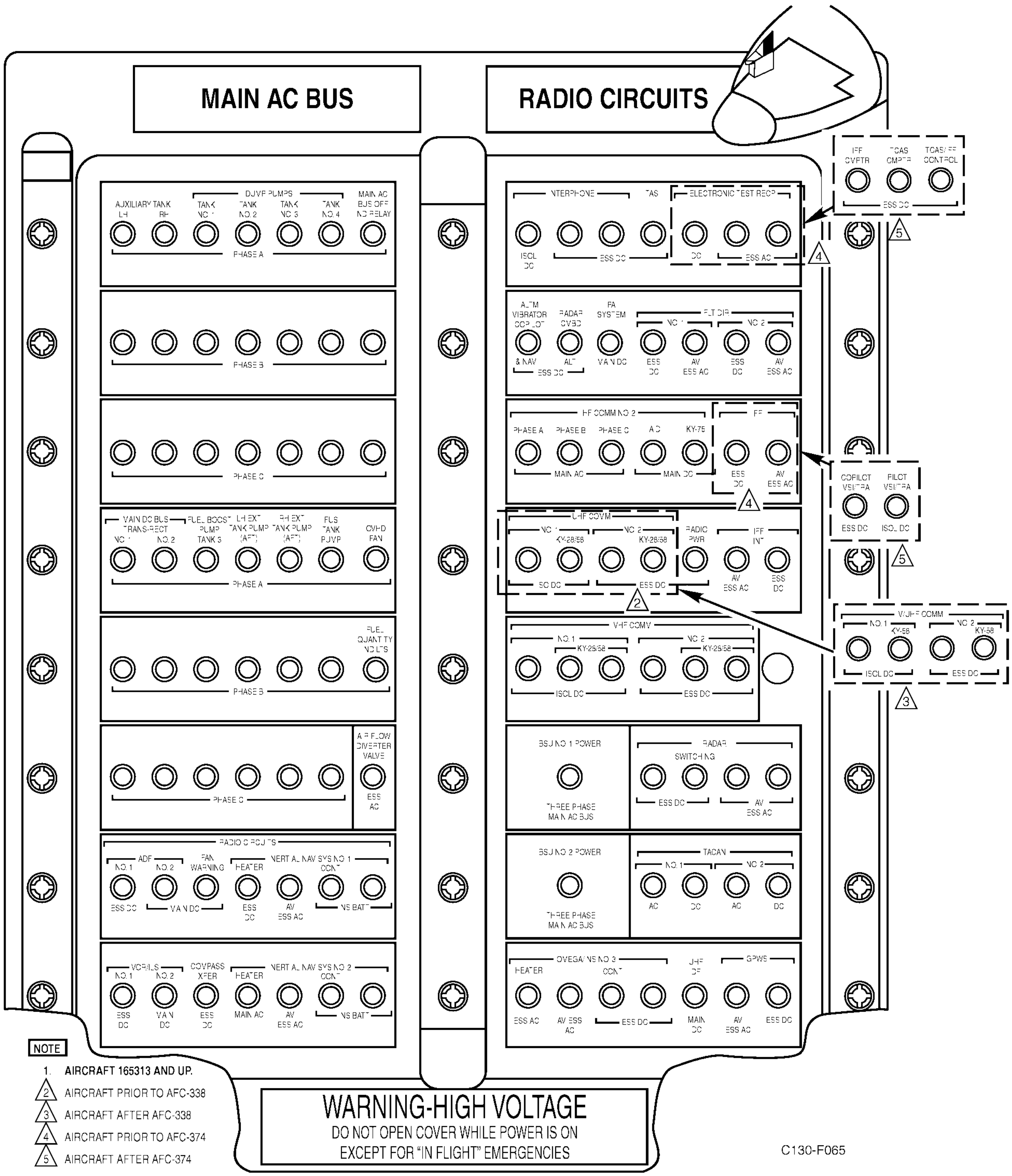


Figure 2-37. Copilot Upper Circuit Breaker Panel (Sheet 3)

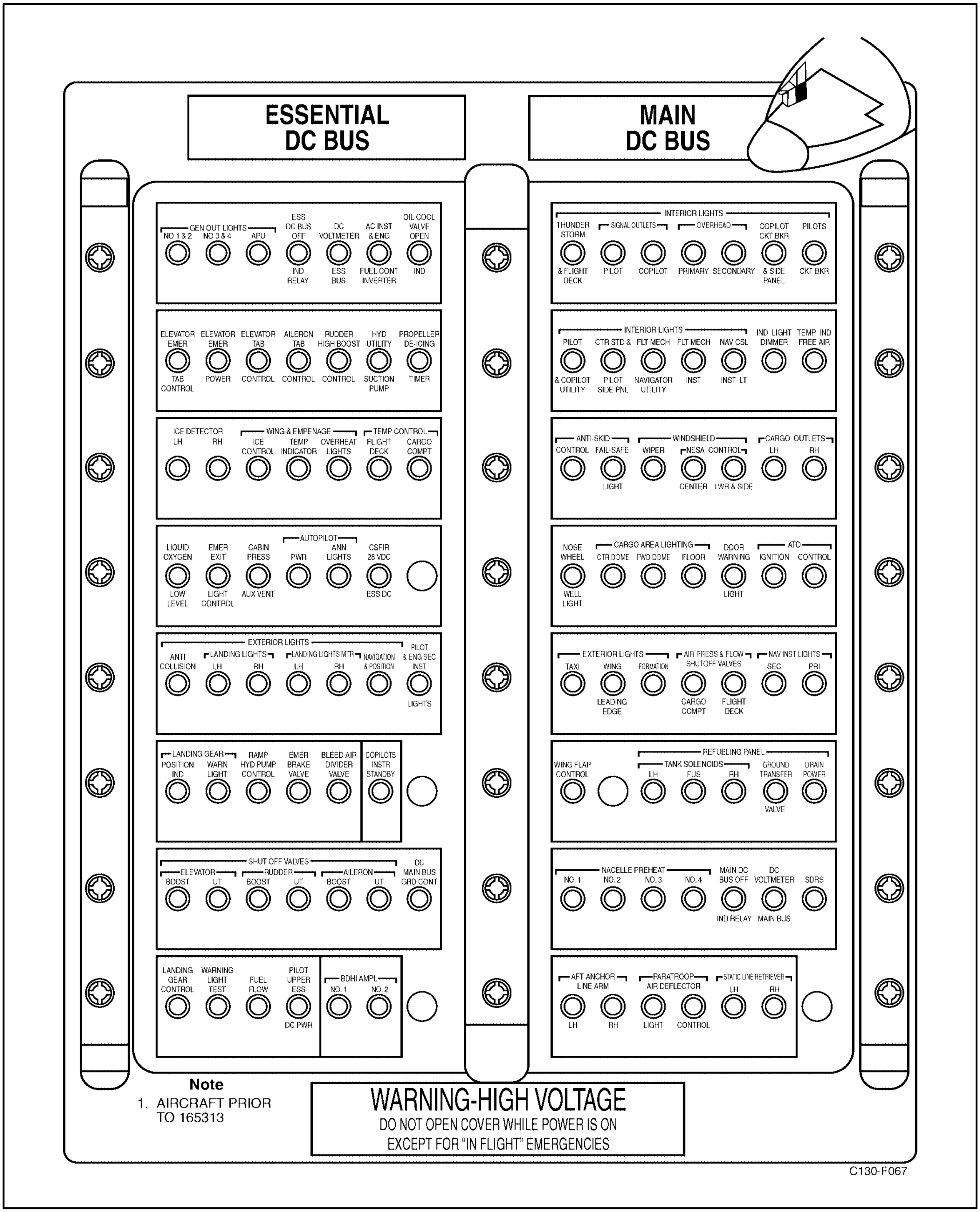


Figure 2-38. Copilot Lower Circuit Breaker Panel (Sheet 1 of 2)

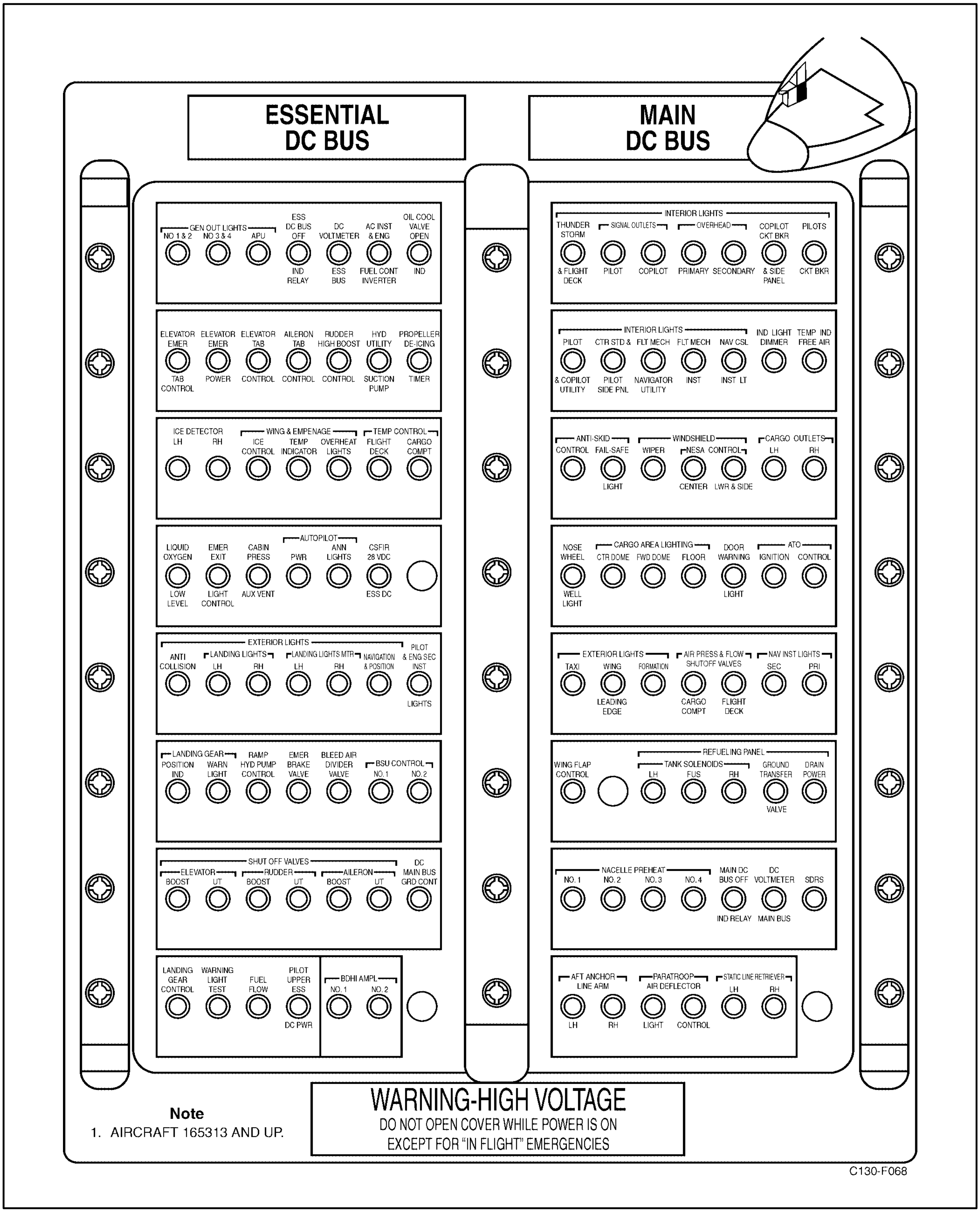


Figure 2-38. Copilot Lower Circuit Breaker Panel (Sheet 2)

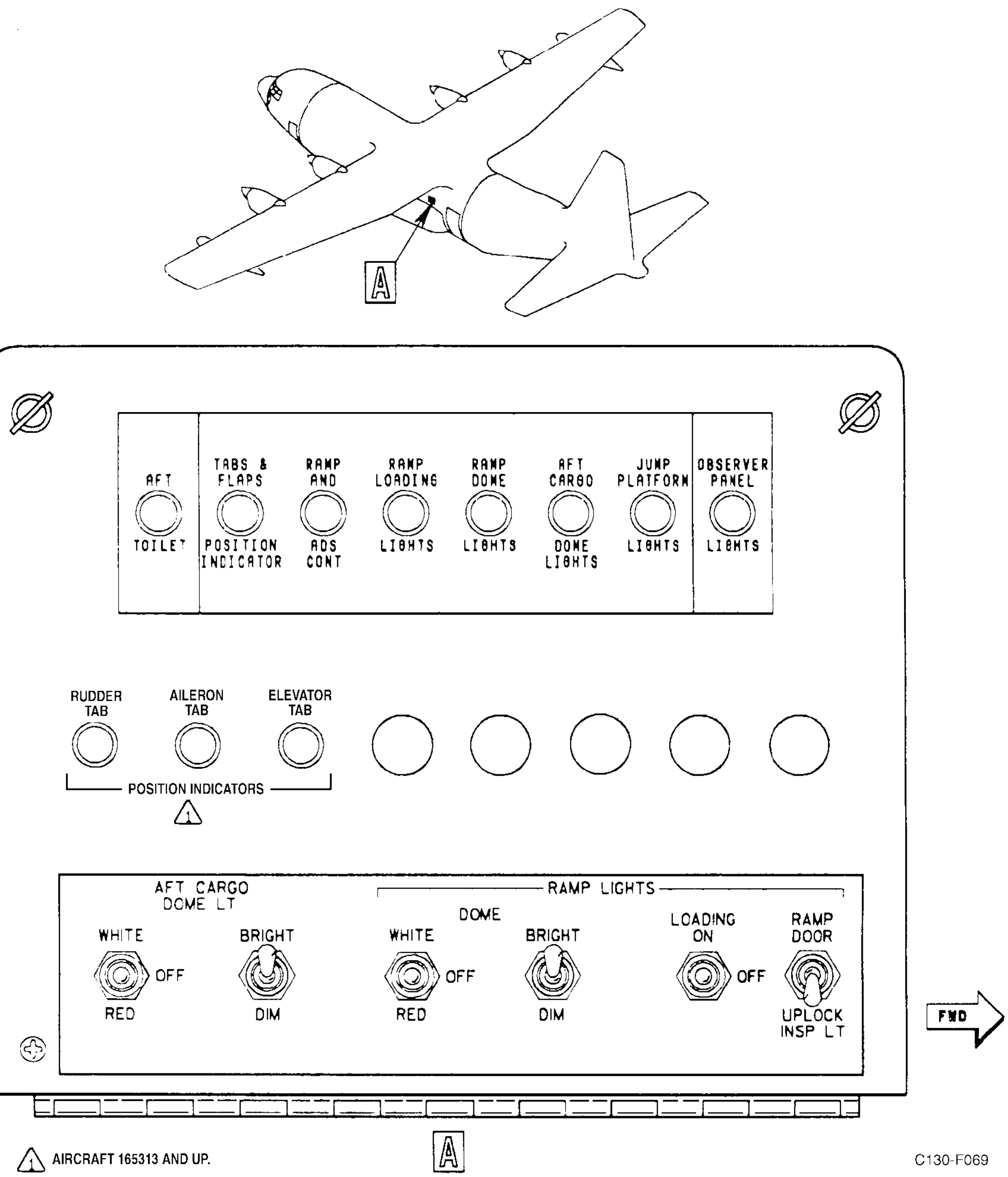


Figure 2-39. Aft Fuselage Junction Box

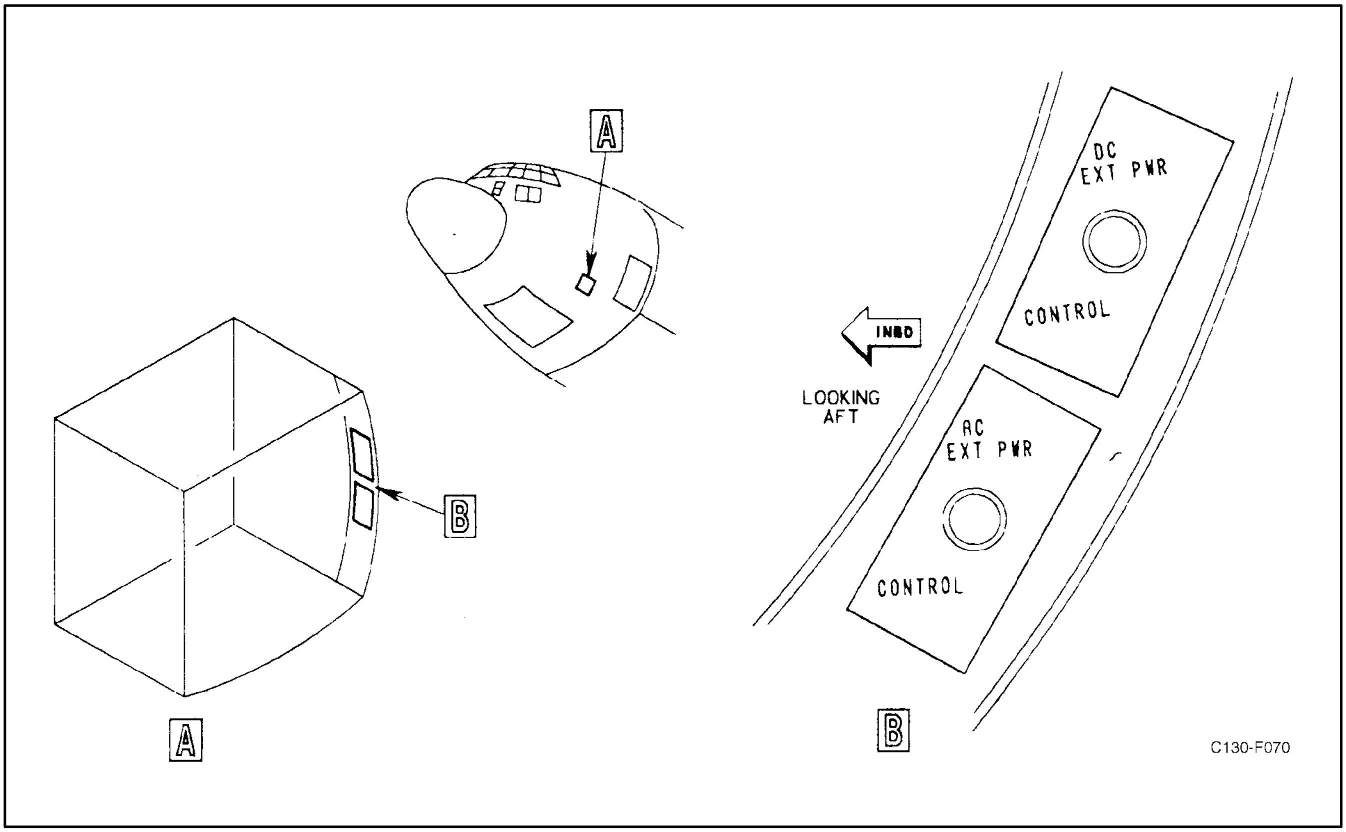


Figure 2-40. Battery Compartment Circuit Breakers

Note

The dc BUS TIE switch is only effective if the touchdown switch is actuated by the aircraft being on the ground.

The isolated bus is connected to the battery bus by the dc power switch through the battery relay. During ground operation with no engines operating, all of the dc buses may be connected and powered through either the battery or the essential dc bus, which can utilize APU ac generator output to the essential ac bus as a power supply. External dc power is fed through the main dc bus and will supply all dc buses, except the battery, when the DC POWER switch (see Figure 2-30) is in the EXT DC PWR position.

2.7.7.2 Batteries. Two 24-volt, 34-ampere-hour batteries are located in a fuselage compartment forward of the crew entrance door (see Figure 1-1). The first battery supplies power to the battery bus and to the isolated bus. A reverse current cutout is connected between the isolated bus and the essential and main dc buses. During flight, it prevents the battery from powering equipment connected to the essential and main dc buses and permits power from the essential and main dc buses to be used to power equipment connected to the isolated bus, and to charge the battery. An amber BAT DISCH light is located on the exterior lights control panel. When the BAT DISCH light is on, it indicates that the battery charge is being depleted by the isolated dc bus loads because of failure of the reverse current cutout. During APU starting, the battery powers the APU starter and control circuits through the APU CONTROL circuit breaker on the pilot side circuit breaker panel. The second battery provides standby power for the No. 1 and No. 2 INS system. A reverse current relay, normally closed, permits the INS battery to be charged and the INS to be powered from the essential dc bus. When essential dc bus power is lost, the reverse current relay opens, preventing reverse current flow from the INS battery to the essential dc bus and allows the INS battery to power the INS.

2.7.8 Dc System Controls. The dc electrical system is powered directly by the ac electrical system and is controlled from the overhead electrical control panel (see Figure 2-28).

2.7.8.1 Dc BUS TIE Switch

Note

On aircraft 165313 and up, the dc BUS TIE switch is labeled GROUND BUS TIE. DC BUS TIE switch is considered the generic term and is used as such throughout this manual.

The dc BUS TIE switch is a two-position, guarded toggle switch which functions in conjunction with the touchdown switch. When the aircraft is on the ground, the dc BUS TIE switch can connect the isolated dc bus and the essential dc bus for current flow in either direction. This allows battery power to feed all dc buses and circuits when the dc power switch is in the BATTERY position.

2.7.8.2 Dc Power Switch. The dc power switch is a three-position, rotary-type switch. When the switch is in the EXT DC PWR position, the external power relays will close when external power is applied in the correct polarity, to connect the external power receptacle to the main dc bus. When the switch is in the BATTERY position, the battery relay is closed and the battery is connected to the isolated bus. This position of the switch permits power to flow from the main dc bus or the essential dc bus through the reverse-current relay to the isolated bus to charge the battery. When the switch is in the OFF position, the external power relay is opened and the external power receptacle is disconnected from the main dc bus and from the isolated bus. When the dc power switch is in the EXT DC PWR position, 24-volt dc control power is supplied from the dc external power source through the aircraft DC EXT PWR control circuit breaker in the aircraft battery compartment.

2.7.8.3 Dc System Indicators. The dc system indicators are located on the overhead electrical control panel (see Figure 2-28).

2.7.8.4 Loadmeters. Four loadmeters, one for each transformer-rectifier unit, indicate percent of rated current load flowing from each unit.

2.7.8.5 Bus Switching Unit Indicators. On aircraft 165313 and up, two bus switching unit indicators (BYPASS) are located on the overhead electrical panel. The indicators indicate the status of the BSUs. When illuminated, they indicate the BSU is in the bypass mode because of an overload condition, the BSU switch is in the OFF position, or the BSU has failed to pass BIT.

2.7.8.6 BUS OFF Indicator Lights. Two bus off indicator lights, one each for the main dc bus, and the essential dc bus give a visual indication of power off condition of the buses. Both the main and the essential dc bus lights are powered from the isolated dc bus.

Note

The isolated dc BUS OFF indicator light will never glow except for malfunction, or if the dc power switch is placed in the EXT DC PWR position when no external power is connected and no internal ac generator power is powering the dc system.

2.7.8.7 Voltmeter and Bus Selector Switch. The voltmeter is connected to the main dc bus, essential dc bus, or battery bus by means of the voltmeter selector switch adjacent to the voltmeter on the overhead electrical control panel (see Figure 2-28). The switch is a rotary selector with three positions: ESSENTIAL DC BUS, MAIN DC BUS, and BAT. Selected bus voltage will be indicated on the voltmeter.

2.7.8.8 External Dc Power Indicator. The EXT DC PWR press-to-test light illuminates when external dc power is connected to the external dc power receptacle in the correct polarity.

2.8 HYDRAULIC POWER SUPPLY SYSTEMS

A booster hydraulic system, a utility hydraulic system, and an auxiliary hydraulic system comprise power supply sources for all hydraulic component operation on the aircraft. The booster system furnishes hydraulic power to a portion of the flight control boost system only. The utility system normally operates the landing gear, wing flaps, brakes, nosewheel steering, a portion of the flight control boost system, and the in-flight refueling reels. The auxiliary system operates the ramp and cargo door, provides emergency pressure for brake operation, provides pressure for emergency extension of the nose landing gear, and emergency pressure for the air refueling reels. Three methods are provided for servicing the hydraulic reservoirs; a single-point system consisting of a fluid receptacle, a manually operated selector valve, and a hand pump for remote servicing; a fill connection to be used with a portable fluid service unit; and a filler port located on the top of the reservoir for direct filling. The hydraulic power supply systems contain a manually operated valve for obtaining a hydraulic fluid sample.

2.8.1 Utility Hydraulic System. The utility hydraulic system (see Figure 2-41) operates from the output of the No. 1 and No. 2 engine-driven hydraulic pumps and supplies hydraulic power to the wing flap hydraulic motor, the main landing gear hydraulic motors, the nose landing gear hydraulic system, the main landing gear brakes, the nosewheel steering, to a portion of the aileron, rudder, and elevator control boost system, and the in-flight refueling reels. The engine-driven variable-displacement pumps are supplied hydraulic fluid under electric suction boost pump pressure from a 6.5-gallon reservoir mounted on the left side of the cargo compartment. The engine-driven pumps are provided with internal control mechanisms to vary their output volume with system demand and to control pressure to maintain approximately 3,000-psi output pressure. If the pump is not operating, the low-pressure warning light will illuminate. The pressurized output fluid of each pump passes through a filter, an electrically operated shutoff valve, and a one-way check valve before merging as system pressure. The one-way check valve allows the system to continue to function in case of failure of a single pump. Fluid supply and output of the engine-driven pumps can be cut off by actuation of the fire emergency handle or engine-driven pump switch for that particular engine. The fluid supply and output is cut off by the closing of electrically actuated shutoff valves. External connections are provided so an external supply of pressure may be used for ground maintenance operation of the system. A ground test valve is incorporated in the system so that system pressure from the auxiliary hydraulic system may be used to check hydraulically supplied systems before the engines are started for ground maintenance operations. The valve provides supply, return, and case drain functions. Four filters are used in the system to provide protection from foreign material contamination. A pressure relief valve provides protection against system overpressures. An accumulator is installed in the utility hydraulic system pressure line to provide reserve pressure and a damping effect during demand and pressure fluctuations. A sight-level gauge mounted on the reservoir gives a visual indication of the reservoir fluid quantity.

All controls and indicators for the utility hydraulic system are on the hydraulic control panel (see Figure 2-44).

2.8.1.1 Utility SUCTION BOOST PUMP Switch. The utility system SUCTION BOOST PUMP switch is a two-position (OFF, ON) toggle switch that furnishes 28-Vdc power from the essential dc bus, through the HYD UTILITY SUCTION PUMP circuit breaker on the copilot lower circuit breaker panel, to operate a relay that controls three-phase ac power to the suction boost pump motor.

2.8.1.2 Suction Boost Pump Pressure Warning Light. The suction boost pump low-pressure warning light is an amber warning light controlled by a pressure-sensitive switch. The warning light will illuminate if pressure output of the suction boost pump drops below approximately 20 psi. The suction boost pump motor is protected by thermal circuit breakers that open and stop the motor if the current exceeds 11 or 12 amperes. When this occurs, the low-pressure warning light will illuminate. As the circuit breakers cool, the circuits will close to restore power to the pump motor, and the light will go off. The light receives 28-Vdc power from the essential dc bus through the HYD UTILITY SUCTION PUMP circuit breaker on the copilot lower circuit breaker panel.

2.8.1.3 ENGINE PUMP Switch. The ENGINE PUMP switch is a two-position (OFF, ON) toggle switch that controls two hydraulic shutoff valves. One of these valves shuts off supply flow to the engine-driven pump, and the other shuts off pump output. These are the same valves operated by the fire emergency handle. Since the engine pump continues to turn after both the supply and output valves are closed, normal flow from the pump case drain passes through a check valve back into the suction port of the pump to form a runaround circuit. This feature is provided to prevent damage to those engine-driven pumps that require a runaround system. The valves receive 28-Vdc power from the essential dc bus through the FIRE SHUTOFF VALVES HYDRAULIC circuit breaker on the copilot side circuit breaker panel.

2.8.1.4 Engine Pump Pressure Warning Light. The engine pump pressure amber warning lights are

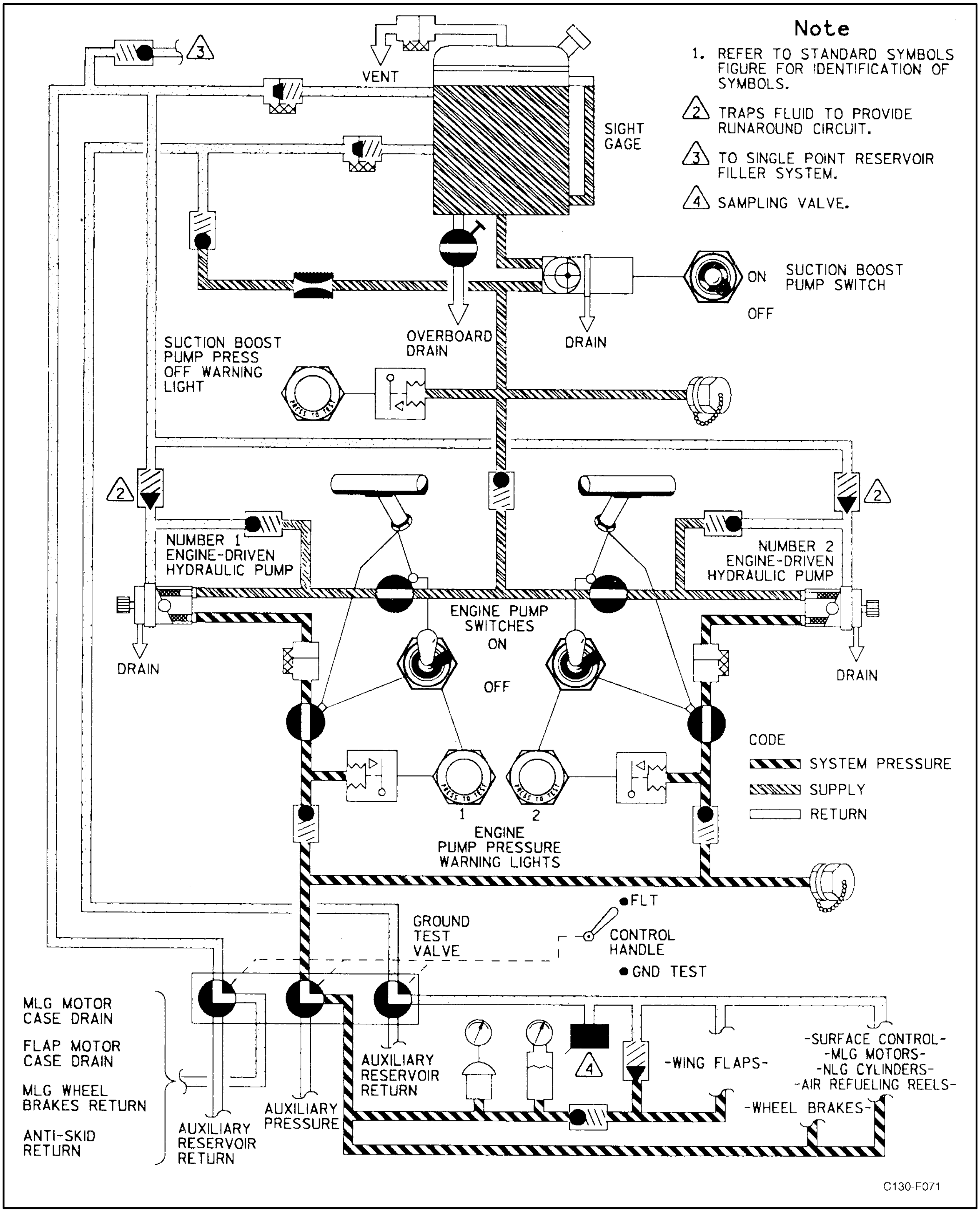


Figure 2-41. Utility Hydraulic System

controlled by pressure-actuated switches that sense the engine-driven pump output pressures. When either engine pump output pressure drops below approximately 1,000 psi, its light will illuminate. The pressure warning light will also illuminate when the engine pump switch is placed in the OFF position. The lights receive 28-Vdc power from the essential dc bus through the HYDRAULIC PUMP PRESSURE WARNING circuit breaker on the copilot side circuit breaker panel.

2.8.1.5 Utility Hydraulic Pressure Gauge. The utility hydraulic pressure gauge is controlled by a remote transmitter and indicates utility system pressure. The gauge receives 26-Vac power from the No. 2 instrument transformer through the INDICATOR HYD PRESSURE UTILITY fuse on the pilot lower circuit breaker panel.

2.8.2 Booster Hydraulic System. The booster hydraulic system (see Figure 2-42) operates from the output of No. 3 and No. 4 engine-driven hydraulic pumps, and supplies hydraulic power to a portion of the elevator, rudder, and aileron control boost system. The engine-driven, variable-displacement pumps are supplied hydraulic fluid under electric suction boost pump pressure from a 2-gallon reservoir mounted on the right side of the cargo compartment. The engine-driven pumps are provided with internal control mechanisms to vary their output volume with system demand and to control pressure to maintain approximately 3,000-psi output pressure. If the pump is not operating, the low-pressure warning light will illuminate. The pressurized output fluid of each pump passes through a filter, an electrically operated shutoff valve, and a one-way check valve before merging as system pressure. The one-way check valve allows the system to continue to function in case of failure of a single-pump. Fluid supply and output of the engine-driven pumps can be cut off by actuation of the fire emergency handle or engine pump switch for that particular engine. The supply fluid and output are cut off by the closing of electrically actuated shutoff valves. Provisions are included in the system for manual overboard draining of the system fluid. External connections are also provided so an external supply of pressure may be used for ground maintenance operation of the system. Four filters are incorporated in the system to provide protection from foreign material contamination. A pressure relief valve provides protection against system overpressures. An accumulator in the system provides reserve pressure and a damping effect during demand and pressure fluctuations. A sight level gauge mounted on the reservoir gives a visual indication of the reservoir fluid quantity.

All controls and indicators for the booster hydraulic system are on the hydraulic control panel (see Figure 2-44).

2.8.2.1 Booster SUCTION BOOST PUMP Switch. The booster system SUCTION BOOST PUMP switch is a two-position (OFF, ON) toggle switch that furnishes 28-Vdc power from the essential dc bus through the HYD BOOST SUCTION PUMP CONTROL circuit breaker on the copilot side circuit breaker panel, and controls three-phase ac power to the suction boost pump motor.

2.8.2.2 Suction Boost Pump Pressure Warning Light. The suction boost pump low-pressure warning light is an amber warning light controlled by a pressure-sensitive switch. The warning light will illuminate if pressure output of the suction boost pump drops below approximately 20 psi. The suction boost pump motor is protected by thermal circuit breakers that open and stop the motor if the current exceeds 11 or 12 amperes. When this occurs, the low-pressure warning light will illuminate. As the circuit breakers cool, the circuit will close to restore power to the pump motor and the light will go off. The light receives 28-Vdc power from the essential dc bus through the HYD BOOST SUCTION PUMP CONTROL circuit breaker on the copilot side circuit breaker panel.

2.8.2.3 ENGINE PUMP Switch. The ENGINE PUMP switch is a two-position (OFF, ON) toggle switch that controls two hydraulic shutoff valves. One of these valves shuts off supply flow to the engine-driven pump, and the other shuts off pump output. These are the same valves operated by the fire emergency handle. Since the engine-driven pump continues to turn after both the supply and output valves are closed, normal flow from the pump case drain passes through a check valve back into the suction port to form a run-around circuit. This feature is provided to prevent damage to those engine-driven pumps that require a run-around system. The valves receive 28-Vdc power from the essential dc bus through the FIRE SHUTOFF VALVES HYDRAULIC circuit breaker on the copilot side circuit breaker panel.

2.8.2.4 Engine Pump Pressure Warning Lights. The engine pump pressure warning lights are amber

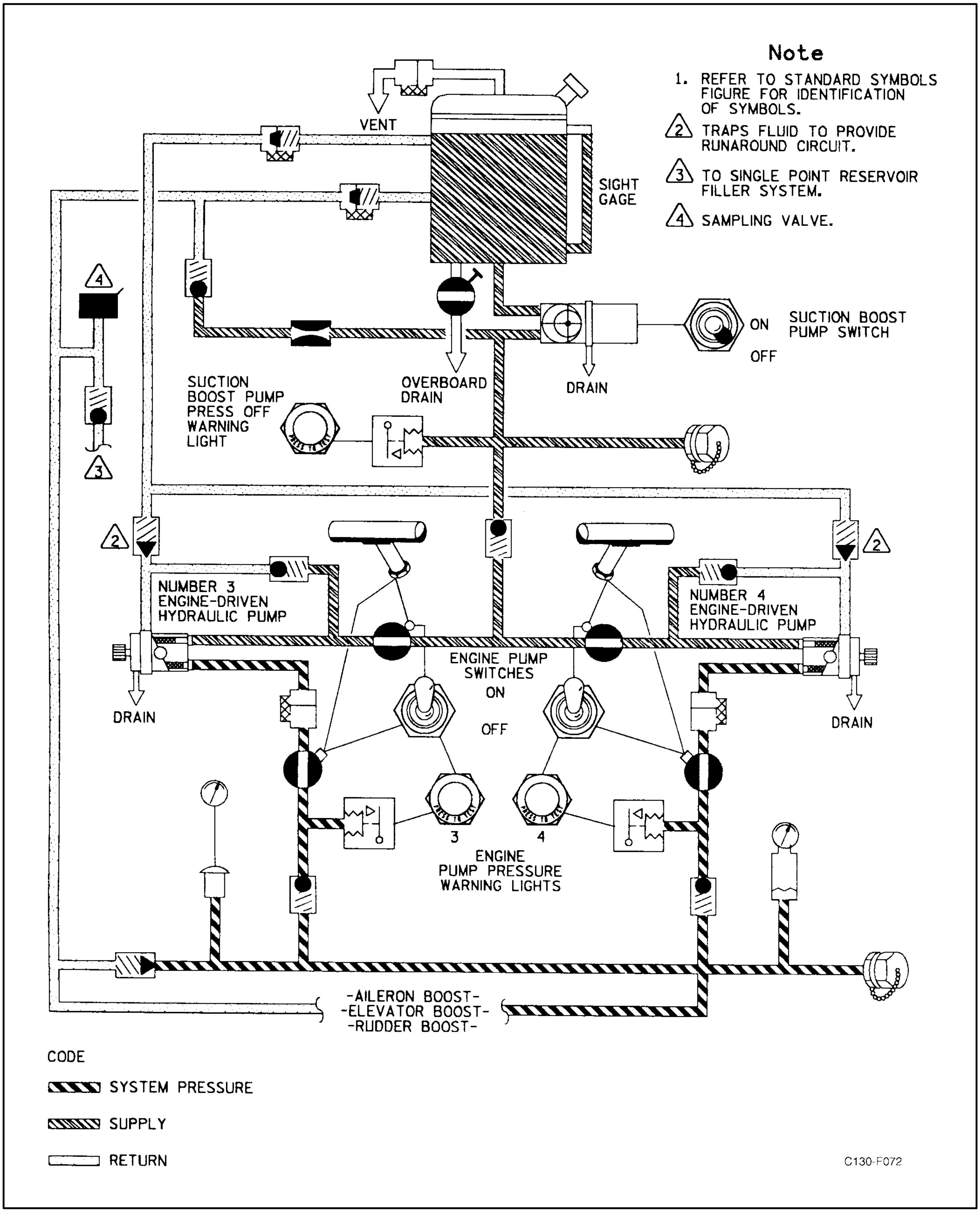


Figure 2-42. Booster Hydraulic System

warning lights controlled by low-pressure-actuated switches that sense the engine-driven pump output pressures. When either engine pump output pressure drops below approximately 1,000 psi, its light will illuminate. The pressure warning light will also illuminate when the engine pump switch is placed in the OFF position. The lights receive 28-Vdc power from the essential dc bus through the HYDRAULIC PUMP PRESSURE WARNING circuit breaker on the copilot side circuit breaker panel.

2.8.2.5 Booster Hydraulic Pressure Gauge. The booster system hydraulic pressure gauge is controlled by a remote transmitter and indicates booster system pressure. The gauge receives 26-Vac power from the No. 1 instrument transformer through the INDICATOR HYD PRESSURE BOOST fuse on the pilot lower circuit breaker panel.

2.8.3 Auxiliary Hydraulic System. The auxiliary hydraulic system (see Figure 2-43) operates from a three-phase, ac, electrically driven hydraulic pump. The pump is air cooled and can be operated continuously. It powers the cargo door and ramp system and provides emergency pressure for the main landing gear brakes, nosegear emergency extension, and air-refueling reels. The system is located in the cargo compartment and may be manually or electrically operated. A handpump in the system provides an optional source of system pressure for ground or in-flight operation. The electrically driven system pump, supplied hydraulic fluid from a 5.8-gallon reservoir, is a variable-volume-output type that will maintain approximately 3,000 psi output pressure. Check valves allow handpump pressure to operate the system when the handpump is operated and the electric pump is off. A manually operated shutoff valve is provided to furnish overboard drain provisions. A manually operated nose landing gear emergency extension valve connects the system to the nose landing gear system, allowing auxiliary system pressure to be transferred to the nose landing gear uplock and to the down actuating cylinder for emergency extension of the nosegear. Two filters provide protection from foreign material contamination within the system.

Controls and indicators for the auxiliary hydraulic system are on the hydraulic control panel (see Figure 2-44) and the ramp control panel (see Figure 2-61).

2.8.3.1 Auxiliary Hydraulic Pump Switches. The auxiliary hydraulic pump may be controlled by either of two ON-OFF toggle switches located on the hydraulic control panel and the ramp control panel. When either switch is placed in the ON position, 28-Vdc power is supplied from the essential dc bus through the RAMP HYD PUMP CONTROL circuit breaker, located on the copilot lower circuit breaker panel, to energize the auxiliary hydraulic pump relay. When the relay is energized, 115/200-volt, three-phase ac power is supplied from the essential ac bus through the HYD PUMP AUX SYS circuit breakers, located on the pilot side circuit breaker panel, to drive the auxiliary hydraulic pump motor. When both switches are placed in the OFF position, the relay is deenergized and power is removed from the auxiliary hydraulic pump motor.

2.8.3.2 Auxiliary Hydraulic Pressure Gauges. The auxiliary hydraulic system pressure is indicated by the gauge located on the hydraulic control panel and by the gauge located in the cargo compartment near the handpump. The gauge located in the cargo compartment is a direct-reading instrument and shows system pressures at all times, whether from the handpump or from the electric pump. The gauge located on the hydraulic control panel is controlled by a remote transmitter; it receives 26-Vac power from the No. 2 instrument transformer through the ramp indicator HYD PRESSURE fuse located on the pilot lower circuit breaker panel.

2.9 FLIGHT CONTROL SYSTEMS

The flight controls include the main surface control systems (aileron, rudder, and elevator), the trim tab control systems, and the flap control system. The main surfaces are controlled by mechanical systems with hydraulic boost. The trim tabs are controlled by electrical control systems. The autopilot, when operating, controls the main surfaces and elevator trim tabs. The flaps are controlled by hydraulic pressure.

2.9.1 Main Surface Control Systems. The main surfaces (ailerons, rudder, and elevators) are controlled by mechanical control systems consisting of cables, pushrods, bellcranks, and torque tubes. Hydraulically-driven booster units provide most of the force required to move the surfaces. The booster units are driven by hydraulic pressure supplied simultaneously by the booster and utility hydraulic systems (see Figure 2-45), each of which serves to power one portion of the booster units. System operation is such that failure or malfunction of any component of either system in any booster

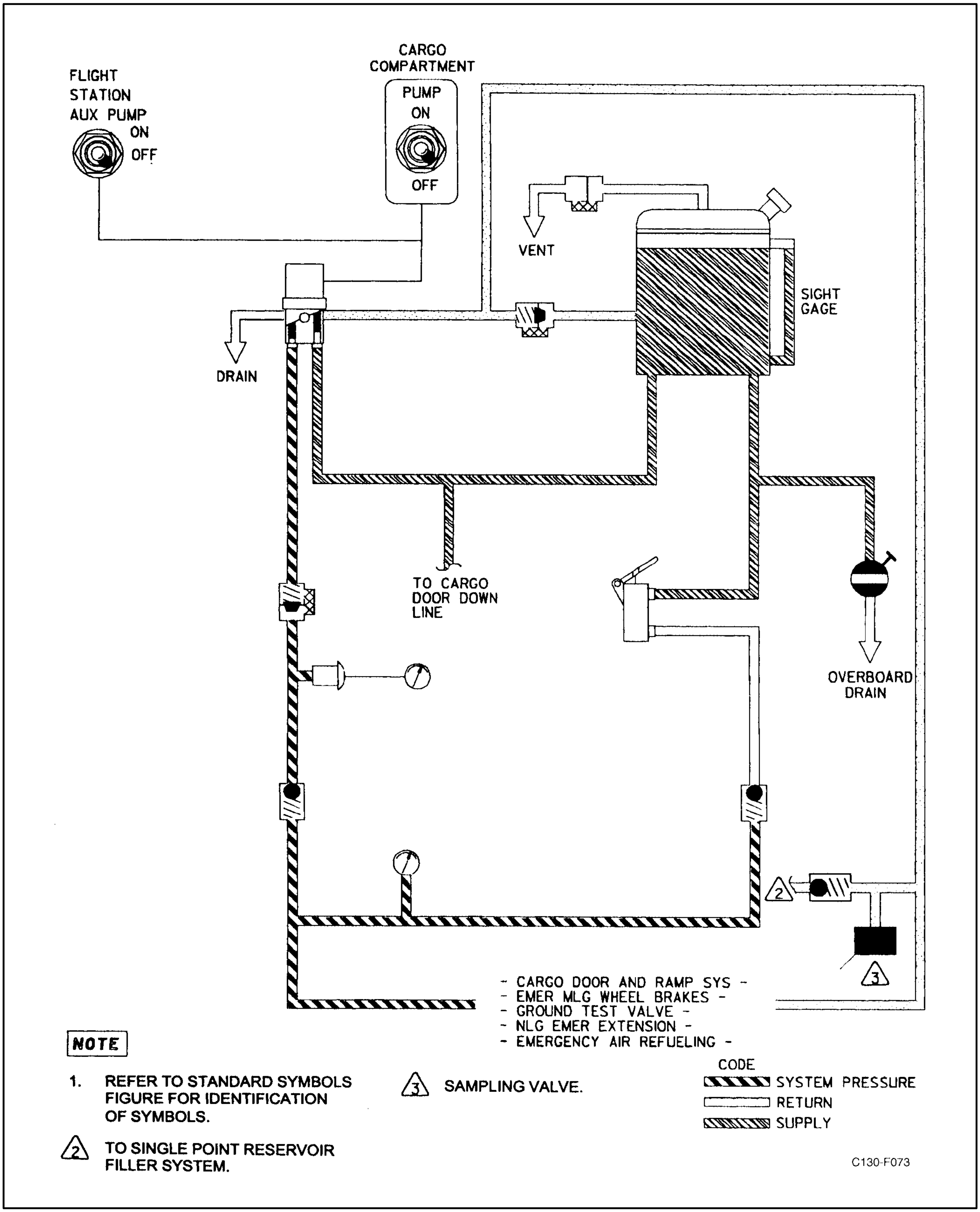


Figure 2-43. Auxiliary Hydraulic System

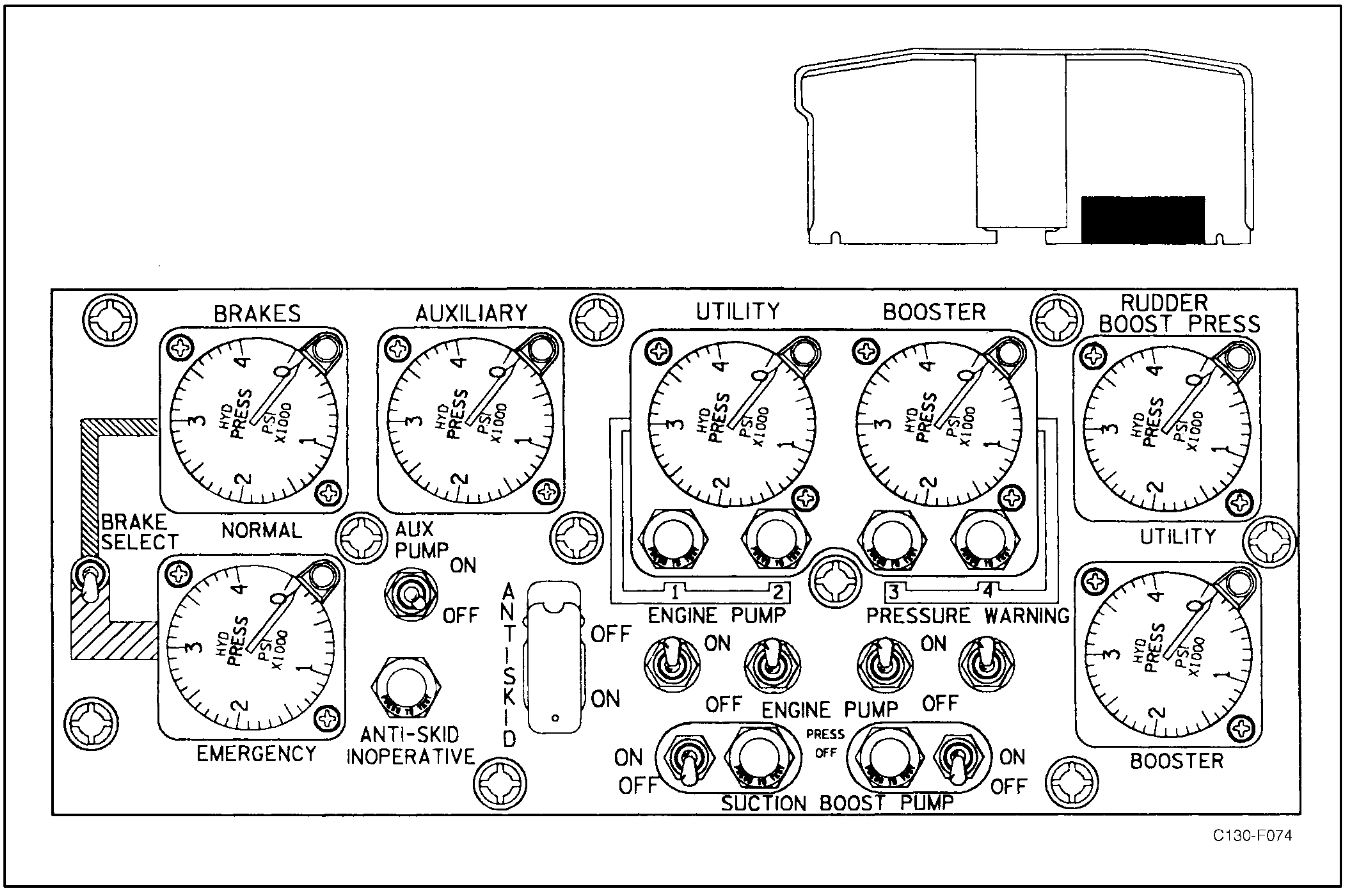


Figure 2-44. Hydraulic Control Panel

unit will allow normal function of the other system powering the same unit. A loss of hydraulic pressure in either hydraulic system results in a corresponding loss in the booster unit, and a proportionate loss of power to operate the unit. The aircraft may be controlled with complete loss of booster unit power by the use of trim tabs and engine power, plus coordinated, increased efforts of the pilot and copilot. Solenoid-operated shutoff valves in each surface control system can be actuated by switches on the control boost switch panel (see Figure 2-45) at the flight station to shut off supply pressure to either of the systems. The valves are spring loaded and will open when deenergized (control boost switches in the ON position). A booster-off warning light for each switch is also powered by the solenoid shutoff valve switch and will illuminate when the switch is in the OFF position. An autopilot servomotor is cable-rigged to each booster unit to substitute for manual control during autopilot operation. Electrical power for operation of the booster shutoff valves is supplied from the essential dc bus through the AILERON, ELEVATOR, and RUDDER SHUTOFF VALVES circuit breakers on the copilot lower circuit breaker panel.

2.9.1.1 Rudder Booster Assembly. The rudder booster assembly is a single tandem-type hydraulic actuating cylinder that furnishes most of the force to actuate the rudder. During normal operation, fluid supplied at approximately 3,000 psi pressure is routed by solenoid-controlled, normally deenergized diverter valves through pressure reducer valves in each of the systems and from there, at a pressure of approximately 1,300 psi, to the rudder booster assembly. This system pressure produces desirable characteristics of sensitivity and surface travel for normal in-flight operation. Movement of the flap lever from the retracted (UP) position to approximately the 15-percent position or beyond will energize the solenoids of the diverter valves, actuating the valves in such a manner that the pressure reducers are bypassed, thereby permitting supply fluid at approximately 3,000 psi pressure to reach the booster assembly. This doubles the available actuating force and gives desirable characteristics of

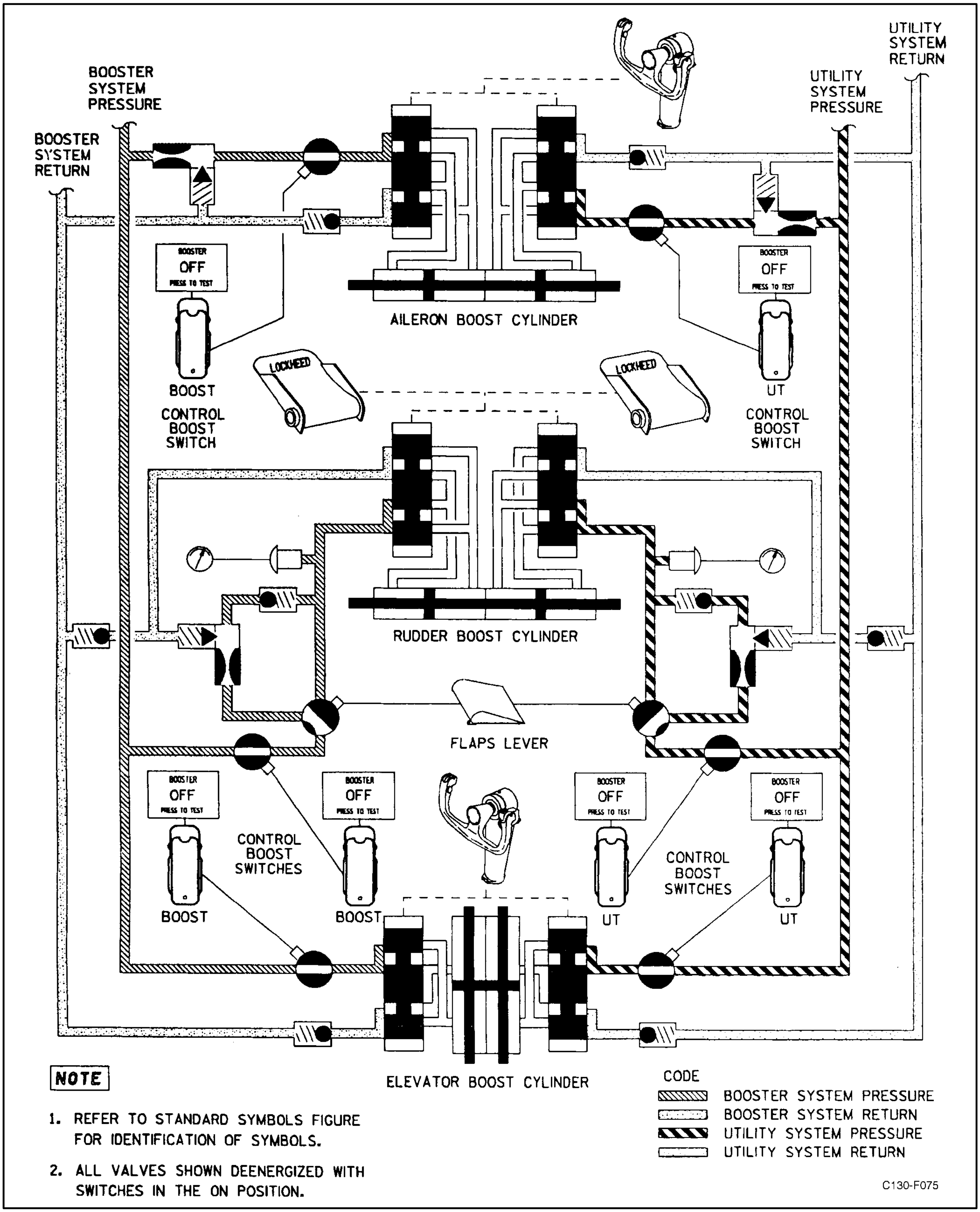


Figure 2-45. Surface Control System

sensitivity and surface travel at low airspeeds such as are encountered in takeoff, landing, and flying traffic patterns, where flaps are used. The diverter valves are powered from the essential dc bus through the RUDDER HIGH BOOST CONTROL circuit breaker located on the copilot lower circuit breaker panel. The amount of pressure actuating the rudder booster assembly (both the booster and utility portion of the system) is indicated on pressure gauges located on the hydraulic panel (see Figure 2-44) of the copilot instrument panel. Transmitters for these indicators are located downstream of the diverter valve, and, therefore, will show high- or low-pressure operation.

2.9.1.2 Aileron Booster Assembly. The aileron booster assembly is a single tandem-type hydraulic actuating cylinder that furnishes most of the force to actuate the ailerons. The booster assembly is furnished fluid through a pressure reducer at approximately 2,050 psi from both the booster and utility hydraulic systems.

2.9.1.3 Elevator Booster Assembly. The elevator booster assembly has dual actuating cylinders connected to the booster assembly output power lever that operates the elevator control surfaces. The actuating cylinders operate simultaneously by 3,000 psi pressure supplied by the booster and utility hydraulic systems, each of which powers one actuating cylinder.

2.9.1.4 Main Surface Control System Controls and Indicators

2.9.1.4.1 Control Columns and Wheels. Control columns and wheels (see Figure 2-46) installed at the pilot and copilot stations to operate the aileron and elevator surface controls are of the conventional type. Mechanical linkage actuates the hydraulically-powered booster unit control valves and servomotors for each of these surface controls. Pushrods (elevator) and a chain-and-cable arrangement (ailerons) connect the control column to bellcranks on torque tubes that are mounted under the flight station beneath the pilot and copilot seats. From there, dual sets of steel cables

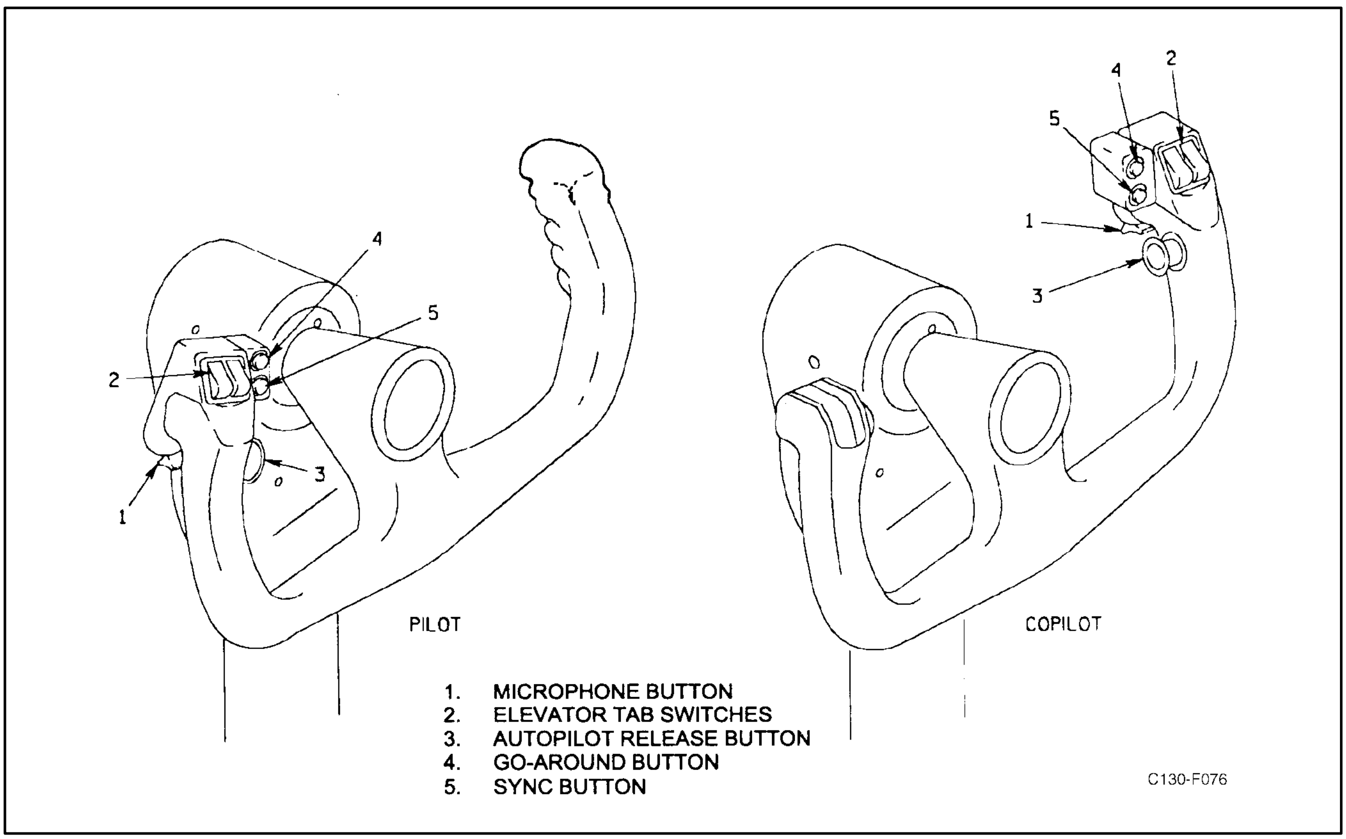


Figure 2-46. Control Wheels

continue the elevator linkage as far as the pressure bulkhead at the extreme rear of the cargo compartment and the aileron linkage to the rear face of the center-section wing rear-beam web. From these points, pushrods and bellcranks pick up the motion and transmit it to the booster unit control valves and servo units.

2.9.1.4.2 Rudder Pedals and Adjustment Controls. Rudder pedals are of the conventional type. Each pair of rudder pedals can be adjusted individually by unlocking the rudder pedal adjustment control (see Figure 2-47) and pushing or releasing the spring-loaded pedals to the desired position. The rudder pedals are used to operate the rudder boosters when hydraulic power is available and to operate the rudder manually when hydraulic power is not available. The pressure on the rudder pedals actuates the brake during either normal or emergency braking.

2.9.1.4.3 Control Boost Switches and Warning Lights. The control booster unit shutoff-valve-actuating switches are located on the control boost switch panel (see Figure 2-48) on the overhead control panel. There are six guarded, two-position toggle switches (ON with cover down, deenergized) that will actuate the shutoff valves to isolate the corresponding booster package and to energize six hooded warning lights that illuminate BOOSTER OFF when their respective switches are placed in the OFF position. The panel switches supply power to the warning lights directly through the copilot lower circuit breaker panel when in the OFF position, and, therefore, furnish no independent indication directly of boost unit failure or that the shutoff valves are closed. The warning light only indicates that the switch is in the OFF position and dc power is routed to the solenoid shutoff valve. Individual pressure control from both the booster and utility systems is available to each boost package. The 28-Vdc power for the lights and valves is supplied from the essential dc bus through the SHUTOFF VALVES circuit breakers on the copilot lower circuit breaker panel.

2.9.2 Trim Tab Control Systems. Trim tabs are provided on the control surfaces to aid in trimming the aircraft during flight. Lateral trim is obtained through operation of a trim tab on the left aileron. A ground adjustable tab is located on the right aileron to compensate for any inherent imbalance about the longitudinal axis of the aircraft. Noseup and nosedown trim is obtained through operation of the trim tabs on the elevators, one trim tab on each elevator control surface. Left and right trim is obtained by operation of the rudder trim tab. During autopilot operation, operation of the

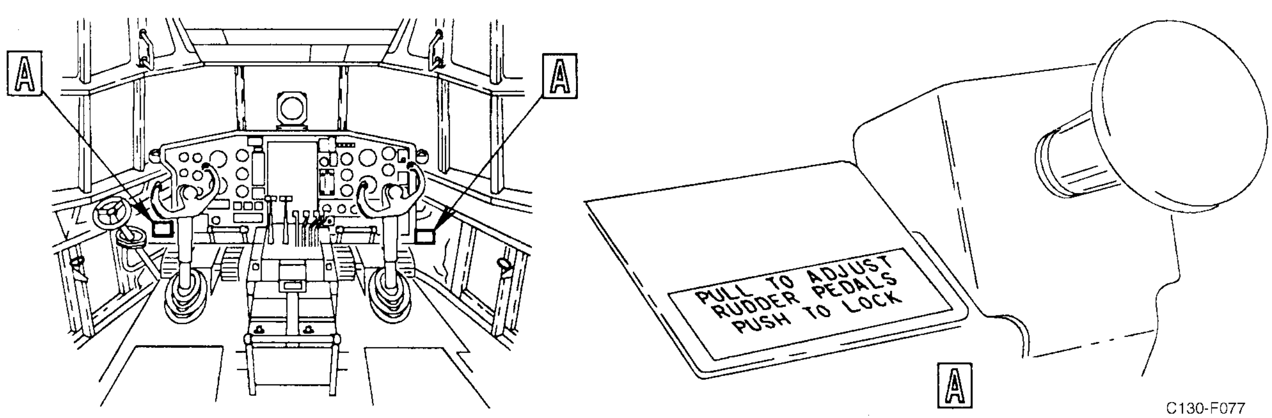


Figure 2-47. Rudder Pedal Adjustment Control

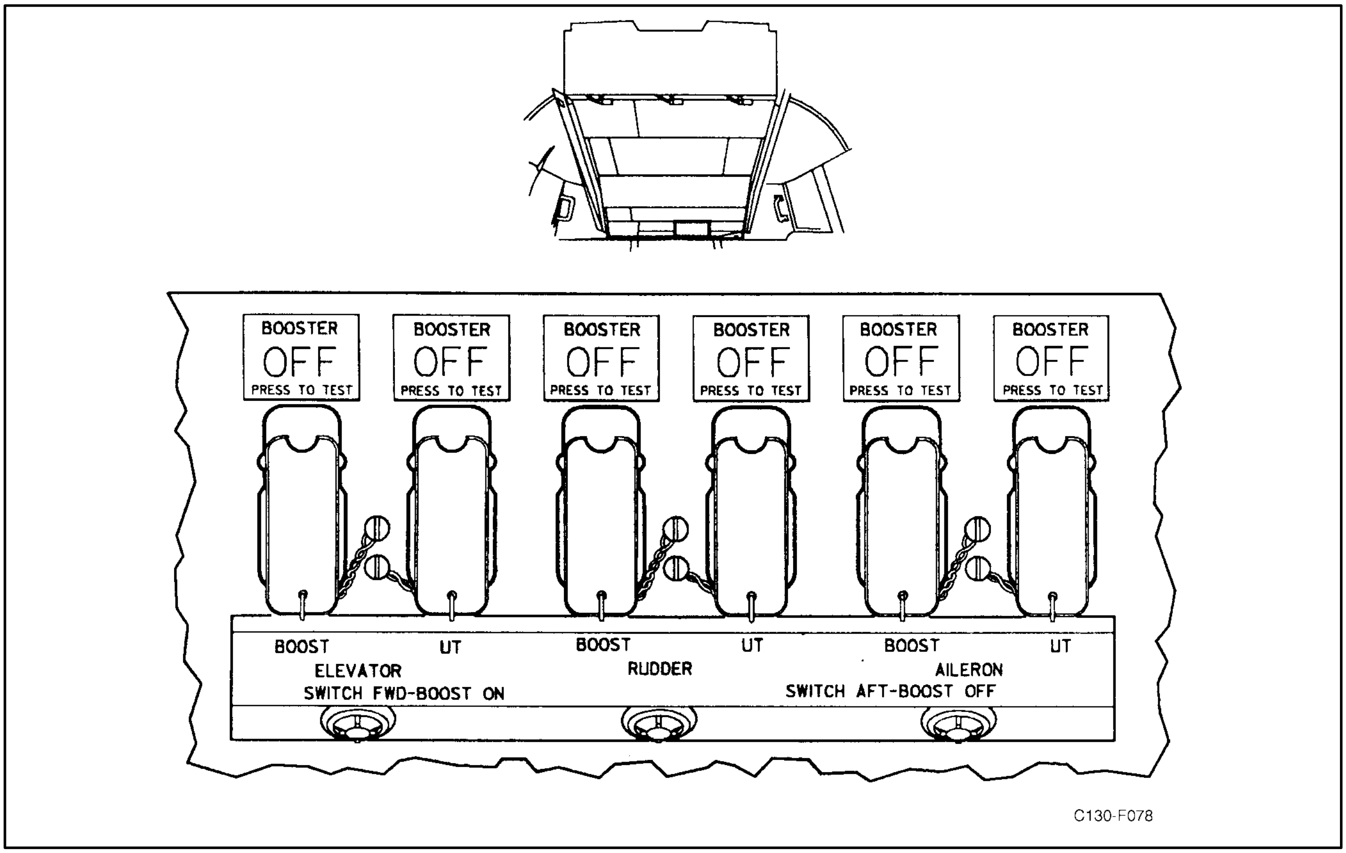


Figure 2-48. Control Boost Switch Panel

ELEV TRIM switch located on either of the control wheels will cause the autopilot to disengage. The autopilot elevator servo will function only when the elevator tab switch is placed in the NORMAL position. All trim tab actuators are driven by 115-volt, single-phase ac motors, except during emergency operation when the elevator trim tab actuator is driven by a 28-Vdc motor.

2.9.2.1 Trim Tab System Controls and Indicators. Trim tab system controls and indicators are shown in Figure 2-49.

2.9.2.1.1 Aileron and Emergency Elevator Trim Tab Switch. An aileron and emergency elevator trim tab switch is located on the trim control panel on the flight control pedestal. It is a recessed, five-position (EMER NOSE UP, EMER NOSE DOWN, OFF, LOWER LEFT WING, LOWER RIGHT WING) toggle switch, with all switch positions other than the OFF (center) position spring loaded to return to the center position upon release of the switch. When the switch is held in the LOWER LEFT WING or LOWER RIGHT WING position, the trim tab on the left aileron control surface is actuated by a tab motor to trim the aircraft laterally. With the ELEV TAB power-selector switch positioned to EMER and the emergency elevator trim tab switch held in the EMER NOSE UP or EMER NOSE DOWN position, the elevator trim tabs are actuated by a tab motor to raise or lower the nose of the aircraft. When the switch is in the OFF (center) position, the electric motors that actuate the trim tabs are deenergized.

The emergency elevator trim tab switch is operative only when the ELEV TAB power selector switch is placed in the EMER position. With the ELEV TAB power selector switch in EMER, 28-Vdc power is supplied to the elevator trim tab control relays, through the emergency elevator trim tab switch, from the essential dc bus through the ELEVATOR EMER TAB CONTROL circuit breaker on the copilot lower circuit breaker panel. When the emergency elevator trim tab switch is placed in the EMER NOSE UP position, it will energize the elevator tab down relay that connects 28-Vdc power to the elevator trim tab dc actuator and will raise the nose of the aircraft. When the switch is

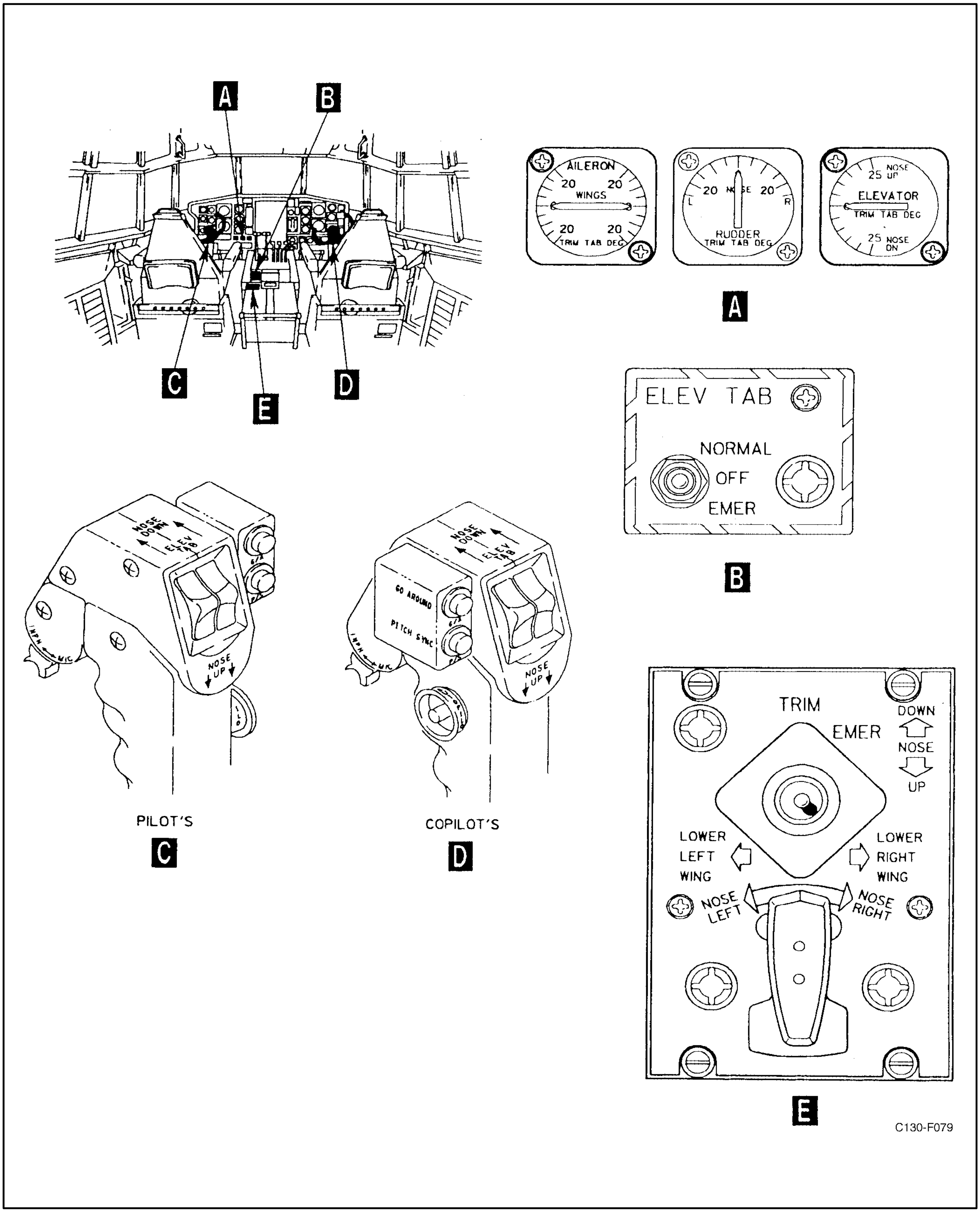


Figure 2-49. Trim Tab System Controls and Indicators

placed in the EMER NOSE DOWN position, the elevator tab up relay is energized, connecting 28-Vdc power to the elevator trim tab dc actuator and will lower the nose of the aircraft. The emergency elevator tab actuator receives 28-Vdc power from the essential dc bus through the ELEVATOR EMER POWER circuit breaker on the copilot lower circuit breaker panel.

Two control relays in the aileron trim tab power circuit are energized by the trim tab control switch. The relays eliminate the necessity to route the 115-Vac power required to operate the aileron trim tab actuator through the trim tab control switch. When the switch is placed in the LOWER LEFT WING position, it will energize the tab down relay that connects 115-Vac power to the aileron trim tab actuator and lowers the left wing. When the switch is placed in the LOWER RIGHT WING position, it will energize the tab up relay that connects 115-Vac power to the aileron trim tab actuator and lowers the right wing. The aileron tab motor receives 115-Vac power from the essential ac bus through the TRIM TAB AILERON circuit breaker on the pilot side circuit breaker panel. The relays are actuated by 28-Vdc power from the essential dc bus through the AILERON TAB CONTROL circuit breaker on the copilot lower circuit breaker panel.

2.9.2.1.2 Elevator Tab Switches. Dual NOSE UP, NOSE DOWN, and center off elevator trim tab switches are located on the outboard handgrip of each control wheel. The dual switches on the pilot or copilot control wheels must be operated simultaneously on their respective wheels to provide both power and ground to the control relays. The two sets of dual switches are connected in parallel and either set of switches can control the tab when the ELEV TAB power selector switch is positioned to NORMAL. When either the pilot or copilot control wheel dual switches are in the NOSE UP or NOSE DOWN position, dual relays are actuated to apply power to the elevator trim tab actuator. With the ELEV TAB power selector switch in NORMAL, 115-Vac power from the essential ac bus, through the TRIM TAB ELEVATOR circuit breaker on the pilot side circuit breaker panel, is applied to the actuator. The elevator tab switches on the control wheels are inoperative when the ELEV TAB power selector switch is placed in the EMER or OFF position.

2.9.2.1.3 Elevator Tab Power Selector Switch. An elevator tab power selector switch is located on the flight control pedestal. It is a three-position (NORMAL, OFF, EMER) toggle switch used to select the source of electrical power for operation of the elevator trim tabs. When the switch is in the NORMAL position, 115-Vac power is supplied from the essential ac bus, through the ELEVATOR TRIM TAB circuit breaker on the pilot side circuit breaker panel, to a trim tab actuating motor relay for autopilot or control wheel handgrip switch operation of the elevator trim tabs. In the NORMAL position, the elevator trim tabs can be controlled only from the control wheels. When in the EMER position, the elevator trim tabs can be controlled only from the emergency elevator trim tab switch located on the pedestal. During emergency operation, 28-Vdc power is supplied from the essential dc bus through the ELEVATOR EMER POWER circuit breaker, located on the copilot lower circuit breaker panel, to a trim tab actuating motor that will drive the elevator trim tabs either up or down when the respective elevator trim tab control relay is energized by actuation of the trim tab control switch on the pedestal. When the ELEV TAB power selector switch is in the NORMAL position, the ELEVATOR TRIM TAB CONTROL relays are powered by 28-Vdc from the essential dc bus, through the ELEV TAB CONTROL circuit breaker located on the copilot lower circuit breaker panel. When the elevator tab power selector switch is in the EMER position, the elevator trim tab control relays are powered by 28-Vdc from the essential dc bus, through the ELEVATOR EMER TAB control circuit breaker located on the copilot lower circuit breaker panel. When the ELEV TAB power selector switch is placed in the OFF position, all circuits to the elevator trim tabs are deenergized.

2.9.2.1.4 Rudder Trim Tab Switch. A rudder trim tab switch is located on the trim tab control panel of the flight control pedestal. It is a three-position (NOSE LEFT, OFF, NOSE RIGHT) switch that controls operation of the rudder trim tab motor. The NOSE LEFT and NOSE RIGHT positions are spring loaded to return to the OFF (center) position upon release of the control switch. When the switch is in NOSE LEFT or NOSE RIGHT position, 115-Vac power from the essential ac bus, through the RUDDER TRIM TAB circuit breaker on the pilot side circuit breaker panel, energizes the rudder trim tab motor to position the rudder trim tab and trim the aircraft.

2.9.2.1.5 Rudder Trim Tab Position Indicator. A rudder trim tab position indicator is located on the pilot instrument panel. The indicator is connected to a transmitter mounted on the rudder trim tab actuator housing and indicates to the pilot the degree of rudder trim tab positioning relative to the rudder control surface. This indicator is energized by 28-Vdc power from the main dc bus, through the TABS & FLAPS POSITION INDICATOR circuit breaker in the aft fuselage junction box. For aircraft 165313 and up, this indicator is energized by 28 Vdc from the main DC bus through the RUDDER TAB circuit breaker in the aft fuselage junction box. The indicator dial face is calibrated from 0° to L and 0° to R in increments of 5° of rudder trim tab travel from the neutral 0° marking. The needle on the indicator shows the exact angle between the rudder trim tab and rudder surface, and shows the direction in which the trim will act.

2.9.2.1.6 Aileron Trim Tab Position Indicator. An aileron trim tab position indicator is located on the pilot instrument panel. This indicator is connected to a transmitter mounted on the left aileron trim tab actuator, and indicates to the pilot the degree of left aileron trim tab positioning relative to the aileron control surface. This indicator is energized by 28-Vdc power from the main dc bus through the TABS & FLAPS POSITION INDICATOR circuit breaker in the aft fuselage junction box. For aircraft 165313 and up, this indicator is energized by 28 Vdc from the main DC bus through the AILERON TAB circuit breaker in the aft fuselage junction box. The indicator dial face is calibrated from the neutral position of 0° to 20° up and 0° to 20° down in 5° increments of left aileron trim tab travel. The needle on the indicator shows the exact angle between the aileron trim tab and the left aileron surface and the direction in which the trim will act.

2.9.2.1.7 Elevator Trim Tab Position Indicator. An elevator trim tab position indicator is located on the pilot instrument panel. The indicator is connected to a transmitter mounted on the elevator trim tab rotary actuator housing and indicates to the pilot the degree of elevator trim tab positioning relative to the elevator control surface. This indicator is energized by 28-Vdc power from the main dc bus through the TABS & FLAPS POSITION INDICATOR circuit breaker in the aft fuselage junction box. For aircraft 165313 and up, this indicator is energized by 28 Vdc from the main DC bus through the ELEVATOR TAB circuit breaker in the aft fuselage junction box. The indicator dial face is calibrated from the neutral position 0° to 25° up or 25° down in 5° increments of elevator trim tab travel. The needle on the indicator shows the exact angle between the elevator trim tabs and the corresponding elevator surface, and the direction in which the trim will act.

Note

Trim tab travel is controlled by limit switches set at 6° nose down and 25° nose up, and by mechanical stops set at 8° nose down and 27° nose up.

2.9.3 Flap Control System. The aircraft is equipped with four flaps, consisting of an outboard and an inboard flap in each wing. The flaps are of the Lockheed-Fowler high-lift type, in which the flap motion is a combination of an aft movement to increase wing area and a downward tilting movement to alter the airfoil section to increase lift and drag. The time required for full extension of the flaps is between 8 and 15 seconds. Full retraction time is between 10 and 15 seconds. When 100 percent extended, the flaps form an angle of approximately 35° with the wings. The flaps are operated by a reversible hydraulic motor, a cam-actuated microswitch followup mechanism, torque tubes, gearbox, and drive screw assemblies. Hydraulic pressure is directed through a check valve to the emergency flap brake valve and the wing flap selector valve, where pressure is directed to the up or down system. The hydraulic motor operates the torque shaft section extending outboard to the gearbox, which rotates ball bearing drive screws for actuation of the flaps. The flaps may be operated manually with a handcrank. Disk-type, spring-loaded flap brakes hold the flaps in the selected position and prevent movement by aerodynamic loads. The brake is released by fluid pressure supplied to the system for operation of the flap drive motor. Emergency flap brakes are splined to the outer ends of the flap drive torque shaft to prevent unequal actuation of the flaps during normal extension and retraction of the flaps. Utility hydraulic system pressure is used for operation of the flap system (see Figure 2-50).

2.9.3.1 Flap System Controls and Indicator. Flap system controls are shown in Figure 2-51.

2.9.3.1.1 Flap Lever. A flap lever is located on the aft end of the flight control pedestal. It is a manually actuated control lever, with the lever range calibrated from UP to DN in increments of 10 percent. There is a detent at approximately the 50-percent position, but the flaps can be extended to any desired position by placing the lever at the selected percent of flap extension. The lever is attached by cables to a movable cam inside a

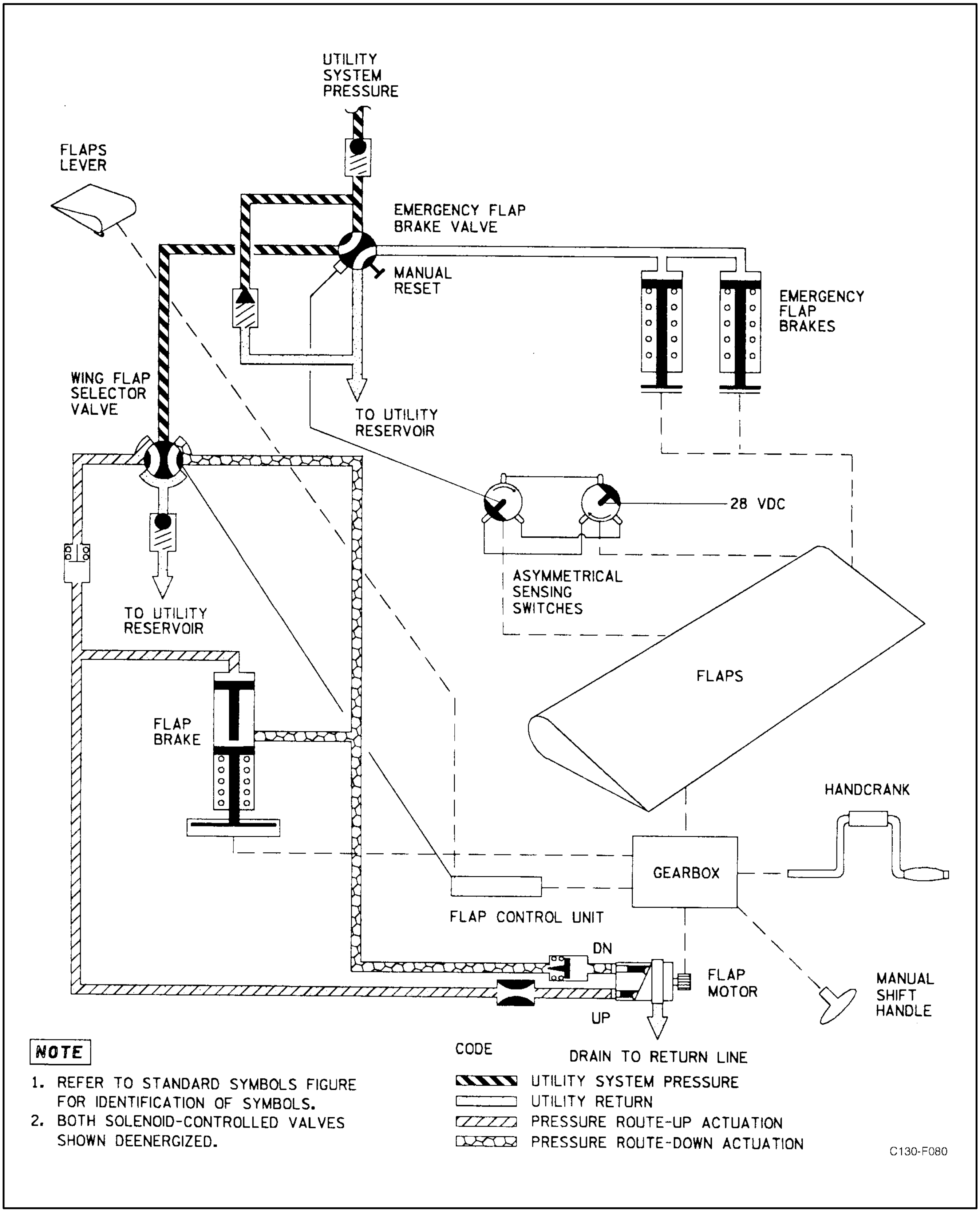


Figure 2-50. Flap Control System

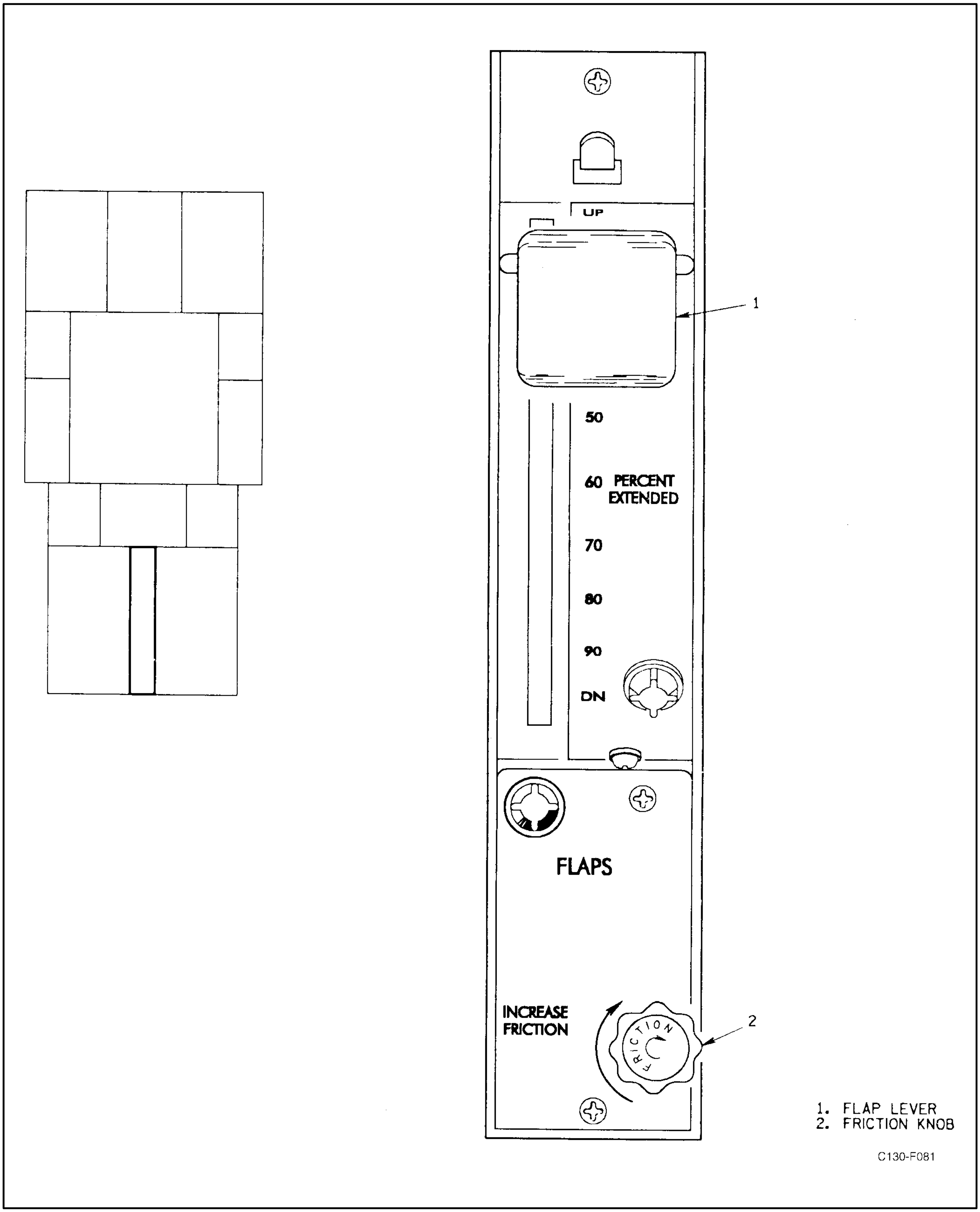


Figure 2-51. Flap Control Panel

flap control unit mounted on the center section wing rear beam in the cargo compartment. Movement of this cam closes limit switches that close a 28-Vdc control circuit for the wing flap selector valve. The actuated valve directs a flow of hydraulic fluid to drive the flap motor in the selected direction. A rudder pressure diverter valve, electrically actuated by a switch on the flap control lever mechanism, controls the pressure available for operation of the rudder. Pressure available for rudder operation of flap settings from 0 to 15 percent is approximately 1,300 psi as compared to approximately 3,000 psi for flap settings from 15 to 100 percent. The pressure control system is provided to prevent excessive air loads at high speeds. When the selected position of the flaps is reached, the limit switches open, the selector valve shuts off hydraulic flow, and a spring-loaded hydraulic brake locks the flaps in the selected position. The wing flap selector valve receives 28-Vdc power from the main dc bus, through the WING FLAP CONTROL circuit breaker on the copilot lower circuit breaker panel.

Note

- The GPWS is interconnected with the flap system. A switch is located on the flap control lever mechanism, at the 40-percent flap setting, to signal the GPWS computer whenever the airspeed/altitude and flap setting are not commensurate to a landing configuration. The 40-percent flap switch may be inhibited by placing the ground proximity flap override switch to the OVERRIDE position.

- The landing gear warning horn is interconnected with the flap system. When the flap lever is set at approximately 80 percent or more with the landing gear up, the landing gear warning horn will sound; it cannot be silenced until the landing gear is down and locked or the flap lever is retracted above 80 percent.

2.9.3.1.2 Flap Lever Friction Knob. A flap lever friction knob is located on the flap control panel. Turning the knob clockwise mechanically tightens the friction on the flap cables, preventing the flap lever from vibrating out of its set position.

2.9.3.1.3 Wing Flap Selector Valve. A wing flap selector valve is mounted on the left-hand hydraulic panel, forward of the left-hand wheelwell. It is a solenoid-operated valve, directing the flow of utility hydraulic fluid to either the up or down side of the flap motor for normal raising and lowering of the flaps, depending on the position of the flap lever. Override controls, consisting of two buttons marked RAISE and LOWER, are located on the selector valve for use in case of electrical failure. Pushing the button marked LOWER routes hydraulic fluid to release the flap brakes and to the gearbox drive motor to lower the flaps. Pushing the button marked RAISE routes hydraulic fluid to release the brakes and to the gearbox drive motor to raise the flaps. In normal operation, the valve is energized by 28-Vdc power from the main dc bus, through the WING FLAP CONTROL circuit breaker on the copilot lower circuit breaker panel.

2.9.3.1.4 Manual Operation. An emergency method of operating the flaps mechanically is provided by an extension stub shaft connected through a universal joint to the torque shaft that drives the flap screwjacks. The extension stub shaft and the handcrank are located on the forward wall of the left-hand main landing gear wheelwell.

2.9.3.1.5 Flaps Position Indicator. A flaps position indicator is located on the copilot instrument panel, Figure 2-78. The indicator is connected to a transmitter that is mounted on the flap drive control unit located on the aft face of the wing rear beam. The indicator dial is calibrated from UP to DOWN in increments of 10 percent. The indicating system is energized by 28-Vdc power from the main dc bus through the TABS & FLAPS POSITION INDICATOR circuit breaker in the aft fuselage junction box.

2.9.3.2 Flap Asymmetrical Control System. The flap asymmetrical control system is designed to sense certain malfunctions in the flap drive system and actuate the emergency flap brakes to stop any further movement of the flaps.

2.9.3.2.1 Asymmetrical Sensing Switches. There are two asymmetrical sensing switches, one at each of the outboard flap drive gearboxes. If a torque tube in the system breaks or a coupling comes apart, the switches sense the resulting out-of-phase condition. When this occurs, 28-Vdc power through the WING FLAP CONTROL VALVE circuit breaker on the copilot lower circuit breaker panel is routed by the switches to the emergency flap brake valve to lock the flap brakes.

2.9.3.2.2 Emergency Flap Brake Valve. The emergency flap brake valve is a solenoid-operated hydraulic valve located on the utility hydraulic panel. In its deenergized position, hydraulic pressure passes through it to the flap selector valve. When energized by the asymmetrical sensing switches, the valve routes hydraulic fluid pressure to the emergency flap brakes and closes off pressure to the flap selector valve. The valve is equipped with a manual override. When locked by the emergency flap brakes, the flaps cannot be raised or lowered by any means until the manual override is moved. The manual override resets the emergency flap brake valve, releasing the emergency flap brakes.

Note

The manual override is for ground use only.

2.9.3.2.3 Emergency Flap Brakes. There are two emergency flap brakes, located one at each of the out-board flap drive gear boxes. The emergency flap brakes are spring-loaded released and hydraulically applied by pressure supplied through the emergency flap brake valve. When actuated, the brakes lock the flaps, preventing any further motion of the flaps. The brakes are released by operating the emergency flap brake valve manual override.

2.10 LANDING GEAR SYSTEM

The landing gear system includes a dual-wheel, steerable nosegear and two tandem-mounted main landing gears. Normal operation of the system is through the utility hydraulic system. The nosegear retracts forward into the nose section of the fuselage; the main landing gears retract vertically into the left and right wheelwells on the sides of the fuselage. In the retracted position, all landing gears are enclosed by mechanically operated flush doors. A landing gear position-indicating system gives a visual indication of the position of each gear and gives a visual and audible indication of an unlocked condition of the landing gear. Under normal operation, retraction or extension time of both nose and main landing gears is 19 seconds or less.

2.10.1 Main Landing Gear. The main landing gear system (see Figure 2-52) consists of four wheels, two mounted in tandem on each side of the fuselage. Each wheel has a separate strut. The landing gear actuation system is normally supplied hydraulic fluid under pressure from the utility system. Fluid from the utility system flows through a landing gear selector valve to each of the two main landing gear motors. Each pair of struts is raised and lowered in vertical tracks by screwjacks driven by torque shafts that are powered by the hydraulic motor through a gearbox. The gearbox contains a spring-loaded brake assembly. After the landing gear contacts the up-limit switch, the landing gear selector valve remains energized, allowing landing gear up hydraulic pressure to be continuously applied to the main landing gear motors. In the event of loss of hydraulic pressure, the main landing gear spring-loaded retraction brakes are applied. With the main gear down and the aircraft on the ground, friction washers on the screwjack assemblies serve as downlocks. Mechanical linkage between the aft main landing gear struts and the doors causes the doors to open and close as the main landing gears are extended and retracted.

2.10.1.1 Manual Operation Provisions. Emergency methods of actuating the main landing gear manually are provided by means of two emergency engaging handles, two extension stub shafts, two handcranks, a main landing gear emergency extension wrench, and six easily removed pressure-sealed doors. The two emergency engaging handles, one located on the forward side of each wheelwell bulkhead, are connected by cables to their respective gearbox assemblies. Pulling an emergency engaging handle shifts the gearbox from power to manual drive and bypasses the brake.

Note

The emergency engaging handles should not be pulled while the aircraft is on the ground. The aircraft may have to be jacked to reset the handles.

Either handcrank (one is located on each side of the fuselage near the wheelwell bulkhead) can then be used to operate the appropriate extension stub shaft for manual extension of either main landing gear. The shaft is connected by mechanical linkage to the gearbox assembly that drives the retraction screwjacks. One extension stub shaft is mounted on the forward wall of each main landing gear wheelwell. The emergency extension wrench is provided for manually extending the main landing gear after both the normal and emergency extension systems have failed. There are seven pressure-sealed access panels on each wheelwell

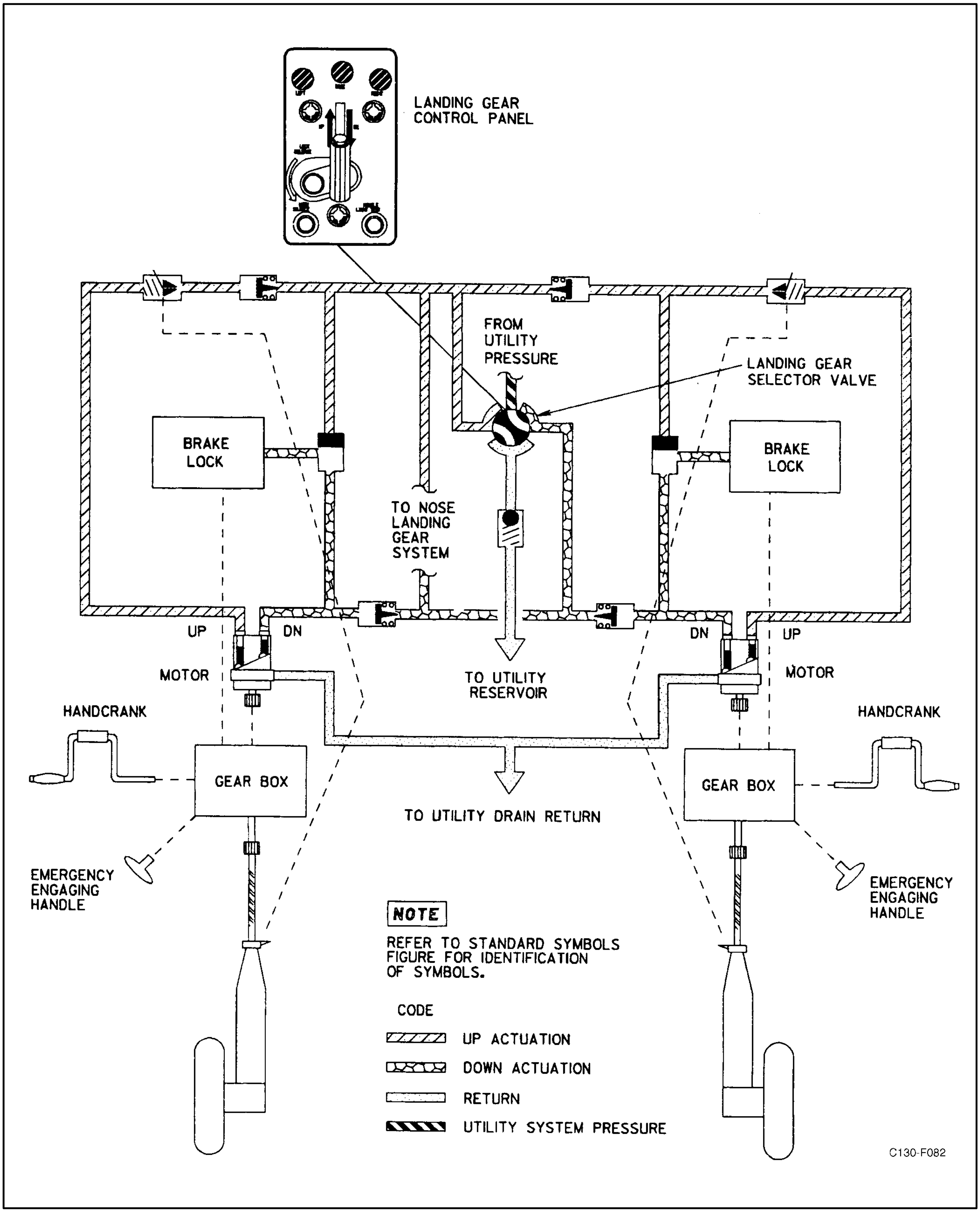


Figure 2-52. Main Landing Gear System

wall. The main landing gear gearbox access panel is located forward and high on each wheelwell wall. This panel provides access to the MLG hydraulic gearbox for manual shift from power to manual drive in the event of manual release-cable jamming or failure. The two upper access panels on each wheelwell wall provide access to the lower end of each vertical torque shaft for disconnecting the vertical torque shaft and use of the MLG emergency extension wrench. The two middle access panels on each wheelwell wall are for maintenance use and are not to be removed in flight. These panels are secured with screws. The two lower access panels at the floor level on each wheelwell wall are inspection windows for determining that the MLG is fully extended. They also provide access to the MLG struts for emergency tiedown. All of the pressure-sealed access panels except the two middle access panels on each side can be removed in flight for emergency requirements. The emergency extension handcrank can be used to remove the bolts securing the access panels. The landing gear down-and-locked indicators remain operative during manual operation.

2.10.2 Nose Landing Gear. The nose landing gear is a swing-type gear, extending down and aft, actuated by a hydraulic cylinder and secured in the up and down positions by locks. The gear is normally supplied with hydraulic fluid under pressure by the utility supply system; however, during an emergency it can be supplied by the auxiliary hydraulic system (for extension only). Hydraulic fluid from either the up or down side of the landing gear selector valve flows to the nose landing gear uplock and downlock cylinders and to the nose landing gear actuating cylinder (see Figure 2-53). The landing gear selector valve remains energized open in the up position, allowing landing-gear-up pressure to be continuously applied to the nose landing gear actuating cylinder and uplock. In the event of loss of hydraulic pressure, the nose landing gear is held in place mechanically by the uplock. Fluid for the nose landing gear steering control valve is supplied from the landing gear selector valve in the down position only. A shuttle valve connects the utility pressure downline to the auxiliary system pressure line, permitting auxiliary pressure to be used to place the nose landing gear in the down-and-locked position when the utility system is inoperative. The manual release handle at the flight station provides a mechanical means of unlocking the nosegear uplock. The nosegear can be visually checked through a nose landing gear inspection window on the aft bulkhead of the nose wheelwell under the flight deck. There are no provisions for emergency retraction of the nose landing gear.

2.10.3 Landing Gear System Controls and Indicators

2.10.3.1 Landing Gear Lever. A landing gear lever (see Figure 2-54) is located on the left side of the copilot instrument panel. It is a two-position (UP, DN) lever that directs the gear actuating mechanism to raise or lower the nose and main landing gears. When the lever is moved to the UP position, a solenoid-operated selector valve directs pressure from the utility hydraulic system to release the nosegear downlock, to the up side of the nose landing gear actuating cylinder, to both main landing gear hydraulic motors, and the landing gears retract. When the lever is moved to the DN position, the nose landing gear uplock is released, the main landing gear motors are reversed, and the landing gear extends. The valve circuit is powered by 28-Vdc from the essential dc bus, through the LANDING GEAR CONTROL circuit breaker on the copilot lower circuit breaker panel. A mechanical locking device is engaged when the landing gear lever is moved to the DN position so that the lever stays in the DN position until released. During takeoff or in flight, the energized position of the touchdown relay energizes the landing gear lever release solenoid to reduce the locking device to a simple detent. At other times, the LOCK RELEASE finger latch (see Figure 2-54) must be pulled down before the landing gear lever can be moved to the UP position. When the landing gear lever is in the UP position, 28-Vdc power is routed from the LANDING GEAR CONTROL circuit breaker on the copilot lower circuit breaker panel to energize the normal brake selector valve to prevent application of normal brakes. When the landing gear lever is in the DN position, the normal brake selector valve is deenergized to allow brake application regardless of main landing gear strut compression. See paragraph 2.13 for interrelation of antiskid provisions.

2.10.3.2 Main Landing Gear Touchdown Switch. A touchdown switch is installed on the lower aft side of each forward main gear strut. The switches are safety devices that either prevent some aircraft system from operating or permit it to operate when the aircraft is on the ground or in flight. The weight of the aircraft on the gear operates these switches.

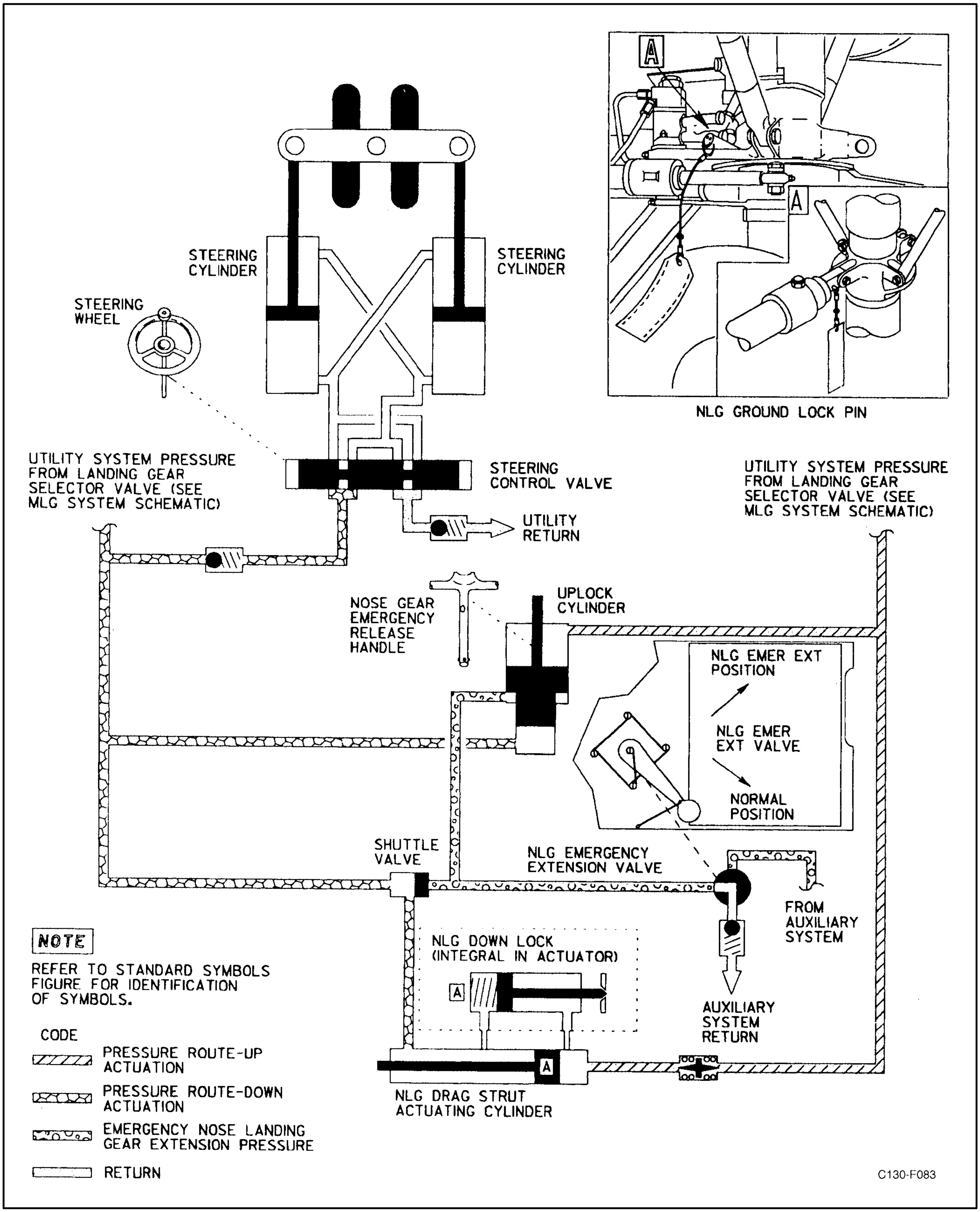


Figure 2-53. Nose Landing Gear System

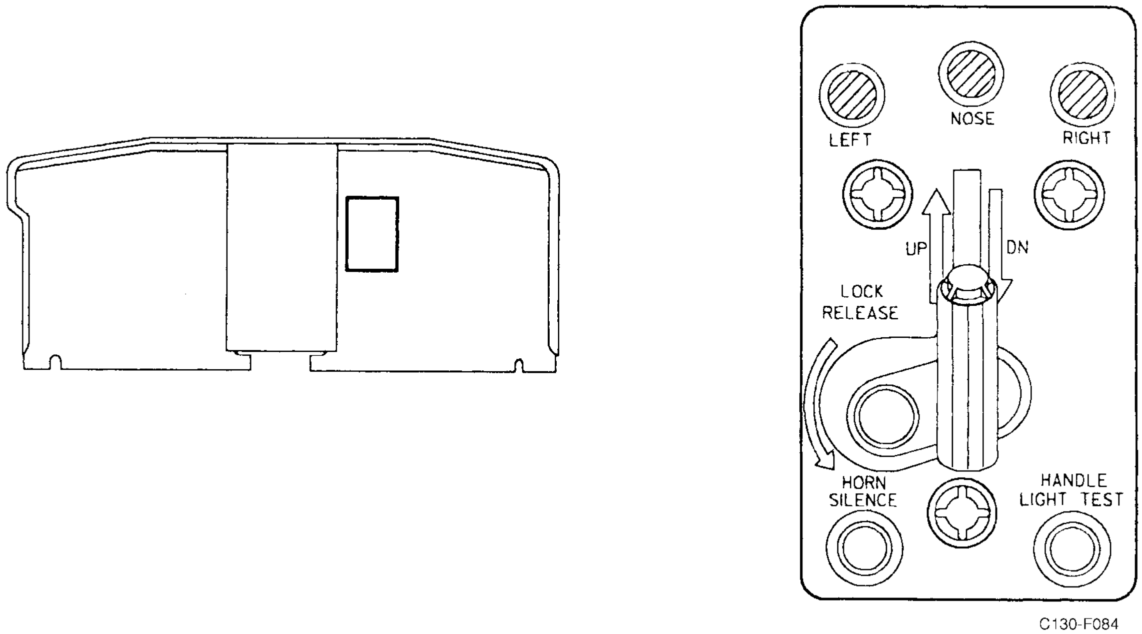


Figure 2-54. Landing Gear Controls and Indicators

Some systems are wired directly through the touch-down switches and others through relays that are controlled by the touchdown switches. Systems that are affected by the touchdown switches and relays are as follows:

1. Touchdown switch
   a. Engine ground stop (inoperative in flight)
   b. Touchdown relay
   c. Auxiliary touchdown relays.
2. Touchdown relay
   a. Landing gear lever lock (unlocked in flight)
   b. Wheelbrakes (antiskid) (brakes inoperative in flight)
   c. Cockpit controls for cargo door and ramp (inoperative on the ground)
   d. Airdrop release (inoperative on the ground).
3. Auxiliary touchdown relay No. 1
   a. Dc bus tie control (inoperative in flight)
   b. APU door control (door opens 35° on the ground and 15° in flight)
   c. TCAS (enables test on ground).
4. Auxiliary touchdown relay No. 2
   a. Autopilot trim monitor test (inoperative in flight)
   b. TCAS and transponder computers.
5. Auxiliary touchdown relay No. 3.
   a. Ground/anticollision/strobes.

2.10.3.3 Emergency Engaging Handle. A yellow emergency engaging handle is located on the forward wall of each wheelwell, just below the landing gear manual operation stub shaft. The handle operates a cable that disengages the main landing gear mechanism brake and the drive motor, and simultaneously engages the mechanical linkage that connects the stub shaft to the gearbox, thereby permitting manual raising or lowering of the main landing gear. The handle must be pulled out and turned counterclockwise approximately one-quarter turn to lock before the landing gear can be extended or retracted manually. To restore the system to normal, the handle must be turned approximately one-quarter turn clockwise to unlock, and then be released to the normal position. Proper positioning of the emergency engaging handle is verified by rotating the handcrank in both directions. If the handle is in the normal position, the handcrank will rotate freely.

2.10.3.4 Landing Gear Handcrank. Two landing gear reversible ratchet-type handcranks are provided for the manual operation of the main landing gears. One handcrank is stored in retaining clips on the forward face of the left wheelwell, and the other is stored on the fuselage wall forward of the right wheelwell. One end of each crank is made to fit over the protruding end of the extension stub shaft located on each wheelwell forward wall, just above the emergency engaging handles. The handcrank also fits the landing gear access panel bolts.

2.10.3.5 Main Landing Gear Emergency Extension Wrench. The emergency extension wrench is provided for manual extension of the main landing gear if both the normal and emergency extension systems fail to extend the gear. The wrench has a fixed splined socket on one end and a ratchet and splined box on the other end. The wrench is used to manually rotate the landing gear ball screws to lower the struts. The wrench is stowed in a bracket located forward of the left main wheelwell area.

2.10.3.6 Main Landing Gear Ground Lock. Two main landing gear ground locks are provided to prevent accidental retraction of the main landing gears while performing maintenance on the gears. The locks are installed on the hexagonal ends of the main landing gear ball screw assemblies, one lock on each side of the aircraft. The locks are stowed in the miscellaneous equipment box aft of the right paratroop door.

2.10.3.7 Nose Landing Gear Ground Pin. A nose landing gear ground pin (see Figure 2-55) is provided to prevent accidental retraction of the nose landing gear while the aircraft is parked. The ground pin consists of a ball-lock pin that is inserted in a hole in the nose landing gear actuator rod-end and prevents release of the internal downlock in the actuator.

2.10.3.8 Nosegear Emergency Release Handle. A nose gear uplock emergency release handle (see Figure 2-56) is located below the floor of the flight station under a hinged panel between the copilot seat and the control pedestal. The handle operates a cable system that releases the nose landing gear uplock and allows the nosegear to fall free.

Note

Practice extension of the nose landing gear with the emergency release handle and auxiliary hydraulic system is not recommended and should be avoided. Extending the nose landing gear by this method and subsequently raising the gear can cause approximately one quart of hydraulic fluid to transfer from the auxiliary hydraulic system to the utility hydraulic system.

2.10.3.9 Landing Gear Warning Horn and Silence Switch. The landing gear warning horn is located above and to the left of the pilot seat. Two things will cause the landing gear warning horn to sound: retarding a throttle to a position within 5° forward of the FLIGHT IDLE position with the landing gear up, and extending the flaps more than approximately 80 percent with the landing gear up. A HORN SILENCE switch (see Figure 2-54) is located on the landing gear control panel. It is a press-type switch used to silence the landing gear warning horn when a throttle is retarded. It will not silence the horn when flaps are extended more than 80 percent. When the switch is pressed, the horn-silencing relay is actuated and the warning horn electrical circuit is broken. Cycling of the landing gears or advancement of an engine throttle will reset the horn-silencing relay so that the horn can sound again. The landing gear warning horn circuit is energized by 28-Vdc power from the essential dc bus through the LANDING GEAR WARN LIGHT circuit breaker on the copilot lower circuit breaker panel. After C-130 AFC-368, audible alarms from the Bleed Air Duct Overheat Detection System are interfaced with existing landing gear warning horn. An audible alarm from the ODS would pulse the horn at a rate of 90 times per minute to distinguish it from the landing gear warning.

2.10.3.10 Landing Gear Warning Light and Warning Light Test Switch. The landing gear warning lights are connected to the landing gear retraction system and the throttle warning switches; they will illuminate whenever the landing gear is not in a locked position or when an engine throttle is retarded

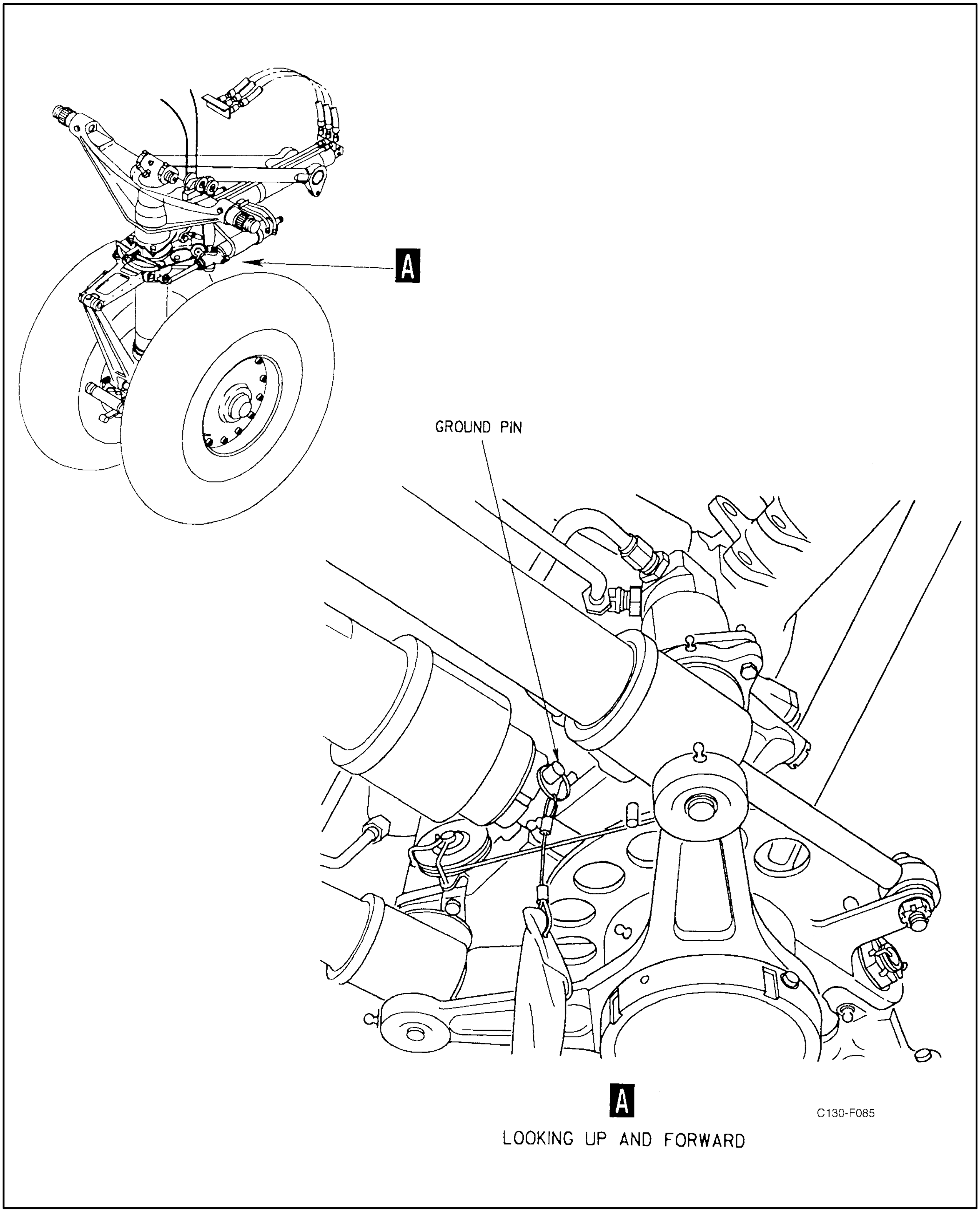


Figure 2-55. Nose Landing Gear Ground Pin

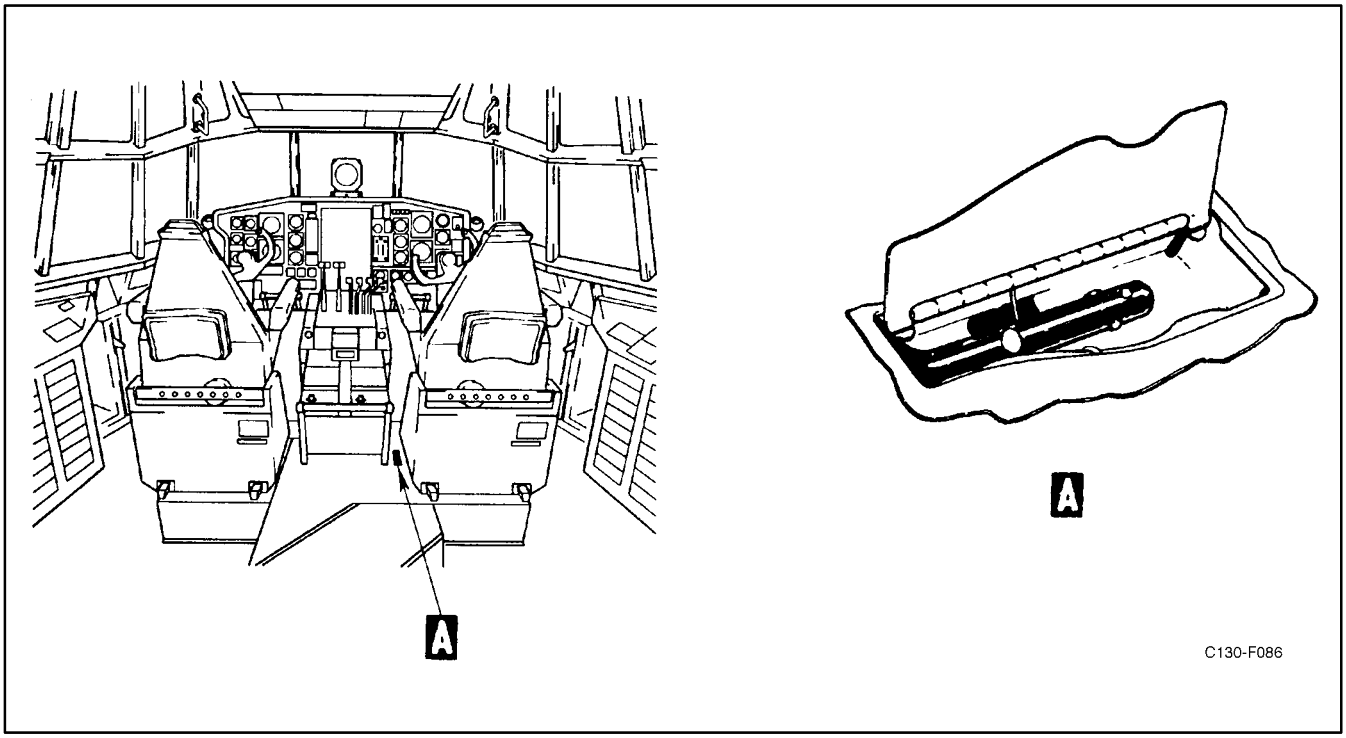


Figure 2-56. Nosegear Uplock Emergency Release Handle

to within 5° of the FLIGHT IDLE position and the landing gear is not fully extended. A HANDLE LIGHT TEST switch (see Figure 2-54) is located on the landing gear control panel. It is a press-type switch used to test the continuity of the landing gear warning light electrical circuit. When the switch is pressed, the landing gear warning light bulbs in the landing gear lever handle will illuminate. Failure of the bulbs to illuminate shows a defective circuit. The landing gear warning lights are energized by 28-Vdc power from the essential dc bus, through the LANDING GEAR WARN LIGHT circuit breaker on the copilot lower circuit breaker panel.

2.10.3.11 Landing Gear Position Indicators. A left main gear position indicator, a nosegear position indicator, and a right main gear position indicator are located on the landing gear control panel (see Figure 2-54). These indicators give a visual indication of position of the landing gear. When the letters UP appear on the face of an indicator, it means that the gear represented by that indicator is retracted and locked. When the picture of a landing gear wheel appears on the face of an indicator, it means that the landing gear represented by that picture is extended and locked. Diagonal lines on the face of an indicator indicates that a gear is somewhere between the extended and retracted positions or that the indicator is inoperative. The landing gear position indicators are energized by 28-Vdc power from the essential dc bus, through the LANDING GEAR POSITION IND circuit breaker on the copilot lower circuit breaker panel.

2.11 NOSEWHEEL STEERING SYSTEM

The aircraft is steered during taxiing by directional control of the nosewheel. The nosewheel is hydraulically actuated and governed by a steering control valve in the utility hydraulic system. The steering control valve is connected by a cable to a manually operated nose steering wheel (see Figure 2-57) located in the flight station at the left of the pilot control column. Directional control of the nosewheel is limited by means of mechanical stops to 60° right and left of center. One and one-fourth turns from center position of the nose steering wheel will turn the steering wheel to the full-left or the full-right position. Orifices in the steering cylinders provide snubbing action to dampen oscillations of the nosewheel and to prevent shimmy. Centering cams on the nosegear strut return the nosewheel to a centered position whenever the weight of the aircraft is removed from the nosegear.

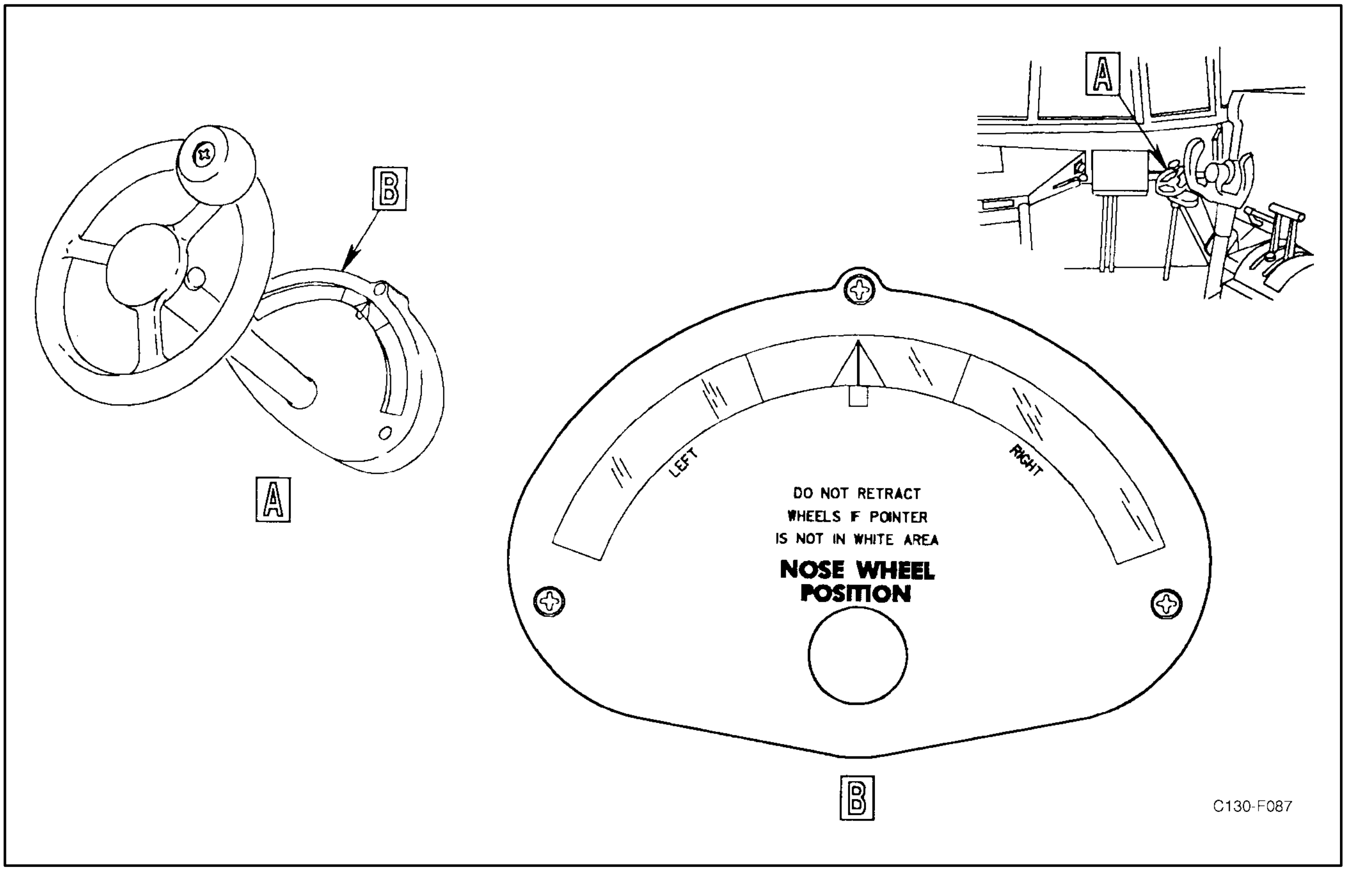
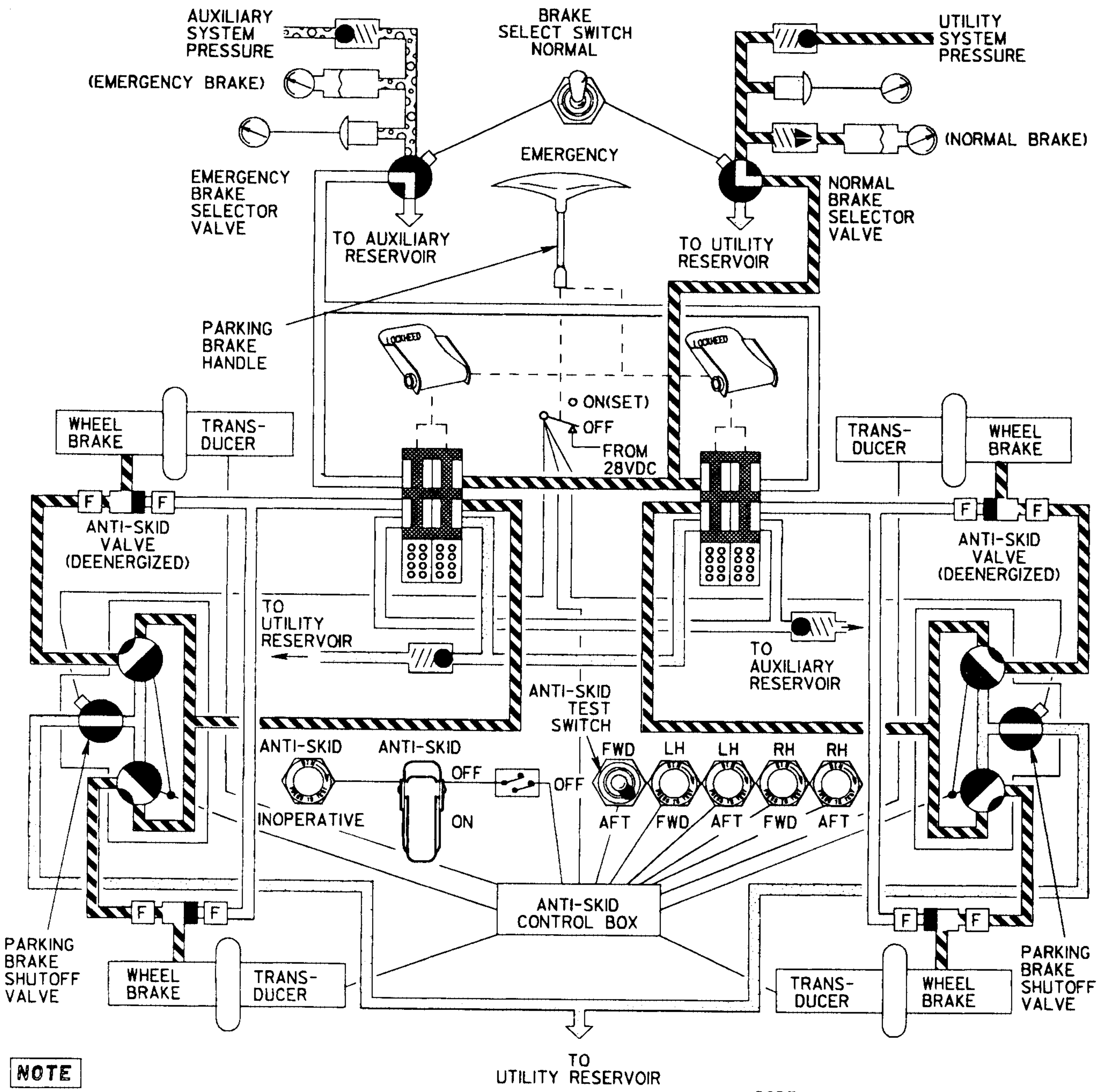


Figure 2-57. Steering Wheel

2.12 BRAKE SYSTEM

The main landing gear brake system (see Figure 2-58) utilizes a hydraulically operated, multiple-disk brake on each of the four main landing gear wheels. The nose landing gear wheels do not have brakes. The brakes normally operate from utility hydraulic system pressure, with an alternate supply available through the auxiliary hydraulic system. If electrical power is off, the system with the highest pressure will supply pressure to operate the brakes. Fluid for the normal brake system flows through a brake pressure selector valve to the right- and left-hand brake control valves. When the fluid leaves the brake control valves, it flows through the dual antiskid valves, brake fuses, and shuttle valves to the brakes. Each brake is controlled by a brake control valve, an antiskid valve, and brake shuttle valve. The auxiliary system supply flows through the emergency brake pressure selector valve. When the emergency brake system is actuated, fluid is directed to the brake control valves, then through hydraulic fuses and shuttle valves directly to the brakes, bypassing the antiskid valves. Utility or auxiliary system pressure is selected by manually positioning a brake pressure selector switch. Auxiliary system handpump pressure can also be used for brake operation in towing operations when utility or electrically driven auxiliary system pressure is not available. The accumulator in the auxiliary system will provide only one brake application; therefore, the brake pedals should be depressed firmly and held when braking is required. System pressure will not build up when the brake pedals are pumped on and off while the auxiliary system handpump is being operated.

2.12.1 Brake System Accumulators. Air-charged accumulators are used in both the normal brake and the emergency brake. Hydraulic systems provide a reserve source of hydraulic pressure in the event of certain system failures and absorb pressure surges. The accumulator in the normal brake system is capable of supplying pressure for about two brake applications. The accumulator in the emergency brake system, having one-half the capacity of the normal brake system



NOTE

1. REFER TO STANDARD SYMBOLS FIGURE FOR IDENTIFICATION OF SYMBOLS.

2. BRAKE PRESSURE SELECTOR SWITCH SHOWN IN NORMAL (UP) POSITION, WITH NORMAL BRAKE SELECTOR VALVE DEENERGIZED AND EMERGENCY BRAKE SELECTOR VALVE ENERGIZED. IN EMERGENCY POSITION (SWITCH DOWN) THE NORMAL BRAKE SELECTOR VALVE IS ENERGIZED (TO RETURN) AND THE EMERGENCY BRAKE SELECTOR VALVE IS DEENERGIZED, CONNECTING AUXILIARY PRESSURE. COMPLETE POWER FAILURE LEAVES BOTH VALVES OPEN TO SUPPLY PRESSURE FROM THEIR RESPECTIVE SYSTEMS. ANTI-SKID VALVES ARE ELECTRO-HYDRAULIC OPERATED.

CODE

UTILITY SYSTEM PRESSURE
UTILITY SYSTEM RETURN
AUXILIARY SYSTEM PRESSURE
TOUCHDOWN SWITCH

C130-F088

Figure 2-58. Main Landing Gear Brake System accumulator, is capable of supplying pressure for about one additional brake application.

2.12.2 Brake Antiskid Provisions. Skidding because of excessive brake application during normal brake operation is controlled by an antiskid system, maintaining maximum braking without excessive wheel skid (refer to paragraph 2.13).

2.12.3 Brake System Controls and Indicators

2.12.3.1 Brake Pedals. Actuation of the brakes is through application of toe pressure on the rudder pedals at either the pilot or copilot station. The amount of braking force is proportional to the force applied to the brake pedals. The right pedals actuate the right-hand brakes, and the left pedals actuate the left-hand brakes. This arrangement allows directional control of the aircraft through differential braking. When the antiskid system is energized, application of brake pressure before touchdown is prevented by a locked-wheel signal through the touchdown relays.

2.12.3.2 Brake Pressure Selector Switch. A two-position (NORMAL, EMERGENCY) BRAKE SELECT toggle switch located on the hydraulic control panel (see Figure 2-44) provides selection of either normal or auxiliary hydraulic pressure for applying the brakes. The NORMAL position will supply utility hydraulic pressure to the brakes, and the EMERGENCY position will supply auxiliary hydraulic pressure to the brakes. With the BRAKE SELECT switch in the NORMAL position and the landing gear lever in the UP position, the normal brake selector valve is energized closed by 28-Vdc power from the essential dc bus through the LANDING GEAR CONTROL circuit breaker on the copilot lower circuit breaker panel.

When the landing gear lever is placed to DN, the normal brake selector is deenergized to open. With the BRAKE SELECT switch in the NORMAL position, the emergency brake selector valve is energized closed by 28-Vdc power from the essential dc bus, received through the EMER BRAKE VALVE circuit breaker located on the copilot lower circuit breaker panel. With the BRAKE SELECT switch in the EMERGENCY position, the normal brake selector valve is energized closed by 28-Vdc power from the main dc bus through the ANTI-SKID CONTROL circuit breaker on the copilot lower circuit breaker panel. When the switch is in the EMERGENCY position, the antiskid system is inoperative. Both the normal and emergency brake selector valves are deenergized open.

Note

In case of dc electrical power failure, the deenergized valves admit either utility or auxiliary hydraulic system pressures to the brake system. The shuttle valves are positioned by the system supplying the greater pressure.

Hydraulic fuses are provided in the normal and emergency systems for each of the main landing gear brakes. If a failure is experienced in the hydraulic line between the fuse and the brake, the fuse will allow approximately 10 cubic inches of fluid to bleed out of the system and then close, thereby retaining the remaining hydraulic fluid for operation of the other three brakes.

2.12.3.3 Parking Brake Handle. A parking brake handle (see Figure 2-59) is located in front of the pilot seat, to the right of the pilot right footrest. The control handle is mounted on a panel support and is attached to a flexible cable. This cable pulls a pawl into a detent in the brake control lever to lock the pedals in a depressed (brakes on) position.

Note

When a hydraulic pump is not supplying pressure, brake pressure will gradually decrease and eventually cause the parking brake to become ineffective. Wheel chocks shall be used for long-term parking.

The brakes are set for parking by first fully depressing the toe section of the rudder pedals, then pulling firmly on the parking brake control handle while letting off slowly on the brakes. The brakes are released by depressing the toe section of the rudder pedals. When the parking brake is set with power on the aircraft and the ANTI-SKID switch ON, a solenoid in the antiskid valve is deenergized to block the return port of the antiskid valve. This prevents rapid leakage and subsequent release of the pressure used for setting the parking brake. With power on the aircraft, the ANTI-SKID INOPERATIVE light will illuminate when the parking brake is set.

2.12.3.4 Brake Pressure Indicators. Two brake pressure indicators are located on the hydraulic control panel (see Figure 2-44) at the bottom of the

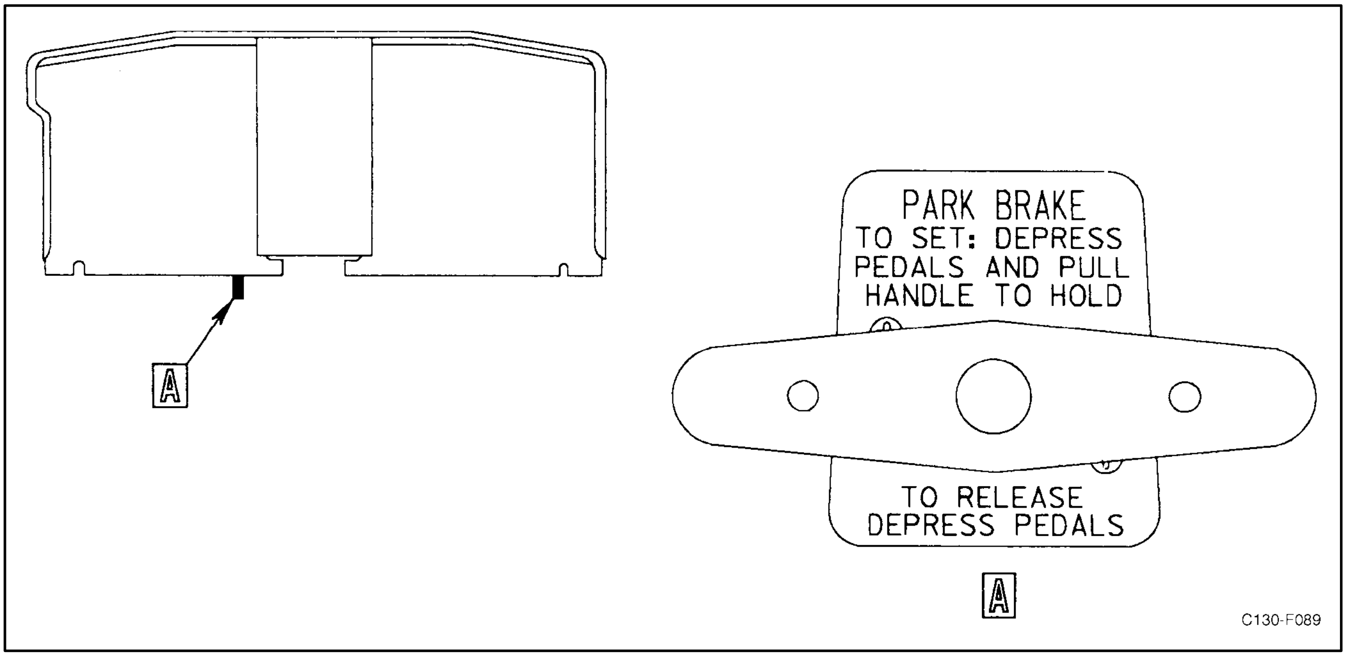


Figure 2-59. Parking Brake Handle

copilot instrument panel. The indicators, which are connected to pressure transmitters in the pressure lines of the brake control system, register the hydraulic pressure available in the brake sections of both the utility and auxiliary hydraulic systems. The indicators are energized by 26-Vac power from the instrument transformers through the BRAKE EMER and NORMAL BRAKE fuses on the pilot lower circuit breaker panel.

2.13 ANTISKID SYSTEM

The antiskid system, an integral part of the main landing gear brake system (see Figure 2-58), consists of four wheel-speed transducers, an electrical control box, and two dual-type electrohydraulic servobrake pressure control (antiskid) valves.

2.13.1 Antiskid System Operation. The system prevents skidding of wheels when too much brake pressure is in effect during aircraft decelerations. This is done through a brake-releasing system, controlled by signals from wheel-speed transducers.

2.13.2 Skid-Detector Operation. The wheel-speed transducer unit mounted in the axle of each main landing gear wheel applies controls to the braking operation through the antiskid valves when the landing gear wheel begins to approach a skid condition. One dual antiskid valve is located above the booster hydraulic reservoir on the forward right-hand wheel-well wall, and the other is on the left-hand hydraulic panel forward of the utility hydraulic reservoir. Each wheel-speed transducer unit contains a frequency generator that senses wheel rotational speed and wheel speed change. The transducers form part of an electrical circuit that prevents landing with brakes on and that releases brakes in case of a locked condition. Should the wheel speed decrease rapidly, indicating approach of a skid condition, the control box sends an electric impulse to an antiskid valve which reduces pressure to the affected brake below the pressure that caused sensing of the skid. As subsequent skids are sensed, they are electronically compared with the amount the hydraulic pressure had to be reduced to eliminate earlier skids detected. This comparison results in a more accurate determination of the minimum reduction in brake pressure required to eliminate the skid. The skid detection and control function is independent for each wheel. The skid control system will not function when the brake system is operating from the auxiliary hydraulic system or when the parking brakes are set.

2.13.3 Antiskid System Controls and Indicators

2.13.3.1 ANTI-SKID Switch. An ANTI-SKID two-position (OFF, ON) guarded toggle switch is located on the hydraulic control panel (see Figure 2-44). It is energized by 28-Vdc power from the main dc bus through the ANTI-SKID CONTROL circuit breaker on the copilot lower circuit breaker panel. When the switch is in the ON position and the ANTI-SKID INOPERATIVE light is extinguished, the antiskid system is operative and becomes an integral part of the wheel-brake system. When the switch is in the OFF position, the landing gear brake system operates as a standard brake system.

2.13.3.2 ANTI-SKID INOPERATIVE Light. An ANTI-SKID INOPERATIVE (press-to-test) light, located on the hydraulic control panel (see Figure 2-44) glows whenever the antiskid system is not operating as an integral part of the landing gear brake system. It warns the pilot that skid protection has been lost on all wheels. This light will also illuminate when the parking brake is set. This system is energized by 28-Vdc power from the main dc bus through the ANTI-SKID FAIL-SAFE LIGHT circuit breaker on the copilot lower circuit breaker panel.

2.13.3.3 ANTI-SKID TEST Switch and Indicator Lights. An antiskid test panel (see Figure 2-43) is located on the aft end of the overhead control panel. The test panel contains a three-position (FWD, OFF and AFT) ANTI-SKID TEST switch and four green indicator lights identified as LEFT FWD, RIGHT FWD, LEFT AFT, and RIGHT AFT. When the test switch is placed in the FWD position, 26-volt, 400-Hz power obtained from the ac instrument and engine fuel control bus (through the ANTI-SKID TEST 26-Vac circuit breaker, located on the pilot lower circuit breaker panel) is applied to the antiskid control box to simulate a skid condition. When the switch is released to the OFF position, the FWD indicator lights should illuminate momentarily. Illumination of the lights indicates that the antiskid control box would have properly responded to an actual skid. When the test switch is placed in the AFT position and released, the AFT indicator lights should illuminate momentarily.

2.14 CARGO DOOR AND RAMP SYSTEM

The cargo door and ramp, providing entry for wheeled vehicles and large loads, are used also for egress during aerial delivery system operations. Normal operation of the door and ramp is achieved by hydraulic pressure supplied through the auxiliary hydraulic system (see Figure 2-60); alternatively, the operating pressure can be supplied in an emergency by a handpump connected to the reservoir of the auxiliary hydraulic system. Control of the system is accomplished electrically or manually from a ramp control panel located aft of the left paratroop door, electrically from the auxiliary ramp control panel, or electrically from the airdrop system control panel (see Figure 2-61) on the flight control pedestal. The airdrop system control panel, however, cannot be operated while the aircraft is on the ground. The cargo door actuating system incorporates an independent hydraulic snubber to prevent the door from being rapidly driven from the uplock during closing. The snubber quantity indicator and servicing instructions are on the snubber cylinder.

2.14.1 Cargo Door and Ramp Controls

2.14.1.1 Door Control Switch. A door control switch is located on the ramp control panel (see Figure 2-61) aft of the left paratroop door. This three-position (CLOSE, unmarked neutral, OPEN) toggle switch, spring loaded to the neutral position, controls the normal ground operation of the cargo door. When the switch is held in the OPEN position, the cargo door control valve is energized by 28-Vdc power through the RAMP & ADS CONT circuit breaker on the aft fuselage junction box. The control valve directs hydraulic pressure to the open side of the cargo door actuating cylinder to unlock the downlocks and open the cargo door. As the door reaches the open position, it engages the cargo door uplock assembly, which latches mechanically. When the switch is held in the CLOSE position, hydraulic pressure is directed to the cargo door uplock cylinder, which unlatches the uplock. The control valve also directs pressure to the closed side of the cargo door actuating cylinder, and the door swings downward to the closed position and locks in place. When the switch is released, the cargo door circuit deenergizes and the valves return to a neutral position.

2.14.1.2 Ramp Control Switch. A ramp control switch is located on the ramp control panel (see Figure 2-61) aft of the left paratroop door. This three-position (RAISE, unmarked neutral, LOWER) toggle switch, spring loaded to the neutral position, controls the normal ground operation of the ramp. When the switch is held in the LOWER position, the ramp control valve is energized by 28-Vdc power through the RAMP & ADS CONT circuit breaker on the aft fuselage junction box. The control valve directs hydraulic pressure to the up side of the ramp actuating cylinders and to the unlock side of the ramp uplock cylinder, until the uplock is unlatched. The hydraulic pressure then is directed to the down side of the ramp actuating cylinders to lower the ramp. When the switch

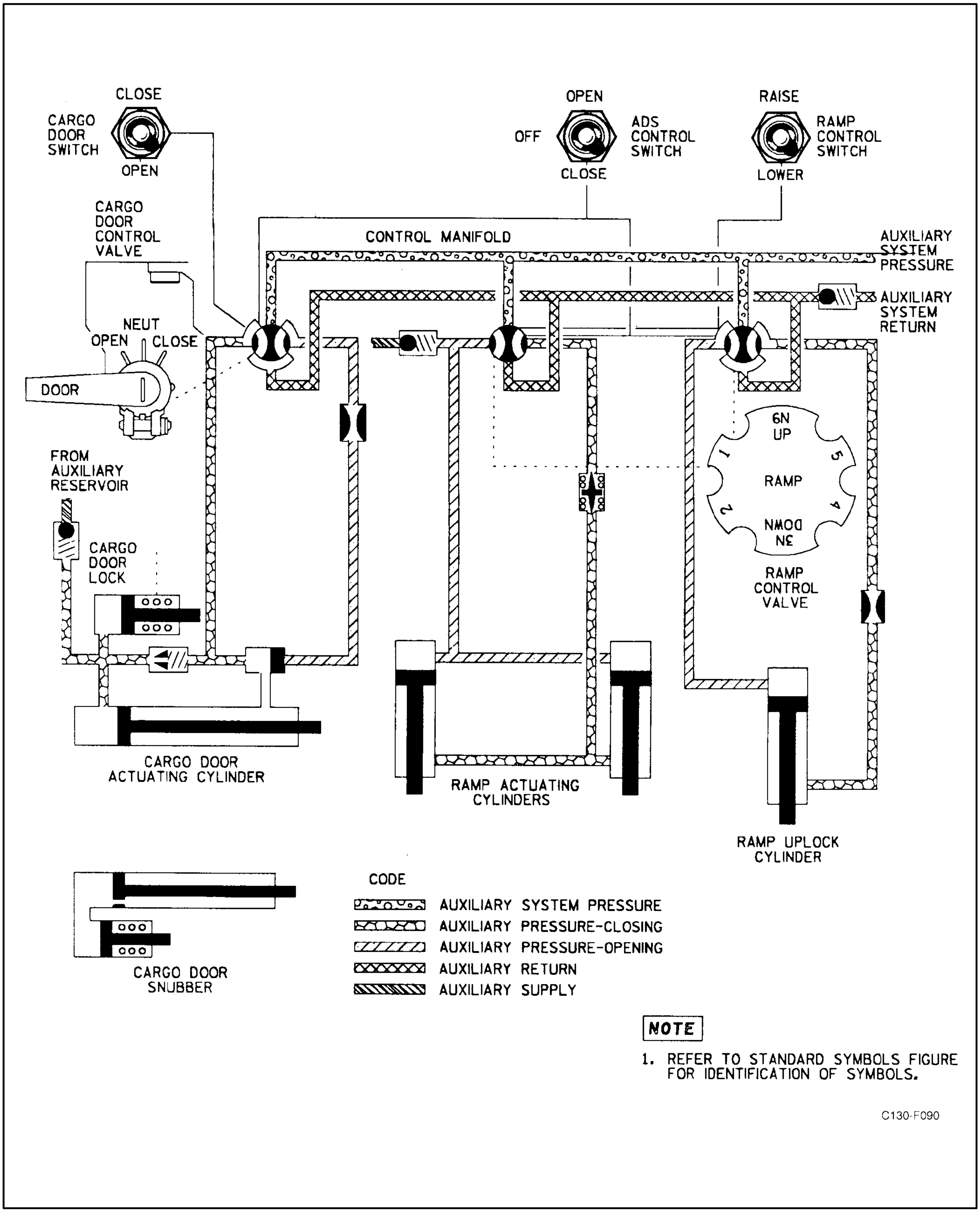


Figure 2-60. Cargo Door and Ramp Hydraulic System

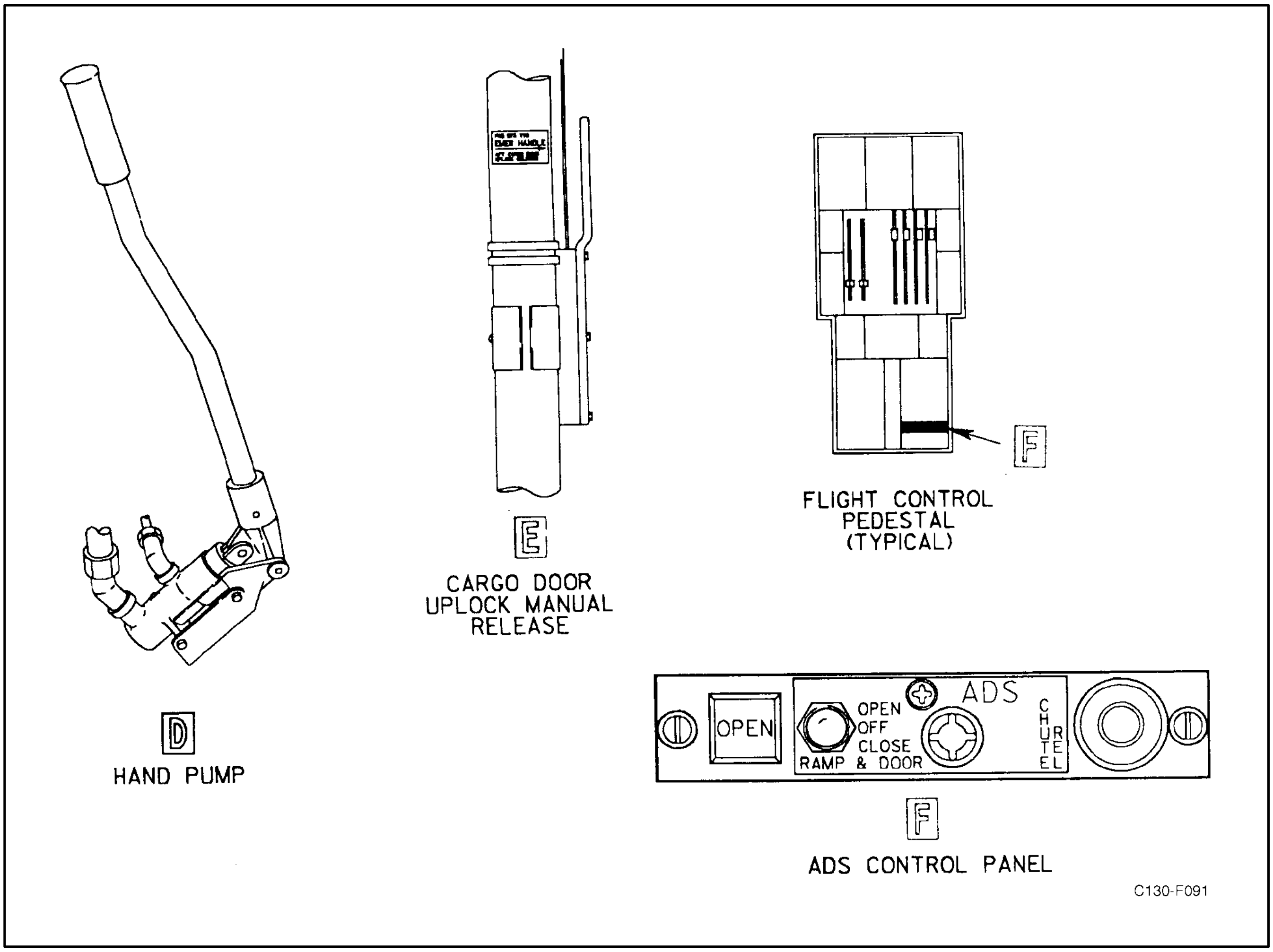


Figure 2-61. Cargo Door and Ramp Controls (Sheet 1 of 3)

is held in the RAISE position, the ramp control valve directs hydraulic pressure to the up side of the ramp actuating cylinders to raise the ramp. At the same time, pressure is directed into the unlock side of the ramp uplock cylinder to unlock the ramp uplock until the ramp is raised into the normal raised position. Pressure then is directed to the lock side of the ramp uplock cylinder to lock the ramp in place. When the switch is released, the ramp circuit is deenergized, and the valves return to a neutral position.

2.14.1.3 Ramp Manual Control Knob. The ramp manual control knob (see Figure 2-61) is a rotary selector located above the ramp control panel. It may be set to any of six numbered positions: DOWN -1 (unlock) and 2 (lower); 3N (neutral); UP -4 (raise) and 5 (lock); and 6N (neutral). These settings of the knob manually position the system valves that control flow, supplied either from the handpump or the auxiliary hydraulic system electric pump, to and from the ramp actuating and ramp uplock cylinders.

When the knob is placed in position 1, hydraulic pressure is directed to the up side of the ramp extension cylinders to raise the ramp off the uplocks, then pressure is directed to the unlock side of the ramp uplock cylinder to unlatch the ramp uplocks. When the knob is moved to position 2, pressure is directed to the down side of the ramp actuating cylinders to lower the ramp. Position 3N on the selector knob is a neutral position. When the knob is moved to position 4, pressure is directed to the up side of the ramp actuating cylinders to raise the ramp. Position 5 directs pressure to the lock side of the ramp uplock cylinder to lock the ramp in the closed position. Position 6N on the selector knob is a neutral position; the knob should be left in this position when the ramp is closed and not being operated.

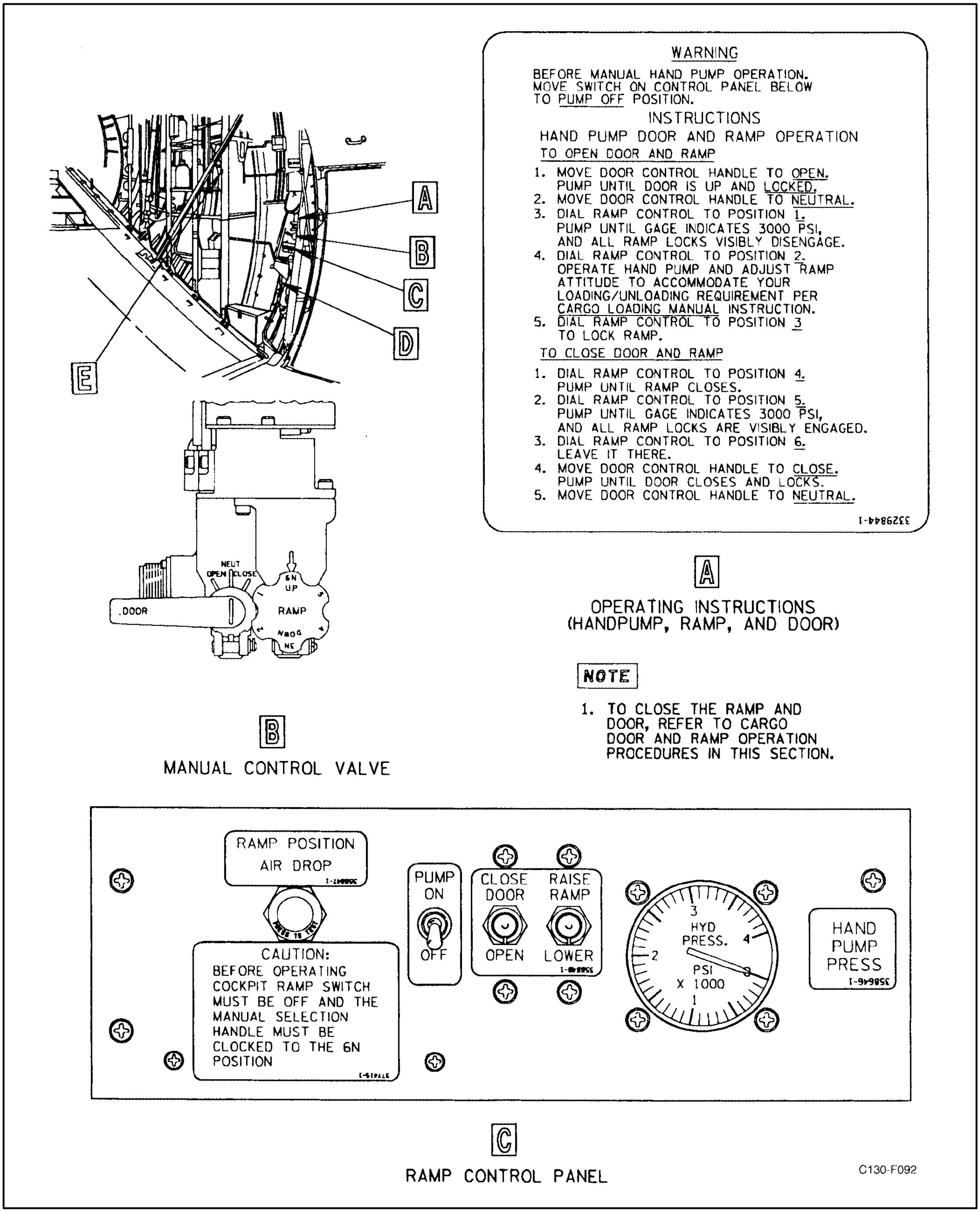


Figure 2-61. Cargo Door and Ramp Controls (Sheet 2)

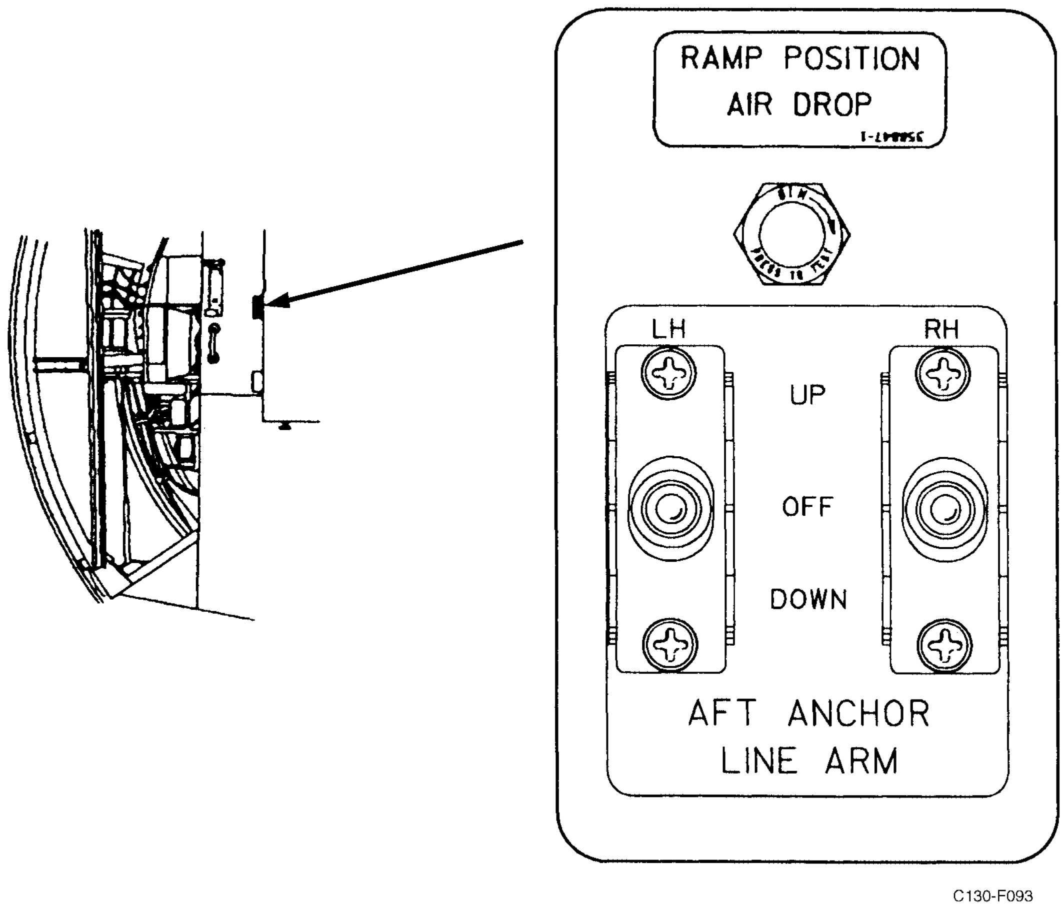


Figure 2-61. Cargo Door and Ramp Controls (Sheet 3)

2.14.1.4 Cargo Door Manual Control Valve Handle. The cargo door manual control valve handle (see Figure 2-61) has three positions: OPEN, NEUT (center), and CLOSE. When the handle is set to OPEN, the valve directs hydraulic pressure, either from the handpump or the auxiliary hydraulic system electrically-driven pump, to the up side of the door actuating cylinder, thus unlocking the downlocks and opening the door. On reaching the fully open position, the door is secured by a spring-loaded uplock. When the handle is set to CLOSE, hydraulic pressure, either from the handpump or the auxiliary hydraulic system electrically driven pump, is directed by the valve to the uplock cylinder to release the uplock engagement of the door and to the down side of the actuating cylinder to close the door. Setting the handle in the NEUT (center) position shuts off hydraulic pressure to the door operating system and leaves the control valve in a position from which it can be actuated by selection at the cargo door control switch.

CAUTION

The cargo door manual control valve handle and the ramp manual control knob must always be placed at the NEUT/6N position when manual operation is not desired; otherwise, the door and ramp may open or close when the auxiliary hydraulic pump is turned on.

2.14.1.5 System Handpump. The auxiliary system handpump (see Figure 2-61), just below the ramp control panel, provides an alternative pressure source to operate the cargo door and ramp in an emergency. The handpump can also be used to provide alternative pressure to operate the nosegear for emergency extension and the emergency brakes.

2.14.1.6 Release. The cargo door uplock release (see Figure 2-61) is a mechanical lever to release the spring-loaded uplock. The lever, connected by a system of cables and pulleys to the door uplock mechanism, is mounted on the outboard side of the tubular strut aft of the left paratroop door. The lever, normally stowed in the vertical (locked) position, pivots forward and downward when pulled to release the door uplock mechanism. The lever resumes the vertical position when it is released.

2.14.1.7 Auxiliary Hydraulic System Pump Switch. A two-position (PUMP ON, OFF) toggle switch, located on the ramp control panel, is used to turn the auxiliary hydraulic system electrically driven pump on and off. If this switch is in the ON position, the auxiliary pump cannot be turned off from the cockpit. When the switch is depressed and held, the auxiliary hydraulic pump provides hydraulic pressure for operation of the ramp and door.

2.14.2 Cargo Door and Ramp Indicators. Indicators are provided to show auxiliary hydraulic system pressure, engagement of the cargo door in the uplock mechanism, and open positions of the ramp and door for airdrop operations. The pressure indicators are on the ramp control panel and the hydraulic control panel. The door and ramp position indicators are lights on the ramp control panel and the ADS control panel. The uplock engagement indicator is a mechanically operated metal flag, illuminated by a red inspection light, attached to the cargo door uplock mechanism. Circuits are provided to illuminate door warning lights located on a panel aft of the right paratroop door, and a master warning light on the pilot instrument panel.

2.14.2.1 Pressure Gauges. The pressure gauges, one mounted on the ramp control panel (see Figure 2-61) and one on the hydraulic control panel (see Figure 2-44), register the pressure of the auxiliary hydraulic system. The gauge located on the ramp control panel is direct indicating, while the one on the hydraulic control panel is electrically operated. The gauge on the ramp control panel, although registering the system pressure supplied either by the electric-driven pump or the handpump, is intended primarily for use during handpump operations and is identified as HAND PUMP PRESS on the panel.

2.14.2.2 RAMP POSITION AIR DROP Light. A press-to-test RAMP POSITION AIR DROP light is located on the ramp control panel (see Figure 2-61) aft of the left paratroop door. The light illuminates when the ramp is in the airdrop position and the cargo door is open and locked. It is energized by 28-Vdc power through the RAMP & ADS CONT circuit breaker on the aft fuselage junction box. This press-to-test light will not illuminate when pressed unless the aft anchor arm supports are in the stowed (raised) position.

2.14.2.3 Ramp and Door Open Light. A press-to-test ramp and door open light is located on the ADS control panel (see Figure 2-61) on the flight control pedestal. The light illuminates when the aft cargo door is fully open and locked and the ramp is lowered to the airdrop position. This light is energized through the RAMP & ADS CONT circuit breaker on the aft fuselage junction box.

2.14.2.4 Cargo Door Uplock Indicator. The cargo door uplock indicator is a black metal flag with a yellow circle. The flag is attached to the uplock mechanism so that when the cargo door is open and locked in the up position, the flag will swing down to provide a visual indication. The flag is spring loaded to return to the masked position whenever the cargo door is not locked in the up position. A red inspection light is installed to illuminate the flag indicator. This light is controlled by a two-position (ON, OFF) toggle switch on the aft fuselage junction box and another switch on the forward public address control panel.

2.15 BLEED-AIR SYSTEM

The bleed-air system (see Figures 2-62 and 2-63) consists of high-pressure, stainless steel ducts and air shutoff valves that direct compressed air to pneumatically operated systems of the aircraft. The entire system of ducts serves as a plenum from which air is distributed to other systems. The following pneumatic systems are served by the bleed-air system:

1. Engine starting system

2. Air-conditioning system

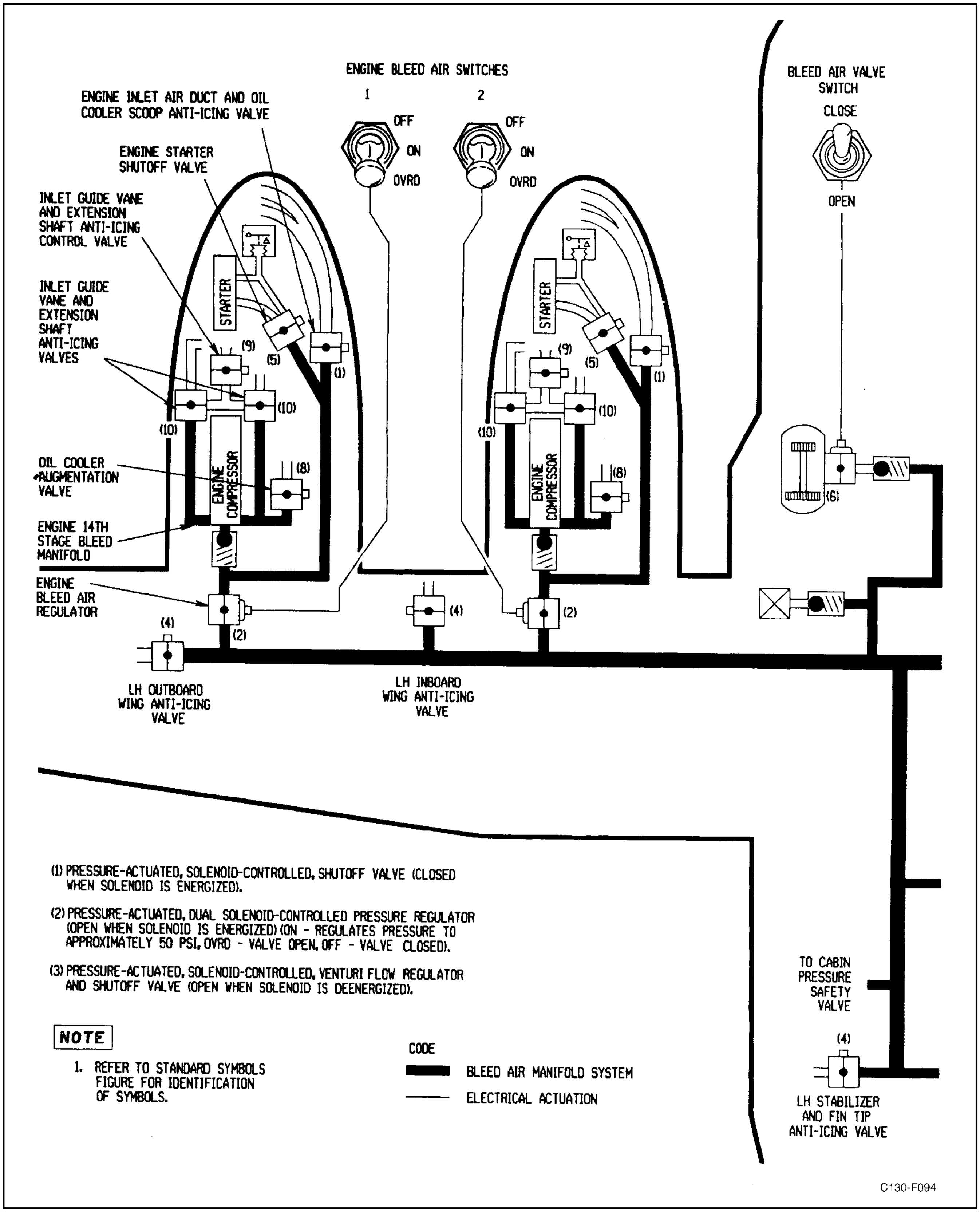


Figure 2-62. Bleed-Air System (Sheet 1 of 2)

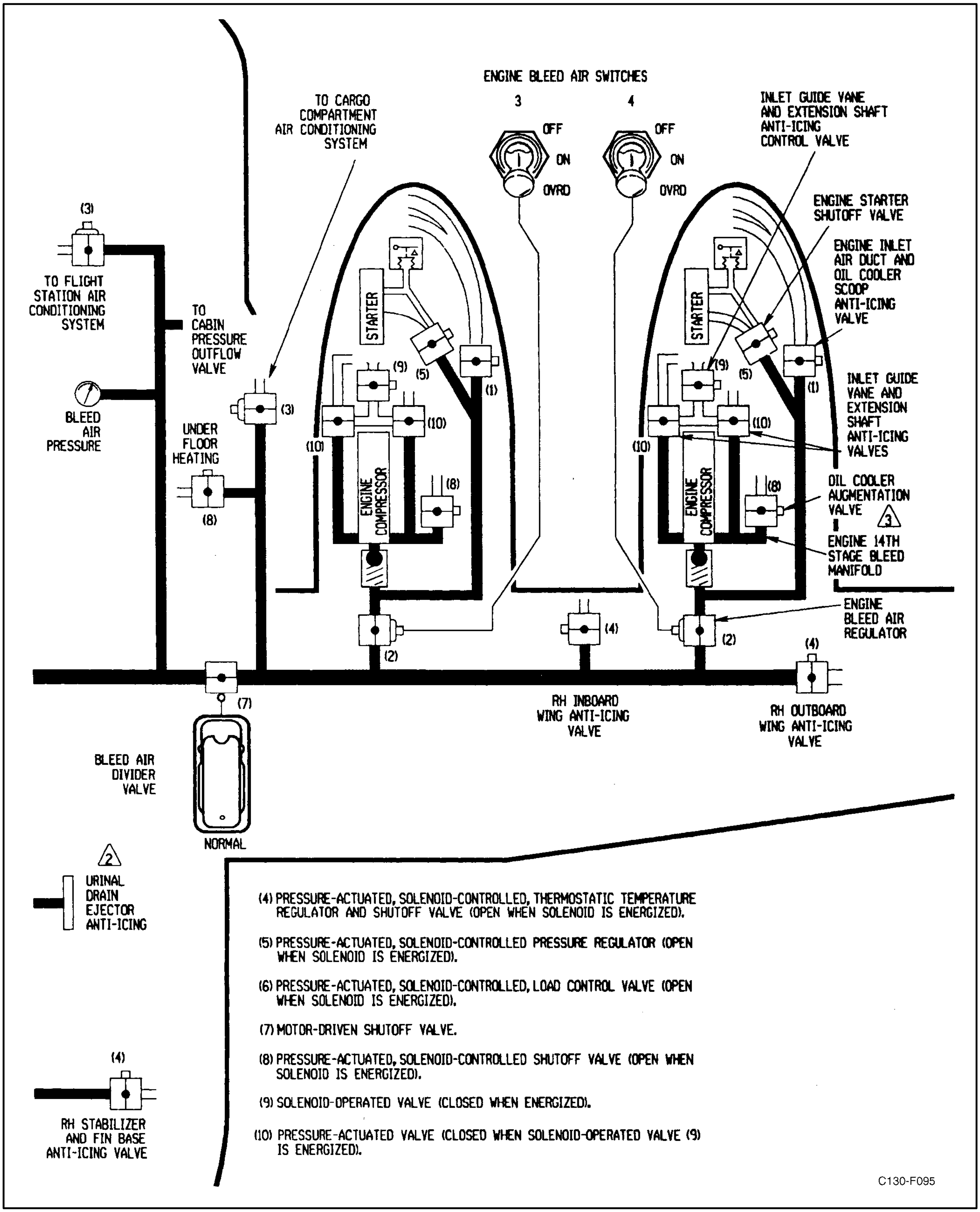


Figure 2-62. Bleed-Air System (Sheet 2)

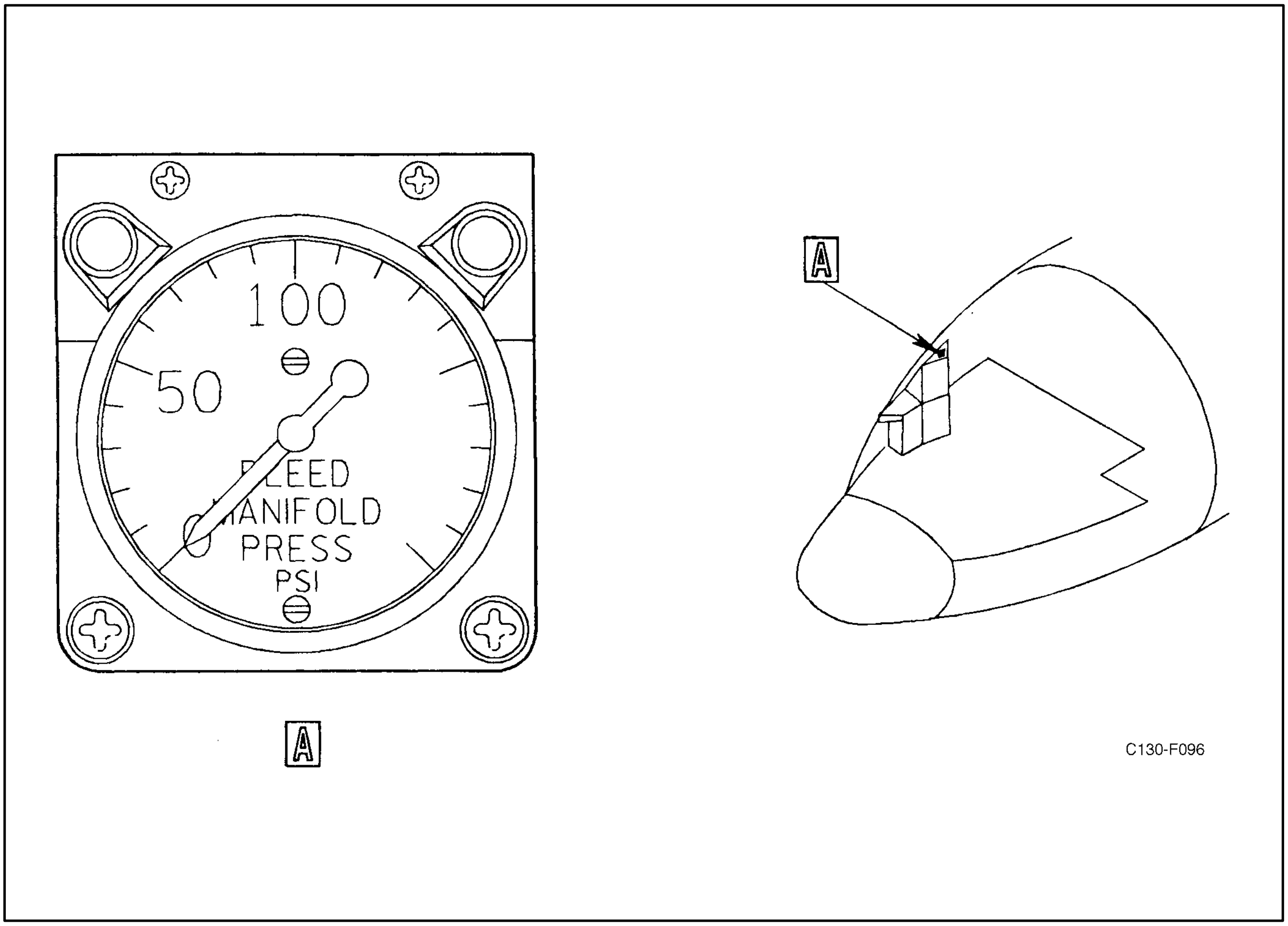


Figure 2-63. Bleed-Air Pressure Gauge

3. Cabin pressurization system

4. Windshield defogging system

5. Engine air inlet scoop anti-icing system

6. Leading edge anti-icing system

7. Oil cooler augmentation.

Compressed air is supplied to the bleed-air system from the engines when they are running, or compressed air is supplied from either the APU or from an external pressure source when the aircraft is on the ground and the engines are not running. The normal procedure is to supply air from the auxiliary power unit or from an external source until the first engine is started; then, engine bleed air is used. The main bleed-air manifold extends across the leading edge of the wing. Air enters the main manifold through five ports, four from the engines and one from the APU or an external source.

Branch ducts connected to the main manifold distribute air for operating the following:

1. Air-conditioning system

2. Leading edge anti-icing system.

Each engine bleed-air manifold is connected to the main manifold just aft of the firewall by an engine bleed-air pressure regulator valve. Branch ducts connected to the engine manifold forward of the firewall distribute air for operating the following:

1. Engine starting system

2. Nacelle preheat system (if installed)

3. Engine air inlet scoop anti-icing

4. Oil cooler augmentation system.

Check valves installed in each engine bleed-air manifold, the APU supply duct, and the external pressure supply duct prevent reverse flow when any of these sources of supply are inoperative.

2.15.1 Engine Bleed-Air Pressure Regulator Controls. Four ENGINE BLEED-AIR switches on the anti-icing systems control panel (see Figure 2-72) control the opening, closing, and regulation of the engine bleed-air pressure regulators. The control circuit for each regulator is connected through a switch actuated by the fire emergency control handle. When the fire emergency control handle is pulled, the engine bleed air regulator is closed and the normal switch control is rendered inoperative. The 28-Vdc power for operation of each regulator is supplied from the essential dc bus through the BLEED AIR FIRE SHUTOFF circuit breaker on the copilot side circuit breaker panel.

2.15.2 Bleed-Air Pressure Gauge. A direct-reading pressure gauge (see Figure 2-63), located on the right-hand circuit breaker box above the copilot upper circuit breaker panel, indicates main bleed-air manifold pressure in pounds per square inch. The gauge is used to check the pressure of the bleed-air supply and the operation of the pneumatic systems.

Note

When the flight station air-conditioning system is on, the bleed-air pressure gauge reads 6 psi lower than the actual pressure in the bleed-air manifold.

2.15.3 BLEED AIR DIVIDER VALVE Switch. The BLEED AIR DIVIDER VALVE switch is a guarded, two-position (CLOSED, NORMAL) switch located on the anti-icing and deicing control panel (see Figure 2-72). The switch controls a shutoff valve located in the bleed-air duct between the outlets going to the flight deck and cargo compartment air-conditioning units. The valve is normally in the open position. Closing the valve isolates the bleed-air supply so that one air-conditioning unit can continue to operate in case of a bleed-air duct failure. Electrical power for the valve is supplied from the 28-volt essential dc bus through the BLEED AIR DIVIDER VALVE circuit breaker on the copilot lower circuit breaker panel.

2.16 AIR-CONDITIONING SYSTEMS

The aircraft is equipped with two independently operating air-conditioning systems (see Figure 2-64), one for the flight station and the other for the cargo compartment. Both are operated by bleed air supplied from the engine compressors, or they may be operated on the ground by air supplied from the APU or by the attachment of an external ground compressor unit. Each system keeps the air at a required temperature and removes excess moisture before sending the air through a system of ducts into the respective flight station or cargo compartment. The principal components of each system comprise a venturi-type airflow regulator, an electrical temperature control system, a water separator, a refrigeration unit, auxiliary vent valve and controls, and distribution ducts. The flight station system includes a windshield defogging system and controls; the cargo compartment system includes a recirculating fan that can be operated independently or in conjunction with a separate heating system for the cargo compartment floor. Both systems are the same except for the distribution duct arrangement. Electrical power for the air-conditioning system control components is supplied through circuit breakers on the copilot lower circuit breaker panel. Air-conditioning on the ground can be accomplished by connecting an external unit to the cooling airscoops with airscoop adapters, and using the aircraft dusting.

2.16.1 Airflow Regulation. The amount of air flowing through each air-conditioning system is controlled by the venturi-type airflow regulator in the system. Each regulator is controlled by a two-position switch located on the air-conditioning and pressurization control panel, for two operating conditions: during flight and during the shutoff condition when neither air-conditioning nor pressurization is required (see Figure 2-65). The flight station and cargo compartment airflow regulators compensate for altitude. The standard day sea level airflow from each regulator is 70 pounds per minute, and, at 35,000 feet, the airflow is 33 pounds per minute. The underfloor heating system provides an additional 34 pounds per minute airflow at 35,000 feet. The regulators operate when the AIR CONDITIONING master switch is in NO PRESS, AUTO PRESS, or MAN PRESS. They are utilized as

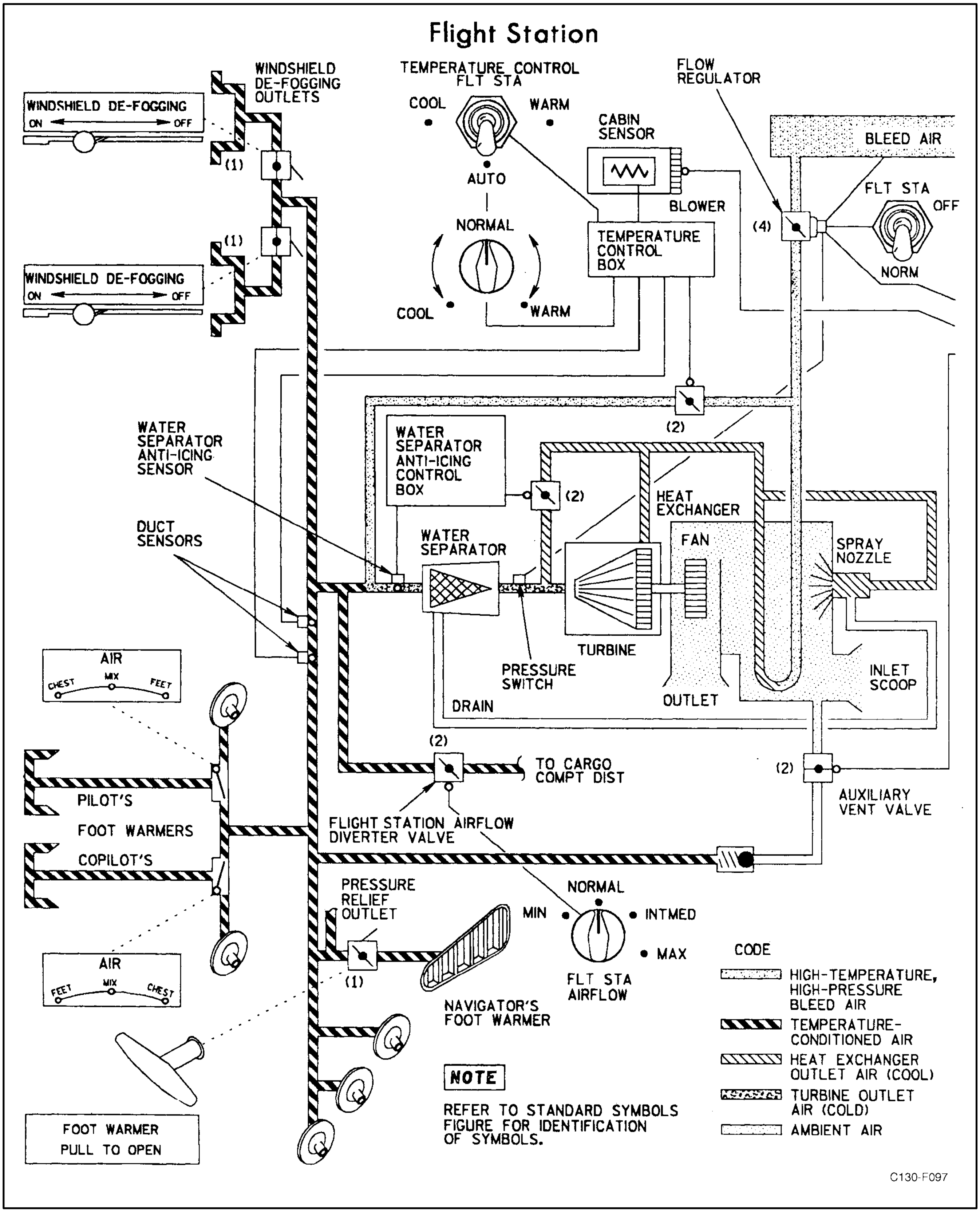


Figure 2-64. Air-Conditioning Systems (Sheet 1 of 2)

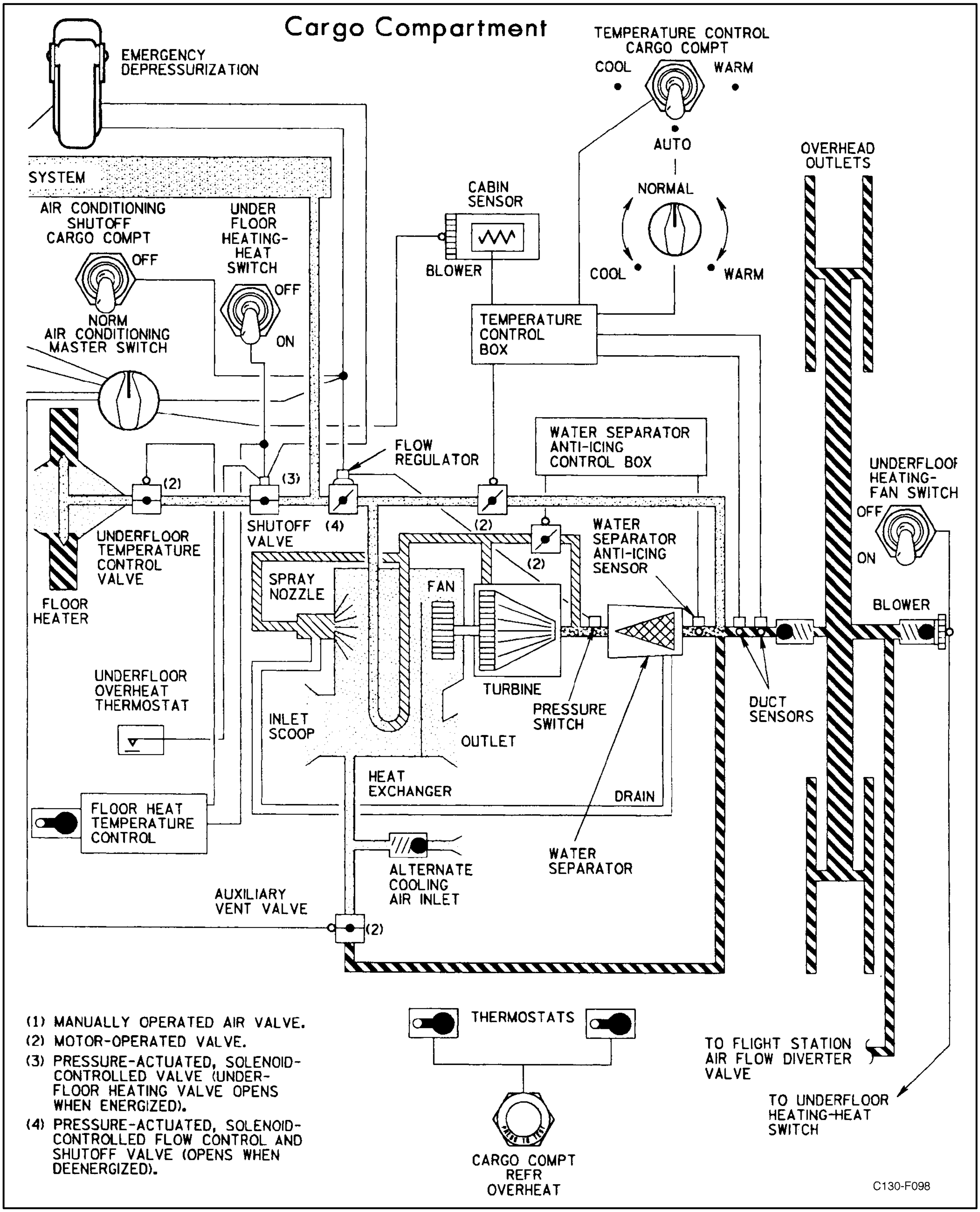


Figure 2-64. Air-Conditioning Systems (Sheet 2)

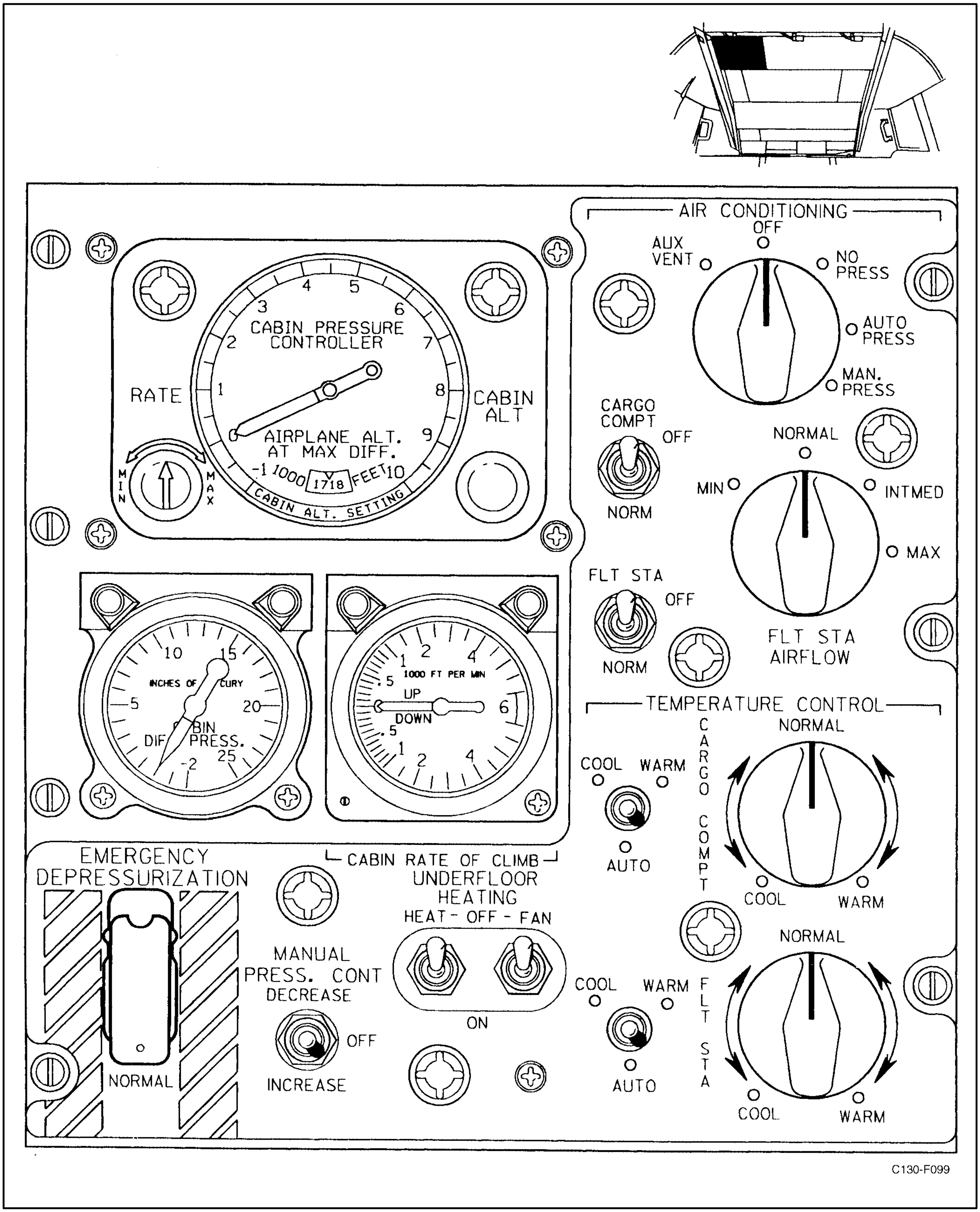


Figure 2-65. Air-Conditioning and Pressurization Control Panel

shutoff valves when the AIR CONDITIONING master switch is in OFF or AUX VENT. They also shut off airflow when the EMERGENCY DEPRESSURIZATION switch is placed to EMERGENCY DEPRESSURIZATION. Switches are installed to protect the refrigeration unit during adverse operating conditions; the flight station and cargo compartment refrigeration unit airflow regulators will shut off automatically if excessive pressure occurs in the water separator, caused by icing because of failure of the low-temperature control. A change of the temperature control setting for the affected system will tend to alleviate the above cited condition and allow reset of the affected unit. To reset the unit, change to a warmer temperature setting, wait 3 minutes or longer, place the AIR CONDITIONING master switch to OFF, and back to the original position. After the air-conditioning unit operation stabilizes, select temperature as desired. Electrical power for control of the airflow regulators is supplied from the 28-volt essential dc bus through the CABIN PRESS AUX VENT circuit breaker on the copilot lower circuit breaker panel.

2.16.2 Air Temperature Control. The temperature control system for each air-conditioning system utilizes a single valve to direct hot bleed air from downstream of the airflow regulator to a point downstream of the water separator, thus bypassing the refrigeration unit. The temperature control valves are electrically operated by either automatic or manual control. During automatic operation, a desired temperature is selected and the system positions the valve intermittently until the selected temperature is sensed by a sensor. Approximately 5 minutes are required for the valve to travel from one extreme position to the other during automatic operation. A high-limit sensor prevents excessively high output air temperature during automatic operation of the temperature control valve. When the valve is controlled manually, it will travel from full cold to full hot in approximately 4 minutes, and from full hot to full cold in approximately 35 seconds. Electrical power for temperature control is supplied from the 28-volt essential dc bus through the TEMP CONTROL FLIGHT DECK and CARGO COMPT circuit breakers on the copilot lower circuit breaker panel.

2.16.3 Refrigeration. Part or all of the bleed air flowing to each air-conditioning system flows through the heat exchanger and turbine. The first stage of cooling is provided by heat transfer in the air-to-air heat exchanger. During flight, ambient air under ram pressure passes through the heat exchanger and provides the cooling medium to initially reduce the bleed-air temperature. Some of this partly cooled bleed air is routed from downstream of the heat exchanger back into the refrigeration unit through an aspirator-type nozzle. Under humid conditions, drain water from the water separator flows into the nozzle and is sprayed on the heat exchanger to obtain maximum cooling. Air that enters the turbine after being partly cooled in the heat exchanger is cooled further by expending its energy to drive the turbine, which is loaded by the cooling air fan. In loading the turbine, the fan also augments the cooling airflow through the heat exchanger. During ground operation, with no ram air provided, the fan will draw air through the heat exchanger whenever the turbine is rotating to ensure first-stage cooling of the bleed air. The cargo compartment refrigeration unit draws supplemental ambient air from the air-conditioning equipment compartment through a check valve into the cooling air plenum. The temperature of the output air depends on what portion of the total airflow is routed through the heat exchanger and turbine.

2.16.4 Water Separator. The water separator will remove from 70 to 85 percent of the moisture that condenses when air is refrigerated. Moisture remaining in the air maintains a comfortable humidity level in the compartments. The water separator contains a cone-shaped bag and a drain. The bag causes fog in the air to form into water droplets that are swirled and thrown against the shell of the separator; they then collect and run down to the drain. If the bag in the water separator becomes clogged, a pressure-sensitive relief valve at the tip of the bag opens to bypass the airflow. To prevent separator icing, a low-limit control valve, sensor, and control box maintain water separator exit temperature at 37 or ±3 °F.

Water separators do not remove all moisture from conditioned air. When CARGO COMPT and/or FLT STA temperature control selectors on the air-conditioning control panel are moved all the way over to COOL, a considerable amount of fog may enter the compartments from the diffusers (see Figure 2-65). Evaporation of fog increases the cooling effect of the air, and the moisture provides a comfortable humidity level in the compartments. Output of fog normally decreases as the selectors are moved toward WARM.

2.16.5 Cargo Compartment Underfloor Heating. The cargo compartment underfloor heating is controlled by the UNDERFLOOR HEATING heat switch on the air-conditioning and pressurization control panel (see Figure 2-65). This two-position (ON, OFF) toggle switch energizes the floor heat shutoff and the floor heat temperature control valves to the underfloor heating ducts. Placing the HEAT switch in the ON position opens the shutoff valve, and the cargo floor thermostat modulates the floor heat temperature control valve to maintain an underfloor temperature of 75 to 85 °F. The bleed air to the underfloor ducts passes through a double jet pump to ensure circulation of the warm air. An overhead duct recirculating fan operates when the underfloor heat switch is turned ON. This fan ensures proper circulation of the air entering the cargo compartment from the overhead ducts.

2.16.6 Auxiliary Ventilation. The auxiliary ventilation provision in each system consists of a valve connecting the heat exchanger cooling air inlet to the conditioned air distribution ducts. When the valve is opened, most of the air entering the cooling airscoop flows directly into the distribution ducts. In flight, the air thus admitted to the aircraft is ambient air under ram pressure. On the ground, adapters can be attached to the cooling airscoops so that air from an external air conditioner can be supplied for ventilation. Collapse of the air-conditioning low pressure ducts is prevented by a check valve and the duct arrangement. The power for the auxiliary vent valves is supplied from the main dc bus through the AIR PRESS & FLOW SHUTOFF VALVES CARGO COMPT and FLIGHT DECK circuit breakers on the copilot lower circuit breaker panel.

2.16.7 Air-Conditioning System Controls and Indicators. The main controls for the two air-conditioning systems are located on the air-conditioning and pressurization control panel (see Figure 2-64). Other air-conditioning controls in the flight station include air delivery diverter levers on the main instrument panel and windshield defogging outlet valve controls on the pilot and copilot side shelves. A CARGO COMPT REFR overheat warning light is located on the anti-icing and deicing systems control panel (see Figure 2-72).

2.16.7.1 AIR CONDITIONING Master Switch. The AIR CONDITIONING master switch, located on the air-conditioning and pressurization control panel, is a five-position (AUX VENT, OFF, NO PRESS, AUTO PRESS, MAN PRESS) rotary switch that selects the type of air-conditioning and pressurization desired. The control functions of the master switch are shown in Figure 2-66.

AIR CONDITIONING MASTER SWITCH	AUX VENT	OFF	NO PRESS	AUTO PRESS	MAN PRESS
AIR FLOW REGULATORS	Closed	Closed	Open	Open	Open
AUX VENT	Open	Closed	Closed	Closed	Closed
OUTFLOW VALVE	Open	Open	Open	Pneumatic modulation	Manually[1] modulated
SAFETY VALVE	Open	Closed	Open	Closed	Closed
TEMP CONTROLS	Power off	Power off	Power on	Power on	Power on
UNDERFLOOR HEAT	Off	Off	As selected	As selected	As selected

[1] Electric actuator energized by use of manual PRESS CONT switch.

Figure 2-66. AIR CONDITIONING Master Switch Control Functions

2.16.7.2 Flight Station and Cargo Compartment Temperature Controls. The flight station and cargo compartment temperature controls consist of two, four-position toggle switches and two rheostats on the air-conditioning and pressurization control panel (see Figure 2-65). One switch and one rheostat are used to control temperature within the cargo compartment.

The toggle-type temperature control switches are used to select WARM, COOL, or AUTO for automatically controlled temperature conditions, but they function only when the AIR CONDITIONING master switch is set to a position other than OFF or AUX VENT. Each switch may be moved from the center (OFF) position upward to COOL or WARM or downward to AUTO. With the temperature control switch set to AUTO, the temperature control valve is controlled automatically to maintain the compartment temperature selected on the temperature rheostats. When the switch is moved to the COOL position, the temperature control valve moves toward the extreme cold setting; the switch must be held for approximately 35 seconds for the valve to move from the extreme hot position to the extreme cold setting. With the switch at WARM, the valve moves toward the extreme hot setting. Complete movement of the valve from the extreme cold setting to the extreme hot position takes approximately 4 minutes. The switch may be released at any time for either the WARM or COOL positions and is spring loaded to return to the center (OFF) position. The temperature control valve will remain at the setting achieved when the switch is released. The system sensor blowers are activated whenever the AIR-CONDITIONING master switch is set to a position other than OFF or AUX VENT.

The two temperature rheostats, located next to their respective temperature control switches, are used to select the temperature conditions desired within the flight station and cargo compartment during automatic temperature control. The settings of each rheostat cover a temperature range from COOL through NORMAL to WARM. Power for the temperature control system is supplied from the essential dc bus, through FLIGHT DECK and CARGO COMPT TEMP CONTROL circuit breakers on the copilot lower circuit breaker panel.

CAUTION

Do not open the TEMP CONTROL circuit breakers on the copilot lower circuit breaker panel during operation of the air-conditioning systems. Opening these circuit breakers will disable the automatic shutoff circuit and may result in damage to the air-conditioning equipment.

2.16.7.3 UNDERFLOOR HEATING FAN Switch. The UNDERFLOOR HEATING FAN switch is a two-position (ON, OFF) toggle switch located on the air-conditioning and pressurization control panel (see Figure 2-65). The switch provides control of a cargo compartment recirculating fan without operating the underfloor heating. The AIR CONDITIONING master switch must be in a position other than OFF or AUX VENT and the UNDERFLOOR HEATING switch must be in the OFF position before the fan switch will operate the recirculating fan. The recirculating fan will operate when the UNDERFLOOR HEATING switch is ON regardless of the FAN switch position. The FAN switch directs 28-volt essential dc power from the TEMP CONTROL CARGO COMPT circuit breaker on the copilot lower circuit breaker panel to the fan relay. The relay directs 115-volt, three-phase ac power from the left-hand ac bus, through the FAN CARGO COMPT circuit breaker on the pilot upper circuit breaker panel, to the underfloor heating recirculating fan.

2.16.7.4 Flight Station Airflow Switch. The FLT STA AIRFLOW switch is a four-position (MIN, NORMAL, INTMED, MAX) rotary switch that controls the flight station airflow diverter valve (see Figure 2-65). With both air-conditioning systems operating, the FLT STA AIRFLOW switch provides the following distribution from the flight station system:

1. MIN — Diverter valve full open, 70 percent to cargo compartment, 30 percent to flight station.
2. NORMAL — Diverter valve partially open, 40 percent to cargo compartment, 60 percent to flight station.

3. INTMED — Diverter valve partially open, 20 percent to cargo compartment, 80 percent to flight station.

4. MAX — Diverter valve closed, 100-percent flow to the flight station.

The flight station airflow switch may be used to provide airflow from the cargo compartment system to the flight station when the flight station is not operating. The diverter valve receives 115-volt single-phase ac electrical power from the essential ac bus through the AIRFLOW DIVERTER VALVE ESS AC circuit breaker located on the copilot upper circuit breaker panel.

2.16.7.5 BLEED AIR DIVIDER VALVE Switch. The BLEED AIR DIVIDER VALVE switch, located on the anti-icing and deicing control panel, controls a shutoff valve located in the bleed-air duct between the outlets going to the flight station and cargo compartment air-conditioning units (see Figure 2-72).

The valve is normally in the open position. Closing the valve isolates the bleed-air supply so that one air-conditioning unit can continue to operate in case of a bleed-air duct failure. Function of the switch is further described in paragraph 2.15.

2.16.7.6 Air Diverter Controls. A three-position (FEET, MIX, CHEST) air diverter lever at each side of the main instrument panel controls a valve through which the conditioned airflow may be directed, by way of a louver, toward each pilot's chest or through floor-level outlets toward each pilot's feet. A central position for the lever, marked MIX, divides the available airflow between the upper and lower outlets. At the rear of the flight station, a similar valve arrangement controlled by a foot-warmer handle on the right-hand edge of the navigator table directs the conditioned airflow through a foot-warming louver below the navigator table or through three directable louvers disposed about the aft flight station. The handle is pulled to open the foot-warming louver and admit temperature-conditioned air to the navigator station, or it is pushed in to close the louver. The three individual louvers in the rear of the flight station and similar louvers at the pilot stations may be moved manually to change the direction of the airflow.

2.16.7.7 Windshield Defogging Levers. A windshield defogging lever on either the pilot or copilot side shelf controls a valve connecting the temperature-conditioned air duct to the windshield defogging outlets on that side of the flight station. With the lever moved to ON, the valve is opened and the available airflow is directed to the windshield defogging outlets and away from the flight station air distribution louvers and outlets.

Note

If the windshield defogging lever is in an intermediate position, with the flight station airflow switch in INTMED or MAX, a loud noise may be heard in the defogging system.

2.16.7.8 Air-Conditioning Shutoff Switches. Two shutoff switches on the air-conditioning and pressurization control panel override the AIR CONDITIONING master switch and enable either air-conditioning system to be shut down individually (see Figure 2-65). Each switch may be set to either OFF or NORM. If the FLT STA switch is set to OFF, the airflow regulator for the flight station air-conditioning system stops the flow of bleed air regardless of the setting of the AIR CONDITIONING master switch. Similarly, if the CARGO COMPT switch is placed to OFF, the airflow regulator closes off the supply of bleed air to the cargo compartment air-conditioning system. With either switch set to NORM, the associated airflow regulator maintains the normal flow of air to the air-conditioning system.

2.16.7.9 Cargo Compartment Refrigerator Overheat Warning Light. A red press-to-test CARGO COMPT REFR OVERHEAT light located on the anti-icing and deicing control panel is provided to warn the pilot of an overheat condition in the cargo compartment refrigerator area (see Figure 2-72). Two overheat detectors are located in the refrigerator area of the wheelwell. When an overheat condition of 200 °F exists, the warning light will illuminate and the overheat condition must be corrected to extinguish the light. Electrical power for the light is supplied from 28-volt essential dc bus through the WING AND EMPENNAGE OVERHEAT lights circuit breaker on the copilot lower circuit breaker panel.

2.16.7.10 EMERGENCY DEPRESSURIZATION Switch. The EMERGENCY DEPRESSURIZATION switch is a guarded, two-position (NORMAL, EMERGENCY DEPRESSURIZATION) toggle switch on the air-conditioning and pressurization control panel (see Figure 2-65). When the switch is moved from NORMAL to EMERGENCY DEPRESSURIZATION, an electrical circuit closes both air-conditioning system flow regulators and opens the outflow and safety valves of the pressurization system. The cargo underfloor heat shutoff valve is also closed. The switch receives 28-Vdc power from the battery bus through the EMER DEPRESS circuit breaker on the pilot side circuit breaker panel.

2.17 PRESSURIZATION SYSTEM

Pressurization of the flight deck and cargo compartment for high-altitude flight is achieved by air supplied from the bleed-air system and ducted through the air-conditioning system (see Figures 2-67 and 2-68). The cargo compartment distribution system incorporates a check valve to prevent rapid loss of cabin pressure in case of failure in the recirculating duct system. The outflow valve, which opens to relieve excess pressure, is used with the pressure controller to maintain cabin pressure automatically at a constant level or to limit the cabin-to-atmosphere differential pressure. The safety valve gives excess pressure relief if the combination of the pressure controller and outflow valve fails to regulate the cabin pressure properly.

2.17.1 Outflow Valve. The outflow valve, located on the right aft side of the flight station (see Figures 2-67 and 2-68) exhausts cabin air to the atmosphere through a louver in the skin. The valve consists of a butterfly valve, a main actuating diaphragm, a relay valve, an air jet pump, and an electric actuator. During automatic pressurization, the butterfly valve is pneumatically positioned by differential pressure across the main actuating diaphragm. The relay valve and air jet pump control the differential pressure in accordance with the cabin altitude selected on the pressure controller. The actuator opens the butterfly valve for depressurization and for any nonpressure operation. Electrical power to energize dump operation is supplied by the battery bus, through the EMER DEPRESS circuit breaker on the pilot side circuit breaker panel. The electric actuator is controlled by a switch to position the butterfly valve during manual operation of the system. Electrical power for manual operation of the outflow valve is supplied from the essential dc bus through the CABIN PRESS AUX VENT circuit breaker on the copilot lower circuit breaker panel.

2.17.2 Cabin Pressure Controller. The cabin pressure controller, on the air-conditioning and pressurization control panel (see Figure 2-65), is divided into three chambers, each providing a separate cabin pressure control system: a constant pressure or isobaric control, a differential control system, and a rate-of-climb control.

The isobaric control system positions the outflow valve to maintain a constant cabin pressure. Any desired cabin altitude from –1,000 feet to 10,000 feet can be selected on the controller, and during automatic pressurization the cabin altitude will be held constant upon reaching the selected cabin altitude. The cabin pressurization chart (see Figure 2-68) should be used to determine the maximum permissible aircraft altitude for any selected cabin altitude setting or to determine the differential pressure expected at any aircraft altitude for any selected cabin altitude setting. The differential control system positions the outflow valve to vary the cabin pressure altitude when the maximum differential pressure is reached. The cabin altitude then will change in order to maintain a constant differential pressure. This system protects the aircraft structure from excessive pressures by overriding the isobaric control system. The rate control system positions the outflow valve to maintain a constant rate of cabin pressure change up to the isobaric altitude selected. During automatic pressurization, the cabin pressure will change at the selected rate until the cabin pressure altitude reaches the isobaric altitude selected on the controller.

2.17.3 Safety Valve. The safety valve is located on the cargo door. It is electrically controlled and pneumatically opened in a nonpressure condition or for emergency depressurization. The valve is normally closed during any pressurized operation. It will open to relieve cabin pressure if the positive differential pressure reaches 15.9 inches Hg or if the negative differential pressure reaches 0.76 inches Hg. When aux vent or nonpressure operation is selected, the valve is opened. Electrical power to energize the safety valve solenoid is supplied from the battery bus through the EMER DEPRESS circuit breaker on the pilot side circuit breaker panel.

2.17.4 Pressurization System Controls and Indicators. Controls and indicators for the cabin pressurization system are located on the air-conditioning and pressurization control panel (see Figure 2-65).

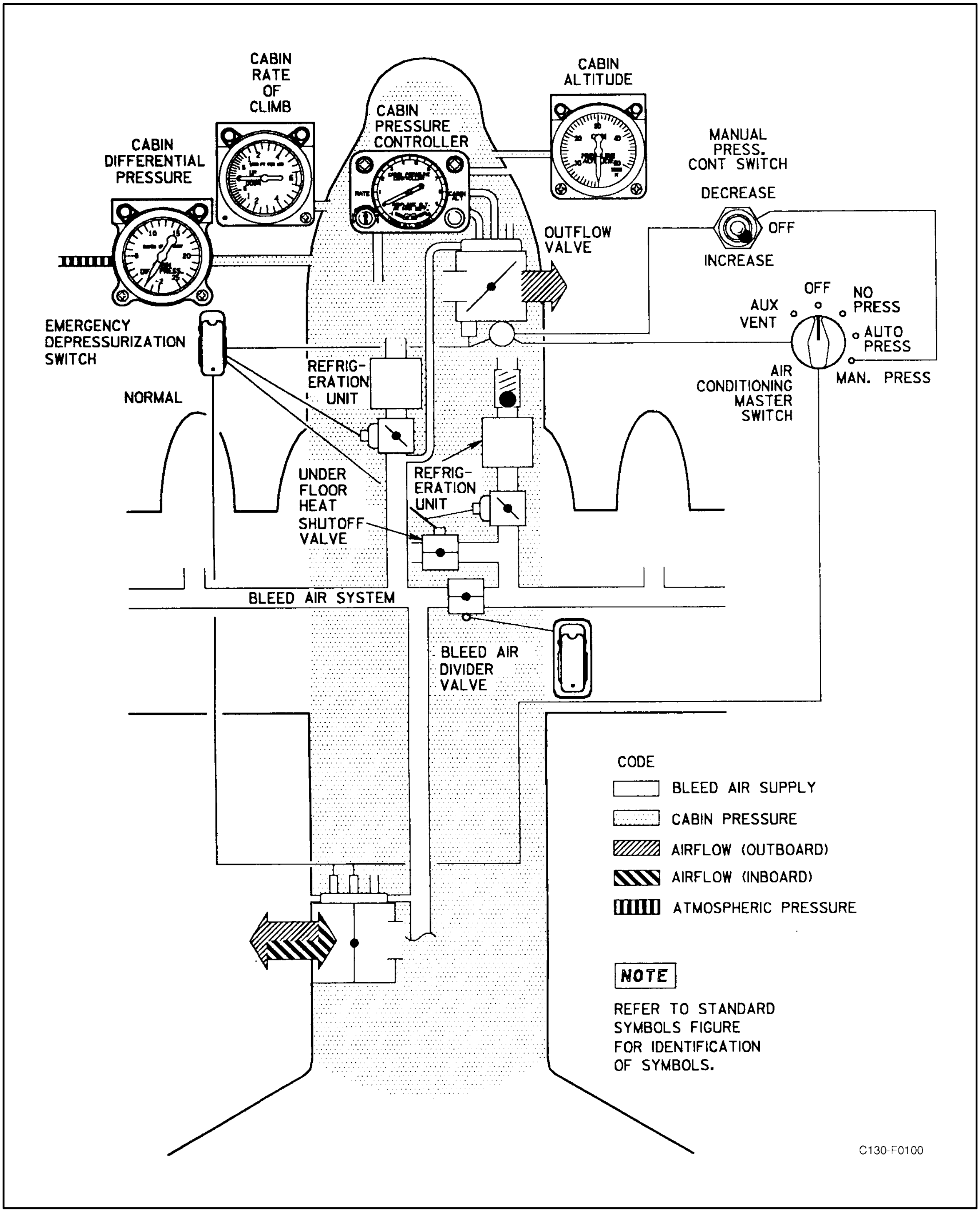


Figure 2-67. Pressurization System

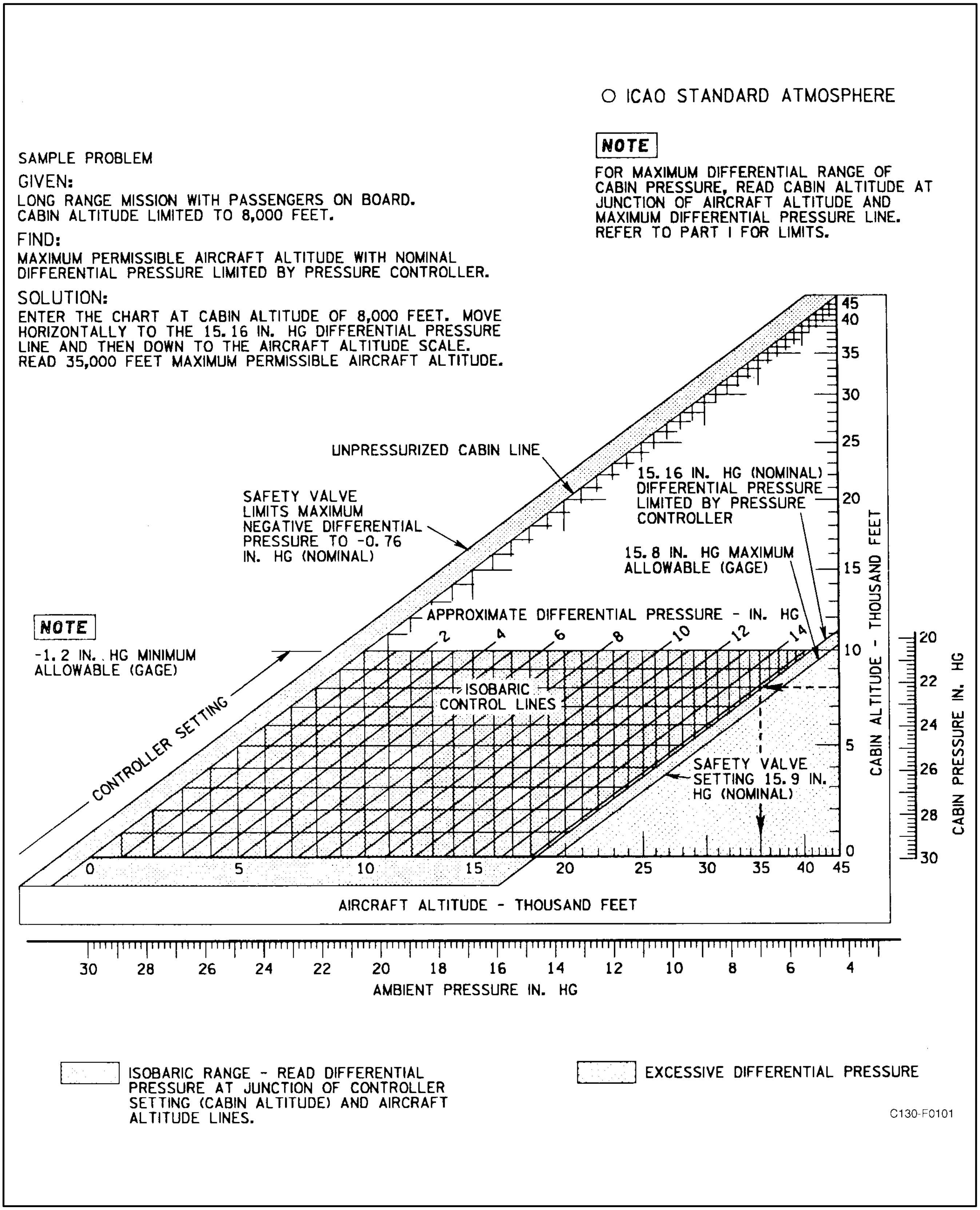


Figure 2-68. Cabin Pressurization Chart

2.17.4.1 Master Switch. The AIR CONDITIONING master switch on the air-conditioning and pressurization control panel (see Figure 2-65) is used to select the type of operation for the air-conditioning and pressurization systems. It controls operation of the outflow valve under conditions of pressurized and nonpressurized operation. For functions of the switch positions, see Figure 2-66. Electrical power for control circuits of the outflow and safety valves is supplied from the essential dc bus through the CABIN PRESS AUX VENT circuit breaker on the copilot lower circuit breaker panel.

2.17.4.2 Cabin Pressure Controller. The cabin pressure controller, on the air-conditioning and pressurization control panel (see Figure 2-65), includes the cabin DIFF PRESS indicators, cabin rate-of-climb indicator, a CABIN ALT selector knob, a RATE selector knob, and a CABIN ALT setting indicator. The CABIN ALT selector knob and pointer are used to preset the required cabin altitude. For the chosen altitude, shown by the pointer on the indicator and selected by turning the knob, a window on the indicator dial face indicates the maximum aircraft altitude that can be reached before cabin differential pressurization begins.

CAUTION

Do not force the CABIN ALT knob below a setting of –1,000 feet or above 10,000 feet. To do so may damage the pressure controller.

The RATE selector knob is used to determine the rate of cabin pressure change until the cabin altitude, as shown by the pointer, is reached. The knob is turned from MIN (30 to 200 feet per minute) clockwise to MAX (1,600 to 2,900 feet per minute).

2.17.4.3 MANUAL PRESS CONT Switch. The MANUAL PRESS CONT switch is a three-position (INCREASE, OFF, DECREASE) toggle switch located on the air-conditioning and pressurization control panel (see Figure 2-65). It has a center spring-loaded OFF position and momentary INCREASE and DECREASE positions. The switch controls the electric actuator of the outflow valve when the AIR CONDITIONING master switch is in the MAN PRESS position. When the switch is held in the INCREASE position, the actuator turns the outflow butterfly valve toward its closed position. When the switch is held in the DECREASE position, the actuator turns the butterfly valve toward its open position. When operating the system manually, the cabin vertical velocity indicator will give the first indication of pressurization. Electrical power for manual pressure control is supplied from the essential dc bus through the CABIN PRESS AUX VENT circuit breaker on the copilot lower circuit breaker panel.

2.17.4.4 EMERGENCY DEPRESSURIZATION Switch. The EMERGENCY DEPRESSURIZATION switch is a two-position (NORMAL, EMERGENCY DEPRESSURIZATION) guarded toggle switch (see Figure 2-65). When the switch is positioned to EMERGENCY DEPRESSURIZATION, battery power from the battery bus (through the EMER DEPRESS circuit breaker on the pilot side circuit breaker panel) is used to override the normal control circuit to open the outflow and safety valves, to close both air-conditioning shutoff valves, and to close the cargo underfloor heat shutoff valve.

2.17.4.5 Emergency Depressurization Handle. An emergency depressurization door, located in the center escape hatch, is released by pulling the EMER DEPRESSURE handle (see Figure 2-69) on the overhead control panel directly above the pilot. The handle is connected by a cable to the release mechanism of the door, which is restrained from consequential loss by two shock cords. After depressurization is accomplished, the door can be closed and the release mechanism reset manually.

2.17.4.6 Pressurization Test Valves. An isobaric and an atmospheric test valve, labeled NO. 1 and NO. 2 respectively, are located on the left side of the overhead control panel. These valves, wired in the open position, are intended only for ground use.

2.17.4.7 Differential Pressure Gauge. The differential pressure gauge, located on the air-conditioning and pressurization control panel (see Figure 2-65), senses both cabin and atmospheric pressures and indicates the pressure differential in inches of mercury.

2.17.4.8 Indicator. The cabin rate-of-climb indicator, which shows the rate of change of cabin altitude in feet per minute, is mounted on the air-conditioning and pressurization control panel (see Figure 2-65).

2.17.4.9 Cabin Altimeter. The cabin altimeter (see Figure 2-70) in the copilot instrument panel indicates cabin air pressure altitude within the range of 0 to 50,000 feet.

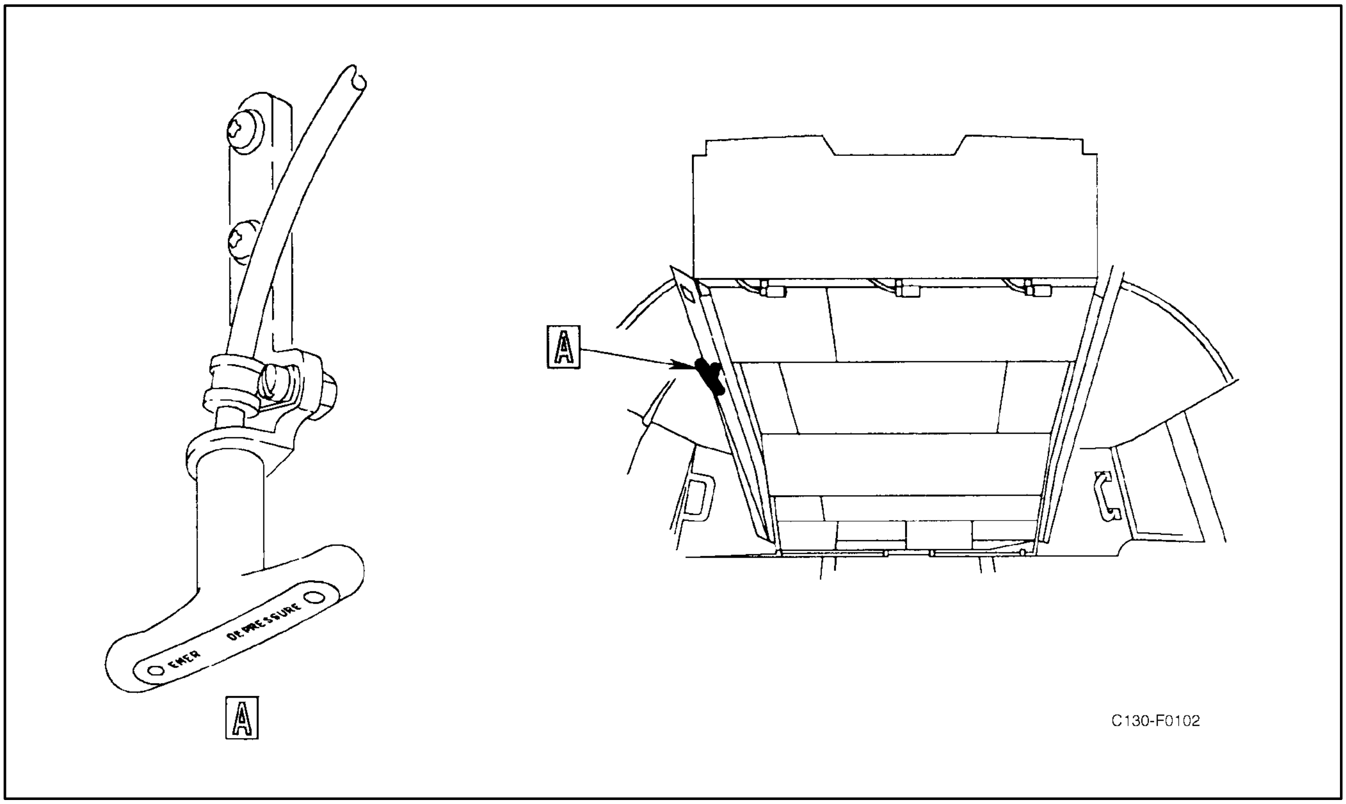


Figure 2-69. Emergency Depressurization Handle

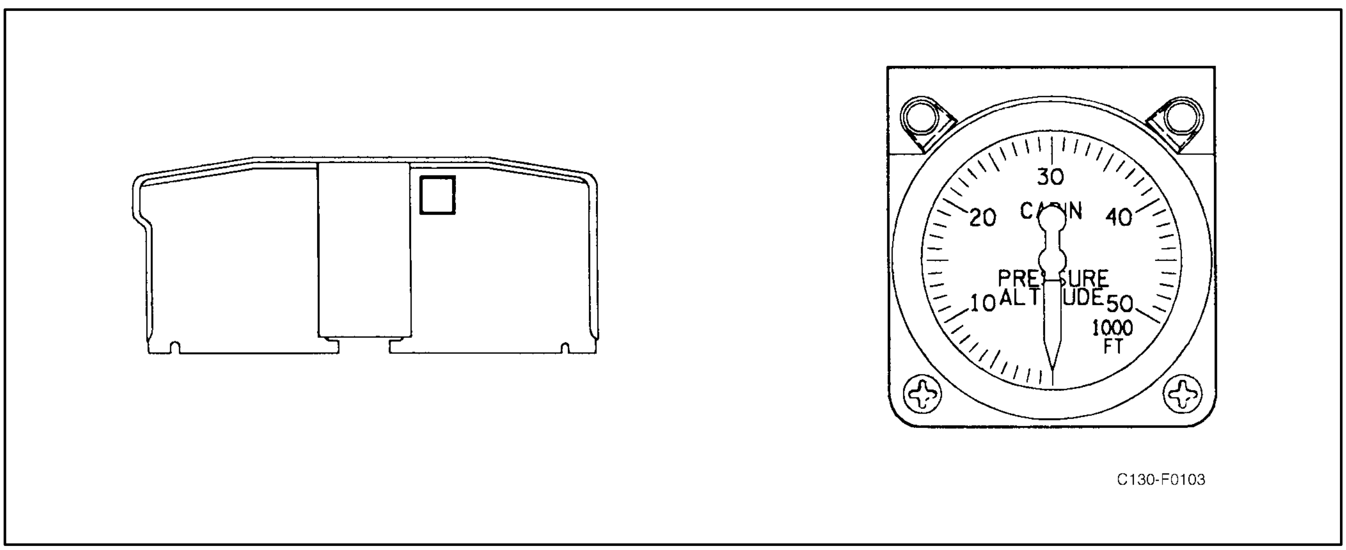


Figure 2-70. Cabin Altimeter

2.18 ANTI-ICING AND DEICING SYSTEMS

Anti-icing systems, which can be used to prevent the formation of ice on critical areas of the aircraft, and de-icing systems, which will remove ice after it is formed, are installed on the aircraft. Heat for the systems is obtained either by the use of electrical heating elements or by heated air drawn from the compressor of each engine.

Anti-icing systems using heated air from the bleed-air system serve the wing and empennage leading edges, the nose radome, and the engine inlet air and oil cooler scoops. Anti-icing of the engine compressor inlet vanes also is accomplished by heated air, but this is supplied directly from the engine compressor and not through the bleed-air system.

Anti-icing systems using heat from electrical sources are installed for the windshield, pitot tubes, and the forward section and afterbody of the propeller spinner. De-icing of the propeller blades and rear section of the propeller spinner also is accomplished electrically. An ice detection system may be used to achieve automatic operation of the following anti-icing and deicing systems:

1. Engine inlet airscoop anti-icing
2. Compressor inlet vane anti-icing
3. Propeller spinner forward section and afterbody anti-icing
4. Propeller blade deicing
5. Propeller spinner middle and rear section deicing
6. Propeller spinner plateaus deicing.

2.18.1 Wing and Empennage Leading Edge Anti-Icing System. The leading edge anti-icing system (see Figure 2-71) is divided into six sections, each consisting of a shutoff valve, ejectors, and control components. The shutoff valves control the flow of air from the bleed-air system to the ejectors, where it is ejected through small nozzles into mixing chambers. The hot bleed air at approximately 600 °F is mixed with the ambient air drawn into the mixing chambers. The resultant mixed air at approximately 350 °F flows through passages next to the leading edge skin. Since some of the air leaving the passages is drawn back in for recirculation, a lower percentage of bleed air is required for continuous anti-icing. An overheat warning system is installed in the leading edge area.

When the temperature in the leading edge area reaches approximately 200 °F, the overheat warning light for that area is energized and the light illuminates.

2.18.1.1 WING and EMPENNAGE ANTI-ICING Switches. The WING and EMPENNAGE ANTI-ICING switches are two-position (ON, OFF) toggle switches, located on the anti-icing and deicing system control panel (see Figure 2-72). When the switches are placed in the ON position, solenoids on the anti-icing shutoff valves are energized and the valves control the flow of bleed air to the leading edge air ejectors. When the switches are in the OFF position, the anti-icing regulators shut off the flow of bleed air. Electrical power for control of the wing and empennage anti-icing shutoff valves is supplied from the essential dc bus, through the WING and EMPENNAGE ICE CONTROL circuit breakers on the copilot lower circuit breaker panel.

2.18.1.2 Leading Edge Temperature Indicators. Six leading edge temperature indicators, one for each section of the anti-icing system, are located on the anti-icing and deicing system control panel (see Figure 2-72). Each indicator is connected to a resistance bulb located in the leading edge area. The resistance bulbs are placed so that they sense the temperature of the air in the area aft of the leading edge skin, not the hot air passing next to the skin. Electrical power for the indicators is supplied from the essential dc bus, through the WING and EMPENNAGE TEMP INDICATOR circuit breaker on the copilot lower circuit breaker panel.

2.18.1.3 Leading Edge Over Temperature Warning Lights. Six OVERTEMPERATURE WARNING lights, one for each section of the leading edge anti-icing system, are located below the temperature indicators on the anti-icing and deicing system control panel (see Figure 2-72). When the temperature in the leading edge reaches approximately 200 °F, the

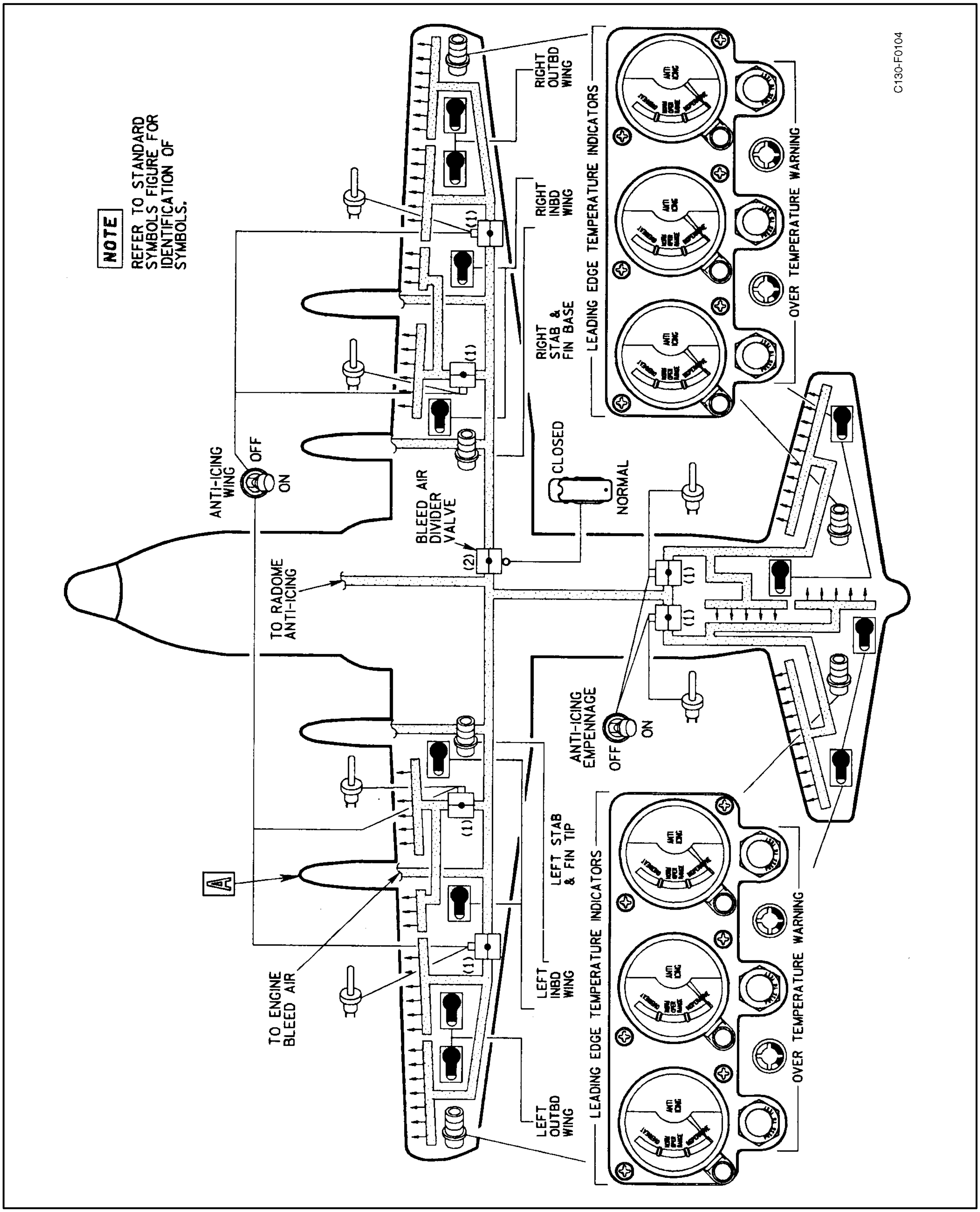
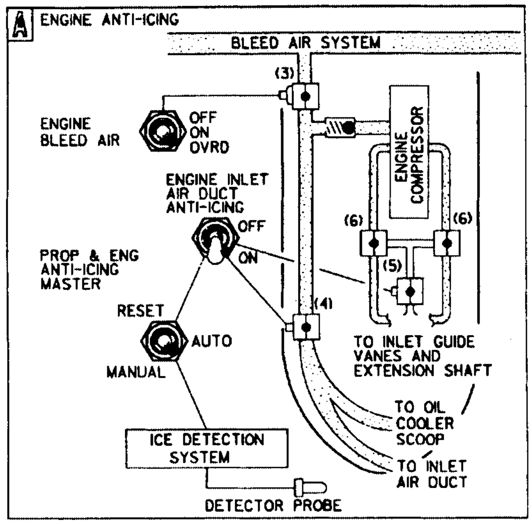


Figure 2-71. Anti-Icing System (Sheet 1 of 2)



(1) PRESSURE-ACTUATED, SOLENOID-CONTROLLED, THERMOSTATIC TEMPERATURE REGULATOR AND SHUTOFF VALVE (OPEN WHEN SOLENOID IS ENERGIZED).

(2) MOTOR-DRIVEN SHUTOFF VALVE.

(3) PRESSURE-ACTUATED, DUAL SOLENOID-CONTROLLED PRESSURE REGULATOR (OPEN WHEN SOLENOID IS ENERGIZED)(ON-REGULATES PRESSURE TO APPROXIMATELY 50 PSI, OVRD-VALVE FULLY OPEN, OFF-VALVE CLOSED).

(4) PRESSURE-ACTUATED, SOLENOID-CONTROLLED SHUTOFF VALVE (CLOSED WHEN SOLENOID IS ENERGIZED).

(5) SOLENOID-OPERATED VALVE (CLOSED WHEN ENERGIZED).

(6) PRESSURE ACTUATED, CLOSED WHEN THE SOLENOID OPERATED VALVE (5) IS ENERGIZED.

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Figure 2-71. Anti-Icing System (Sheet 2)

warning light for that area illuminates. Electrical power for the lights is supplied from the essential dc bus through the WING and EMPENNAGE OVERHEAT LIGHTS circuit breaker on the copilot lower circuit breaker panel.

2.18.1.4 Normal Operation of Leading Edge Anti-Icing System. The wing and empennage leading edge anti-icing system is turned on or off by the ANTI-ICING switches on the anti-icing and deicing system control panel. Regulation of temperatures within the leading edges is achieved automatically by thermostatic control of the valves permitting entry of bleed air to the system ejectors. The temperature indicators on the control panel, however, should be monitored while the system is operating since an emergency condition will exist if either the associated indicators or the warning lights show an overheated condition in any section.

CAUTION

The leading edge anti-icing system must not be used to remove ice from surfaces when the aircraft is on the ground. With no airflow over the surface, the air within the leading edge area quickly rises in temperature and the excessive heat damages fuel tank sealants, paint, structure, and other equipment. If the system is operated for testing, constant monitoring of the temperature indicators must be maintained and the system must not remain on for more than 30 seconds.

2.18.2 Radome Anti-Icing System. Deactivated.

2.18.3 Engine Inlet Air Duct Anti-Icing Systems. Two systems (see Figure 2-71) are provided for engine inlet air duct anti-icing. One system

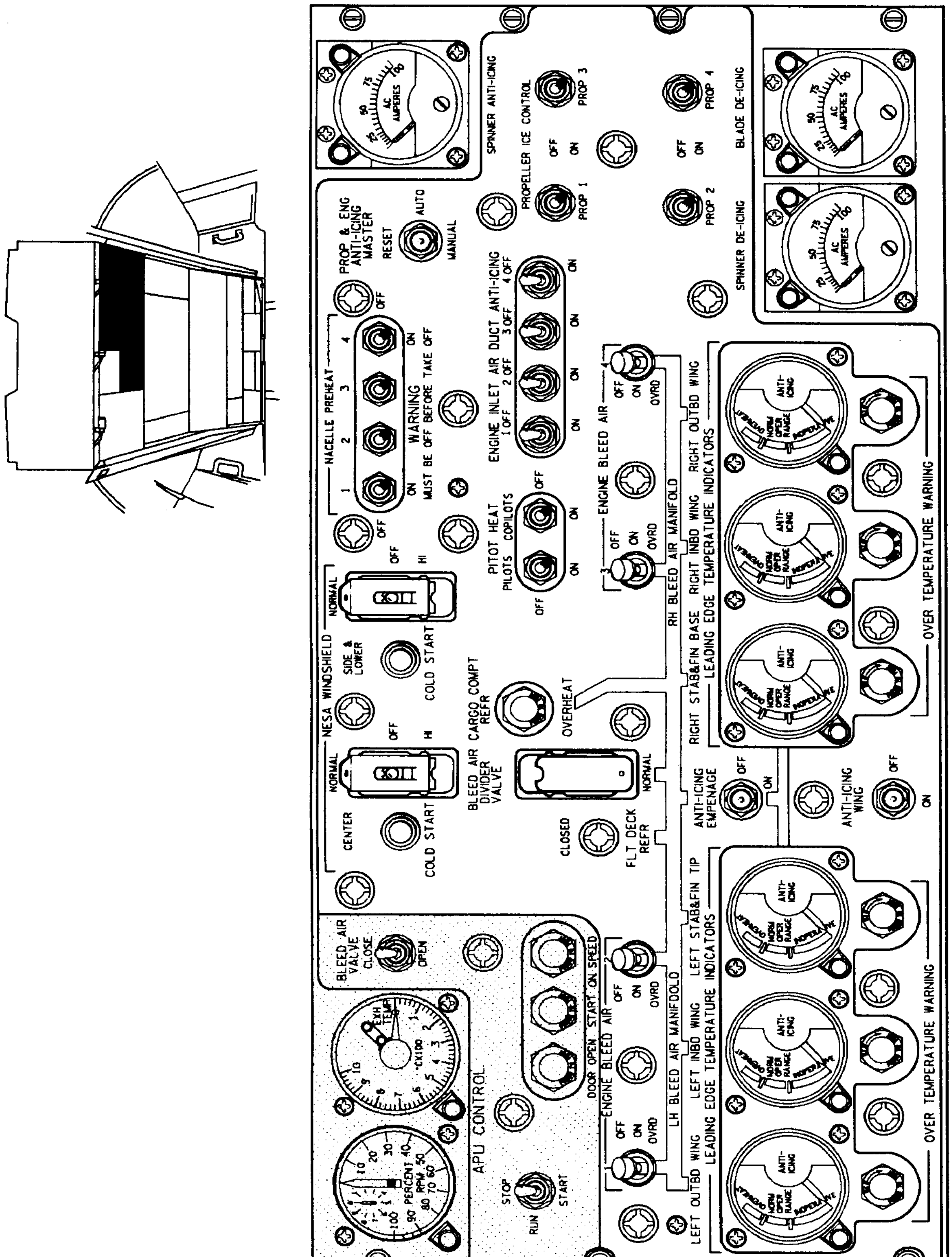


Figure 2-72. Anti-Icing and Deicing Systems Control Panels

routes bleed air from the bleed-air system to passages in the engine inlet airscoop and oil cooler scoop to heat the scoops.

The other system routes air from the compressor diffuser section of the engine to passages in the compressor inlet vanes. The scoop anti-icing airflow is shut off by a solenoid valve that is energized closed. The air flows when the valve is deenergized open. The vane anti-icing airflow is controlled by two pressure-actuated valves, which are controlled by a single solenoid valve. When the solenoid valve is energized, the pressure-actuated valves shut off the airflow, and, when the solenoid valve is deenergized, the pressure-actuated valves open. Both the scoop and vane anti-icing systems are termed fail-safe, meaning that anti-icing is provided when the system power supply is lost. The electrical control circuits are interconnected with the ice detection system so that the duct anti-icing can be turned on automatically when the detection system senses icing.

2.18.3.1 ENGINE INLET AIR DUCT ANTI-ICING Switches. Four ENGINE INLET AIR DUCT ANTI-ICING switches are located on the anti-icing and deicing systems control panel (see Figure 2-72). Each switch has ON and OFF positions. If a switch is in the ON position, the scoop and vane anti-icing systems for that engine are turned on if the PROP & ENG ANTI-ICING MASTER switch is in MANUAL. If the master switch is in the AUTO position, anti-icing is turned on when the ice detection system detects ice. When an ENGINE INLET AIR DUCT ANTI-ICING switch is in the OFF position, both scoop and vane anti-icing valves for that engine close to shut off the anti-icing airflow.

2.18.4 Propeller Anti-Icing and Deicing Systems. The propeller spinner and blades are equipped with heating elements for anti-icing and deicing (see Figure 2-73).

2.18.4.1 Propeller Anti-Icing System. The forward section of the spinner and the propeller afterbody are covered by electrical-resistance heating elements to provide anti-icing. Phase A primary ac power is applied to the heating elements to warm the surface of the spinner and prevent the formation of ice. The ac power is applied by relays controlled by dc control circuits that are protected by the SPINNER ANTI-ICING circuit breakers on the pilot upper circuit breaker panel. The control circuits are interconnected with the ice detection system so that the propeller anti-icing can be turned on automatically when the detection system senses icing. The propeller anti-icing is a continuous-heating-type system.

2.18.4.2 Propeller Deicing System. The aft portion of the front spinner section, the rear rotating spinner section, the spinner plateaus, and the leading edges and fairing of the propeller blades contain heating elements for deicing the surfaces. The aft portion of the front spinner section, along with the forward part of the rear rotating spinner section and the spinner plateaus, use phase B primary ac power and are protected by the SPINNER DE-ICING circuit breaker on the upper main ac distribution panel. The aft portion of the rear rotating spinner section and the leading edges and fairing of the propeller blades use phase C primary ac power and are protected by the BLADE DE-ICING circuit breaker on the upper main ac distribution panel. The heating elements are supplied with 115-Vac power from the RH ac bus through the BLADE and SPINNER DE-ICING circuit breakers on the upper main ac distribution panel. The control circuits for the propeller deicing, like the control circuits for the propeller anti-icing system, are connected to the ice detection system so that they may be turned on automatically. The application of spinner and blade deicing power to the heating elements is controlled by the deicing timer. The timer receives 28-Vdc power from the essential dc bus through the PROPELLER DE-ICING TIMER circuit breaker on the copilot lower circuit breaker panel. The timer applies power to the heating elements of only one propeller at a time; the elements of each propeller are energized 15 seconds during each 1-minute cycle.

2.18.4.3 PROPELLER ICE CONTROL Switches. Four PROPELLER ICE CONTROL switches are located on the anti-icing and deicing systems control panel (see Figure 2-72). These two-position (ON, OFF) toggle switches control the propeller anti-icing and deicing systems. When a switch is placed in the ON position and the PROP & ENG ANTI-ICING MASTER switch is in the MANUAL position, the anti-icing and deicing systems for the corresponding propeller are energized. If a switch is positioned to ON while the PROP & ENGINE ANTI-ICING MASTER switch is in the AUTO position, the anti-icing and deicing systems are energized only when the ice detection system detects icing. When a switch is placed in the OFF position, the anti-icing and de-icing systems for the corresponding propeller are deenergized.

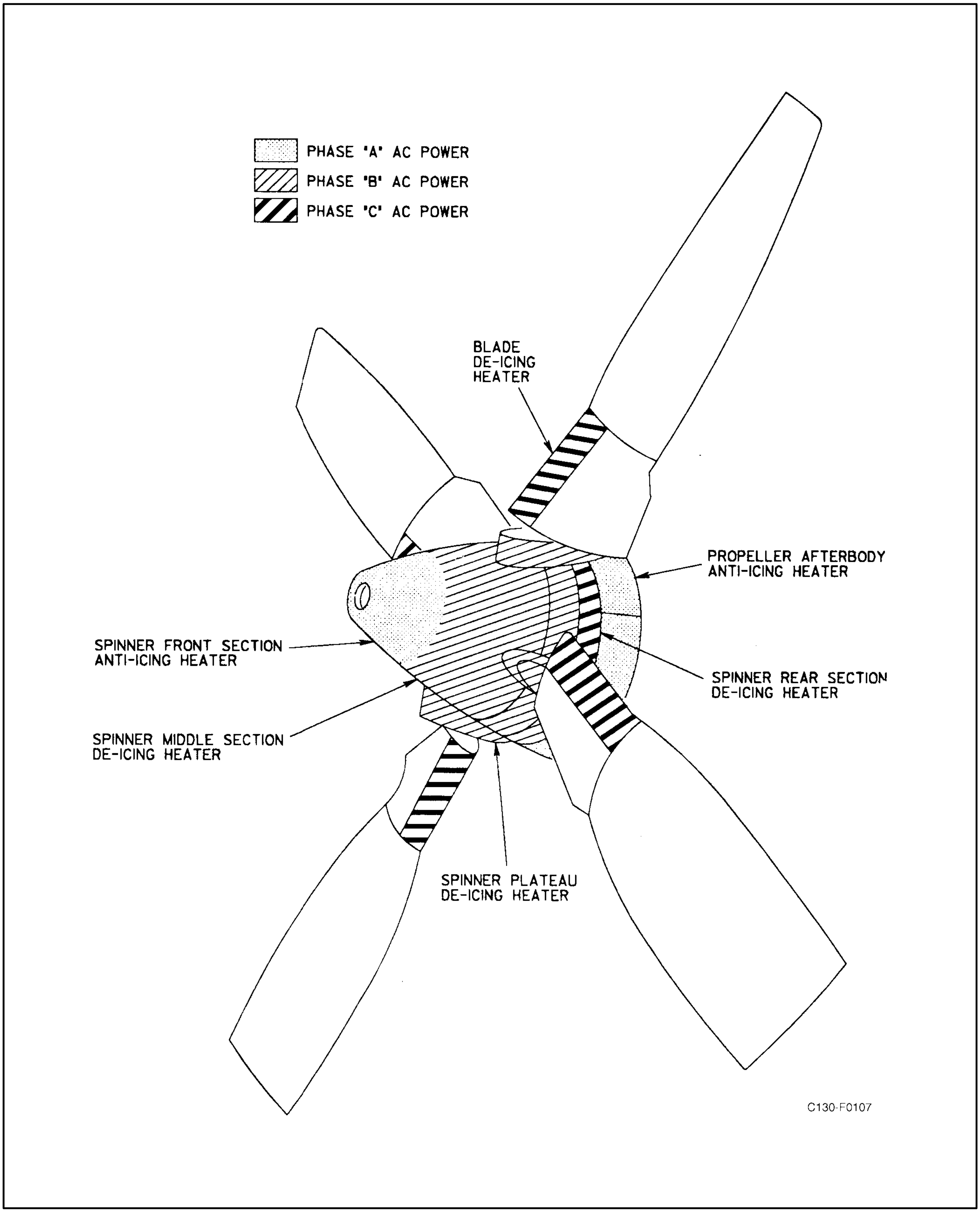


Figure 2-73. Propeller Anti-Icing and Deicing System

2.18.4.4 Anti-Icing and Deicing Ammeters. Three ammeters located on the anti-icing and deicing systems control panel (see Figure 2-72) indicate the amperage of the various phases of primary ac power drawn for the propeller anti-icing and deicing systems. The SPINNER ANTI-ICING ammeter indicates the amperage of phase A power drawn for anti-icing; the SPINNER DE-ICING ammeter indicates the amperage of phase B power drawn for deicing; and the BLADE DE-ICING ammeter indicates the amperage of phase C power drawn for deicing.

2.18.5 Ice Detection System. The ice detection system is used as an automatic control for turning on the radome anti-icing, engine inlet air duct anti-icing, and propeller anti-icing and deicing systems. The detection system consists of a PROP & ENG ANTI-ICING MASTER switch, two sets of detector units, indicator lights, a test switch, and control relays. Each set of detection units has a detector and an interpreter. Each detector includes a probe: one is mounted in the No. 2 engine inlet air duct, and the other is in the No. 3 engine duct. The detection units are armed by dc power applied through the engine starting circuits, and they are operative when the No. 2 or No. 3 engines are running and the PROP & ENG ANTI-ICING MASTER switch is in AUTO. If either probe becomes iced over while the engine in which it is installed is running, and if the PROP & ENG ANTI-ICING MASTER switch is in the AUTO position at that time, the detection units trigger a control relay. This relay turns on the anti-icing and deicing systems if the switches for those systems are in the ON or AUTO positions. The relay also turns on an indicator light. The ice detection system does not turn off the anti-icing and de-icing systems automatically when icing conditions no longer exist, but the master switch can be held at the RESET position to turn them all off simultaneously. Timers in the ice detection system operate after the No. 2 and No. 3 engines are shut down and disarm the detection system. If any of the anti-icing or deicing systems have been left in automatic operation, they are turned off upon disarming of the detection system at engine shutdown.

2.18.5.1 PROP & ENGINE ANTI-ICING MASTER Switch. The PROP & ENG ANTI-ICING MASTER switch is located on the anti-icing and deicing systems control panel (see Figure 2-72). It has three positions: AUTO, MANUAL, and RESET. When in the AUTO position, it permits control of the radome anti-icing, engine inlet air duct anti-icing, and propeller anti-icing and deicing systems by the ice detection system. The AUTO position is also used to permit testing of the ice detection system. When in the MANUAL position, the switch permits control of the anti-icing and deicing systems by the individual control switches for the systems. The RESET position is a momentary position used to turn off the anti-icing and deicing systems when icing conditions no longer exist. When the switch is positioned at RESET and allowed to return to AUTO, the ice detection system remains armed; therefore, it will automatically turn on the anti-icing and deicing systems again if it senses icing.

2.18.5.2 TEST Switch. The TEST switch is located on the ice detection panel (see Figure 2-74). It has NO. 2 and NO. 3 momentary positions and a center off position. It is used to test operation of the two sets of ice detector units by simulating ice detections. If it is held in the NO. 2 position while the No. 2 engine is running and the PROP & ENG ANTI-ICING MASTER switch is in AUTO, the ON indicator light on the ice detection panel illuminates to indicate that the ice detection system has triggered the control relay that turns on the anti-icing and deicing systems. The NO. 3 position of the switch is used in the same manner to test operation of the other set of detector units. After the TEST switch is operated to either position, the PROP & ENG ANTI-ICING MASTER switch must be held at RESET momentarily in unlock the control relay and to rearm the detection system.

2.18.5.3 ON Light and PRESS FOR LIGHT OUT Switch. The ON light and the PRESS FOR LIGHT OUT switch are located on the ice detection panel (see Figure 2-74). The indicator light is turned on by the ice detection system whenever it detects ice while the PROP & ENG ANTI-ICING MASTER switch is in the AUTO position. When lighted, it indicates that icing has been detected by probes in the engine inlet airscoops and that anti-icing systems have been turned on automatically if the individual system switches are set at ON or AUTO. It also lights when the TEST switch is operated and, then, indicates that the detection units are functioning. The momentary light out switch can be operated to turn the light off. If the PROP & ENG ANTI-ICING MASTER switch is held in the RESET position to turn off the anti-icing and deicing systems, the light remains off if icing no longer exists.

2.18.5.4 NO ICE Light. The NO ICE light is on the ice detection panel (see Figure 2-74). It is turned on when the probes of the detection system are no longer

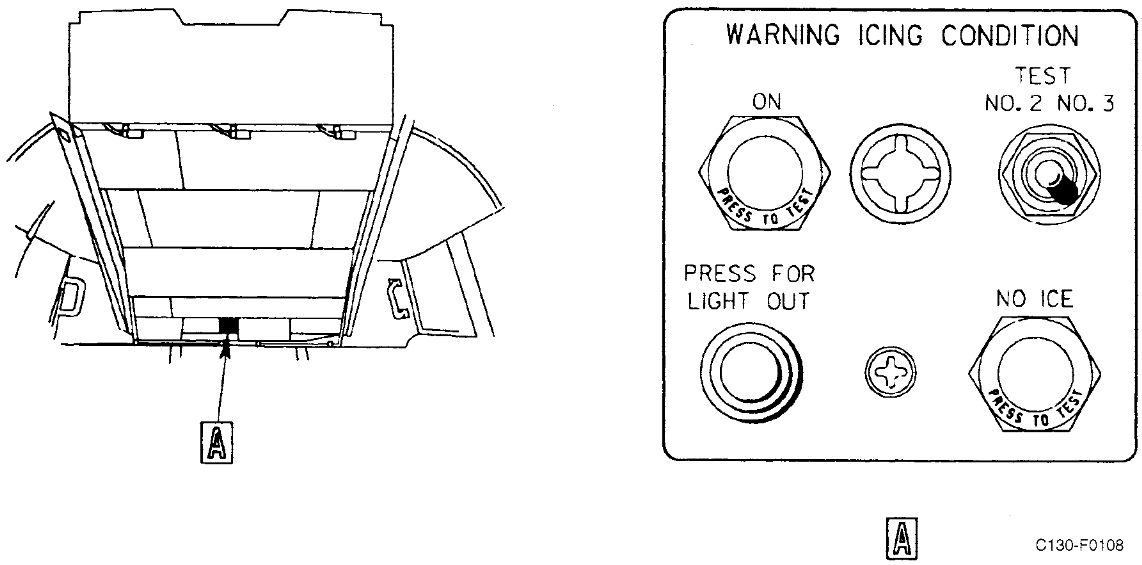


Figure 2-74. Ice Detection Panel

icing and indicates that the anti-icing and deicing systems can be turned off. If the PROP & ENG ANTI-ICING MASTER switch is held in the RESET position to turn the anti-icing and deicing systems off, the light also goes off.

2.18.6 Pitot Tube Anti-Icing System. Pitot-static tube anti-icing is provided to the four pitot-static tubes by ac electric heating elements. The heating elements are energized by 115-volt, single-phase ac power from the essential ac bus through the PITOT HEAT NO. 1, NO. 2, NO. 3 and NO. 4 circuit breakers on the pilot side circuit breaker panel. Control of the pitot-static tube anti-icing system is provided by the PITOT HEAT switches located on the overhead anti-icing control panel. Two PITOT HEAT OFF indicator lights are installed on the main instrument panel to inform the pilot of system status.

2.18.6.1 PITOT HEAT Switches. The pilot and copilot PITOT HEAT switches are located on the anti-icing and deicing systems control panel (see Figure 2-72). These two-position toggle switches have ON and OFF positions. The PITOT HEAT PILOTS switch energizes the No. 1 (upper left side) and the No. 3 (lower right side) pitot-static tube heating elements. The PITOT HEAT COPILOTS switch energizes the No. 2 (upper right side) and the No. 4 (lower left side) pitot-static tube heating elements. When a switch is placed in the ON position, the heating elements for the corresponding pitot tubes are energized and the corresponding PITOT HEAT OFF indicator light is extinguished. When the switch is in the OFF position, the corresponding heating elements are deenergized and the corresponding PITOT HEAT OFF indicator light is illuminated.

2.18.6.2 PITOT HEAT OFF Lights. Two amber PITOT HEAT OFF indicator lights are installed on the main instrument panel to show that the affected system is turned off, or, if the system is turned on to show that a heating element is inoperative (see Figures 2-77 and 2-78). The indicator lights use 28-Vdc power from the isolated dc bus through the PITOT HEATER IND circuit breaker on the pilot side circuit breaker panel.

2.18.7 Windshield Anti-Icing System. The three windshields, the two windows on each side of the windshields, and the two lower windows in front of the pilot are NESA-type. These panels are heated by applying unregulated ac power from the left-hand ac bus to a resistance material between the layers of glass. The ac power is applied by automatic dc control systems that cycle to maintain window temperature within specific limits. A center windshield system controls heating of the three center windshields, and a side and lower system controls heating of the side and lower windows. The two systems are identical except for the amount of total ac power provided. Provisions are made for selecting either a normal or high rate of heating. When a high rate is selected, higher voltage is applied for shorter periods of time so that the NESA heats more rapidly, but not to a higher temperature. Provisions are also made for controlling the temperature increase manually when the NESA panels are extremely cold. The control systems do not function automatically when window temperature is below –45 °F.

CAUTION

Operation of NESA anti-icing when outside air temperature is above 27 °C (81 °F) will increase the possibility of delamination within the NESA panels.

2.18.7.1 NESA WINDSHIELD Switches. The NESA WINDSHIELD switches are on the anti-icing and deicing systems control panel (see Figure 2-72). Each switch has NORMAL, OFF, and HI positions. When the center windshield switch is in the NORMAL position, the three center windshields are heated at the normal rate. If the switch is positioned to HI, the three center windshields have higher voltage applied to the heating material so that they heat more rapidly. Heating of the side and lower windows is controlled in the same manner by the side and lower windshield switch.

2.18.7.2 NESA WINDSHIELD COLD START Switches. The COLD START switches are located on the anti-icing and deicing systems control panel (see Figure 2-72) next to the NESA WINDSHIELD control switches. The COLD START switches are push-type momentary switches. The purpose of the switches is to provide manual control of windshield heating to raise the windshield temperature gradually from extremely cold temperatures to prevent damaging the glass panels. If the temperature of the windshield panels is below –45 °F, the control systems do not function automatically. Pressing the COLD START switches causes the control systems to apply ac power to the windshield panels while the switches are held.

2.18.8 Nacelle Preheat System (If Installed)

Note

The NACELLE PREHEAT system is inoperative due to the NACELLE PREHEAT valve not being installed.

When the nacelle preheat valves are installed, the nacelle preheat system allows hot air from the bleed-air system to flow into the nacelle to heat the engine and nacelle equipment before starting the engine. A solenoid valve and diffuser in each nacelle controls the airflow. The engine bleed-air regulator in a nacelle must be open before bleed air can flow to the preheat valve; the ENGINE BLEED AIR switch must be in OVRD. The preheat valves are controlled by four nacelle preheat switches on the anti-icing and deicing systems control panel (see Figure 2-72). The control circuits for the valves are energized by 28-Vdc power from the isolated dc bus through the NACELLE PREHEAT circuit breakers on the copilot lower circuit breaker panel only while the corresponding engine condition levers are in the GROUND STOP or FEATHER position and the aircraft is on the ground.

2.18.8.1 NACELLE PREHEAT Switches. The four NACELLE PREHEAT switches, located on the anti-icing and deicing systems control panel, are two-position (ON, OFF) toggle switches (see Figure 2-72). When a switch is placed in the ON position while the aircraft is on the ground and the corresponding engine condition lever is at GROUND STOP or FEATHER, the nacelle preheat valve (when installed) is energized open and remains open as long as the switch is in the ON position. Placing the NACELLE PREHEAT switch in the OFF position deenergizes the valve (when installed) closed.

Note

Nacelle preheat is operational only when the touchdown switch is closed, that is, when the aircraft is on the ground.

2.19 AUXILIARY POWER UNIT

The APU (see Figure 2-75), located forward in the left wheelwell, supplies air for ground operation of the air-conditioning systems, for engine starting, and provides shaft power to drive a 40-Kva ac generator.

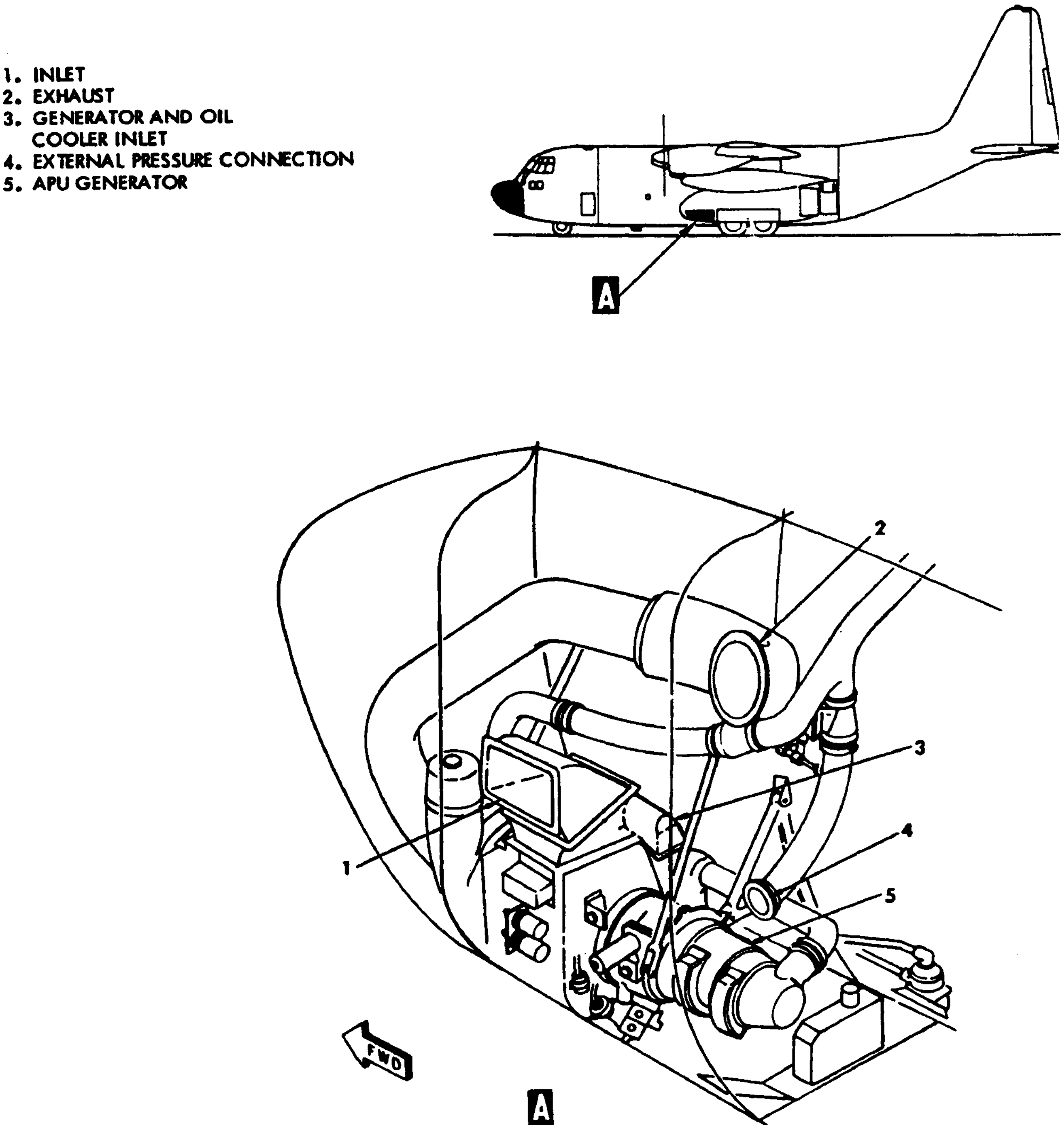


Figure 2-75. Auxiliary Power Unit

The unit is composed of a compressor assembly, power turbine assembly, and an accessory assembly. The APU ignition and electrical controls are energized by 28-Vdc power provided by the isolated dc bus through the APU CONTROL circuit breaker on the pilot side circuit breaker panel.

2.19.1 Compressor Assembly. The APU uses a two-stage, centrifugal-type compressor. When the compressor is operating at full speed, part of the compressed air is discharged into the power turbine to support combustion and the remainder is available as pneumatic power.

2.19.2 Power Turbine Assembly. The power turbine assembly drives the compressor and the APU accessories. The assembly consists of a turbine section and a combustor. Fuel is injected into the combustion chamber, mixed with air, and burned. The combustion gases are directed against the turbine wheel, which supplies rotary power to drive the compressor and accessory assemblies. After being used to turn the turbine wheel, the combustion gases pass out the exhaust.

2.19.3 Accessory Assembly. The accessory assembly of the APU consists of a starter motor, oil and fuel pumps, an oil generator cooler fan, tachometer generator, mounting pad for shaft powered accessories (APU generator), and a governor. The accessory group, with the exception of the starter motor, is powered through a reduction gear train directly coupled to the compressor drive shaft. The starter motor is coupled to the reduction gear train through a spring-loaded clutch.

2.19.4 APU Oil System. The APU oil circulation system provides lubrication for all gears and shaft bearings. Oil from a reservoir in the APU compartment is delivered by a gear-type pump through an oil filter to the various lubrication points. A relief valve in the system maintains the desired pressure. Oil is removed from the unit by a dual scavenge pump and returned to the reservoir, either through the oil cooler or, if oil temperature is below 27 °C (80 °F), through the oil cooler bypass valve. An oil drain line is connected to the accessory section to eliminate the possibility of oil accumulation after the APU is stopped. Oil used in this unit must conform to the specification and grade listed in the servicing diagram (see Figure 3-1).

2.19.5 APU Fuel System. Fuel is gravity fed from the No. 2 main fuel tank through a motor-operated shutoff valve located in the No. 2 dry bay. The valve is open when the APU CONTROL switch is in the START position and is held open when the switch is released to RUN and the START light is illuminated. The valve is closed when the switch is in the STOP position or when the APU fire emergency control handle is pulled. A fuel strainer is located in line behind the APU compartment. During the starting cycle, when the oil pressure in the APU oil system reaches approximately 4 psi, the fuel and ignition circuits are energized through a switch actuated by oil pressure.

2.19.6 APU Control System. The operation of the APU is governor-controlled to maintain a nearly constant speed of approximately 100-percent rpm under varying load conditions. The speed-sensing governor, powered by the accessory gear train, controls the unit by regulating fuel flow into the combustion chamber. An overspeed switch deenergizes the control circuit, which shuts the unit down.

2.19.7 APU Controls. All APU controls are located on the APU control panel on the overhead control panel (see Figure 2-76). The APU controls are energized by 28-Vdc power from the isolated dc bus through the APU CONTROL circuit breaker on the pilot side circuit breaker panel.

A three-position (STOP, RUN, START) toggle switch controls the operation of the APU. When the APU CONTROL switch is placed in the RUN or START position, power is supplied to open the APU inlet door. The inlet door is powered through contacts of the auxiliary touchdown relay. The door opens approximately 35° on the ground and 15° in flight.

WARNING

Ensure that the APU CONTROL circuit breaker on the pilot side circuit breaker panel is open before working around the APU air intake door. Failure to comply could result in injury to personnel because of the action of the APU door.

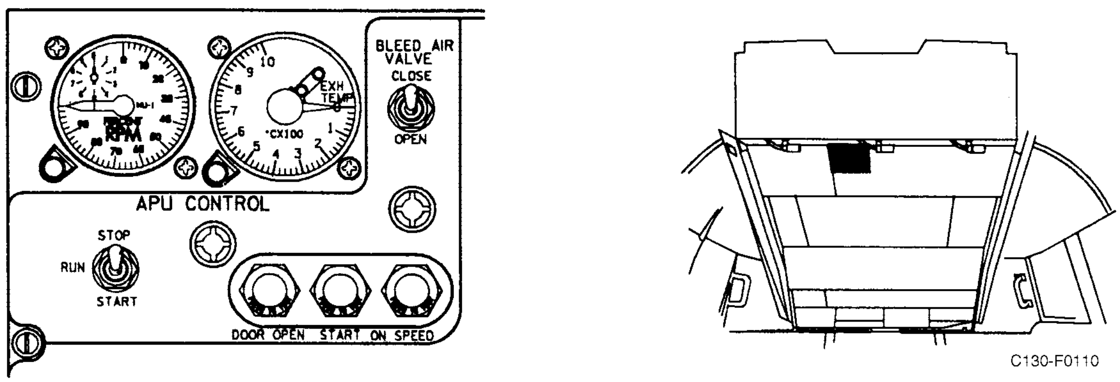


Figure 2-76. Auxiliary Power Unit Control Panel

Note

The APU door can be opened on the ground to run the APU when the door actuator has failed by removing the access panel, removing the retaining bolt on the actuator, sliding the actuator forward to open the door, and replacing the bolt to retain the door in the open position. To bypass the actuator limit switch, disconnect the actuator connector plug and attach it to the dummy receptacle adjacent to the actuator.

Holding the APU CONTROL switch in the spring-loaded START position energizes the start and holding relays, which opens the wing tank APU fuel shutoff valve and energizes the starter. The start relay remains energized until the circuit is broken by the 35-percent speed switch or by moving the APU CONTROL switch to the STOP position. When the switch is released, it moves to the RUN position. In this position, all APU circuits are energized to the various automatic controls. These oil-pressure and speed-sensitive switches control their respective circuits to accomplish starting and running of the APU. When the switch is in the STOP position, all circuits are deenergized. When the APU CONTROL switch is placed in the STOP position, the overspeed test solenoid breaks the contacts on the 110-percent speed switch and shuts down the APU. If the 110-percent speed switch is inoperative, the APU will not shut down and the fire emergency control handle must be pulled to deenergize the holding circuit and to close the APU fuel shutoff valve in the No. 2 dry bay. When the APU CONTROL switch is placed in the STOP position or the fire emergency control handle is pulled, the APU inlet door is energized to close after the APU speed has decreased to approximately 18-percent rpm. This action is provided by an oil pressure switch that actuates at approximately 20 psi and is done to prevent collapse of the inlet duct because of negative pressure when the door closes.

2.19.7.1 BLEED AIR VALVE Switch. A BLEED AIR VALVE switch is located on the APU control panel. After the compressor reaches 95-percent rpm, this two-position (OPEN, CLOSE) toggle switch controls the normally closed, solenoid-operated bleed-air valve. With the valve closed, air is supplied to the power turbine combustion chamber only. With the valve open, air is supplied to both the combustion chamber and the bleed-air manifold of the aircraft. Applying a bleed-air load to the compressor before it reaches operating speed is prevented by the 95-percent speed switch, which completes the circuit to the BLEED AIR VALVE switch only after operating speed is reached.

2.19.7.2 Fire Emergency Control Handle. The APU fire emergency control handle on the overhead control panel provides for emergency shutdown of the APU. This handle, when pulled, energizes the motor-operated fuel shutoff valve closed and energizes the APU door closed after APU speed has decreased to approximately 18-percent rpm. It also interrupts control power to the APU, causing it to shut down. The fire extinguisher system control valves are positioned, and the extinguishing AGENT DISCHARGE switch is armed.

2.19.8 APU Indicators. The indicators for the APU are located on the APU control panel, which is part of the overhead control panel.

2.19.8.1 START Light. A press-to-test START light is located on the APU control panel. This press-to-test light illuminates to indicate that the starter circuit is energized and engaged with the APU drive train. The light remains illuminated until the compressor reaches approximately 35-percent rpm, at which time a centrifugal switch deenergizes both the starter and the start light.

2.19.8.2 APU ON SPEED Light. A press-to-test, ON SPEED light, located on the APU control panel, is energized through the 95-percent speed switch and indicates that the APU has reached or is maintaining operating speed.

2.19.8.3 APU DOOR OPEN Light. An APU DOOR OPEN light is located on the APU control panel. This press-to-test light illuminates when the APU intake door is not closed.

2.19.8.4 APU Tachometer. The tachometer located on the APU control panel indicates APU speed in percent of normal APU rpm. Normal rpm (100 percent) equals 42,000 rpm. A vernier dial on each indicator makes it possible to read to the nearest percentage. The tachometer system has an APU-driven tachometer generator and is not dependent upon the aircraft electrical system for operation.

2.19.8.5 Exhaust Gas Temperature Indicator. The EGT indicator is located on the APU control panel. The indicator is graduated from 0 to 1,000 °C with 20° increments. The EGT system is a thermocouple thermometer that is not dependent upon the aircraft electrical system for operation.

2.20 INSTRUMENTS

2.20.1 Standby Attitude Indicator. A standby attitude indicator is provided on the pilot instrument panel (see Figure 2-77). The indicator (see Figure 2-79) contains an electrically driven vertical gyro that maintains vertical orientation through use of a mechanical erection system. The erection system incorporates automatic erection cutoff when subjected to fore-aft or lateral accelerations exceeding approximately 0.16g. The display of attitude information is accomplished by mechanical coupling from the vertical gyro to the display drum. A caging pitch trim knob is provided on the lower right corner of the indicator. A warning (OFF) flag appears when power is removed from the indicator. The warning flag drives out of view on application of power and appears immediately when power is removed. A switch actuated by the caging knob causes the warning flag to appear when the caging knob is pulled. The gyro wheel speed and the unique nature of the erection mechanism combine to provide a minimum of 9 minutes of attitude information after a loss of power to the indicator. The warning flag being in view during this time period does not invalidate the attitude information. Power is supplied to the standby attitude indicator from the isolated dc bus through the STANDBY ATTITUDE INDICATOR circuit breaker on the pilot side circuit breaker panel.

Caging the indicator by pulling the caging/pitch trim knob to its fully extended position orients the gyro spin axis to the position of the case. If the indicator case is misoriented during caging operation, the spin axis will not be caged to true vertical and will require time to erect to true vertical. This erection rate is a nominal 2.5° per minute. Caging of the attitude indicator after power is off during shutdown is recommended.

Note

Pulling the caging/pitch trim knob to the fully extended position, rotating clockwise, and releasing to a detent position locks the gimbals of the gyro. This position may be used during turn-on procedure to eliminate nutations of the drum. To unlock the gimbals (uncage gyro), pull the caging/pitch trim knob from the detent to fully extended, rotate counterclockwise to align the miniature aircraft with the horizon line, and slowly allow the knob to return to its in position. An increase in audible noise may be evident when operating in the caged position.

2.20.1.1 Operating Procedures

2.20.1.1.1 Startup and Checkout. To place the indicator in operation, perform the following:

1. Adjust lighting via the pilot's instrument lighting control on the pilot's side shelf.
2. Uncage the gyro by pulling the caging/pitch trim knob out, rotating counterclockwise, and gradually releasing the knob to the full "in" position. Observe that the warning flag is driven from view and the indication is completely stabilized within 3 minutes.
3. Adjust the caging knob clockwise or counterclockwise to obtain the desired pitch axis presentation.

Note

If the desired pitch trim adjustment cannot be obtained, the indicator may be installed improperly. Do not recage the indicator to correct pitch attitude misalignment.

2.20.1.1.2 In-Flight. The indicator does not normally require adjustment during flight. However, in the event errors are caused by extended steep maneuvers, the aircraft should be brought to level flight and the indicator should be momentarily caged.

Note

Cage and lock the operating attitude indicator only when the aircraft is at a complete stop. Never cage and lock the operating attitude indicator while the aircraft is in motion (i.e., flying, taxiing, towing).

2.20.1.1.3 Postflight. To power down the standby attitude indicator, perform the following:

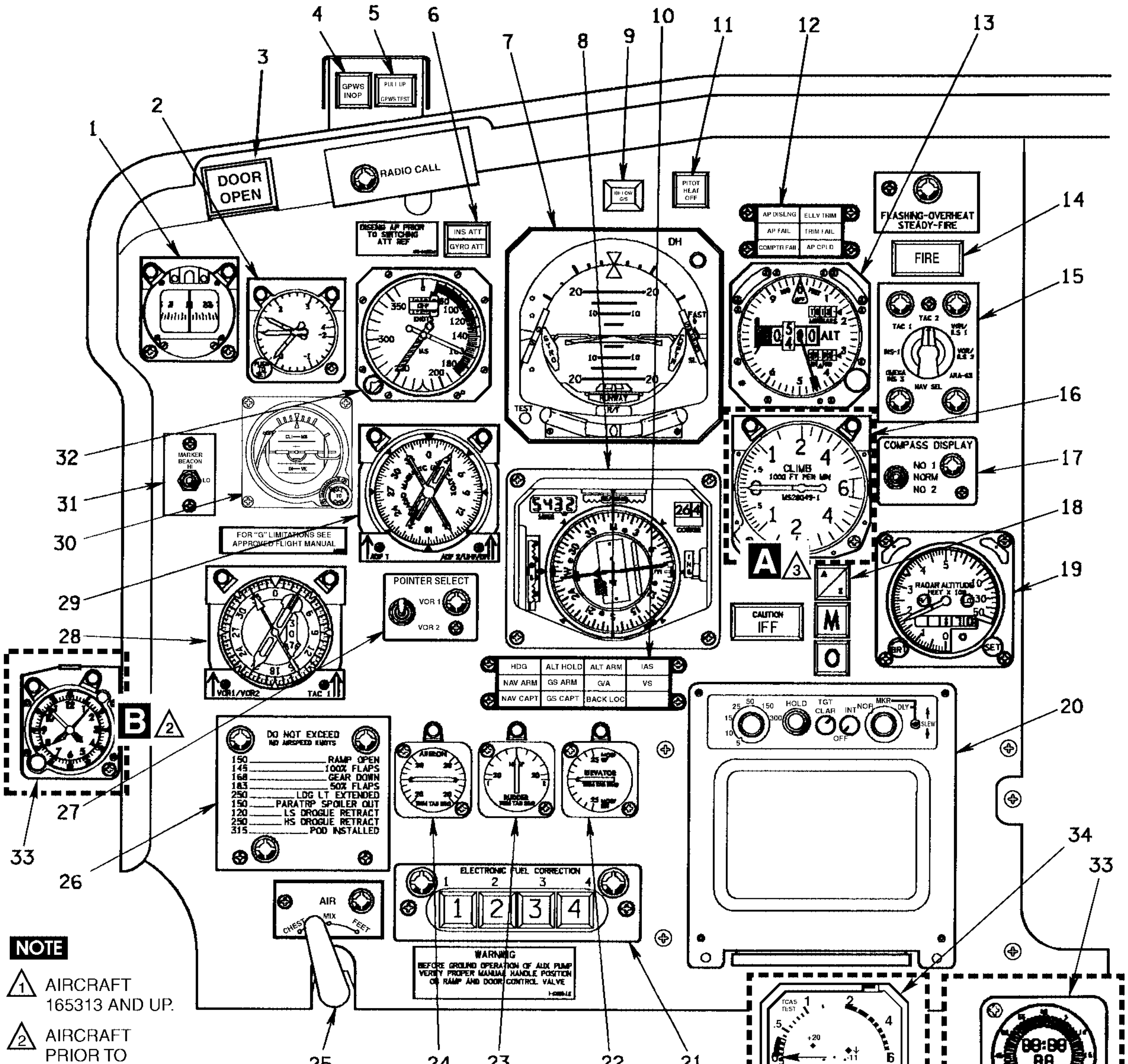
1. Cage the indicator by pulling the caging/pitch trim knob to the fully extended position, rotating clockwise, and releasing into the detent position.

2.20.2 Pitot-Static Instruments. Ram air (pitot) pressure and atmospheric (static) pressure to operate the vertical velocity, airspeed, and altimeter indicators are supplied by the pitot-static system (see Figure 2-80). Static pressure is supplied for the cabin differential pressure indicator, cabin pressure controller, cabin pressure safety valve, and the flight station air-conditioning unit airflow regulator. Each aircraft is equipped with Rosemount pitot-static probes, two on each side of the aircraft. Each probe provides one pitot pressure and two static pressure sources for a total of four systems. One system is dedicated to the pilot instruments; one is for the copilot instruments; and one is for the navigator instruments, TAS computer, airspeed sensor and cabin differential pressure gauge. The fourth system provides static pressure only to the FCS air data control units. There are three static ports on the right side of the aircraft to provide atmospheric pressure for the flight station air-conditioning and cabin pressure control systems.

2.20.2.1 Vertical Velocity Indicators (Aircraft Prior to AFC-374). The vertical velocity indicators, one mounted on the pilot instrument panel (see Figure 2-77) and the other mounted on the copilot instrument panel (see Figure 2-78), sense the rate of pressure change as the aircraft climbs or descends and indicate it as a rate of change of altitude in feet per minute.

2.20.2.2 Vertical Speed Indicator/Traffic and Resolution Advisory Display Indicators (VSI/TRA) (Aircraft Modified by AFC-374). Two VSI/TRA indicators, one mounted on the pilot's instrument panel and the other mounted on the copilot's instrument panel, display vertical speed data (current rate of climb/descent) and Traffic Alert and Collision Avoidance System (TCAS) information. As a vertical speed indicator, the VSI/TRA provides a standard display of vertical speed in feet per minute with a range of ±6,000 feet per minute. Refer to paragraph 2.21.22.2 for TCAS display and operating information. The pilot's VSI/TRA receives 28 Vdc from the isolated dc bus through the PILOT VSI/TRA circuit breaker on the copilot's upper circuit breaker panel. The copilot's VSI/TRA receives 28 Vdc from the essential dc bus through the COPILOT VSI/TRA circuit breaker on the copilot's upper circuit breaker panel.

2.20.2.3 Airspeed Indicators. The three airspeed indicators, one mounted on the pilot instrument panel (see Figure 2-77), one on the copilot instrument panel (see Figure 2-78), and a true airspeed indicator on the navigator instrument panel (see Figure 1-7), are instruments that use differential air pressure to determine airspeed. Each of the indicators is calibrated in knots. The banded pointer (maximum allowable pointer) on the pilot and copilot indicator constantly



1. MAGNETIC COMPASS
2. ACCELEROMETER
3. DOOR OPEN WARN LIGHT
4. GPWS INOP ANNUNCIATOR
5. GPWS PULL UP ANNUNCIATOR/TEST SWITCH
6. INS ATT GYRO ATT INDICATOR LIGHT PANEL
7. ATTITUDE DIRECTOR INDICATOR
8. HORIZONTAL SITUATION INDICATOR
9. GPWS BELOW GS ANN./BELOW GS WARN. INHIBIT SW
10. FCS MODE ANNUNCIATOR LIGHT PANEL
11. PITOT HEAT INDICATOR
12. FCS WARN OR ADVISORY ANN. LIGHT PANEL
13. ALTIMETER-ENCODER
14. MASTER FIRE WARN LIGHT
15. NAV SELECTOR CONTROL PANEL
16. VERTICAL VELOCITY INDICATOR
17. COMPASS DISPLAY SELECTOR PANEL
18. MARKER BEACON INDICATOR (3)
19. RADAR ALTIMETER
20. RADAR INDICATOR
21. ELECTRONIC FUEL CORRECTION PANEL
22. ELEV TAB POSITION INDICATOR
23. RUD TAB POSITION INDICATOR
24. AIL TAB POSITION INDICATOR
25. AIR DIVERTER HANDLE
26. AIRSPEED LIMITATION PLACARD
27. POINTER SELECT SWITCH PANEL
28. BDHI
29. RADIO MAGNETIC INDICATOR
30. STANDBY ATT IND.
31. MARKER BEACON SENSITIVITY SWITCH
32. AIRSPEED INDICATOR
33. CLOCK
34. VSI/TRA DISPLAY INDICATOR

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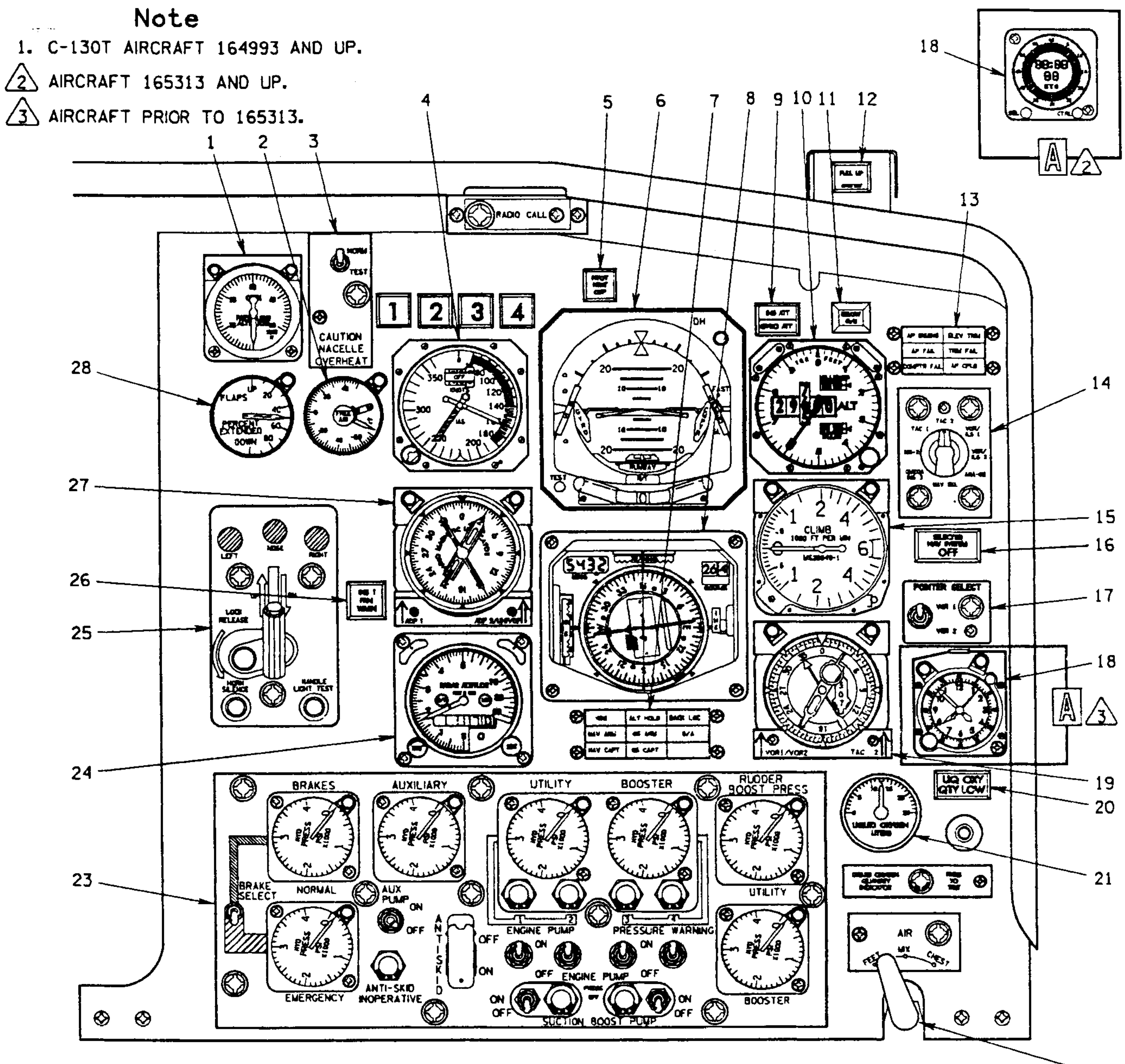
Figure 2-77. Pilot Instrument Panel

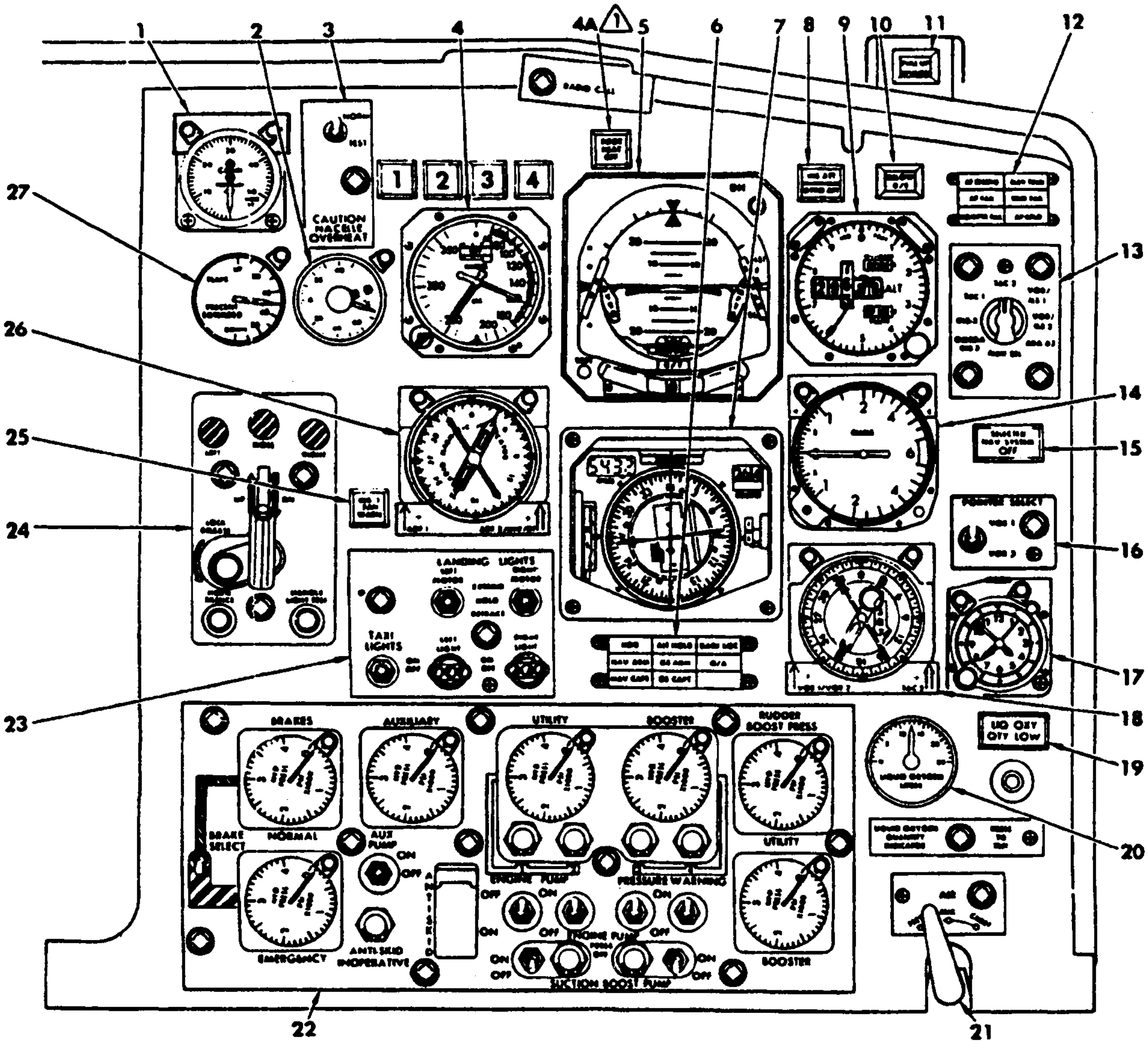


1. CABIN PRESSURE INDICATOR
2. FREE AIR TEMPERATURE INDICATOR
3. NACELLE OVERHEAT TEST PANEL
4. AIRSPEED INDICATOR
5. PITOT HEAT INDICATOR
6. ATTITUDE DIRECTOR INDICATOR
7. FCS MODE ANNUNCIATOR LIGHT PANEL
8. HORIZONTAL SITUATION INDICATOR
9. ATT SEL SW AND IND LIGHT
10. ALTIMETER
11. GPWS BELOW GS ANN./BELOW GS WARN. INHIBIT SW.
12. GPWS PULL UP ANN.
13. FCS WARN OR ADVISORY ANN. LIGHT PANEL
14. NAV SELECTOR CONTROL PANEL
15. VERTICAL VELOCITY INDICATOR
16. SEL NAV SYSTEM OFF LIGHT
17. POINTER SELECT SWITCH PANEL
18. CLOCK
19. BDHI
20. LOX LOW QTY WARN LIGHT
21. LOX QTY INDICATOR
22. AIR DIVERTER HANDLE
23. HYDRAULIC CONTROL PANEL
24. CARA INDICATOR
25. LANDING GEAR CONTROL PANEL
26. INS FAN WARN LIGHT
27. RADIO MAGNETIC INDICATOR
28. WING FLAP POSITION INDICATOR

Figure 2-78. Copilot Instrument Panel (Sheet 1 of 2)

Note

1. C-130T AIRCRAFT PRIOR TO 164993.



1. CABIN PRESSURE INDICATOR
2. FREE AIR TEMPERATURE
3. NACELLE OVERHEAT TEST PANEL
4. AIRSPEED INDICATOR
4A. PITOT HEAT INDICATOR
5. ATTITUDE DIRECTOR INDICATOR
6. FCS MODE ANNUNCIATOR LIGHT PANEL
7. HORIZONTAL SITUATION INDICATOR
8. ATT SEL SW AND IND LIGHT
9. ALTIMETER
10. GPWS BELOW GS ANN./BELOW GS WARN. INHIBIT SW.
11. GPWS PULL UP ANN.
12. FCS WARN OR ADVISORY ANN. LIGHT PANEL
13. NAV SELECTOR CONTROL PANEL
14. VERTICAL VELOCITY INDICATOR
15. SEL NAV SYSTEM OFF LIGHT
16. POINTER SELECT SWITCH PANEL
17. CLOCK
18. BDHI
19. LOX LOW QTY WARN LIGHT
20. LOX QTY INDICATOR
21. AIR DIVERTER HANDLE
22. HYDRAULIC CONTROL PANEL
23. LANDING AND TAXI LIGHTS CONTROL PANEL
24. LANDING GEAR CONTROL PANEL
25. INS FAN WARN LIGHT
26. RADIO MAGNETIC INDICATOR
27. WING FLAP POSITION INDICATOR

C130-F0112

Figure 2-78. Copilot Instrument Panel (Sheet 2)

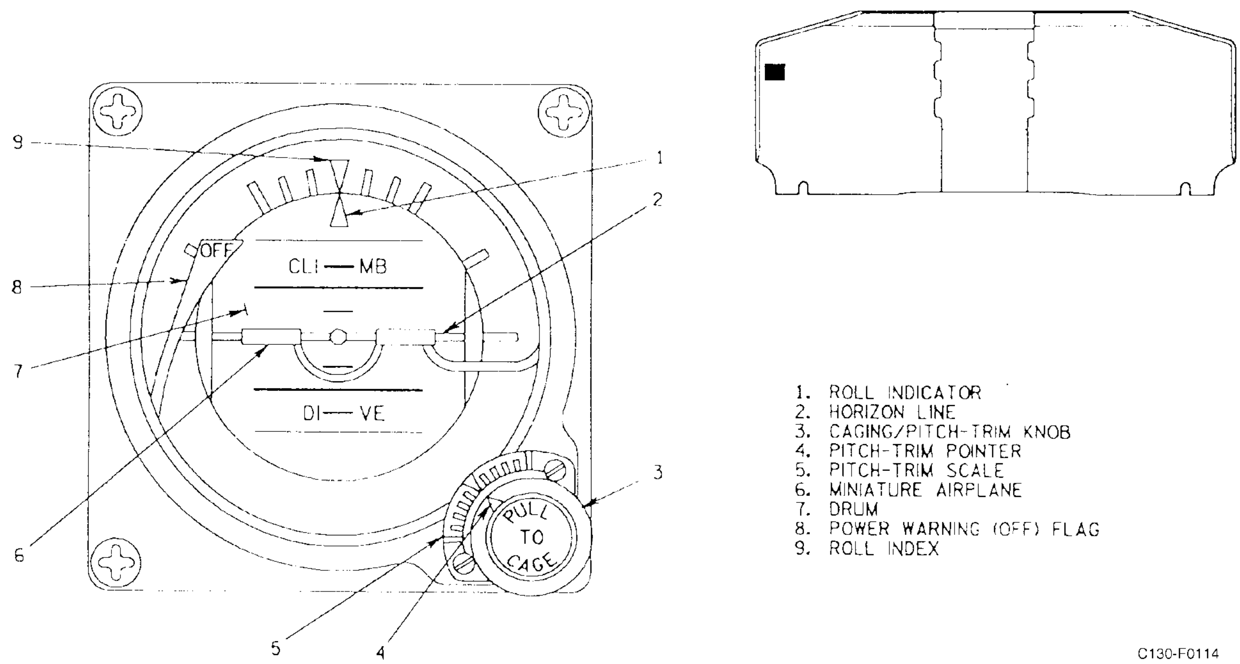


Figure 2-79. Standby Attitude Indicator

indicates the maximum recommended speed limit (V_H-1 with refueling pods off) for the respective aircraft altitude. The IAS pointer reflects the aircraft airspeed. The IAS counter repeats the IAS pointer indication as a digital readout. An OFF flag will be displayed in the IAS counter window until the aircraft speed exceeds 60 KIAS, at which time the flag will be biased out of view. An IAS push-to-test button, located on the lower right of the instrument face, is provided to test the IAS counter. Depressing and holding the pushbutton until the digital readout registers 300 indicates that the IAS counter is operational. The press-to-test button is functional on the ground or in flight and does not affect the indicator signal output when activated.

Note

A loss of ac power to the indicator will cause the IAS counter to fail and the OFF flag to appear in the counter window. The IAS pointer will continue to operate.

The indicator also incorporates a bug-type pointer that can be set with an adjustable knob on the face of the indicator. The pointer provides the pilot with a means of referencing appropriate selected airspeeds for approach, climb, etc. The pilot and copilot airspeed indicators provide signals to the respective ADI speed flag and speed deviation pointer to display the difference between actual aircraft speed and manually set speed. Signals from the pilot airspeed indicator are used by air data control No. 1 for IAS hold mode during autopilot-coupled operation. The airspeed signal circuits are powered by 26-Vac from the essential ac bus through the AIRSPEED-PILOT and COPILOT circuit breakers on the pilot upper circuit breaker panel.

2.20.2.4 Altimeters. The three altimeters, one mounted on the pilot instrument panel (see Figure 2-77), one on the copilot instrument panel (see Figure 2-78), and one on the navigator instrument panel (see Figure 1-7), are barometric-type instruments measuring variations in pressure by means of aneroid units. Each altimeter is calibrated in feet.

The pilot altimeter combines a conventional barometer altimeter and an altitude-reporting encoder in one self-contained unit. A 10,000- and 1000-foot digital counter indicator and a 100-foot drum indicator provide direct digital output and readout of altitude in increments of 100 feet, from –1,000 to 50,000 feet. The encoder digital output is referenced to 1,013 millibars and to 29.92 inches of mercury, and is not affected by changes in barometric setting. A pointer repeats the indications of the 100-foot drum and serves both as a vernier for the drum and as a quick indication of the rate and sense of altitude changes. Two methods may be used to read indicated altitude on the counter-drum-pointer altimeter:

1. Read the digital counter indicator and the 100-foot drum indicator without reference to the pointer, as shown by a direct digital readout in thousands and hundreds of feet.

2. Read the thousands of feet on the two digital counter indicators without referring to the drum indicator, and then add the 100-foot pointer indication.

The self-contained servodriven encoder provides altitude data encoded in 100-foot increments for automatic transmission when the air traffic control transponder is interrogated in mode C. In case of power loss to the encoder-altimeter, an orange OFF flag will appear in a window in the upper portion of the display, indicating that the pilot altimeter is inoperative. The pilot encoder is powered by 26-Vac from the essential ac bus through the ALTM ENCODER PILOT circuit breaker on the pilot upper circuit breaker panel.

The pilot altimeter is interconnected with the altitude alerter/preselect system to provide synchro outputs of baro-corrected altitude and flag alarm signals. The altimeter setting is entered by use of a manually operated barometric set knob in the lower right front of the instrument case. The altimeter setting appears on digital displays at the right of the altitude display and has a range of settings from 950 to 1,050 millibars, and from 28.1 to 31.0 inches of mercury. A press-to-test button, located on the lower left front of the instrument case, is provided to functionally test the servomechanism. When actuated, the button causes a negative pointer offset indicating that the servo is operating.

The copilot and navigator altimeters are read in the same manner as the pilot altimeter. However, these altimeters do not contain an altitude reporting encoder and, hence, no OFF flag. The altimeters also are not equipped with the functional test button. The copilot and navigator altimeters have internal vibrators that operate continuously whenever aircraft dc power is turned on. The vibrator minimizes internal mechanical friction, enabling the instrument to provide a smoother display during changing altitude conditions. Should vibrator failure occur, the altimeter will continue to function pneumatically, but a less smooth movement of the instrument display will be evident with changes in altitude. The vibrators are powered by 28-Vdc power from the essential dc bus through the ALTIMETER VIBRATOR CO-PILOT & NAV dc circuit breaker on the copilot upper circuit breaker panel.

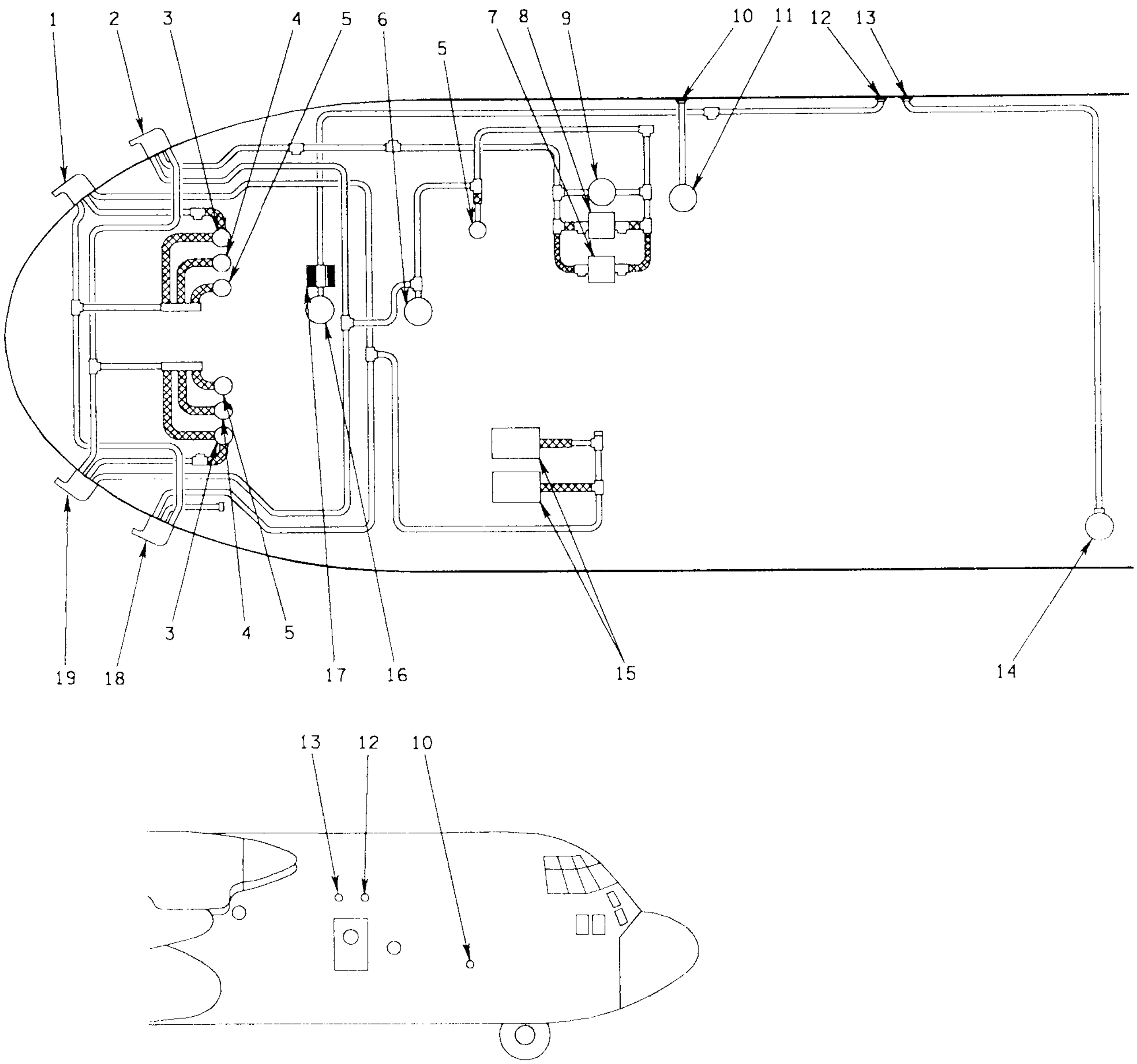
WARNING

If the altimeter internal vibrator is inoperative because of either internal failure or dc power failure, the 100-foot pointer may hang up momentarily when passing through 0 (12-o'clock position). If the vibrator has failed, the 100-foot pointer hangup can be minimized by tapping the case of the altimeter. Pilots should be especially watchful for this failure when their minimum approach altitude lies within the 800- to 1,000-foot part of the scale (1,800 to 2,000 feet, 2,800 to 3,000 feet, etc.), and should use any appropriate altitude backup information available.

2.20.2.5 True Airspeed Computer. The TAS computer provides TAS input to the INS INU for applicable system navigational functions. The computer is mounted on the RH underdeck rack. Ram air pressure and atmospheric pressure to operate the TAS computer is provided by the pitot-static system (see Figure 2-80). Outside air temperature is provided from a total temperature probe installed on the left side of the aircraft above the crew entrance door. The TAS computer uses 26-Vac power from the essential ac bus through the TAS circuit breaker on the pilot upper circuit breaker panel, and 28-Vdc power through the TAS circuit breaker on the copilot upper circuit breaker panel.

2.20.3 Miscellaneous Instruments

2.20.3.1 Free-Air Temperature Indicators. Two free-air temperature indicators, one on the co-pilot instrument panel and the other on the navigator instrument panel, indicate ambient outside air temperature (see Figures 2-77 and 1-7). This temperature must be corrected for compressibility for true air temperature



1. PITOT-STATIC HEAD-SYSTEM NO. 2 (UPPER RIGHT)
2. PITOT-STATIC HEAD-SYSTEM NO. 3 (LOWER RIGHT)
3. AIRSPEED INDICATOR
4. VERTICAL VELOCITY INDICATOR
5. ALTIMETER
6. CABIN DIFFERENTIAL PRESSURE INDICATOR
7. TAS TRANSDUCER
8. GPWS COMPUTER
9. AIRSPEED SENSOR
10. STATIC PORT (FLIGHT STATION AIR CONDITIONING)
11. AIRFLOW REGULATOR (FLIGHT STATION AIR CONDITIONING)
12. STATIC PORT (CABIN PRESSURE CONTROLLER)
13. STATIC PORT (CABIN PRESSURE SAFETY VALVE)
14. SAFETY VALVE
15. FCS AIR DATA CONTROL
16. CABIN PRESSURE CONTROLLER
17. SHUTOFF VALVE
18. PITOT-STATIC HEAD-SYSTEM NO. 4 (LOWER LEFT)
19. PITOT-STATIC HEAD-SYSTEM NO. 1 (UPPER LEFT)

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Figure 2-80. Pitot-Static System

during flight. The indicators are electrically connected to resistance bulbs mounted on each side of the aircraft. The free-air temperature indicators receive 28-Vdc power from the main dc bus through the TEMP IND FREE AIR circuit breaker on the copilot lower circuit breaker panel.

Note

The navigator indicator will read slightly higher than the copilot indicator when the radome anti-icing or radar is on.

2.20.4 Magnetic Compass. A magnetic compass (see Figure 2-77) is mounted on the pilot instrument panel. It is a standard floating-card compass that indicates the direction that the aircraft is headed with respect to magnetic north.

Note

The magnetic compass is intended as a standby compass and should not be used except in case of emergency. For the most reliable operation of the magnetic compass, the pitot heat should be turned on and the HSI set to correspond with the aircraft heading.

2.20.4.1 Accelerometer. An accelerometer (see Figure 2-77) on the pilot instrument panel gives instantaneous readings and maximum positive and negative readings of the g forces exerted on the aircraft. The gauge is calibrated from +4 g to –2 g. The maximum indication needles will remain at their highest readings until the push-to-set button on the gauge case is pushed, then they both will return to +1g and immediately register maximum value until again reset.

2.20.4.2 Clocks. Three clocks are mounted in the aircraft, one each on the pilot, copilot , and navigator instrument panels (see Figures 2-77, 2-78, and 1-7).

2.20.4.3 Electronic Clocks (Aircraft 165313 and Up). Three electronic six-digit liquid-crystal display clocks are installed. Two are installed on the main instrument panel, one for the pilot and one for the copilot (see Figures 2-77 and 2-78). An additional clock is installed at the navigator station. Each clock has an internal battery that allows continuous timekeeping when 28-Vdc power is not applied. The clocks have two operating modes: elapsed time (ET) and clock time (C). To select between ET and C, press the SEL pushbutton. Power is supplied to the clocks from the isolated dc bus through the CLOCKS circuit breaker on the pilot side circuit breaker panel.

Self-Test:

1. During the first 5 seconds of operation, the clocks initiate a self-test that illuminates all of the segments. After completion of the self-test, the clocks start up in C mode.

Elapsed-time operation:

2. If ET operating mode is not indicated, press SEL pushbutton to select ET operating.
3. Press CTRL pushbutton to start elapsed timer counting upward.
4. Press CTRL pushbutton a second time to stop elapsed time.
5. Press CTRL pushbutton a third time to zeroize elapsed timer.
6. Press CTRL pushbutton a fourth time to reset elapsed timer.

To set time in C mode:

7. Press SEL and CTRL pushbuttons simultaneously.
8. When the hour digits are flashing, press CTRL pushbutton to advance hours in one unit increments, or hold to scroll to desired time.
9. To set minutes, press SEL pushbutton. When the minutes digits are flashing, press CTRL pushbutton to advance hours in one unit increments, or hold to scroll to desired time.
10. To set seconds, press SEL pushbutton. When the seconds digits are flashing, press CTRL pushbutton to advance hours in one unit increments, or hold to scroll to desired time.
11. Pressing SEL pushbutton while the seconds digits are flashing returns the clock to the C mode.

2.21 COMMUNICATION AND NAVIGATION EQUIPMENT

The communication and associated electronic equipment consists of radio and intercommunication equipment to provide aircraft-to-aircraft communication, aircraft-to-ground communication, and intra-aircraft communication; navigation sets for guidance; and radar sets for identification and warning (see Figure 2-81). For antenna locations, see Figure 2-82. For equipment rack locations, see Figure 2-83. For an interface illustration of the heading/navigational reference component relationship, see Figure 2-84.

2.21.1 AN/AIC-18 or AN/AIC-25 Intercommunication System. The ICS permits voice communication among flight station and cargo compartment intercommunication stations. The AN/AIC-18 ICS is installed on aircraft prior to 165313, while the AN/AIC-25 ICS is installed on aircraft 165313 and up. Voice communication is also possible with the groundcrew through an external interphone receptacle at the left aft edge of the radome. Audio signals from the command and liaison radio receivers and transmitters can be monitored at each of the flight station intercommunication stations. Audio signals from the VHF and UHF radio receivers and transmitters (aircraft not modified by AFC-338) or VHF and V/UHF radio receivers and transmitters (aircraft modified by AFC-338) can be monitored at each of the observer stations. Transmissions through all radio transmitters can be accomplished at the flight station intercommunication stations. The observers can transmit only on VHF 1, VHF 2, UHF 1, and UHF 2 (aircraft not modified by AFC-338) or VHF 1, VHF 2, V/UHF 1, and V/UHF 2 (aircraft modified by AFC-338). Reception and transmission over the channels available at a particular station are made possible by headset microphones at each intercommunication station. A three-position microphone/interphone switch on both the pilot and copilot control wheels permits transmissions from these positions. A press-to-talk button on the connector cords at all other intercommunication stations can be used to talk from these stations. A foot switch is located at the navigator station and flight engineer station, and can be used as an alternate switch to talk from these stations. The auxiliary intercommunication control panel, installed in the forward cargo compartment, differs from all other panels both in appearance and capability. It is equipped with two controls, a call button, and a volume knob and is restricted to voice communication through the ICS. The forward cargo compartment interphone station at FS 245 bulkhead includes a microphone headset with a 75-foot extension cord stowed in a protective bag next to the control panel. The ICS is operated from 28-Vdc power supplied from the isolated bus and essential dc bus through the INTERPHONE circuit breakers on the copilot upper circuit breaker panel.

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
Intercommunication equipment	AN/AIC-18A or AN/AIC-25	Crew intercommunication	Crewmembers	Crew stations within the aircraft and external for ground crew	Pilot side shelf extension, copilot side shelf extension, overhead control panel, navigator station, left forward bulkhead, forward for each paratroop exit door, at top of pilot side circuit breaker
Public address system	AN/AIC-13	One-way communication for cargo compartment	Crewmembers	Interior of aircraft and servicing personnel	Navigator station, auxiliary: pilot side shelf, left forward bulkhead, and at left-hand paratroop door
VHF AM-FM radio (2)	AN/ARC-186(V)	Two-way voice communication in the range of 30 to 87.975 MHz FM to 151.975 MHz AM	Pilot and copilot	Line of sight	CDNUs
UHF communication radio (2) 3	AN/ARC-159(V)1	Two-way voice communication in the range of 225 to 399.975 MHz	Pilot and copilot	Line of sight	UHF No. 2 copilot side shelf extension UHF No. 1 flight control pedestal

Figure 2-81. Table of Communications and Associated Electronic Equipment (Sheet 1 of 3)

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
Encryption unit (4) 3	KY-58	Secures voice communication for VHF and UHF radios	Pilot and copilot	—	UHF No. 2 copilot side shelf extension Others flight control pedestal
HF command radio (2)	AN/ARC-190	Airborne voice communication in the range of 2 to 30 MHz	Pilot and copilot	100 to 2,500 miles on AM and greatly extended range on SSB depending on operating frequency, altitude, and time of day	Flight control pedestal (No. 1), copilot side shelf extension (No. 2).
Encryption unit (2)	AN/USC-43	Secures voice communication for HF radios	Pilot and copilot	—	Flight control pedestal, copilot side shelf extension and navigator station
Automatic direction finder (2)	DF-206	For homing and bearing; also receives voice and code signals	Pilot and copilot	20 to 200 miles depending on power, class of ground station, frequency, and time of day	Flight control pedestal
VHF navigation system (2)	AN/ARN-126	Reception of all VHF/VOR, tone localizer and voice facilities; reception of glideslope information and location marker symbols	Pilot and copilot	Localizer — 45 miles; Omni — 200 miles depending on altitude; Glideslope — 15 miles; Marker beacon — any altitude	CDNUs
Tacan (2)	AN/ARN-118(V) or AN/ARN-139(V)	Receives bearing and distance information	Pilot and copilot	Line of sight depending on altitude	CDNUs
Receiving decoding group	AN/ARA-63A	Enables the aircraft to land at airfields equipped with an Aircraft Approach Control System (AACS)	Pilot	20 miles	Flight control pedestal
UHF direction finder 3	AN/ARA-50 1 DF-301E 2	Homing on ARC-159 transmitter	Pilot and copilot	Line of sight	Flight control pedestal
UHF direction finder 4	AN/ARA-50 DF-301E	Homing on AN/ARC-210 transmitter	Pilot and copilot	Line of sight	CDNUs
Encryption units (4) 4	KY-58	Secures voice communications for VHF and V/UHF radios	Pilot and copilot		VHF 1 and 2 control pedestal; V/UHF 1 control pilot side shelf; V/UHF 2 control copilot's side shelf
V/UHF communication radio 4	AN/ARC-210	Two-way voice communication	Pilot and copilot	Line of sight	CDNUs
TCAS/IFF control panel 6	—	Control of TCAS and IFF functions	Pilot and copilot	—	Flight control pedestal
Global positioning system (GPS)	AN/ARN-151	Provides highly accurate position, velocity, and time	Pilot, copilot, navigator	—	CDNUs

Figure 2-81. Table of Communications and Associated Electronic Equipment (Sheet 2)

TYPE	DESIGNATION	FUNCTION	PRIMARY OPERATOR	RANGE	LOCATION OF CONTROLS
Combined altitude radar altimeter	AN/APN-232(V)6	Indicates absolute altitude of aircraft above the terrain	Pilot and navigator 1 Pilot and copilot 2	0 to 50,000 feet altitude	Pilot and navigator instrument panels 1 Pilot and copilot instrument panels 2
Ground proximity warning system		Provides the pilot and copilot with visual and aural warnings of a flight condition that could cause the aircraft to come in close proximity to the ground	Automatic	Any altitude	Flight control pedestal
Altitude alerter/ preselect system	540-25100-004	Provides automatic visual and aural signals during approach to or departure from a preselected altitude	Pilot	0 to 50,000 feet altitude	Pilot glareshield
IFF transponder system 5	AN/APX-100(V)	Identifies aircraft as friend or foe	Pilot and copilot	—	Flight control pedestal
IFF interrogator	AN/APX-76B	Interrogates properly equipped receiver aircraft	Navigator	Line of sight	Navigator control panel
Flight control system	FCS 105	For automatic pilot or instrument flying with INS, VOR/ILS, or tacan	Pilot and copilot	—	Flight control pedestal and main instrument panel
Inertial navigation system	LTN-72 or LN-100	Provides accurate navigation and position determination information	Navigator	—	CDU No. 2 navigator station; CDU No. 1 flight control pedestal
True airspeed computer	Model 2504	Computes and displays true airspeed using temperature, altitude, and airspeed data	Navigator	—	Navigator control panel
Multimode radar	AN/APS-133 (M)	Navigation and weather radar — displays IFF, INS, ONS data and mapping	Pilot and navigator	5 to 300 miles	Indicators: navigator station and pilot instrument panel; control panels: navigator control panel, pilot side shelf/extension, and pedestal
Compass system (2)	C-12	Detects and indicates relative heading referenced to magnetic north	Navigator	—	Navigator station
Emergency rescue transmitter (4)	AN/PRT-5E	Distress signals	Crewmembers	1,000 miles	On transmitter

Notes

1. C-130T aircraft prior to 164993
2. C-130T aircraft 164993 and up
3. Aircraft without AFC-338
4. Aircraft modified by AFC-338
5. Aircraft without AFC-374
6. Aircraft with AFC-374

Figure 2-81. Table of Communications and Associated Electronic Equipment (Sheet 3)

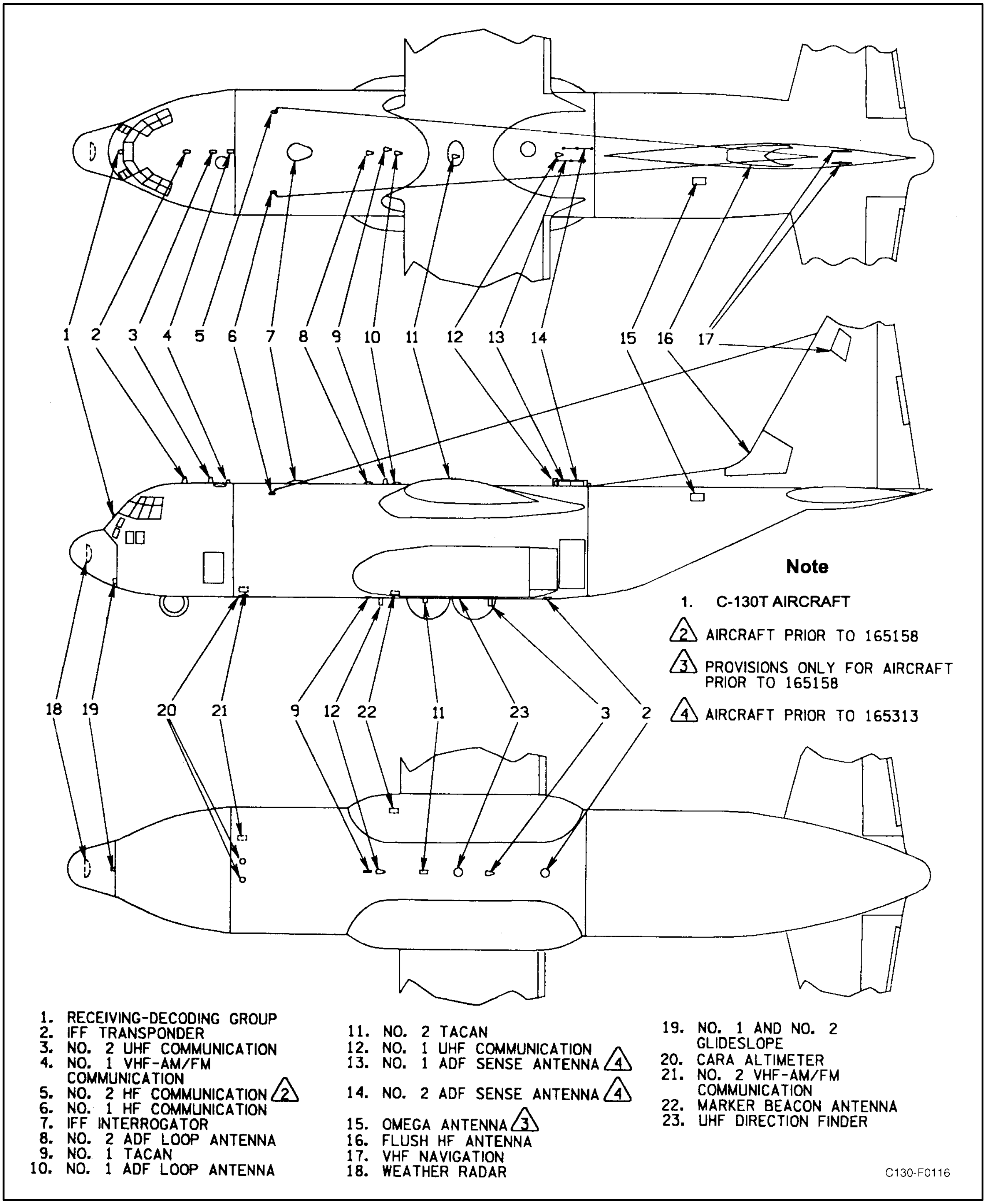
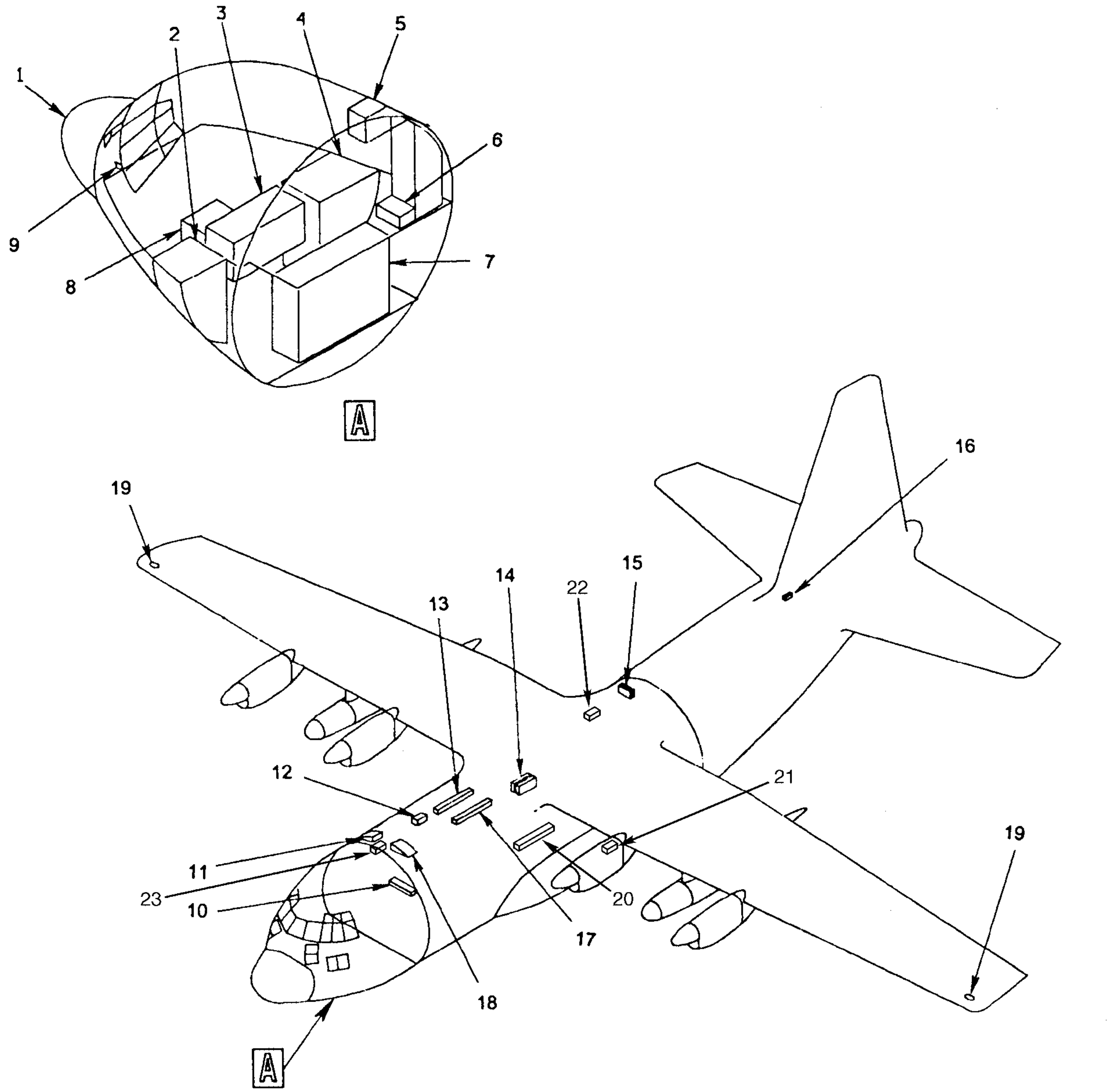


Figure 2-82. Antenna Locations



1. NOSE RADOME
2. LH UNDERDECK RACK
3. CENTER UNDERDECK RACK
4. RH UNDERDECK RACK
5. NAVIGATOR CONSOLE
6. UNDERBUNK RACK
7. ELECTRICAL CONTROL AND SUPPLY RACK
8. NOSE WHEELWELL EQUIPMENT RACK
9. AACS RECEIVER RACK
10. COMPASS EQUIPMENT RACK
11. RH ELECTRONIC RACK
12. KY-58/75 EQUIPMENT RACK
13. IFF RACK
14. IFF RECEIVER-TRANSMITTER RACK
15. ADF RECEIVER RACK
16. AFT CARGO COMPARTMENT OVERHEAD
17. FUEL SYSTEM EQUIPMENT RACK
18. LH ELECTRONIC RACK
19. MAGNETIC AZIMUTH DETECTOR INSTALLATION
20. LH CARGO BAY EQUIPMENT RACK
21. LH SIDEWALL EQUIPMENT RACK
22. RH SIDEWALL EQUIPMENT RACK
23. ODS EQUIPMENT RACK

C130-f0117

Figure 2-83. Electrical and Electronic Equipment Installation (Sheet 1 of 5)

SYSTEM — COMPONENTS	LOCATION — RACK
Aircraft Approach Control System (AACS) (AN/ARA-63A):	
Pulse decoder	LH underdeck rack
Receiver	AACS receiver rack
Altimeter (CARA)	
Receiver-transmitter	Electrical control and supply rack
Audible fire warning:	
Amplifier	LH electronic rack
Generator	LH electronic rack
Relay	LH electronic rack
Automatic direction finder (ADF) (DF-206):	
Receiver No. 1	ADF receiver rack
Receiver No. 2	ADF receiver rack
Compass (C-12):	
Amplifier — Power supply No. 1	Compass equipment rack
Amplifier — Power supply No. 2	Compass equipment rack
Directional gyro No. 1	Compass equipment rack
Directional gyro No. 2	Compass equipment rack
Magnetic azimuth detector No. 1	LH wingtip
Magnetic azimuth detector No. 2	RH wingtip
Electrical:	
Ac generator control panels (4)	Electrical control and supply rack
Ac generator voltage regulators (4) △3	Electrical control and supply rack
Ac instrument and engine fuel control inverter	RH underdeck rack
APU ac generator control panel	Electrical control and supply rack
APU ac generator voltage regulator	Electrical control and supply rack
APU generator control unit △4	Electrical control and supply rack
Copilot inverter	RH underdeck rack
Essential bus transformer-rectifier units (2)	Electrical control and supply rack
Generator control unit (4) △4	Electrical control and supply rack
Main bus transformer-rectifier units (2)	Electrical control and supply rack
Flight control systems (FCS 105):	
Acceleration sensor	LH underdeck rack
Air data control No. 1	LH underdeck rack
Air data control No. 2	LH underdeck rack
Airspeed sensor	Navigator console
Autopilot amplifier	LH underdeck rack
Flight computer No. 1	LH underdeck rack
Flight computer No. 2	LH underdeck rack
Mode coupler No. 1	LH underdeck rack
Mode coupler No. 2	LH underdeck rack
Turn rate sensor No. 1	Center underdeck rack
Turn rate sensor No. 2	Center underdeck rack
Vertical gyro No. 1	Underbunk rack
Vertical gyro No. 2	Underbunk rack
Yaw damper computer	LH underdeck rack

Figure 2-83. Electrical and Electronic Equipment Installation (Sheet 2)

SYSTEM — COMPONENTS	LOCATION — RACK
Fuel:	
Fuel flow meter power supply	Fuel system equipment rack
Fuel quantity totalizer	Fuel system equipment rack
Relays (3)	Fuel system equipment rack
Global Positioning System (GPS):	
Interface ship set	LH cargo equipment rack
Database couplers	LH cargo equipment rack
Signal data converter	LH cargo equipment rack
Ground proximity warning system:	
Adapter	Underbunk rack
Air data computer	Navigator console
Computer	Navigator console
HF communication radio (ARC-190):	
Antenna coupler No. 1 — HF	LH electronic rack
Antenna coupler No. 2 — HF	RH electronic rack
Coaxial resistor No. 1	LH electronic rack
Coaxial resistor No. 2	RH electronic rack
HF relay No. 1	LH electronic rack
HF relay No. 2	RH electronic rack
Interface boxes (if installed)	Equipment rack KY-58/75
Transceiver No. 1	Center underdeck rack
Transceiver No. 2	Center underdeck rack
IFF (AN/APX-100(V)): 7	
Antenna selection relay	IFF rack
Mode 4 computer	LH underdeck rack
Receiver-transmitter	IFF rack
IFF interrogator (AN/APX-76B(V)):	
Converter-synchronizer	IFF equipment rack
Mode 4 computer	LH equipment rack
Power relay	IFF receiver-transmitter rack
Receiver-transmitter	IFF receiver-transmitter rack
Transient suppressor	IFF receiver-transmitter rack
Inertial navigation (LTN-72 or LN-100):	
Inertial nav unit No. 1	Electrical control and supply rack
Inertial nav unit No. 2	Electrical control and supply rack
INS battery (if installed)	Electrical control and supply rack
INU fan No. 1	Electrical control and supply rack
INU fan No. 2	Electrical control and supply rack
INU fan power relay No. 1	Electrical control and supply rack
INU fan power relay No. 2	Electrical control and supply rack
INU fan warn relay No. 1	Electrical control and supply rack
INU fan warn relay No. 2	Electrical control and supply rack
Overheat detection system control unit	ODS equipment rack
Propeller synchrophaser unit	Electrical control and supply rack

Figure 2-83. Electrical and Electronic Equipment Installation (Sheet 3)

SYSTEM — COMPONENTS	LOCATION — RACK
Public address (AN/AIC-13):	
Audio frequency amplifiers (3)	Center underdeck rack
Radar, multimode (AN/APS-133(M)):	
Interface unit	RH underdeck rack
Receiver-transmitter	RH underdeck rack
Roll compensator	RH underdeck rack
Radar control switching relays	Underbunk rack
Secure voice system (KY-58):	
Processors, UHF (2) △5	KY-58/75 equipment rack
Processors, VHF (2)	KY-58/75 equipment rack
Processors, V/UHF (2) △6	LH avionics equipment rack
TCAS/IFF △8	
IFF transponder	IFF rack
TCAS receiver-transmitter	IFF rack
Mode 4 computer	IFF rack
Secure voice system (KY-75):	
Keyers HF (2)	KY-58/75 equipment rack
Remote control units (RCU-11A/B):	
(RCU-IIIA)	Navigator control panel
(RCU-111B)	Pedestal (No. 1) copilot side shelf extension (No. 2)
Tacan (AN/ARN-118)/(AN/ARN-139(V)):	
Bearing adapter No. 1	LH underdeck rack
Digital to analog adapter No. 1	LH underdeck rack
Digital to analog adapter No. 2	LH underdeck rack
Receiver-transmitter No. 1	LH underdeck rack
Receiver-transmitter No. 2	LH underdeck rack
True airspeed computer (model 2504):	
Computer	RH underdeck rack
Transducer	RH underdeck rack
UHF communication radio (AN/ARC-159(V)): △5	
Receiver/transmitter No. 1	Pedestal
Receiver/transmitter No. 2	Copilot's side extension shelf
Antenna selector No. 1	Electrical control and supply rack
Antenna selector No. 2	LH underdeck rack
Antenna switch No. 1	Electrical control and supply rack
Antenna switch No. 2	LH underdeck rack
UHF low pass filter	Electrical control and supply rack
UHF direction finder (AN/ARA-50): △1	
Amplifier relay	Electrical control and supply rack
UHF direction finder (DF-301E): △2	
UHF/DF selector	LH underdeck rack

Figure 2-83. Electrical and Electronic Equipment Installation (Sheet 4)

SYSTEM — COMPONENTS	LOCATION — RACK
VHF AM-FM communication radio (AN/ARC-186(V)):	
Receiver-transmitter No. 1	Underbunk rack
Receiver-transmitter No. 2	Underbunk rack
VHF Navigation system (AN/ARN-126):	
Receiver No. 1	LH underdeck rack
Receiver No. 2	LH underdeck rack
V/UHF communication radio (AN/ARC-210): ⚠6	
Antenna converter No. 1	LH sidewall equipment rack
Antenna converter No. 2	RH sidewall equipment rack
Receiver-transmitter No. 1	LH cargo bay equipment rack
Receiver-transmitter No. 2	LH cargo bay equipment rack
Antenna selector coaxial switch No. 1	LH cargo bay equipment rack
Antenna selector coaxial switch No. 2	LH cargo bay equipment rack
Filter No. 1	LH cargo bay equipment rack
Filter No. 2	LH cargo bay equipment rack
Audio amplifier No. 1 (provisions)	LH cargo bay equipment rack
Audio amplifier No. 2 (provisions)	LH cargo bay equipment rack
Control unit No. 1	LH cargo bay equipment rack

⚠1 Aircraft prior to 164993
⚠2 Aircraft 164993 and up
⚠3 Aircraft prior to 165313
⚠4 Aircraft 165313 and up
⚠5 Aircraft not modified by AFC-338
⚠6 Aircraft modified by AFC-338
⚠7 Aircraft not modified by AFC-374
⚠8 Aircraft modified by AFC-374

Figure 2-83. Electrical and Electronic Equipment Installation (Sheet 5)

2.21.1.1 Intercommunication System Controls

2.21.1.1.1 Main Control Panel. Identical ICS control panels (see Figure 2-85) are installed on each pilot side shelf extension, on the overhead control panel, on the navigator side panel/console, at the lower crew bunk, and above the pilot upper circuit breaker panel for use by a flight instructor. A similar control panel is installed at each observer station.

The main control panels are equipped with similar push-pull switches for:

1. VHF 1 — AN/ARC-186 VHF command radio No. 1
2. VHF 2 — AN/ARC-186 VHF command radio No. 2
3. UHF 1 — AN/ARC-159 UHF command radio No. 1 (aircraft not modified by AFC-338)
4. V/UHF 1 — AN/ARC-210 V/UHF command radio (aircraft modified by AFC-338)
5. UHF 2 — AN/ARC-159 UHF Command Radio No. 2 (aircraft not modified by AFC-338)
6. V/UHF 2 — AN/ARC-210 V/UHF command radio (aircraft modified by AFC-338)
7. HF 1 — AN/ARC-190 HF command radio No. 1
8. HF 2 — AN/ARC-190 HF command radio No. 2 (except HF 1 and HF 2, which are not available at observer stations).

Push-pull switches are also provided on the control panel for interphone (INT) and hot mike (HOT MIC) operation; the latter uses a listen switch and a talk switch. This panel also carries a master volume control, a call button, and a rotary transmission selector switch.

2.21.1.1.2 Transmission Selector Switch. The transmission selector switch on the control panels in the

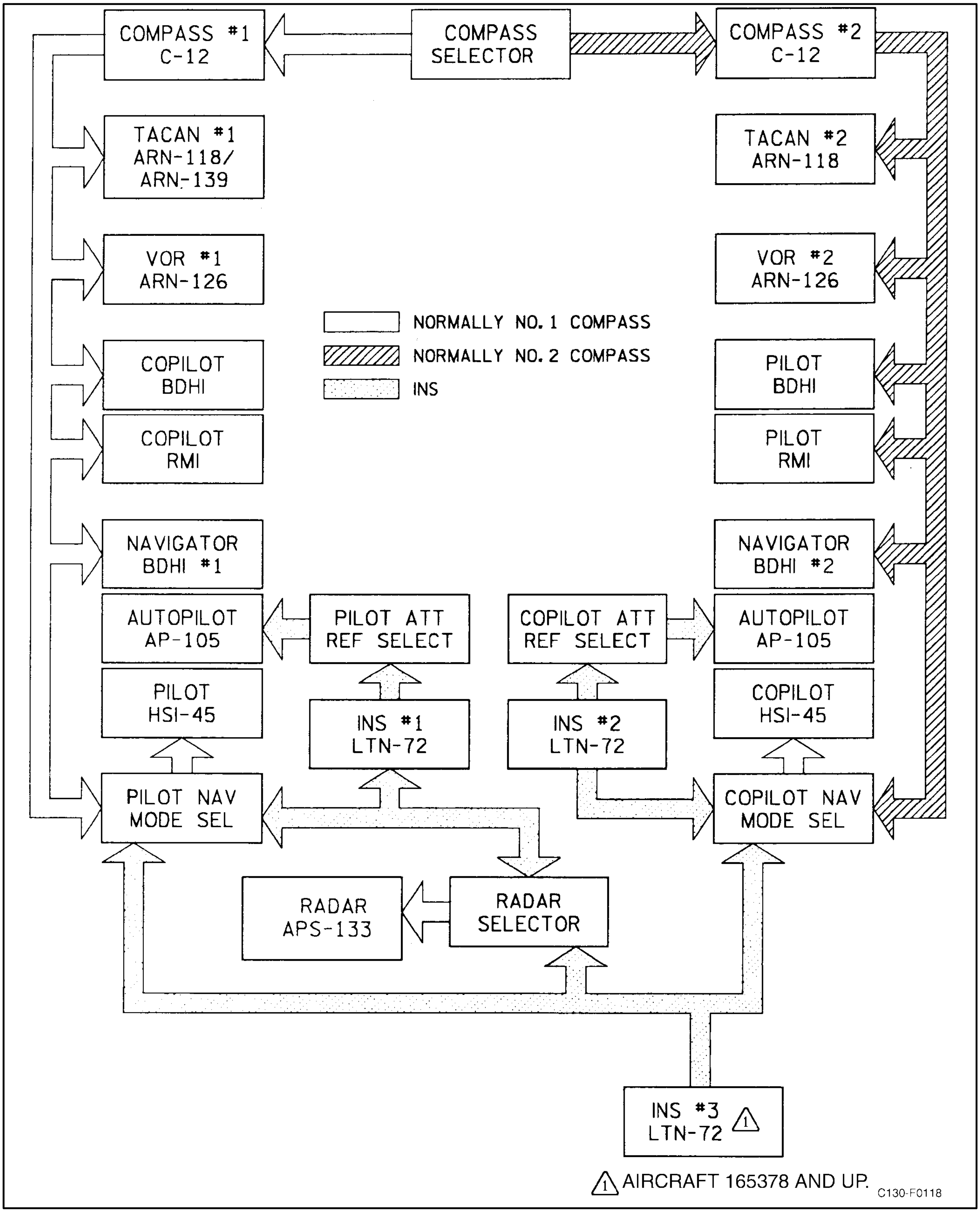


Figure 2-84. Heading Reference System

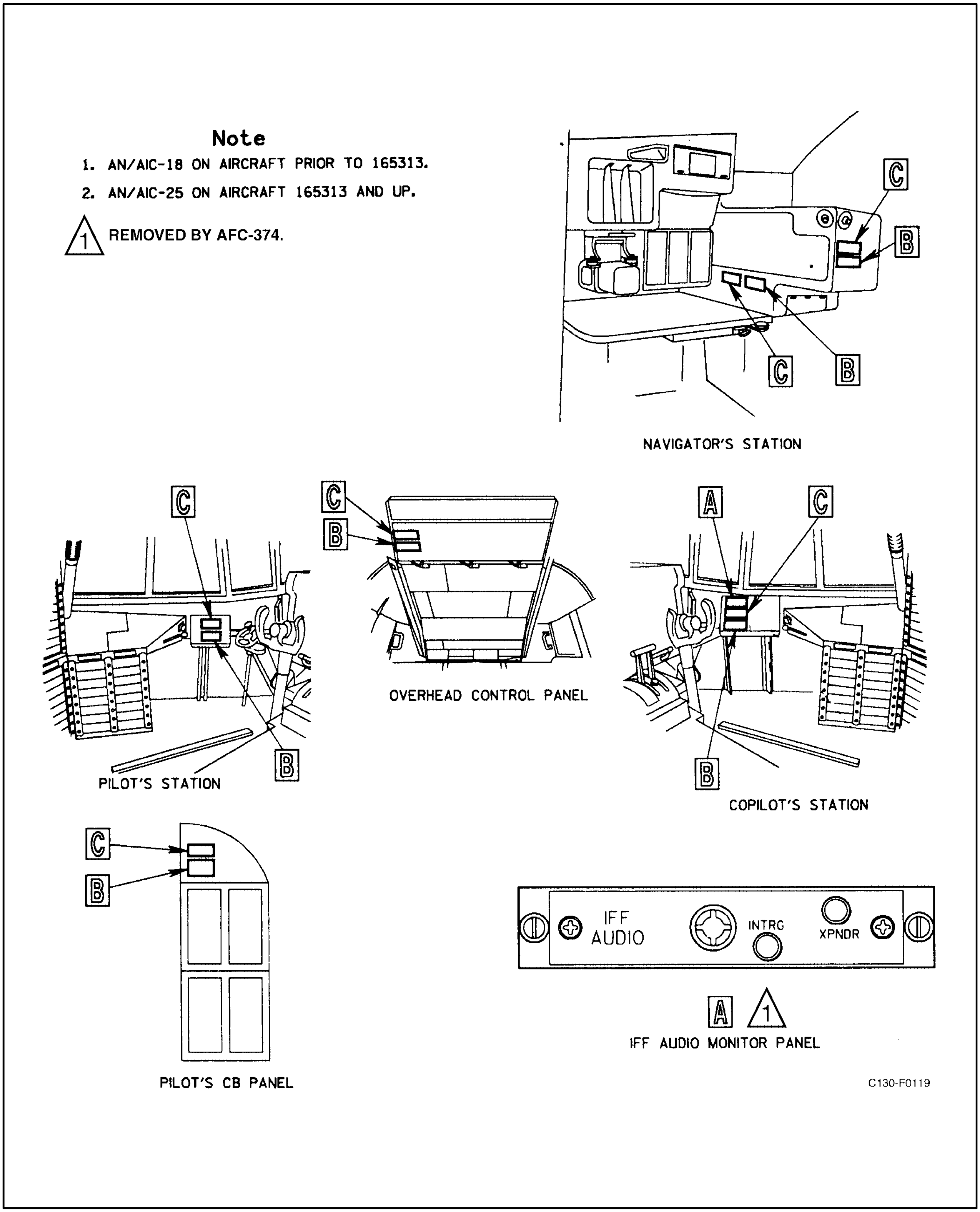


Figure 2-85. Intercommunication System Control Panels (Sheet 1 of 2)

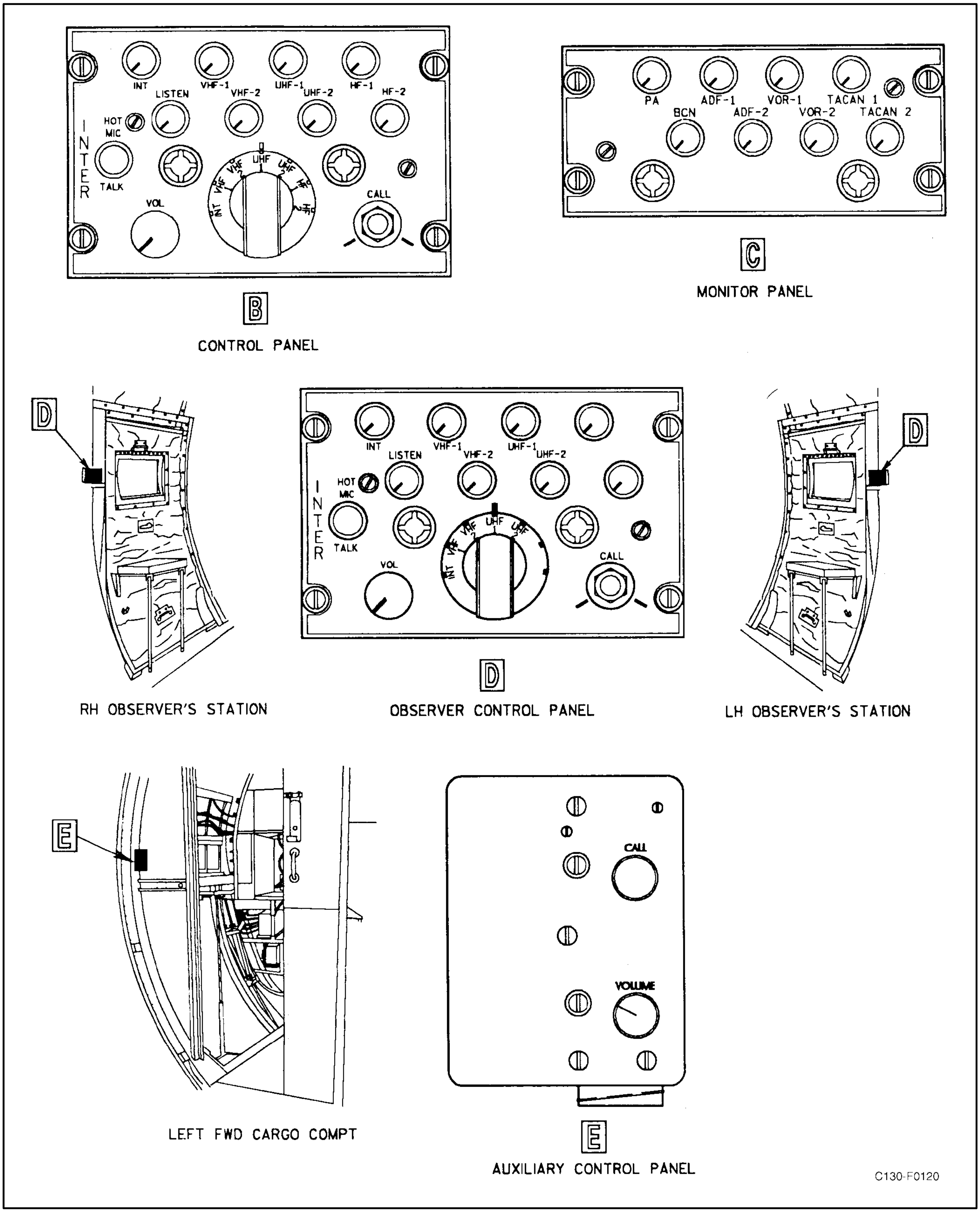


Figure 2-85. Intercommunication System Control Panels (Sheet 2)

flight station may be set to any one of seven positions, by rotation from left to right: INT for interphone and PA system operation; VHF 1 and VHF 2 for transmission through the two VHF command radios; UHF 1 and UHF 2 for transmission through the two UHF command radios; and HF 1 and HF 2 for transmission through the two HF command radios. The observers can transmit only on INT, VHF 1, VHF 2, UHF 1, and UHF 2 by placing their transmission selector switches in the desired position. On aircraft modified by AFC-338, switch and panel nomenclature "UHF" has been replaced with "V/UHF."

2.21.1.1.3 HOT MIC Switches. The hot mike (HOT MIC) mode of operation permits direct transmission to all other intercommunication stations on the aircraft without operating the individual microphone switches.

When the hot mike system is not being used, the HOT MIC switches should be pushed in to restore the inter-communication system to normal functioning. The three-position (INPH, OFF, MIC) microphone switches on the control wheels are spring loaded to the OFF position. With the switch held at the INPH position, the pilot can transmit to all other intercommunication stations. If the switch is held to the MIC position, the pilot can transmit through the communication transmitter selected on the transmission selector switch. Foot-controlled microphone switches are located on the floor at the flight engineer and navigator stations.

2.21.1.1.4 CALL Button. A CALL button is located at the lower right corner of each of the crew station intercommunication control panels. When the button is pressed, all radio receiver transmissions on the ICS are subdued 6 dB and all intercommunication stations are put into direct contact with the calling station.

2.21.1.1.5 Intercommunication System Monitor Panel. Each crew station, except the left and right observer stations, is equipped with monitoring or mixer switches, enabling all audio navigational systems to be connected to the ICS. The switches are of the push-pull type (pulled for ON, pushed for OFF). They may be turned to regulate volume at the individual intercommunication station. The ICS monitor panels (see Figure 2-84) serve to provide interconnection with the following communication and audio navigational systems:

1. PA — AN/AIC-13 public address system
2. BCN — AN/ARN-126 marker beacon receiver
3. ADF 1 — DF-206 automatic direction finder No. 1.
4. ADF 2 — DF-206 automatic direction finder No. 2
5. VOR 1 — AN/ARN-126 VHF navigation receiver No. 1
6. VOR 2 — AN/ARN-126 VHF navigation receiver No. 2
7. TACAN 1 — AN/ARN-139(V) tacan No. 1
8. TACAN 2 — AN/ARN-118(V) tacan No. 2
9. AUXILIARY — Control panel.

2.21.1.1.6 Auxiliary Control Panel. The ICS auxiliary control panel (see Figure 2-85) is equipped only with a CALL button and a VOLUME control. This control panel is located at the forward bulkhead on the left side. The function of the call button on the auxiliary panel is the same as for the CALL buttons on the crew station control panels; pressing the button puts the calling station in direct communication with all other intercommunication stations and causes all radio receiver transmissions on the ICS to be subdued 6 dB.

2.21.1.1.7 IFF Audio Monitor Panel (Aircraft Prior to AFC-374). The IFF audio monitor panel (see Figure 2-85) located on the copilot side shelf extension provides a capability for the pilot to monitor audio signals generated by either the AN/APX-100 IFF transponder or the AN/APX-76B IFF interrogator. Two rotary knobs, INTRG and XPNDR, are utilized to select and control volume for the selected system audio signals. The audio signal will be heard as a short burst (buzz) in the 300- to 400-Hz range when monitoring mode 4 interrogations.

2.21.1.2 Operation of the Intercommunication System (Crew Station Positions). The procedure for operating the ICS from any of the crew positions or the crew bunk positions is as follows:

Note

Classified information will not be discussed on the ICS or on radios operating in secure mode while other radios are transmitting in clear mode. Conversely, no radio will transmit in clear mode while classified information is being discussed on the ICS or another radio is transmitting in secure mode.

1. To talk:

   a. Set the transmission selector switch as desired.

   b. Press the microphone switch (except for HOT MIC operation), and speak into the microphone.

2. To listen:

   a. To listen to any radio communication receiver, pull the switch for the selected communication system; turn the switch after pulling to regulate the volume to a desired level.

   b. Push the switch in to disconnect the selected radio communication system.

2.21.1.3 Operation of the Intercommunication System (Auxiliary Stations). To talk from the auxiliary intercommunication station, press the microphone switch on the microphone and speak into the microphone. To listen, adjust the volume control to a comfortable level. Listening is possible only on the ICS line.

Note

Classified information will not be discussed on the ICS or on radios operating in secure mode while other radios are transmitting in clear mode. Conversely, no radio will transmit in clear mode while classified information is being discussed on the ICS or another radio is transmitting in secure mode.

2.21.2 AN/AIC-13 Public Address System. The PA system provides one-way communication with the cargo area through seven speakers located in the cargo compartment. The main control panel for the PA system is located at the navigator station, with auxiliary control panels located on the pilot side shelf extension, at the forward cargo compartment control panel, and on the left observer panel forward of the left paratroop door. The PA system operates using 28-volt power from the main dc bus through a circuit breaker on the copilot upper circuit breaker panel.

2.21.2.1 Public Address System Controls

2.21.2.1.1 Main Control Panel. The main control of the PA system is from a control panel (see Figure 2-86) located at the navigator station. Microphone connections to the PA system are made through all intercommunication control panels and through microphone connectors for use with extension cords on the cargo compartment auxiliary control panels at the forward cargo compartment and left paratroop door positions. A power switch, a speaker selector switch, four mixer switches, and a volume control switch constitute the controls on the main control panel.

2.21.2.1.2 Power Switch. The power switch has PWR ON and OFF positions. When the switch is placed in the PWR ON position, power is supplied to all circuits of the system for normal operation.

2.21.2.1.3 Speaker Selector Switch. The four-position (ALL, FWD, AFT, JUMP) speaker selector switch selects the speaker or combination of speakers to be operated. In the ALL position, all the speakers except the one located over the cargo ramp are in operation. In the FWD position, only the speaker in the cargo compartment forward area is in operation. In the AFT position, only the speaker over the cargo ramp is in operation. In the JUMP position, the two speakers adjacent to the paratroop exit doors are in operation.

2.21.2.1.4 VOL Control Switch. The 11-position VOL control switch is used to adjust the audio output of the PA system. This switch is manually controlled at the navigator station and electrically actuated by the PA GAIN control switch on the pilot side shelf and auxiliary control panels

2.21.2.1.5 Mixer Switches. Four mixer switches (ADF 1, ADF 2, UHF COMM, VHF COMM for

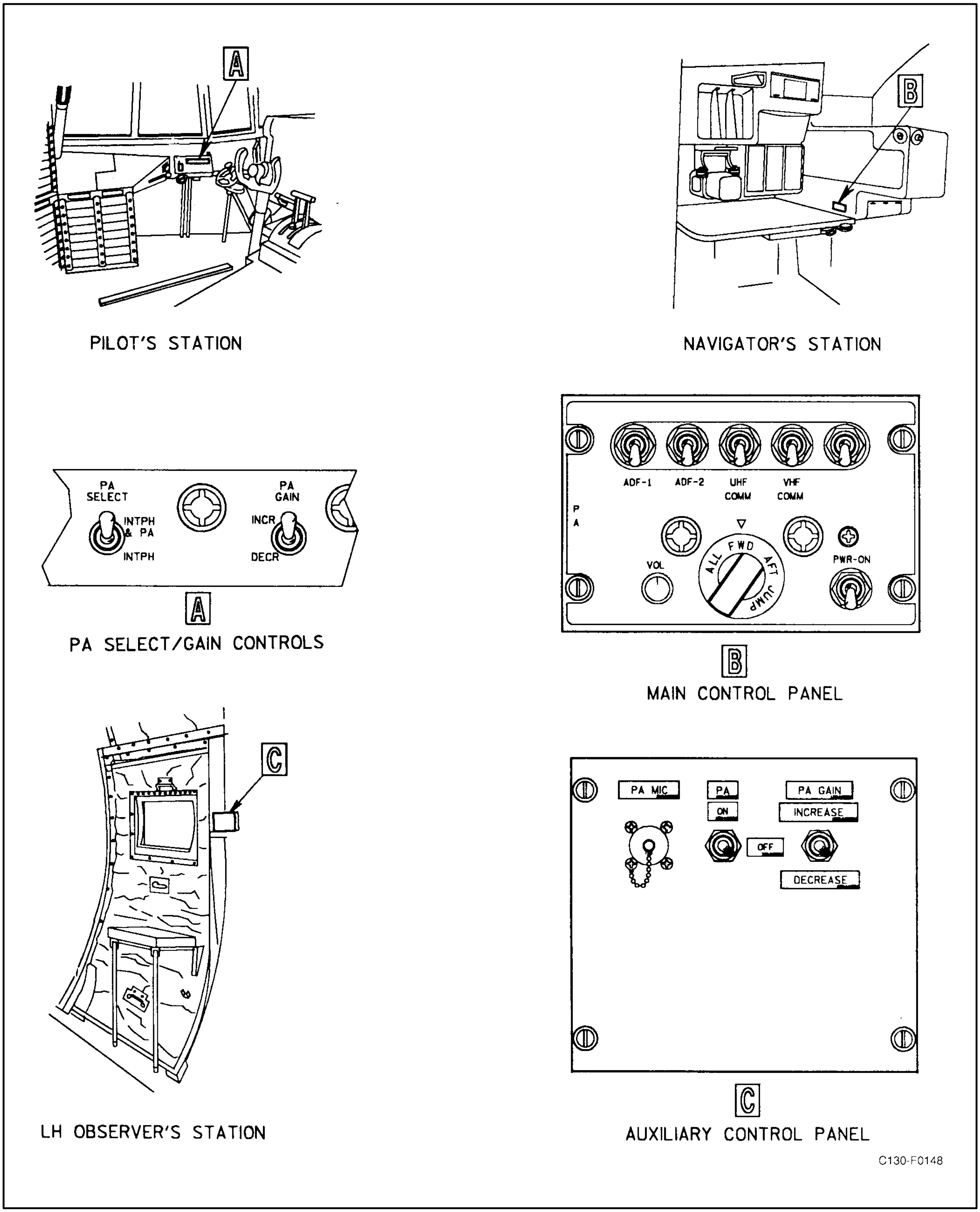


Figure 2-86. AN/AIC-13 Public Address Control Panels (Sheet 1 of 2)

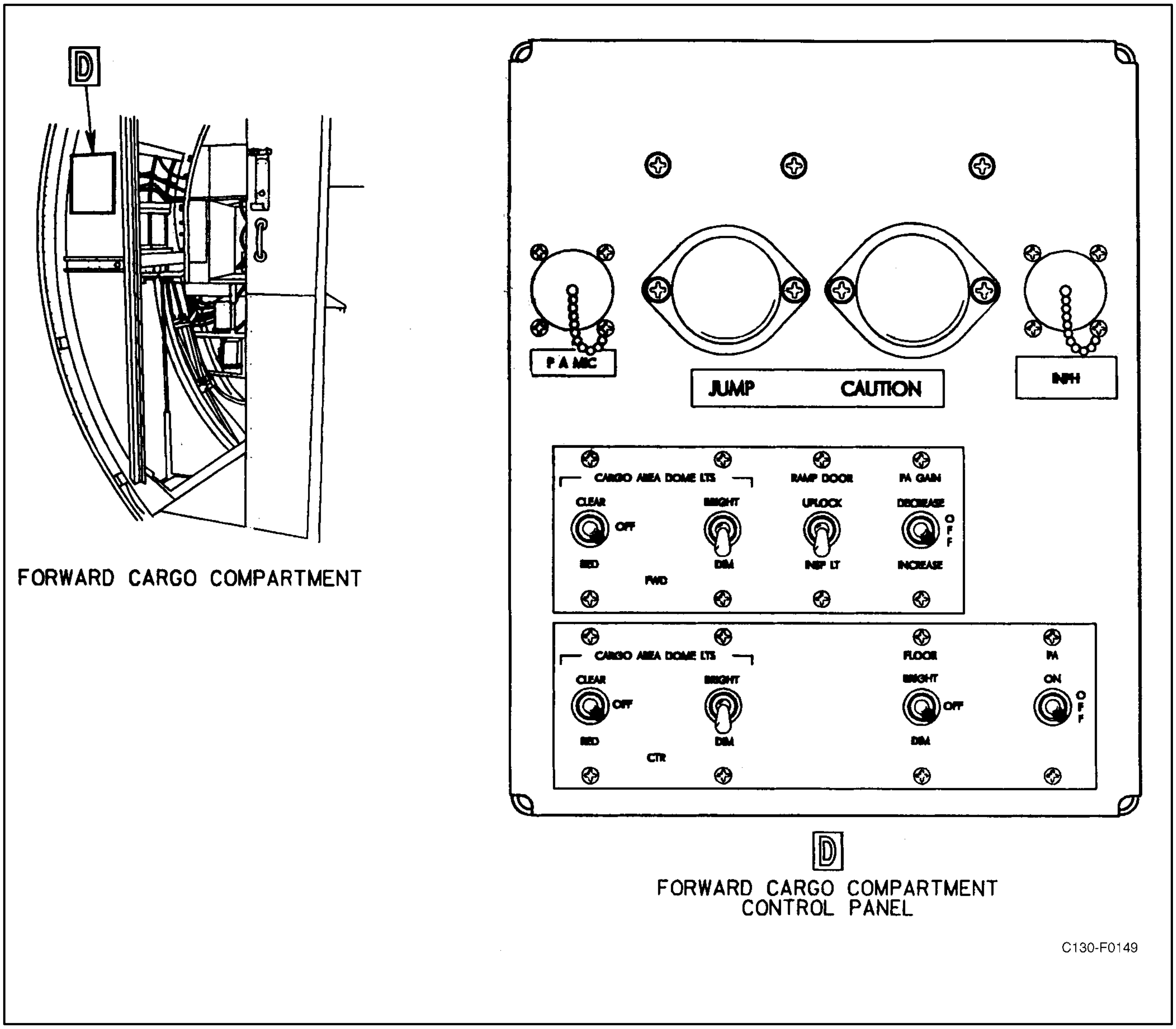


Figure 2-86. AN/AIC-13 Public Address Control Panels (Sheet 2)

aircraft not modified by AFC-338 or ADF-1, ADF-2, V/UHF COMM, VHF COMM for aircraft modified by AFC-338) are located on the main control panel for supplying radio receiver signals to the PA system. To connect a receiver to the system, place the mixer switch for that receiver in the ON (up) position.

Note

> The UHF COMM switch is for use with the UHF No. 1 system for aircraft not modified by AFC-338. The V/UHF COMM switch is for use with the V/UHF 1 system for aircraft modified by AFC-338.

2.21.2.1.6 Auxiliary Control Panels. After the PA system has been actuated and speaker selections made at the main control panel, the auxiliary control panels (see Figure 2-86) can be used to operate the system. The PA SELECT switch on the pilot auxiliary control panel and the PA ON-OFF switch on the cargo compartment auxiliary control panel are used to connect each station to the PA system. Voice communication from the flight station intercommunication control positions is transmitted to the PA system through the ICS. The audio output of the PA system is controlled by a PA GAIN switch on each of the auxiliary control panels.

2.21.2.1.7 PA SELECT Switch. The PA SELECT switch is a two-position (INTPH & PA, INTPH) switch located on the pilot side shelf extension and is used to connect the ICS to the PA system. When the switch is placed in the INTPH position, intercommunication conversation is confined to the interphone circuit. When the switch is placed in the INTPH & PA position, intercommunication conversation is supplied to the PA system and radio receiver signals are eliminated from the PA system.

2.21.2.1.8 PA Switch. This switch, installed on the cargo compartment auxiliary control panels, is a two-position (ON, OFF) momentary switch used to connect that station to the PA system. Holding the PA switch in the ON position permits voice communication through the speaker(s) selected on the main control panel. Activating this switch silences any radio inputs that may be selected on the main control panel but does not silence microphone inputs from other PA stations on the aircraft.

2.21.2.1.9 PA GAIN Switch. The PA GAIN switch is a three-position (INCREASE, OFF, DECREASE) momentary-type switch. When the switch is held in the INCREASE position, the audio output of the PA system increases. When the switch is held in the DECREASE position, the audio output of the system decreases. When the switch is released from either position, a spring return moves it to the OFF (center) position. The manual control knob on the main control panel will be physically rotated by an electric motor controlled by these switches.

2.21.2.2 Normal Operation of the Public Address System. Operate the PA system as follows:

1. Place the power switch in the ON position.
2. Place the speaker selector switch in the desired position.
3. If the PA system is to be operated from the flight station, place the PA SELECT switch in the INTPH & PA position. When the PA system is keyed, radio receiver signals will be eliminated, and voice communication from the flight station will be transmitted through the PA system and through the ICS. If the PA system is to be operated from the cargo compartment forward auxiliary panel, or the observer station in the left rear of the cargo compartment, hold the PA switch to the ON position.
4. Press the microphone button and talk.
5. If radio signals are to be heard over the PA system, place the desired mixer switch to the ON (up) position and place the PA SELECT switch in the INTPH position.
6. To adjust the audio output of the system, rotate the VOL knob on the main control panel, or actuate the PA GAIN switch on the auxiliary panel(s).
7. PA audio may be monitored at all flight station positions by turning on the PA switch on the respective interphone panels.
8. When the PA system is operated from either cargo compartment position, monitor the speaker audio so the volume can be adjusted to a suitable level.

To turn the PA system off:

9. Place the power switch in the OFF position.

2.21.3 Communication-Navigation Management System. The Communication-Navigation Management System (CNMS) provides control of the systems listed in Figure 2-87. System control and status monitoring is accomplished using Control Display Navigation Units (CDNUs).

System	Designation
VHF/UHF Comm. No. 1	AN/ARC-210(V) (Aircraft with AFC-338)
VHF/UHF Comm. No. 2	AN/ARC-210(V) (Aircraft with AFC-338)
VHF1 Comm. No. 1	AN/ARC-186(V)
VHF2 Comm. No. 2	AN/ARC-186(V)
VHF Nav. No. 1	AN/ARN-126(V)
VHF Nav. No. 2	AN/ARN-126(V)
Tacan No. 1	AN/ARN-139(V)
Tacan No. 2	AN/ARN-118(V)
Satellite Signals Navigation Set (GPS)	AN/ARN-151(V)

Figure 2-87. CNMS Controlled Systems

2.21.3.1 Control Display Navigation Unit (CDNU). CNMS control and status monitoring are accomplished using the Control Display Navigation Units (CDNUs). CDNUs are installed on the flight control pedestal, the copilot side panel and navigator station (see Figures 2-88 and 2-89). The pilot's CDNU is designated as CDNU1, the copilot's is CDNU2, and the navigator's is CDNU3. Any single CDNU has all the required resources to completely operate the CNMS and associated systems. Each CDNU operates as either a bus controller (BC) or a remote terminal/backup bus controller (RT/BBC). The CDNU that receives electrical power first will function as the BC CDNU. The BC CDNU performs navigation computations, builds page displays, communicates with associated equipment, and performs all other computations required to support CNMS and associated systems operations. The RT/BBC CDNUs serve as spare BCs which process keystroke inputs, display pages built by the BC CDNU, and perform continuous built-in-testing (BIT) with any free processor time. CDNU 1 receives 28 Vdc power from the isolated DC bus through the PILOTS CDNU circuit breaker on the pilot's upper circuit breaker panel. CDNUs 2 and 3 receive 28 Vdc power from the essential DC bus through the COPILOTS CDNU and NAV CDNU circuit breakers on the pilot's upper circuit breaker panel.

CAUTION

CDNU1 receives electrical power from the isolated DC bus and should be turned on first to ensure that it serves as the BC controller in the event of power loss or fluctuations to the essential DC bus.

2.21.3.2 CDNU Display. The CDNU display has 8 lines of 22 characters each (see Figure 2-89). Lines 1, 3, 5, and 7 are data lines with a line select key on both the left and right side of the field. Line 2 is reserved for the page title and line 6 is reserved as an annunciation line. Line 4 is an unreserved data line and line 8 is the scratchpad for displaying keypad entries.

2.21.3.2.1 Scratchpad. The scratchpad is used to hold all keystrokes prior to executing the input. Incorrect scratchpad entries may be cleared using the CLR key. A single press of the CLR key clears the last character entered and a second press (without additional intervening keystrokes) will clear the entire scratchpad. Holding the CLR key begins to repeat deletion of one character at a time. The scratchpad is cleared automatically when the system accepts valid data inputs.

2.21.3.3 CDNU Controls. CDNU data entry operations are performed with a full alphanumeric keypad, arrow keys, function keys and eight line select keys (see Figure 2-89). Each CDNU provides simultaneous and independent operation; meaning that one CDNU can be used to display systems status while another is being used to edit the flight plan. The only exception to the simultaneous and independent operation involves system annunciations on Line 6 of all CDNUs simultaneously. Symbolic aids are used to indicate what entries can be made, what functions are on or engaged, and what selections are possible. Figure 2-90 lists several symbol aids and their definition.

2.21.3.3.1 OFF/ON. The rotary knob on the lower right side of the CDNU display screen turns CDNU power on and off.

2.21.3.3.2 BRT. The rotary knob on the lower left side of the CDNU display controls the intensity and brightness of the CDNU display.

2.21.3.3.3 Line Select Keys. These keys can be used to access lower level pages, toggle modes of a function, or enter data in an associated field. For certain functions, line selects may be used both for selecting a mode and for input of numeric values used by the mode. If the scratchpad is blank, pressing the line select toggles the mode. If the scratchpad is not blank, pressing the line select will input numeric data (if valid) and will not toggle the mode. When undefined line selects are pressed, no operation is performed.

2.21.3.3.4 Alphabetic, Numeric and Punctuation Keys. These keys allow for data entry into the scratchpad. The period (.) and slash (/) keys are used to enter navigational data. The dash (–) key can be used to delete input data or to enter negative valued data.

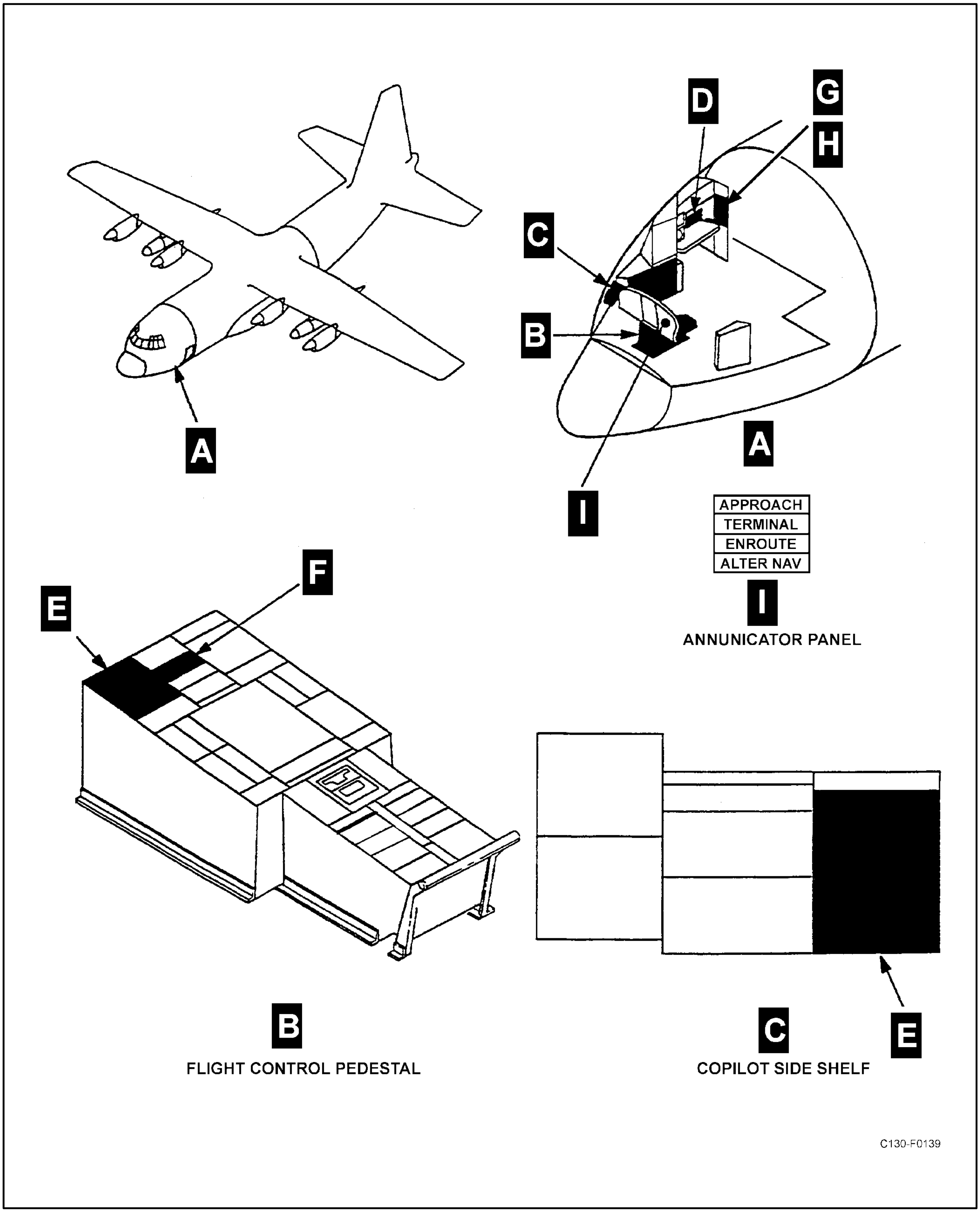


Figure 2-88. CNMS Components Locations (Sheet 1 of 2)

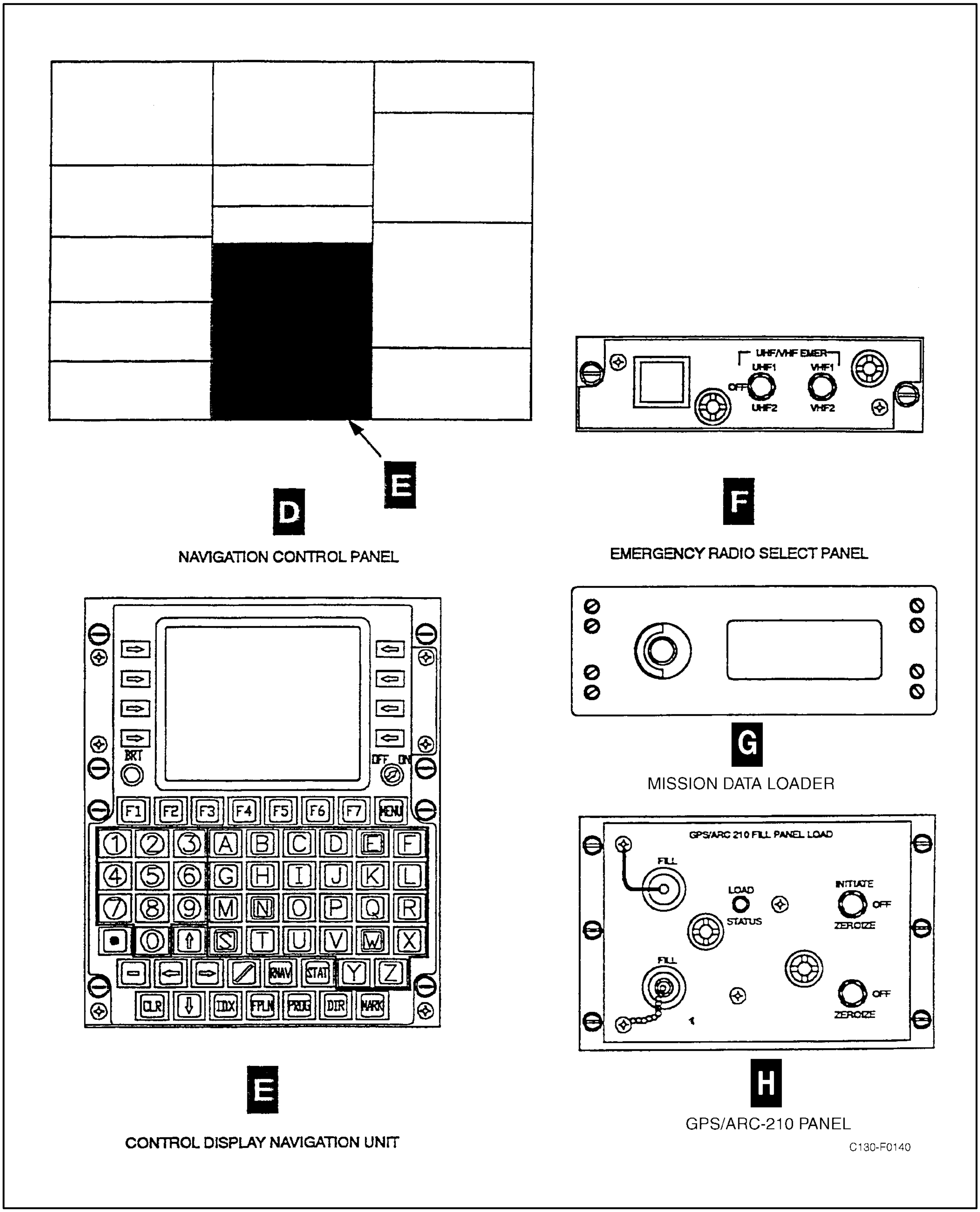
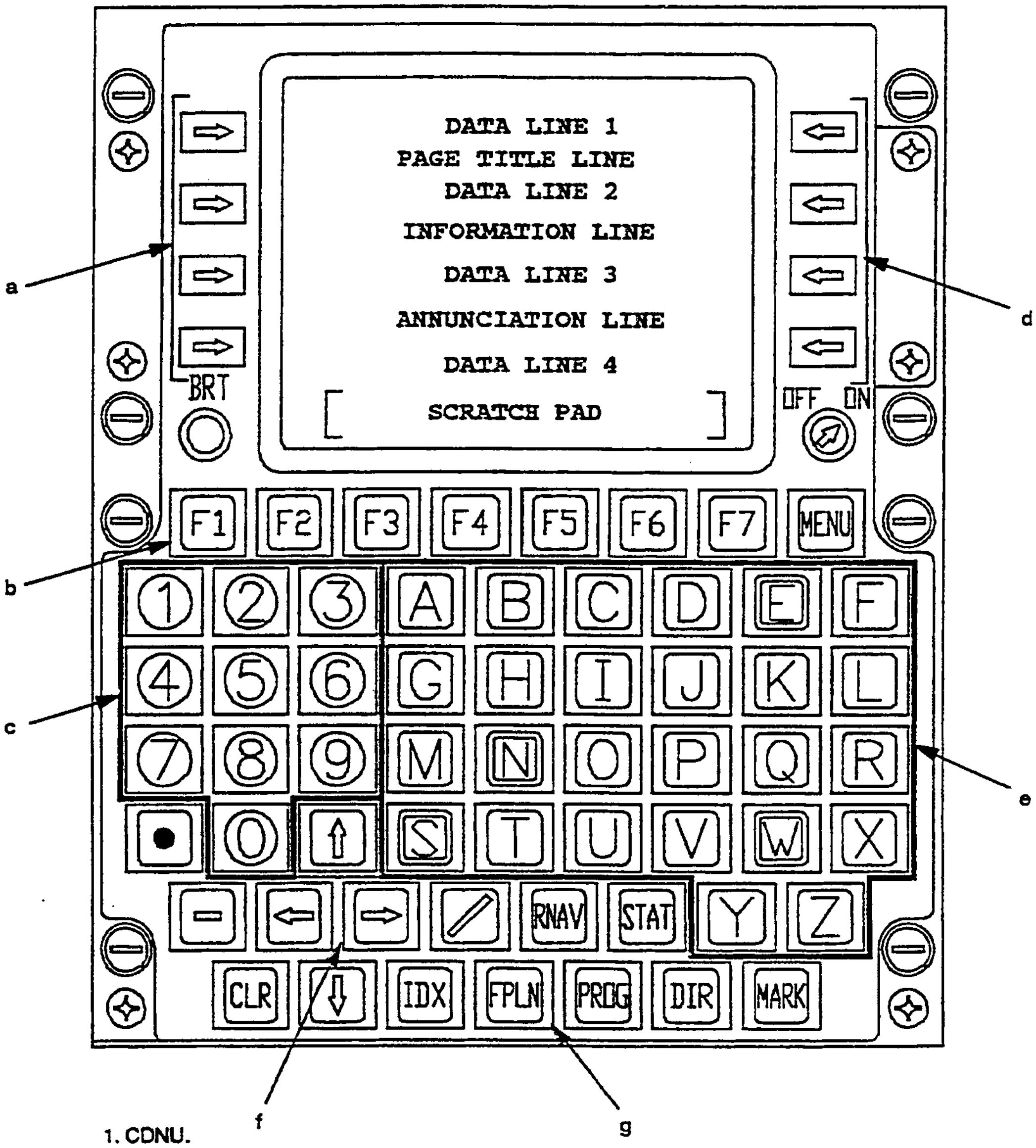


Figure 2-88. CNMS Components Locations (Sheet 2)

Control Display Navigation Unit Front Panel

1. CDNU.



1. CDNU.
   a. Line select keys 1–4
   b. Special function keys
   c. Numeric keys
   d. Line select keys 5–8
   e. Alphabetical keys
   f. Arrow keys
   g. Direct access keys

C130-F0142

Figure 2-89. Control Display Navigation Unit Front Panel

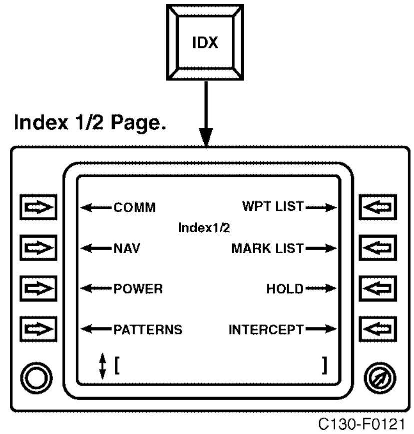
CDNU SYMBOL	DEFINITION
← →	Pushing line select key accessed different page
→ ←	Pushing line select key selects item or enables mode
*	Indicates function is engaged or enabled
:	Alternate selection among modes
✓	Check, as in check status for equipment failures
– – –	Indicates no computed data is available or power is off
[ ]	Indicates data entry from scratch-pad is possible or required
↕	Indicates vertical page or line scrolling is possible
↔	Indicates lateral page scrolling is possible
✥	Indicates lateral and vertical page scrolling is possible

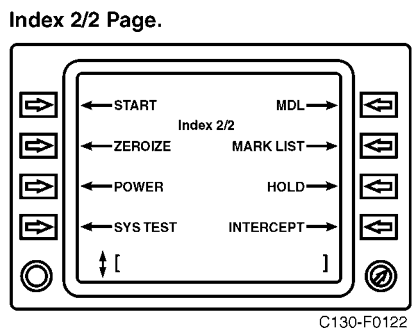
Figure 2-90. CDNU Symbology

2.21.3.3.5 Special Function Keys. Keys F1 through F7 are special function keys. The functions of each key are shown in Figures 2-91 and 2-92.

2.21.3.3.6 Direct Access Keys. The direct access keys consist of RNAV (area navigation), STAT (system status), IDX (index), FPLN (flight plan), PROG (progress), DIR (direct to), MENU (menu), and MARK (current position to scratchpad). The direct access keys provide access to various functional CDNU pages as shown in Figures 2-91 and 2-93.

1. INX — Index pages provide access to a variety of Utility pages (see Figure 2-91 and paragraph 2.21.3.4) and support functions required to operate and test system hardware.





2. FPLN — The Flight Plan page is the center of the navigation function, providing access not only to the flight plan itself, but also to the associated functions in support of flight plan maintenance and execution. This key provides for display of the flight plan on CDNU. Past and present waypoint data may be accessed using the scroll keys (refer to paragraph 2.21.4.4.3).

3. DIR — Pressing the DIR key causes the CDNU to display flight plan waypoints on the direct to [ ] page. Waypoints may be accessed via the scroll page and selected for direct to navigation with the corresponding line select key (refer to paragraph 2.21.4.4.6).

4. STAT — System Status pages provide information concerning the availability of various system equipment (refer to paragraph 2.21.3.4).

5. PROG — Progress pages indicate where the aircraft is in relation to the desired flight plan and provide guidance to acquire and execute the flight plan (refer to paragraph 2.21.4.4.5).

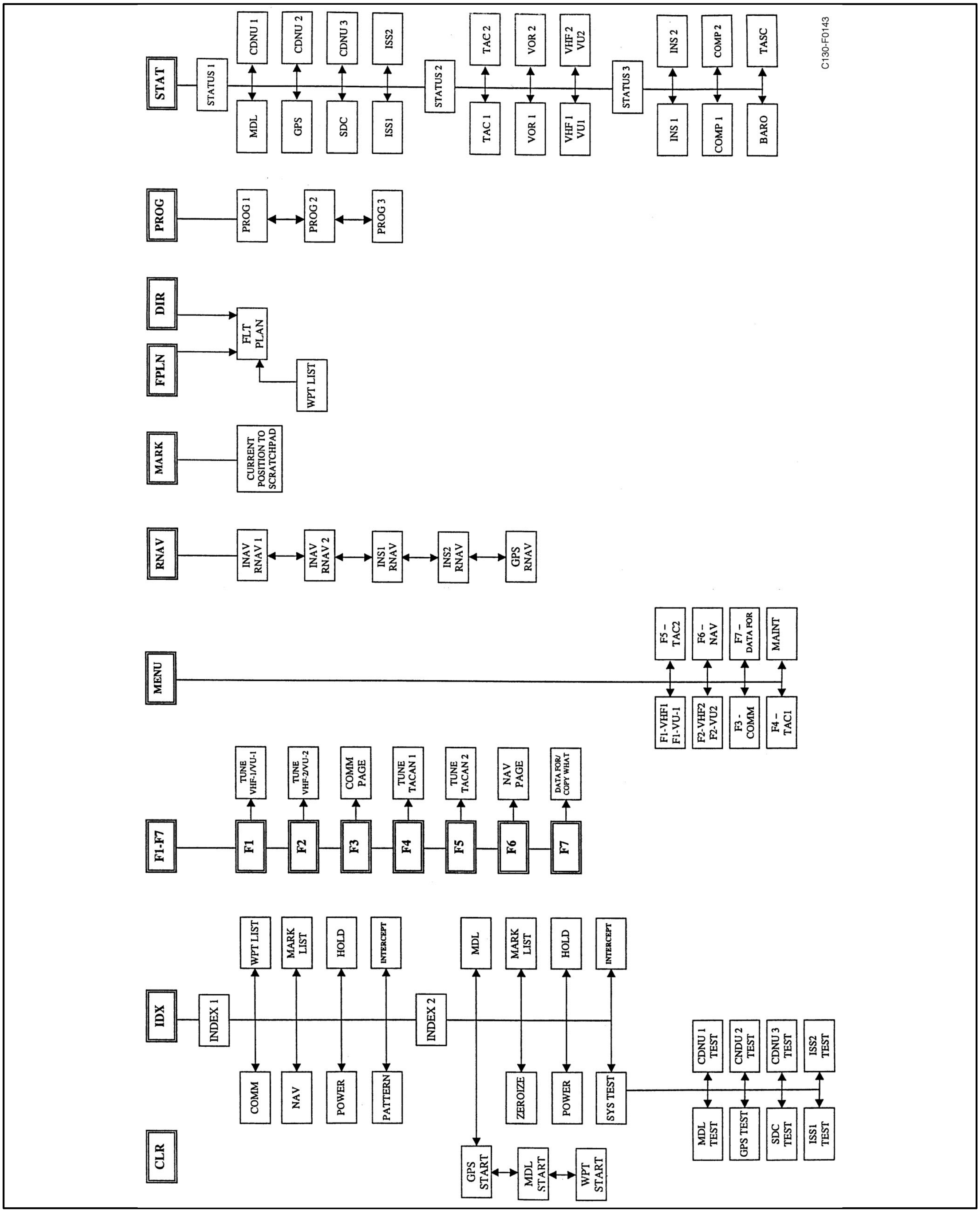
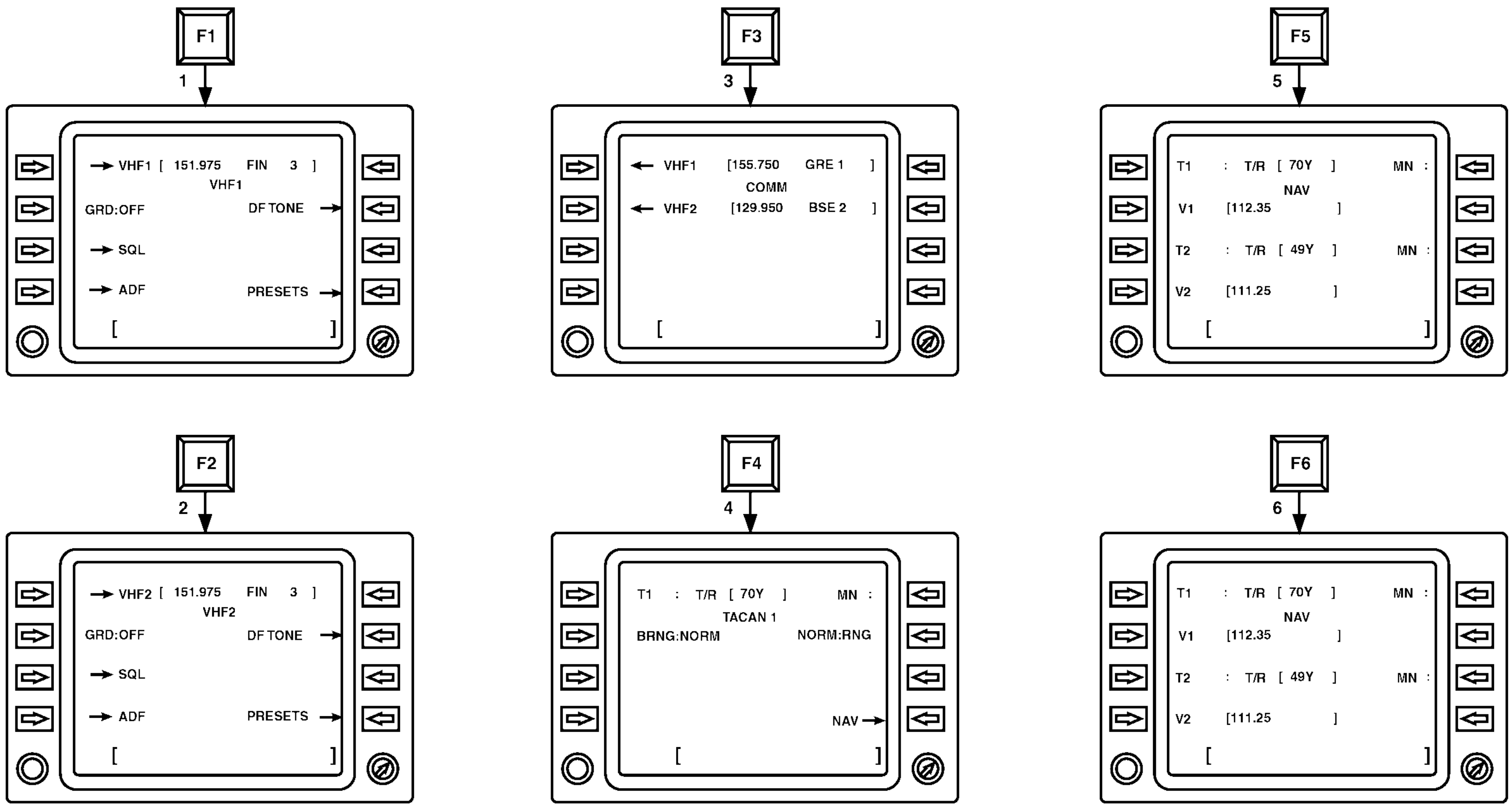


Figure 2-91. CDNU Page Tree

Special Function Keys

AN/ARC-210(V) not installed



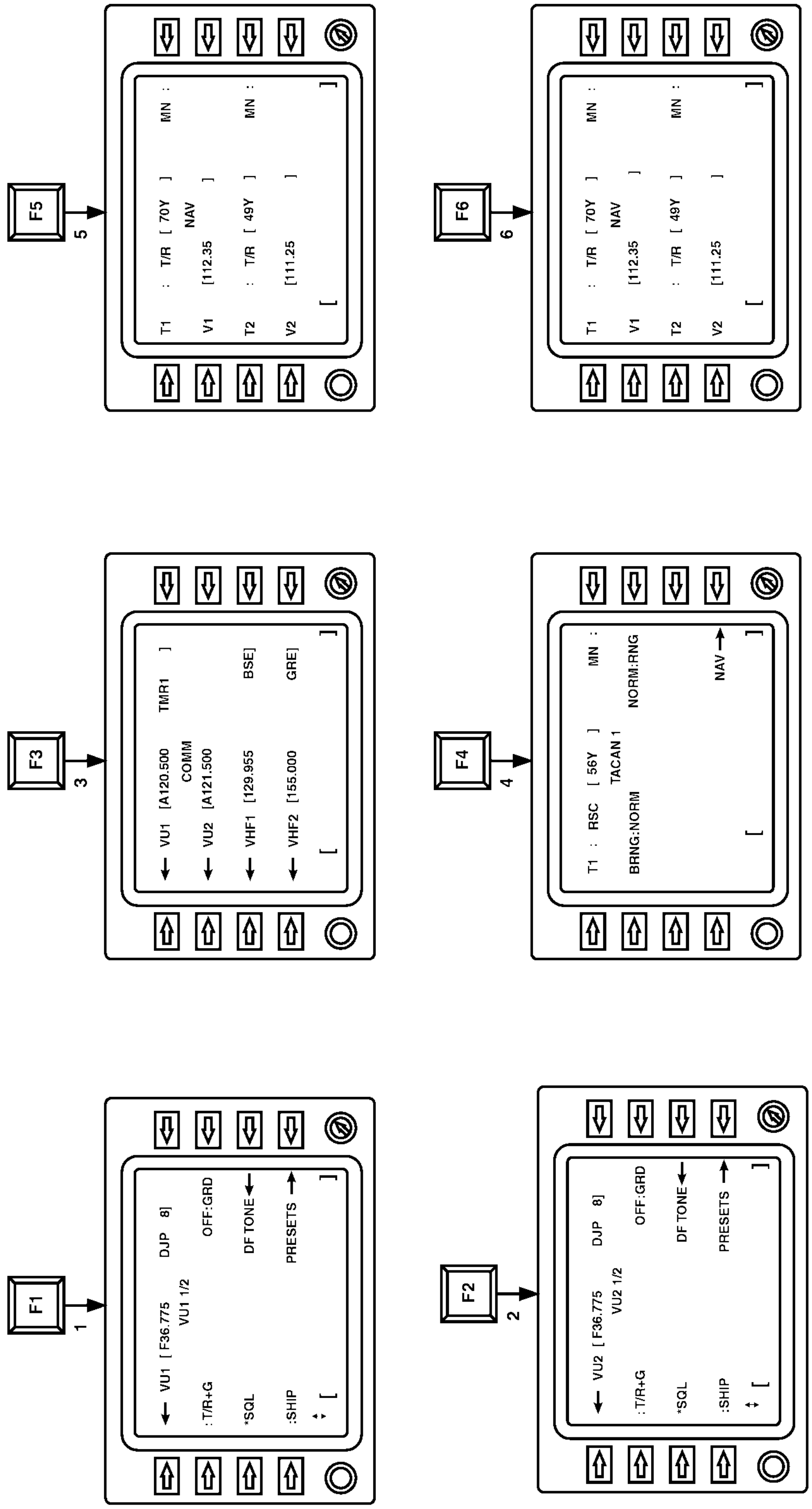
1. Provides quick method in tuning VHF1. Pressing F1 with valid frequency in scratch pad will tune VHF1 to selected frequency. If F1 is pressed with blank scratch pad, VHF1 Page will be displayed.
2. Provides quick method in tuning VHF2. Pressing F2 with valid frequency in scratch pad will tune VHF2 to selected frequency. If F2 is pressed with blank scratch pad, VHF2 Page will be displayed.
3. Provides access to Comm Page.
4. Provides quick method in tuning TAC1. Pressing F4 with valid frequency in scratch pad will tune TAC1 to selected frequency. If F4 is pressed with blank scratch pad, NAV Page will be displayed.
5. Provides quick method in tuning TAC2. Pressing F5 with valid frequency in scratch pad will tune TAC2 to selected frequency. If F5 is pressed with blank scratch pad, NAV Page will be displayed.
6. Provides access to Nav Page.
7. Pressing F7 alternately writes DATA FOR? and COPY WHAT? into scratch pad permitting access to detailed way point data page or copying a way point with all associated attributes into scratch pad.

C130-F0144

Figure 2-92. Special Function Keys [AN/ARC-210(V) Not Installed] (Sheet 1 of 2)

Special Function Keys

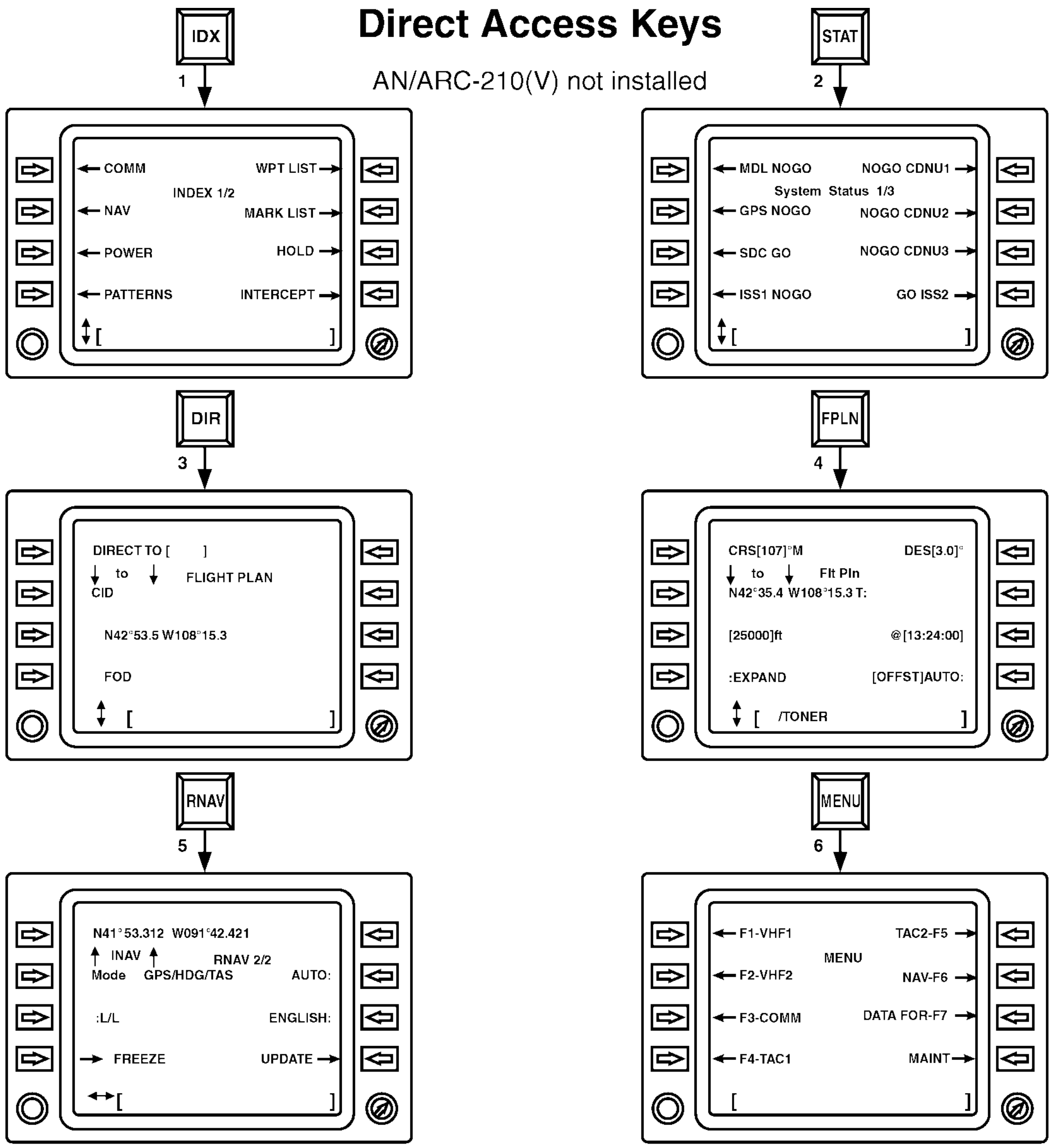
AN/ARC-210(V) installed

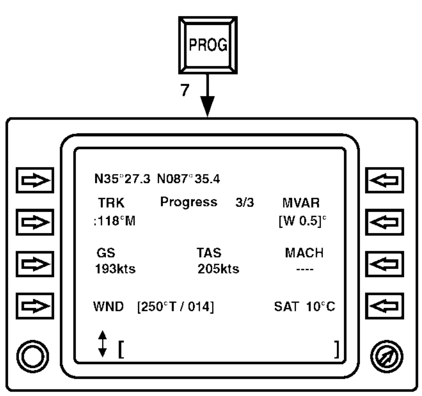


1. Provides quick method in tuning VU1. Pressing F1 with valid frequency in scratch pad will tune VU1 to selected frequency. If F1 is pressed with blank scratch pad, VU1 Page will be displayed.
2. Provides quick method in tuning VU2. Pressing F2 with valid frequency in scratch pad will tune VU2 to selected frequency. If F2 is pressed with blank scratch pad, VU2 Page will be displayed.
3. Provides access to Comm Page.
4. Provides quick method in tuning TAC1. Pressing F4 with valid frequency in scratch pad will tune TAC1 to selected frequency. If F4 is pressed with blank scratch pad, NAV Page will be displayed.
5. Provides quick method in tuning TAC2. Pressing F5 with valid frequency in scratch pad will tune TAC2 to selected frequency. If F5 is pressed with blank scratch pad, NAV Page will be displayed.
6. Provides access to Nav Page.
7. Pressing F7 alternately writes DATA FOR? and COPY WHAT? into scratch pad permitting access to detailed way point data page or copying a way point with all associated attributes into scratch pad.

C130-F0145

Figure 2-92. Special Function Keys [AN/ARC-210(V) Installed] (Sheet 2)

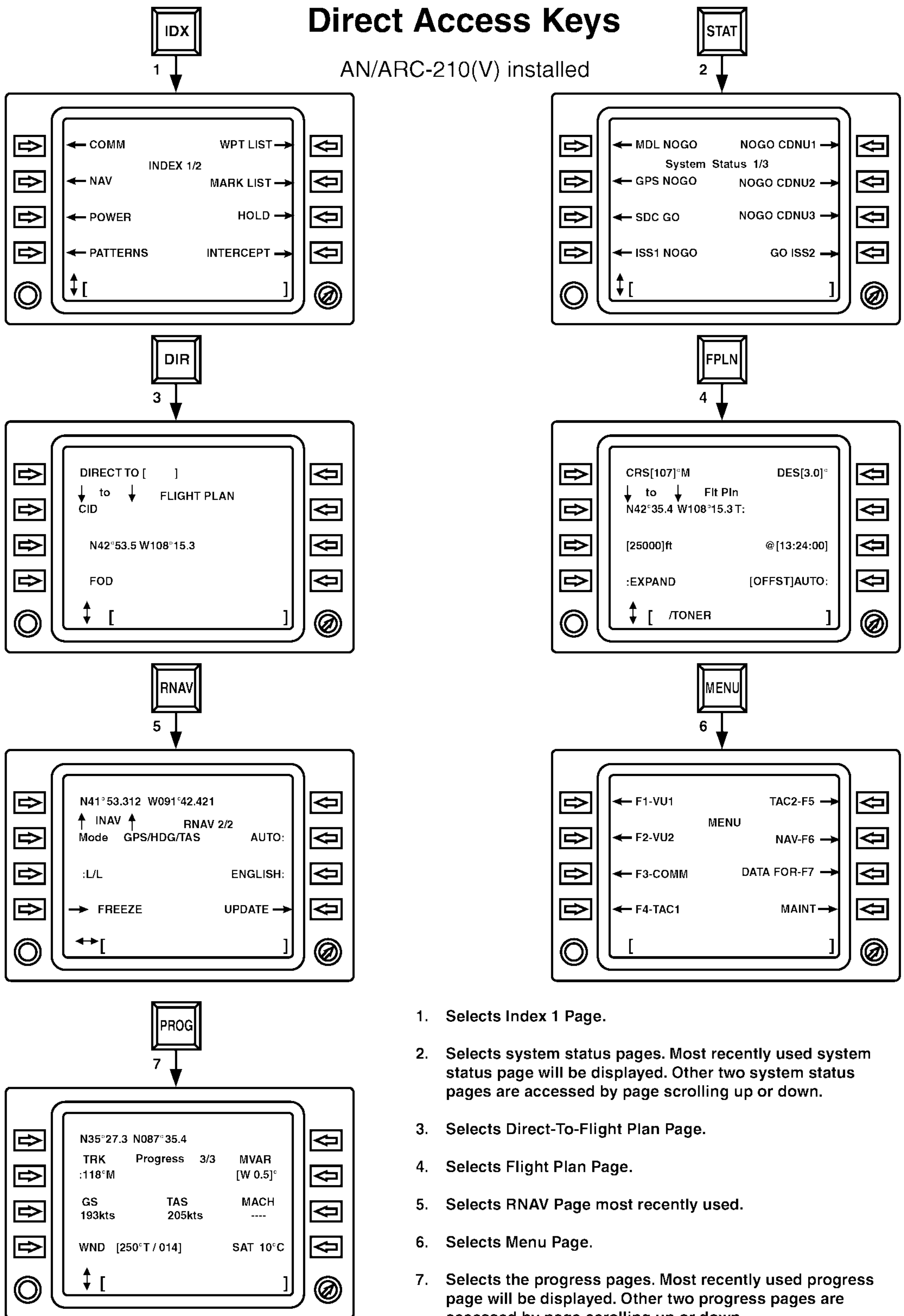




1. Selects Index 1 Page.
2. Selects system status pages. Most recently used system status page will be displayed. Other two system status pages are accessed by page scrolling up or down.
3. Selects Direct-To-Flight Plan Page.
4. Selects Flight Plan Page.
5. Selects RNAV Page most recently used.
6. Selects Menu Page.
7. Selects the progress pages. Most recently used progress page will be displayed. Other two progress pages are accessed by page scrolling up or down.

C130-F0146

Figure 2-93. Direct Access Keys [AN/ARC-210(V) Not Installed] (Sheet 1 of 2)



1. Selects Index 1 Page.
2. Selects system status pages. Most recently used system status page will be displayed. Other two system status pages are accessed by page scrolling up or down.
3. Selects Direct-To-Flight Plan Page.
4. Selects Flight Plan Page.
5. Selects RNAV Page most recently used.
6. Selects Menu Page.
7. Selects the progress pages. Most recently used progress page will be displayed. Other two progress pages are accessed by page scrolling up or down.

C130-F0147

Figure 2-93. Direct Access Keys [AN/ARC-210(V) Installed] (Sheet 2)

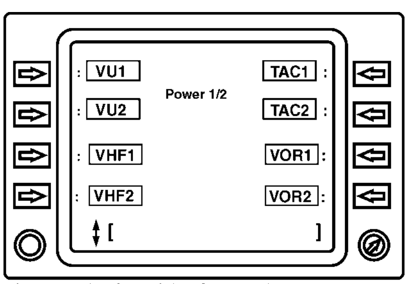
6. RNAV — The Area Navigation pages provide control and display or individual navigation sensors and how they are integrated to form the navigational solution (refer to paragraph 2.21.4.4.4).

7. MARK — The mark key writes the instantaneous present position solution of the system integrated navigation solution into the scratchpad.

8. MENU — The Menu Page provides a list of the functions associated with the special function keys.

2.21.3.4 CDNU Utility Pages. The CDNU utility pages consist of the Power, Zeroize, Start, Systems status and Systems test pages. These pages are accessed via the IDX and STAT direct access keys. They provide for overall operation and test of the CDNU and CNMS associated equipment.

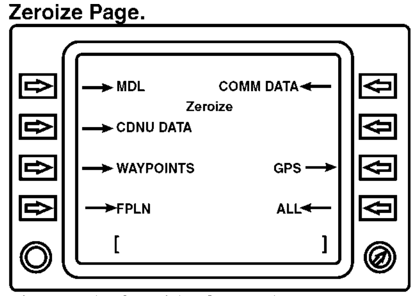
1. Power page — The Power page gives the operator control of system power for CNMS navigation and communication equipment. Line select keys next to the system name are used to turn system power on and off. A line box around the equipment name indicates the system is powered.



(WITH AN/ARC-210(V) INSTALLED) C130-F0123

2. Zeroize page — The Zeroize page permits selective zeroing of non-volatile memory in the CDNU, MDL, GPS receiver and AN/ARC-210(V) radio set. In addition to selective blanking, a single key commands a master zeroize of all data stored in the system. All requests for zeroize require confirmation by pressing the associated line select key a second time.

Zeroize Page.

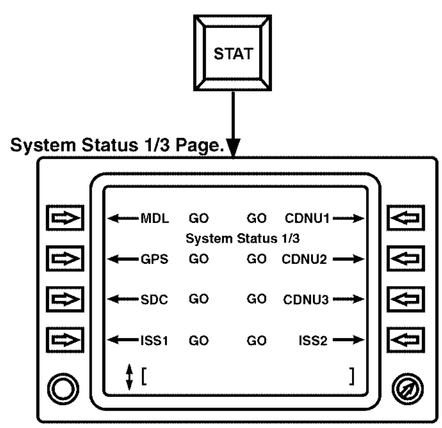


(WITH AN/ARC-210(V) INSTALLED) C130-F0124

Note

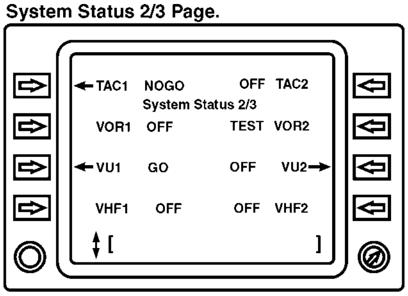
To avoid erasing the operational flight program and rendering the system unusable, flight crew personnel should not select ZEROIZE MDL (LS1) or ZEROIZE ALL (LS8).

3. Systems Status Pages — The CDNU monitors the status of each CNMS component and executes continuous built-in test (CBIT) software which evaluates those items that can be assessed during normal operations with the hardware on-line. This occurs without any required operator action and the results are available for display at all times. When a failure is detected in the CBIT routine, a ✓ STATUS annunciation appears on the line 6 annunciation line. A ✓ XXXX STATUS message is displayed in the scratchpad if operation is attempted which cannot be performed due to conditions causing the ✓ STATUS annunciation. Outputs from a component indicating a failed status are not used for computations or display. Results from CBIT routines are compiled and reported on the Systems Status Pages. Additionally, detailed status pages are available for most components and are indicated by outward pointing arrows on the status pages.



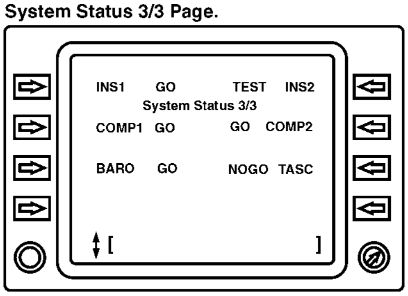
C130-F0125

System Status 2/3 Page.



C130-F0126

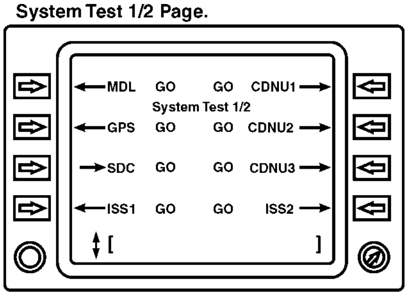
System Status 3/3 Page.



C130-F0127

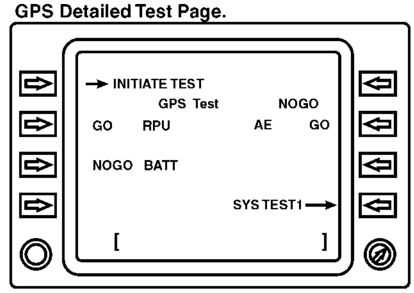
4. System Test Pages — The SYS TEST page provides the capability to BIT test the CDNU, MDL, GPS receiver, ISS and CDNU units. When the line select key is pressed on the SYS TEST page, the CDNU screen will either go to the detailed test page of the associated component or perform the BIT test of that component. Systems with detailed test pages have outward pointing arrows on the SYS TEST page. Tests for systems with inward pointing arrows are initiated when the associated line select is pressed.

System Test 1/2 Page.



C130-F0128

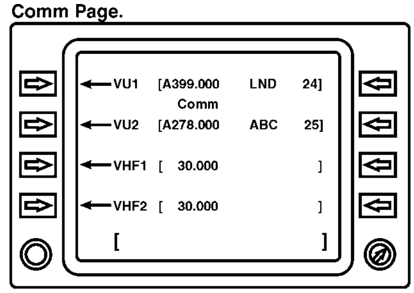
GPS Detailed Test Page.



C130-F0129

5. Comm Page — The comm page controls tuning and other function settings for the VHF 1 and VHF 2 communication systems and also V/U-1 and V/U-2 communication systems for ARC-210 equipped aircraft. The comm page is accessed via the F3 key or via the index page. Tuning is accomplished by entering the appropriate frequency in the scratchpad and then pressing the line select key next to the corresponding radio. Pressing the line select key with no frequency in the scratchpad (blank scratchpad) will access the detailed page for the corresponding radio. Quick tuning can be accomplished by entering the frequency in the scratchpad and pressing F1 for VHF 1/VU-1 or F2 for VHF 2/VU-2. Returning to the previously selected frequency may be accomplished by tuning 0.

Comm Page.

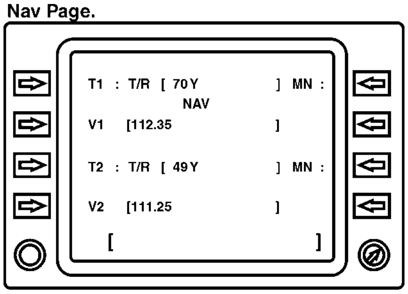


C130-F0130

6. Nav Page — The NAV page controls tuning and basic function settings for the VOR-1, VOR-2, tacan-1 and tacan-2 navigation systems. The NAV page is accessed via the F6 key or via the index page. Tuning is accomplished by entering the appropriate channel/frequency in the scratchpad and then pressing the corresponding left-side line select key. Pressing the line select key with no channel or frequency in the scratchpad (blank scratchpad) will access the detailed page for the

corresponding VOR or tacan. Quick tuning for the tacans can be accomplished by entering the channel in the scratchpad and pressing F4 for tacan-1 or F5 for tacan-2. Returning to the previously selected frequency may be accomplished by tuning 0. Additionally, the operator can also pair TAC-1 to VOR-1 and TAC-2 to VOR-2 for simultaneous tuning to paired NAVAID frequencies. Paired operation is enabled using the right-side line select key next to the respective tacan. The letters “PR” on the CDNU display indicates the paired function is enabled and the paired tacan channel will automatically be tuned to correspond with the VOR frequency; “MN” indicates that the paired function is not enabled.

Nav Page.



C130-F0131

2.21.3.5 Interface Shipsets. Two interface shipsets (ISS) are incorporated with the CNMS to convert analog and discrete signals to the digital format required by the CDNU. The ISS units receive 26 Vac power through the ISS circuit breaker on the pilot’s upper circuit breaker panel. ISS1 receives 28 Vdc power from the isolated DC bus through the ISS NO. 1 circuit breaker and ISS2 receives 28 Vdc power from the essential DC bus through the ISS NO. 2 circuit breaker.

2.21.3.6 Signal Data Converter. The Signal Data Converter (SDC), CV-4138/A, converts serial digital outputs from the CDNU to analog signals used to drive flight instruments, displays and annunciators. The SDC is located in the left-hand cargo bay equipment rack. The SDC receives 115 V and 26 Vac power from the essential AC bus through the SDC circuit breakers on the pilot’s upper circuit breaker panel.

2.21.4 AN/ARN-151(V) Satellite Signals Navigation Set (Global Positioning System). The AN/ARN-151 Satellite Signals Navigation Set is a worldwide all-weather navigation aid that receives and processes navigation information from NAVSTAR GPS satellites. GPS is a space-based radio positioning system that provides its users with highly accurate position, velocity and time data. This service is provided globally, continuously, and under all weather conditions to users. GPS receivers operate passively, thus allowing an unlimited number of simultaneous users. The GPS has features that can deny accurate service to unauthorized users, prevent spoofing and reduce receiver susceptibility to jamming.

WARNING

Use of GPS for approaches or as a primary means of instrument navigation is not authorized at this time. GPS is only authorized as an aid to visual navigation (VFR).

GPS provides the most useful and accurate navigation solution available, but operators are cautioned not to be over-confident of the system. Appropriate cross-checking of GPS with other forms of navigation (INS, VOR, tacan and visual methods) should be employed to ensure safety and mission accomplishment.

2.21.4.1 Theory of Operation. The GPS comprises three major segments: Space, Control and User. The Space segment consists of a constellation of GPS satellites in orbit around the Earth. Each satellite broadcasts radio-frequency ranging codes and a navigational data message. The Control segment consists of a Master Control Station (MCS) and a number of monitor stations located around the world. The MCS tracks, monitors and manages the satellite constellation and updates the navigational data messages. The User segment consists of various navigational receivers specifically designed to receive, decode and process the GPS satellite-ranging codes and navigational data messages.

CAUTION

Standard military GPS systems do not provide a navigation integrity function which would monitor and cross check the validity of satellite transmitters and GPS receivers.

The ranging codes broadcast by the satellites enable a GPS receiver to measure the transit time of the signals and thereby determine the range between a satellite and the user. The navigation data message enables a receiver to calculate the position of each satellite at the time of transmission of the signal. Four satellites are generally required to be simultaneously “in-view” of the receiver for three-dimensional (3-D) positioning purposes. Less than four satellites can be used if the user altitude or system time is precisely known.

2.21.4.2 Levels of Service. Two levels of navigation are provided by the GPS, the Precise Positioning Service (PPS) and the Standard Positioning Service (SPS). The PPS is a highly accurate positioning, velocity and timing service that is made available only to authorized users. The SPS is a less accurate positioning and timing service that is available to all GPS users.

2.21.4.2.1 Precise Positioning Service (PPS). The PPS provides 16-meter Spherical Error Probable (SEP) positioning accuracy and 100 nanosecond Universal Coordinated Time (UTC) time transfer accuracy to authorized users. The PPS is primarily intended for military purposes. Authorization to use the PPS is determined by the Department of Defense (DoD), based on U.S. defense requirements and international commitments.

Access to the PPS is controlled by two features using cryptographic techniques. A Selective Availability (S/A) feature (when turned on) is used to reduce the accuracy of the GPS position, velocity and time data available to unauthorized users. S/A operates by introducing controlled errors into the satellite signals. System accuracy degradations can be increased during crises or war. An Anti-Spoofing (A-S) feature is invoked at random times without warning by the U.S. to negate potential spoofing (hostile information) of PPS signals. Encryption keys and techniques are provided to PPS users that allow them to remove the effects of S/A and A-S and thereby attain the maximum available accuracy of GPS. PPS-capable receivers that do not have the proper encryption keys installed will be subject to the accuracy degradations of S/A and potential spoofing or jamming of GPS signals.

CAUTION

- Operate GPS receivers in keyed mode for greater position, velocity and time accuracy as well as improved anti-spoofing and anti-jam capability. Failure to do so may lead to gross navigational errors.

- Aircrews should be aware that GPS is susceptible to intentional and unintentional interference and loss of GPS timing can affect HaveQuick operation.

2.21.4.2.2 Standard Positioning Service (SPS). The SPS provides 100-meter horizontal positioning accuracy to any GPS user during peacetime. SPS receivers can also achieve approximately 337-nanosecond UTC time transfer accuracy. The SPS is primarily intended for civilian purposes, although it has many peacetime military uses as well. The SPS horizontal accuracy specification includes the peacetime degradation of S/A that is the dominant SPS error source.

2.21.4.3 AN/ARN-151(V) System Components. The AN/ARN-151 Satellite Signals Navigation Set consists of the following primary components:

1. GPS receiver
2. Mission Data Loader
3. GPS Fill Panel
4. Control Display Navigation Unit (CDNU)
5. Main Annunciator Panel.

2.21.4.3.1 GPS Receiver. The R-2332/AR GPS receiver is the receiver/processor for the GPS. The receiver decodes satellite signals and provides position coordinates, altitude, speed and time data to aircraft systems. The GPS receiver is located in the LH Cargo Bay Equipment rack. The system receives 115 Vac power from the essential AC bus through the GPS

RCVR circuit breaker and 28 Vdc power from the essential DC bus through the FLT DATA SW PNL and DATA LOADER circuit breakers located on the pilot's upper circuit breaker panel. Three C-cell batteries comprise a battery power supply that is located at the front of the receiver. The battery power supply ensures that critical data in memory will not be lost when aircraft electrical power is secured. A time source and nuclear event detector is also powered by the battery supply.

2.21.4.3.2 Mission Data Loader. The AN/ASQ-215 Mission Data Loader is designed to provide bulk memory storage for military aircraft parameters, waypoint database, and maintenance and avionics initialization data. It consists of an Interface Receptacle Unit (IRU) located in the navigator's sidewall equipment panel (see Figure 2-88) and a Data Transfer Module (DTM). The removable DTM contains data that can be accessed by the CDNU. The MDL provides flight crews with the ability to transfer flight plans, current GPS almanac data and a waypoint database directly to the CDNU.

2.21.4.3.3 GPS Fill Panel. The GPS Fill Panel enables loading of the GPS security codes from a KYK-13 Electronic Transfer Device (see Figure 2-88). These codes enable precision GPS navigation during times when S/A and/or A-S are activated. The fill panel has two switches, one to initiate loading of security codes and one to zeroize existing codes. An LED status indicator on the panel will illuminate briefly when the GPS receiver has accepted the security code. Reaction time is approximately 4 to 5 seconds. Illumination indicates correct parity, but does not indicate that the code is correct. The panel is located in the navigator's sidewall equipment panel.

2.21.4.3.4 Control Display Navigation Unit (CDNU). System control and status monitoring are accomplished using the Control Display Navigation Units (CDNUs). The CDNU is the primary pilot-to-GPS interface. The CDNU performs all control, display, crew data entry, processing and navigation computations for the GPS. CDNUs are installed on the flight control pedestal, the copilot side panel and navigator station. Each CDNU is capable of operating the GPS. GPS information and status is displayed on various CDNU screen pages. Refer to paragraph 2.21.3 for CDNU specifics.

2.21.4.3.5 Main Annunciator Panel. The main annunciator panel is located on the pilot's instrument panel (see Figure 2-88). The annunciator panel has four CNMS/GPS related indicator lights associated with the corresponding flight mode. Flight mode is set by the operator on the CDNU expanded FPLN page. Indicator light and flight modes are as follows:

1. EN ROUTE light: Indicates the aircraft is in the enroute mode. With CDNU selected on the Navigation Selector, two dots of deflection on the HSI equals 4.0 nm. A NAV invalid flag will appear on the HSI if GPS Estimated Horizontal Error (EHE) exceeds 1000 meters.

2. TERMINAL light: Indicates the aircraft is in the terminal mode. With CDNU selected on the Navigation Selector, two dots of deflection on the HSI equals 1.0 nm. A NAV invalid flag will appear on the HSI if GPS EHE exceeds 500 meters.

3. APPROACH light: Indicates the aircraft is in the approach mode. With CDNU selected on the Navigation Selector, two dots of deflection on the HSI equals .3 nm. A NAV invalid flag will appear on the HSI if GPS EHE exceeds 100 meters.

4. ALTER NAV light: Indicates the GPS is not being used as a navigation sensor and errors are no longer bounded to the GPS navigation solution.

2.21.4.4 GPS and CDNU Navigation Operations

2.21.4.4.1 System Power. GPS system power is controlled via the CDNU power page. A rectangle box around the GPS component name indicates the unit is ON.

2.21.4.4.2 Loading GPS Secure Keys. GPS secure keys provide for secure (PPS) operation and are loaded at the GPS fill panel using the KYK-13.

Note

If keying GPS with power applied, ensure date and time are correct as displayed on the GPS Start Page. Keys may not be loaded when GPS IBIT testing is in progress.

1. Connect KYK-13 to FILL connector on GPS Fill Panel.

2. Set KYK-13 address switch to desired setting (1–6).

3. Set KYK-13 Mode switch to ON.

4. Momentarily hold GPS Fill Panel INITIATE/ ZEROIZE switch to INITIATE (parity indicator flashes).

5. On GPS Fill Panel, verify LOAD/STATUS indicator flashes within 5 seconds to indicate successful load.

6. Set KYK-13 Mode switch to OFF.

7. Disconnect KYK-13 from GPS Fill Panel.

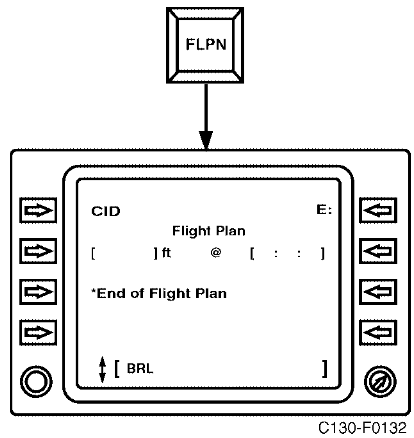
CAUTION

Failure to re-initialize the GPS after loading crypto keys may result in significant navigation errors. After the GPS system has been loaded with crypto keys and has acquired a figure of merit of one or two navigation solution, access the power page of the control display navigation unit and cycle the GPS power off and then back on or access the system test page and perform an initiated built in test on the GPS system. Either of these two procedures will re-initialize the GPS receiver.

2.21.4.4.3 Loading Flight Plans and Waypoints. The CDNU maintains several databases internally and on the MDL cartridge to support flight-planning operations. The crew can create and maintain a flight plan of up to 50 geographic locations, stored in the order to be flown. The flight plan is maintained through addition, modification, or deletion of waypoints. When waypoints are added in the middle of the flight plan, succeeding waypoints are automatically moved down the list. Similarly, when waypoints are deleted, the flight plan automatically eliminates all holes by moving waypoints up the list. The flight plan may be selected and loaded from the MDL or created within the CDNU manually point-by-point.

A magnetic variation database is maintained in the CDNU for conversion of references from True and Magnetic North. This database is automatically transferred from the MDL cartridge each time the cartridge is inserted if it is more recent than the existing CDNU database. Once loaded, a magnetic variation database remains in effect until overwritten by insertion of a new cartridge containing a more recent magnetic variation database.

1. Flight Plan Page — Pressing the FPLN direct access key accesses the Flight Plan page. All information defining the flight plan is available by scrolling through the Flight Plan Page with the up and down arrow keys. Two display modes are available: Expanded display shows full display of waypoint attributes; Compact display shows only horizontal positions.



2. Load a Flight Plan from the MDL

   a. Press IDX key to access Index Page 1/2.

   b. Press down arrow to access Index Page 2/2.

   c. Press LS1 to access Start Pages.

   d. Scroll up/down to MDL Start Page. Select MDL Start Page with corresponding LS key.

   e. Press LS8 to access Flight Plan Select 1/2 Page.

   f. Scroll up/down to desired Flight Plan and select with corresponding LS key.

3. Manual Entry of Waypoints into a Flight Plan

   a. Press FPLN key to access FLIGHT PLAN.

   b. Press down arrow to scroll to desired portion of flight plan.

   c. If MDL is loaded, insert waypoint by typing fix or NAVAID identifier into scratchpad.

d. If MDL is not loaded or waypoint is not in database, enter coordinates into scratchpad (N1234.5W12345.6).

e. Press LS key to place waypoint into flight plan.

Note

Fix coordinates may be assigned a specific label for display vice the underlying coordinates and definition. Enter 2-, 3-, 4-, or 5-letter label into the scratchpad preceded by a slash "/" (i.e. /HOME). Press the LS key adjacent to waypoint coordinates to assign the label.

4. Deleting Waypoints from the Flight Plan

   a. Press FPLN key to access FLIGHT PLAN.

   b. Press down arrow to scroll to desired portion of flight plan.

   c. Enter minus symbol (–) into the scratchpad.

   d. Press LS key to place waypoint into flight plan.

Note

Current waypoint cannot be deleted. Use DIRect to follow-on waypoint.

5. Calculate Waypoint Lat/Long from Radial/DME Information

   a. Enter base NAVAID as a waypoint.

   b. Enter radial/DME information into scratchpad (e.g. 150/10).

   c. Press LS key of NAVAID waypoint.

   d. Scratchpad will display calculated coordinates of the radial/DME fix.

   e. Verify the accuracy of the calculated position using navigation charts.

   f. Enter calculated coordinates into flight plan and label as required.

6. GPS to INS Crossfill — The CDNU can download up to nine waypoints of a flight plan to the inertial navigation systems (INS). For crossfill to work correctly, the crewmember must first initialize crossfill acceptance as follows:

   a. Press IDX key to access Index Page 1/2.

   b. Press down arrow to access Index Page 2/2.

   c. Press LS1 to access Start Pages.

   d. Scroll up/down to WPT Start Page. Select WPT Start Page with corresponding LS key.

   e. On WPT Start Page, ensure CROSSFILL ENABLE/DISABLE toggle reads ENABLE.

   f. Set INS AUTO/MAN/RMT function select switch to RMT.

   g. Set INS Display Selector Switch to WPT.

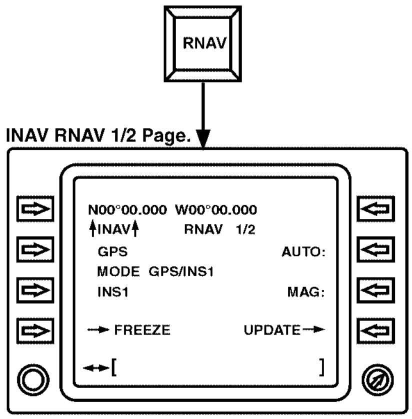
   h. Press TK CHG, then INSERT. Verify 00 flashes in From/To display.

   i. Verify up to 9 waypoints transferred to INS using WPT selector thumbwheel.

   j. Return INS AUTO/MAN/RMT function select switch back to AUTO or MAN.

2.21.4.4.4 Navigation Computations. The function of the area navigation computations is to maintain an estimate of present horizontal position and velocity. This is done using integrated navigation (INAV) computations that determine the method of computing the position and velocity depending on the availability of sensor data.

INAV computations are displayed and controlled via the RNAV pages. INAV RNAV pages 1 and 2 display and control data for integrated navigation. There are two INAV modes available: AUTOmatic and MANual. In MANual, a colon (:) will appear adjacent to LS2 allowing the operator to toggle between GPS, INS1 or INS2 as the primary sensor. The default setting is GPS. In AUTOmatic, the primary sensor and navigation mode will be automatically selected. Lateral scrolling from the INAV RNAV pages will access the GPS RNAV, INS1 RNAV and INS2 RNAV pages that display specific sensor navigation data; including GPS EHE, FOM and number of satellites, and sensor deviation from the INAV solution.



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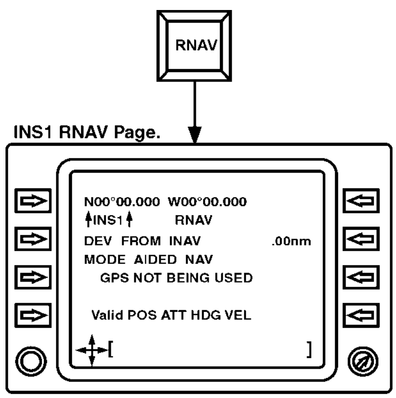

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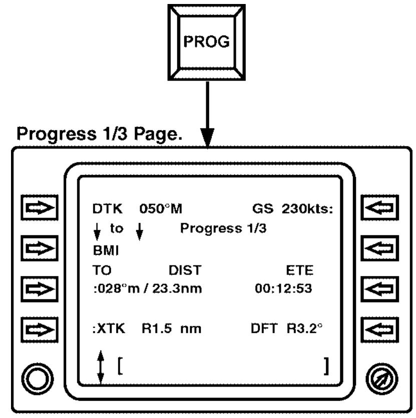
2.21.4.4.5 Flight Progress Monitoring. In-flight navigation guidance and tracking information relative to the current waypoint can be obtained from the PROGress pages. The PROGress pages provide detailed situation awareness displays to indicate the current aircraft position, TAS, groundspeed, waypoint bearing and distance, waypoint ETE, wind, course deviations, etc. Progress pages are accessed via the PROG direct access key and vertical scrolling arrow keys. Progress Page 1 provides lateral guidance information relative to the flight plan, Progress Page 2 provides vertical information relative to VNAV functions, and Progress Page 3 displays aircraft operating conditions that are independent from the flight plan. Basic navigational data (bearing, distance and ETE) for flight plan follow-on waypoints may be obtained by accessing the FPLN page and pressing the LS key next to the corresponding waypoint.



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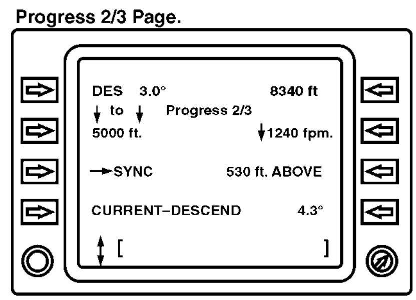

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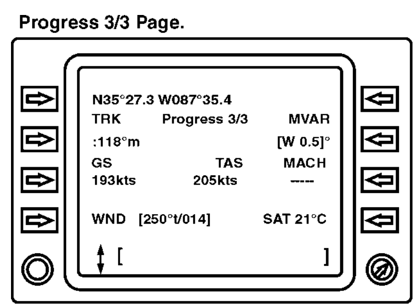

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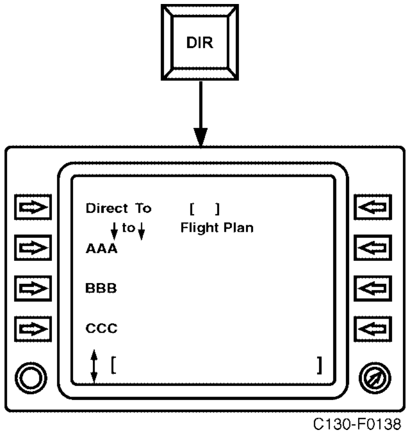
2.21.4.4.6 Direct-To Courses. Direct-To courses are used to either bypass existing waypoints in the flight plan or to insert an impromptu waypoint, interrupting the current leg. Direct-To operations are accessed via the DIR direct access key.

1. Press DIR to access DIRECT TO page.
2. Press up/down arrow keys to display desired waypoint.
3. Press LS key adjacent to desired waypoint.



2.21.5 AN/ARC-186(V) VHF AM-FM Radio. The VHF AM-FM communication system consists of a transceiver and a control panel. Manual frequency selection of 4,080 channels is available in the range of 30.000 MHz to 87.975 MHz in the FM band, and in the range of 108.000 MHz to 151.975 MHz in the AM band. Twenty preset channels are also available, as well as FM and AM emergency channels. Channel selection is provided from the VHF communication/navigation control panel located on the flight control pedestal. The No. 1 VHF radio receives 28-Vdc power from the isolated dc bus through the VHF COMM NO. 1 circuit breaker on the copilot upper circuit breaker panel. The No. 2 VHF radio receives 28-Vdc power from the essential dc bus through the VHF COMM NO. 2 circuit breaker on the copilot upper circuit breaker panel.

2.21.5.1 VHF AM-FM Radio Tuning and Control. The VHF radios are tuned and controlled via the CDNU Comm page or detailed VHF page. System power is controlled via the CDNU Power page (a box around the system name indicates the unit is powered). The Comm page is accessed via the F3 key or via the index page. Tuning is accomplished by entering the appropriate frequency in the scratchpad and then pressing the line select key next to the corresponding radio. Pressing the line select key with no frequency in the scratchpad (blank scratchpad) will access the detailed page for the corresponding radio. Quick tuning of the VHF radios on aircraft without ARC-210 radios (aircraft without AFC-338) can be accomplished by entering the frequency in the scratchpad and pressing F1 for VHF 1 or F2 for VHF 2. Pressing the F1 or F2 keys with no frequency in the scratchpad will access the corresponding detailed VHF page (or the detailed V/U page for aircraft after AFC-338). Returning to the previously selected frequency may be accomplished by tuning 0. For additional functions and controls of the VHF radios, refer to Figure 2-94.

2.21.5.2 Normal Operation of the VHF AM-FM Radio. Operate the VHF radio as follows:

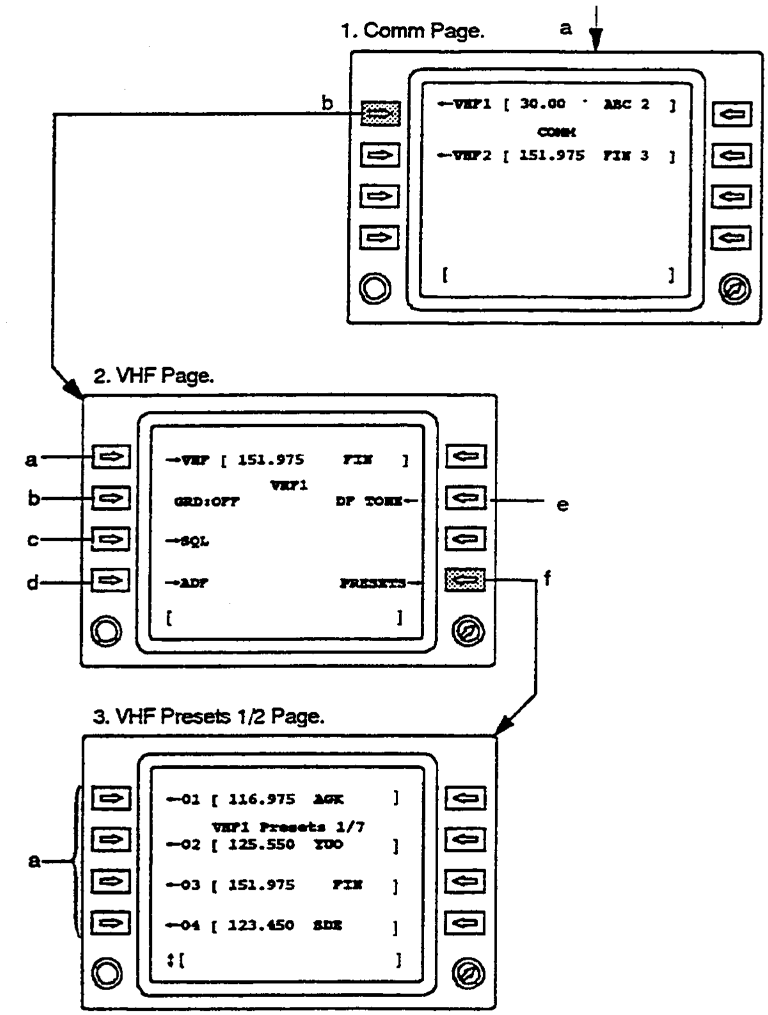
1. Tune desired frequency in VHF 1 or VHF 2 via the CDNU.
2. To receive, pull the corresponding VHF push-pull mixer switch on the intercommunication control panel (ICS).
3. Adjust squelch (via CDNU) and volume (via individual mixer switch or master volume knob on ICS panel).
4. To transmit, place the transmission selector on the ICS panel to the VHF 1 or VHF 2 position.

2.21.6 AN/ARC-159(V)1 UHF Command Radio (Aircraft Not Modified by AFC-338). Two UHF command radio sets, designated UHF No. 1 and UHF No. 2, provide voice transmission and reception in the frequency range of 225.000 to 399.975 MHz, with 7,000 frequencies in steps of 25 kHz. Receiver and transmitter tuning is accomplished automatically after a frequency change. In addition, the UHF radio set is capable of guard frequency reception and transmission and ADF reception. The guard receiver module is self-contained, fix tuned, set to a guard frequency, and can receive simultaneously with the main receiver. The No. 1 UHF command radio operates from 28-Vdc power from the isolated dc bus through the UHF NO. 1 circuit breaker on the copilot upper circuit breaker panel. The No. 2 UHF command radio operates from 28-Vdc power from the essential dc bus through the UHF NO. 2 circuit breaker on the copilot upper circuit breaker panel.

2.21.6.1 UHF Command Radio Controls

2.21.6.1.1 Radio Controls. The two UHF command radios (see Figure 2-95), located on the flight control pedestal and the copilot side shelf extension, provide operating controls on the radio. The four-position (OFF, MAIN, BOTH, ADF) function switch permits selection of the operational mode of the radio. In the MAIN position, the main receiver and transmitter are operational. In the BOTH position, the functions are operational and the guard receiver is turned on. The

Comm Page
[AN/ARC-210(V) not installed]



1. Comm Page.
   a. Access Comm Page via Index 1/2 Page.
   b. Accesses VHF1 Page. LS2 provides same function for VHF2.
2. VHF Page (VHF1 Page shown).
   a. Tunes radio if valid frequency is entered in scratch pad. If scratch pad is blank, Comm Page is accessed.
   b. Toggles guard (GRD) options:
      1) OFF
      2) AM: Selects guard frequency 121.500 MHz AM
      3) FM: Selects guard frequency 40.500 MHz FM
   c. Toggles squelch on and off:
      1) →SQL= off
      2) *SQL = on
   d. Toggles ADF mode on and off:
      1) →ADF = off
      2) *ADF= on
   e. Toggles DF Tone on and off:
      1) DF TONE ←= off
      2) DF TONE *:= on
   f. Accesses VHF Presets page.
3. VHF Presets Page (7 total VHF Presets pages)
   a. Pressing LS1–LS4 with valid frequency in scratch pad inserts frequency into associated preset position. Pressing LS1–LS4 with blank scratch pad tunes radio to associated preset frequency.

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Figure 2-94. VHF Comm Page [AN/ARC-210(V) Not Installed]

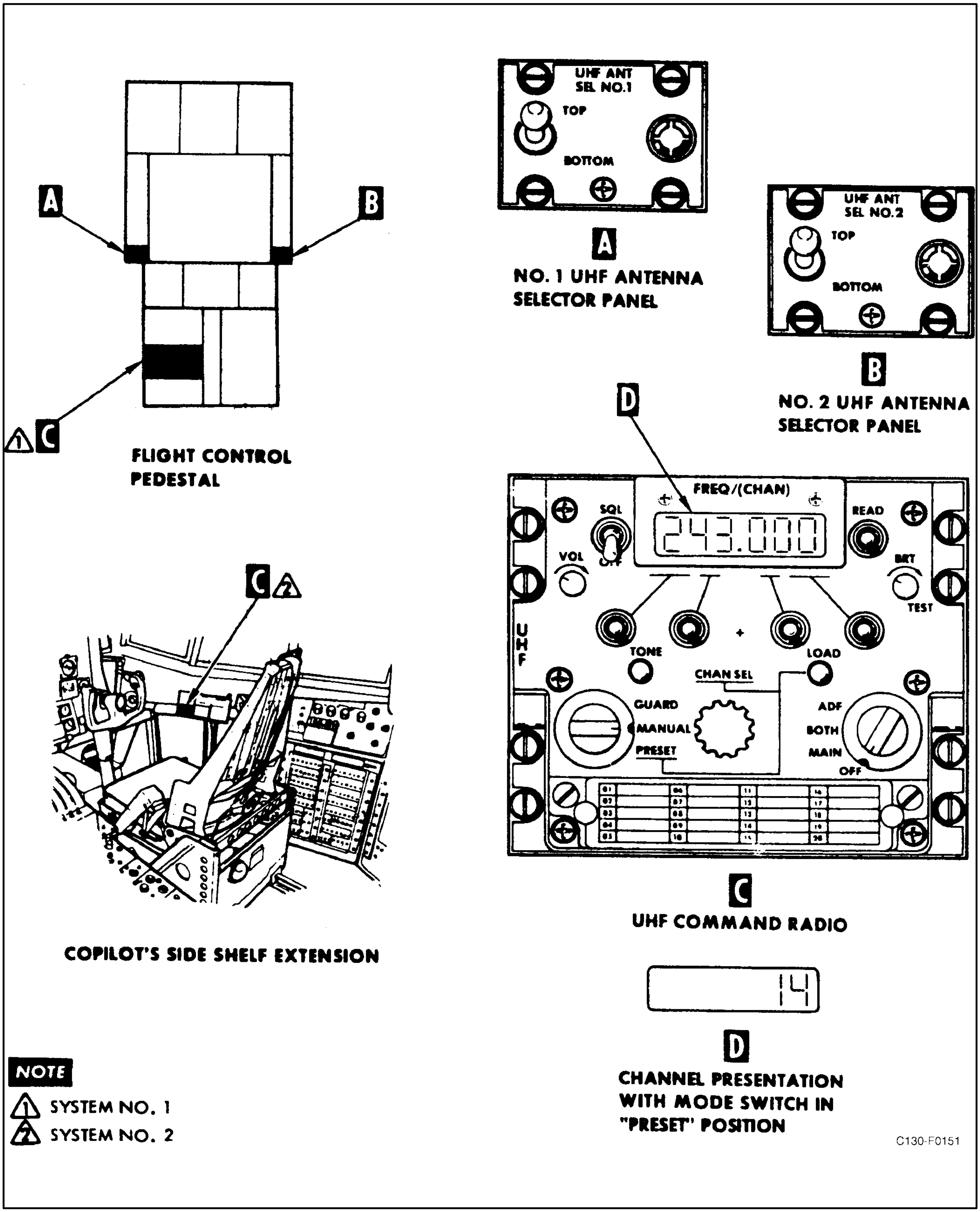


Figure 2-95. AN/ARC-159(V)1 UHF Command Radio Control Panels

ADF position on the No. 1 UHF radio activates the UHF direction finder.

The three-position (PRESET, MANUAL, GUARD) mode selector switch determines frequency selection and permits indication of frequency and/or channel selection. The PRESET position permits one of 20 preset channels to be selected with the preset channel selector knob and displays the channel selected on the readout indicator. The MANUAL position permits selection of any one of 7,000 frequencies by use of the manual frequency selector switches. The frequency selected is displayed on the FREQ/(CHAN) readout indicator. The preset channel selector knob is ineffective when the mode selector switch is in the MANUAL position. The GUARD position shifts the transceiver to the guard frequency and causes the guard frequency to be displayed on the readout indicator. The preset CHAN SEL and manual frequency selector switches are ineffective when the mode selector switch is in the GUARD position.

Note

- The GUARD position of the mode selector switch should not be used except in actual emergencies.

- When utilizing the radio mode selector (GUARD/MANUAL/PRESET) switch, ensure that the switch is cleanly placed into one of the three detent positions. If the switch is placed between two of the detent positions, the radio FREQUENCY DISPLAY may be either blank or will not display the correct preset channel/frequency. Cycling power to the radio will correct the situation.

The PRESET CHAN SEL knob is used to select any one of 20 preset channels when the mode selector switch is in the PRESET position.

The BRT/TEST knob is used to adjust light intensity of the readout lamps and to test the readout lamps when the switch is positioned to TEST.

The four spring-loaded toggle switches below the readout indicator are used to select the operating frequency when the mode selector switch is in MANUAL.

The VOL knob is used to adjust the level of the audio signal.

The TONE pushbutton, when depressed, causes the transmitter to transmit a 1020-Hz tone signal.

The SQL switch enables or disables the main receiver squelch.

The READ control switch causes the selected preset channel frequency to be displayed on the FREQ/(CHAN) readout indicator.

Preset channel frequency storage is achieved by setting up the desired frequency and channel and then pressing the LOAD control pushbutton switch.

2.21.6.1.2 Antenna Selector Panels. The antenna selector panels (see Figure 2-95) are equipped with a single toggle-type switch that can be set to one of two positions: TOP or BOTTOM. The switch permits manual selection of operation through the top-mounted antenna or bottom-mounted antenna.

2.21.6.2 Normal Operation of the UHF Command Radio. To put the radio into operation, proceed as follows:

1. Place the function selector switch to MAIN or BOTH.
2. Allow 1 minute for warmup.
3. Select a channel using the channel selector knob or a frequency using the manual frequency selector switches.
4. To receive only, activate the respective UHF monitor switch-volume knob on the ICS control panel; turn the knob to the midrange position.
5. Adjust the volume as necessary with the VOL knob on the UHF radio control panel to obtain a comfortable reception level.
6. To transmit and receive, place the transmission selector switch on the ICS control panel to UHF.
7. Select the desired antenna by placing the UHF ANT SEL switch to TOP or BOTTOM.

To turn the radio off:

8. Place the function selector switch to the OFF position.

Note

When operating a UHF communication radio under emergency conditions, set the UHF mode selector switch to GUARD and the function selector switch to MAIN. Do not use the BOTH position since the noise from the two receivers may make the incoming signal unintelligible.

If the equipment fails in some particular function, the remaining workable functions may satisfy minimum requirements for operation. If transmission on a preset channel is not possible, an attempt may be made to use a manually selected channel or the guard frequency. If reception fails on a selected channel, reception on the guard frequency may be tried.

2.21.7 AN/ARC-210 V/UHF Radio (Aircraft Modified by AFC-338). Two V/UHF radio systems, designated V/UHF No. 1 and V/UHF No. 2, provide voice transmissions in the frequency bands and modes listed in Figure 2-96. The No. 1 V/UHF radio operates from 28-Vdc power from the isolated dc bus through the V/UHF COMM NO. 1 circuit breakers (2) on the copilot upper circuit breaker panel. The No. 2 V/UHF radio operates from 28-Vdc power from the essential dc bus through the V/UHF COMM NO. 2 circuit breakers (2) on the copilot upper circuit breaker panel.

2.21.7.1 V/UHF Radio Controls

2.21.7.1.1 Control Display Navigation Unit. The Control Display Navigation Units (Figure 2-97), located on the flight control pedestal and the copilot side shelf extension, provide primary operating control for both V/UHF radios.

2.21.7.1.2 Control Unit. A V/UHF Control Unit (Figure 2-97) is located on the flight control pedestal and is provided for emergency control of the V/UHF COMM No. 1 radio. A list of controls and indicators is provided in Figure 2-98.

2.21.7.1.3 Antenna Selector Panel. The antenna selector panels (Figure 2-97) are equipped with a single toggle-type switch that can be set to one of two positions: TOP or BOTTOM. The switch permits the manual selection of operations through the top-mounted antenna or bottom-mounted antenna.

2.21.7.1.4 Emergency Select Switch Panel. The emergency select switch panel (Figure 2-97) is equipped with two switches that can be set to one of two positions: VHFx or UHFx (x = 1,2). With the switch in the VHF position, the AN/ARC-186 tunes to guard frequency 121.5 MHz. With the switch in the UHF position, the AN/ARC 210 tunes to guard frequency 243 MHz. One switch controls the No. 1 system and the other switch controls the No. 2 system.

2.21.7.1.5 GPS/ARC-210 Fill Panel. The GPS/ ARC-210 fill panel is located between the navigators station and radio operators station (Figure 2-97). For ARC-210 operations, the panel is equipped with a fill connector and a switch. Preset information is loaded into the ARC-210 radio via the fill connector using the CYZ-10 Data Transfer Device (DTD) (Figure 2-99). Zeroization of preset information occurs by momentarily placing the switch in the ZEROIZE position.

MODE	FREQUENCY RANGE	FUNCTIONS
Low VHF (FM)	30 – 87.9875 MHz	Normal Voice, Secure Voice, SINCGARS, Tone Transmission
VHF (AM)	108 – 135.9875 MHz	Normal Voice, Secure Voice, ADF, Tone Transmission, Transmit inhibited from 108 to 117.9875 MHz
VHF (AM/FM)	136 – 155.9875 MHz	Normal Voice, Secure Voice, ADF, Tone Transmission, Default is FM
VHF (FM)	156 – 173.9875 MHz	Normal Voice, Secure Voice, Maritime Operation, Tone Transmission
UHF (AM/FM)	225 – 399.9875 MHz	Normal Voice, Secure Voice, HAVEQUICK, ADF, Tone Transmission, Default is AM

Figure 2-96. Table of AN/ARC-210 Modes

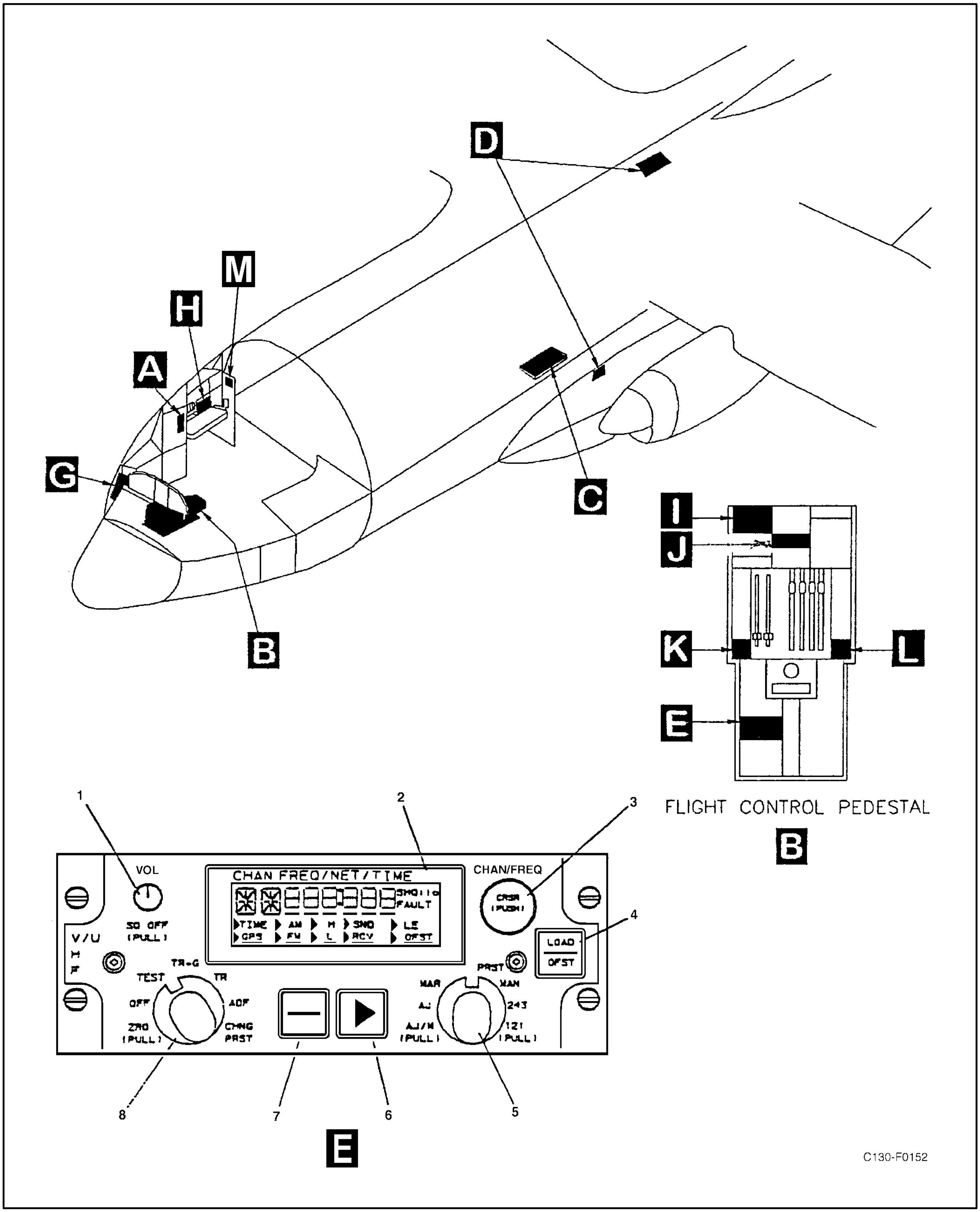


Figure 2-97. AN/ARC-210(V) UHF/VHF Communication System Components Location (Sheet 1 of 2)

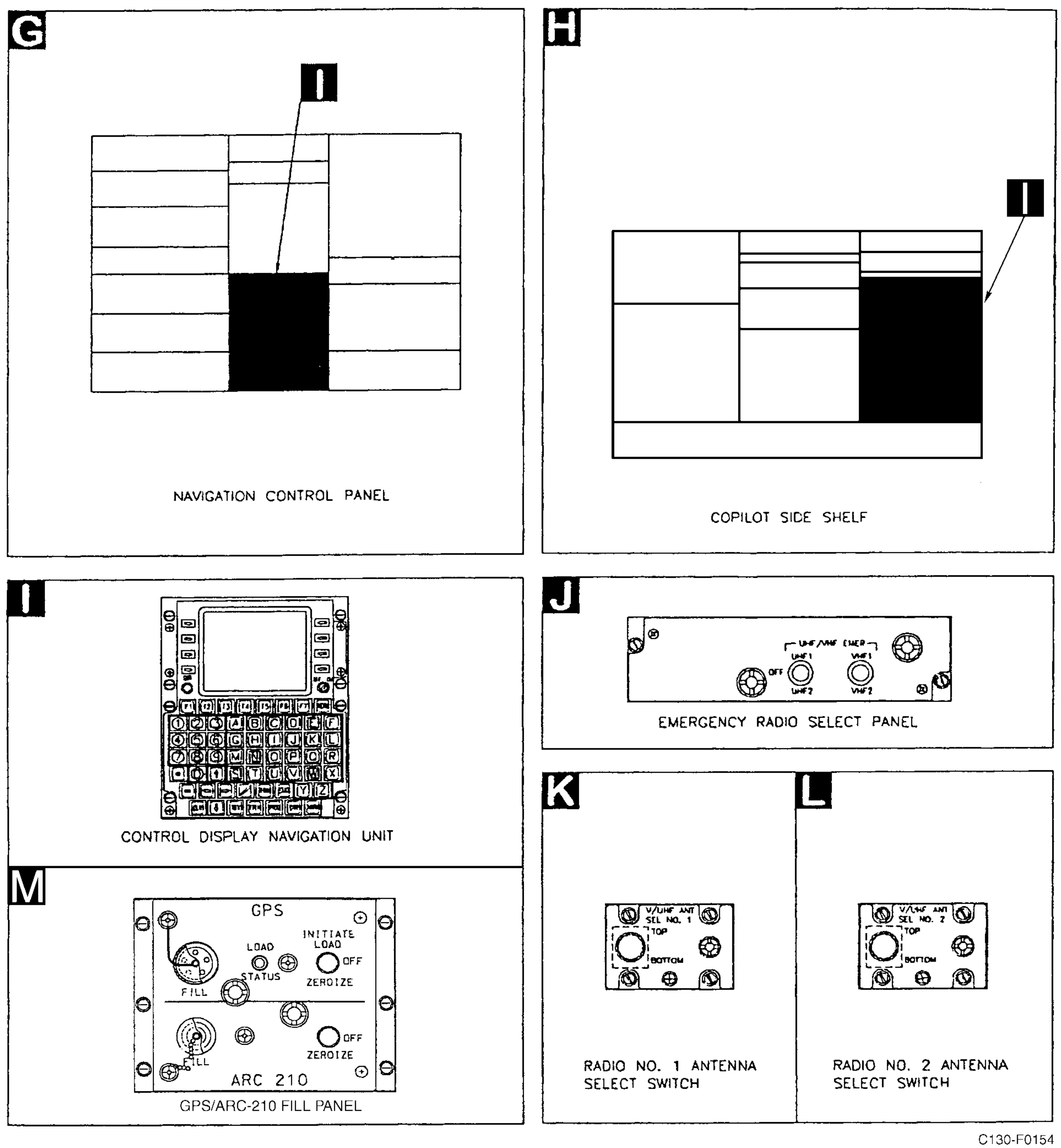


Figure 2-97. AN/ARC-210(V) UHF/VHF Communication System Components Location (Sheet 2)

ITEM	CONTROL/INDICATOR	FUNCTION
1	SQ OFF VOL-(disabled)	SQ OFF push-pull switch disables main receiver squelch in the “out” position and enables squelch in the “in” position.
2	CHAN/FREQ/NET/TIME Display	Liquid crystal module display. Displays channel, frequency, net time, mode, or built-in-test (BIT) results.
3	CHAN/FREQ CSR Selector	CHAN (channel)/FREQ (frequency) CRSR (cursor) pushbutton rotary switch. Each time the switch is depressed, the cursor position changes. Rotating the switch changes the channel or frequency value depending upon the mode selected and the cursor position.
4	LOAD/OFST	Pushbutton switch. When depressed, enables the loading of various data depending upon the mode selected.
5	Frequency Mode Selector	Isolated position rotary switch (knob must be pulled out to enter or exit positions marked PULL). Selects the following frequency modes.
	121 (PULL)	With the rotary switch pulled and placed in the 121 position (pull-to-turn), VHF guard mode is selected. The transmitter and main receiver are tuned to 121.500 MHz (AM). The preset and manual frequency selector controls become inoperative.
	243	With the rotary switch pulled and placed in the 243 position (pull-to-turn), UHF guard mode is selected. The transmitter and main receiver are tuned to 243.000 MHz (AM). The preset and manual frequency selector controls become inoperative. Selection of this mode will also turn on the radio with the operational mode selector in the OFF condition with primary power present.
	MAN	Selects manual frequency select mode. Operator may select any of the radio operating frequencies. The following ancillary modes may also be selected. **NOTE** To select ancillary modes, the ancillary mode pushbutton switch (7) is used to position the cursor under the desired mode, and the pointer pushbutton switch (6) is used to select or deselect the mode.
	Manual Ancillary Modes	
	GPS	Global Positioning System (GPS) time mode. Enables the receipt of time from a GPS Receiver when a CD-17/ARC Frequency Countermeasures Controller is attached to the Receiver-Transmitter.
	AM/FM	AM/FM mode selection. Identifies modulation to be employed in the VHF band 136 to 155.985 MHz and the UHF band 225 to 399.985 MHz.
	SND/RCV	Send (SND) and receive (RCV) mode. Used for over-the-air transfers between radios on the same frequency when the LOAD/OFST pushbutton is depressed. HAVEQUICK TOD may be transferred with the radio operating frequency in the UHF range. SINCGARS ERF may be transferred if the radio operating frequency is in the VHF-FM (30–87.975 MHz) range. This switch is also used for Emergency Start time.
	OFST	Offset mode. Enables the selection of any frequency in the valid operating bands from 30 to 399.975 MHz in 5-kHz steps. Offsets of 0 kHz, ±5 kHz and ±10 kHz can be selected after the pointer is placed in front of the OFST menu selection, and pressing the LOAD/OFST pushbutton switch to increment in 5 kHz steps.

Figure 2-98. AN/ARC-210(V) V/UHF Control Unit Functions (Sheet 1 of 3)

ITEM	CONTROL/INDICATOR	FUNCTION
5 (cont.)	Manual Ancillary Modes (cont.)	
	PRST	Preset mode. Using the CHAN/FREQ switch, the operator may select up to 25 preset channels (1 through 25) for simplex operation. The selected channel, frequency, and modulation type (AM/FM) is displayed. SCAN mode is selected when SCAN is displayed. Preset channels 22 through 25 are scanned. Channel 22 is the command channel and 23 through 25 are secondary channels. When a signal is detected on a scan channel, the channel number and frequency are displayed. Depressing LOAD/OFST during scanning will RESULT in the selection of the last active channel. Depressing LOAD/OFST a second and/or third time will tune the Receiver-Transmitter to the last active second and/or third channel. Depressing the LOAD/OFST a fourth time will resume scanning operations. The same ancillary modes described for MAN mode are also available in the PRST.
	MAR	Maritime mode. Operator may select any one of the 57 preset maritime channels (channels 1 through 28 and 60 through 88). Maritime channel and transmit frequency are displayed. Alternately depressing the LOAD/OFST pushbutton while in the MAR mode changes transmit frequency and station operation from shore to ship-station and back.
	AJ	ECCM AJ (Anti-Jam) mode. Operator may select up to 25 AJ preset networks, either HAVEQUICK or SINCGARS ECCM nets, if all 25 channels are loaded with fill information, or the SINCGARS CUE channel in addition to Cold Start channel. The channel and preset net number are displayed when the Cold Start channel is selected. Following operator selection, the appliqué supplies all frequency and control data for operation of the Receiver-Transmitter and antenna. The operator may define a HAVEQUICK channel by loading the WOD/MWOD and HAVEQUICK type. In HAVEQUICK, the GPS and SND/RCV time ancillary modes are available. In SINCGARS the GPS, SND/RCV ERF (ECCM Remote Fill), H (Hopsets), L (Lockout Sets), and LE (Late Entry) modes are available and SINCGARS CUE channel is monitored.
	AJ/M (PULL)	With the rotary switch pulled and placed in the AJ/M position (pull-to-turn), AJ/M (anti-jam/master net) mode is selected. Provides same capabilities as AJ mode plus the added functions associated with a SINCGARS master net controller.
6	Pointer Pushbutton Switch	Positions pointer to select or deselect ancillary mode option identified by cursor positioned by ancillary mode pushbutton switch (7).
7	Ancillary Mode Pushbutton Switch	Positions cursor under various ancillary mode options. Used with pointer pushbutton switch (6) to select and deselect ancillary modes.
8	Operational Mode Selector	Isolated position rotary switch (knob must be pulled out to enter or exit positions marked Pull). Selects the following operational modes.
	ZRO (PULL)	With rotary switch pulled and placed in the ZRO (zeroize) position, all ECCM fill data is zeroized by completely erasing them from memory. ZRO is displayed.
	OFF	Select Off mode. Turns power off.
	TEST	Selects Test mode. Initiates Built-in-Test (BIT) of the control unit, Receiver-Transmitter, appliqué, antenna converter unit, and antenna. Display is blanked except for a momentary side pointer followed by the decimal point with the test in progress. Faults detected are displayed. With no faults detected, the display illuminates all function indicators. The operator may single step through each test and display the results by depressing the LOAD/OFST pushbutton switch (4) within 2 seconds of selecting test mode. Test mode takes precedence over all operations except 243 MHz Guard.

Figure 2-98. AN/ARC-210(V) V/UHF Control Unit Functions (Sheet 2)

ITEM	CONTROL/INDICATOR	FUNCTION
8 (cont.)	TR+G	Selects main Receiver-Transmitter mode plus guard mode. The main receiver, transmitter, and guard receiver are on and able to perform all functions.
	TR	Selects main Receiver-Transmitter mode. The main communications receiver and transmitter are on. Guard Receiver is off.
	ADF	Selects automatic direction finding mode. Transmitter functions normally. The main receiver is connected to the ADF antenna port. The receiver will provide normal receive audio in addition to providing the demodulated ADF signal. Guard receiver is on. In FM mode, degraded operation may be noted.
	CHNG PRST	Selects change presets mode. Preset channels including COLD START, CUE, and corresponding operating frequencies and modulation can be loaded into Receiver-Transmitter memory and the HAVE-QUICK ECCM net codes loaded into the ECCM controller memory. Presets may be loaded by the operator via the control unit, MIL-STD-1553B data bus or data transfer device.

Figure 2-98. AN/ARC-210(V) V/UHF Control Unit Functions (Sheet 3)

1. CYZ-10 Data Transfer Device
   a. Fill Connector
   b. Display
   c. Keypad

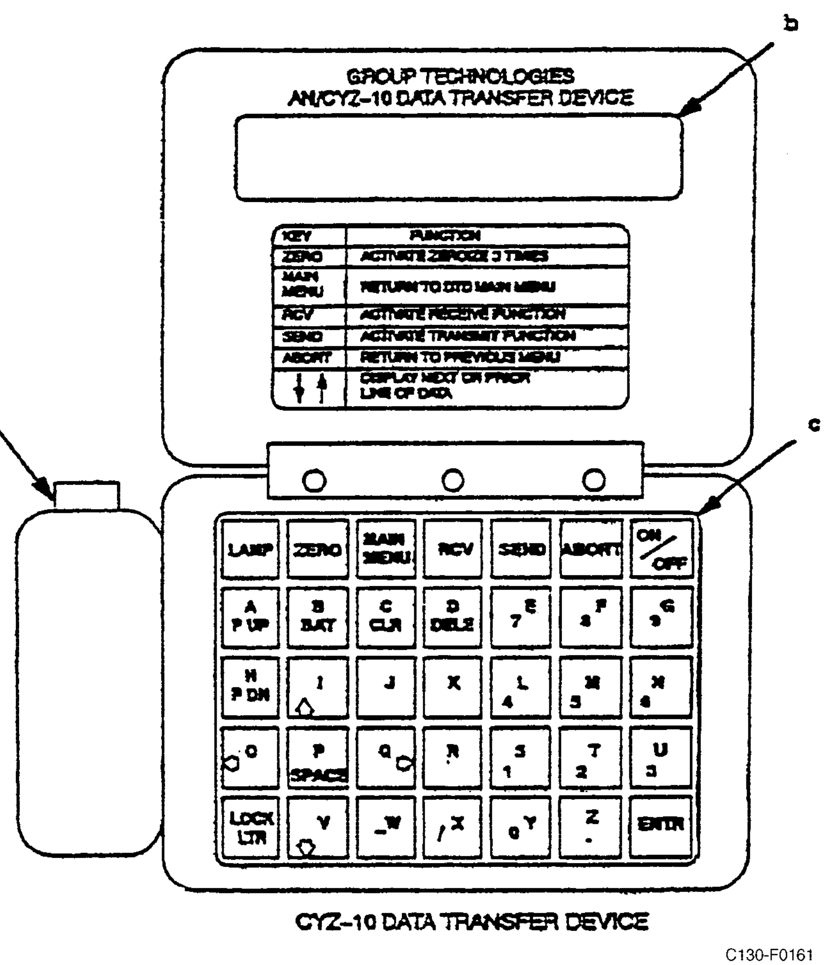


Figure 2-99. CYZ-10 Data Transfer Device

2.21.7.2 Normal Operations of the V/UHF Radio Using the CDNU

Note

Normal operations are given assuming that the AN/CYZ-10 Data Transfer Device has been loaded with the appropriate preset information.

2.21.7.2.1 Loading Presets into Radios

1. Connect the DTD to the GPS/ARC-210 Fill Port located at the radio operator’s station using fill cable.
2. Press ON/OFF to turn on the DTD.
3. Press “A” for “Application” on the DTD key pad.
4. Select “XMIT” by pressing the ENTER key on the DTD key pad.
5. Press “P” for “Platform” on the DTD key pad.
6. Press P UP or P DN on the DTD key pad to select the appropriate fill file.
7. Press ENTER to select “BUSSED.”
8. Press ⇓ key to initiate gathering of data.
9. Press ⇓ key to initiate loading.
10. Disconnect cable.
11. Press ON/OFF to turn off the DTD.

Note

Prior to step 12, verify three satellites have been acquired on the RNAV Page of the CDNU. This page can be found by first pressing the RNAV key and then pressing ⇒ key until the page is found.

12. On the CDNU, enter “/I” in the scratchpad and press Function Key F3.
13. Wait 3 minutes for presets to load into the radios. The CDNU will display “UPLOAD DONE” when loading is complete.

2.21.7.2.2 V/UHF Radio Tuning and Control. The V/UHF radios are tuned and controlled via the CDNU Comm page or detailed VHF page. System power is controlled via the CDNU Power page (a box around the system name indicates the unit is powered). The Comm page is accessed via the F3 key or via the index page. Tuning is accomplished by entering the appropriate frequency in the scratchpad and then pressing the line select key next to the corresponding radio. Pressing the line select key with no frequency in the scratchpad (blank scratchpad) will access the detailed page for the corresponding radio. Quick tuning can be accomplished by entering the frequency in the scratchpad and pressing F1 for V/U-1 or F2 for V/U-2. Pressing the F1 or F2 keys with no frequency in the scratchpad will access the corresponding detailed V/UHF page. Returning to the previously selected frequency may be accomplished by tuning 0. For additional functions and controls of the V/UHF radios, refer to Figures 2-100 through 2-103.

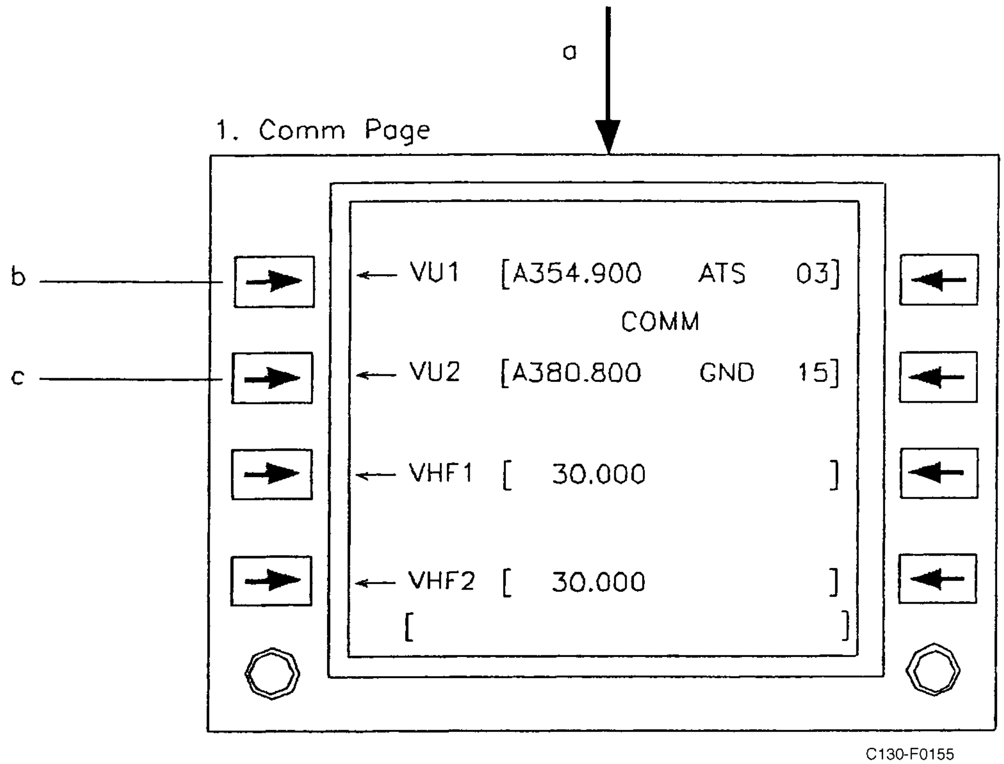
2.21.7.2.3 Normal Operation. Operate the V/UHF radio as follows:

1. Tune desired frequency in V/UHF-1 or V/UHF-2 via the CDNU.
2. To receive, pull the corresponding V/UHF push-pull mixer switch on the intercommunication control panel (ICS).
3. Adjust squelch (via CDNU) and volume (via individual mixer switch or master volume knob on ICS panel).
4. To transmit, place the transmission selector on the ICS panel to the V/UHF-1 or V/UHF-2 position.

2.21.7.3 Normal Operations of the V/UHF Radio Using the Control Unit

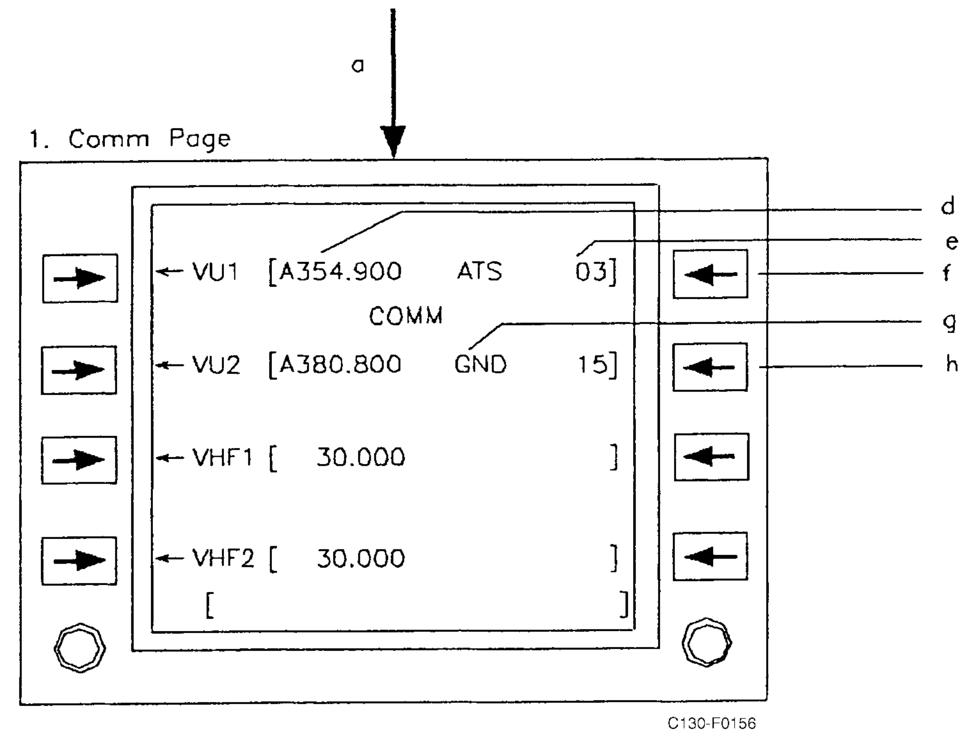
Note

Normal operations are given assuming that the radio has been loaded with preset information in accordance with the procedure provided in the previous paragraphs. Since the control unit is considered to be a backup unit, only critical operations are described.



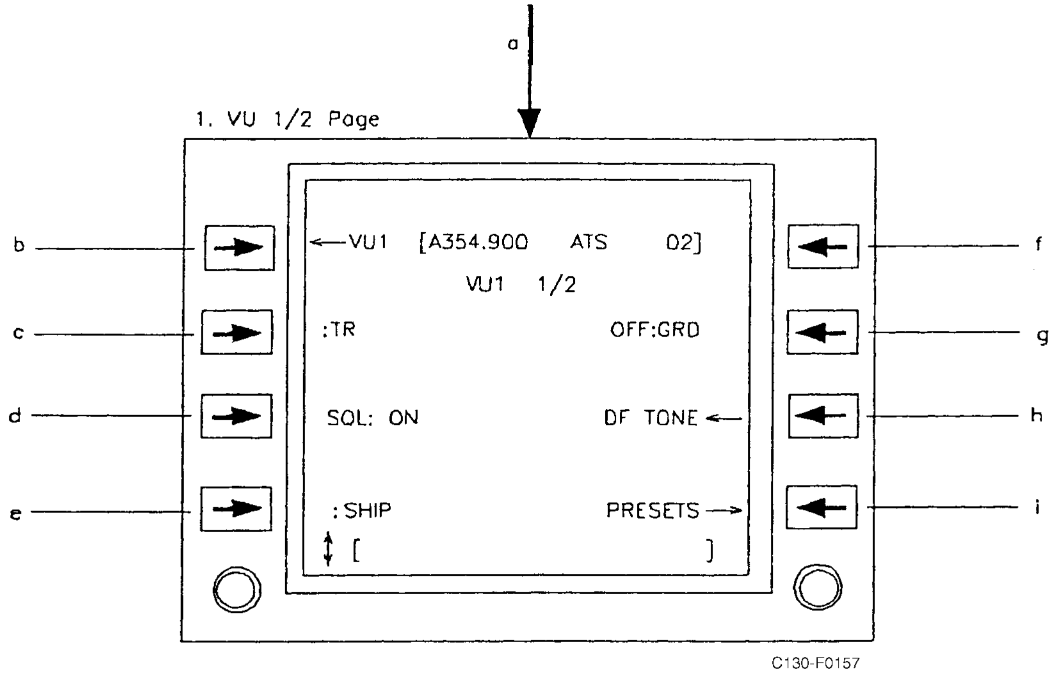
1. Comm Page.
   a. Access Comm Page via Index 1/2 Page.
   b. Depends on scratchpad entry:
      (1) Blank Accesses VU1 1/2 Page
      (2) Valid modulation type: Sets modulation type (A for AM; F for FM) of frequency in brackets.
      (3) Valid frequency: Tunes radio to frequency in scratchpad. Frequency and modulation type are displayed in brackets [ ]. Radio selects default modulation type for frequency band. Decimal point and trailing zeros are not required.
      (4) Valid modulation and valid frequency: Same as (2) and (3).
      (5) Valid antijam preset number: Tunes radio to net number associated with preset number. Antijam preset number must be preceded by an A when entered into scratchpad. If any data associated with the antijam preset are missing, error message will appear in brackets in place of the net number. When preset A26 is entered, CUE is displayed indicating radio is tuned to the CUE frequency. When preset A27 is entered, COLD is displayed indicating radio is tuned to the COLD START frequency.
      (6) Valid non-antijam preset number: Tunes radio to frequency associated with preset number. Frequency, modulation type and alphabetic ID (if applicable) are displayed in brackets.
      (7) Valid alphabetic ID: Tunes radio to frequency associated with alphabetic ID.
      (8) Valid maritime channel: Tunes radio to frequency associated with maritime channel. Frequency, modulation type, transmission frequency designation (SHP for ship; SHO for shore), and channel number preceded by M are displayed in brackets.
      (9) Letter S: Toggles scan function on and off. With scan enabled, radio scans through frequencies defined on Scan List Page. If LOCK or HELD mode become operational while scanning was active, radio automatically tunes to locked or held frequency when scanning is toggled off. If no frequency was locked or held, radio tunes to frequency it was tuned to prior to activation of scanning.
      (10) Zero (0) in scratchpad: Tunes radio to previously tuned frequency. Frequency and all associated attributes are displayed in brackets.
   c. Function same as LSK1 except for VU2.

Figure 2-100. AN/ARC-210(V) V/UHF Comm Pages (Sheet 1 of 2)



1. Comm Page (cont).
   d. Frequency or net radio is tuned to preceding letter indicates:
      (1) A = AM modulation
      (2) F = FM modulation
      (3) SX = (x = 1, 2, 3 or 4): Current scan frequency as defined on Scan List Page. H or S following net number indicates net type (H = HAVEQUICK, S = SINCGARS)
   e. Preset number of frequency defined on VU preset pages. Preceding blank, A or M indicates:
      (1) Blank = Non-antijam preset
      (2) A = Antijam preset
      (3) M = Maritime preset
   f. Operations associated with LSK5 are defined in two different situations:
      (1) Valid offset (0, ±.005, ±.01) entered into scratchpad: Offset is added to frequency in brackets. Has to be a non-antijam or non-maritime frequency.
      (2) Scanning enabled and blank in scratchpad: Scanning is interrupted and last locked-on frequency (or command frequency if no previous lock has occurred) is held. Locked-on frequency and HELD are displayed in brackets. Resume scanning by pressing LSK5 second time.
   g. This field can be occupied by five different items:
      (1) Alphabetic ID = Three-letter alphabetic identifier
      (2) CUE = Antijam preset A26 has been entered and radio is tuned to the CUE frequency.
      (3) COLD = Antijam preset A27 has been entered and radio is tuned to the cold start frequency.
      (4) SHP = Ship station maritime preset selected.
      (5) SHO = Shore station maritime preset selected.
   h. LSK6 functions same as LSK5 except for VU2.

Figure 2-100. AN/ARC-210(V) V/UHF Comm Pages (Sheet 2)



1. VU1 1/2 Page (VU1 1/2 Page shown).
   a. Access VU1 1/2 Page via Comm Page (Figure 2-100).
   b. Accesses Comm Page if blank in scratchpad. Otherwise, operates same as defined for LSK1 on Comm Page (Figure 2-100).
   c. Selects radio mode:
      (1) TR
      (2) TR+G
      (3) ADF (ADF is not an option with VU2).
   d. Toggles squelch.
      (1) SQL: ON
      (2) SQL: OFF
   e. Depends on radio operation:
      (1) Radio is tuned to non-antijam frequency other than maritime channels 6, 8, 72 or 77: Toggles between SHIP and SHORE. Selection of SHORE while maritime channel 6, 8, 72 or 77 is active is not permitted.
      (2) Radio is turned to SINCGARS net: Arrow followed by SINCGR SETUP is displayed adjacent to LSK4: Accesses VU1 SINCGARS Setup Page.
      (3) Radio is tuned to HQ net: Arrow followed by HQ SETUP is displayed adjacent to LSK4: Accesses VU1 HQ Setup Page.
   f. Operates same as defined for LSK5 on Comm Page (Figure 2-100)
   g. Sets VU1 guard channel to UHF GUARD, VHF GUARD or OFF (notes 2 and 3)
   h. Toggles DF tone:
      (1) DF TONE*=On
      (2) DF TONE ← =OFF

NOTE

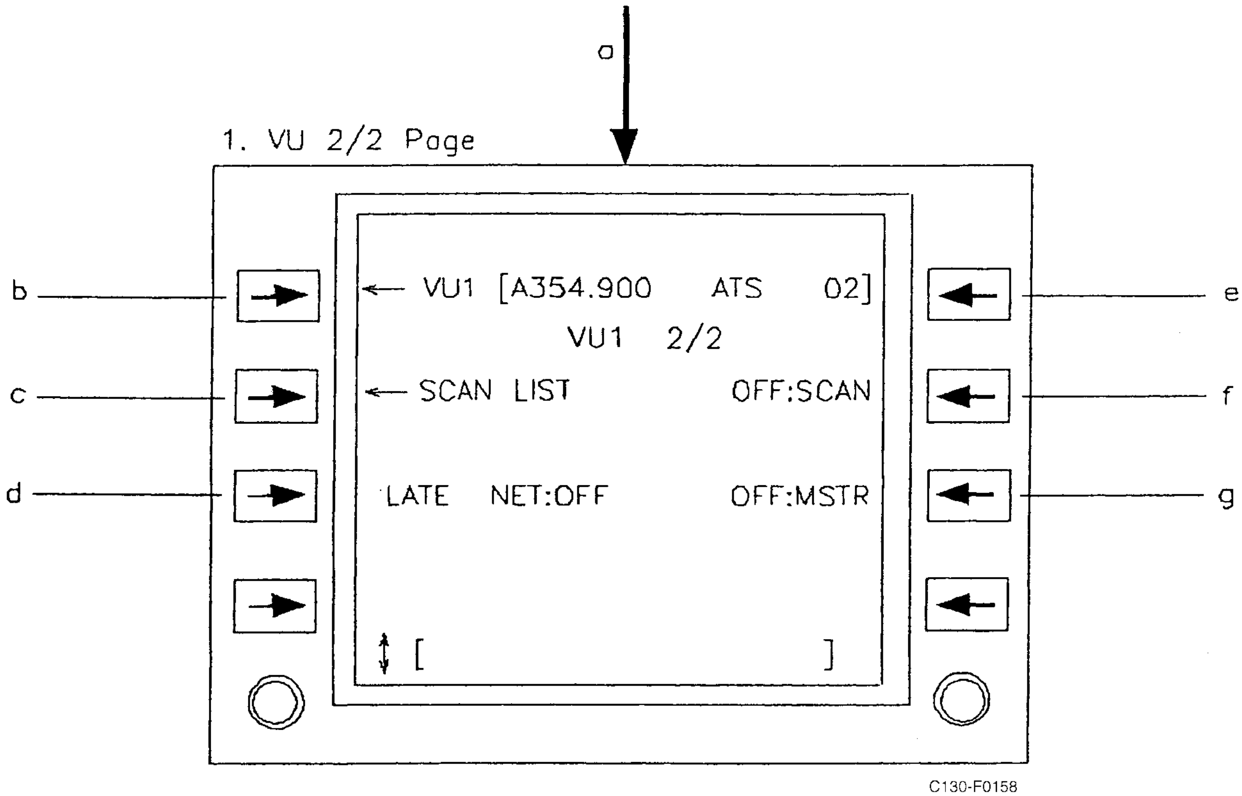
DF TONE disappears from CDNU screen when a HQ is selected.

   i. Accesses VU1 Non-AJ Presets Page or VU1 AJ Presets Page depending on frequency type in brackets, antijam (AJ) or non-antijam (non AJ).

Notes:

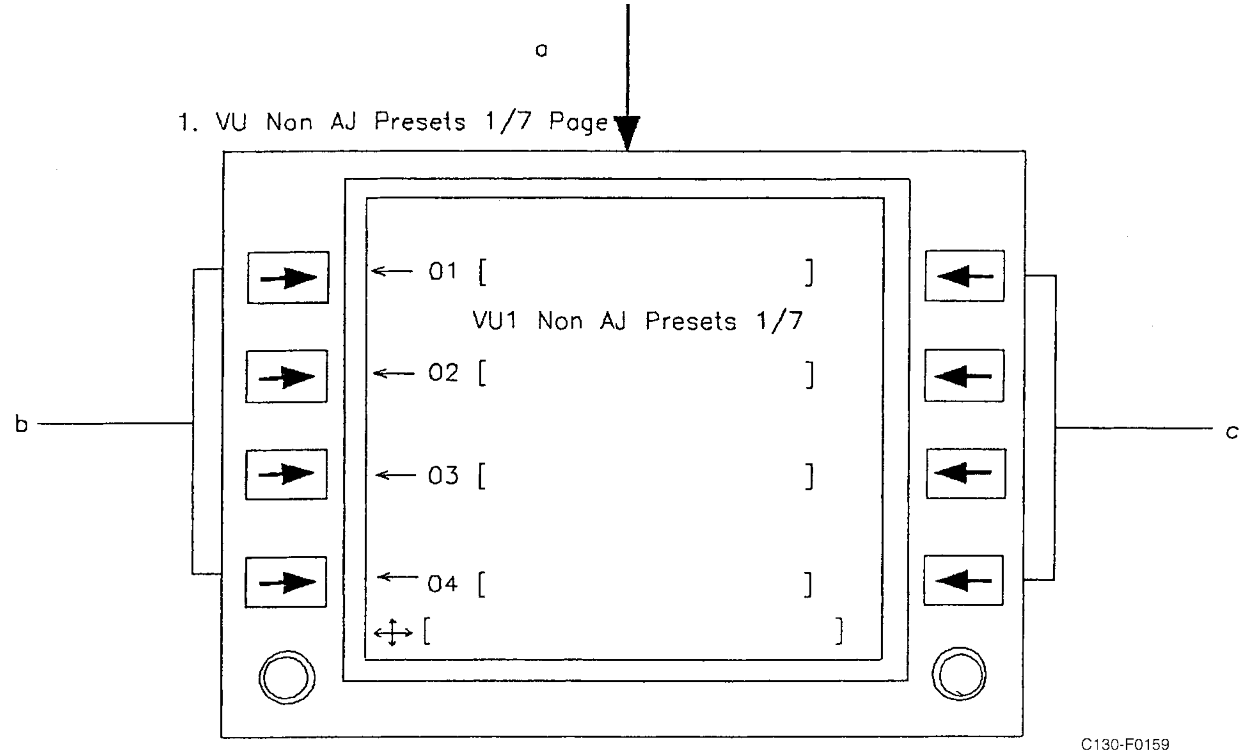
1. Selecting guard frequency via emergency radio select panel tunes radio to 243.000 MHz AM.
2. Selecting VHF GRD with LS6 tunes radio to 121.500 MHz AM.
3. Selecting UHF GRD with LS6 tunes radio to 243.000 MHz AM.

Figure 2-101. AN/ARC-210(V) V/UHF 1/2 Page (Sheet 1 of 2)



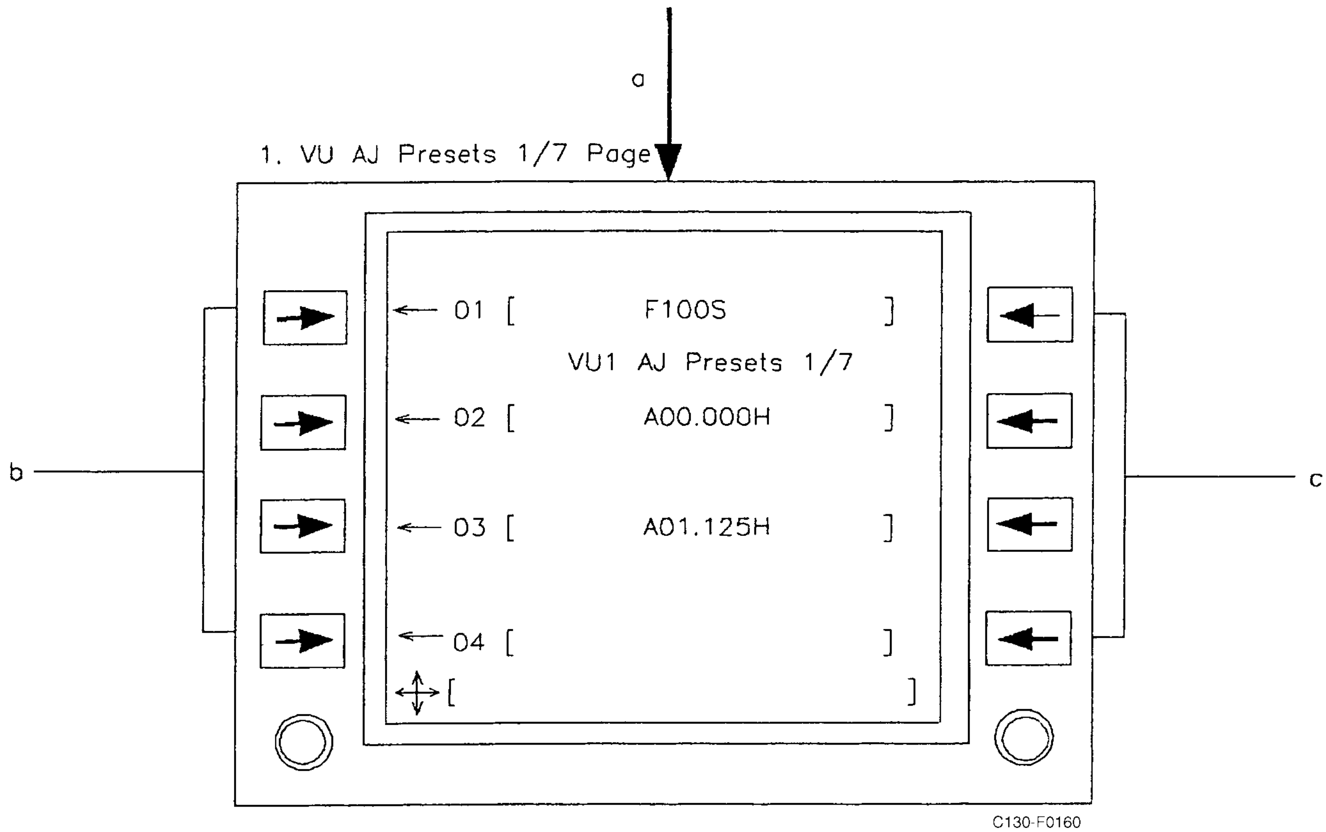
1. VU 2/2 Page (VU1 2/2 Page shown).
   a. Access VU1 2/2 Page via Comm Page (Figure 2-100).
   b. Operations are same as described for LSK1 on Comm Page except when scratchpad is blank. When scratchpad is blank accesses Comm Page.
   c. Accesses Scan List Page.
   d. Depends on SINCGARS status:
      (1) SINCGARS net active and VU1 not in net or acting as net master. Toggles late entry ON and OFF.
      (2) SINCGARS net active and VU1 in net: LATE NET is set to OFF and toggling is not permitted.
      (3) SINCGARS net active and VU1 net master: LATE NET is set to OFF and toggling is not permitted. Any attempt to toggle LATE NET will generate error message.
      (4) SINCGARS net not active: LATE NET is set to OFF and toggling is not permitted.
   e. Operations are same as defined for LSK5 on Comm Page (Figure 2-100).
   f. Toggles scanning mode ON and OFF.
   g. Depends on SINCGARS status:
      (1) SINCGARS net active and VU1 not attempting late net entry: Toggles MSTR ON and OFF.
      (2) SINCGARS net active and VU1 attempting late net entry: MSTR is set to OFF and toggling is not permitted. Any attempt to toggle MSTR will generate error message.
      (3) SINCGARS net not active: MSTR is set to OFF and toggling is not permitted.

Figure 2-101. AN/ARC-210(V) V/UHF 2/2 Page (Sheet 2)



1. VU Non AJ Presets Page (VU1 Non AJ Presets 1/7 Page shown).
   a. Access VU1 Non AJ Presets 1/7 Page via VU1 1/2 Page and scrolling as required.
   b. Depends on scratchpad entry:
      (1) Blank: Radio tunes to frequency in brackets and accesses VU1 1/2 Page.
      (2) Valid modulation type: Sets modulation type of frequency in brackets.
      (3) Valid frequency: Inputs frequency from scratchpad into brackets. Radio selects default modulation type for frequency band.
      (4) Valid frequency and valid modulation type: Inputs frequency and modulation from scratchpad into brackets.
      (5) Valid alphabetic ID: Assigns alphabetic ID to frequency in brackets.
      (6) Valid frequency and alphabetic ID: Inputs frequency and alphabetic ID into brackets. Frequency and alphabetic ID must be separated by slash (/).
      (7) Minus-slash symbol (–/): Deletes frequency in brackets. Alphabetic identifier remains present.
      (8) Slash-minus symbol (/–): Deletes alphabetic identifier from brackets. Frequency remains present.
      (9) Minus (–) or minus-slash-minus (–/–): Deletes both frequency and alphabetic identifier from brackets.
   c. Adds valid offset (0, ±.005, ±.01) entered into scratchpad to frequency in brackets.

Figure 2-102. V/UHF Non-Antijam Presets Page



1. VU AJ Presets Page (VU1 AJ Presets 1/7 Page shown).

   a. Access VU1 AJ Presets 1/7 Page via VU1 1/2 Page and scrolling as required.

   b. Depends on scratchpad entry:

      (1) Blank: Radio tunes to frequency in brackets and accesses VU1 1/2 Page.

      (2) Valid alphabetic ID: Assigns alphabetic ID to frequency net in brackets.

      (3) Valid HQ frequency net number and valid alphabetic ID: Inputs net number and alphabetic ID into brackets. Frequency net number and alphabetic ID must be separated by slash (/).

      (4) Minus-slash symbol (–/): Deletes frequency in brackets. Alphabetic identifier remains present.

      (5) Slash-minus symbol (/–): Deletes alphabetic identifier from brackets. Frequency remains present.

      (6) Minus (–) or minus-slash-minus (–/–): Deletes both frequency and alphabetic identifier from brackets.

   c. With blank scratchpad accesses HQ setup when HQ net is in associated brackets. With blank scratchpad accesses SINCGARS setup page, when SINCGARS net is in associated brackets.

Figure 2-103. V/UHF Antijam Presets Page

2.21.7.3.1 Manual Mode Operations

1. Place the OPERATIONAL MODE SELECTOR switch to TR&G or TR.
2. Place the FREQUENCY MODE SELECTOR switch to MAN.
3. Rotate the CHAN/FREQ/CRSR selector to the desired frequency value. Press the selector to change the cursor position.

2.21.7.3.2 Preset Mode Operations

1. Place the OPERATIONAL MODE SELECTOR switch to TR&G or TR.
2. Place the FREQUENCY MODE SELECTOR switch to PRST.
3. Rotate the CHAN/FREQ/CRSR selector to the desired preset number.

2.21.7.3.3 Receiving Time From GPS

1. Place the OPERATIONAL MODE SELECTOR switch to TR&G or TR.
2. Place the FREQUENCY MODE SELECTOR switch to MAN.
3. Press the ANCILLARY MODE pushbutton switch until GPS is underlined.
4. Press the POINTER pushbutton switch to receive GPS time.

2.21.7.3.4 AJ Mode Operations

1. Place the OPERATIONAL MODE SELECTOR switch to TR&G or TR.
2. Place the FREQUENCY MODE SELECTOR switch to AJ.
3. Rotate the CHAN/FREQ/CRSR selector to the desired preset number.

2.21.8 KY-58 Encryption Unit. Four encryption units provide for the transmission and reception of coded voice messages on the two UHF command radios (AN/ARC-159 UHF radios on aircraft not modified by AFC-338) and the two VHF AM-FM radios. A microphone and control panel are provided for each radio. The encryption units are located on the flight control pedestal (see Figure 2-104).

The pilot and copilot must use the handheld microphones for encrypted transmissions in the radio coupled to the respective KY-58.

Note

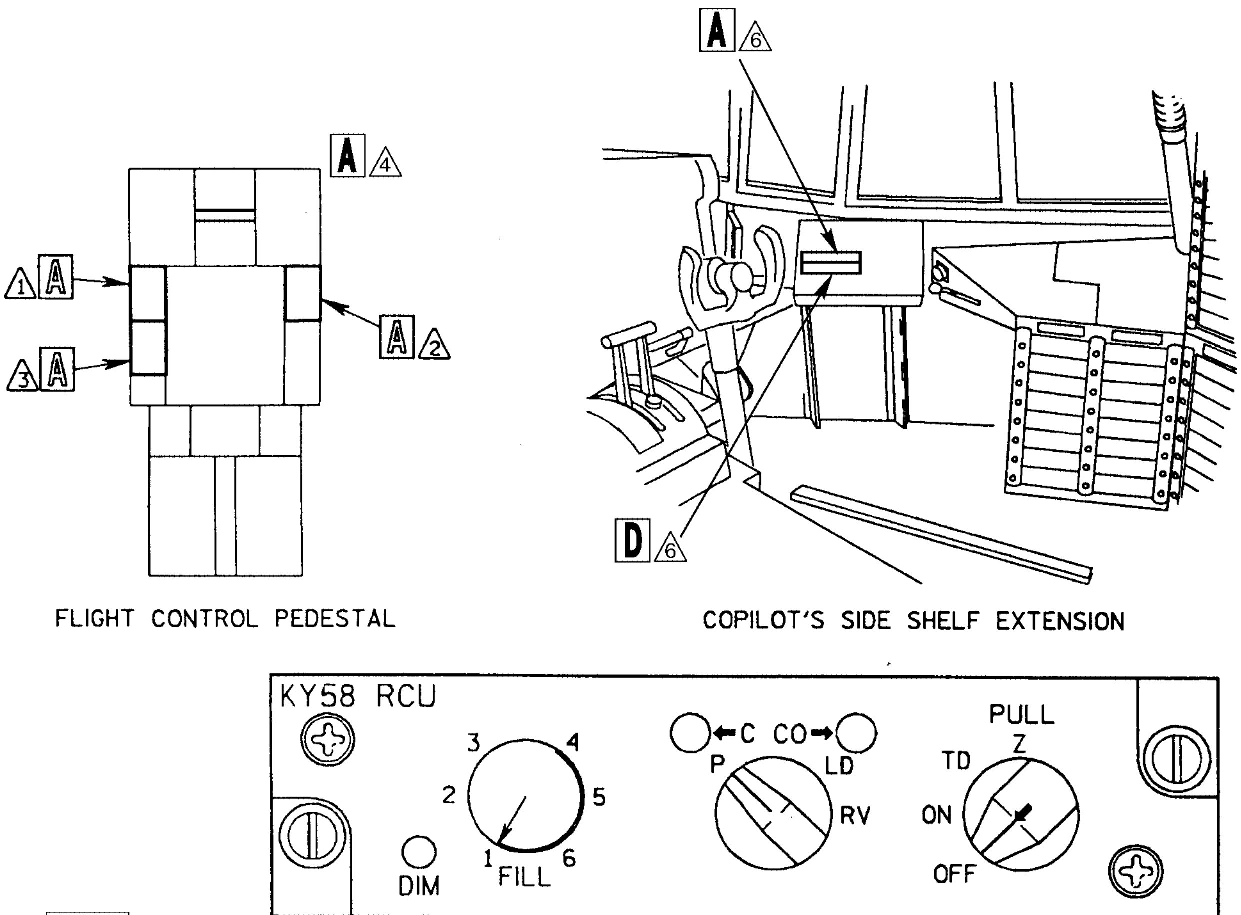
Classified information will not be discussed on the ICS or on radios operating in the secure mode while other radios are transmitting in clear mode. Conversely, no radio will transmit in clear mode while classified information is being discussed on the ICS or another radio transmitting in secure mode.

Power is supplied to the No. 1 UHF radio encryption unit from the isolated dc bus through a NO. 1 KY 28/58 circuit breaker on the copilot upper circuit breaker panel. Power is supplied to the No. 2 UHF unit from the essential dc bus through a NO. 2 KY 28/58 circuit breaker on the copilot upper circuit breaker panel. Power is supplied to the No. 1 VHF radio encryption unit from the isolated dc bus through two NO. 1 KY 28/58 circuit breakers on the copilot upper circuit breaker panel. Power is supplied to the No. 2 VHF unit from the essential dc bus through two NO. 2 KY 28/58 circuit breakers on the copilot upper circuit breaker panel.

2.21.8.1 Secure-Voice Controls and Indicators. Controls for operation of the systems are provided on each remote control unit. Additional controls are provided on the processor mount (see Figure 2-104).

2.21.8.1.1 KY-58 Remote Control Unit Controls. The KY-58 remote control unit provides switches and indicators for operating the system. The switches and indicators are described as follows:

1. DIM switch — The DIM switch controls the brightness of the indicator lights.
2. Cipher light — The green cipher light indicates that secure-voice communications are being transmitted or received when the mode switch is in the C or CO position.
3. Cipher-only light — The yellow cipher only light indicates that the mode switch is in CO cipher-only position.



NOTE

1. USED WITH NO. 1 VHF RADIO
2. USED WITH NO. 2 VHF RADIO
3. USED WITH NO. 1 UHF RADIO (NOT MODIFIED BY AFC-338)
4. USED WITH NO. 2 UHF RADIO (NOT MODIFIED BY AFC-338)
5. USED WITH NO. 1 V/UHF RADIO (AIRCRAFT MODIFIED BY AFC-338)
6. USED WITH NO. 2 V/UHF RADIO (AIRCRAFT MODIFIED BY AFC-338)

Figure 2-104. KY-58 Encryption Unit Control Panels (Sheet 1 of 3)

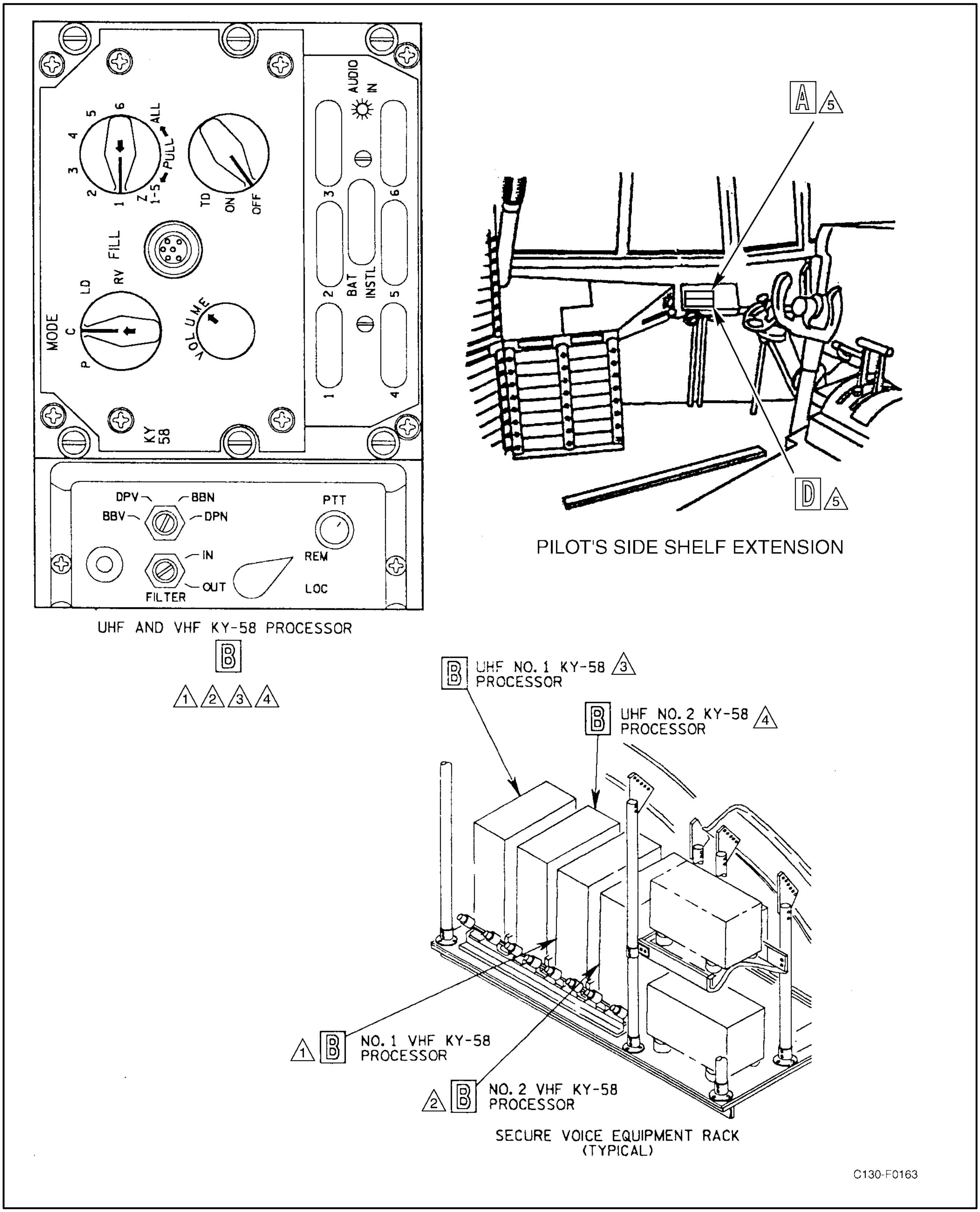


Figure 2-104. KY-58 Encryption Unit Control Panels (Sheet 2)

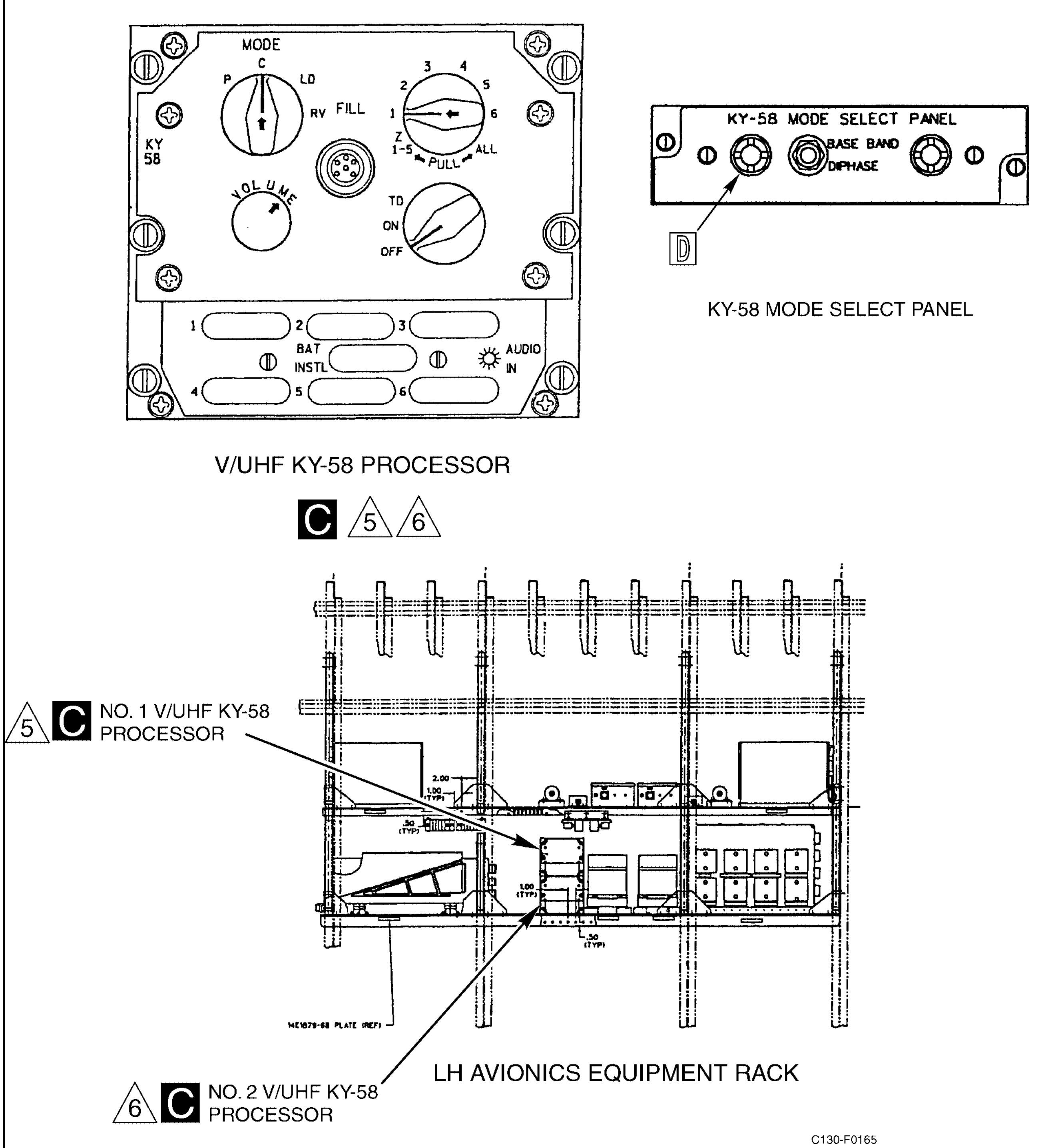


Figure 2-104. KY-58 Encryption Unit Control Panels (Sheet 3)

4. FILL switch — The six-position FILL switch selects the preset code storage position.

5. Mode switch — A five-position (P, C, CO, LD, RV) mode switch controls the various modes of operation. The positions are described as follows:

   a. Plain (P) — Radio is used as plain-language receiver and transmitter.

   b. Cipher (C) — Radio is used to transmit and receive secure-voice communications. The radio will also receive plain-language communications.

   c. Cipher only (CO) — Radio is used to transmit and receive secure-voice communications only.

   d. Load (LD) — Processor will accept preset codes into storage.

   e. RV — This position is not operational.

6. Function switch — The four-position (OFF, ON, TD, Z) function switch controls the various functions. The positions are described as follows:

   a. OFF — Removes power to the processor.

   b. ON — Applies power to the processor.

   c. Time delay (TD) — This position is not used.

   d. Zeroize (Z) — The preset codes are erased from all fill positions. The switch must be pulled and turned to be placed to this position.

2.21.8.1.2 KY-58 Processor Mount Controls. The Z-AHQ adapter in the KY-58 processor mount provides the following controls:

1. BBV/DPV/BBN/DPN switch — A four-position, screwdriver-operated rotary switch used to adapt the processor to the radio and remote control unit. The BBV position provides baseband signal processing for AN/ARC-159(V)l UHF radios and ARC-186 VHF radios. The DPV position provides diphase signal processing for AN/ARC-159(V)l UHF radios. The BBN and DPN positions are not used.

2. REMOTE/LOCAL (REM/LOC) switch — A two-position rotary switch, spring-loaded to the REM position. Rotating the switch momentarily to the LOC position places the processor in local operation controlled by the controls on the processor front panel until a remote unit PTT switch is actuated.

3. PTT pushbutton switch — This switch is pressed for transmitting purposes when operating the processor on local status.

4. FILTER switch — A two-position IN, OUT screwdriver-operated rotary switch. The IN position provides a filtered cipher output. The OUT position bypasses the filter.

5. Processor controls — The controls on the KY-58 processor are used to operate the processor when loading preset codes into the system. The controls are described as follows:

   a. MODE switch — The four-position (P, C, LD, RV) switch controls the mode of operation of the processor. The positions are functionally the same as described for the RCU.

   b. Function switch — The three-position (TD, ON, OFF) switch controls power to the processor. The TD position is not functional and the OFF-ON positions control the power.

   c. FILL switch — The eight-position FILL switch (Z 1-5, ALL, 1, 2, 3, 4, 5, 6) selects and zeroizes the preset code storage positions.

   d. VOLUME control — The volume control adjusts the audio level of the system.

2.21.8.2 Normal Operation of the KY-58 Secure Voice Communications System

2.21.8.2.1 Loading

1. Place REM/LOC switch in LOC position.

2. Place BBV/DPV/BBN/DPN switch to BBV or DPV position.

3. Connect loading device to fill connector.

4. Place MODE switch in C position.

5. Place TD/ON/OFF switch in ON position. Continuous beeping (crypto alarm) and background noise is heard in headset.

6. Press PTT (push-to-talk) button and release. Crypto alarm is silenced. The KY-58 is ready for loading.

7. Place MODE switch in LD position. Constant tone indicates an empty storage register. A beep indicates a variable is stored in the register.

8. Turn the loading device on.

9. Place FILL switch to 1 to 6 as desired.

10. Turn the loading device to output storage register 1 to 6.

11. Press and release PTT pushbutton switch.

12. Turn the MODE switch on the loading device to OFF/CHECK.

13. Place the MODE switch to the C position.

14. Disconnect loading device.

15. Place TD/ON/OFF switch to OFF position.

16. Repeat steps 1 through 15 for each KY-58 system.

2.21.8.2.2 Operation. To operate in the plain-text mode:

1. Place processor MODE switch to P position.

2. Place processor FILL switch to desired register position.

3. Place processor function switch to ON.

4. Actuate PTT switch to clear power-up alarm.

5. Select desired operating frequency on the applicable UHF or VHF control panel.

6. Place REM/LOC control switch to REM.

7. Place RCU function switch to ON.

8. Place RCU MODE switch to P position.

9. Place RCU FILL switch to desired register position. Transmission and reception will be in plain text.

To transmit in the cipher-text mode:

10. Contact receiving station to switch applicable KY-58 unit to C.

11. Place processor MODE switch to C.

12. Place RCU MODE switch to C.

    a. Note that the C indicator illuminates.

    b. Transmission and reception will be in cipher text.

2.21.9 KY-58 Encryption Unit (UHF Encryption Units Modified by AFC-338). Two encryption units provide for the transmission and reception of coded voice messages on the two AN/ARC-210 V/UHF radios. The encryption units used with the No. 1 and No. 2 V/UHF radios are installed in the Left Hand Avionics Equipment Rack. The encryption unit control unit used with the No. 1 V/UHF radio is located on the pilot side shelf extension. The encryption unit control unit used with the No. 2 V/UHF radio is located on the copilot side shelf extension. (See Figure 2-104.)

Note

Classified information will not be discussed on the ICS or on radios operating in the secure mode while other radios are transmitting in the clear mode. Conversely, no radio will transmit in the clear mode while classified information is being discussed on the ICS or another radio transmitting in secure mode.

Power is supplied to the No. 1 V/UHF radio encryption unit from the isolated dc bus through a No. 1 KY-58 circuit breaker on the copilot upper circuit breaker panel. Power is supplied to the No. 2 V/UHF radio encryption unit from the essential dc bus through the No. 2 KY-58 circuit breaker on the copilot upper circuit breaker panel.

2.21.9.1 Secure-Voice Controls and Indicators. A remote control unit and a separate switch panel control each encryption unit. Z-AHQ processor mounts are not installed with encryption units interfacing with the AN/ARC-210 radios.

2.21.9.1.1 KY-58 Remote Control Unit Controls. The KY-58 remote control unit provides switches and indicators for operating the system. The switches and indicators are described as follows:

1. DIM switch — The DIM switch controls the brightness of the indicator lights.
2. Cipher light — The green cipher light indicates that secure-voice communications are being transmitted or received when the mode switch is in the C or CO position.
3. Cipher-only light — The yellow cipher only light indicates that the mode switch is in CO cipher-only position.
4. FILL switch — The six-position FILL switch selects the preset code storage position.
5. Mode switch — A five-position (P, C, CO, LD, RV) mode switch controls the various modes of operation. The positions are described as follows:
    a. Plain (P) — Radio is used as plain-language receiver and transmitter.
    b. Cipher (C) — Radio is used to transmit and receive secure-voice communications. The radio will also receive plain-language communications.
    c. Cipher only (CO) — Radio is used to transmit and receive secure-voice communications only.
    d. Load (LD) — Processor will accept preset codes into storage.
    e. RV — This position is not operational.
6. Function switch — The four-position (OFF, ON, TD, Z) function switch controls the various functions. The positions are described as follows:
    a. OFF — Removes power to the processor.
    b. ON — Applies power to the processor.
    c. Time delay (TD) — This position is not used.
    d. Zeroize (Z) — The preset codes are erased from all fill positions. The switch must be pulled and turned to be placed to this position.

2.21.9.1.2 Baseband/Diphase Switch Panel. A two-position switch provides the capability to select baseband or diphase signal processing.

2.21.9.2 Normal Operation of the KY-58 Secure Voice Communications System

2.21.9.2.1 Loading

1. Connect loading device to the encryption unit fill connector.
2. Place the control unit MODE switch in the C position.
3. Place the control unit FUNCTION switch to the ON position. Continuous beeping (crypto alarm) and background noise is heard in headset.
4. Press the PTT (push to talk) button and release. Crypto alarm is silenced. The KY-58 is ready for loading.
5. Place control unit MODE switch in LD position. Constant tone indicates an empty storage register. A beep indicates a variable is stored in the register.
6. Turn the loading device on.
7. Place control unit FILL switch to 1 to 6 as desired.
8. Select output storage register 1 to 6 on the loading device.
9. Press and release PTT pushbutton switch.
10. Turn the loading device off.
11. Place the control unit FUNCTION switch to the OFF position.
12. Repeat steps 1 through 11 for the other encryption unit.

2.21.9.2.2 Operation. To operate in the plain text mode:

1. Place the control unit MODE switch to P position.
2. Place the control unit FILL switch to desired register position.

3. Place control unit FUNCTION switch to ON.

4. Actuate PTT switch to clear power-up alarm.

5. Select desired operating frequency on the AN/ARC-210 radio. Transmission and reception will be in plain text.

To operate in cipher text mode:

6. Contact receiving station to switch applicable KY-58 unit to C.

7. Place control unit MODE switch to C or CO. Transmission and reception will be in cipher text. Plain text reception will be heard if the operator has selected C. Plain text reception will not be heard if the operator has selected CO.

For further information on the KY-58, refer to Supplement NAVAIR 01-75GAA-2-8-1.

2.21.10 AN/ARC-190 HF Command Radio. Two separate but identical HF command radio installations, for single-sideband and amplitude-modulation operation, provide two-way voice and code communication in the 2- to 30-MHz frequency range. The radios receive and transmit on any one of 280,000 manually selected frequency channels spaced at 100-Hz increments, or any one of 30 preset frequency channels in the HF band. Modes of operation are upper sideband (USB), lower sideband (LSB), amplitude modulation equivalent (AME), continuous wave (CW), data USB, and data LSB. The No. 1 HF command radio operates from 115-volt, three-phase, essential ac bus power supplied through HF COMM NO. 1 circuit breakers on the pilot side circuit breaker panel. The No. 2 HF command radio operates from 115-volt, three-phase, main ac bus power supplied through HF COMM NO. 2 circuit breakers on the copilot upper circuit breaker panel.

2.21.10.1 HF Command Radio Controls. A separate control panel (see Figure 2-105) for each radio contains all the controls necessary for frequency selection of any of the 280,000 available channels. The No. 1 HF control panel is located on the flight control pedestal and the No. 2 HF control panel is located on the copilot side shelf extension. Thumbwheel switches are provided for selection of frequency channels, preset channels, and modes of operation. A spring-loaded, momentary-action switch is used for turning the radio set on or off. Selection for reception or transmission through the HF radio transceivers is made at the appropriate ICS control panel(s).

2.21.10.1.1 CHAN Switches. Two thumbwheel switches are provided that select 30 channels (00 through 29) for preset mode and frequency data.

2.21.10.1.2 MODE Switch. A thumbwheel switch is provided to select the following modes:

1. LV — lower sideband voice.

2. UV — upper sideband voice.

3. LD — lower sideband data.

4. UD — upper sideband data.

5. CW — continuous wave.

6. AM — amplitude modulation equivalent.

7. P — preset.

8. A — undefined (CONTL FAULT indicator will illuminate when in this mode).

2.21.10.1.3 FREQ Switch. Six thumbwheel switches are provided that select 280,000 frequency channels spaced at 100-Hz increments from 2.0000 to 29.9999 MHz. Selection below 2.0000 MHz will cause a control fault indication.

2.21.10.1.4 TAKE CMD/OFF Switch. A spring-loaded, momentary-action switch is used for turning the radio set on or off, or taking command from an alternate radio set control.

2.21.10.1.5 ON Indicator. The ON indicator is illuminated when radio set power is turned on.

2.21.10.1.6 TAKE CMD Indicator. The TAKE CMD indicator is illuminated when the radio set control has taken command.

2.21.10.1.7 LOAD Pushbutton Switch. A momentary-action pushbutton switch causes mode and frequency data to be stored in the receiver-transmitter preset channel memory when pressed. Data is stored in the memory location indicated by the preset channel switches.

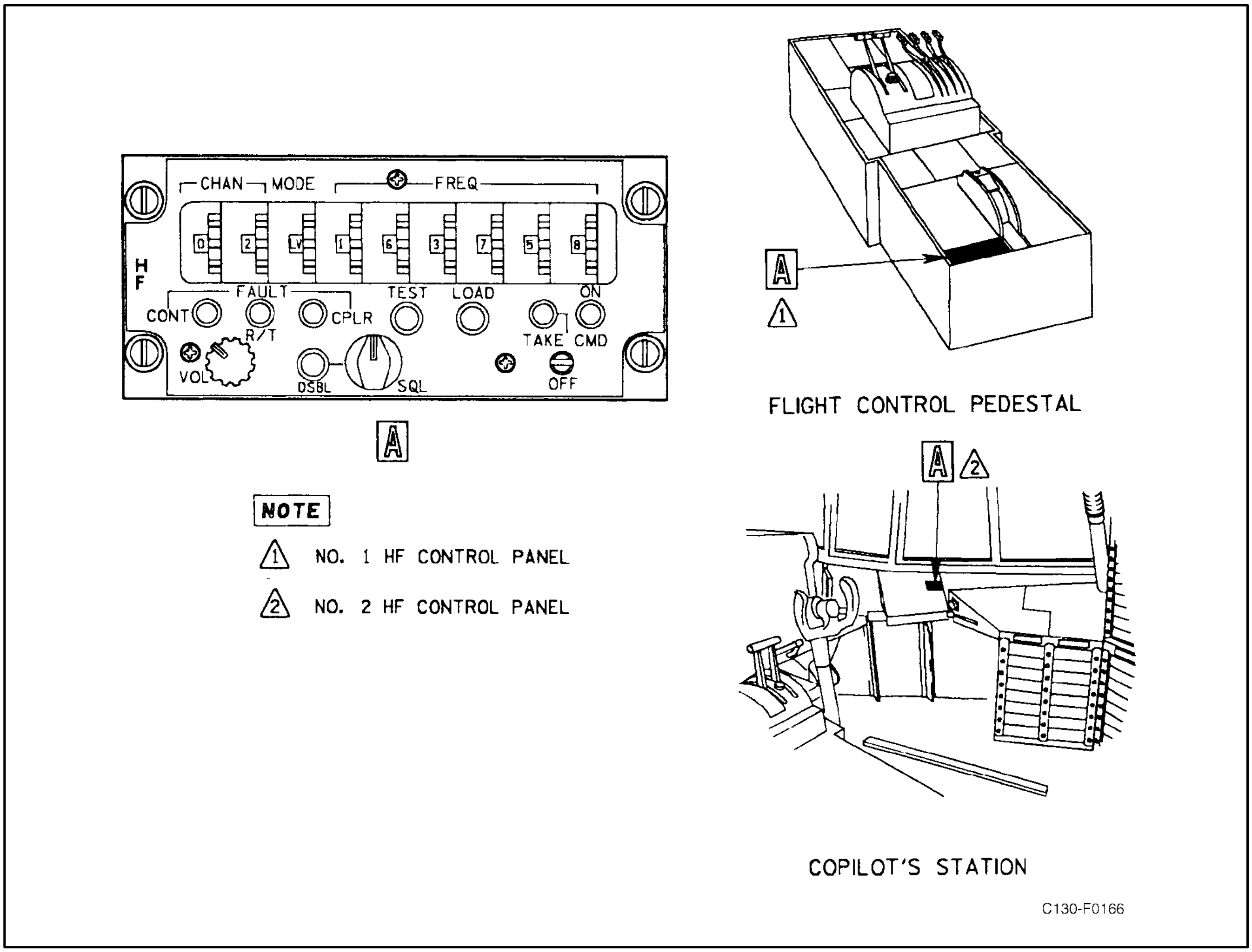


Figure 2-105. AN/ARC-190 HF Command Radio Control Panels

2.21.10.1.8 TEST Pushbutton Switch. A momentary-action pushbutton switch initiates the self-test cycle. When pressed, all fault indicators illuminate and the radio set goes through a receive self-test cycle. When released, all fault indicators are extinguished. If the test fails, one of the fault indicators remains illuminated, depending upon where the fault is. After pressing the TEST pushbutton, the next time the microphone push-to-test switch is pressed, a transmit self-test cycle is initiated. If the test fails, one of the fault indicators will be illuminated.

2.21.10.1.9 SQL Switch. A four-position SQL switch selects the squelch threshold level. The squelch is fully disabled with the switch in the full counterclockwise position.

2.21.10.1.10 DSBL Pushbutton Switch. The DSBL switch is an alternate-action pushbutton switch that disables the squelch threshold when pressed in. When in the out position, squelch threshold level is selected by the SQL switch.

2.21.10.1.11 VOL Switch. The eight-position VOL switch sets the receiver-transmitter audio output level.

2.21.10.1.12 CONT FAULT Indicator. The CONT FAULT indicator is illuminated when a malfunction occurs in the radio set control, if FREQ switches are set below 2.0000 MHz, if CHAN switches are set to an unloaded preset channel with the mode switch set to P, or when the mode switch is set to A.

2.21.10.1.13 R/T FAULT Indicator. The R/T fault indicator is illuminated when a malfunction occurs in the receiver-transmitter.

2.21.10.1.14 CPLR FAULT Indicator. The CPLR FAULT indicator is illuminated when a malfunction occurs in the antenna coupler.

2.21.10.2 Normal Operation of the HF Command Radio

2.21.10.2.1 Operation On Preset Channels. To put the HF command radio into operation:

1. Momentarily actuate the TAKE CMD/OFF switch to TAKE CMD. The ON and TAKE CMD indicators will light.
2. Set the MODE switch to P.
3. Set the CHAN switches to the desired channel that has been previously loaded. The CONT FAULT indicator will illuminate if an unloaded preset channel is selected.
4. Momentarily key the radio set.
5. Adjust VOL and SQL controls as desired.

To turn the HF command radio off:

6. Momentarily actuate the TAKE CMD/OFF switch to OFF.

2.21.10.3 Operation on Nonpreset Channels. To put the HF command radio into operation:

1. Momentarily actuate the TAKE CMD/OFF switch to TAKE CMD. The ON and TAKE CMD indicators will light.
2. Set the MODE switch to the desired mode.
3. Set the FREQ switches to the desired frequency.
4. Momentarily key the radio set.
5. Adjust VOL and SQL controls as desired.

To turn the HF command radio off:

6. Momentarily actuate the TAKE CMD/OFF switch to OFF.

2.21.10.3.1 Mode and Frequency Presetting. To preset modes and frequencies:

1. Momentarily actuate the TAKE CMD/OFF switch to TAKE CMD. The ON and TAKE CMD indicators will light.
2. Set the MODE switch to the desired mode (except A).
3. Set FREQ switches to the desired frequency.
4. Set CHAN switches to the desired channel (00 to 29).
5. Press the LOAD pushbutton.
6. Repeat steps 2 through 5 for each preset channel desired.
7. Momentarily actuate the TAKE CMD/OFF switch to OFF.

2.21.10.3.2 Fault Clearing. To clear faults of a temporary nature and to extinguish the fault indicators, operate one of the FREQ switches off frequency and back again.

2.21.11 Encryption Unit (AN/USC-43(V)3). Provisions for two identical HF advanced narrowband digital voice terminal (ANDVT) secure voice systems are installed. Each system is used with an HF radio; No.1 is used with HF No. 1 and No. 2 is used with HF No. 2. The HF secure voice system equipment is integrated with and operates with the HF radio to permit secure voice communication. The ANDVT system consists of a COMSEC module (CM) mated with basic terminal units (BTU) and remote control panels. The system has two basic modes of operation: plain or cipher. The plain mode is used during normal HF communication. The cipher mode is used when secure voice communications are required. The HF radio must be operational and the secure voice system equipment must be installed and operational for proper secure voice operations. The receiving station must be properly equipped to receive transmissions in the cipher mode. When the secure voice system equipment is removed, the HF radio may be operated normally.

Power is provided to the No.1 system from the essential dc bus through the AN/USC-43 circuit breaker on the pilot side circuit breaker panel and for the No. 2 system by the main dc bus through the AN/USC-43 circuit breaker on the copilot upper circuit breaker panel.

2.21.11.1 HF Secure Voice Controls and Indicators. The split remote control unit (SRCU IIA and IIB) control panels for the system are located on the copilot side console and at the navigator station for C-130T aircraft and on the copilot side console and at the radio operator station on KC-130T aircraft. (See Figure 2-106.) The CM/BT is located in the radio operator equipment rack on KC-130T aircraft and on the secure equipment rack on C-130T aircraft. The panels provide controls and indicators for operating the system as follows:

Note

Classified information will not be discussed on the intercommunication system or on radios operating in the secure mode while other radios are transmitting in clear mode. Conversely, no radio will transmit in clear mode while classified information is being discussed on the intercommunication system or another radio transmitting in secure mode.

2.21.11.1.1 SRCU IIB Controls and Indicators

1. DIM switch. Controls the intensity of all panel indicator lights. The IND OFF completely deactivates all indicator lights and does not affect the intensity of the panel illumination.
2. LT (light test) pushbutton switch. Activates the lamp test.
3. BYPASS/ANDVT/ZERO (PULL) switch. The three-position lever action (BYPASS, ANDVT, ZERO (PULL)) switch controls the modes of operation as follows:
    a. BYPASS —Controls and routes HF communications around the CM.
    b. ANDVT — System is used to transmit and receive secure voice communication.
    c. ZERO (PULL) — The switch erases all TEKs stored in the CM and does not require the CM POWER switch to be in the RMT position to be operable.
4. XMT MODE CT (transmit mode cipher text) light. The green XMT MODE CT light indicates the system is on-line and ready to transmit in the secure mode.
5. XMT MODE PT (transmit mode plain text) light. The green XMT MODE PT light indicates the system is on-line and ready to transmit in the plain language mode.
6. RCV CT (receive cipher text) light. The green RCV CT light indicates that a secure voice coded message is being received.
7. B (BTU) light. The green B light indicates BTU power is on and the RCU-IIB panel has control.
8. NET/P-P Switch. Selects one of six traffic encryption keys (TEKs) or plain text when RCU-IIB has control.

2.21.11.1.2 SRCU IIA Controls and Indicators

1. XMT MODE CT (transmit mode cipher text) light. The green XMT MODE CT light indicates the system is on-line and ready to transmit in the secure mode.
2. XMT MODE PT (transmit mode plain text) light. The green XMT MODE PT light indicates the system is on-line and ready to transmit in the plain language mode.
3. RCV CT (receive cipher text) light. The green RCV CT light indicates that a secure voice coded message is being received.
4. ALM (alarm) light. The green light indicates a crypto alarm in the system. The light flashes momentarily during an alarm check.
5. Fill connector. Provides connection for a fill device.
6. Numeric display. Displays results or status of system functions.
7. Mode initiate switch. The three-position lever lock INIT, normal, ZERO (PULL) switch is used

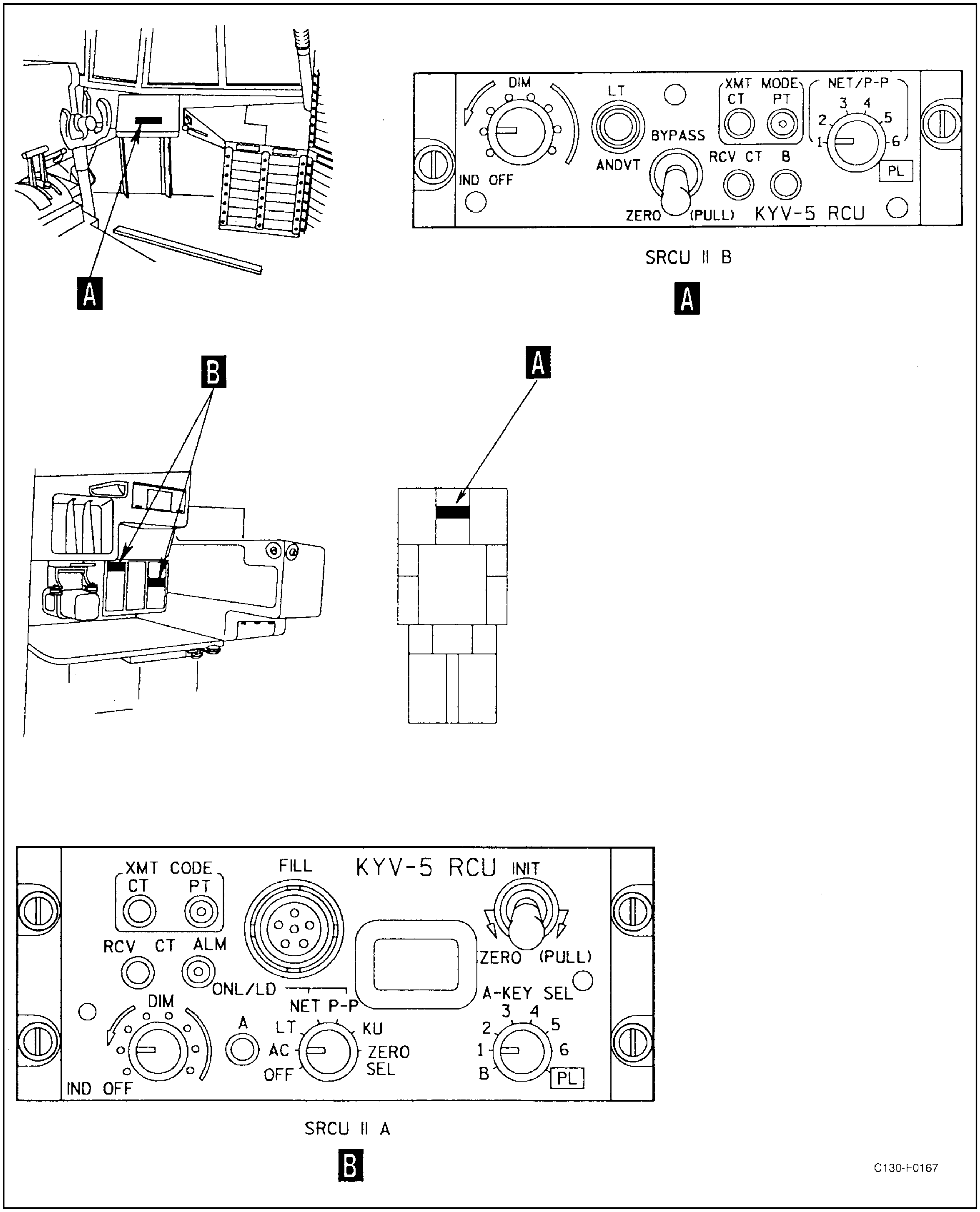


Figure 2-106. Encryption Unit Control Panels (USC-43) (Sheet 1 of 2)

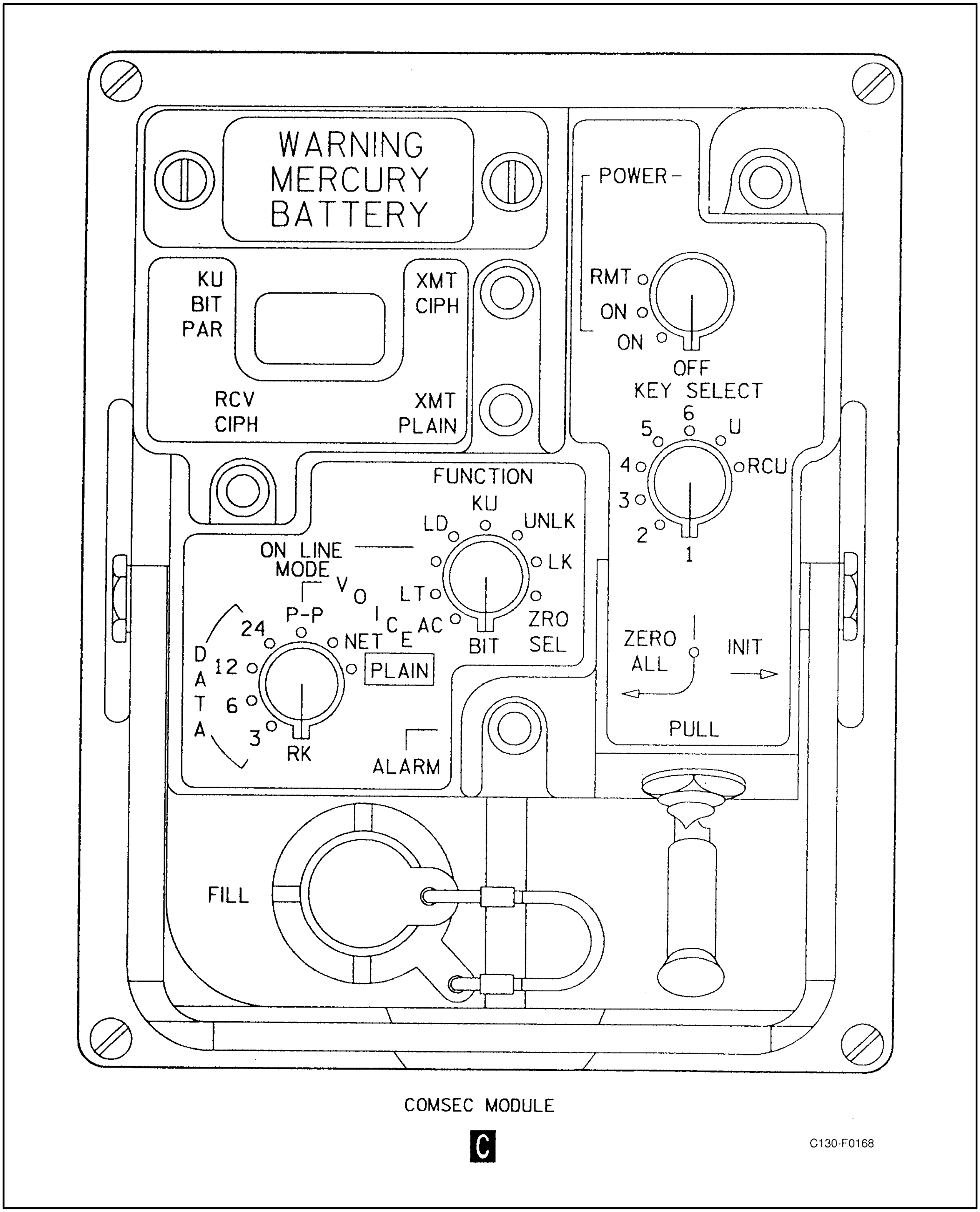


Figure 2-106. Encryption Unit Control Panels (USC-43) (Sheet 2)

to initiate off-line functions. Modes of operation are as follows:

a. INIT (initiate) — Initiates off-line functions selected by the RCU-IIA function switch.

b. Normal — Normal position for system secure voice operation.

c. ZERO (PULL) — When the switch is positioned to ZERO (PULL), all TKEs stored in the CM are erased (zeroized). The switch will remain in ZERO (PULL) until manually returned to the normal position, it is not spring-loaded back to normal.

8. A-KEY SEL switch. The eight-position (B, 1, 2, 3, 4, 5, 6, PL) switch controls operation as follows:

a. B — Selects control of the RCU-IIB.

b. 1,2,3,4,5,6 — Selects one of six TEKs for secure voice operation.

c. PL — Selects plain text operation.

9. FUNCTION switch. The seven-position OFF, AC, LT, ONL/LD NET, ONL/LD P-P, KU, ZERO SEL switch is used to control off-line functions or put the terminal in an on-line mode. Modes of operation are as follows:

a. OFF — Shuts the system off when the CM POWER switch is in the RMT position. RCU has no power control when the CM POWER switch is in the OFF position.

b. AC (alarm check) — Enables the manual initiation of a COMSEC confidence check, which includes a cryptographic alarm check. An alarm check initiated on the RCU-IIA checks the CM logic. The check is initiated when the Mode Initiate switch is positioned to INIT. The INIT position will have no effect if the A-KEY SEL switch is in either the B or PL positions.

c. LT (lamp test) — Enables the testing of the panel indicator lights when Mode Initiate switch is positioned to INIT. Once initiated, the RCU-IIA discrete indicators are sequenced. After release of the switch, the display characters are sequenced through all 16 digits.

d. ONL/LD NET (on-line/load net) — Puts the system in the on-line net operating mode.

Note

The CM can normally be filled by positioning the Mode Initiate switch to 1NIT and there is no traffic through the system. TEKs can only be loaded at the CM.

e. NL/LD P-P (on-line/load point to point) — Puts the system in the on-line point to point operating mode.

Note

The CM can normally be filled by positioning the Mode Initiate switch to INIT and there is no traffic through the system. TEKs can only be loaded at the CM.

f. KU (TEK update) — Enables display of the update status of the TEK selected by the A-KEY SEL switch, and performs the update of TEKs 1 through 6 by positioning the Mode Initiate switch to INIT. The INIT position will have no affect if the A-KEY SEL switch is in either the B or PL positions.

g. ZERO SEL (zero select) — Allows selected TEK zeroization by positioning the Mode Initiate switch to INIT. The INIT position will have no effect if the A-KEY SEL switch is in either the B or PL positions.

10. A (BTU) light. The green A light indicates BTU power is on and the RCU-IIA panel has control.

11. DIM switch. Controls the intensity of all panel indicator lights. The IND OFF completely deactivates all indicator lights, including the display, and does not affect the intensity of the panel illumination.

2.21.11.1.3 COMSEC Module Controls and Indicators

1. KU/BIT PAR display. Displays key update count, display error and fault codes, parity KU operations and channel quality.

2. XMT CIPH light. Indicates cipher operation selection.

3. XMT PLAIN light. Indicates plain operation selection.

4. POWER light. Indicates power on. Only operable when the second ON position of the POWER SWITCH is selected.

5. POWER switch. Controls system power and provides for different system power configurations. The switch positions are described as follows:

   a. OFF — All power is removed from the system.

   b. First ON — Supplies power to the BTUs. CM indicator lights and display will be off.

   c. Second ON — Supplies power to the BTUs. CM indicator lights and display will be on.

   d. RMT — Transfers power and system control to the RCU. CM display, indicator lights and controls off and disabled.

6. KEY SELECT switch. Controls system functions. Switch positions are described as follows:

   a. 1 THRU 6 — Memory storage for traffic keys.

   b. U — Memory storage for rekeying AK and MK operation.

   c. RCU — Memory storage for RCU CM key.

7. ZERO ALL/INIT switch. Controls selected modes of operation. Switch positions are described as follows:

   a. INIT — Activation required for all off-line modes.

   b. ZERO ALL — Erases all key memory storage.

8. ALARM light. Indicates COMSEC alarm condition. Also comes on momentarily during transmit.

9. FILL connector. Provides connection for fill device. (Key transfer interface.)

10. DATA/VOICE switch. Active with function switch on-line. Selects secure voice, plain text, RK (AK and MK) or data rate.

11. FUNCTION switch. Controls selected modes of operation. Switch positions are described as follows:

    a. ON LINE MODE — Enables plain text or secure voice operation.

    b. LD — Key load.

    c. KU — Key update count.

    d. UNLK — CM unlock.

    e. LK — CM lock.

    f. ZRO SEL — Zero selected key.

    g. BIT — Fault detect.

    h. AC — CM alarm check.

    i. LT — Lamp test.

12. RCV CIPH light. Indicates a secure voice coded message is being received.

2.21.11.2 HF Secure Voice System Loading Procedures

2.21.11.2.1 Loading TEKs and System Operation. To load the TEKs and place the HF secure voice in operation proceed as follows.

Note

- The system may be loaded using either the KYK-13 fill device or AN/CYZ-10 data transfer device. Procedures for both are contained in the following steps.

- The following procedures load a TEK into the storage location selected by the CM KEY SEL switch. This can only be accomplished after the system has been initialized and the CM is not in a loaded state.

2.21.11.2.2 KYK-13 Fill Device Loading Procedures

1. Place the CM POWER switch to second ON position.
2. Connect KYK-13 to the CM FILL connector.
3. Turn on the KYK-13 and select the location of the key to be transferred to the CM.
4. Place the CM KEY SELECT switch to the position at which the key is to be loaded.
5. Place CM FUNCTION switch to LD.
6. Place the CM ZERO ALL/INIT switch to the INIT position and release it. The display will flash 01 momentarily for a successful transfer, or FF for a failed load procedure. If FF is displayed, check CM and KYK-13 then repeat the procedure. If procedure fails again, record the failed display code and report this data to Maintenance.
7. After completion of loading, turn off the KYK-13 and remove its connector from the CM fill port.

CAUTION

Failure to turn the KYK-l3 off prior to removal from the CM may cause the TEKs to zeroize.

2.21.11.2.3 AN/CYZ-10 Data Transfer Device Loading Procedures

1. Place the CM POWER switch to second ON position.
2. Insert the crypto ignition key into the AN/CYZ-10.
3. Connect AN/CYZ-10 to the CM FILL connector.
4. On AN/CYZ-10, select APPL, FILL, SETUP, PROTOCOL, CFD, KY13 or KYl5, and XMIT.
5. On AN/CYZ-l0, page down to view key, press Enter to select key, select Quit when key has been selected.
6. On AN/CYZ-10, press Clear Key.
7. Press push-to-talk button on the handset to start crypto fill initiate.
8. After completion of loading, remove the AN/CYZ-l0 connector from the CM fill port.

2.21.11.3 CM Control Transfer Procedures. Procedures to transfer control from the CM to the RCUs are as follows:

1. Position the CM switches as follows:
   a. FUNCTION switch to ON LINE.
   b. KEY SELECT switch to RCU.
   c. POWER switch to RMT. All CM indications will go out and RCU indications will come on.
2. Place the RCUIIA Function switch to NET ONL/LD.
3. Set intensity level. Rotate the Dim switch clockwise from the IND OFF position to turn on and increase the intensity of the indicators and displays to a visible level.
4. Place the RCU-IIA A-KEY SEL switch to the filled position for a previously loaded key (1, 2, 3, 4, 5, 6) for secure voice operation, or the PL position for plaintext operation.

2.21.11.4 RCU Control Transfer Procedures. Procedures to transfer control from the RCU-IIA to the RCU-IIB are as follows:

1. Position the RCU-IIA A-Key switch to B.
2. Place the RCU-IIB NET P-P switch to the filled position for a previously loaded key (1, 2, 3, 4, 5, 6) for secure voice operation, or the PL position for plaintext operation.

2.21.11.5 Set Intensity Level. Rotate the DIM switch clockwise from the IND OFF position to turn on and increase the intensity of the indicators and displays to a visible level.

Note

When operating the secure voice in the secure mode and when the radio PTT is pressed, wait for system crypto preamble to cease before talking.

2.21.11.6 Zeroize System and Shutdown

1. To zeroize the system, place the ZERO ALL/INIT switch on the CM to the ZERO position. This zeroizes all TEKs in a connected CM.

2. To turn the system off, place the POWER switch to OFF.

2.21.12 DF-206 Automatic Direction Finder. Two complete DF-206 automatic direction-finding systems are installed. The systems are combination automatic direction-finding and radio receiver systems within the frequency range of 190 to 1750 kHz. The systems supply direction-finding information for visual display on the pilot and copilot RMIs and the navigator BDHI. With no signal present, the pointer parks at 90° right of the lubber line. Each RMI has an azimuth card and two pointers. The systems have two uses: as an automatic direction finder, and as a voice receiver. As an automatic direction finder, each system automatically and continuously determines the bearing of the station with respect to the aircraft, and displays the bearing visually on the RMI and BDHI. As a voice receiver, the system provides reception of weather reports from range stations and entertainment from broadcast stations and is a backup communications receiver. The ADF systems operate from 26-Vac power from the essential ac bus through the ADF No. 1 and No. 2 fuses on the pilot lower circuit breaker panel, and from 28-Vdc power from the essential dc bus through the ADF No. 1 and No. 2 circuit breakers on the copilot upper circuit breaker panel.

2.21.12.1 Automatic Direction-Finder Controls. The dual control panel for operation of both ADF systems is mounted on the flight control pedestal (see Figures 2-4 and 2-107). The control panel consists of the following controls and indicators.

2.21.12.1.1 Function Selector Knobs. The function selector knobs permit selection of the following functions:

1. OFF — No power to system.

2. ANT — Used for reception of voice and for tuning. The loop antenna is not used.

3. ADF — Radio signals received by the loop antenna are compared with signals received by the sense antenna to provide a relative bearing to the selected station. This bearing information is displayed on the pilot and copilot RMI and the navigator BDHI.

4. TEST — Generates a tone signal to provide an on-channel test signal for self-test. The bearing pointer drives to 45° right of the lubber line during self-test.

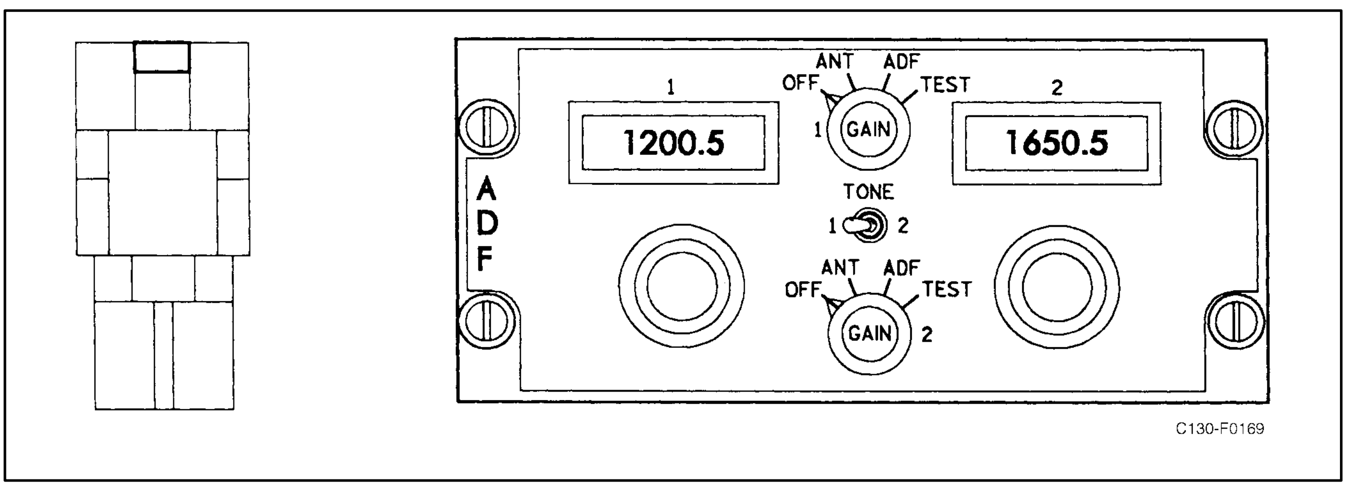


Figure 2-107. Automatic Direction-Finder Control Panel (DF-206)

5. GAIN knob — The GAIN knob controls the volume for the ANT, ADF, and TEST position of the function selector knobs.

6. TONE switch — Provides CW tone to either system No. 1 or No. 2.

7. Frequency indicators — Used to provide a digital readout in kHz of the frequency to which the ADF system is tuned.

8. Frequency selector knobs — Permit selection of the desired frequency as indicated on the adjacent frequency indicator.

   a. The large knob is used to select thousands and hundreds of kHz in 100-kHz steps.

   b. The middle knob is used to select tens of kHz in 10-kHz steps.

   c. The small knob is used to select units and tenths of kHz in 0.5-kHz steps.

2.21.12.2 Normal Operation of the Automatic Direction Finder

1. Position the function selector knob to ANT. Select an unused frequency for test. Allow 5 minutes for warmup.

2. Pull the applicable ADF monitor switch volume knob on the ICS control panel; turn the knob to the midrange position.

3. Perform the test by positioning the function selector knob to TEST. Observe that the ADF pointer for the corresponding system on the pilot or copilot RMI and the navigator BDHI indicates 45° right from the lubber line. A beat tone should be heard in the headset.

4. Select the desired operating frequency with the frequency selector knobs and adjust the volume control on the ADF control panel as necessary to obtain a comfortable reception level.

5. Position the function selector knob to the operational mode desired (ANT or ADF).

2.21.12.2.1 Automatic Direction Finding

1. Place the function selector knob for the desired system(s) to ANT.

2. Select operating frequencies with the frequency selector knobs.

3. Find magnetic bearing to the station by placing the function selector knob to the ADF position and observing position of pointers on the pilot and copilot RMIs or navigator BDHI.

Note

If the received signal is too weak for reliable use, the pointer will be idled at 90° left of the lubber line.

2.21.12.2.2 Voice Reception. For use as a voice receiver, either of the two function selector knob positions, ANT or ADF, may be used, but ANT will usually provide a clearer signal.

2.21.13 AN/ARN-126 VHF Navigation System. Two independent VHF navigation systems are installed on the aircraft. Each system receiver performs dual functions. When tuned to a VOR frequency, the receiver furnishes VOR magnetic bearing to the pilot and copilot BDHIs, and to the navigator No. 2 BDHI. When VOR/ILS is selected on the NAV SEL switch, VOR course deviation, to-from indication, and system validity are provided to the flight control system for display and flight computer steering. Tuning the receiver to an ILS frequency activates the localizer and glideslope sections of the receiver. With VOR ILS selected on the NAV SEL switch, horizontal and vertical position information is furnished by the receiver to the flight control system for display on the HSIs and ADIs and for use by the flight computers to compute steering signals for the autopilot and ADI command bars. The glideslope section of the receiver also provides information to the ground proximity warning system computer. ILS validity is provided to ensure that a valid signal is being received by the flight control system. Magnetic heading information to the No. 1 VHF navigation system is provided by the No. 1 C-12 compass while the No. 2 VHF navigation system receives its heading information from the No. 2 C-12 compass. The pilot and copilot HSIs provide desired course data to the No. 1 and No. 2 VHF navigation systems, respectively, for course deviation resolution.

Audio signals from the VOR stations may be monitored on the ICS by pulling out the appropriate VOR 1 or VOR 2 monitor switches. The marker beacon section of the No. 1 VHF receiver gives visual and aural coded signals when the aircraft is in range of or passing over a marker beacon transmitter. The visual signal is given through three press-to-test colored indicator lights on a panel on the pilot instrument panel: white (labeled A/I) for airway/inner marker, amber (labeled M) for an ILS middle marker, and blue (labeled O) for an ILS outer marker (see Figure 2-77). A two-position, HI-LO marker beacon switch, located on the pilot instrument panel, is used to select either high or low receiver sensitivity according to the strength of the incoming signal. The LO position of the switch narrows the apparent width of marker beacon transmissions. The audio signal (400 Hz for outer marker, 1300 Hz for middle marker, and 3000 Hz for airway/inner markers) is provided through the ICS. Some airport installations, such as category II, have an inner marker that indicates a point at which the aircraft is at a designated decision height on the glideslope between the middle marker and the landing threshold. The airways inner marker is utilized to indicate the inner marker beacon position. The No. 1 and No. 2 VHF navigational systems are supplied 28-Vdc power from the essential dc bus through the VOR/ILS NO. 1 and NO. 2 circuit breakers on the copilot upper circuit breaker panel. The NO. 1 and NO. 2 VHF navigational systems are supplied with 26-Vac power from the essential ac bus through the VOR/ILS NO. 1 and NO. 2 circuit breakers on the pilot upper circuit breaker panel.

2.21.13.1 VHF Navigation System Control and Tuning. The VOR navigation radios are tuned and controlled via the CDNU Nav page. System power is controlled via the CDNU Power page (a box around the system name indicates the unit is powered). The NAV page is accessed via the F6 key or via the index page. Tuning is accomplished by entering the appropriate frequency in the scratchpad and then pressing the line select key next to the corresponding radio. Returning to the previously selected frequency may be accomplished by tuning 0. For additional functions and controls of the VOR navigation radios, refer to Figure 2-108.

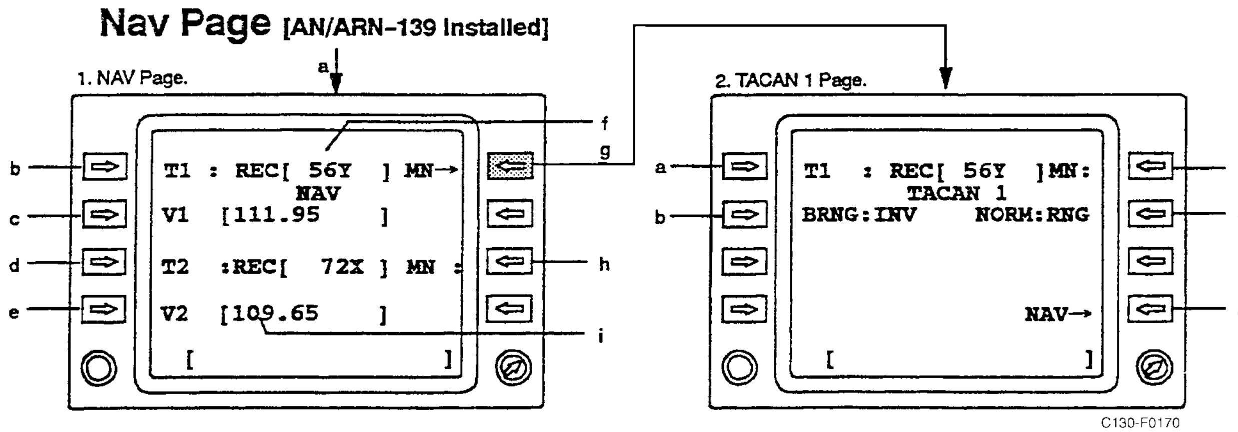
2.21.13.2 Normal Operation of VHF Navigation Systems

2.21.13.2.1 VHF Navigation System Operation. To put the tacan system(s) into operation, proceed as follows:

1. Tune desired frequency in VOR-1 or VOR-2 via the CDNU.
2. Set pointer select switches as necessary for the selected VOR receiver to the BDHI.
3. Select appropriate VOR/ILS position with NAV SEL switch for display on HSI.
4. Set course to be flown with the course set knob.
5. Check station identifier by pulling out the appropriate VOR monitor switch-volume mixer on the ICS control panel.
6. Adjust volume as necessary via individual mixer switch or master volume knob on ICS panel.

2.21.13.2.2 VHF Navigation Test

1. Tune a valid frequency in VOR-1 or VOR-2 via the CDNU (a valid VOR frequency is required to test).
2. Place the required NAV SEL switch(es) in the appropriate position for tacan operation.
3. Select a course providing zero deviation with the course select knob.
4. Test VOR via CDNU (access via IDX, then SYSTEMS TEST page 2/2).
   a. The TO-FROM indication should indicate TO.
   b. All three marker beacon lights should flicker.
   c. The course deviation bar should have slight right deflection.
   d. A 30-Hz VOR and marker beacon test tone should be heard.
   e. Bearing indications should be between 1 and 5 degrees.
   f. The NAV warning flag should come into view after 1 second and go out of view within 5 seconds.



1. NAV Page.

   a. Access Nav Page via Index 1/2 Page.

   b. Depends on scratchpad entry:

      (1) Blank: Toggles operating mode:
      REC — Receiver mode
      T/R — Transmit/receive mode
      A/R — Air-to-air receive mode
      A/T — Air-to-air transmit/receive mode

      (2) Valid tacan channel: Tunes TAC1 to channel. New channel is displayed in brackets [ ].

      (3) Zero (0): Tunes TAC1 to previously tuned channel. Channel in brackets [ ] is replaced.

   c. Depends on scratchpad entry.

      (1) Valid frequency: Tunes VOR1 to frequency. New frequency is displayed in brackets [ ].

      (2) Zero (0): Tunes VOR1 to previously tuned frequency.

   d. Functions same LS1 except for TAC2.

   e. Functions same LS2 except for VOR2.

   f. Indicates TAC1 is tuned to channel 56Y.

   g. Accesses Tacan 1 Page.

   h. Indicates tacan pairing state specified on TAC1 Page:

      (1) MN — manual

      (2) PR — paired

   i. Indicates VOR 2 is tuned to 109.65 MHz.

2. Tacan 1 Page.

   a. Depends on scratchpad entry:

      (1) Blank: Toggles operating mode:
      REC — Receiver mode
      T/R — Transmit/receive mode
      A/R — Air-to-air receive mode
      A/T — Air-to-air transmit/receive mode

      (2) Valid tacan channel: Tunes TAC1 to channel. New channel is displayed in brackets [ ].

      (3) Zero (0): Tunes TAC1 to previously tuned channel. Channel in brackets [ ] is replaced.

   b. Toggles bearing (BRNG) between inverse (INV) and normal (NORM).

   c. Toggles TAC1 pairing state between:

      (1) MN — manual

      (2) PR — paired

   d. Toggles RNG:

      (1) NORM: normal

      (2) EXT: extended

   e. Returns to NAV Page.

Figure 2-108. NAV Page (AN/ARN-139 Installed)

2.21.13.2.3 ILS Navigation Test

1. Tune a valid ILS frequency in VOR-1 or VOR-2 via the CDNU (a valid VOR frequency is required to test).

2. Place the required NAV SEL switch(es) in the appropriate position for tacan operation.

3. Test VOR via CDNU (access via IDX, then SYSTEMS TEST page 2/2).

   a. The course deviation bar should indicate a right deflection of approximately one dot.

   b. The glideslope indicator should indicate a down deflection of approximately one dot.

   c. All three marker beacon lights should flicker.

   d. A 30-Hz VOR and marker beacon test tone should be heard.

   e. The glideslope warning flag should come into view after 1 second and then go out of view within 5 seconds.

   f. The NAV warning flag should come into view after 1 second and go out of view within 5 seconds.

2.21.14 Tacan

Note

The No. 1 tacan system is an AN/ARN-139(V), and the No. 2 tacan system is an AN/ARN-118(V).

Two independently operating tacan navigation systems are installed on the aircraft (see Figure 2-108). When the tacan systems are on and operating, magnetic bearing information as indicated is furnished to the pilot and copilot BDHI and selectable at the navigator station on the navigator left- and right-hand BDHI. The No. 1 tacan system supplies distance and distance validity directly to the pilot BDHI and navigator left-hand BDHI, while the No. 2 system supplies the copilot BDHI and navigator right-hand BDHI. Distance information from the No. 1 system is displayed on the pilot HSI miles display whenever system No. 1 is operating and the pilot NAV SEL switch is in any position except INS 1, CDNU, or TAC 2. Similarly, distance information from the No. 2 system is displayed on the copilot HSI miles display whenever system No. 2 is operating and the copilot NAV SEL switch is in any position other than INS 2, CDNU, or TAC 1. When a tacan is selected on the instrument selector control panel, the selected system course deviation, to-from indication, and tacan validity (flag warning) are provided to the flight control system (FCS 105) for display on the HSI and for use by the flight computers to compute a steering signal to the autopilot and ADI command bars. Magnetic heading information to the No. 1 tacan is normally provided by the No. 1 C-12 compass, while the No. 2 tacan system normally receives its heading from the No. 2 C-12 compass. The pilot and copilot HSIs provide desired course data to the No. 1 and No. 2 tacan systems, respectively, for course deviation resolution. Tacan audio signals can be monitored by pulling the appropriate tacan monitor switch-volume knob on the intercommunication system control panel. The tacan systems are powered by 28-Vdc power and 115-Vac power from essential dc and ac buses through TACAN NO. 1 and NO. 2 ac and dc circuit breakers on the copilot upper circuit breaker panel.

Note

When using the AN/ARN-139 tacan for bearing information and switching between TAC 1 and ADF 2 at the navigator No. 1 BDHI, the tacan bearing function at the pilot HSI (if TAC 1 is selected), copilot HSI (if TAC 1 is selected), and NAV BDHI (if TAC 1 is selected) may break lock-on for 2 or 3 seconds, and then recover lock-on to indicate the correct tacan bearing. This anomaly may occur either while switching from TAC 1 to ADF 2, or from ADF 2 to TAC 1.

The tacan navigation set has provisions for 126 X and 126 Y channels. The Y channels differ from the X channels in frequency assignment and pulse spacing. The maximum operating range of the tacan navigation set is 390 nm when the selected tacan station is a surface beacon and 200 nm when the selected tacan station is an airborne beacon.

Note

The Y channels were developed to alleviate congestion of the X channels. Use of Y channels is encouraged in air-to-air modes.

Note

In air-to-air modes, the receiver aircraft must select a channel 63 channels above or below the cooperating aircraft channel. Audio station identification is not received from cooperating aircraft.

Use of Y channels is recommended to prevent possible DME interference. Also, to prevent interference from IFF or transponder signals, select Y channels or select X channels between 11 and 58, or 74 and 121.

2.21.14.1 Tacan System Control and Tuning. The tacan navigation radios are tuned and controlled via the CDNU Nav page or detailed tacan page. System power is controlled via the CDNU Power page (a box around the system name indicates the unit is powered). The NAV page is accessed via the F6 key or via the index page. Tuning is accomplished by entering the appropriate channel in the scratchpad and then pressing the line select key next to the corresponding radio. Pressing the line select key with no channel in the scratchpad (blank scratchpad) will access the detailed page for the corresponding radio. Quick tuning for the tacans can be accomplished by entering the channel in the scratchpad and pressing F4 for tacan-1 or F5 for tacan-2. Pressing the F4 or F5 keys with no channel in the scratchpad will access the corresponding detailed tacan page. Returning to the previously selected frequency may be accomplished by tuning 0. The tacan and DME can be set to automatically tune to the channel paired with the VOR frequencies. Paired operation is enabled using the right-side line select key next to the respective tacan. The letters “PR” on the CDNU display indicate the paired function is enabled and the paired tacan channel will automatically be tuned to correspond with the VOR frequency; “MN” indicates that the paired function is not enabled. For additional functions and controls of the tacan navigation radios, refer to Figure 2-108.

2.21.14.2 Tacan Air-to-Air Interaction. Figure 2-109 gives the information received for a receiver tacan set based on the interaction between modes selected on a transmitter and receiver tacan. To use Figure 2-109:

Note

The AN/ARN-118(V) tacan system can receive both distance and bearing information from other suitably equipped aircraft but can only transmit distance information.

1. Under TRANSMITTER, select the tacan set and mode.
2. To the right of RECEIVER, select the tacan set and mode.
3. Read the results where the TRANSMITTER column and RECEIVER row intersect.

To find the information a transmitter receives, reverse the above procedure.

2.21.14.3 Normal Operation of Tacan Systems

2.21.14.3.1 Preflight or Ground Test

1. Turn on tacan and set to T/R mode via CDNU.

Note

Normal warm-up time is 90 seconds.

2. Place the required NAV SEL switch(es) in the appropriate position for tacan operation.
3. Test tacan via CDNU (access via IDX, then SYSTEMS TEST page 2/2).
   a. The distance shutter and NAV flag on the HSI should come into view, if not already in view.
   b. The tacan bearing pointer should slew to 270 degrees for a nominal 7 seconds.
   c. The distance shutter and NAV flag go out of view.
   d. The distance indication on BDHI and HSI should be 000.0 ±2 nm, and the bearing pointers should slew to 180 degrees ±5.

All indications should remain displayed for approximately 15 seconds and the system returns to normal operation.

Note: This table is applicable to air-to-air operations only.			TRANSMITTER									
			AN/ARN-118(V)		AN/ARN-139(V)							
		MODE	A/A REC	A/A T/R	A/A NORM NORMAL	A/A NORM EXTEND	A/A INV NORMAL	A/A INV EXTEND	BCN NORM NORMAL	BCN NORM EXTEND	BCN INV NORMAL	BCN INV EXTEND
RECEIVER	AN/ARN-118(V)	A/A REC									B	B
	AN/ARN-139(V)	A/A T/R		D	D	D	D	D	D	D	B/D	B/D
		A/A NORM NORMAL		D	D	D	D	D	D	D	B/D	B/D
		A/A NORM EXTEND		D	D	D	D	D	D	D	D	D
		A/A INV NORMAL		D	D	D	D	D	B/D	B/D	D	D
		A/A INV EXTEND		D	D	D	D	D	D	D	D	D
		BCN NORM NORMAL		D	D	D	D	D	D	D	B/D	B/D
		BCN NORM EXTEND		D	D	D	D	D	D	D	D	D
		BCN INV NORMAL		D	D	D	D	D	B/D	B/D	D	D
		BCN INV EXTEND		D	D	D	D	D	D	D	D	D

NO INFORMATION AVAILABLE	BEARING	DISTANCE	BEARING AND DISTANCE
	B	D	B/D

Figure 2-109. Tacan Air-to-Air Interaction

2.21.14.3.2 Tacan System Operation. To put the tacan system(s) into operation, proceed as follows:

1. Turn on tacan and set to T/R mode via CDNU.

Note

Normal warm-up time is 90 seconds. There is no delay when switching from REC to T/R.

2. Tune desired frequency in tacan-1 or tacan-2 via the CDNU.

3. Select appropriate tacan position with NAV SEL switch for display on HSI. (No SEL switch action required to display tacan information on BDHIs.)

4. Set course to be flown with the course set knob.

5. Check station identifier by pulling out the appropriate tacan monitor switch-volume mixer on the ICS control panel.

Note

Audio station identification is not received from cooperating aircraft.

6. Adjust volume as necessary via individual mixer switch or master volume knob on ICS panel.

7. If air-to-air mode of operation is desired, set in a channel that is 63 digits removed from the channel in the other aircraft (e.g., channel 15 is selected by one aircraft, while the other aircraft selects channel 78).

Note

In general, avoid using channels close to 1 or 126 for air-to-air mode of operation. Also avoid using local tacan channels. With interrogating aircraft flying in close proximity of each other, it is possible that erroneous distances may be displayed because of the calibration of the tacan system in either aircraft.

2.21.15 AN/ARA-63A Receiving-Decoding Group. The receiving-decoding group is the airborne part of the aircraft approach control system.

2.21.15.1 Receiving-Decoding Group Controls. A receiving-decoding group control panel (see Figure 2-110) located on the flight control pedestal provides the primary operating controls for the system. The panel contains a POWER switch and indicator, a pushbutton BIT switch, and a CHANNEL select switch.

The ARA-63A receives and decodes TPN-30, TRN-28 and SPN-41 scanning beam pulse-coded microwave landing system signals from ground/surface stations. The system continuously computes lateral (azimuth) and vertical (elevation) deviations from the optimum approach line in space. Flight instrument indications are similar to ILS except:

1. A one-dot deflection of the azimuth indicator corresponds to a 6° aircraft deviation from the optimum approach line. Azimuth deviations of up to 6° result in a proportional deflection on the indicator. Azimuth deviation of 6° to 20° results in full-scale deflection on the indicator. If ARA-63A is selected, optimum azimuth is displayed by the ADI runway symbol and HSI course deviation bar on the affected flight director.

2. A one-dot elevation deflection of the elevation indicator corresponds to a 1.4° result in proportional deflection on the indicator. Elevation deviations from 1.4° to 10.0° result in a full-scale deflection on the indicator. If ARA-63A is selected, optimum elevation is displayed by the ADI and HSI glideslope pointers on the affected flight director.

The ARA-63A system is supplied with three-phase 115-Vac essential ac power through the AN/ARA-63 circuit breakers located on the pilot side circuit breaker panel. The system is supplied with 28-Vdc essential dc power through the AN/ARA-63 circuit breaker located on the copilot upper circuit breaker panel.

Note

- The AN/ARA-63A is not compatible with civil microwave landing systems.

- If required, DME must be obtained from the aircraft tacan equipment.

2.21.15.1.1 POWER Switch and Indicator Lamp. When the POWER switch is selected to OFF, no power is supplied to the system. When the POWER switch is selected to ON, power is supplied to the system and the power indicator lamp illuminates.

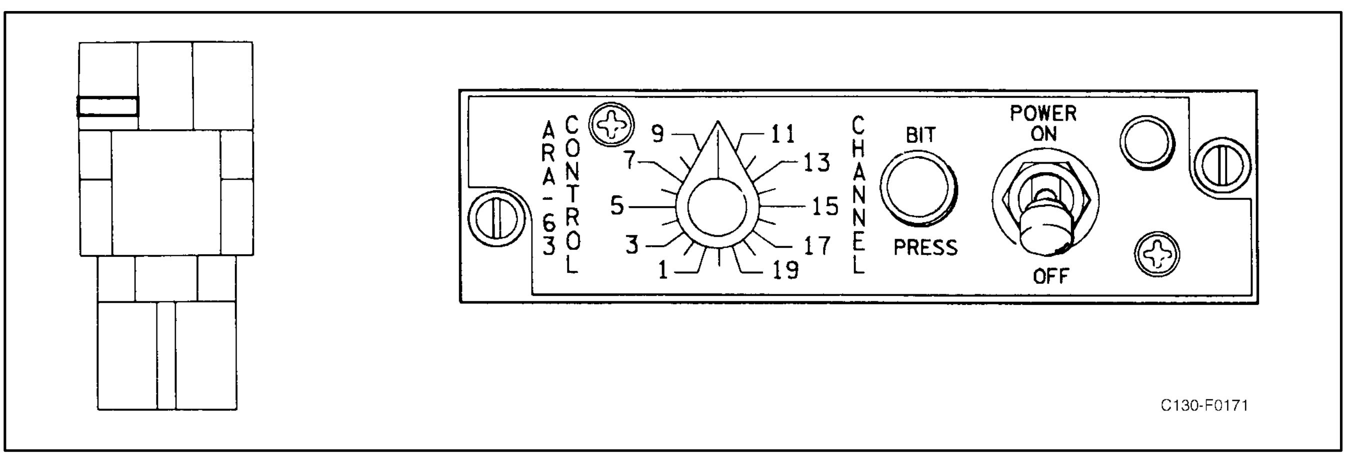


Figure 2-110. AN/ARA-63A Receiving-Decoding Group Control Panel

2.21.15.1.2 CHANNEL Selector. The CHANNEL select switch is a rotary switch and is used to select any one of the 20 PCMLS channels in the Ku band (see Figure 2-110).

2.21.15.1.3 BIT Switch. The pushbutton BIT switch provides the pilot with a degree of confidence in the systems operation. When the switch is depressed and held, the system causes the following indications to appear. For correct system functioning, the ADI command bars will indicate fly right and fly left at a 4-second-per-cycle rate and the glideslope pointer will indicate on glideslope. A malfunction detected by the BIT turns on failure indicators in the receiver or decoder, or both.

Note

> The optimum elevation angle selector on the back of the receiver is not intended for routine aircrew use. Verification of the desired optimum elevation angle (normally 3°) is recommended during preflight on sorties requiring use of the AN/ARA-63A system.

2.21.15.2 Normal Operation of the Receiving-Decoding Group. To turn the system on:

1. Place the POWER switch to the ON position.
2. Select the desired operating channel.
3. Place the NAV SEL switch to the ARA-63 position.
4. To test the system, depress and hold the BIT pushbutton switch.

To turn the system off:

5. Place the POWER switch to the OFF position.

2.21.16 AN/ARA-50 UHF Direction Finder (Aircraft Prior to 164993). The UHF direction finder is used to indicate the relative bearing of, and to home on, radio signals being received by the No. 1 AN/ARN-159 UHF (or AN/ARC-210 V/UHF for aircraft modified by AFC-338) radio. When the operator sets the radio to the ADF function, continuous indication of relative bearing is provided by the No. 2 needle of the RMI on the pilot and copilot instrument panels. The UHF direction finder operates from 115-Vac power and 28-Vdc power from the main ac bus and main dc bus through UHF DF circuit breakers on the copilot upper circuit breaker panel.

2.21.17 DF-301E UHF Direction Finder (Aircraft 164993 and Up). The DF-301E direction finder is used to indicate the relative bearing of, and to home on, radio signals being received by the No. 1 AN/ARN-159 UHF (or AN/ARC-210 V/UHF for aircraft modified by AFC-338) radio. When the operator sets the radio to the ADF function, continuous indication of relative bearing is provided by the No. 2 needle of the RMIs, on the pilot and copilot instrument panels. The DF-301E direction finder operates from 28-volt main dc bus power provided through the UHF DF circuit breaker on the copilot upper circuit breaker panel.

2.21.17.1 AN/ARA-50 or DF-301E UHF Direction Finder Controls. The direction finder is controlled from the No. 1 UHF or V/UHF-1 radio (see Figure 2-95) on the flight control pedestal. The direction finder is turned on by placing the function switch in the ADF position or by selecting ADF operations via the CDNU for aircraft modified by AFC-338. The operating frequency is selected on the No. 1 UHF or V/UHF-1 radio.

2.21.17.2 Normal Operation of the AN/ARA-50 or DF-301E UHF Direction Finder with AN/ARC-159 UHF Radio (Aircraft Prior to AFC-338)

2.21.17.2.1 Homing. Home on UHF radio stations as follows:

1. Rotate the function switch on the No. 1 UHF radio to the ADF position.
2. Select the operating frequency on the No. 1 UHF radio.
3. Turn the aircraft to place the head of the No. 2 bearing pointer under the top index of the RMI.
4. To turn off, move the function switch on the UHF radio from the ADF position.

2.21.17.2.2 Direction Finding. Perform direction finding as follows:

1. Rotate the function switch on the No. 1 UHF radio to the ADF position.
2. Select the operating frequency on the No. 1 UHF radio.
3. Read the bearing to the received signal under the head of the No. 2 bearing pointer on the compass card of the RMI.
4. To turn off, move the function switch on the UHF radio from the ADF position.

2.21.17.2.3 Emergency Operation of the Direction Finder. The direction finder has no provision for emergency operation. If a fault in the direction finder interferes with operation of the UHF radio, remove the P879 plug on the front panel of the AM-3624/ARA-50 amplifier relay. The amplifier relay is located on the electrical control and supply rack (see Figure 2-81).

2.21.17.3 Operation of the AN/ARA-50 or DF-301E UHF Direction Finder with ARC-210 V/UHF Radio (Aircraft Modified by AFC-338)

2.21.17.3.1 Homing. Home on UHF radio frequencies as follows:

1. Press the F1 function key on the CDNU to display the VU1 1 of 2 Page.
2. Enter the operating frequency in the scratchpad of the CDNU and press line select key 1 (first left selection button) to tune the V/UHF radio.
3. Toggle the operational mode (line select key 2) from T/R or TR&G to ADF.
4. Turn the aircraft to place the head of the No. 2 bearing pointer under the top index of the BDHI.
5. To turn off, from the VU1 1 of 2 Page, toggle the operational mode (line select key 2) from ADF to TR&G or TR.

2.21.17.3.2 Direction Finding. Perform direction finding as follows:

1. Press the F1 function key on the CDNU to display the VU1 1 of 2 Page.
2. Enter the operating frequency in the scratchpad of the CDNU and press line select key 1 (first left selection button) to tune the V/UHF radio.
3. Toggle the operational mode (line select key 2) from T/R or TR&G to ADF.
4. Read the bearing to the received signal under the head of the No. 2 bearing pointer on the compass card of the BDHI.
5. To turn off, from the VU1 1 of 2 Page, toggle the operational mode (line select key 2) from ADF to TR&G or TR.

2.21.17.3.3 Emergency Operation of the Direction Finder (Aircraft Modified by AFC-338). The direction finder can be controlled from the V/UHF control unit located on the pedestal.

2.21.17.3.4 Homing with V/UHF Pedestal Control Unit. Home on UHF radio stations as follows:

1. Rotate the frequency selector switch to MAN.
2. Rotate the chan/freq/csr selector switch to the operating frequency. Press the selector switch to change cursor positions.
3. Rotate the operational selector switch to ADF.
4. Turn the aircraft to place the head of the No. 2 bearing pointer under the top index of the BDHI.
5. To turn off, rotate the operational selector switch to TR or TR&G.

2.21.17.3.5 Direction Finding with V/UHF Pedestal Control Unit. Perform direction finding as follows:

1. Rotate the frequency selector switch to MAN.
2. Rotate the chan/freq/csr selector switch to the operating frequency. Press the selector switch to change cursor positions.

3. Rotate the operational selector switch to ADF.

4. Read the bearing to the received signal under the head of the No. 2 bearing pointer on the compass card of the BDHI.

5. To turn off, rotate the operational selector switch to TR or TR&G.

2.21.18 AN/APN-232(V)6 Combined Altitude Radar Altimeter. CARA indicators, one each in the pilot and navigator instrument panels, are installed in C-130T aircraft prior to 164993. C-130T aircraft 164993 and up have CARA indicators installed in the pilot and copilot instrument panels (Figure 2-111). CARA indicates the altitude the aircraft is above the terrain, up to 50,000 feet. The pilot CARA provides information to the ground proximity warning system, and, on C-130T aircraft prior to 164993, the pilot and copilot decision height annunciators. On C-130T aircraft 164993 and up, the pilot and copilot decision height annunciators are provided information by their respective CARA indicators. The CARA system consists of two indicators, two antennas, and one receiver-transmitter.

The system operates from 28-Vdc essential bus power through the ALTIMETER RADAR CMBD ALT circuit breaker on the copilot upper circuit breaker panel.

2.21.18.1 CARA Indicators and Controls. The following items are located on each indicator:

1. Analog altitude pointer and dial — The pointer indicates altitude from 0 to 5,000 feet. Above 5,000 feet, the pointer is masked. The dial is graduated in increments of 10 feet from 0 to 500, 50 feet from 500 to 1,000, and 500 feet from 1,000 to 5,000.

2. Digital altitude display — Five light-emitting diodes provide a digital indication of altitude and indicate in 1-foot increments from 0 to 100 feet and 10-foot increments from 100 to 50,000 feet. The word FAIL is displayed by the LED if the system fails.

3. LO altitude warning indicator — The indicator illuminates when the VALI setting has been attained.

4. R/T status indicator — Illumination indicates a fault in the receiver-transmitter.

5. Ambient light sensor — Senses cockpit light level and works in conjunction with the BRT knob to set digital display brightness.

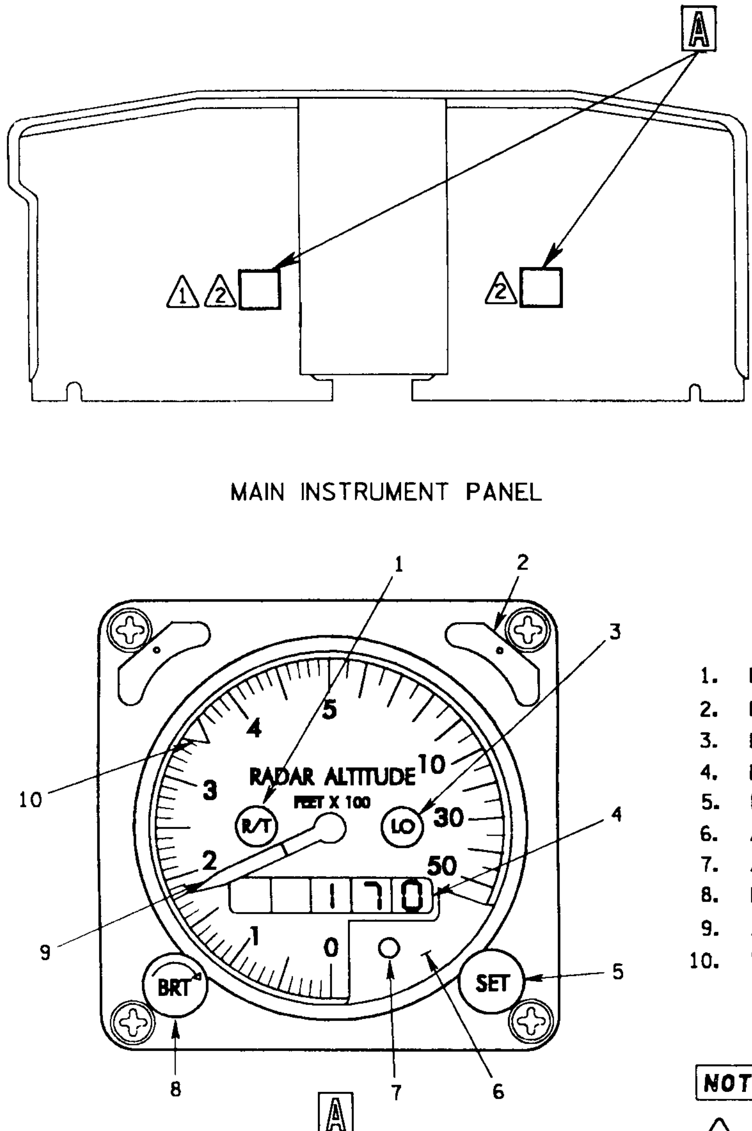
6. BRT knob — Used to change brightness of the digital display, as set by the ambient light sensor during cockpit low-light conditions. During bright light conditions, the ambient light sensor sets the display to bright and the BRT knob cannot dim the display.

7. SET knob — The radar altimeter control SET knob serves three functions: as an on-off control, to set the VALI, and as a test button to check the system. Initially, turning the knob clockwise applies power to the system; further rotation of the knob rotates the VALI indicator from zero to a desired minimum altitude setting. Momentarily depressing the SET knob activates the self-test feature of the system, and, if the system is operating properly, the following sequence of events will occur:

   a. The analog altitude pointer will move to 500 feet, the digital display will read 88888, and the R/T indicator will illuminate for approximately 1.5 seconds. The LO indicator will also illuminate if the VALI is set above 500 feet.

   b. After approximately 1.5 seconds, the system will complete the self-test with a digital reading of 300 ±10 feet. The R/T indicator will be extinguished. The LO indicator will be illuminated if the VALI is set above 300 feet. This test will terminate approximately 1.5 seconds later. If, instead of events a and b occurring, the word FAIL appears on the digital display and the analog altitude pointer goes behind the mask, a failure has occurred in the indicator. If the R/T indicator also illuminates when the word FAIL appears on the digital display, the most probable failure is in the receiver-transmitter.

8. VALI — The VALI indicates the altitude setting at which the LO altitude warning indicator will illuminate. The SET knob is used to set the VALI.



1. RECEIVER TRANSMITTER STATUS INDICATOR
2. FRONT REPLACEABLE LAMP ASSEMBLY
3. LOW ALTITUDE WARNING INDICATOR
4. DIGITAL ALTITUDE DISPLAY
5. RADAR ALTIMETER CONTROL
6. ANALOG POINTER MASK
7. AMBIENT LIGHT SENSOR
8. DIGITAL READOUT DIMMER CONTROL
9. ANALOG ALTITUDE POINTER
10. VARIABLE ALTITUDE LIMIT INDEX

NOTE

1 C-130T AIRCRAFT PRIOR TO 164993.

2 C-130T AIRCRAFT 164993 AND UP.

C130-F0172

Figure 2-111. AN/APN-232(V)6 Combined Altitude Radar Altimeter

On C-130T aircraft prior to 164993, the decision height annunciators on the ADIs are set through the pilot CARA indicator SET knob. On C-130T aircraft 164993 and up, the pilot and copilot decision height annunciators are set through the respective (pilot or copilot) CARA indicator SET knob.

2.21.18.2 Normal Operation of the CARA

Note

The CARA may break lock and the height indication may fluctuate or cycle during ground operation or in flight above 10,000 feet with the nose landing gear down. This is normal and not a discrepant condition as long as operation is normal under other conditions.

To put the CARA into operation:

1. On the pilot indicator, rotate the SET knob out of the off detent. Wait 5 seconds for warmup. The analog altitude pointer indicates zero.

2. Set the desired altitude reference with the SET knob.

To test the radar altimeter for correct operation:

3. Set the VALI to 400 feet.

4. Momentarily depress the SET knob. Observe that the analog pointer moves to 500 ±10 feet, the digital display reads 88888, and the R/T indicator illuminates. After approximately 1.5 seconds, observe that the digital display changes to 300 ±10 feet, the analog pointer moves to 300 ±10 feet, the R/T lamp extinguishes, and the LO lamp illuminates. This display lasts approximately 1.5 seconds, after which the system returns to normal operation.

To turn the CARA off:

5. Rotate the SET knob on the pilot indicator to off.

Repeat steps 1 through 5 on the navigator/copilot indicator.

2.21.19 Ground Proximity Warning System (Mark VII).

The GPWS provides both the pilot and copilot with visual and aural warnings for a flight condition or aircraft attitude that, if uncorrected, would cause the aircraft to come in close proximity or contact the terrain in its flightpath. The Mark VII GPWS consists of a solid-state computer, warning annunciators on the pilot and copilot instrument panel and glareshield, an air data computer (barometric altitude/rate and Mach), tactical (TACT) and approach (APPR) mode selector switches and annunciators on the pilot and copilot instrument panels, and switches to monitor landing gear and flap position (see Figure 2-112). The Mark VII GPWS receives signals from the radar altimeter, VHF navigation system, No. 1 and No. 2 flight director system, and the vertical gyro. Power is supplied from the essential ac and essential dc buses through the GPWS circuit breakers located on the copilot upper circuit breaker panel.

2.21.19.1 Annunciators and Controls.

GPWS annunciators and controls are located on the instrument panel and center pedestal (see Figure 2-112) and are explained in the following paragraphs.

2.21.19.1.1 PULL UP Annunciators/GPWS TEST Switches.

The combination PULL UP annunciators/GPWS TEST switches are located on the pilot and copilot main instrument panels. When the aircraft enters the warning envelope of excessive sink rate (mode 10) or excessive closure rate (mode 2), the PULL UP annunciator lights will illuminate and the aural “Whoop whoop pull up” is heard on all flight station positions through the pilot and copilot intercommunications system. When an annunciator/switch is depressed, a self-test is initiated if the aircraft is on the ground or airborne above 200 feet.

2.21.19.1.2 BELOW G/S Annunciators/Switches.

The BELOW G/S annunciators are located on the pilot and copilot instrument panels. The annunciators are also push-type switches used to inhibit glideslope warnings below 1,500 feet altitude. When the aircraft enters the warning envelope of descent below glideslope (mode 5), the BELOW G/S annunciator lights will illuminate and an aural “Glideslope” warning is heard on all flight station positions through the pilot and copilot ICS.

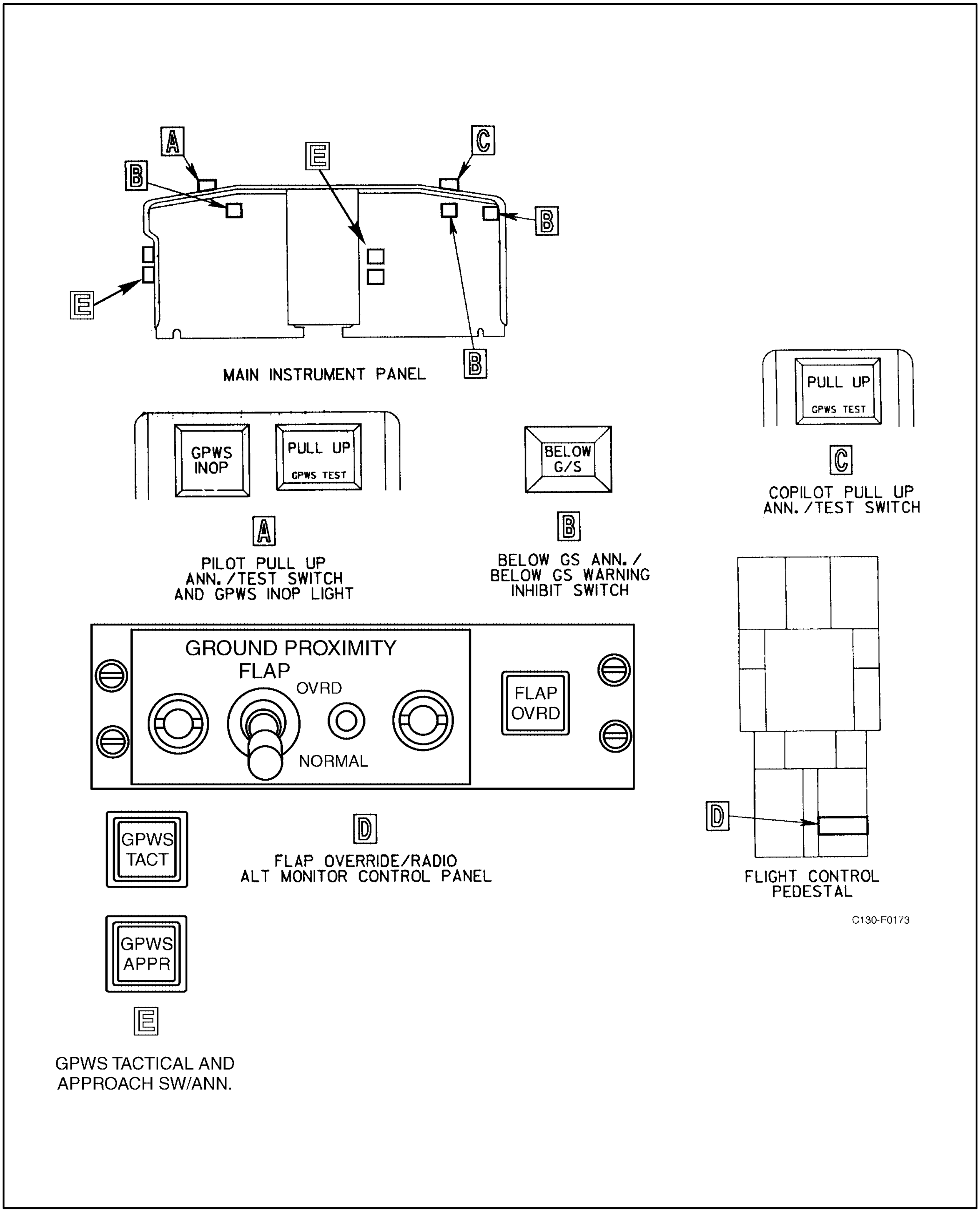


Figure 2-112. Ground Proximity Warning System Switches and Control Panel

2.21.19.1.3 GPWS INOP Annunciator. The GPWS INOP annunciator is located on the pilot instrument panel glareshield adjacent to the PULL UP annunciator. The annunciator illuminates when any of the following conditions occur:

1. No validated signal is being received from the radio/radar altimeter.

2. No validated signal (barometric altitude/rate) is being received from the GPWS air data computer.

3. A fault exists within the GPWS.

4. Other system wiring faults.

2.21.19.1.4 GPWS TACT Switches and Annunciators. Combination GPWS TACT switches/annunciators are located on the pilot and copilot instrument panels. Tactical mode annunciation is provided by GPWS TAC mode advisory lights located on the pilot and copilot instrument panels. The switches are used when mission requirements specify en route flight below 800 feet AGL or when a maximum-effort landing is to be made. Depression of either switch sets the GPWS to the tactical mission mode and causes the annunciator to illuminate. The GPWS can be reset to the normal mode by depressing the switch again or by ascending through 2,450 feet AGL.

2.21.19.1.5 GPWS APPR Switches and Annunciators. Combination GPWS APPR switches/annunciators are located on the pilot and copilot instrument panels. Approach mode annunciation is provided by GPWS APPR mode advisory lights located on the pilot and copilot mode advisory panel. The switches provide the means for supplying the GPWS computer with glideslope information for approach mode operation. The GPWS approach mode is automatically selected when either VOR/ILS No. 1 or VOR/ILS No. 2 is tuned to a localizer frequency and selected on the pilot NAV SEL switch. At this time, glideslope information is supplied to the GPWS computer and the pilot GPWS APPR annunciator illuminates. Selecting a localizer-tuned VOR/ILS with the copilot NAV SEL switch and momentarily depressing the copilot GPWS APPR switch will allow the copilot to fly the ILS approach with the GPWS computer being supplied glideslope information from VOR//ILS selected by the copilot. At this time the pilot GPWS APPR annunciator will be extinguished and the copilot annunciator will be illuminated. To resume flying the ILS approach, the pilot selects a localizer-tuned VOR/ILS and momentarily depresses the GPWS APPR switch on the pilot instrument panel. The copilot annunciator will extinguish, the pilot annunciator will illuminate, and the GPWS computer will again be supplied information from the VOR/ILS selected by the pilot.

2.21.19.1.6 GROUND PROXIMITY FLAP OVERRIDE Switch. The GROUND PROXIMITY FLAP OVERRIDE switch is a two-position (NORMAL, OVERRIDE) toggle switch on the ground proximity flap-override control panel mounted on the flight control pedestal (Figure 2-112). When the switch is placed to the NORMAL position, the circuit to the 40-percent flap switch (located in the flap control quadrant) is completed for appropriate aircraft configuration signals (mode 4B) to be validated by the GPWS computer. When the switch is placed to the OVERRIDE position, the 40-percent flap switch is inhibited and no warning signal is available. This feature is provided for operations below 245 feet with partial flap settings.

2.21.19.1.7 Nose Landing Gear Down-and-Locked Limit Switch. The nose landing gear down-and-locked limit switch provides the GPWS computer with the appropriate aircraft configuration data when the aircraft enters the envelope for terrain clearance (mode 4A) with the landing gear not in the down position.

2.21.19.2 Modes of Operation. The ground proximity warning system provides aural warnings, along with visual warnings, that segregate the various warnings when the aircraft flightpath and configuration would result in imminent hazardous proximity to the terrain. The following paragraphs describe the visual and aural warnings for the various modes.

2.21.19.2.1 Mode 1A — Excessive Sink Rate. Mode 1A is independent of aircraft configuration and is functional at all times. When the aircraft penetrates a predetermined outer envelope, the PULL UP annunciator is illuminated and the “SINK RATE” aural warning is given. If the inner envelope is penetrated, the “WHOOP WHOOP PULL UP” warning is given. The mode 1A envelope is shaped in such a manner that, at higher altitudes, steeper visual approaches can be made without causing a warning, and, at lower altitudes, additional protection has been added for windshear and visual transition.

2.21.19.2.2 Mode 1B — Excessive Sink Rate, Tactical Mission Mode. When mode 1B is selected and landing gear is down, the boundaries for the inner and outer envelopes are changed to accommodate the higher sink rates that may be required for a maximum effort landing. The warnings given are the same as for mode 1A. When the landing gear is up, no warnings are provided.

2.21.19.2.3 Mode 2A — Excessive Closure Rate, Flaps Up. Mode 2A provides alerts and warnings for excessive closure rates with respect to terrain. At airspeeds up to 195 KIAS, the boundary limits range from the lower limit of 30 feet radio/radar altitude at a closure rate of 2,038 fpm to the upper limit of 1,650 feet radio/radar altitude at a closure rate of 5,733 fpm. As airspeed is increased from 195 KIAS to 250 KIAS, the upper boundary increases proportionally to 2,450 feet and 9,800 fpm. If the aircraft penetrates mode 2A envelope, the PULL UP annunciator illuminates and the “TERRAIN-TERRAIN” warning is sounded. If this warning lasts longer than 1.4 seconds, the aural warning changes to “WHOOP WHOOP PULL UP.” When the aircraft leaves the boundary with landing gear and flaps up and not in tactical mission mode, the “TERRAIN-TERRAIN” aural warning returns and is repeated every 0.75 second until the aircraft gains 300 feet barometric altitude above the values existing when the aircraft left the boundary. The altitude gain function is inhibited when the landing gear is extended or when GPWS is in the tactical mission mode.

2.21.19.2.4 Mode 2B — Excessive Closure Rate, Flaps Down or Tactical Mission Mode. Lowering the flaps to landing position or in the tactical mission mode switches the CB computer to mode 2B. Penetration of mode 2B boundary activates the same warnings as in mode 2A except that the lower limit is raised to 200 feet radio/radar altitude at 2,253 fpm and the upper limit is lowered to 790 feet radio/radar altitude at 3,000 fpm. Below 700 feet terrain clearance with landing gear and flaps down, the “WHOOP WHOOP PULL UP” warning is inhibited and only the “TERRAIN-TERRAIN” warning will sound.

2.21.19.2.5 Mode 3 — Descent After Takeoff. Mode 3 warnings are provided when a barometric altitude loss occurs after takeoff or during a missed approach. Mode 3 is effective between 30 and 533 feet radio/radar altitude for climbout speeds up to 178 KIAS, and between 30 and 1,066 feet for climbout speeds above 178 KIAS. If the aircraft descends through this boundary during climbout after takeoff or during a missed approach, the PULL UP annunciator will illuminate and the “DON’T SINK” aural warning will sound twice. If an additional 20 percent of altitude is lost, the “DON’T SINK” aural warning is repeated. A pull-up warning is not issued so as not to cause overreaction during this critical period when the aircraft stall margin may be very small. In addition, if the aircraft passes over rising terrain during climbout and loses more than 25 percent of radio/radar altitude, a “TOO LOW TERRAIN” aural warning will sound. This feature is not activated until the aircraft has reached a radio/radar altitude of 150 feet.

The missed-approach mode does not arm until the aircraft is below 245 feet radio/radar altitude and both the flaps and gear are in the landing position.

2.21.19.2.6 Mode 4A — Insufficient Terrain Clearance, Gear Up. Mode 4A provides for insufficient terrain clearance when the aircraft landing gear is not down and locked. The mode 4A upper boundary is 400 feet radio/radar altitude for airspeeds up to 178 KIAS. This boundary increases proportionally up to 800 feet as airspeed is increased from 178 to 226 KIAS. Penetration of the 400-foot boundary at less than 178 KIAS causes the PULL UP annunciator to illuminate and the “TOO LOW GEAR” aural warning to sound. Penetration of the boundary between 400 and 800 feet with airspeed between 178 and 226 KIAS causes the PULL UP annunciator to illuminate and the “TOO LOW TERRAIN” aural warning to sound. The aural warnings are given twice. If an additional 20 percent of radio/radar altitude is lost, the aural warnings are repeated. The warning is silenced when the landing gear is down and locked.

2.21.19.2.7 Mode 4B — Insufficient Terrain Clearance, Flaps Up. Mode 4B is activated when the landing gear is down and locked but the flaps are not in the landing position. Mode 4B differs from mode 4A in that the boundary altitude decreases to 245 feet radio/radar altitude when the gear is lowered and airspeed is increased above 159 KIAS. Penetration of the boundary above 159 KIAS causes the PULL UP annunciator to illuminate and the "TOO LOW TERRAIN" aural warning to sound. Penetration of the boundary at 159 KIAS or below causes the PULL UP annunciator to illuminate and the "TOO LOW FLAPS" aural warning to sound. The aural warning is given twice and repeated twice when an additional 20 percent radio/radar altitude is lost. The warning is silenced by selecting landing flaps.

2.21.19.2.8 Mode 4C — Insufficient Terrain Clearance, Tactical Mission Mode. Mode 4C is activated when the GPWS TACT switch on the pilot instrument panel is actuated to place the GPWS in the tactical mission mode. The PULL UP annunciators are illuminated and aural warnings are given as follows:

1. Descent through 150 feet with airspeed greater than 150 KIAS produces no warning.

2. Descent through 150 feet with airspeed 150 KIAS or less illuminates the PULL UP annunciator and produces a "TOO LOW GEAR" aural warning if the landing gear is up or a "TOO LOW FLAPS" aural warning if the flaps are up.

2.21.19.2.9 Mode 5 — Descent Below Glideslope. Mode 5 is activated when an ILS frequency has been selected and the GPWS approach mode is selected. There are two boundaries (soft and loud) for this mode. The first (soft) boundary occurs when the aircraft is below 1,000 feet radio/radar altitude and more than 1.3 dots below the glideslope beam. The second (loud) boundary is when the aircraft is below 300 feet radio/radar altitude and more than 2 dots below the glideslope beam. When the soft boundary is penetrated, the BELOW G/S annunciator illuminates and a "GLIDESLOPE" aural warning is sounded at one-half volume. If the loud boundary is penetrated, the aural warning is sounded at normal volume. The repetition rate of the aural is varied as a function of the radio/radar altitude and glideslope deviation. The repetition rate is slow at 1,000 feet and 1.3 dots deviation, speeding up as altitude decreases and/or glideslope deviation increases.

2.21.19.2.10 Mode 6A — Descent Below Decision Height. Mode 6A provides a "MINIMUMS, MINIMUMS" aural warning between 30 and 1,000 feet radio/radar altitude when the aircraft passes through the decision height as set on the radio/radar altimeter. No warning annunciator is illuminated in this mode. If the decision height is reset to a lower altitude, no output is produced. The threshold may be reset by climbing above 1,000 feet radio/radar altitude, descending below 30 feet, or retracting and reextending the landing gear.

2.21.19.2.11 Mode 6B — Descent Below Decision Height, Tactical Mode. When flying a tactical mission with the GPWS set to the tactical mission mode and with airspeed greater than 150 KIAS, an "ALTITUDE-ALTITUDE" aural warning will sound when the aircraft is more than 50 feet below the minimum altitude set on the radio/radar altimeter.

2.21.19.2.12 Mode 7 — Windshear. The windshear mode is not operational.

2.21.19.2.13 Mode 8 — Excessive Bank Angle. Mode 8 provides a warning for excessive bank angle based on radio/radar altitude and roll attitude. The computer also considers roll rate and descent rate in arriving at an output. The bank angle boundary begins at 130 feet radio/radar altitude and 60° maximum bank angle, decreasing to 30 feet and 10° maximum bank angle. Exceeding the bank angle or inducing a roll rate that, if continued, would result in exceeding the bank angle for a given altitude, causes a "BANK ANGLE" aural warning. The audio alert may be repeated once after a 0.75-second delay.

2.21.19.3 Summary of System Visual/Aural Alerts and Warnings. Simultaneous visual annunciator alert and audio advisories occur when the outer envelopes of modes 1 through 5 are penetrated. Warnings are issued upon entering the inner envelopes of modes 1A, 1B, 2A, and 2B. Modes 3, 4, and 5 issue alert advisories only and are not followed by warnings. See the following table for summary.

2.21.19.4 Message Priorities. With the possibility of more than one warning occurring at the same time, a priority system of message transmission is built into the GPWS computer. The various messages, their priority, and their associated modes are as follows:

PRIORITY	MESSAGE	MODE
1	Whoop whoop pull up	1A, 1B, 2A and 2B
2	Terrain	2A and 2B
3	Minimums	6A
4	Too low terrain	4A, 4B and 4C
5	Too low gear	4A and 4C
6	Too low flaps	4B and 4C
7	Sink rate	1A and 1B
8	Don't sink	3
9	Glideslope	5
10	Bank angle	8
11	Altitude	6B

2.21.19.5 Normal Operation of the GPWS

Note

If the GPWS INOP annunciator illuminates steady or flashes after power is applied, a malfunction/failure in the GPWS computer is indicated.

2.21.19.5.1 GPWS Self-test. The GPWS self-test may be performed as follows:

1. Check that the GPWS INOP annunciator is not illuminated.
2. Momentarily depress the PULL UP GPWS TEST annunciator and verify the following occur:
   a. GPWS INOP annunciator illuminates.
   b. After approximately 1 second, the PULL UP, BELOW G/S, and GPWS TACT annunciators illuminate.
   c. After approximately 3 seconds, a "Ground prox ok" audio message sounds and the PULL UP, BELOW G/S, and GPWS TACT annunciators extinguish.
   d. After approximately 5 seconds, the GPWS INOP annunciator extinguishes.

2.21.19.5.2 GPWS Approach Mode Operation. To place the GPWS in the approach mode:

1. Tune the No. 1 or No. 2 VOR to a valid ILS localizer frequency.
2. Select the tuned VOR/ILS with the pilot or copilot NAV SEL switch.

If the pilot makes the selection:

3. Verify the pilot GPWS APPR annunciator is illuminated indicating the GPWS is in the approach mode utilizing glideslope information from the VOR/ILS selected by the pilot.

If the copilot makes the selection:

4. Momentarily depress the copilot GPWS APPR switch.
5. Verify the copilot GPWS APPR annunciator is illuminated indicating the GPWS is in the approach mode utilizing glideslope information from the VOR/ILS selected by the copilot.

Should the pilot wish to assume control from the copilot:

1. Select the VOR/ILS that is tuned to the proper ILS frequency utilizing the pilot NAV SEL switch.
2. Momentarily depress the GPWS APPR switch.
3. Verify that the pilot GPWS APPR switch illuminates and the copilot GPWS APPR switch extinguishes.

2.21.19.5.3 GPWS Tactical Mode Operation. To operate the GPWS in the tactical mission mode:

1. Set the radio/radar altimeter minimum altitude marker to the desired minimum altitude for the tactical low-level route.
2. Momentarily depress the pilot or copilot GPWS TACT switch.
3. Verify the GPWS TACT annunciators on the pilot and copilot instrument panels illuminate.

To return the GPWS to normal mode:

4. Momentarily depress the pilot or copilot GPWS TACT switch.
5. Verify the GPWS TACT annunciators extinguish. The GPWS may also be reset to normal by climbing through 2,450 feet AGL.

2.21.20 Altitude Alerter/Preselect System

The altitude alerter/preselect system consists of an altitude alerter/preselect control, located on the main instrument panel glareshield, and a tone generator mounted overhead in the flight station. The system provides automatic visual and aural signals during approach to or departure from a preselected altitude. The operating range of the altitude alerter/preselect control is 0 to 50,000 feet in 100-foot increments. The system is interconnected with the pilot altimeter-encoder, air data control No. 1, and the pilot and copilot interphone system for tone generator aural signal reception. The altitude alerter/preselect system uses 26-Vac power from the essential ac bus through the ALTITUDE ALERT circuit breaker on the pilot upper circuit breaker panel.

2.21.20.1 Altitude Alerter/Preselect System Controls. Altitude alerter/preselect control contains a manual set knob, an ALT alert light, and a failure warning (OFF) flag (see Figure 2-113).

2.21.20.1.1 Manual Set Knob. The manual set knob is used to preset the desired altitude for visual display on the altitude alerter/preselect control.

2.21.20.1.2 ALT Alert Light. The ALT alert light provides an illuminated signal that the aircraft is approaching within 1,000 feet of the preset altitude or departing the preset altitude by ±300 feet. As the aircraft approaches the outer level (1,000 feet) of a preset altitude, the ALT alert light and aural tone generator are activated. The tone generator is activated for approximately 2 seconds. The ALT alert light, however, remains illuminated until the aircraft crosses the inner level (300 feet) of the preset altitude, at which time it is extinguished. Should the aircraft depart from the preset altitude by more than ±300 feet, the aural tone and ALT alert light will again be activated. The light will remain illuminated until the aircraft returns to the preset altitude or until a new altitude is selected.

2.21.20.1.3 Failure Warning Flag. The failure warning (OFF) flag indicates a loss of flag alarm signal from the altimeter or a loss of electrical power to the indicator.

2.21.21 AN/APX-100(V) IFF Transponder (Aircraft Not Modified by AFC-374). The IFF transponder provides automatic radar identification of the aircraft when interrogated by surface or airborne radar sets. Also the system enables friendly aircraft to identify themselves apart from other friendly aircraft and provides a means of transmitting a special coded signal known as an emergency reply. In addition to the identification information, the reply signal reports the altitude of the aircraft.

The IFF transponder system consists of a transponder control panel (see Figure 2-114) and a receiver-transmitter. Antennas are provided on the top and bottom of the fuselage. The antenna selector switch is located on the transponder control panel. There are space provisions for a KIT-lA/T SEC computer transponder on the left-hand underdeck rack. The IFF caution indicator on the pilot instrument panel does not

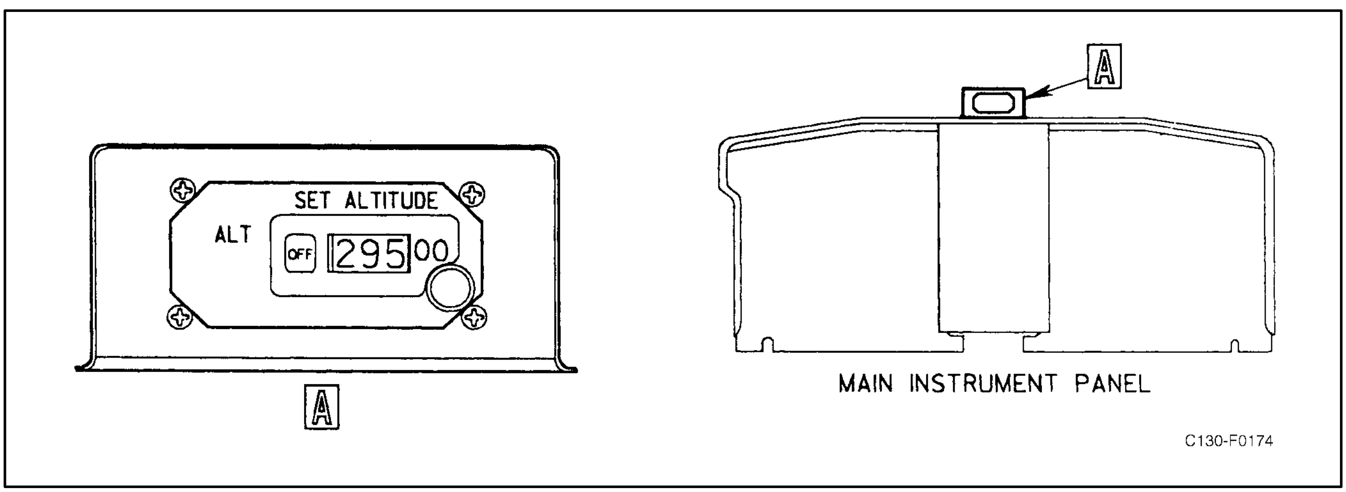


Figure 2-113. Altitude Alerter/Preselect Control

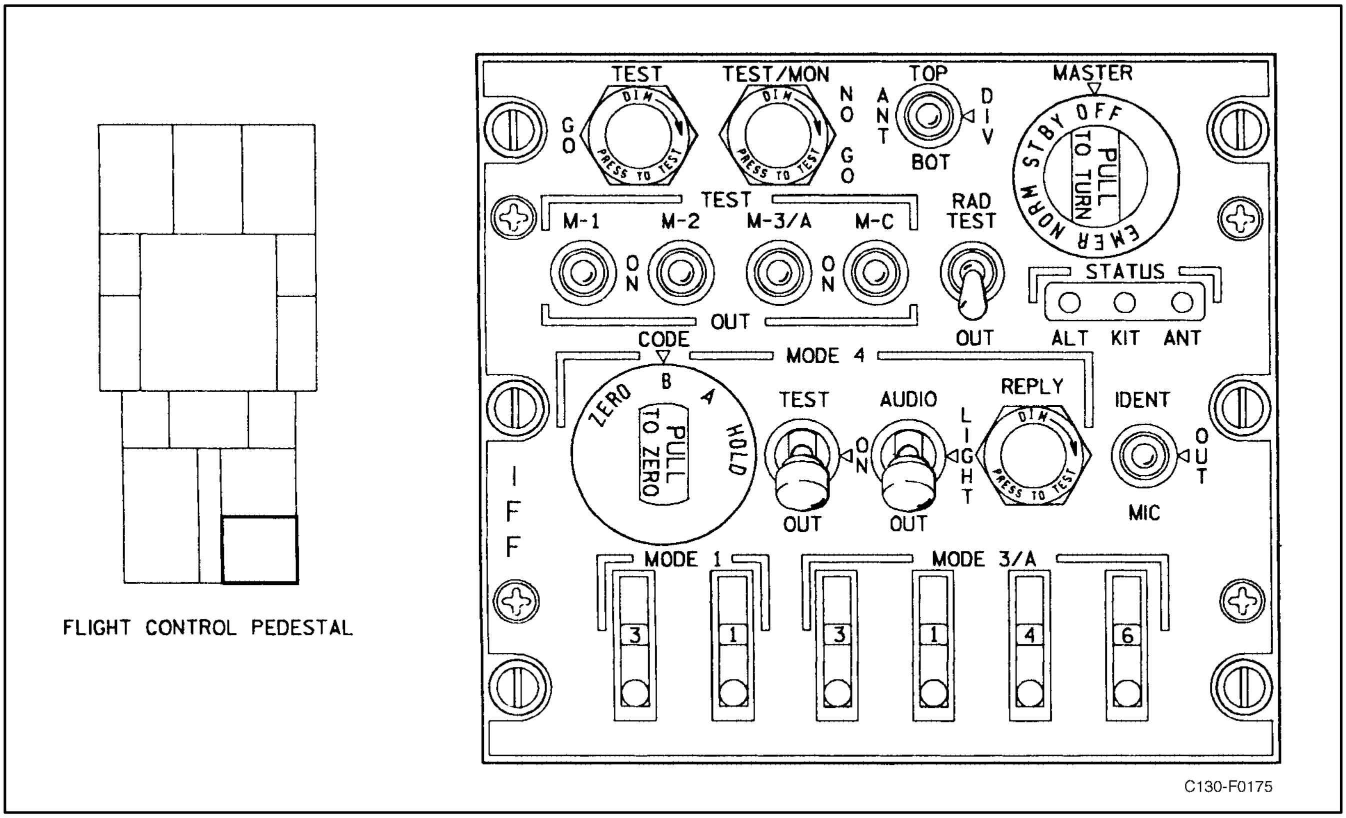


Figure 2-114. AN/APX-100(V) IFF Controls and Indicators (Sheet 1 of 3)

operate unless the computer is installed (see Figure 2-77). An altimeter-encoder is installed on the pilot instrument panel.

The radar identification system receives, decodes, and responds to the characteristic interrogations of operational modes 1, 2, 3/A, C, and 4 (when the computer is encoded). The receiver operates on a frequency of 1030 MHz, and the transmitter operates on a frequency of 1090 MHz. Specially coded identification of position and emergency signals may be transmitted to interrogating stations when conditions warrant.

Signals, consisting of pairs of pulses spaced to form a code, are transmitted from the interrogating station and received by the receiver-transmitter. These signals are transferred to the decoder, where they are checked for valid code and proper mode (except for mode 4 interrogations, which are sent directly to the mode 4 board). If valid, the decoded signals are sent to the encoder board that prepares the coded reply. The coded reply is sent through the transmitter and antenna to the interrogating station. The radar identification system can be operated in any one of the following categories of operation, each of which may be selected by the pilot or copilot at the control panel:

1. Normal (sensitivity) operation
2. Identification of position (IDENT-MIC)
3. Emergency operation.

Five independent coding modes are available. The first three modes may be used independently or in combination. Mode 1 provides 32 possible code combinations, any one of which may be selected at the control. Mode 2 provides 4,096 possible code combinations, but only one is available for operation in flight since the selection dials must be preset at the receiver-transmitter before flight. Mode 3/A provides 4,096 possible codes, any one of which may be selected from the control panel. Mode C (when the system is connected to the altimeter encoder) will indicate the pressure altitude of the aircraft interrogated. Mode 4 (when the system is connected to the computer) can be selected to display any one of many classified operational codes for security identification.

CONTROL	POSITION	FUNCTION
MASTER Control	OFF	Deenergizes the system.
	STBY	Places system in warm-up (standby) condition.
	NORM	Allows operation of system at normal receiver sensitivity.
	EMER	Allows system to transmit emergency replies to mode 1, 2, or 3/A interrogations regardless of mode control setting.
IDENT-OUT-MIC Switch	IDENT	When spring-loaded switch is momentarily actuated, it initiates identification of position reply for approximately 30 seconds.
	OUT	Prevents triggering to mode 1 interrogations.
	MIC	Allows transmission of identification of position replies when UHF-1 or UHF-2 is keyed.
M-1 Switch	ON	Allows system to reply to mode 1 interrogations.
	OUT	Prevents reply to mode 1 interrogations.
	TEST	Allows test set/BIT to locally interrogate receiver-transmitter in mode 1.
M-2 Switch	ON	Allows system to reply to mode 2 interrogations.
	OUT	Prevents reply to mode 2 interrogations.
	TEST	Allows test set/BIT to locally interrogate receiver-transmitter in mode 2.
M-3/A Switch	ON	Allows system to reply to mode 3 interrogations.
	OUT	Prevents reply to mode 3/A interrogations.
	TEST	Allows test set/BIT to locally interrogate receiver-transmitter in mode 3/A.
M-C Switch	ON	Allows system to reply to mode C interrogations.
	OUT	Prevents reply to mode C interrogations.
	TEST	Tests the altitude reporting mode.
Test Indicator		Illuminates when system responds properly to self-test.
MODE 4 Switch	ON	Allows system to reply to mode 4 interrogations.
	OUT	Prevents reply to mode 4 interrogations.
	TEST	Allows test set/BIT to locally interrogate receiver-transmitter in mode 4.
CODE Control	ZERO	Zeroizes code setting.
	A	Selects A code.
	B	Selects B code.
	HOLD	If selected 15 seconds prior to turning power off.

Figure 2-114. AN/APX-100(V) IFF Controls and Indicators (Sheet 2)

CONTROL	POSITION	FUNCTION
AUDIO-LIGHT Switch	AUDIO	Enables aural and reply light monitoring of valid mode 4 interrogations and replies.
	LIGHT	Enables reply light only monitoring of valid mode 4 interrogations and replies.
	OUT	Disables aural and reply light monitoring of valid mode 4 interrogations and replies.
REPLY Indicator		Lights when valid mode 4 replies are present.
RAD Switch	TEST	Allows receiver-transmitter to reply to test mode interrogations from an external test set (AN/UPM-92 or equivalent). Other functions of this switch are classified.
	OUT	Disables RAD test.
MODE 1 Code Select Switches		Select two-digit mode 1 reply code.
Mode 3/A Code Select Switches		Select four-digit mode 3/A reply code.
TEST/MON Indicator		Illuminates to indicate a unit malfunction.
ANT Switch	TOP	Selects top antenna/receiver.
	DIV	Allows system to automatically select antenna/receiver with stronger signal.
	BOT	Selects bottom antenna/receiver.
Status ALT Indicator		Illuminates to indicate a failure is due to altitude digitizer.
Status KIT Indicator		Illuminates to indicate a failure is due to the computer (if installed).
Status ANT Indicator		Illuminates to indicate a failure is due to high voltage standing wave ratio (VSWR) in antenna.

Figure 2-114. AN/APX-100(V) IFF Controls and Indicators (Sheet 3)

The range of the system is limited to line-of-sight transmission, since its frequency of operation is in the UHF band. This makes the range of operation dependent on the altitude of the aircraft.

The system has provisions whereby the position of the aircraft being interrogated can be obtained. This feature is used when a group of aircraft are being interrogated in the same area and it is desired to single out one particular aircraft within the group. The IDENT reply can be made in mode 1, 2, or 3/A and appears as two short dashes on the interrogating radar indicator. This mode of operation is selected by placing the IDENT-OUT-MIC switch on the control panel to the IDENT position. The system will automatically transmit the reply during the time that the switch is held and for 30 seconds after the switch is released. An emergency reply capability is also available to allow identification of aircraft in distress. When the MASTER switch on the control panel is set to EMER, the system transmits an emergency signal, which is displayed as four dashes on the interrogating radar indicator.

Operation and control of the system is accomplished with the control panel. The control panel contains switches that are used to select the desired coded reply for modes 1 and 3/A. Mode 1 switches permit selection of a desired code from 00 to 73. Mode 3/A switches permit selection of a desired code from 0000 through

7777. The control panel contains the majority of the operating controls for the system. The MASTER switch allows the operator to select the following operating conditions for the receiver-transmitter: OFF, STBY (standby), NORM (normal sensitivity), and EMER (emergency). When the switch is set to OFF, all power is removed from the system. When the switch is set to STBY, power is applied to the system and the system is warmed up. The transmitter circuits cannot be energized until after the 80-second warmup period. After the system has warmed up, the system may be placed in operation by positioning the switch to NORM. When the MASTER switch is set to EMER, the emergency circuits are operated to transmit distress replies to interrogations.

Three switches on the control panel enable or disable the system for mode 1, 2, or 3/A. Replies are possible only when the MODE 1-OUT, or MODE 3-OUT switches are placed in the up position. The IDENT-OUT-MIC switch is spring loaded to the OUT position. If identification operation is desired, the switch must be held in the IDENT position. This causes the system to transmit identification signals while the switch is held at IDENT, and for 30 seconds after the switch is released. When the switch is released, it returns to the OUT position. When the switch is in the MIC position, the identification signal will be transmitted when either the No. 1 or No. 2 UHF transmitters are keyed and for 30 seconds after the switch is released.

When the KIT-lA/T SEC computer transponder is installed, mode 4 interrogations bypass the decoder in the receiver-transmitter and are applied directly to the KIT-lA/T SEC computer transponder. The mode 4 interrogation signal is decoded and applied to a mode 4 recognition circuit. When mode 4 coincidence exists, the mode 4 recognition circuit generates a signal to the mode 4 computer, which in turn generates a signal to the mode 4 reply. The REPLY light on the control panel illuminates to indicate that a mode 4 reply is being transmitted. An IFF caution light on the pilot instrument panel illuminates when mode 4 interrogations are not properly decoded. The IFF caution light does not operate unless the KIT-lA/T SEC computer is installed.

The AN/APX-100(V) has a BIT circuit that tests the mode 1, 2, 3/A, C, and 4 functions of the receiver-transmitter. When the self-test function is selected for a particular mode, the test is done by sending a test pulse to the receiver-transmitter and analyzing the receiver-transmitter response. If the response is within certain parameters, such as pulse spacing, power output, and frequency, the test set/BIT accepts the results and notifies the operator by illuminating the TEST GO light on the control panel. If the response is incorrect, the TEST/MON NO GO light illuminates. The AN/APX-100(V) BIT continuously monitors the system operation. If the responses are incorrect, the TEST/MON NO GO light on the control panel illuminates. The AN/APX-100(V) system receives 28-Vdc power from the essential dc bus through the IFF dc circuit breaker on the copilot upper circuit breaker panel. The AN/APX-100(V) system receives 115-Vac power from the essential ac bus through the IFF ac circuit breaker on the copilot upper circuit breaker panel. The altimeter-encoder is powered by 115-Vac power from the essential ac bus and 28-Vdc power from the essential dc bus through the ALTIMETER AC and DC circuit breakers on the copilot upper circuit breaker panel.

2.21.21.1 IFF Radar Identification System Controls. The transponder control panel contains all of the controls and indicators (except mode 2 select switches) normally required to operate the system. The functions of these controls and indicators are as shown in Figure 2-114.

2.21.21.2 Normal Operation of the IFF Radar Identification System. To put the system in operation:

1. Set the MASTER switch to OFF.
2. Set the IDENT-MIC, M-1, M-2, M-3/A, M-C, and MODE 4 switches to OUT.
3. Set the AUDIO LIGHT and RAD switches to OUT.
4. Set the required operational code in the MODE 1 and 3/A code select switches and ensure proper code insertion has been made for modes 2 and 4.
5. Set the MASTER switch to STBY and allow a 1-minute warmup for standard temperature or a 2-minute warmup for cold-weather operation.
6. Set the MASTER switch to NORM.
7. Set the M-1, M-2, M-3/A, M-C, and mode 4 switches to ON, as required by the operational codes being used.
8. Set the AUDIO LIGHT switch to LIGHT.
9. Set the IDENT-MIC switch to OUT.

To check that the system is operating properly:

10. Set the M-1 switch momentarily to TEST and check that the test indicator illuminates.

11. Repeat step 10 for the M-2 and M-3/A switches.

12. Set the MODE 4 code switch to A. If the computer is used, set a code in it.

13. Set the AUDIO LIGHT switch to OUT.

14. Set the MODE 4 TEST-ON-OUT switch momentarily to TEST. If the computer is used, observe that TEST GO indicator illuminates. If the computer is not used, observe that TEST/MON NO GO and kit status indicators illuminate and that MODE 4 REPLY and CAUTION IFF indicators (on pilot instrument panel) do not illuminate.

15. Set AUDIO LIGHT switch to LIGHT.

16. Set the MODE 4 TEST-ON-OUT switch to ON if the computer is used or to OUT if no computer is used.

2.21.21.3 Identification of Position Operation

1. Hold the IDENT-MIC switch at IDENT.

2.21.21.4 Emergency Operation

1. Pull the MASTER switch out and rotate it to the EMER position.

2. Let the MASTER switch remain in the EMER position during the emergency.

3. When the emergency is over, return the MASTER switch to NORM.

To turn the system off:

4. Set the MASTER switch to OFF.

2.21.22 Identification Friend-or-Foe (IFF)/ Mode S Transponder System with Traffic Alert and Collision Avoidance System (TCAS) (Aircraft Modified by AFC-374)

2.21.22.1 IFF/Mode S Transponder System. The IFF/Mode S Transponder is a combined IFF and Mode S transponder. The IFF portion of the system provides surveillance and identification functions to surface or airborne interrogator radar sets. When interrogated, the IFF transponder automatically transmits a reply. The reply, dependent upon what type of interrogation, will identify the aircraft or report its altitude. When operated in the secure mode, it will reply using the secure code of the day, thereby identifying itself as friendly. The Mode S portion of the system provides the aircraft with a permanent unique address code that is used in Mode S replies. The transponder also provides a means of transmitting a specially coded signal known as an emergency reply that contains the aircraft's identification and altitude.

2.21.22.1.1 System Components. The IFF/ Mode S transponder system consists of an IFF transponder, located in the IFF equipment rack; a combined TCAS/IFF control panel and an IFF Caution light, located on the center pedestal; and two antennas, one located on the top of the fuselage and one located on the bottom of the fuselage. There are provisions for a KIT-1C/TSEC Mode 4 computer in the IFF equipment rack.

The transponder receives 28 Vdc from the essential DC bus through the IFF CMPTR circuit breaker on the copilot's upper circuit breaker panel. The combined TCAS/IFF control panel receives 28 Vdc from the essential DC bus through the TCAS/IFF CONTROL circuit breaker on the copilot's upper circuit breaker panel.

2.21.22.1.2 Theory of Operation. The transponder receives interrogations on 1030 MHz and transmits replies to interrogations on 1090 MHz. When an interrogation is received, the transponder monitors the signal on the top and bottom antenna ports and selects the best port based on signal strength and time of arrival. The system will transmit a coded reply in response to an interrogation if the signal has the proper characteristics for the mode selected. The coded reply is sent through the transmitter and antennas to the interrogating station.

The transponder has two independent RF receiver channels, allowing both top and bottom interrogations to be monitored simultaneously. The IFF portion of the transponder is a surveillance system for classifying targets as either friendly or hostile. There are six IFF modes: 1, 2, 3A, C, 4, and S. Modes 1 and 2 are used by the military for identification. Mode 3A is used by both military and civilian air traffic control stations. Mode C is used to report the aircraft's altitude to an air traffic control station. Mode C replies are determined by altitude information provided from the air data computer. Mode 4 is a military encrypted code that is classified. This code, or key, is loaded into the Mode 4 computer. Successful identification of a target is based on both the interrogator and transponder possessing the same code. Mode S is a two-way (up/down) digital data link which transmits Mode 3A, Mode C, a unique aircraft identification code, and Mode S information/ instructions between Mode S capable air traffic control stations and/or other Mode S/TCAS capable aircraft. The unique aircraft identification code/address is based on the aircraft bureau number and is set into the transponder via hardwired aircraft wiring discretes. Using this unique code, interrogations can be directed to a particular aircraft and replies can be positively identified. Channel interference (RF clutter) can be minimized because an air traffic control station or aircraft can limit its interrogations to specific targets of interest. Mode S replies are dependent on what was requested in the Mode S interrogation and are coordinated by the transponder. When the aircraft is on the ground, the transponder will receive a signal from the right main landing gear touchdown switch. This will allow the Mode S reply to include the information that the aircraft is on the ground.

2.21.22.1.3 IFF/Mode S Transponder Controls. Control of the IFF/Mode S transponder system is accomplished with the combined TCAS/IFF control panel (see Figure 2-115). Before turning the control panel on, the Combined Altitude Radar Altimeter (CARA) must be operating. Power must also be applied to the High Integration Air Data Computer through the HIADC DC circuit breaker on the copilot's side circuit breaker panel.

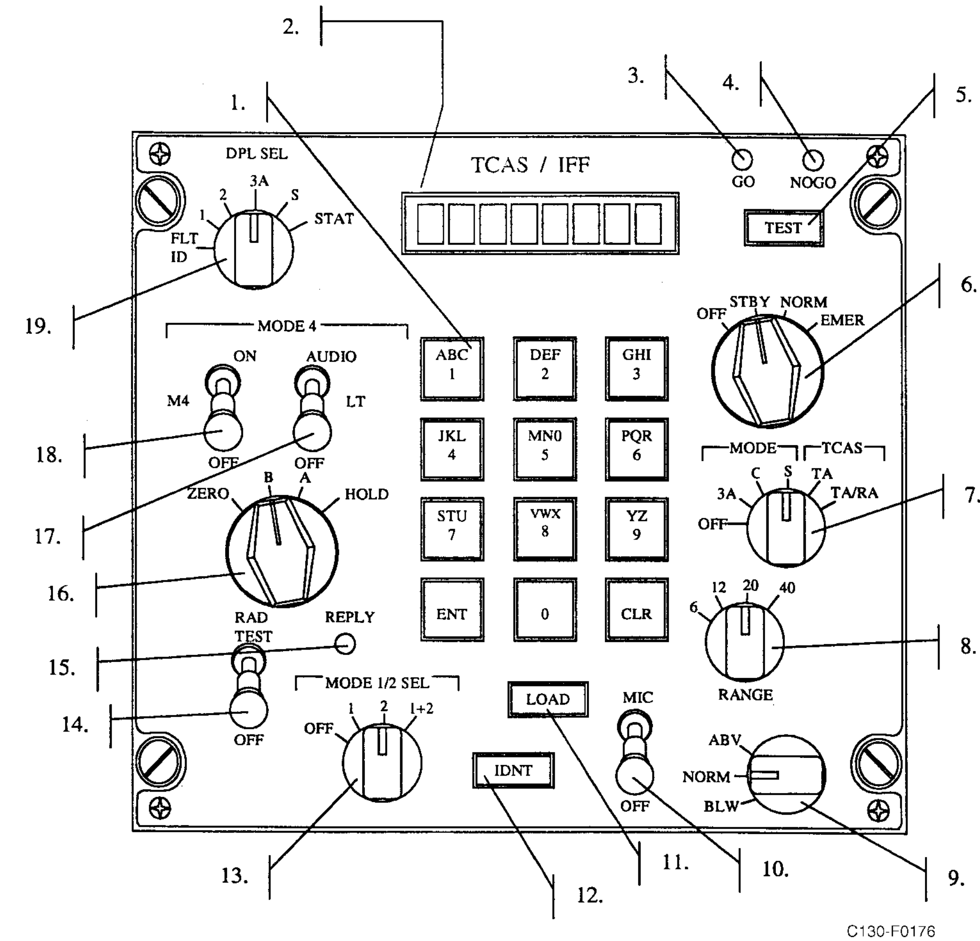
a. MASTER SYSTEM Switch. The MASTER SYSTEM SWITCH on the combined TCAS/IFF control panel allows the operator to select the following operating conditions for the transponder: OFF, STBY (standby), NORM (normal sensitivity), and EMER (emergency). When the switch is set to OFF, all power is removed from the system. When the switch is set to STBY, the SYS GO annunciator will illuminate momentarily. The transponder receives air and ground interrogations but does not reply. When the switch is set to NORM, the SYS GO annunciator will illuminate momentarily. Depending on which mode is enabled, the transponder will reply to air and ground interrogations in Mode 3A, C, and S. When the switch is set to EMER, the transponder will transmit emergency code 7700 in Mode 3A to indicate the aircraft is in distress. The transponder will reply with an emergency code regardless of which mode is selected. EMER reply does not affect Mode C or Mode 4 operation. The switch must be pushed down and then turned in order to select EMER.

b. IDENT Reply. An IDENT reply can be made in Mode 1, 2, 3A, or S. This mode of operation is selected by placing the REMOTE MIC ENABLE SWITCH on the combined TCAS/IFF control panel to OFF and momentarily pressing the IDNT button. The system will automatically transmit the reply during the time the IDNT button is pressed and released for a total of 18 seconds. This mode of operation may also be selected by placing the REMOTE MIC ENABLE SWITCH to MIC and the pilot or copilot keying either of the UHF or V/UHF radios. The system will automatically transmit the reply during the time radios are keyed and released for a total of 18 seconds. Placing the REMOTE MIC ENABLE SWITCH to MIC will inhibit the IDNT button from operating.

c. MODE SELECT/TCAS ENABLE Switch. The MODE SELECT/TCAS ENABLE switch is a six-position rotary switch enabling different modes of operation and allowing for selection of TCAS functions. In the OFF position, Modes 3A, C, and S are disabled and TCAS is set to standby. Selection of MODE 3A enables mode 3A only. MODE C enables modes 3A and C and MODE S enables modes S, C, and 3A.

d. MODE 1–2 Switch. The MODE 1–2 switch is a four-position rotary switch enabling Mode 1, Mode 2 or Mode 1 and 2 operating modes.

2.21.22.1.4 IFF/Mode S Transponder Display Selections. The control panel contains switches that are used to select and input the desired code for Modes 1, 2, 3A, and S and Flight ID. See Figures 2-116 through 2-119 for display selections and entering selected codes.



ITEM	CONTROL	SWITCH POSITION	FUNCTION
1.	CODE ENTRY KEYPAD	N/A	The Code Entry Keypad consists of 12 keys used to provide entry of Mode S Address, Mode 1, Mode 2, Mode 3A and Flight ID codes.
2.	ALPHANUMERIC CHARACTER DISPLAY	N/A	Consists of an eight Alphanumeric Character, Liquid Crystal Display. Display has white characters on a black background. Displays selected codes, software version, status, failures and transponder messages.
3.	GO ANNUNCIATOR	N/A	Indicates no failures in the system or indicates a new transponder message has been received by the control panel.
4.	NOGO ANNUNCIATOR	N/A	Indicates system failures.
5.	SYSTEM TEST PUSHBUTTON	N/A	Momentary test pushbutton to activate system functional test.
6.	MASTER SYSTEM SWITCH		Four position rotary switch allowing master system control to the OFF, STBY, NORM and EMER positions. OFF and EMER positions are locking, to select and deselect these positions the switch must be pushed and turned.
		OFF	Completely disables all transponder and TCAS functions.

Figure 2-115. IFF/Mode S Transponder Controls (Sheet 1 of 3)

ITEM	CONTROL	SWITCH POSITION	FUNCTION
		STBY	Inhibits transmission of Modes 1, 2, 3A, C, 4 and S. All other control panel functions shall be enabled. Inhibits TCAS TA and TA/RA interrogations.
		NORM	Enables selected transponder mode replies. Enables TCAS TA and TA/RA interrogations if selected.
		EMER	Enables transponder Modes 1, 2, 3A and S to reply with an emergency code automatically regardless of the selection on the Mode Select and TCAS Enable Switch. Mode 3A shall transmit code 7700. The emergency feature does not affect Mode C or Mode 4 operation.
7.	MODE SELECT AND TCAS ENABLE SWITCH		Six position rotary switch enabling the different modes of operation and allowing for selection of TCAS functions.
		OFF	Disables Modes 3A, C, S and sets TCAS to standby.
		3A	Selection of Mode 3A shall enable Mode 3A only.
		C	Selection of Mode C shall enable Mode C and continue to enable Mode 3A.
		S	Selection of Mode S shall enable Mode S and continue to enable Modes 3A and C.
		TA	Selection of TA shall enable TCAS traffic advisories and continue to enable Modes 3A, C and S.
		TA/RA	Selection of TA/RA shall enable TCAS traffic and resolution advisories and continue to enable Modes 3A, C and S.
8.	HORIZONTAL RANGE SWITCH		Four position rotary switch allowing the selection of horizontal display range in nautical miles.
		6	Selects 6 nm range for VSI/TRA displays.
		12	Selects 12 nm range for VSI/TRA displays.
		20	Selects 20 nm range for VSI/TRA displays.
		40	Selects 40 nm range for VSI/TRA displays.
9.	VERTICAL RANGE SWITCH		Three position rotary switch allowing selection of altitude ranges, with respect to aircraft, for traffic display on the VSI/TRA displays.
		ABV	Sets TCAS range limits at 9900 ft above and 2700 ft below aircraft.
		NORM	Sets TCAS range limits at 2700 ft above and below aircraft.
		BLW	Sets TCAS range limits at 2700 ft above and 9900 ft below aircraft.
10.	REMOTE MIC ENABLE SWITCH		Two position locking lever toggle switch that controls IDENT function.
		OFF	Allows IDENT to be performed when IDNT pushbutton is momentarily pressed.
		MIC	Allows IDENT function to be performed upon keying of either UHF or V/UHF radio by the pilot or copilot and inhibits the front panel IDNT Switch.
11.	LOAD PUSHBUTTON	N/A	Momentary pushbutton used to transmit a completed code to the transponder or TCAS computer as displayed on the LCD.
12.	IDENT PUSHBUTTON	N/A	Momentary pushbutton labeled IDNT used to initiate IDENT when the Remote Mic Enable Switch is in the OFF position.

Figure 2-115. IFF/Mode S Transponder Controls (Sheet 2)

ITEM	CONTROL	SWITCH POSITION	FUNCTION
13.	MODE 1–2 SWITCH		Four position rotary switch allowing Mode 1, Mode 2 or Mode 1 and 2 operating modes.
		OFF	Disables Mode 1 and Mode 2 operation.
		1	Enables Mode 1 operation.
		2	Enables Mode 2 operation.
		1 + 2	Enables Mode 1 and Mode 2 operation.
14.	RAD TEST SWITCH		Two position momentary selection locking lever switch to enable the Mode 4 radiated test function.
		OFF	Inhibits Mode 4 radiated verify bit 1 test.
		RAD TEST	Enables Mode 4 radiated verify bit 1 test.
15.	REPLY ANNUNCIATOR	N/A	Indicates Mode 4 replies are being transmitted.
16.	MODE 4 CODE CONTROL SWITCH		Four position spring-loaded rotary switch. Allows selection of Mode 4 A or B Code, HOLD or ZERO. The ZERO position is a locking position, to select the switch must be pushed and turned. The HOLD position is spring-loaded, to activate the HOLD function the switch must be turned and held momentarily
		HOLD	The Mode 4 HOLD control shall enable an operator in the aircraft to retain the Mode 4 Code settings if power is to be removed from the transponder while the aircraft is on the ground.
		A	Permits selection of Mode 4 Code A.
		B	Permits selection of Mode 4 Code B.
		ZERO	When selected shall zeroize Mode 4 Code A and Code B in KIT-1C and KIR-1C if installed in the aircraft.
17.	REPLY MONITORING CONTROL SWITCH		Three position locking lever switch allowing control of the front panel reply indicator and the Mode 4 audio.
		OFF	Disables Mode 4 REPLY annunciator and audio.
		LT	Enables front panel REPLY annunciator operation.
		AUDIO	Enables Mode 4 audio tone and front panel REPLY annunciator operation.
18.	MODE 4 ON/OFF SWITCH		Two position locking lever switch allowing Mode 4 enable.
		OFF	Mode 4 operation is disabled.
		ON	Enables Mode 4 operation.
19.	DISPLAY SELECT SWITCH		Six position rotary switch allowing selection of the different display Modes in the Alphanumeric Character Display (Item 2.)
		FLT ID	Enables FLT ID Display and Keypad Entry Mode.
		1	Enables Mode 1 Display and Keypad Entry Mode
		2	Enables Mode 2 Display and Keypad Entry Mode
		3A	Enables Mode 3A Display and Keypad Entry Mode
		S	Enables Mode S Display and Keypad Entry Mode
		STAT	Enables display of transponder status messages.

Figure 2-115. IFF/Mode S Transponder Controls (Sheet 3)

1.	Selecting **1** in the **DPL SEL** switch enables the Mode 1 display and keypad entry mode.
2.	Mode-1 code entries are displayed in the 4th and 5th character locations starting from the left on the LCD.
3.	Mode-1 code range is from 00 to 73 (octal). Keys **0** to **7** are enabled for the first entry; keys **8**, **9**, **ENT** and alpha entries are disabled. Keys **0** to **3** are enabled for the second entry; Keys **4** to **9**, **ENT** key, and alpha entries are disabled. Alpha entries are not allowed for code entry of Mode-1.
4.	If a complete Mode-1 code is displayed on the LCD, and a new valid key is pressed, then the number selected will be displayed in the first location assigned for Mode-1 code on the LCD. Remaining entry characters for Mode-1 code are indicated by displaying an underscore.
5.	Subsequent entries will be displayed to the right of the first entry. Mode-1 has a maximum of two locations to complete a code.
6.	Invalid key entries for Mode-1 code will not affect the code currently being displayed. If the **CLR** key is pressed, then the transmitted Mode-1 code is recalled and displayed on the LCD, replacing the complete or incomplete code that was previously being displayed.
7.	To transmit the code displayed on the LCD, the pilot must press the **LOAD** pushbutton key.
8.	There is a five (5) second timer after each key is pressed. If after those five seconds a new entry has not been made, then the currently transmitted code is recalled and displayed on the LCD.
9.	There is a five (5) second timer after a completed Mode-1 code has been selected and displayed on the LCD. If after those five seconds the **LOAD** has not been pressed to transmit the completed code, then the transmitted Mode 1 code is recalled and displayed on the LCD.

Figure 2-116. Mode 1 Display Selection

2.21.22.1.5 Mode 4 Operations. When the KIT-1C/TSEC Mode 4 computer is installed, Mode 4 interrogations bypass the decoder in the transponder and are applied directly to the Mode 4 computer. The Mode 4 interrogation signal is decoded and applied to a Mode 4 recognition circuit. When a Mode 4 coincidence exists, the Mode 4 recognition circuit generates a signal to the Mode 4 computer, which in turn generates a signal to the Mode 4 reply. The REPLY annunciator on the control panel illuminates to indicate that a Mode 4 reply is being transmitted. An IFF Caution light is located on the center pedestal. The IFF Caution light will illuminate when the aircraft receives incompatible Mode 4 interrogations under the following conditions:

1. The Mode 4 switch is OFF.
2. The transponder is in STBY.
3. The Mode 4 computer is not properly responding to interrogations.
4. The Mode 4 computer is connected but the crypto codes are not loaded (zeroized).
5. The transponder transmitter is defective.
6. The Mode 4 computer video interfaces have failed.

Note

The IFF Caution light does not operate unless the Mode 4 computer is installed.

The landing gear interlock line to the KIT-1C/TSEC and KIR-1C crypto computers is controlled by the left main landing gear switch. When the landing gear is down, the switch is deenergized, grounding the landing gear interlock line. When the landing gear is raised, the landing gear interlock line is opened and the KIT-1C/TSEC and KIR-1C crypto computers go to electrical hold.

1.	Selecting **2** in the **DPL SEL** switch enables Mode-2 display and keypad entry mode. Selecting **3A** in the **DPL SEL** switch enables Mode-3A (ATC) display and keypad entry mode.
2.	Mode 2 or 3A codes are displayed in the 3^{rd}, $4^{th,}$ 5^{th}, and 6^{th} character locations, starting from the left of the LCD.
3.	Mode 2 or 3A code range is from 0000 to 7777(octal). Keys **0** to **7** are enabled; keys **8**, **9**, **ENT**, and alpha entries are inhibited.
4.	If a complete Mode 2 or 3A code is displayed on the LCD window and a new valid key is pressed, then the number selected will be displayed in the first location assigned for Mode 2 or 3A code on the LCD. Remaining entries for a Mode-2 or 3A complete code are indicated by an underscore.
5.	Subsequent entries replace the underscores and are displayed to the right of the first entry. A complete Mode-2 or Mode-3A code is one that covers the four center characters of the LCD window.
6.	Invalid key entries for Mode-2 code do not alter the code currently being displayed.
7.	If the **CLR** key is pressed when the **DPL SEL 2** is selected, then the transmitted Mode-2 code is recalled and displayed on the LCD, replacing the complete or incomplete code displayed, whatever the case may be.
8.	If the **CLR** key is pressed when the **DPL SEL 3A** is selected, then the transmitted Mode-3A code is recalled and displayed on the LCD, replacing the complete or incomplete code displayed, whatever the case may be.
9.	To transmit the Mode-2 or Mode-3A code displayed on the LCD, the pilot must press the **LOAD** push-button key.
10.	There is a five (5) second timer after each key is pressed. If after those five seconds a new entry has not been made, then the currently transmitted code is recalled and displayed on the LCD.
11.	There is a five (5) second timer after a completed Mode-2 and 3A code has been selected and displayed on the LCD. If after those five seconds **LOAD** has not been pressed to transmit the completed code then the transmitted Mode-2 or Mode-3A code is recalled and displayed on the LCD.
12.	When the control panel EMER mode is enabled, the Mode-3A military emergency code 7700 is displayed. The Mode-3A code remains at 7700 as long as the Master System Switch is in the **EMER** position. The control panel retains in non-volatile memory the Mode-3A, 4096 code displayed prior to going into EMER mode. When the operator returns the Master System Switch position from **EMER** back to **NORM** or **STBY**, the control panel displays the Mode-3A, 4096 code selected prior to emergency.
13.	During the **EMER** selection, the front panel keypad is disabled.

Figure 2-117. Mode 2 and Mode 3A Display Selection

1.	Selecting **FLAT ID** in the **DPL SEL** switch enables the Flight ID display and keypad entry mode.
2.	Flight ID is displayed using all eight characters on the LCD.
3.	Flight ID code range is from 00000000 to 99999999 and all alpha entries are valid.
4.	If a complete Flight ID code is displayed on the LCD and a key is pressed, then that entry is displayed in the first character location (from the left). The remaining characters are replaced by an underscore indicating remaining entries need to be entered.
5.	To select the alpha characters the same key must be pressed repeatedly so that it is possible for the user to scroll through the number and the alphabet characters. For example, pressing key **1** four times displays 1-A-B-C; pressing key **2** four times display 2-D-E-F, etc.
6.	To validate a new entry and move to the next character, the **ENT** key must be pressed which causes the next character to be blanked, pending a new entry. Entering a new number or alpha character replaces the blank indication for the current digit.
7.	Pressing the **CLR** key replaces the current entry with an underscore and returns control to the previous location for a new entry.
8.	During first character entry, pressing the **CLR** key causes the current character being displayed to be replaced with an underscore.
9.	To enter a Flight ID code that has less than eight characters, the pilot must enter spaces to complete the code. For example, DL4567 is entered **D-L-4-5-6-7-space-space**.
10.	To enter a space the pilot must simply press the **ENT** key upon which the underscore for that location is removed and remain blank.
11.	Blank characters or spaces between alpha and/or numeric entries are not recognized.
12.	Spaces or **ENT** key is inhibited for entries into the first character location.
13.	To transmit the code displayed on the LCD, the user must press the **LOAD** pushbutton key. There are no timers associated with incomplete or complete codes displayed on the LCD.
14.	All eight-character locations including spaces must be entered to complete a Flight ID code. If an incomplete code is displayed on the LCD, then the **LOAD** key is inhibited.
15.	After a complete code has been entered and the **LOAD** key has been pressed to transmit the new code, pressing the **CLR** key causes the panel to replace the present code displayed with underscores. The control panel continues to transmit the present code until a new code has been validated for transmission by pressing the **LOAD** key.
16.	Flight ID codes is transmitted following ISO-5 format.

Figure 2-118. Flight ID Mode Display Selection

1.	Selecting **S** in the **DPL SEL** switch enables Mode-S display and keypad entry mode.
2.	Mode-S addresses are displayed using eight character locations on the LCD.
3.	Mode-S address range is from 00000000 to 77777777. Keys **0** to **7** are enabled; keys **8**, **9**, **ENT**, and alpha entries are inhibited.
4.	If a complete Mode-S address is displayed on the LCD and a valid key is pressed, then the number selected is displayed in the first location assigned for Mode-S address on the LCD. Pending entries to complete Mode-S address are indicated with an underscore.
5.	Subsequent entries are displayed to the right of the first entry. A complete Mode-S address is one that completes all eight-character locations on the LCD.
6.	Invalid key entries for Mode-S address do not affect the address currently displayed.
7.	If the **CLR** key is pressed when the **DPL SEL S** position is selected, then the transmitted Mode S address is recalled and displayed on the LCD, replacing the complete or incomplete address displayed, whatever the case may be.
8.	To transmit the address displayed on the LCD, the user must press the **LOAD** pushbutton key.
9.	There is a five (5) second timer after each key is pressed. If after those five seconds a new entry has not been made, then the currently transmitted address is recalled and displayed on the LCD.
10.	There is a five (5) second timer after a completed Mode-S address has been selected and displayed on the LCD module. If after those five seconds the **LOAD** has not been pressed to transmit the completed address, then the previously transmitted Mode-S address is recalled and displayed on the LCD.

Figure 2-119. Mode S Address Display Selection

When either the KIT-1C/TSEC or KIR-1C crypto computers are first loaded with the Mode 4 key, the key will not be lost if power is removed. After the aircraft takes off and the landing gear is retracted, the Mode 4 key will be zeroized with the next loss of power. To hold the key, lower the landing gear and place the combined TCAS/IFF control panel's Mode 4 code control switch in the hold position, in that order. The Mode 4 code control switch is spring-loaded and only needs to be placed in the HOLD position momentarily.

When the Reply Monitoring Control Switch, on the combined TCAS/IFF control panel, is placed in the AUDIO position, the Mode 4 audio warning is annunciated under the following conditions:

1. The IFF/Mode S transponder receives a compatible Mode 4 interrogation but the Master System Switch is set to STBY or the Mode 4 switch is Off.

2. Anytime the IFF/Mode S transponder receives an incompatible Mode 4 interrogation.

3. When either the KIT-1C/TSEC or KIR-1C crypto computers are first loaded with the Mode 4 key, the key will not be lost if power is removed. When the aircraft takes off and the landing gear is retracted, the IFF/Mode S transponder receives a compatible or incompatible Mode 4 interrogation but the KIT-1C/TSEC crypto computer codes are zeroized.

4. The IFF/Mode S transponder receives a compatible or incompatible Mode 4 interrogation but the KIT-1C/TSEC crypto computer has not been installed in the aircraft.

2.21.22.1.6 IFF/Mode S Transponder Self Test. The IFF/Mode S transponder system has a built-in self-test for enabled transponder modes. The transponder continuously monitors and tests itself when power is applied to it. The flightcrew can initiate a test by placing the MASTER SYSTEM SWITCH on the control panel to NORM and pressing the TEST button. First, a lamp test of the control panel will be conducted, turning all of the control panel lights and the IFF Caution light on for the duration of the TEST button being held. Then the control panel will conduct an internal test. CP PASS will appear on the control panel if the self-test passes. CP FAIL will appear if there is an internal failure of the control panel. The GO light will illuminate and SYS GO will appear when the system is operational for the transponder modes selected. A NOGO annunciator will illuminate when the transponder is partially or completely inoperative. To view fault messages, position the DPL SEL (Display Select) switch to STAT. Pressing ENT will show additional failures if there is more than one failure. The fault message, SYS FAIL, indicates that the transponder is partially or completely inoperative or the combined TCAS/IFF control panel has lost transmitting and receiving signals from the transponder. The fault message, KIT FAIL, indicates that the Mode 4 is inoperative. The fault message, ALT FAIL, indicates that the transponder is not receiving altitude information from the High Integration Air Data Computer. Modes C and S will be inoperative if ALT FAIL is displayed.

2.21.22.2 Traffic Alert and Collision Avoidance System. The Traffic Alert and Collision Avoidance System (TCAS) is an onboard advisory system designed to act as a backup to the air traffic control radar beacon system (ATCRBS) and the "see and avoid" procedures used by flightcrews. By computing the closure rate and altitude of all transponder-equipped aircraft in the surrounding airspace, TCAS can anticipate a potential midair collision before it has a chance to materialize.

2.21.22.2.1 System Components. The TCAS system consists of a TCAS computer, located in the IFF equipment rack; a combined TCAS/IFF control panel, located on the center pedestal; and two Vertical Speed Indicator/Traffic Resolution Advisory Display Indicators (VSI/TRA), one located on the pilot's instrument panel and one located on the copilot's instrument panel. The system also has two antennas, one located on the top of the fuselage and one located on the bottom of the fuselage, and a cockpit speaker, located on the right side of the cockpit.

The TCAS computer receives 28 Vdc from the essential DC bus through the TCAS CMPTR circuit breaker on the copilot's upper circuit breaker panel. The pilot's VSI/TRA receives 28 Vdc from the isolated DC bus through the PILOT VSI/TRA circuit breaker on the copilot's upper circuit breaker panel. The copilot's VSI/TRA receives 28 Vdc from the essential DC bus through the COPILOT VSI/TRA circuit breaker on the copilot's upper circuit breaker panel.

2.21.22.2.2 Theory of Operation. TCAS, working in conjunction with the IFF/Mode S transponder, monitors the flight paths of the 50 closest or highest threat aircraft in the TCAS equipped aircraft's immediate airspace. This airspace is approximately 80 nm or more; however, the TCAS display is limited to 40 nm. Depending on the IFF Mode the intruding aircraft is using, TCAS determines the range, bearing, and altitude of other aircraft, relative to the TCAS equipped aircraft. TCAS continuously monitors the flight paths of these aircraft to determine if any of them constitute a potential collision hazard. If a potential collision hazard is detected, an advisory is displayed to the pilot and copilot on the VSI/TRAs and an aural indication/warning is heard in the headsets.

The advisory may also provide guidance for an ideal vertical avoidance maneuver. If both aircraft are equipped with TCAS, the two systems are able to communicate through their Mode S and coordinate complementary vertical avoidance maneuvers between aircraft. Vertical guidance to avoid midair collisions is accomplished when the TCAS equipped aircraft interrogates the Mode C and/or Mode S transponders of potential intruder aircraft and provides advisories to the flightcrew in order to assure vertical separation. Two levels of advisories are provided:

1. Traffic Advisory (TA). Traffic advisories will indicate the range, bearing, and relative altitude of the intruder aircraft to aid in the sighting of the intruder aircraft. TAs from aircraft with only a Mode A transponder will not display all of the available data.

2. Resolution Advisory (RA). Resolution advisories indicate what vertical maneuver should be performed or avoided in order to assure safe separation between aircraft. RAs can only be generated by other aircraft that have altitude-reporting capability.

The two types of advisories correspond to time-based protection zones around the aircraft. The airspace around the TCAS equipped aircraft where an RA would be announced represents the warning area, while the larger airspace where a TA would be announced is the caution area. See Figure 2-120.

2.21.22.2.3 TCAS Operation and Control. Operation and control of TCAS are accomplished with the combined TCAS/IFF control panel. Before selecting

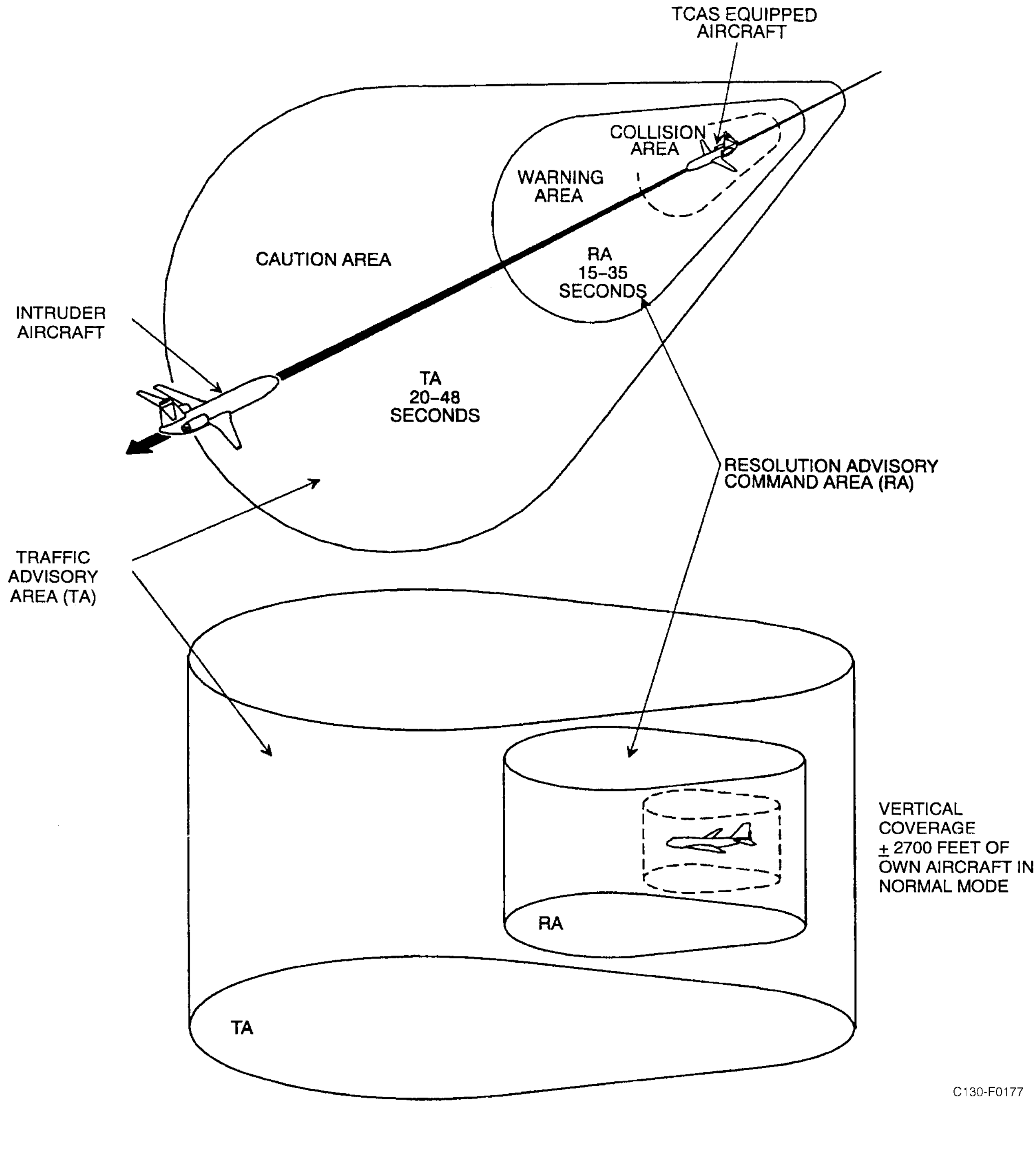


Figure 2-120. Traffic Alert and Collision Avoidance System (TCAS) Coverage Area

TCAS functions, the Combined Altitude Radar Altimeter (CARA) and the transponder Mode C must be operating. For normal TCAS operation, the MASTER SYSTEM SWITCH must be placed in the NORM (normal) position. The MODE SELECT/TCAS ENABLE SWITCH must be placed in the TA or TA/RA position. For full control details, refer to Figure 2-115.

a. MASTER SYSTEM Switch. When the MASTER SYSTEM switch is placed in the OFF or STBY position, all TCAS TAs and RAs will be inhibited. TA and RA information is available when the MASTER SYSTEM switch is placed in the NORM or EMER position. When the EMER (emergency) position is selected and the MODE SELECT/TCAS ENABLE SWITCH is in the TA/RA position, TCAS will issue both TAs and RAs and the transponder will broadcast an emergency code in Mode 3A, and reply to Modes C and S air and ground interrogations.

b. MODE SELECT/TCAS ENABLE Switch. When the MODE SELECT/TCAS ENABLE switch is placed in TA, TCAS will only issue TA information — no RA information will be issued. This mode prevents TCAS from issuing RAs when the aircraft is intentionally flying close to another aircraft, such as in formation or on a closely spaced parallel approach. Only TAs will appear on the VSI/TRAs in this mode. When the MODE SELECT/TCAS ENABLE switch is placed in TA/RA, TCAS will issue both TA and RA information. This is the normal TCAS operating mode. Both TAs and RAs will appear on the VSI/TRAs. With either TA or TA/RA selected on the MODE SELECT/TCAS ENABLE switch, the IFF/Mode S transponder will reply to air and ground interrogations in Modes 3A, C, and S.

c. HORIZONTAL RANGE Switch. The HORIZONTAL RANGE SWITCH selects the horizontal display range on the VSI/TRAs in nautical miles. See Figure 2-121 for the dimensions of each range.

d. VERTICAL RANGE Switch. The VERTICAL RANGE switch selects the altitude range, with respect to the aircraft, for traffic displays on the VSI/TRAs. ABV sets the range at 9900 feet above and 2700 feet below the aircraft. NORM sets the range at 2700 feet above and 2700 feet below the aircraft. BLW sets the range at 2700 feet above and 9900 feet below the aircraft.

2.21.22.2.4 TCAS Visual Display and Indications. The VSI/TRAs display vertical speed data (current rate of climb or rate of descent information) and TCAS traffic and resolution advisory information (Figure 2-122). As a vertical speed indicator, the VSI/TRA provides a standard display of vertical speed in feet per minute with a range plus or minus 6,000 feet per minute. As a traffic and resolution advisory indicator, the VSI/TRAs display symbols representing local air traffic within a variable range up to 40 nm of the TCAS equipped aircraft. Up to 8 aircraft can be displayed at any given time. Each symbol reflects the bearing, relative altitude, and range of each aircraft.

WARNING

Prolonged VHF No. 1 transmissions in the 135.025 to 137.500 and 120.775 to 121.500 MHz frequency bands can result in the loss of displayed targets on the TCAS VSI/TRAs. The flight crew should utilize the VHF No. 2 or V/UHF radios if communications are required at the affected frequencies.

TCAS RANGE SETTING	RANGE RING	RANGE BEING DISPLAYED FORWARD OF AIRCRAFT	RANGE BEING DISPLAYED LEFT AND RIGHT OF AIRCRAFT	RANGE BEING DISPLAYED AFT OF AIRCRAFT
6	2 nm	6 nm	4.2 nm	2.5 nm
12	Inner 2 nm Outer 5 nm	12 nm	8.3 nm	5 nm
20	8.4 nm	20 nm	14 nm	8.4 nm
40	17 nm	40 nm	28 nm	17 nm

Figure 2-121. TCAS Range Display

A white aircraft symbol representing aircraft position is displayed in the lower center of the VSI/TRA. This is surrounded by a white range ring made up of 12 dots, each corresponding to a normal clock position. The function of the range ring is to assist in interpreting TCAS information. The position of the range knob determines the scale of the VSI/TRA display. The various scales are shown in Figure 2-121.

The VSI/TRA indicator uses color-coded symbols and data tags to map intruder aircraft, proximate air traffic, and other air traffic. Four traffic symbols are used: solid circle, solid square, solid diamond, and hollow diamond. The traffic symbols, with their corresponding colors and display functions, are shown in Figure 2-123. A two-digit data tag number, with a plus (+) or minus (–) sign and arrow, may appear either above or below a traffic symbol. For traffic above the aircraft, the data tag will be placed above the traffic symbol and preceded by a plus (+) sign and a two-digit number. For traffic below the aircraft, the data tag will be placed below the traffic symbol and preceded by a minus (–) sign and a two-digit number. The two-digit number represents the relative altitude of the intruder, proximate, or other aircraft traffic in relation to own aircraft. For example; a data tag of +21 would indicate that the traffic is 2100 feet above own aircraft's present altitude. If an intruder aircraft is either climbing or descending in excess of 500 feet per minute, an arrow will appear to the immediate right of the traffic symbol. The arrow will point down if the traffic is descending and will point up if the traffic is climbing.

During a resolution advisory (RA), red and green bands will overlay the vertical speed scale. The bands reflect the RA in progress and act as vertical speed advisories for the pilot. The red band indicates what vertical speed range is to be avoided by the pilot. The green band indicates the recommended vertical speed that the pilot is to attain in order to achieve safe separation from an intruder aircraft. Climb commands are inhibited at or above 24,000 feet for C-130T aircraft. Climb commands will not exceed a 1500 FPM climb rate.

An off-scale traffic advisory occurs when TCAS is tracking an intruder that is outside the range of the VSI/TRA but has entered the Caution or Warning areas. One half of the appropriate symbol will appear at the proper bearing at the edge of the display area. The symbol will appear at the appropriate color and shape and will display a data tag, provided there is enough room.

If TCAS is unable to track the bearing of an intruder, a no-bearing advisory will appear. The inability to track the bearing of an intruder is usually caused by temporary antenna shielding due to steep bank angles or by a failure in the TCAS antennas. TCAS will still be able to compute traffic and resolution advisories. When TCAS is unable to track the bearing of the intruder aircraft, no symbol will be displayed on the VSI/TRA. Instead, a no-bearing advisory will appear in alphanumeric form. It will display the acronym "TA" or "RA," the distance of the intruder from the own aircraft in nautical miles, and the relative altitude and direction of the intruder from the own aircraft. For example, an intruder creating a resolution advisory that is 0.6 nautical miles and 600 feet below the own aircraft would cause a display that would read "RA 0.6 –06." This display will also appear in the appropriate color depending on the type of alert.

Current operation modes appear in white letters. The modes include TCAS OFF and TA only. Failure modes appear in amber letters and displace the current operation modes in case of system failure. The failure modes include TCAS FAIL, RA FAIL, VSI FAIL, and TA FAIL.

2.21.22.2.5 TCAS Aural Announcements. TCAS is programmed with 14 aural announcements (see Figure 2-124), excluding test announcements. These 14 announcements alert the aircrew to changing traffic conditions and are broadcast from a cockpit loud speaker as well as to the flightcrew headsets from the interphone communication system. The aural announcement, TRAFFIC, TRAFFIC, is generated when a potential traffic threat is approaching. A variety of aural alerts are given when the first RA of an encounter is displayed and each time a subsequent change in the advisory is displayed, either strengthened or weakened. The announcements differentiate the advisories by type. The weakened advisory, MONITOR VERTICAL SPEED, is initiated to facilitate minimizing the vertical deviation from ATC clearances. An aural announcement also indicates that the aircraft is CLEAR OF CONFLICT. This announcement occurs when the RA is removed from the VSI/TRA and the intruder aircraft has begun to diverge in range.

Figure 2-122. VSI/TRA Display Indicator

SYMBOL	COLOR	DISPLAY FUNCTION	DEFINITION
Solid Circle	Amber	Traffic Advisory (TA)	Intruder aircraft are entering the caution area, 30 to 45 seconds from the TCAS collision area. Prompt action is required to avoid the intruder.
Solid Square	Red	Resolution Advisory (RA)	Intruder aircraft are entering the warning area, 20 to 30 seconds from the TCAS collision area. A visual search is recommended to prepare for intruder avoidance.
Solid Diamond	Blue	Proximate Traffic	Aircraft are within 6.0 nautical miles and +1200 feet vertically from own aircraft. Proximate traffic is shown to improve situational awareness in the event of a potential conflict with other aircraft. The flightpaths of proximate traffic are not predicted to enter the TCAS collision area.
Hollow Diamond	Blue	Other Traffic	Aircraft are within the range of the VSI/TRA display and +2700 feet vertically from own aircraft. The flightpaths of other traffic are not predicted to enter the TCAS collision area.

Figure 2-123. TCAS Traffic Symbology

MESSAGE TYPE	AURAL WARNING	MEANING
Traffic Advisories (TA)	“Traffic – Traffic”	TCAS predicts that an intruder aircraft will enter the collision area within 35 to 45 seconds. Amber solid circle showing the range and relative bearing on the VSI/TRA.
Preventive Resolution Advisory (RA)	“Monitor Vertical Speed – Monitor Vertical Speed”	Indicates that certain changes in vertical speed may not be safe. Pilot should monitor the vertical speed of the aircraft and keep the VSI pointer out of the RED area on the VSI scale.
Corrective Resolution Advisories (RA)	“Climb – Climb”	The VSI/TRA is RED from the negative limit to +1,500 fpm and GREEN from +1,500 to +2,000 fpm. Pilot should immediately climb at the rate indicated by the green arc.
	“Descend – Descend”	The VSI/TRA is RED from the positive limit to –1,500 fpm and GREEN from –1,500 to –2,000 fpm. Pilot should immediately begin to descend at the rate indicated by the green arc.
	“Climb, Crossing Climb – Climb, Crossing Climb”	The VSI/TRA is RED from the negative limit to +1,500 fpm and GREEN from +1,500 to +2,000 fpm. Pilot should start to climb at the rate shown on the VSI. This flightpath will cross the intruder aircraft’s altitude.
Strengthening Resolution Advisories (RA)	“Descend, Crossing Descend – Descend, Crossing Descend”	The VSI/TRA is RED from the positive limit to –1,500 fpm and GREEN from –1,500 to –2,000 fpm. Pilot should start to descend at the rate shown on the VSI. This flightpath will cross the intruder aircraft’s altitude.
	“Adjust Vertical Speed, Adjust”	The VSI/TRA indicates the prohibited vertical speeds by a RED arc. The goal is to make the aircraft smoothly attain the recommended vertical speed indicated by the GREEN arc.
Strengthening Resolution Advisories (RA)	“Increase Climb – Increase Climb”	Inhibited on C-130T aircraft.
	“Increase Descent – Increase Descent”	The VSI/TRA is RED from the positive limit to –2,500 fpm and GREEN from –2,500 to –3,000 fpm. This indicates that the vertical speed must be increased to ensure adequate separation. Pilot should immediately increase descent rate as indicated by the GREEN arc.
	“Climb, Climb Now! – Climb, Climb Now!”	Indicates that a reversal of vertical speed is necessary to provide vertical separation between the aircraft and an intruder aircraft. The VSI/TRA is RED from the negative limit to +1,500 fpm and GREEN from +1,500 to 2,000 fpm.
	“Descend, Descend Now! – Descend, Descend Now!”	Indicates that a reversal of vertical speed is necessary to provide vertical separation between the aircraft and an intruder aircraft. The VSI/TRA is RED from the positive limit to –1,500 fpm and GREEN from –1,500 to –2,000 fpm.
Weakening or Restrictive Resolution Advisories (RA)	“Maintain Vertical Speed, Maintain”	Indicates vertical speed is not within the RED restricted vertical speeds shown on the VSI/TRA. Keep vertical speed out of the RED unsafe areas as indicated on the VSI/TRA.
	“Adjust Vertical Speed, Adjust”	The VSI/TRA indicates the prohibited vertical speeds by a RED arc. The goal is to make the aircraft smoothly attain the recommended vertical speed indicated by the GREEN arc.
	“Maintain Vertical Speed, Crossing Maintain”	The VSI/TRA indicates prohibited vertical speeds in RED and the target vertical speeds in GREEN. Separation with the intruder aircraft is adequate if a current vertical speed commanded is maintained.
Clear of Conflict Advisory	“Clear of Conflict”	The VSI/TRA RED and GREEN arcs are removed. Confirms that the encounter has ended and separation between the aircraft and intruder aircraft is increasing. A return to the original ATC clearance profile is expected.

Figure 2-124. TCAS Aural Announcements

2.21.22.2.6 Pilot Responsibilities. TCAS is intended as a backup to visual collision avoidance, application of "right-of-way rules," and Air Traffic Control (ATC) separation service. To work effectively, timely and reliable crew response to TCAS advisories is essential. Flightcrews operating in United States airspace are expected to respond to TCAS in accordance with the following guidelines. Flightcrews operating in other country's airspace are expected to familiarize themselves with any special rules that may be in effect relating to TCAS operations prior to entering that airspace.

a. Traffic Advisories. Respond immediately to TAs (Traffic Advisories) by attempting to establish visual contact with the intruder aircraft and other aircraft that may be in the vicinity. If traffic is acquired visually, continue to maintain or attain safe separation in accordance with good operating practices and current FAR's (United States Federal Aviation Regulations) or other applicable air regulations. TA displays and advisories are intended only for assistance in visually locating the traffic.

Note

- The pilot should not initiate evasive maneuvers using information from the traffic display only, or upon receipt of a Traffic Advisory (TA) only, without positive visual identification of the traffic.
- The pilot should reduce vertical speed to 1,500 feet per minute or less when within 2,000 feet of an ATC directed level-off altitude to reduce the incidence of unnecessary TAs.

b. Resolution Advisories. Respond immediately to satisfy Corrective RAs using positive control inputs, in the direction and with the magnitude TCAS advises, while attempting to sight the conflicting traffic. The aircraft's vertical speed indication as shown on the VSI/TRA must be moved out of the RED band and into the GREEN band. Compliance with TCAS Resolution Advisories (RAs) is necessary and authorized according to United States Federal Air Regulation (FAR 91.123) which allows pilots to deviate from an ATC clearance if "the deviation is in response to a traffic alert and collision avoidance system resolution advisory." Following a TCAS "CLEAR OF CONFLICT" advisory, the pilot should expeditiously return to the applicable ATC clearance unless otherwise directed, and notify ATC.

For TCAS to properly function, initial vertical speed response is expected within five seconds of an RA. A prompt, smooth pitch change of 2° to 6° should be sufficient to resolve nearly all conflicts. Maneuvering g-forces should be similar to those felt when responding to an ATC clearance to climb or descend immediately (0.25 g increment). From level flight, proper response to a TCAS RA typically results in an overall altitude deviation of 300 to 700 feet in order to successfully resolve a traffic conflict. If possible, visually confirm the necessity and suitability of the avoidance maneuver but recognize that any other aircraft seen visually may not necessarily be the threat aircraft or the only aircraft that is triggering the TCAS system response.

WARNING

During any airplane configuration that could limit the normal climb capability of the airplane (such as engine out, ramp open, etc.) or during an operational situation where a resolution advisory (RA) maneuver is prohibited, TCAS should be placed in TA only if used.

CAUTION

- Maneuvering in response to RAs must be done manually by the pilot flying the aircraft. Autopilot response time may be too slow to provide the desired separation. Pilots must disconnect the autopilot and establish the proper pitch attitude manually.
- Altitude excursions to cardinal altitudes not assigned, or beyond that directed by the TCAS, may compromise the safety of the entire ATC system and may cause severe and dangerous effects for all aircraft.

CAUTION

- Noncompliance with a Crossing RA by one airplane may result in reduced vertical separation. Therefore, safe horizontal separation must also be assured by visual means.

- Once a Non-Crossing RA has been issued, safe separation could be compromised if current vertical speed direction is changed, except as necessary to comply with the RA. This is because TCAS-to-TCAS coordination with the intruder airplane may be in progress and any change in vertical speed that does not comply with the RA may negate the effectiveness of the other aircraft's compliance with the RA.

Note

- A Climb RA does not mandate a Missed Approach. The pilot must exercise appropriate judgment to assure the airplane is properly configured for the maneuver, whether it be a subsequent landing or a Go-Around/Missed Approach. In most cases, the TCAS event will be resolved with only a minor deviation to the intended flight path and sufficient time and altitude may exist to recover safely to the desired flight path.

- An Altitude-Crossing maneuver may occur when the intruder or host aircraft is climbing or descending at a high rate. Under these conditions, the TCAS logic determines that safe separation is best achieved through an Altitude-Crossing maneuver. This maneuver will result in the TCAS aircraft and the intruder crossing through each other's altitude. This safe strategy will result in adequate vertical separation between aircraft.

2.21.23 AN/APX-76B IFF Interrogator. The AN/APX-76B IFF interrogator is an air-to-air interrogator that operates in conjunction with the AN/APN-59E search radar or the AN/APS-133(M) multimode radar. It is capable of generating interrogations on IFF/SIF mode 1, 2, 3/A, or 4 and develops a video output to the search radar indicator. Returns from the interrogated aircraft indicate the aircraft identification, position in azimuth, and range from interrogating aircraft. The interrogator system consists of an IFF interrogator control panel and a display control unit located on the navigator control panel (see Figure 2-125). An IFF interrogator antenna (see Figure 2-82) is mounted on top of the fuselage. The system receives 115-Vac power from the essential ac bus on, and 28-Vdc power from the essential dc bus through the IFF interrogator circuit breakers on the copilot upper circuit breaker panel.

2.21.23.1 IFF Interrogator Control Panel. The interrogator control panel (see Figure 2-125) contains the controls, indications, and functions as follows:

1. IFF interrogator controls — See Figure 2-125 for control panel functions.

2. IFF interrogator switch panel controls — Display control unit contains the controls as shown in Figure 2-125.

3. Display control unit.

Note

See AN/APS-133(M) multimode radar for an explanation of the remaining switches on the display control unit.

2.21.23.2 Normal Operation of the IFF Interrogator System. To place the IFF interrogator into operation, proceed as follows:

Note

On the AN/APS-133(M) multimode radar, the radar indicator must be on.

On the control panel:

1. Set the mode selector switch to the desired mode.

2. Set the code selector switches to the desired code.

On the AN/APS-133M display control unit:

3. Place the PWR/IFF switch to the ON position.

On the IFF audio monitor panel:

4. Set the copilot interphone IFF audio as desired (see Figure 2-85).

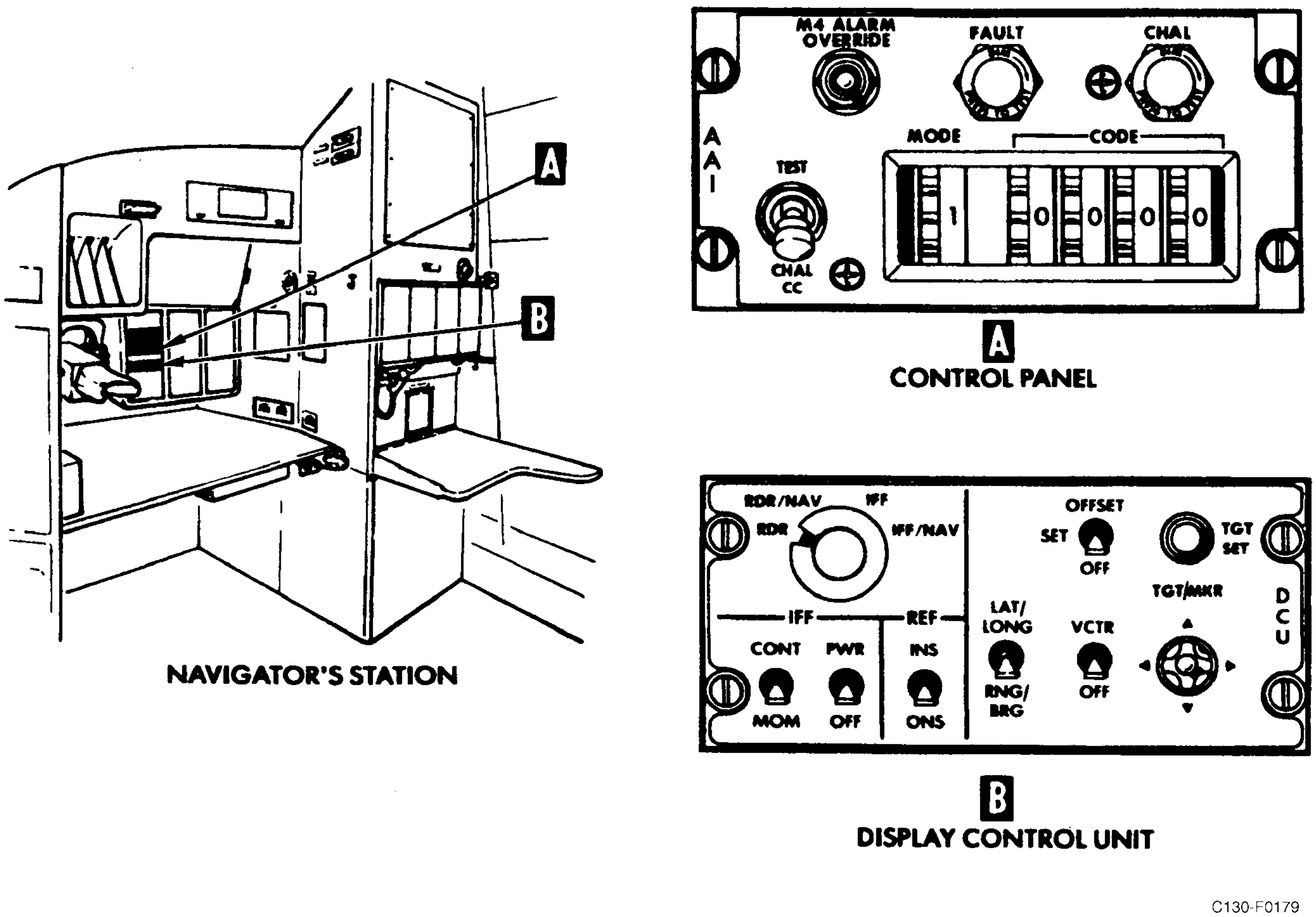


Figure 2-125. AN/APX-76B(V) IFF Interrogator Controls and Indicators (Sheet 1 of 2)

IFF INTERROGATOR CONTROLS		
CONTROL	**POSITION**	**FUNCTION**
M4 ALARM OVERRIDE Switch	M4 ALARM OVERRIDE	Allows overriding of the mode 4 alarm, if desired.
TEST-CHAL CC Switch	TEST CHAL CC	Activates the interrogator for loop testing with the aircraft IFF transponder. Initiates a challenge resulting in correct code display.
FAULT Light Indicator	Press-to-test and turn-to-dim (amber)	When illuminated, advises that there is a fault in the system.
CHAL Light	Press-to-test and turn-to-dim (green)	Light remains on during the length of time interrogation is being made.
DISPLAY CONTROL UNIT		
IFF Power	PWR-OFF	Connects ac and dc power to the system.
IFF challenge	CONT-MOM (center OFF position)	Used to operate the system. Continuous (CONT) or momentary (MOM) challenge is provided. The MOM position is spring-loaded to return to the OFF position.
Note See AN/APS-133(M) multi-mode radar for an explanation of the remaining switches on the display control unit.		

Figure 2-125. AN/APX-76B(V) IFF Interrogator Controls and Indicators (Sheet 2)

Note

With the CHAL switch on the switch panel in the CONT position (continuous interrogation), bracket returns (single video slash) can be eliminated by placing the TEST-CHAL CC switch on the control panel to CHAL CC, leaving only the correct code (double video slash) returns displayed.

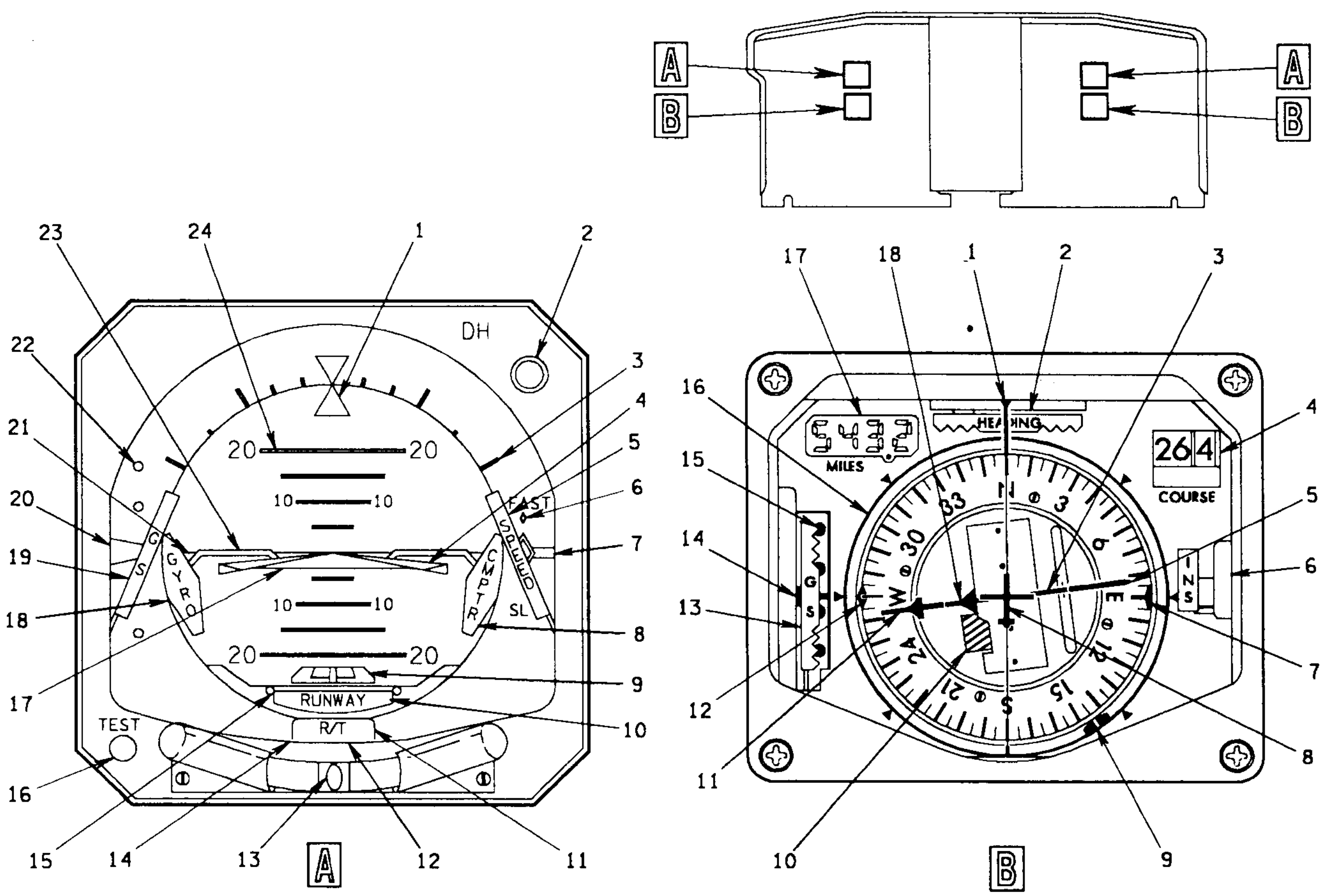
5. With the AN/APS-133(M) multimode radar in the IFF or IFF/NAV mode, press the TEST-CHAL CC switch on the IFF interrogator control panel to the CHAL CC position to interrogate aircraft on the correct code.

6. To test the system, set up both the interrogator and transponder system to the same mode and code and press the TEST-CHAL CC to the TEST position. The interrogation reply of the transponder will appear on the search radar indicator at approximately a 4-mile range (may be a continuous line).

2.21.24 FCS 105 Flight Control System. FCS 105 is a combination of autopilot, guidance, displays, and sensors and is made up of two flight director systems (Collins FD 109) and the autopilot (Collins AP-105V). Flight director system Nos. 1 and 2 receive 28-Vdc power from the essential dc bus through the FLT DIR NO. 1 and FLT DIR NO. 2 circuit breakers located on the copilot upper circuit breaker panel and 115-Vac power from the essential ac bus through the FLT DIR NO. 1 and FLT DIR NO. 2 circuit breakers located on the copilot upper circuit breaker panel. The autopilot is powered by 28-Vdc power from the essential dc bus through the AUTOPILOT PWR and ANN LIGHTS circuit breakers on the copilot lower circuit breaker panel and 115-Vac power from the essential ac bus through the AUTOPILOT circuit breaker on the pilot upper circuit breaker panel.

2.21.24.1 Attitude Director Indicator. ADIs present a three-dimensional display of aircraft attitude, steering commands, localizer and glideslope deviation, rate of turn, aircraft slip or skid, radar altitude, and decision height (see Figure 2-126). When the autopilot is coupled, the ADI is used to monitor autopilot performance. When the autopilot is not coupled, the pilot uses the display to manually fly the aircraft. The following paragraphs describe the ADI.

2.21.24.1.1 Aircraft Symbol and Attitude Display. A fixed delta-shaped symbol represents the aircraft. Aircraft pitch and roll attitude is displayed by the relationship of the aircraft symbol to the movable attitude tape. Pitch indexes are shown on the attitude tape. The pitch attitude tape is colored with a blue sky above a brown earth separated by a white horizon line;



ATTITUDE
DIRECTOR INDICATOR

1. BANK POINTER
2. DECISION HEIGHT ANNUNCIATOR
3. BANK SCALE
4. COMMAND BARS
5. SPEED FLAG
6. SPEED DEVIATION SCALE
7. SPEED DEVIATION POINTER
8. COMPUTER WARNING FLAG
9. RISING RUNWAY
10. RUNWAY WARNING FLAG
11. RATE OF TURN SCALE (UNDER FLAG)
12. RATE OF TURN POINTER (UNDER FLAG)
13. SLIP INDICATOR
14. RATE OF TURN WARNING FLAG
15. RUNWAY SCALE
16. TEST BUTTON
17. AIRCRAFT SYMBOL
18. GYRO WARNING FLAG
19. GLIDESLOPE WARNING FLAG
20. GLIDESLOPE POINTER
21. HORIZON LINE
22. GLIDESLOPE SCALE
23. ATTITUDE REFERENCE BARS
24. PITCH ATTITUDE TAPE

HORIZONTAL
SITUATION INDICATOR

1. LUBBER LINE
2. HEADING WARNING FLAG
3. COURSE DEVIATION BAR
4. COURSE DISPLAY
5. COURSE TAIL
6. INS ANNUNCIATOR
7. BEARING POINTER (INS)
8. AIRCRAFT SYMBOL
9. HEADING MARKER
10. NAV WARNING FLAG
11. COURSE ARROW
12. BEARING POINTER
13. GLIDESLOPE WARNING FLAG
14. GLIDESLOPE POINTER
15. GLIDESLOPE SCALE (UNDER FLAG)
16. AZIMUTH CARD
17. MILES DISPLAY
18. TO-FROM INDICATOR

C130-F0180

Figure 2-126. FCS 105 Flight Control System Indicators roll indexes show 10°, 20°, 30°, 45°, and 60° of right and left bank. Two sources of pitch and roll attitude reference are available for use by the attitude display: gyro attitude (GYRO ATT) or INS attitude (INS ATT). The source is controlled by the attitude select switches located on the pilot and copilot instrument panel (see Figure 2-129). INS attitude is the primary attitude reference.

2.21.24.1.2 Command Bars. The command bars display computed pitch and bank commands. These bars move up or down to command a climb or descent and roll clockwise or counterclockwise to command a right or left bank. The aircraft is maneuvered in roll and pitch to align the aircraft symbol and command bars.

2.21.24.1.3 Glideslope Pointer and Scale. The glideslope pointer represents the center of the glideslope beam and displays vertical aircraft displacement from the glideslope-beam center. The center of the glide-slope scale represents the aircraft. When the pointer is deflected upward, the aircraft is below the glidepath. This is displacement information only; pitch commands are presented by the pitch command bars. The glideslope pointer is in view only when the navigation receiver is tuned to a localizer frequency. It is not in view during a back-course approach.

2.21.24.1.4 Runway Symbol. The rising runway symbol represents a combination of radio altitude and expanded-scale localizer information. It depicts aircraft altitude relative to the runway during the last 200 feet of descent. Left and right movement displays the aircraft deviation from localizer center. Full-scale deflection (outside marks) is equivalent to the inner dots on the HSI (approximately 1-1/4° from the localizer center-line). Up and down movement is controlled by the radio/radar altimeter. Vertical movement begins at 200-feet radio/radar altitude and is marked in 50-foot increments. The symbol comes into view and displays information when a reliable localizer signal is being received.

2.21.24.1.5 Decision Height Annunciator. On C-130T aircraft prior to 164993, the radar altimeter illuminates the decision height annunciator at the preselected radar altitude set on the CARA indicator. On C-130T aircraft 164993 and up, the radar altimeter illuminates the pilot and copilot decision height annunciators at the preselected radar altitude set on the respective (pilot/copilot) CARA indicator.

2.21.24.1.6 Slip Indicator (Inclinometer). The slip indicator or inclinometer displays aircraft slip or skid. The inclinometer consists of a weighted ball in a liquid-filled, curved glass tube.

2.21.24.1.7 Rate-of-Turn Pointer. The rate-of-turn pointer displays aircraft rate of turn about the yaw axis. A two-needle width deviation shows a standard rate turn of 3° per second; a one-needle width deviation shows a half-standard rate turn of 1-1/2° per second.

2.21.24.1.8 Speed Deviation Pointer and Speed Flag. The speed deviation pointer and SPEED flag are used to display the difference between actual aircraft speed and a computed optimum speed as manually set on the pilot airspeed indicator. When speed exceeds the target speed by approximately 20 knots, the pointer is deflected out of view. When approximately 20 knots below target speed, the pointer remains in view. When not in use, the pointer is deflected out of view.

Note

The SPEED flag remains out of view anytime dc power is applied to the system and does not indicate proper operation of the system. When in view, it indicates only that power is off.

2.21.24.1.9 Test Switch. The TEST pushbutton switch permits partial testing of the ADI pitch and roll servo systems. Pressing this pushbutton causes the attitude display to change by 10° (+3°) pitchup and 20° (–5°) right bank. The gyro flag also appears.

2.21.24.1.10 ADI Warning Flags

1. Glideslope (GS) warning flag — When VOR/ILS 1 or VOR/ILS 2 has been selected on the NAV SEL switch and the receiver set on a localizer frequency, the glideslope warning flag appears when the glideslope deviation being displayed is unreliable. All glideslope-related vertical commands are unusable while the flag is in view. The glideslope warning flag is removed from view in the back-course mode.

2. Computer (CMPTR) warning flag — The CMPTR warning flag indicates that any steering commands from the flight computer to the associated ADI command bars and autopilot (if coupled) are unreliable for the mode selected.

When the flag appears, the command bars go out of view.

3. Runway warning flag — The RUNWAY warning flag indicates that the runway symbol information is unreliable. An unreliable localizer signal causes the flag to come into view. A CARA malfunction or a failure of the symbol to follow input signals causes the flag to come into view.

4. GYRO warning flag — The GYRO warning flag indicates that the attitude information being displayed may be incorrect. The cause of the flag may be because of a malfunction of or loss of power to the vertical reference furnishing attitude information or internal failure of the attitude display mechanism.

5. Rate of turn (R/T) warning flag — The R/T warning flag indicates that the rate-of-turn pointer is unreliable. A malfunction of or loss of power to the turn rate gyro will cause the flag to come into view.

2.21.24.2 Horizontal Situation Indicator. HSIs display a pictorial view of an aircraft with respect to magnetic north, selected course, and selected heading (see Figure 2-126). Selected heading and course are read against a servo-driven azimuth card. Digital miles and course displays are provided. Meter movements display course deviation, to-from indication, and glideslope deviation. Warning flags monitor the azimuth card and navigation and glideslope signals. Remote selection of course and heading are controlled by the course indicator remote HDG and COURSE control knobs. The following paragraphs describe the HSI.

2.21.24.2.1 Aircraft Symbol. The aircraft symbol shows aircraft position and heading in relation to the azimuth card, course deviation bar, and heading marker.

2.21.24.2.2 Azimuth Card. The rotating azimuth card displays magnetic heading information from its respective C-12 compass system. If INS or Omega is selected with the NAV SEL switch, the card displays heading information from the selected system. When INS is selected, the heading is true unless modified by a manual conversion to magnetic heading. When Omega is selected, the heading is true and, during turns, there will be small jumps of the azimuth card because of the delay in the ONS processing the heading. The jumps will depend upon the rate of turn and, under normal conditions, will be in very small increments. The heading is read on the azimuth card beneath the lubber line.

2.21.24.2.3 Heading Marker. The heading marker is set to the desired heading as read on the azimuth card by rotating the HDG knob on the remote heading and course selector control panel.

2.21.24.2.4 Course Arrow. The course arrow is set to the desired course with the COURSE knob on the remote heading and course selector control panel. When INS or ONS data is displayed, the course arrow is driven to the desired course. The course tail displays the reciprocal of the course arrow and is read with respect to the azimuth card.

2.21.24.2.5 Course Display. The course display on the upper right corner of the HSI displays a digital readout of course indicated by the course arrow. When INS or Omega is selected with the NAV SEL switch, the course display will be the desired course.

2.21.24.2.6 Course Deviation Bar. The course deviation bar represents the centerline of the VOR, tacan, or localizer course. When INS or ONS data is displayed, the course deviation bar displays crosstrack deviation.

2.21.24.2.7 Miles Display. The miles display on the upper left corner of the HSI provides a digital readout of distance in nautical miles. This distance information is provided from the No. 1 tacan system, when operating, for the pilot HSI as long as the pilot NAV SEL switch is in any position except TAC 2 ONS or INS 1. Similarly, distance information from the No. 2 tacan system is displayed on the copilot HSI whenever system No. 2 is operating and the copilot NAV SEL switch is in any position except TAC 1, ONS, or INS 2. The miles display goes blank when receiving an unreliable distance signal.

2.21.24.2.8 To-From Indicator. The to-from indicator reflects the direction to or from the VOR or tacan station. The indicator arrow is not visible when a localizer frequency is selected. When the HSI displays INS or ONS data, the to-from indicator reflects the direction to the TO waypoint.

2.21.24.2.9 Bearing Pointer. When VOR is selected, the diamond-shaped pointer displays bearing to the navigational aid. When INS is selected, the INS actual track is read against the azimuth card on the "T" end of the pointer.

2.21.24.2.10 Glideslope Pointer. The glideslope pointer represents the center of the glideslope beam and displays glideslope position above or below the aircraft. When the pointer is above the glideslope scale centerline, the aircraft is below the glideslope. The pointer is in view only when the navigation receiver is tuned to a valid localizer frequency and the FCS 105 is not in the BACK LOC mode.

2.21.24.2.11 INS Annunciator. The INS annunciator appears when the inertial navigation system is the source of navigation data displayed on the HSI.

2.21.24.3 HSI Warning Flags

2.21.24.3.1 Heading Warning Flag. The heading warning flag indicates an unreliable heading signal.

2.21.24.3.2 Navigation Warning Flag. The NAV warning flag indicates an unreliable navigation signal.

2.21.24.3.3 Glideslope (GS) Warning Flag. The GS warning flag indicates an unreliable glideslope signal. The GS flag is out of view except when the navigation receiver is tuned to a localizer frequency and the FCS 105 is not in BACK LOC mode.

2.21.24.4 Flight Selector (FLT SEL) Panels. FLT SEL panels provide separate mode control over the No. 1 and 2 flight computers (see Figure 2-127). Each flight selector panel is configured with solenoid-held pushbuttons (push on, push off) used for flight mode selection. An FCS 105 flight mode can be engaged by depressing the desired mode pushbutton. If the pushbutton remains depressed, the green ON flag at the bottom of the pushbutton appears and the mode is engaged. Depressing an engaged pushbutton again will disengage the flight mode. Light intensity for the pushbutton is controlled through the PILOT CENTER STAND & PILOTS SIDE PANEL lights switch. When a flight mode is engaged, steering commands from the flight computer will be displayed on the corresponding attitude director indicator command bars. The autopilot, if engaged, can be coupled to either of the two flight computers by depressing the AP CPLD pushbutton. Once engaged, the autopilot will accept steering commands from the selected flight computer. HDG and NAV LOC are lateral modes, and APPR is a combination of both lateral and vertical modes. The ALT SEL (altitude preselect), ALT (altitude hold), VS (vertical speed hold), and IAS (indicated airspeed hold) are vertical modes and require prior lateral mode engagement before they will engage. When lateral modes, including go-around, are not engaged, the command bars are out of view, the flight computer is in the off mode, and the autopilot will not couple. Pitch attitude hold steering is provided when a lateral mode is engaged without a vertical mode being selected. The flight selector pushbuttons are described in the following paragraphs.

2.21.24.4.1 AP CPLD. This pushbutton engages the autopilot coupled mode. In this mode, flight computer steering commands for the mode selected will control the autopilot. The flight selector panel on which the pushbutton is depressed determines which flight computer will control the autopilot. Depressing the opposite AP CPLD pushbutton releases the prior pushbutton and transfers control to the opposite computer. Disengaging the autopilot releases the AP CPLD pushbutton.

2.21.24.4.2 HDG. This pushbutton engages the heading select mode. Lateral steering commands are controlled through the HSI heading marker. Maximum bank angle command during this mode is 25°. Depressing the NAV LOC or APPR pushbutton or selecting the go-around mode automatically disengages the HDG pushbutton.

2.21.24.4.3 NAV LOC. This pushbutton engages a lateral NAV mode. In this mode, a lateral steering command is provided to capture and track the NAVAID selected by the NAV SEL switch. Prior to the capture point, heading-select-mode steering is provided. Bank angle commands are limited to 25° during capture. The bank limit during track is 8° for VOR, 30° for INS or ONS, and 15° for localizer. Depressing either the HDG or APPR pushbutton or selecting the go-around mode automatically disengages the NAV LOC pushbutton.

2.21.24.4.4 APPR. This pushbutton engages the approach mode, which is the same as NAV LOC mode, with the addition of glideslope guidance. With ILS selected by the NAV SEL switch, this mode will provide lateral and vertical steering commands to

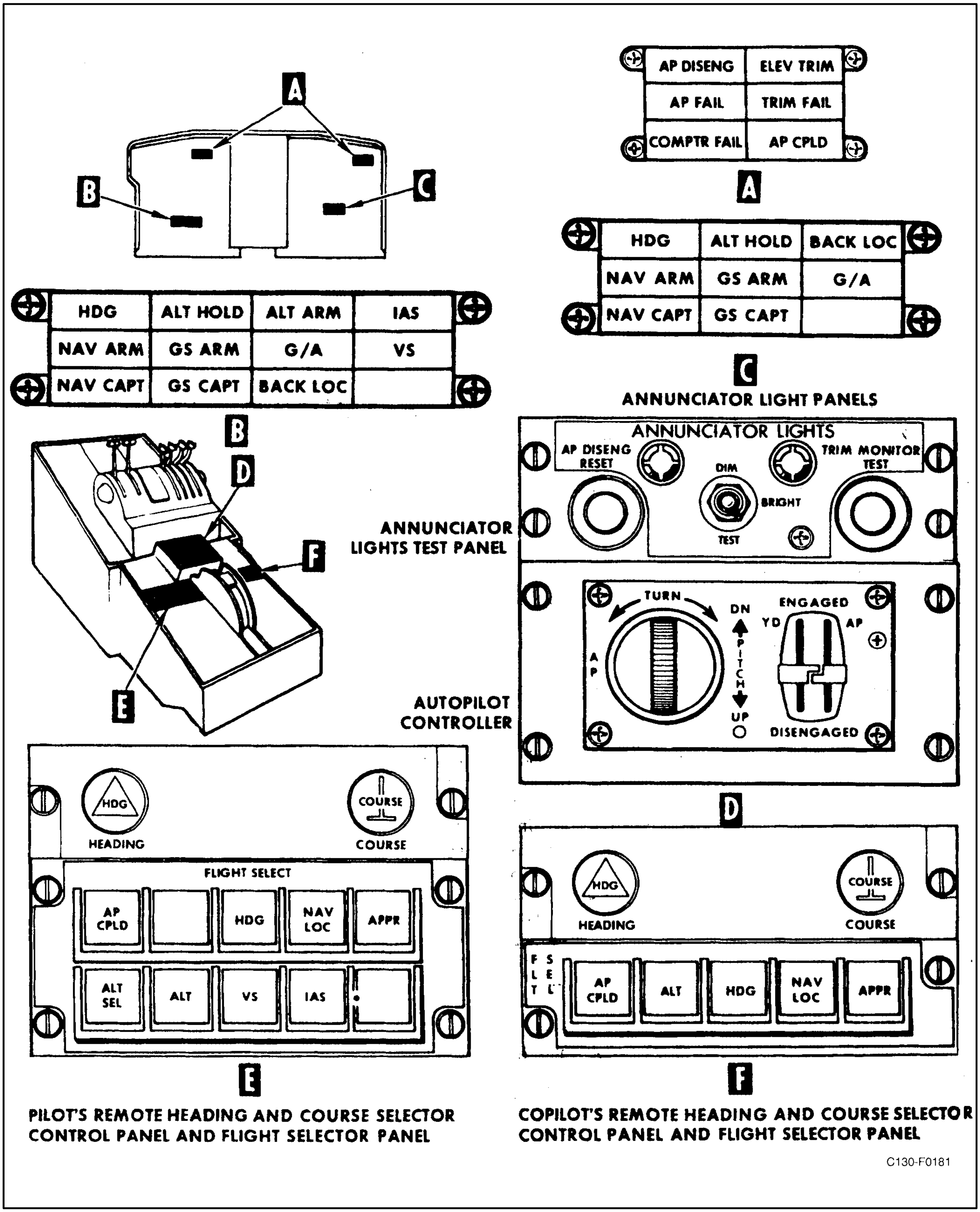


Figure 2-127. Flight Control System Controls and Annunciator Lights

intercept and track localizer and glideslope beams. Prior to localizer capture, heading select mode steering is provided. Unless altitude hold is engaged, pitch attitude hold mode is provided. Bank angle limit during localizer capture is 25°, being reduced to 15° on track. Following glideslope capture, pitch angle commands are limited to 20°. Depressing the HDG or NAV LOC pushbutton or selecting the go-around mode automatically disengages the APPR pushbutton.

2.21.24.4.5 ALT SEL. The altitude preselect mode is functional only on the No. 1 flight computer. In the ALT SEL mode, the flight control system is armed to capture a preselected altitude as set in the altitude alerter/preselect control. In the armed condition, IAS, or VS vertical mode may be selected and flown to capture the selected altitude. The system will remain armed until the preselected altitude is captured. At capture, the ALT HOLD annunciator light illuminates, a smooth transition from either ascent or descent is made, and the desired altitude is maintained. After capture, a new altitude may be selected on the altitude alerter/preselect control and the system will be commanded to ascend or descend to the newly selected altitude. The ALT SEL mode is automatically released when autopilot controller pitch control is moved from the detent.

2.21.24.4.6 ALT. This pushbutton engages the altitude hold mode. Vertical steering commands are provided to maintain pressure altitude present when the pushbutton was depressed. This mode disengages if the existing lateral mode is disengaged, glideslope capture during ILS occurs, go-around mode is engaged, or the pitch control is moved out of detent prior to glideslope capture with the autopilot coupled to the flight computer.

2.21.24.4.7 VS. The vertical-speed hold mode is functional only on the No. 1 flight computer. In the VS hold mode, the flight computer uses pitch attitude and a vertical-speed error signal to generate steering commands. These steering commands are to maintain the vertical speed at which the VS mode was selected. The VS mode is automatically released when the glideslope is captured, another vertical mode is selected, or when the flight control system is engaged and coupled and the autopilot controller pitch control is moved out of the detent.

2.21.24.4.8 IAS. The IAS hold mode is functional only on the No. 1 flight computer. In the IAS hold mode, the flight computer uses pitch attitude and an indicated airspeed error signal to generate vertical steering commands. These steering commands are to maintain the indicated airspeed at which the IAS mode was selected. The IAS mode is automatically released at glideslope capture, when another vertical mode is selected, or when the flight control system is engaged and coupled and the autopilot controller pitch control is moved out of the detent.

2.21.24.5 Aircraft Control Wheels. Located on the outboard side of the pilot and copilot, control wheels contain a sync (SYN) pushbutton and a go-around (G/A) pushbutton (see Figure 2-46).

2.21.24.5.1 SYNC (SYN) Pushbutton. The SYN pushbutton is primarily used as an attitude-director indicator function. Its secondary function is to provide synchronized control wheel steering with the basic autopilot engaged. Each pushbutton separately affects its respective flight computer only. Pressing a pushbutton when the autopilot is disengaged synchronizes the ADI pitch command bars with the aircraft attitude. When the sync pushbutton is released, the command bar is referenced to the aircraft attitude at the moment of release. If agreement between the pilot and copilot ADI is desired, both sync pushbuttons must be activated at about the same time, or the second one must be activated when the first command bar is aligned with the aircraft symbol. Pressing a pushbutton during autopilot operation allows the aircraft to be manually flown to the desired attitude without disengaging the basic autopilot. Upon actuation, the autopilot coupled and any coupled vertical flight mode will be disengaged. When the sync pushbutton is released, the autopilot coupled and any desired vertical flight mode must be reengaged. If the flight computer is in the APPR mode, pressing the SYN pushbutton will have no effect after glideslope capture.

2.21.24.5.2 Go-Around (G/A) Pushbutton. Go-around is selected by pressing the G/A pushbutton on either control wheel. Actuating either pushbutton disengages the autopilot, releases all mode pushbuttons on the flight selector panel, and provides signals from the flight computer to the command bars for a wings-level, 7° pitchup attitude. The autopilot may then be reengaged, if desired.

2.21.24.6 Autopilot Controller. The autopilot controller contains the yaw damper (YD) and autopilot (AP) engage levers and autopilot turn and pitch controls (see Figure 2-127). Placing the engage levers to ENGAGED couples the flight control system rudder, aileron, and elevator servos to the aircraft main surface control-cable system. Autopilot engagement also maintains automatic pitch trim through the elevator trim tab system.

2.21.24.6.1 Engage Lever. The engage lever is a dual section lever having two positions: ENGAGED and DISENGAGED. This solenoid-held lever is spring loaded to the DISENGAGED position. The lever is mechanically designed such that the autopilot cannot be engaged without yaw damper engagement. However, the yaw damper may be engaged independent of the autopilot lever. (Pilot-initiated autopilot disengagement will release the levers from the solenoid-held ENGAGED position.) Automatic release occurs if selected attitude reference failure is detected, failure of the servo motors is detected, system power is lost, manual elevator trim is attempted, or the ELEV TAB power selector switch is moved from the NORMAL position. The engage lever is the master disconnect for both systems.

WARNING

On aircraft 165313 and up when disengaging the autopilot system using the control wheel elevator trim (ELEV TRIM) switches, you must manually select the yaw damper (YD) switch to DISENGAGE prior to landing. Failure to ensure yaw damper disengagement may cause significant resistance to pilot-initiated rudder pedal inputs with loss of normal control authority, damage to the aircraft and injury to personnel. Normal use of the AP disconnect switches will disengage both the autopilot and yaw damper switches.

When the autopilot engage lever is in the ENGAGED position, elevator tab control is transferred from the pilot to the autopilot, allowing the autopilot to automatically maintain pitch trim and preventing abrupt elevator movements when the autopilot is disengaged.

2.21.24.6.2 PITCH Control. When the autopilot is engaged and not coupled, the PITCH control supplies pitch commands to the autopilot system. The PITCH control supplies a pitch rate command that increases in proportion to control displacement from the center detent. Pitchdown is commanded when the control is rotated forward toward DN, and pitchup is commanded when the control is rotated aft toward UP. The pitch control is spring loaded to a center detent. When engaged, the autopilot maintains the aircraft pitch attitude that exists when the control is returned to the detent.

Moving the PITCH control out of the detent with the autopilot coupled causes the altitude hold (ALT), altitude preselect (ALT SEL), indicated airspeed hold (IAS), and vertical speed hold (VS) modes to release, placing the autopilot and flight computer in the pitch hold mode. The PITCH control is disabled by glide-slope capture.

Note

Refer to paragraph 2.21.24.4 for operation of the attitude select switches.

2.21.24.6.3 TURN Control. When the autopilot is engaged, the TURN control supplies bank command to the autopilot system. It is a roll-rate command that increases in proportion to the TURN control displacement from the center detent. The TURN control is also spring loaded to a center detent. Rotating the TURN control out of detent with the autopilot coupled causes all mode pushbuttons of the respective flight selector to release. Bank-angle limit during turn control operation is 30°. When the aircraft bank attitude is greater than 2° and the TURN control is returned to the center detent, the autopilot holds bank attitude. When the aircraft bank attitude is less than 2° and the control is returned to the detent, the autopilot remains in heading hold.

2.21.24.7 Autopilot Release Switch. An autopilot release pushbutton switch is installed on both the pilot and copilot control wheels. Pressing either one of the pushbutton switches releases the AP and YD switches, allowing them to return to the DISENGAGED position, disconnecting the servos from each axis.

WARNING

On aircraft 165313 and up when disengaging the autopilot system using the control wheel elevator trim (ELEV TRIM) switches, you must manually select the yaw damper (YD) switch to DISENGAGE prior to landing. Failure to ensure yaw damper disengagement may cause significant resistance to pilot-initiated rudder pedal inputs with loss of normal control authority, damage to the aircraft and injury to personnel. Normal use of the AP disconnect switches will disengage both the autopilot and yaw damper switches.

2.21.24.8 AP Disengage Reset Switch. The AP DISENG RESET pushbutton switch is located on the annunciator lights test panel (see Figure 2-127). This pushbutton switch extinguishes the AP DISENG annunciator light.

2.21.24.9 Remote Heading and Course Selector Control Panel. The remote heading and course selector control panels are located on the flight control pedestal (see Figure 2-127). The HDG and COURSE knobs on each panel position the heading marker and course arrow on the respective HSI.

2.21.24.10 System Annunciator Lights. There are four annunciator light panel assemblies, two annunciator warning or advisory light panels, and two flight selector mode annunciator panels. One of each of these panels is located on the pilot instrument panel and one each on the copilot instrument panel (see Figure 2-127). The warning or advisory annunciator lights are as follows:

1. AP DISENG (amber) — Illuminates when the autopilot is disengaged.

2. AP FAIL (red) — Illuminates when monitoring system indicates gyro, power, servo, or internal failure.

3. COMPTR FAIL (red) — Illuminates whenever flight computer or mode input fails. Indicates that the flight selector panel or failed mode must not be used. Attitude information is still supplied to the ADI and autopilot for basic gyro mode, provided failure was not because of the gyro.

4. ELEV TRIM (amber) — The elevator servo is sensing an out-of-trim condition. Pilot should expect to see elevator trim moving to satisfy the trim requirements, at which time the light will extinguish.

5. TRIM FAIL (red) — Illumination indicates the monitoring system is sensing a trim system failure. The pilot should anticipate an out-of-trim condition upon disengagement of the autopilot.

6. AP CPLD (green) — Illuminates on pilot panel when autopilot is coupled to the No. 1 flight computer and on copilot panel when coupled to the No. 2 flight computer.

The flight-selector-mode annunciator lights are illuminated to indicate the following:

1. HDG (green) — Bank command is responding to heading marker selection on HSI.

2. ALT HOLD (green) — Pitch command is responding to barometric altitude existing at time of ALT HOLD engagement.

3. BACK LOC (green) — Back localizer mode active in NAV LOC. Glideslope pointer and flag are biased out of view. If APPR is engaged, GS pointer and flags are biased out of view and GS ARM and GS CAPT annunciator lights are inhibited.

4. NAV ARM (white) — System is set up (armed) for a capture of set course.

5. NAV CAPT (green) — Capture of set course has been initiated.

6. GS ARM (white) — System is set up (armed) for a capture of glideslope.

7. GS CAPT (green) — Glideslope capture has been initiated.

8. G/A (green) — The flight computer is in the go-around mode.

9. ALT ARM (white) — System is armed to capture a preselected altitude. Pitch command is responding to pitch attitude existing at time of ALT SEL engagement.

10. VS (green) — System is using pitch attitude and a vertical speed error signal to generate steering commands.

11. IAS (green) — System is using pitch attitude and an indicated airspeed error signal to generate vertical steering commands.

2.21.24.11 ANNUNCIATOR LIGHTS Test Switch. The annunciator lights test switch is located on the pedestal (see Figure 2-127). This three-position switch has TEST, BRIGHT, and DIM positions.

2.21.24.12 TRIM MONITOR TEST Switch. The TRIM MONITOR TEST switch is located on the pedestal (see Figure 2-127). This switch is used to test the autopilot automatic trim circuitry and annunciator lights. The test must be performed while the aircraft is on the ground.

2.21.24.13 NAV SEL Switches. There are two navigation selector control panels (see Figure 2-128) located on the pilot and copilot instrument panel. Each panel contains a NAV SEL switch. The multiposition NAV SEL switches are provided to connect a navigation system to the HSIs and the flight control system computers. Seven positions (OMEGA, OMEGA INS 3, INS 1 (pilot), INS 2 (copilot), TAC 1, TAC 2, VOR/ILS 1, VOR/ILS 2, ARA-63) are available on the pilot and copilot switches.

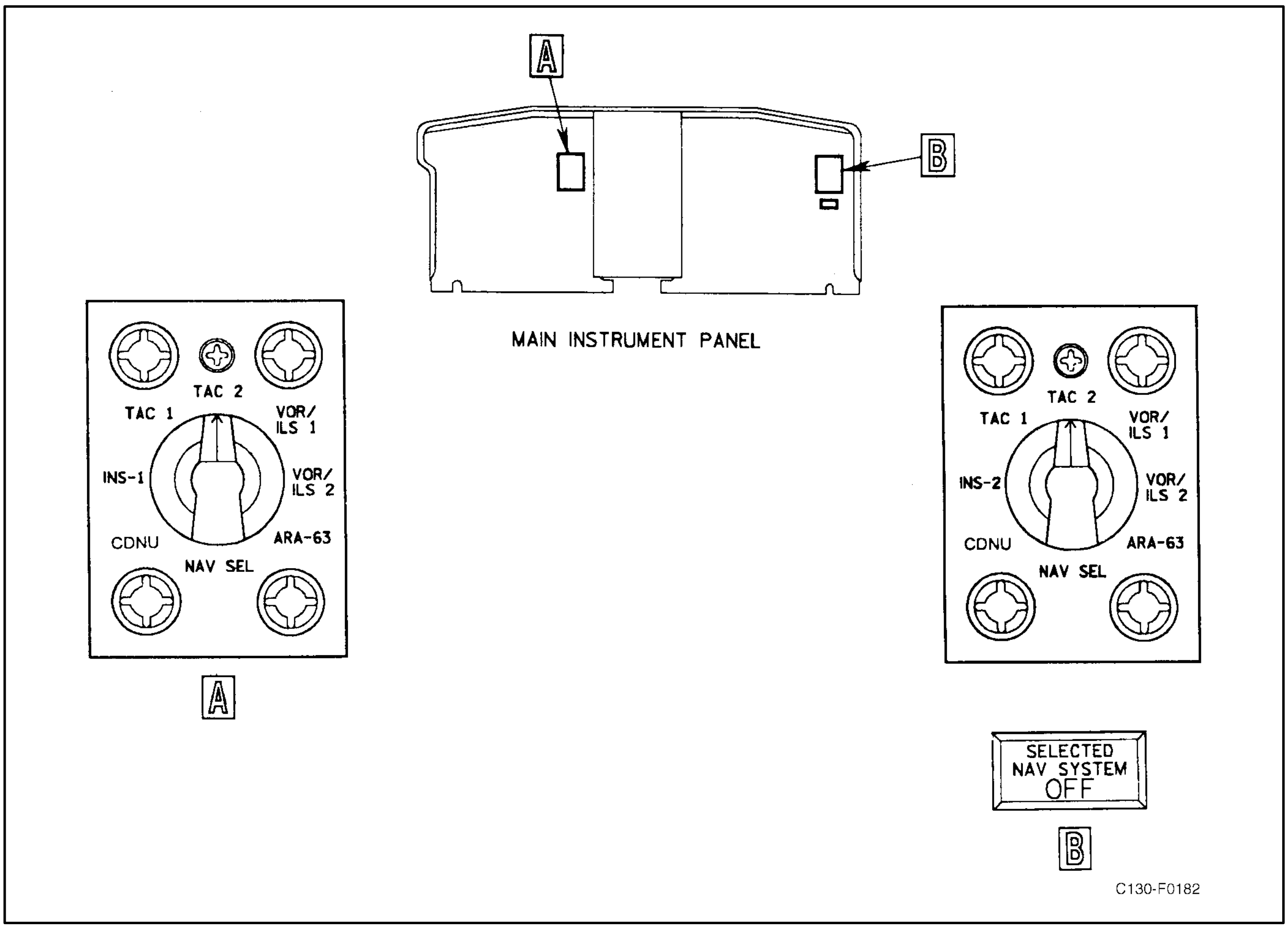


Figure 2-128. Navigation Selector Control Panels

2.21.24.13.1 NAV SEL Switch Modes of Operation

a. INS Selection. When INS 1 (pilot) or INS 2 (copilot) or INS 3 (if installed) is selected with the corresponding NAV SEL switch, information from the INS is provided to the flight control system (FSC 105). The course arrow is controlled by the INS computer to display desired track information. The course deviation indicates cross-track displacement with full scale (2 dots) being equivalent to 7.5 nm. The azimuth card displays true heading (or magnetic heading when variation is inserted into the INS) from the INS, and the to-from indicator reflects direction to the set waypoint. With the NAV LOC pushbutton on the flight selector panel depressed, the flight computer is placed in the INS NAV mode and produces guidance commands to capture and maintain the desired track. Two minutes prior to a waypoint the alert annunciator on the CDU illuminates. If the function selector switch on the CDU is in AUTO, the INS automatically switches from the present track to the next track at a computed point prior to reaching the waypoint. When this occurs, the new course is displayed on the HSI, the alert annunciator extinguishes, and a guidance command is produced to capture and maintain the new track. If the function selector is in MAN, automatic switching does not occur and the command is along the extended desired track beyond the waypoint. The alert annunciator light begins to flash 30 seconds prior to reaching a waypoint and continues to flash until the operator initiates a track change.

b. TAC 1, TAC 2 (Tacan) Selections. With the NAV SEL switch in TAC 1 or TAC 2 and the FLT SEL switch in NAV LOC, the associated flight computer will be in the NAV LOC mode after capture of the set course (NAV CAPT), using information from the selected tacan system that is tuned to the desired station. The course arrow on the associated HSI is set to the selected tacan radial to supply a course-error signal (difference between aircraft heading and set course) to the flight computer and to resolve the signals from the tacan receiver. The flight computer combines course-error input with course deviation and bank angle to produce a steering command for display on the ADI command bars and for use by the autopilot if coupled. This command will provide an asymptotic intercept after capture of the set course (NAV CAPT). Once on course it will be maintained. When overstation is sensed, bank commands because of course deviation are minimized and course changes can be made to intercept the new outbound course. The computer warning flag remains out of view as long as the computer functions properly and is receiving valid information. All other flags in the ADI remain out of view. Information displayed on the HSI consists of course deviation on the course deviation bar, distance to the station on the miles display, and ambiguity on the to-from indicator. The outer mark (dot) on course deviation scale is equal to 10. The NAV warning flag remains out of view while a valid signal from the tacan set is maintained.

c. VOL/ILS Selection. With the NAV SEL switch in VOR/ILS I or VOR/ILS 2, and the FLT SEL switch in NAV LOC, the flight computer will be in the NAV LOC mode when the corresponding NAV receiver is tuned to a VOR or localizer frequency. When the NAV receiver is tuned to a VOR frequency, information displayed on the HSI and the ADI is the same as described for tacan. Distance information is not available unless tacan is tuned and DME is valid. When the NAV receiver is tuned to a localizer frequency, the NAV SEL switch is in VOR/ILS 1 or VOR/ILS 2, and the FLT SEL switch is in APPR, the flight computer selects the ILS mode. The flight computer now uses information from the localizer and glideslope receivers. The course arrow on the HSI must be set to the inbound localizer course. The ADI runway flag uncovers the runway symbol as long as valid information is being received and the navigation receiver and radar altimeter are functioning properly. The glideslope warning flag remains out of view as long as valid information is being received and the glideslope receiver is functioning properly. Localizer deviation is displayed by the course deviation bar on the HSI and by the runway symbol on the ADI. No ambiguity information is available. The glideslope pointer continues to give glideslope deviation. The flight computer produces the necessary steering commands to the ADI command bars and autopilot to intercept and track the localizer and glideslope beam centers. If the autopilot is coupled, the aircraft will be controlled automatically by the autopilot. The point for start of localizer capture is variable depending on the intercept angle, rate of closure on beam center, and course deviation. Once this point is reached, the flight computer combines course error, localizer deviation, and bank angle to capture and then maintain beam center. Glideslope capture occurs at a fixed glideslope deviation and can be accomplished from above or below the beam. When the capture point is reached, a pitch up or down command is produced. Once the glideslope is captured, the flight computer uses the glideslope deviation, normal acceleration, and pitch angle to command a pitch attitude to maintain beam center. The glideslope signal is desensitized as a function of radar altitude or marker beacon to reduce the effects of beam narrowing, noise, and bends.

d. ARA-63 Selection. With the NAV SEL switch in the ARA-63 position, the attitude director indicator command bars will display lateral and vertical deviations from the optimum approach line.

e. CDNU Selection. When CDNU is selected with the NAV SEL switch, information from the CDNU is provided to the flight control system (FSC-105) and HSI. The course arrow is controlled by the CDNU to display desired track information and distance to the next waypoint will be displayed. Full scale displacement on the course deviation indicator will be determined by the flight mode. The flight mode is set via the CDNU expanded FPLN page and displayed on the annunciator panel. Maximum deviations for each mode are as follows:

1. EN ROUTE mode — Full scale deflection on the HSI equals 4.0 nm. NAV invalid flag will appear on HSI if GPS estimated horizontal error (EHE) exceeds 1000 meters.

2. TERMINAL mode — Full scale deflection on the HSI equals 1.0 nm. NAV invalid flag will appear on HSI if GPS EHE exceeds 500 meters.

3. APPROACH mode — Full scale deflection on the HSI equals .3 nm. NAV invalid flag will appear on HSI if GPS EHE exceeds 100 meters.

The HSI azimuth card will display either true or magnetic heading based on the reference source selected on the CDNU INAV RNAV page and the to-from indicator will point in the direction of the set waypoint. With the NAV LOC pushbutton on the flight selector panel depressed, the flight computer produces guidance commands to maintain the desired track. Upon passing a waypoint, sequencing to follow-on waypoints is automatically controlled by the CDNU and new track, distance, and guidance commands to capture and maintain the new track are displayed on the HSI.

2.21.24.14 Pointer Selector Switch. Pointer selector switches, located on the pilot and copilot instrument panels and on the navigator instrument panel, are provided to permit selection of the source of information to be displayed on BDHIs. The pilot and copilot can selectively direct VOR 1 or VOR 2 information on the No. 1 pointer of the VOR/TAC BDHI located on their respective instrument panels; the navigator can selectively direct TAC 1 or ADF 2 information to the No. 2 pointer on the ADF/TAC BDHI or can selectively direct VOR 2 or TAC 2 information to the No. 2 pointer of the VOR/TAC BDHI.

2.21.24.15 SELECTED NAV SYSTEM OFF Indicator. The SELECTED NAV SYSTEM OFF indicator, located on the copilot instrument panel, will illuminate to indicate that the copilot selection with his NAV SEL switch has been disconnected (see Figure 2-128). Selection of a VOR/ILS, TAC, ARA-63, or Omega/INS 3 mode by the copilot will be disconnected if the pilot selects the same mode of operation. For INS mode, the pilot selects No. 1 and the copilot No. 2 exclusively. The SELECTED NAV SYSTEM OFF indicator is powered through the circuit breaker associated with the system selected by the pilot and is affected by the interlock relays of both the pilot and copilot NAV SEL switches.

2.21.24.16 Operational Checkout of the FCS 105 Flight Control System

CAUTION

As the autopilot is engaged, hold the control wheel and rudder pedals to cushion rapid movement against the limit stops. Accomplish the checks with autopilot engaged as rapidly as practical to avoid servo overheating.

Note

Copilot AC INST switch and the ELEV TAB power switch must be in the NORMAL position. If the G/A annunciator light(s) is illuminated, press the SYN pushbutton on the corresponding control wheel to extinguish the light.

1. Check flight control system annunciator lights in TEST.

2. Test both attitude director indicators. Check that the attitude display indicates a change of 10° ±3°

pitchup and 20° ±5° right bank, and that the gyro warning flag comes into view.

3. Set both heading markers to the lubber line.

4. Center all flight controls.

5. Engage autopilot.

6. Relax centering force on column. Observe that elevator trim tab is driving nose up and both ELEV TRIM annunciator lights are illuminated.

7. Slowly exert a back force on the control column until a nosedown trim direction is observed; hold this column position. Press and hold the TRIM MONITOR TEST switch. Check that the TRIM FAIL warning annunciator light starts flashing, the ELEV TRIM annunciator light remains illuminated, and the elevator trim tab begins driving in the noseup direction. Release TRIM MONITOR TEST switch and observe that the TRIM FAIL light extinguishes, the ELEV TRIM light remains illuminated, and the elevator trim tab again moves in the nosedown direction. Relax back force until the control column is centered.

8. Depress HDG and ALT pushbutton on both FLT SEL panels. Depress AP CPLD pushbutton on No. 1 FLT SEL panel. Check that the pilot AP CPLD annunciator light illuminates. Check that the pilot and copilot HDG and ALT HOLD annunciator lights illuminate.

9. Move pilot and copilot heading markers 5° right of the lubber line. Check that the control wheel turns right and both ADI command bars indicate right bank command. Return both heading markers to lubber line.

10. Depress AP CPLD pushbutton on No. 2 FLT SEL panel. Check that the copilot AP CPLD annunciator light illuminates and the pilot AP CPLD annunciator extinguishes.

11. Move pilot and copilot heading markers 5° left of the lubber line. Check that the control wheel turns left and both ADI command bars indicate a left bank command. Return both heading markers to the lubber line.

12. Depress the pilot G/A pushbutton. Check the following:

    a. The YD and AP switches move to the DISENGAGED position.

    b. The pilot command bars indicate a 7° pitchup command above zero attitude reference.

    c. The pilot G/A annunciator light illuminates.

    d. Both AP DISENG annunciator lights illuminate.

    e. HDG and ALT hold annunciator lights extinguish.

13. Depress the pilot SYN pushbutton. The G/A annunciator light will extinguish and the pilot command bars will be removed from view.

14. Engage the autopilot.

15. Repeat steps 12 and 13 substituting the word “copilot” for “pilot.”

16. Engage the autopilot and depress the HDG, ALT, and AP CPLD pushbuttons on No. 1 FLT SEL panel. Slowly rotate the autopilot pitch control toward UP. After aft-column movement, rotate the autopilot pitch control toward DN. Center column with the autopilot pitch control. Check that the ALT HOLD annunciator light is extinguished.

17. Slowly rotate autopilot turn control to the right. After right control wheel movement is observed, rotate autopilot turn control left past the center detent. After control wheel rotates left past center, check that HDG and AP CPLD annunciator lights are extinguished.

18. Depress pilot autopilot release switch. The AP and YD switches will move to the DISENGAGED position and the AP DISENG annunciator lights will illuminate.

19. Engage the autopilot.

20. Repeat step 18 using copilot release.

21. Depress the AP DISENG reset switch and check that the AP DISENG annunciator light extinguishes.

22. Zero the elevator trim tab.

2.21.24.17 Normal Operation of the FCS 105 Flight Control System

WARNING

Do not operate with the autopilot engaged during takeoff and landing or at gross weights above 155,000 pounds. During ILS coupled approach, do not operate with the autopilot engaged below 200 feet AGL.

The autopilot may be used for four- or three-engine operation during climb, cruise, and descent. Three-engine coupled approaches are not recommended. The autopilot is capable of intercepts up to 90° (75° during course ILS), but to enhance intercept performance a maximum of 45° is recommended.

Before engaging the autopilot:

1. Ensure that all flight control system circuit breakers are in.
2. Ensure that the No. 1 compass and flight control system attitude reference are operating properly.
3. Ensure that the ELEV TAB power selector switch is in the NORMAL position.
4. Trim the aircraft for straight-and-level flight.

Engaging basic autopilot:

1. Position the YD and AP switches to ENGAGED.

Note

Do not press the pilot ADI test pushbutton with the autopilot engaged. Pressing the pilot ADI test pushbutton may cause a slight autopilot roll reaction of momentary duration.

2. Maneuver the aircraft with the AP pitch and turn knobs on the autopilot controller.

CAUTION

Disengage autopilot and yaw damper prior to switching attitude reference.

2.21.24.17.1 Autopilot Coupled (AP CPLD). The basic autopilot can be coupled to either of the two flight computers for automatic lateral and vertical guidance in a selected flight mode. Coupling occurs with selection of AP CPLD on one of the respective FLT SEL panels after any lateral mode is engaged.

2.21.24.17.2 Selected Heading (AP CPLD)

1. Engage the basic autopilot.
2. Set the heading marker on the HSI to the aircraft heading with the heading control knob.
3. Depress the HDG pushbutton, then the AP CPLD pushbutton on the FLT SEL panel. The HDG and AP CPLD annunciator lights illuminate.
4. For aircraft heading control, set the desired heading on the HSI heading marker. The autopilot will turn to and maintain the set heading. The bank angle is limited to 25° during selected heading mode.

2.21.24.17.3 VOR or Tacan Navigation (AP CPLD)

1. Engage the basic autopilot.
2. Tune the VHF NAV or tacan receiver to the correct frequency and select VOR/ILS or TAC with the NAV SEL switch.
3. Set the desired course on the HSI with the course control knob and set the heading marker to the desired intercept heading with the HDG control knob.
4. Depress the NAV LOC pushbutton, then the AP CPLD pushbutton on the FLT SEL panel. The HDG, NAV ARM, and AP CPLD annunciator lights illuminate and the aircraft will assume the selected intercept heading.
5. When the capture point is reached, the aircraft turns to capture the desired course. The HDG and NAV ARM annunciator lights extinguish and the NAV CAPT annunciator light illuminates. The bank angle limit during capture is 25°.
6. Once on course, the maximum bank produced by course deviation is 8°. When passing over a VOR or tacan station, this limit is further reduced to 3°.

However, if a course change is made during overstation, a full bank angle may be obtained since the bank limit caused by course error is 25°.

7. To initiate a new capture or manually place the system on course, depress the HDG pushbutton on the FLT SEL panel, set the heading marker to the new intercept heading, then depress the NAV LOC pushbutton.

2.21.24.17.4 INS Navigation (AP CPLD). To establish the aircraft on a desired track, perform the following:

1. Engage the basic autopilot.

2. With the INS set up to provide track information, place the CDU function selector switch to the AUTO position.

3. Place the NAV SEL switch to the INS position. Observe proper HSI presentation.

4. Set the HSI heading marker to aircraft heading, using the HDG knob on the remote heading and course selector control panel.

5. Depress NAV LOC pushbutton on the FLT SEL panel. The NAV ARM and HDG annunciator lights illuminate, indicating that the system is armed for navigation capture.

6. Depress the AP CPLD pushbutton on the appropriate FLT SEL panel and observe that the AP CPLD annunciator light illuminates. Set intercept angle with the heading marker.

7. When capture is initiated, the NAV ARM and HDG annunciator lights extinguish and the NAV CAPT annunciator light illuminates. Once capture occurs, the steering is provided directly from the INS through the flight computer. This INS-generated steering signal is bank limited at 30°.

8. Two minutes before reaching a waypoint, the alert annunciator legend will illuminate. At 30 seconds prior to reaching a waypoint, the to-from display will change to the next set of waypoints. When this occurs, the ALERT annunciator legend extinguishes and the change is displayed on the HSI.

2.21.24.17.5 Altitude Preselect (AP CPLD)

1. Engage basic autopilot.

2. Set the altitude alerter/preselect control at the desired altitude.

3. Select a lateral mode and depress the ALT SEL pushbutton on the No. 1 FLT SEL panel. The ALT ARM annunciator light illuminates and the command bars will display the command to ascend or descend to capture the preselected altitude.

4. Depress the AP CPLD pushbutton on the No. 1 FLT SEL panel.

5. When the preselected altitude is captured, the ALT HOLD annunciator light illuminates. Depress the ALT pushbutton. The ALT ARM annunciator light will extinguish and the ALT HOLD annunciator light remains illuminated.

2.21.24.17.6 Altitude Hold (AP CPLD)

1. Engage basic autopilot.

2. Select a lateral mode and depress the ALT pushbutton on the FLT SEL panel. The command bars will display the command to maintain the altitude at the time of selection.

3. Depress the AP CPLD pushbutton on the FLT SEL panel.

2.21.24.17.7 Indicated Airspeed Hold (AP CPLD)

1. Engage basic autopilot.

2. Select a lateral mode and depress the IAS pushbutton on the No. 1 FLT SEL panel. The command bars will display the vertical steering command to maintain the airspeed at which the IAS mode was selected.

3. Depress the AP CPLD pushbutton on the No. 1 FLT SEL panel.

2.21.24.17.8 Vertical Speed Hold (AP CPLD)

1. Engage basic autopilot.

2. Select a lateral mode and depress the VS pushbutton on the No. 1 FLT SEL panel. The command

bars will display the vertical steering command to maintain the vertical speed at which the VS mode was selected.

3. Depress the AP CPLD pushbutton on the No. 1 FLT SEL panel.

2.21.24.17.9 ILS Approach (AP CPLD)

1. Tune and identify localizer station on both VHF NAV receivers.

2. Place the NAV SEL switch to VOR/ILS 1 on the pilot navigation selector control panel and VOR/ILS 2 on the copilot navigation selector control panel.

3. Set the course arrows on the HSIs to the published localizer inbound course.

4. Set decision height on the radar altimeter indicator.

5. Set HSI heading markers to aircraft heading. Depress the HDG pushbutton on the FLT SEL panels. The HDG annunciator lights will illuminate.

6. Engage the basic autopilot and depress the AP CPLD pushbutton on the No. 1 or No. 2 FLT SEL panel. The AP CPLD annunciator light on the side selected will illuminate.

7. Depress the ALT pushbutton on the FLT SEL panels when constant altitude is to be maintained. The ALT HOLD annunciator lights will illuminate.

8. Depress the VS or IAS pushbutton on the No. 1 FLT SEL panel when constant vertical speed or constant indicated airspeed is to be maintained. The VS or IAS annunciator light will illuminate as selected.

9. Use the heading marker to fly the aircraft to the desired intercept angle. Depress the NAV LOC pushbutton on the FLT SEL panels. The NAV ARM annunciator lights will illuminate.

10. The aircraft assumes and maintains intercept heading until the capture point is reached, then turns to capture the localizer course. The NAV ARM and HDG annunciator lights extinguish and the NAV CAPT annunciator lights illuminate. Once established on localizer course, bank angle is limited to 15°.

11. Prior to capture of glideslope, depress the APPR pushbutton on the FLT SEL panels. The GS arm annunciator lights illuminate.

12. After glideslope capture, monitor ILS progress on the ADI and HSI. The GS CAPT annunciator lights illuminate, and the ALT HOLD and GS ARM annunciator lights extinguish.

13. Disengage the autopilot when normal landing is to be executed (no lower than 200 feet AGL).

Note

The ADI command bars should be utilized to monitor the approach; however, the glideslope pointers and course deviation bars will be utilized as primary indication for aircraft position when flying ILS.

2.21.24.17.10 Back-Course Localizer (AP CPLD)

1. Engage the basic autopilot.

2. Tune and identify localizer station on both VHF NAV receivers.

3. Place the NAV SEL switch to VOR/ILS 1 on the pilot navigation selector control panel and VOR/ILS 2 on the copilot navigation selector control panel.

4. Set the course arrow on the HSIs to the published localizer inbound front course.

5. Set minimum descent altitude on the radar altimeter indicator.

6. Set HSI heading markers to aircraft heading. Depress the HDG pushbutton on the FLT SEL panels. The HDG annunciator lights illuminate.

7. Depress the AP CPLD pushbutton on No. 1 or No. 2 FLT SEL panel. The AP CPLD annunciator light on the side selected illuminates.

8. Depress the ALT pushbutton on the FLT SEL panels when constant altitude is to be maintained.

The ALT HOLD annunciator lights will illuminate.

9. Use heading marker to fly aircraft to the desired intercept angle.

10. After established on intercept heading, depress the NAV LOC pushbutton on the FLT SEL panels. The BACK LOC annunciator lights will illuminate.

Note

When the BACK LOC annunciator light illuminates, the glideslope pointers and warning flags will be removed from view.

11. After capture has been initiated, all localizer indications will be the same as a normal ILS. Set heading markers to back course.

12. Disengage altitude hold and use the autopilot pitch control on the autopilot controller to establish and maintain desired rate of descent.

Note

After disengaging ALT HOLD, all pitch indications on command bars are referenced to a fixed pitch attitude as in paragraph 2.21.24.17.2.

13. Disengage the autopilot at no lower than 200 feet AGL or before flying over the localizer transmitter.

Note

It is recommended that the HDG mode be used when flying over the localizer transmitter because of large radio deviations.

2.21.24.17.11 Disengaging the Autopilot. Autopilot control is normally discontinued by either of the following actions:

1. Depressing the pilot or copilot autopilot release switch pushbutton.

2. Placing the YD and AP switches to the DISENGAGED position.

In addition, the autopilot may be disengaged by any of the following methods:

1. Positioning the ELEV TAB power selector switch out of the NORMAL position.

2. Actuating the ELEV TAB switch on the pilot or copilot control wheel.

3. Pulling the AUTOPILOT circuit breaker.

4. Depressing the pilot or copilot G/A pushbutton.

2.21.24.17.12 Attitude Director Indicator (Autopilot Disengaged). The ADI command bars display steering guidance that can be used by the pilot to control the aircraft manually during takeoff, initial climb, cruise navigation modes, ILS approaches, and go-around maneuver. To satisfy the commands, the aircraft must be maneuvered so that the aircraft symbol is flown into the command bars until they are in alignment.

2.21.24.17.13 Cruise Modes (NAV LOC). The procedures and results using the ADI command bar steering during cruise navigation modes are the same as the autopilot, except the autopilot is disengaged and the pilot controls the aircraft to maintain command bar alignment with aircraft symbol.

2.21.24.17.14 ILS Approach. The procedures for use of the ADI during ILS operation are the same as autopilot, including indications, except the autopilot is disengaged and the pilot controls the aircraft to maintain command bar alignment with aircraft symbol during the approach.

Note

The ADI command bars should be utilized to fly the approach; however, the glideslope pointers and course deviation bars will be utilized as primary indicators for aircraft position when flying ILS.

2.21.24.17.15 Back-Course Localizer. The procedures for use of the ADI during back-course localizer operation are the same as autopilot, including indications, except the autopilot is disengaged and the pilot controls the aircraft to maintain command-bar alignment with aircraft symbol during the approach.

Note

After disengaging the altitude hold mode, all pitch indications on command bars are referenced to a fixed pitch attitude as in paragraph 2.21.24.17.2.

2.21.24.18 Go-Around

Note

If the flaps fail to retract to 50 percent at initiation of go-around, do not activate the go-around mode. Manually establish the desired climb.

The go-around mode can be engaged by depressing the G/A pushbutton switch on the control wheel.

1. G/A pushbutton — Depressed.

2. Fly aircraft symbol into command bars. Command bars will command wings level and 7° nose up.

3. If desired, depress the HDG pushbutton on the FLT SEL panel. The command bars will command bank angles necessary to follow the heading marker, but the pitch bars will remain at 7° nose up.

The go-around mode can be disengaged by depressing the SYN pushbutton switch on the control wheel. However, if this is done before step 3 above, the command bars will be biased out of view.

Note

Depressing either G/A pushbutton will disengage the autopilot. The corresponding ADI command bars will display go-around command steering, but the other ADI will not change from the previously selected mode.

2.21.24.18.1 SYNC. To maintain a fixed pitch attitude after a pitch attitude change, depress and release the SYN pushbutton on the control wheel and fly the aircraft symbol into the command bars.

Note

Depressing and releasing the SYN pushbutton only affects the corresponding ADI display and will not disengage the autopilot. Pitch sync is inoperative after glideslope capture.

2.21.25 LTN-72/LN-100 Inertial Navigation System. Two INS are installed on the aircraft. A third system (No. 3 INS) may be installed. The INS is a self-contained navigational aid that provides accurate navigation and position determination anywhere on the Earth, in any weather, without the aid of ground-based equipment. Each INS consists of the following units: inertial navigation unit, inverter, mode selector unit, control display unit, and switches and indicators. The INS provides steering information to the FCS 105 flight control system for autopilot automatic control and ADI manual control using the indicator command bar lateral steering. Search mode capability is also available. Position and heading information are also provided for display on the HSI. Navigation signals from the No. 1 INS are displayed on the pilot ADI and HSI. Navigation signals from the No. 2 INS are displayed on the copilot ADI and HSI. Navigation signals from the No. 3 INS, if installed, can be displayed on either the pilot or copilot ADI and HSI. The LN-100 INS can be set up to use GPS velocity and position data for in-flight alignment (IFA) or for automatic position, velocity, and bias updating in NAV mode. The INS is supplied with 115-Vac power from the essential ac bus through INERTIAL NAV SYS NO. 1 AND NO. 2 circuit breakers on the copilot upper circuit breaker panel. Each INS is supplied with 26-Vac power from the essential ac bus through INERTIAL NAV SYS circuit breakers on the pilot upper circuit breaker panel. The INS is supplied with 28-Vdc power from the essential dc bus through INERTIAL NAV SYS NO. 1 AND NO. 2 circuit breakers on the copilot upper circuit breaker panel. An auxiliary battery is available to provide 28-Vdc power in the event essential dc bus power is lost. The No. 3 INS, if installed, is supplied with 115-Vac power and 28-Vdc power from the essential ac and dc buses through OMEGA/INS NO. 3 circuit breakers on the copilot upper circuit breaker panel.

Note

Provisions for the installation of LN-100 Inertial Navigation Units are only present in the No. 1 and No. 2 positions.

2.21.25.1 INS Controls. The MSU controls the mode of operation of the INS and is used to energize and align the system before flight (see Figure 2-129). Located on the MSU panel is a rotary-type selector switch that provides the mode control for the INS. Also on this panel are two press-to-test annunciator lights (READY NAV, BATT). The CDU controls the entry of navigational data into the INS, displays data selected by the CDU display selector switch in two numerical displays, and provides three annunciators that illuminate as certain failures or events occur. The CDU also controls the automatic, manual, and remote operational functions with the CDU function selector switch. INU fan or blower warning lights are provided on the main instrument panel and/or at the navigator station and illuminate when cooling air is not being supplied to the INU.

2.21.25.1.1 Mode Selector Unit. The No. 1 MSU is located on the flight control pedestal. The No. 2 MSU and No. 3 MSU (if installed), are located on the navigator control panel. The five-position (OFF, STBY, ALIGN, NAV, ATT REF) MSU mode selector switch is detented in the NAV position to prevent the INS from inadvertently being switched out of the NAV position. The knob must be pulled away from the MSU panel before the switch can be moved out of the NAV position. The following functions are performed for each position of the MSU mode selector switch.

1. OFF — Power is applied only to the MSU and CDU edge lighting. Primary power to the INS is off.

2. STBY — In standby, INS primary power is applied. While in this position, the navigation tests can be performed and present position entered. The alignment sequence starts during which the platform cages to the aircraft axis, and platform temperature stabilization and gyro runup are initiated.

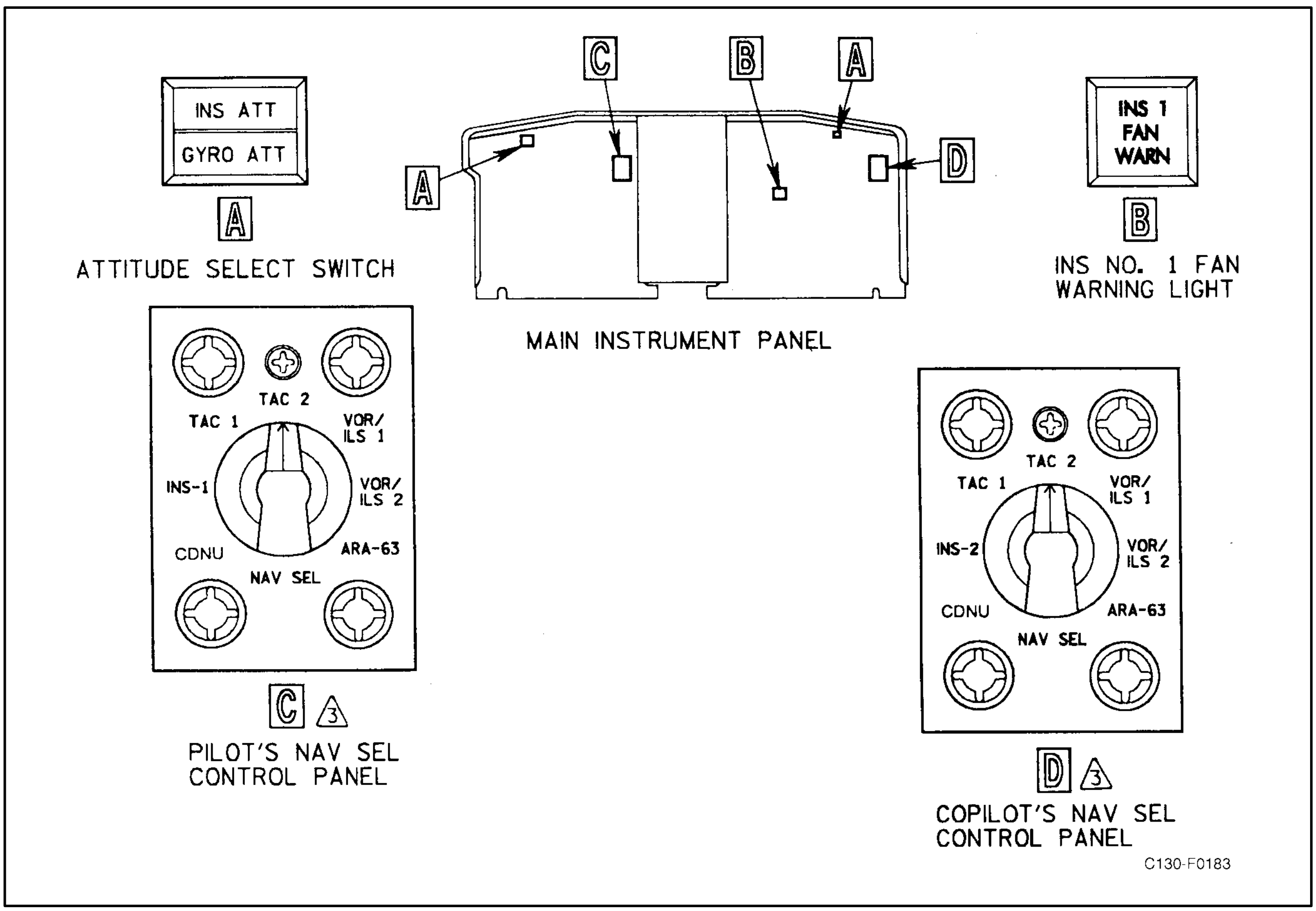


Figure 2-129. LTN-72/LN-100 Inertial Navigation Controls and Indicators (Sheet 1 of 2)

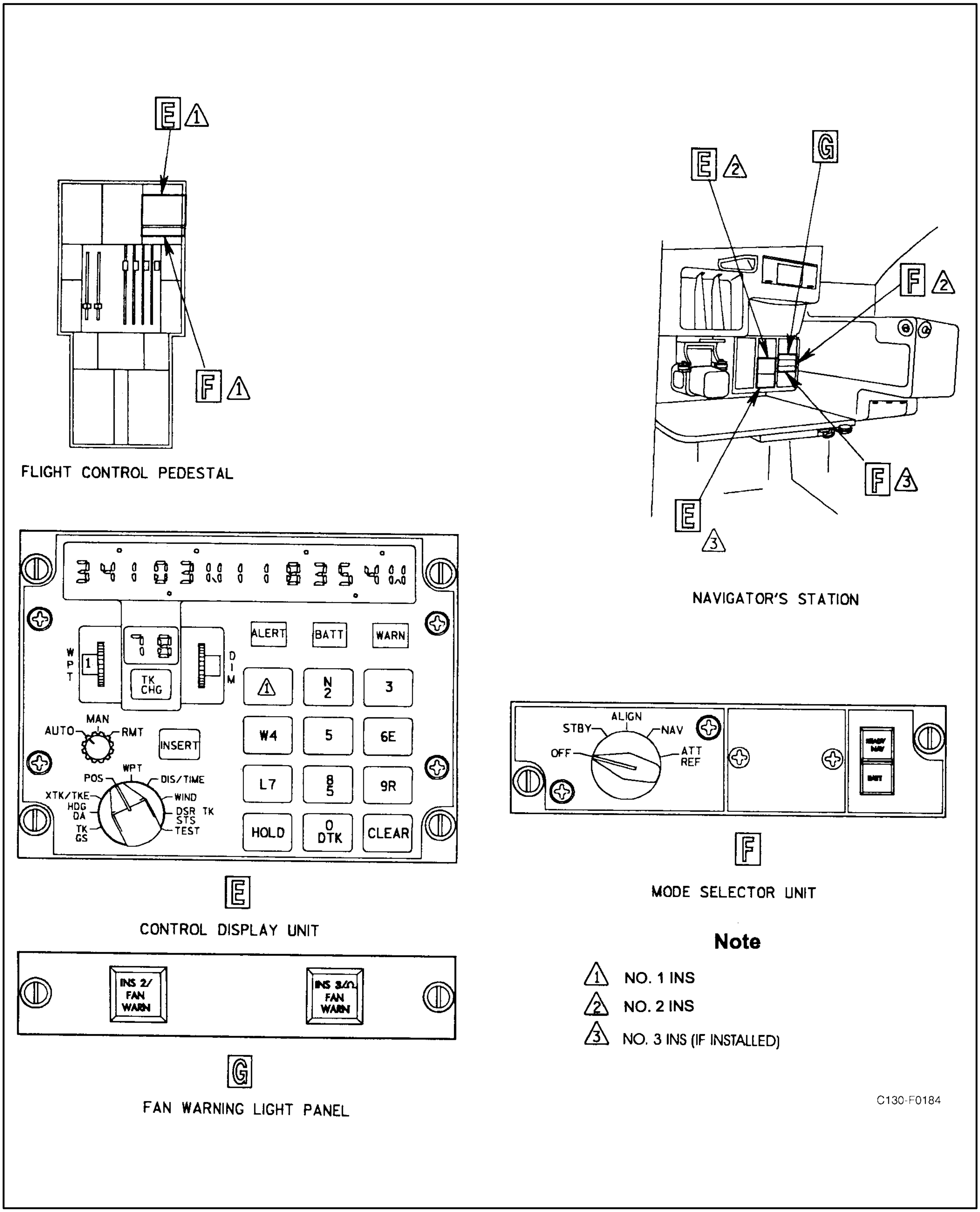


Figure 2-129. LTN-72/LN-100 Inertial Navigation Controls and Indicators (Sheet 2)

3. ALIGN — The automatic alignment sequence begins, and a platform alignment sequence is initiated. When the automatic alignment sequence is completed, the READY NAV annunciator illuminates to indicate that the navigate mode may be selected by setting the MSU mode selector switch to NAV. The aircraft must not be moved when the MSU mode selector switch is set to ALIGN. However, gusty wind conditions and movement caused by fueling or crew loading do not significantly affect alignment.

4. NAV — In navigate, the aircraft may be moved and/or normal in-flight operations performed.

Note

If the MSU mode selector switch of the LTN-72 INS is moved out of the NAV position, the INS navigational capability is lost and an alignment must be performed on the ground. An in-flight alignment can be performed for the LN-100 INS.

5. ATT REF — In attitude reference, the INS provides pitch, roll, and platform heading outputs only. No navigational capability exists, and the CDU numerical displays are blank. Once the switch has been placed in the ATT REF position, a complete ground alignment must be performed before in-flight navigation will be available.

6. READY NAV annunciator (green) — When this annunciator illuminates, the INS is ready to perform the navigation function. Rotating the mode selector switch to NAV will cause the READY NAV annunciator to extinguish.

7. BATT annunciator (red) — This annunciator illuminates when backup power is less than the minimum required to operate the INS. The annunciator must be pressed to reset to off when power is restored or it will remain illuminated as long as sufficient power is available to illuminate the annunciator lamp.

2.21.25.1.2 Control Display Unit. The No. 1 CDU is located on the flight control pedestal. The No. 2 CDU and No. 3 CDU (if installed), are on the navigator control panel. The controls, numerical displays, and annunciators located on the CDU are used to perform the following functions.

a. Display Selector Switch. The CDU display selector is a nine-position, rotary-type switch that controls the selected data to be presented on the left and right numerical displays. Certain positions of the switch are required during data entries and navigational changes. The nine positions and functions controlled by this switch are as follows:

1. Track angle and groundspeed (TK GS) — The track angle being made to the nearest tenth of a degree is shown on the left numerical display. Groundspeed to the nearest knot is shown on the right numerical display.

2. Heading and drift angle (HDG DA) — The aircraft true heading to the nearest tenth of a degree is shown on the left numerical display. Drift angle to the nearest tenth of a degree is shown on the right numerical display. The R or L preceding the reading indicates that the aircraft present track is to the right or left of the aircraft heading.

3. Crosstrack distance and track angle error (XTK TKE) — Crosstrack distance to the nearest tenth of a nautical mile is shown on the left numerical display. The R or L preceding the readout indicates that the aircraft present position is to the right or left of the desired track. Track angle error to the nearest tenth of a degree is shown on the right numerical display. The R or L preceding the readout indicates that the present track angle is to the right or left of the desired track angle.

4. Present position (POS) — Aircraft present position coordinates in latitude and longitude, to the nearest tenth of an arc-minute, are shown on the left and right numerical displays, respectively. The readout is frozen to facilitate position checks by pressing the HOLD pushbutton. The HOLD pushbutton illuminates and remains illuminated until the display is restarted by pressing the HOLD pushbutton again. The INS continuously computes position during the display freeze, and, when the display is restarted, correct present position is shown.

5. Waypoint positions (WPT) — Waypoint latitude and longitude to the nearest tenth of an arc-minute are shown on the left and right numerical displays, respectively. WPT selector switch settings 1 through 9 represent the corresponding waypoint positions that are stored in the digital computer.

WPT 0 represents the current aircraft position anytime it is desired to initiate a track from present position to a waypoint.

6. Distance and time to waypoint (DIS TIME) — Distance to go to the nearest nautical mile is shown on the left numerical display and is measured between the aircraft present position and to waypoint of the track being navigated. Time to go to the nearest tenth of a minute, up to 480 minutes maximum, is shown on the right numerical display and is derived from the distance along the desired track and groundspeed along the present track.

7. Wind direction and speed (WIND) — The wind direction to the nearest degree is shown on the left numerical display and windspeed to the nearest knot is shown on the right numerical display after manual input of true airspeed. For the LTN-72 and LN-100 systems, true airspeed will be supplied by the TAS computer and no operator action is required.

8. Desired track angle (DSR TK STS) — When search pattern parameters are not being entered, desired track angle measured from true north, from 0.0° to 360.0° is shown on the left display. The left display reads 0° until a track leg is inserted. The right display indicates action codes and alignment status. If the HOLD pushbutton is depressed, the right display will display the malfunction codes as well as status. After a search pattern has been initialized, the to/from display, with the display switch set to DSR TK STS, will always display search status (00, 22, 33, 44, 55, or 66). Also, with the display switch set to DSR TK STS, search parameters are recalled during search mode operation.

9. Display test (TEST) — The display test enables the operator to verify that the CDU numerical displays, to-from display, and annunciators are operating correctly. The display test may be performed with the MSU mode selector switch set to STBY, ALIGN, or NAV.

b. DIM Control. The DIM controls the intensity of the numerical and to-from displays; intensity can be reduced to zero, causing displays to extinguish.

c. Waypoint Selector. When the WPT thumbwheel is set to a waypoint (0 through 9) with the CDU display selector switch positioned to WPT, the waypoint coordinates will appear on the left and right numerical displays. It is also used during waypoint data insertion.

d. TK CHG Pushbutton. Allows initiation of manual track leg change.

e. To-From Waypoint Display. Displays from waypoint number and to waypoint number of track leg being navigated.

f. Function Selector Switch. The CDU function selector is a three-position, rotary-type switch. The functions performed at each position of the switch are as follows:

1. AUTO — Provides automatic sequential track changes at waypoints.

2. MAN — Allows manually initiated track changes to be accomplished.

3. RMT — Used for remote ranging and to display inserted crosstrack offset, inserted TAS, time, and inserted magnetic variation.

g. Numerical Displays. The numerical displays display data selected by the display selector switch.

h. HOLD Pushbutton. The HOLD pushbutton holds present position on left and right numerical displays or initiates manual updating of present position.

i. CLEAR Pushbutton. The CLEAR pushbutton removes entered data if pressed before the INSERT pushbutton is pressed.

j. Data Keyboard. The data keyboard provides 10 keys (0 through 9) that are used to enter present position and waypoint coordinates and from-to waypoints along with other data.

k. INSERT Pushbutton. The INSERT pushbutton transfers entered data into the INS computer when pressed.

l. ALERT Annunciator (Amber). The annunciator will illuminate 2 minutes before each approaching to waypoint is reached and then either is extinguished when a track leg change is automatically made (automatic operation) or flashes to indicate that a track leg change must be manually initiated (manual operation). When track change is initiated manually, the annunciator will extinguish.

m. BATT Annunciator (Amber). The BATT annunciator illuminates when primary INS power is lost and the system has switched to backup battery power.

n. WARN Annunciator (Red). The WARN annunciator illuminates when a system malfunction occurs or, during the align mode, flashes to indicate that incorrect present position latitude is inserted or an INS alignment failure has occurred.

2.21.25.2 Pilot/Copilot INS Control/Indicators

2.21.25.2.1 NAV SEL SWITCH. The INS position of the NAV SEL switch can be selected to display INS information on the HSI and ADI and for INS steering when the autopilot is engaged and coupled (refer to paragraph 2.21.24.13.1).

2.21.25.2.2 Horizontal Situation Indicator. When the NAV SEL switch on the instrument selector panel is in the INS position, the INS will provide the following information to be displayed on the HSI:

1. True heading (TH) — The HSI azimuth card is supplied true heading data from the INS. The heading under the lubber line is the true heading of the aircraft, unless magnetic variation has been manually inserted in the computer.

2. Desired track angle (DSR TRK) — The course arrow on the HSI is supplied desired track angle data from the INS. This allows the course arrow to be driven to a position on the azimuth card to indicate desired track angle to be flown. A digital readout of the desired track angle appears in the course display. When a track change is made, the new track will be automatically displayed.

3. Crosstrack distance (XTK) — The crosstrack distance is supplied to the HSI course deviation bar. A two-dot course deviation is equivalent to approximately 7.5 nm. The bearing pointer displays present track.

4. To-From — The to-from indicator receives to-from data from the INS to indicate direction to the set waypoint.

The heading and NAV warning flags on the HSI come into view to indicate a failure of the INS heading or navigation input. These warning flags are controlled by the INS only when INS has been selected with the NAV SEL switch.

2.21.25.2.3 Attitude Director Indicator. The gyro warning flag in the ADI comes into view to indicate a failure of the INS attitude input, if INS ATT has been selected.

2.21.25.2.4 Attitude Select Switch. An attitude select switch is located on each pilot instrument panel. The switch is a push/push-type switch with either upper green (INS ATT) portion, which selects the INS as the primary source of attitude reference, or the lower white (GYRO ATT) portion illuminated at all times. Anytime the switch is momentarily depressed, the opposite light illuminates and signal source switches as described below.

2.21.25.2.5 Pilot Attitude Select Switch. When GYRO ATT legend is illuminated, the pilot ADI, the No. 1 flight computer, and the autopilot receive roll and pitch attitude information from vertical gyro No. 1 and the autopilot receives heading information from the No. 1 C-12 compass. When INS ATT is illuminated, the attitude source is switched from vertical gyro No. 1 to INS No. 1 and heading for the autopilot is also furnished by the INS.

Note

When the autopilot is using INS (true heading) input for heading hold and magnetic heading is displayed on the HSI, a change in magnetic variation as the flight progresses will produce an apparent change in the heading being maintained.

2.21.25.2.6 Copilot Attitude Select Switch. When GYRO ATT is illuminated, the copilot ADI and the No. 2 flight computer receive roll and pitch attitude information from vertical gyro No. 2. When INS ATT is illuminated, they receive attitude information from INS No. 2.

2.21.25.2.7 INS FAN Warning Lights. The INS FAN warning lights are located on the copilot instrument panel and on the navigator control panel. INS 1 FAN WARN light is on the copilot instrument panel and INS 2 FAN WARN light and INS 3/OMEGA FAN WARN light are on the navigator control panel. The INS

FAN WARN lights illuminate when cooling air is not being supplied to the applicable INU.

2.21.25.3 Initial Operation of the INS

CAUTION

Prior to placing the copilot AC INST SEL switch to the STBY position, select GYRO ATT and disengage all flight director modes. Do not select INS ATT while in standby as this will result in damage to the ADI.

2.21.25.3.1 INS FAN Warning. If an INS blower/ fan warning light illuminates, visually check the INS cooling fan to determine if the fan is operating. Check the INS fan warning light probe for correct position. Reposition the probe if necessary. If the INS cooling fan has stopped, shut down the INS, at pilot discretion, or the system will automatically shut down without damage to the equipment.

2.21.25.3.2 INS Startup

1. MSU mode selector switch — STBY.

WARNING

If ATT REF is selected for flight operations on the LTN-72 INS, a 3-minute period under stable conditions is required to enable the INS inertial platform to level, prior to relying on the INS for attitude outputs. The time required for the LN-100 system is 30 seconds.

Note

The MSU mode selector switch should be placed to the ATT REF position anytime it is not planned to proceed with the alignment procedures for the purpose of using the INS navigational capability. With the LN-100 system, an in-flight alignment can be performed at a later time. The following procedures need not be accomplished if the attitude reference mode is selected for flight operations.

2.21.25.3.3 CDU System Tests

1. Complete the INS STARTUP procedure.

2. CDU function selector switch — MAN.

3. CDU display selector switch — POS.

Note

For the LTN-72 system, verify that the CDU right numerical display indicates the appropriate program number. The left display should contain 00000N, and the from-to display should be 0, 0. Pressing hold on the LN-100 system will cause the display to cycle between program number, program checksum, and date of program assembly.

4. CDU display selector switch — TEST.

5. CDU displays and annunciators — Checked.

Note

Check that left and right numerical displays, degree sign, decimal points, arc-minute signs, NS and EW, and from-to display are functioning and that the ALERT, BATT, and WARN annunciators illuminate. All numerical displays indicate 8.

6. NAV SEL switch — INS.

Note

- Verify that the heading on the HSI is between 118° and 122°, the desired track is between 168° and 171°, the “T” end of the bearing pointer indicates between 131° and 134°, and the course deviation bar displays a crosstrack deviation of 3.5 nm (one dot) left of track.

- Verify that the ADI attitude warning flag goes out of view.

7. Place the NAV SEL switch to a position other than INS.

2.21.25.3.4 Present Position Entry

1. INS STARTUP procedure — Completed.

2. CDU display selector switch — POS.

Note

If correct present position is displayed, proceed to step 9.

3. Keyboard pushbutton N or S — Depressed.

4. Present latitude — Entered.

Note

Starting with the most significant digit, enter latitude to the nearest tenth of a minute by pressing the corresponding pushbutton on the data keyboard. As each pushbutton is pressed, verify that the corresponding digit is displayed on the left numerical display as the last significant digit and that each preceding digit moves one place to the left.

5. INSERT pushbutton — Depressed.

6. Keyboard pushbutton W or E — Depressed.

7. Present longitude — Entered.

8. INSERT pushbutton — Depressed.

9. MSU mode selector switch — Align.

Note

The READY NAV annunciator legend shall normally illuminate within 18 minutes for the LTN-72 INS and within 4 minutes for the LN-100 INS. Do not move the aircraft (and for optimum alignment, do not start engines) until alignment has been completed (i.e., READY NAV annunciator has illuminated and MSU mode selector switch is rotated to NAV position).

2.21.25.3.5 LTN-72 INS Alignment Status Indications. The status of INS alignment is monitored by placing the CDU display selector switch to DSR TK STS with the MSU mode selector switch in STBY or ALIGN. The two-digit numeral that appears in the right CDU display is the status number. The initial status number is 90, which appears when STBY is selected. If INS attitude selection is activated and the NAV SEL switch is placed to the INS position, the HSI heading and NAV warning flags will come into view as the display status changes to 80. The heading warning flag will go out of view when the display changes to status 50. After 2 minutes and with the MSU mode selector switch positioned to ALIGN with present position inserted, the status changes to 70. Status 70 is maintained until INS operating temperature has been reached. Once this occurs, status is changed to 60. At status 60, the INS roughly determines the accuracy of the present position inserted. If present position is incorrect, the CDU WARN annunciator begins to flash. If entered present position, when checked, is correct, the flashing annunciator means that the INS has failed. If present position is incorrect, rotate the MSU mode selector switch to OFF and restart alignment procedure with the correct position entered.

CAUTION

If the MSU mode selector switch has just been set to the OFF position, it should remain in the OFF position for at least 4 minutes before selecting STBY, or damage to the equipment may result.

Status 50 indicates that present position is satisfactory. Status continues to decrease. When status 02 is reached, or approximately 6 minutes has elapsed since status 10, the MSU READY NAV annunciator illuminates to indicate that the system is ready to navigate. If the CDU WARN annunciator begins to flash, check the action code.

2.21.25.3.6 LN-100 Alignment Status Indications. When the display selector is set to DSR TRK STS, the right display indicates alignment status of the LN-100 with the MSU mode selector switch in STBY or ALIGN. Upon being set to STBY, the status will be 90 and will decrement to status 02 after present position has been entered and the MSU has been positioned to either ALIGN or NAV.

Note

Although it is recommended that the NAV mode be selected just prior to flight operations, the mode switch can be set directly to NAV from STBY as soon as present position coordinates have been inserted. The INU will automatically enter the NAV mode upon completion of the alignment as indicated by an 01 status on the CDU right display.

If present position has not been entered, the alignment will be held at status 80. At status 60, the INU tests for Normal Automatic Alignment. If alignment is within tolerance, the alignment will proceed to status 50 where True Heading becomes valid and the heading flag goes out of view. If the INU detects a fault in the alignment, the WARN light on the CDU will begin to flash. After a 4 minute normal alignment time with ALIGN selected on the MSU, the READY NAV light will illuminate indicating the alignment was successful and the MSU may now be set to NAV. If NAV was selected immediately after present position entry was completed, the INU will proceed directly into Navigate mode without illuminating the READY NAV light.

CAUTION

The LN-100 system defaults to a closed-loop mode during alignment. In this mode (indicated by a "⊂" on the DSR TK/STS display), the INS position will be automatically updated by GPS data. GPS is only authorized as a back-up to visual navigation; therefore, closed-loop updates shall be terminated prior to using LN-100 data as a primary means of instrument navigation or prior to overwater navigation. Refer to paragraph 2.21.25.4.2.

2.21.25.3.7 INS Action Code. With the CDU display selector switch positioned to DSR TK STS and with a possible INS malfunction present, an action code will appear in the right display to the left of the status code. Should the CDU WARN annunciator commence flashing with the MSU mode selector switch in ALIGN and the action code is 2, 3, or 6, turn the MSU mode selector switch to OFF, check the INS circuit breakers, and restart the alignment procedure. If the MSU mode selector switch is in NAV and the CDU WARN annunciator remains illuminated with an action code 1 displayed, turn the MSU mode selector switch to OFF. If a warning flag (HEADING, NAV) comes into view on the HSI, without a CDU WARN annunciator and an action code of 4, do not use the INS steering or display information. After any failure or repeat failure, determine the malfunction code by pressing the CDU HOLD pushbutton before turning the MSU mode selector switch to OFF. The malfunction code will appear in place of the action code.

Note

More than one malfunction may exist. Repeated pressing of the CDU HOLD pushbutton will cause a sequential display of code numbers for all malfunctions. This should be repeated until the initial malfunction code reappears.

2.21.25.3.8 Rapid Alignment (LN-100 Only). A rapid alignment mode is available for use when it is anticipated that the normal four-minute alignment time will affect mission requirements. A rapid alignment is based on the stored position and heading from a reference alignment. It is therefore required that a normal alignment be performed as a reference alignment at some time previous to the need for a rapid alignment and that the aircraft remain stationary during the interval between the reference alignment and the rapid alignment (i.e., the heading, latitude, and longitude of the aircraft must not change). A rapid alignment at 70 °F requires about 30 seconds. At the end of Status 70, the status goes directly to Status 02 if in ALIGN mode. If in NAV mode, the status goes directly to Status 01. Navigation performance may be degraded up to four miles per hour following a rapid alignment. To perform a rapid alignment, first perform a normal alignment. Then set the MSU Mode switch to OFF (MSU must not be set to the NAV position). After normal alignment, perform the following:

1. Set the MSU Mode switch to STBY.
2. Set the CDU Display switch to POS and press HOLD, 9, and then INSERT.
3. Verify that the present position from the reference alignment is displayed on the CDU.
4. Set the MSU Mode switch to ALIGN.
5. On the MSU, observe that the green READY NAV annunciator illuminates in approximately 0.6 seconds.

2.21.25.3.9 Waypoint Coordinates Entry

1. INS Startup and present position entry — Completed.
2. CDU function selector switch — MAN or AUTO.

3. CDU display selector switch — WPT.

4. Press TK CHG and INSERT pushbuttons.

5. WPT selector — As Required.

Note

The initial en route waypoint coordinates are entered into waypoint 1 unless an anticipated return track to point of departure is required, in which case the initial en route waypoint coordinates are entered into waypoint 2 and the point of departure waypoint is entered in waypoint 1.

6. Keyboard pushbutton N or S — Depressed.

7. First waypoint latitude — Entered.

8. INSERT pushbutton — Depressed.

9. Keyboard pushbutton W or E — Entered.

10. First waypoint longitude — Entered.

11. INSERT pushbutton — Depressed.

Note

Repeat steps 5 through 11 for subsequent waypoint entries.

2.21.25.3.10 Intersystem Crossfill. Crossfill is a feature that is utilized for multiple INS installations. Waypoint coordinates are entered into any one of the INS systems and then the waypoints are automatically transmitted to the other INS systems in the aircraft. The INS selected for entry of the data is referred to as the Master INS. Crossfill can be performed while the aircraft is on the ground and the MSU mode switches are set to STBY, ALIGN, or NAV. Crossfill can also be performed in flight with the MSU mode switches set to NAV. Crossfill waypoint coordinates are entered as follows:

1. On the desired Master (transmitting) INS system, set AUTO/MAN/RMT switch on the CDU to RMT. Verify that the From/To display starts flashing.

2. Press TK CHG and then INSERT on the Master CDU. Verify that the CDU From/To display flashes 00.

3. Repeat steps 1 and 2 for the Slaved (receiving) CDU. Verify that the CDU From/To display flashes 00.

4. Enter the desired waypoint coordinates into the Master CDU or, if waypoints are already present, reenter any single waypoint into the Master CDU. This transfer may take up to 18 seconds.

5. Verify that the crossfill was performed by setting the Slaved CDU Display switch to WPT and sequence through all of the waypoint coordinates. Waypoint coordinates should be the same for all of the INS systems.

6. Set AUTO/MAN/RMT switches on all of the CDUs to AUTO or MAN.

2.21.25.3.11 CDNU to INS Intersystem Crossfill. Waypoint coordinates can be entered into any of the CDNUs and then automatically transferred to any INS in the aircraft. Waypoint coordinates that are entered into the CDNU Flight Plan are transferred to any INS as follows:

1. Enter waypoints into the CDNU Flight Plan.

2. Access the Waypoint Start Page on the CDNU. Enable the crossfill function.

3. Place the INS to the transfer mode by setting the AUTO/MAN/RMT switch to RMT.

4. Place the CDU Display switch to WPT.

5. Press TK CHG, and then press INSERT. Allow two minutes for waypoint transfer.

6. Compare the CDNU Flight Plan waypoint list with the INS waypoints. The waypoint coordinates should be the same.

2.21.25.3.12 Status Check. Status check of alignment progress is normally made after waypoint entry; however, it can be accomplished at any time during system alignment.

1. INS startup, present position entry, and waypoint coordinates entry procedures — Completed.

2. CDU display selector switch — DSR TK STS.

Note

Observe status number on CDU right numerical display. After the status number decreases to 02 and approximately 6 minutes have elapsed since start of status 10, the READY NAV annunciator illuminates.

3. READY NAV annunciator — Illuminated.

4. MSU mode selector switch — NAV.

5. READY NAV annunciator — Extinguished.

6. INS alignment — Completed.

CAUTION

The LN-100 system defaults to a closed-loop mode during alignment. In this mode (indicated by a "⊂" on the DSR TK/STS display), the INS position will be automatically updated by GPS data. GPS is only authorized as a back-up to visual navigation; therefore, closed-loop updates shall be terminated prior to using LN-100 data as a primary means of instrument navigation or prior to overwater navigation. Refer to paragraph 2.21.25.4.2.

Note

- This completes the alignment procedure, and the aircraft can now be moved.

- If desired, the MSU mode selector switch can be set directly to NAV from STBY after present position has been inserted. System alignment will progress normally, except the READY NAV annunciator will not illuminate when alignment is complete. A 01 status is the only indication that the system has aligned.

2.21.25.3.13 Attitude Reference Check

1. Attitude select switch — Depressed.

Note

Check that the GYRO ATT legends illuminate, ADI GYRO flags are not in view, and proper attitude references are displayed.

2. Attitude select switch — Depressed.

Note

Observe that normal INS ATT indications return.

2.21.25.3.14 Initial Track Selection. The initial track selection to a waypoint must be accomplished before INS navigational steering will be provided. Normally, this would be accomplished in flight after takeoff when cleared to the first waypoint. The selection, however, may be accomplished on the ground if the after takeoff flightpath makes it convenient to do so. The initial en route waypoint latitude and longitude should be entered before Initial Track Selection procedures are accomplished.

To enter the initial track without return to point of departure entry, accomplish the following:

1. Alignment — Completed.

2. CDU function selector switch — As Desired.

3. TK CHG keyboard pushbutton — Depressed.

Note

Verify the TK CHG and INSERT pushbutton legends illuminate and the from-to display is blank.

4. Keyboard pushbuttons 0, then 1 — Depressed.

Note

Verify that from-to display is 0, 1.

5. INSERT pushbutton — Depressed.

Note

- Verify that INSERT and TK CHG pushbutton legends extinguish. Verify that initial desired track is accurate.

- Crosstrack distance and track-angle error (XTK/TKE), distance and time to next waypoint (DIS/TIME), and desired track angle (DSR TK) data are not available until the initial track is initiated.

To enter initial track when return to point of departure procedure is used, accomplish the following procedures.

1. CDU function selector switch — As Desired.

2. TK CHG keyboard pushbutton — Depressed.

Note

Verify that TK CHG and INSERT pushbutton legends illuminate and the from-to display is blank.

3. Keyboard pushbuttons 0, then 2 — Depressed.

Note

Verify that from-to display is 0, 2.

4. INSERT pushbutton — Depressed.

Note

- Verify that INSERT and TK CHG pushbutton legends extinguish. Verify that initial desired track is accurate.
- Crosstrack distance and track-angle (XTK/TKE), distance and time to next waypoint (DIS/TIME), and desired track angle (DSR TK) data are not available until the initial track is initiated.

2.21.25.3.15 Taxi Speed/Track Angle Monitoring. The INS displays taxi speed when taxi speed exceeds 1 knot and displays meaningful track angle indications at taxi speeds in excess of 10 knots. Track angle and heading displays are the same at taxi speeds less than 10 knots.

1. CDU display selector switch — TK GS.

Note

Read groundspeed to the nearest knot from the right numerical display. Read track-angle to the nearest tenth of a degree from the left numerical display.

2.21.25.4 In-Flight Operation of the INS. The terms automatic and manual, as used in these procedures, apply only to track selection. When in the navigate mode, the INS provides the same navigation data whether the CDU function selector switch is set to AUTO (automatic) or MAN (manual). During automatic operation, the INS navigates through each selected waypoint in sequence and automatically changes track at each waypoint. During manual operation, the INS navigates from waypoint to waypoint, but the operator must initiate a track change at each waypoint. CDU display selection and waypoint position entries may be accomplished with the CDU function selector switch set to either AUTO or MAN.

2.21.25.4.1 In-Flight Warn Indications. The INS provides integral warn indications and signals that cause aircraft instruments to provide warn indications pertaining to INS operation. These warn indications are as follows.

a. INS WARN Indications. If the WARN annunciator illuminates, the INS is malfunctioning and may not be providing accurate data. Refer to paragraph 2.21.25.4.3 for operating procedures.

b. Aircraft Instrument Warn Indications. The INS provides signals that cause aircraft instruments to provide warn indications as follows:

WARN SIGNAL	WARN INDICATION
Pitch or roll	ADI altitude warning flag
HSI	ADI course warning flag

WARNING

If the MSU mode selector switch is set to ATT REF, the INS attitude outputs must not be used until the aircraft has been flown in the wings-level attitude at a constant speed for the first 3 minutes after ATT REF is selected to allow the INS inertial platform to complete a level sequence. If this procedure is not followed, erroneous INS attitude outputs may occur.

Note

- Do not set the MSU mode selector switch on the LTN-72 INS out of NAV unless an INS malfunction occurs. If the INS is switched out of NAV, the NAV MODE cannot be reset in flight, as the INS must be aligned on the ground. An in-flight alignment may be performed for the LN-100 INS.
- If the CDU BATT annunciator illuminates, the INS is operating on dc backup power. The dc backup power is a battery unit with approximately 2 hours duration for INS operation. The No. 3 INU battery

is a nickel-cadium unit packaged in a metal case. The battery has a 6.5-ampere-hour capacity, which is sufficient to operate the system for 15 minutes. A battery trickle charger is included in the No. 3 inertial navigation unit to maintain full battery capacity when the system is operating from 400-Hz power. Action must be taken to substitute for the INS, particularly if the INS is providing information for automatic flight control of the aircraft.

- If the MSU BATT annunciator illuminates, the dc backup power is less than the minimum required to operate the INS. Automatic INS shutdown will occur, and the warn annunciator will illuminate. The MSU mode selector switch should be set to OFF if the MSU BATT annunciator illuminates. If normal power is restored, ground alignment, in-flight alignment (LN-100), or in-flight leveling may be attempted a maximum of three times.

2.21.25.4.2 GPS Aided Operations. The INS can be updated in NAV mode utilizing GPS data. Navigation updates are performed in either closed loop mode (where GPS data is used to update position, velocity, platform tilts, and gyro biases) or open loop mode (where inertial solutions are maintained in the computer separate from the GPS updated solution). The LN-100 INS can be aligned during flight. In-flight alignments can only be performed in a closed loop mode. During normal ground alignment, by default, the LN-100 INS will be aided by GPS in closed loop (Align status will indicate $\subset$02) when valid GPS data is available. With the INS in NAV, open or closed loop GPS updating can be enabled, terminated and flushed as required. When GPS updating is terminated, the CDU displays and data bus parameters are returned to free inertial outputs.

CAUTION

GPS is only authorized as a back-up to visual navigation. Closed loop mode shall be terminated prior to using INS data as a primary means of instrument navigation or for overwater navigation.

a. Navigation Updates. All GPS aided operations are under CDU control and several status and advisory displays are available. Both control and display are performed with the CDU Display Switch in the DSR TK/STS position. Basic GPS mode data is provided in the space between the action/malfunction code and the system status, with $\cup$ indicating open loop and $\subset$ indicating closed loop operation. For example: $\cup$01 indicates GPS open loop aided NAV mode. $\subset$01 indicates GPS closed loop aided NAV mode. GPS mode control and additional status displays are enabled by pressing the 1 key on the CDU, which causes the left display to blank and the right display to display status. After pressing the 1 key, the mode selection entry codes are as follows:

1 key	Enable open loop update
2 key	Enable closed loop update
5 key	Terminate open or closed loop updates
9 key	Flush open loop updates

The left display provides visual confirmation of mode selection in the fifth (from left) digit. After selecting the required mode, press INSERT to enable or disable GPS aiding. The previous display will return.

To enable open loop update:

1. Set CDU Display Switch to DSR TK/STS.

2. Press 1, the left display blanks and INSERT light illuminates.

3. Press 1 and verify the left display is 1.

4. Press INSERT and verify INSERT light extinguishes, left display is DSR TK, and right display is $\cup$01.

5. If the $\cup$ does not appear (STS display is 01), press 1 to obtain the update status display. Press CLEAR to revert to standard DSR TK/STS.

To enable closed loop update:

1. Set CDU Display Switch to DSR TK/STS.

2. Press 1, the left display blanks and INSERT light illuminates.

3. Press 2 and verify the left display is 2.

4. Press INSERT and verify INSERT light extinguishes, left display is DSR TK, and right display is $\subset$01.

5. If the $\subset$ does not appear (STS display is 01), press 1 to obtain the update status display. Press CLEAR to revert to standard DSR TK/STS.

To terminate open and closed loop updates:

1. Set display switch to DSR TK/STS.

2. Press 1, the left display blanks and INSERT light illuminates.

3. Press 5 and verify the left display is 5.

4. Press INSERT and verify INSERT light extinguishes, left display is DSR TK, and right display is 01.

To terminate and flush open loop updates:

1. Set display switch to DSR TK/STS.

2. Press 1, the left display blanks and INSERT light illuminates.

3. Press 9 and verify the left display is 9.

4. Press INSERT and verify INSERT light extinguishes, left display is DSR TK, and right display is 01.

b. In-Flight Alignment (IFA) (LN-100 Only). The LN-100 may be aligned by one of three methods:

1. Normal Ground Alignment.

2. In-Flight Align (IFA). Alignment is initiated and completed during flight.

3. Hybrid Align. Alignment is started on the ground with the aircraft stationary and completed during taxi or in flight.

Note

The preferred operational procedure is to perform a normal ground alignment, allowing the system to enter NAV mode.

In-Flight Alignment can be used when preflight time does not allow a normal ground alignment or the operator desires to realign the system during flight. A system can be realigned in flight by recycling the MSU to OFF then to STBY. Cycling through the OFF mode will allow the LN-100 to perform a fast level during Status 90 at turn on, thereby removing any large platform tilt errors that may have occurred. If a large position error is not present, the MSU can be cycled to STBY without going to OFF. GPS will initialize the system position and no position entry by the operator is necessary. When IFA is initiated, the system will remain in Air Align Hold mode with the CDU displaying align status 80, with no # present, until both of the following conditions are met:

1. GPS ground speed is greater than 20 knots.

2. Alignment time is less than 85 seconds.

When these conditions are met the system will exit Air Align Hold mode, sequence to align status $\subset$70, and initialize position and velocity from the GPS values. $\subset$70 indicates that GPS updating is enabled and proceeding. If the $\subset$ does not appear, updates are being rejected. Press CLEAR to revert to standard DSR TK/STS.

If possible, aircraft maneuvers should be restricted to straight and level flight until about one minute after status 70 has been achieved. Moderate aircraft maneuvering thereafter is desirable and will speed the alignment. During a maneuver that exceeds the acceleration and heading rate limits, GPS updates will not be accepted and a status code 1 2 b b 2 (Acceleration/ Heading Rate Excessive) will be displayed. Approximately 15 seconds after completion of the excessive maneuver GPS updates will again be allowed.

IFA can be enabled during any part of a ground alignment if it is necessary to complete the alignment with the aircraft moving. This procedure is termed a Hybrid IFA. For an IFA initiated during align status 70, the system will enter Air Align Hold until GPS ground speed exceeds 20 knots. For an IFA initiated after status 70, the 20 knot limitation does not apply.

When the alignment is complete, STS display is $\subset$02 and the READY NAV light illuminates. The system may be left in ALIGN mode or may be switched to NAV mode. Alternatively the MSU can be cycled directly to NAV after IFA is enabled. If an IFA is terminated by the operator prior to the system sequencing to NAV mode then the align status will be reset to status 80 and Action Code 3/22 (Enter Present Position) will be displayed until the MSU is switched to STBY.

Note

If the system is left in ALIGN, the LN-100 remains in closed loop update mode and continues to align the system based on GPS inputs. If the system is switched to NAV, two separate navigation solutions are maintained in the LN-100 computer, one inertial and the other from the Kalman filter best estimate based on INU and GPS measurements. By default, GPS-aided data is displayed on the CDU. Switching to NAV is recommended to prevent possible corruption of the alignment from loss of lock conditions.

IFA procedures are as follows:

1. Set CDU Display Switch to DSR TK/STS.

2. Press 1 and verify left display blanks and INSERT illuminates.

3. Press 2 and verify a 2 is displayed.

4. Press INSERT. The display reverts to standard DSR TK/STS with either align status 90 or 80 displayed.

5. Set MSU to ALIGN.

6. When STS display indicates ⊂02 and READY NAV light illuminates, set MSU to NAV.

7. Terminate and flush closed loop updates.

8. Perform manual position update with an accurate known position fix.

2.21.25.4.3 Attitude Reference Selection.

When only pitch, roll, and platform heading outputs are required and navigational capability is not necessary, the INS can be operated in the attitude reference mode.

Note

To ensure that the INS inertial platform is level, keep the aircraft stationary or taxiing at a constant speed and a steady course for 3 minutes after placing the INS mode selector switch to the ATT REF position.

1. MSU mode selector switch — ATT REF.

Note

The MSU mode selector switch is detented in the NAV position and the knob must be pulled away from the MSU panel before the mode selector switch can be moved through the NAV position.

2.21.25.4.4 Initial Track Selection

1. Without return to point of departure — Perform same procedure as outlined for ground initial track selection (without return to point of departure entry). When the INSERT pushbutton is depressed, steering is provided from aircraft present in-flight position (WPT 0) to waypoint 1.

2. With return to point of departure — Perform same procedure as outlined for ground initial track selection (with return to point of departure entry). When the INSERT pushbutton is depressed, steering will be provided from the aircraft in-flight position (WPT 0) to waypoint 2.

2.21.25.4.5 Flight Plan and Update Changes.

A normal flight plan includes several flight legs. The INS is capable of storing nine waypoint coordinates at one time. When the system is operating automatically, the navigation will be sequential through each waypoint as indicated on the from-to display, thereby producing automatic sequential track steering. During manual operation, the desired from-to waypoints are manually inserted, and the track steering associated with these waypoints will be produced.

2.21.25.4.6 Automatic Track Switching at Waypoint.

Automatic track switching at a point prior to reaching a waypoint is provided when the CDU function selector switch is in the AUTO position. When this track switching point is reached, the INS automatically changes to the next track, the new leg (track) is displayed in the from-to display, steering to the new track is supplied, and the ALERT annunciator extinguishes. This operation will continue sequentially through each waypoint. Should a new track be established manually, such as between waypoints 2 and 4, and the CDU function selector switch is returned to

AUTO, automatic switching at waypoint 4 occurs. The new track between waypoints 4 and 5 is established and automatic sequential track switching will resume.

2.21.25.4.7 Manual Track Switching at Waypoint. When the CDU function selector switch is in the MAN position, a track change to the next desired track must be accomplished manually by the pilot as the waypoint is approached. To accomplish this operation, the following operations would be performed:

1. CDU function selector switch — MAN.
2. TK CHG keyboard pushbutton — Depressed.

Note

After TK CHG pushbutton is depressed, the TK CHG and INSERT pushbutton legends will be illuminated.

3. Keyboard pushbuttons — Depressed.

Note

Depress the next from waypoint numerical keyboard pushbutton, then depress the next to waypoint numerical keyboard pushbutton.

4. INSERT pushbutton — Depressed.

Note

When the INSERT pushbutton is depressed, a track change is initiated; steering to the next track is produced and the new track will be displayed. As long as the manual function is used, a new track will have to be inserted manually at each waypoint.

2.21.25.4.8 Waypoint Bypassing from Present Position. The operator can bypass a waypoint or a number of waypoints from present position at any time. Assume the aircraft is on a from-to track of 1, 2 and it is necessary to fly from present position to waypoint 3.

1. CDU function selector switch — As Desired.
2. TK CHG keyboard pushbutton — Depressed.
3. TK CHG and INSERT pushbutton legends — Illuminated.
4. Keyboard pushbutton 0, then 3 — Depressed.
5. INSERT pushbutton — Depressed.

Note

- When the INSERT pushbutton is depressed, steering from present position to waypoint 3 will be initiated and the new from-to track of 0, 3 will appear in the from-to display.
- If the CDU function selector switch is set to AUTO, automatic switching occurs as the next waypoint is reached and the from-to track of 3, 4 becomes the new desired track.

2.21.25.4.9 Intermediate Waypoint Bypassing. The operator can bypass one or more waypoints by performing certain manual operations on the CDU. For example, assume the aircraft is on a from-to track of 1, 2 and is midway to waypoint 2. A decision is made to bypass waypoint 3 and go directly from waypoint 2 to waypoint 4. The following manual operation will be performed:

1. CDU function selector switch — As Desired.
2. TK CHG keyboard pushbutton — Depressed.
3. TK CHG and INSERT pushbutton legends — Illuminated.
4. Keyboard pushbutton 2, then 4 — Depressed.
5. INSERT pushbutton — Depressed.

Note

When the INSERT pushbutton is depressed, the programmed from-to track between 2 and 3 is deleted, a new from-to track between 2 and 4 is established, and steering to the new track is provided. Normally, the track change would not be initiated until at or near waypoint 2.

2.21.25.4.10 Track Offset. This mode allows the operator to fly a track parallel to the present track at a fixed offset distance. This distance will be set in by the operator. To enter this mode, the following operation will be performed.

1. CDU display selector switch — XTK/TKE.
2. Keyboard pushbutton 1 — Depressed.

Note

- Observe that the left CDU display goes blank and INSERT pushbutton legend is illuminated.

- Left 5.3 nm will be used as an example.

3. In sequence, press L, 5, and 3 keyboard pushbuttons — Depressed.

Note

The left display will indicate L 5.3. For a right effect, use R in place of L. Track offset must be entered to the nearest tenth of a nautical mile.

4. INSERT pushbutton — Depressed.

Verify that correct offset distance is displayed prior to depressing the INSERT pushbutton. After insertion, the right display will display crosstrack distance from the original track and steering to the offset track. As the aircraft is flown to the offset track, the crosstrack distance will begin to increase (as shown in left display) and the track-angle error (right display) steadily increases from the value prior to offset track insertion. As the new track is intercepted, steering will be produced to allow the aircraft to be flown to and maintain the offset track. When on offset track, the offset distance (L 005.3) is displayed in the left display and track-angle error is displayed in the right display.

To return to original track, accomplish the following operations:

5. CDU display selector switch — XTK/TKE.

6. In sequence, press 1, L or R, and INSERT pushbuttons.

Note

Steering is provided to return the aircraft to the original track.

2.21.25.4.11 Waypoint Position Change. The operator can change the coordinates of waypoints or use past waypoint storage locations as future waypoints. Enter waypoints as described in paragraph 2.21.25.3.9. If past waypoint storage locations are to be used as future waypoints, enter future waypoints sequentially, starting with 1 and continuing through the last number used to permit automatic sequential switching.

2.21.25.4.12 Flight Plan Change Between Waypoints. A flight plan change to a new waypoint or destination can be initiated at any time between waypoints. Assume the aircraft is between waypoints 3 and 4, and it becomes necessary to fly direct from present position to the new destination. Assuming the destination to be waypoint 7, insert new waypoint 7 latitude and longitude, using the Waypoint Coordinates Entry procedure. Use waypoint bypassing from present position procedure to insert new track, 0, 7 into system. When INSERT pushbutton is depressed, the new from-to track will be initiated and the new from-to track of 0, 7 will appear in the from-to display.

2.21.25.4.13 INS Track Select Mode. The operator can initiate an INS track select mode of operation (referenced to true north from the aircraft present track, rather than a track between waypoints). By this method, the pilot may fly the aircraft off track.

1. CDU display selector switch — DSR TK STS.

2. CDU function selector switch — MAN.

3. Keyboard pushbutton 0 — Depressed.

Note

Verify that left numerical and from-to displays are blank and that the INSERT pushbutton legend illuminates.

4. Enter desired track angle to the nearest tenth of a degree on the data keyboard.

Note

Verify that left numerical display is the track angle entered.

5. INSERT pushbutton — Depressed.

Note

Verify that INSERT pushbutton legend extinguishes, the from-to display is 9, 9 and the DIS/TIME and XTK numerical displays are all zeros.

The aircraft will turn and fly along a line parallel to the inserted track at the point of insertion. The lateral displacement from this line is determined by the maximum roll rate commanded, aircraft speed, and autopilot characteristics. The aircraft will maintain the inserted track.

6. When desired, return to previous mode by initiating the next track change.

2.21.25.4.14 Position Update, Check, and Selection. At any time during flight, the INS present position can be updated to a position fix apparently more accurate than the inertially derived position. Present position can be updated a maximum 30 arc-minutes in both latitude and longitude for any one update. The INS retains the original updated present position for the duration of the navigation mode, thereby permitting future comparison of updated with nonupdated positions. If in a future comparison, the nonupdated position proves more accurate than the updated position, the system may drop the updated position and revert to the nonupdated position. In the following procedure, when the CDU HOLD pushbutton is pressed, the present position display freezes. The INS, however, automatically compensates for position changes during this display freeze.

2.21.25.4.15 Position Update

1. CDU HOLD pushbutton — Depressed.

2. CDU display selector switch — POS.

If update is not necessary, proceed to step 3; if necessary, proceed to step 4.

3. CDU HOLD pushbutton — Depressed.

Note

Step 3 restores display to normal operation.

4. Latitude and longitude of fix position — Entered.

Refer to steps 3 through 8 of paragraph 2.21.25.3.4, noting that the original (nonupdated) coordinate will appear on the numerical display when the INSERT pushbutton is pressed and will not be updated until the second coordinate is inserted or the CDU HOLD pushbutton is pressed.

If both latitude and longitude have been updated, numerical displays will restart when the INSERT pushbutton is pressed the second time. If only latitude or longitude is updated, press the CDU HOLD pushbutton to restart the display. The CDU HOLD pushbutton legend extinguishes, position changes that occurred during the display freeze and updating procedures are automatically compensated for, and position display reflects new present position referenced from updated coordinates.

2.21.25.4.16 Position Update Check. Check the position update versus nonupdated position as follows:

1. At known waypoint, CDU HOLD pushbutton — Depressed.

2. CDU display selector switch — POS.

The display will indicate the frozen value of present position with update (if applicable). With this position noted, a comparison with a known point (waypoint) can be accomplished by proceeding to the next step.

3. CDU display selector switch — WPT.

Verify that coordinates of nonupdated position appear in the numerical displays. If updated position is more accurate than nonupdated position, restart displays by pressing the CDU HOLD pushbutton. The updated position will continue to be displayed when the display selector switch is set to POS.

2.21.25.4.17 Update Removal. If the nonupdated position is more accurate than the updated position, remove the updated position by performing the following steps.

1. CDU HOLD pushbutton — Depressed (if not illuminated).

2. CDU display selector switch — DSR TK/STS.

3. Keyboard O/DTK pushbutton — Depressed.

4. INSERT pushbutton — Depressed.

Note

If track is being flown from present position to any waypoint, reinitiate track to pick up new 0 position. If a track hold mode is being flown, reinitiate the track hold procedure.

The CDU HOLD pushbutton legend extinguishes, and the nonupdated position will be displayed when CDU display selector switch is set to POS.

A new updated position can be entered at any time during the navigation mode by performing steps 2 through 8 of paragraph 2.21.25.3.4.

2.21.25.4.18 True Airspeed and Time Entry and Display

Note

True airspeed is supplied to the INS by a TAS computer. In order to obtain TAS inputs to the INS from the TAS computer, a zero TAS must be entered manually. In the event that the TAS goes invalid, the TAS may be entered manually.

Enter the true airspeed and time data as follows:

1. CDU function selector switch — RMT.

2. CDU display selector switch — WIND.

3. Keyboard DTK pushbutton — Depressed.

Note

Verify that the INSERT pushbutton legend illuminates.

4. True airspeed — Entered.

5. If the true airspeed display is correct, press the INSERT pushbutton.

6. If the true airspeed display is incorrect, press the CLEAR pushbutton and repeat steps 3 through 5.

7. Keyboard pushbutton 5 — Depressed.

Note

Verify that the INSERT pushbutton legend illuminates.

8. Time — Entered.

9. If time display is correct, press the INSERT pushbutton.

10. If time display is incorrect, press the CLEAR pushbutton and repeat steps 7 through 9.

Note

True airspeed and time can be displayed by setting the CDU function selector switch to RMT and the CDU display selector switch to WIND. Last entered values of true airspeed and current time will be displayed.

2.21.25.4.19 Magnetic Heading Entry and Display. The magnetic heading is displayed on the CDU left display and HSI whenever a manual entry of the magnetic variation has been entered. Determine the magnetic variation for present position, then accomplish the following procedure for magnetic variation entry.

1. CDU function selector switch — RMT.

2. CDU display selector switch — HDG DA.

3. Keyboard pushbutton W or E — Depressed.

Note

If direction of variation is west, depress W; for east, depress E.

4. Degrees of magnetic variation — Entered.

Note

Verify magnetic heading in the left display and magnetic variation in the right display.

5. INSERT pushbutton — Depressed.

Note

- A zero will appear as the extreme left character of the right display when true heading is being displayed. A 1 will appear when magnetic heading is being displayed.
- If correct magnetic heading is to be maintained, it will be necessary to update the INS as variation changes.

To remove magnetic heading, accomplish Magnetic Heading Entry procedure except that a zero variation is entered in step 4.

2.21.25.4.20 Wind Computation. The wind display is blank until TAS is entered or the computer (if installed) accepts computed true airspeed. If the TAS computer is available, manually zero the TAS to get the computer to accept manual insertion. Refer to paragraph 2.21.25.4.18.

2.21.25.4.21 Distance/Time Along Flight Plan Route. The cumulative distance and time along the flight plan route from present position to any waypoint can be displayed. This can be obtained on the ground as well as in flight, as long as the MSU mode selector switch is in STBY, ALIGN, or NAV with present position and route to be flown entered. To obtain this distance and time, perform the following manual operation:

1. CDU function selector switch — RMT.

2. Keyboard TK CHG pushbutton — Depressed.

3. Keyboard pushbutton 0 and desired waypoint number pushbutton — Depressed.

Note

Verify that from-to display is the two selected waypoints or present position and waypoint.

4. INSERT pushbutton — Depressed.

The total distance along the flight plan route selected will appear in the left display. The time will appear in the right display. Time is based on a fixed velocity of 512 knots when groundspeed is less than 100 knots, and is based on actual groundspeed when speed is greater than 100 knots.

2.21.25.4.22 Altitude Reference Mode Operation. Attitude reference mode operation enables the aircraft to use the INS as a source of pitch, roll, and platform heading (attitude) data. Attitude reference is selected in flight when the INS is providing attitude data but no navigational data, as indicated when the WARN annunciator illuminates with the MSU mode selector switch set to NAV, and extinguishes when the MSU mode selector switch is set to ATT REF.

Note

Switching to ATT REF with the MSU mode selector switch does not affect the attitude selection made with the attitude select switch(es) on the main instrument panel, since the same output is available with the MSU mode selector switch in either NAV or ATT REF.

If the WARN annunciator illuminates:

1. MSU mode selector switch — ATT REF.

If the WARN annunciator remains illuminated, the INS has malfunctioned and is not providing reliable navigational or attitude data. If the annunciator extinguishes, the INS is providing accurate attitude data but no navigational data.

If the WARN annunciator extinguishes:

2. Verify that the left and right numerical and from-to displays are blank.

If the WARN annunciator remains illuminated:

CAUTION

Disengage autopilot prior to switching attitude reference with the attitude select switch(es).

3. Attitude select switches — GYRO ATT.

4. MSU mode selector switch — OFF.

5. NAV SEL switch — As Desired (except INS).

Note

Once the MSU mode selector switch on the LTN-72 INS is placed in ATT REF, a ground alignment must be performed before normal navigation can be resumed. An in-flight alignment may be performed for the LN-100 INS.

2.21.25.4.23 Search Mode Operation. Search mode data can be entered and search pattern initiated whenever the system is in NAV mode. Search pattern designation as well as initiation and termination of search modes are all accomplished through use of the CDU from-to display. Both systems can be programmed for search patterns and coupled to the autopilot.

In all CDU selector positions except DSR TK STS, the from-to display functions as described previously until a search mode is initiated, and then displays 77.

With the CDU display selector switch in DSR TK STS, the following search mode information is displayed:

FROM-TO	DESCRIPTION
00	Search Mode Disabled
22	Ladder
33	Sector
44	Square
55	Auto Search Start (when to waypoint is reached)
66	Manual Search Start

Like numbers only can be inserted when the CDU display selector switch is in DSR TK STS. Unlike numbers will be rejected. Search pattern designation, data entry, search mode initiation, and termination are accomplished as follows:

1. A search pattern may be designated by depressing the TK CHG pushbutton with the CDU display selector switch in DSR TK STS and entering either 22 (ladder), 33 (sector), or 44 (square) as desired. The CDU function selector switch must be in either AUTO or MAN.

2. Search mode parameters required to define each search pattern may then be entered through the DSR TK STS left and right displays. Search mode data must be entered and verified on the CDU prior to beginning the search.

3. Search mode may then be enabled in one of two ways:

   a. Manually — By inserting 66 into the from-to display (with CDU display selector switch set to DSR TK STS), the search pattern is immediately initiated and present position is used as the datum modem point.

   b. Automatically — When 55 is inserted into the from-to display (with CDU display selector switch set to DSR TK STS), search mode will not be entered until distance to go to the to waypoint reaches 0. At that time, present position is stored as the datum modem point and the search pattern is initiated.

Note

Manually inserted crosstrack offsets are automatically removed at the time 55 or 66 is entered.

The search pattern (22, 33, or 44) must have been designated before search initiation (55 or 66) can be accomplished. Once 55 or 66 is entered, it will be displayed in the from-to display (with the CDU display selector switch in DSR TK STS) for approximately 5 seconds, after which the display will revert back to the search pattern being flown. The from-to display indicates 77 in all CDU display selector switch positions other than DSR TK STS, once a search pattern has been initiated.

Note

Should the operator wish to recall search mode parameters during search execution, the CLEAR pushbutton may be pressed on the CDU. With the CDU display selector switch set to DSR TK STS, search data will be displayed for approximately 5 seconds. The method of search mode initiation (55 or 66) will also be displayed for 5 seconds. During search operation, search mode data cannot be entered or altered.

4. Two steps are required to terminate a search mode:

   a. 00 must be entered through the from-to display with the CDU display selector switch set to DSR TK STS.

   b. A new track must be established by entering a track change. The CDU display selector switch must be in a position other than DSR TK STS.

Once a search mode is partially terminated (by entering 00), the TK CHG pushbutton will flash, indicating the need to establish a new track. Should the operator fail to make a track change before the aircraft reaches the current waypoint (waypoint 8), the INS will behave as if in the manual mode, regardless of the setting of the CDU function selector switch. The ALERT light will begin flashing as an indication to change tracks, but the aircraft will continue on the previously determined track until a track change has been initiated.

Once a 55 or 66 has been entered into the system, the only entry allowed with the CDU function selector switch in DSR TK STS is 00; anything else will be rejected.

a. Search Mode Initialization. The operator has the option of initiating a search mode either manually (66) or automatically (55). The procedure for automatic search initialization with the INS coupled to the autopilot is as follows:

1. Enter the search initialize latitude and longitude position into the CDU as a waypoint.

2. Set the CDU function selector switch to AUTO or MAN.

3. Select a desired track to the search initialize waypoint (by entering the waypoint used for the search initialize position as the to waypoint).

4. Two steps are required to terminate a search mode: in DSR TK STS, enter and verify the search mode data for the desired searchpath.

5. Couple the autopilot to the INS.

6. With the CDU display selector switch set to DSR TK STS, enter 55 into the from-to display. When distance to go reaches zero, the search pattern will automatically begin.

Note

Should search parameters be entered that would produce nonoptimal steering (i.e., excessive overshooting) the TK CHG and INSERT lights will flash at the time the search pattern is initiated. The pattern may be continued, should the operator desire, with the lights flashing, or search mode may be terminated and new parameters inserted.

b. Search Mode Readouts. CDU readouts during search mode operation are as follows:

1. From-to display indicates 77 in all positions of the display selector switch except DSR TK STS.

2. XTK/TKE display values are aircraft position with respect to the searchpath.

3. Waypoints 7, 8, and 9 contain position coordinates of from, to, and next waypoints.

Note

Waypoints 7, 8, and 9 coordinates change as search progresses. During search mode operation, waypoints 7, 8, and 9 cannot be manually changed.

4. DIS/TIME display values are with respect to the to waypoint (waypoint 8) of the search.

5. Desired track with respect to the searchpath is displayed in the DSR TK STS position.

HSI readouts for the INS being used are as follows:

1. Course arrow with respect to the compass card is the desired track angle of the searchpath.

2. Course arrow with respect to the “T” end of the bearing pointer is the track-angle error of aircraft track with respect to desired track angle of the searchpath.

3. Course bar indications display crosstrack distance deviation from desired searchpath (one dot deviation equals 3,000 yards, about 1.5 nm).

4. Compass card with respect to the lubber line is the true heading of the aircraft.

5. The “T” end of the bearing pointer with respect to the compass card is the track angle of the aircraft.

6. The “T” end of the bearing pointer with respect to the lubber line is the drift angle of the aircraft.

c. Termination of Search Mode. The following procedure must be used in order to terminate the search mode:

1. Verify that the coordinates of fly-to waypoint are entered into any numbered waypoint except waypoints 7, 8, or 9.

2. CDU display selector switch — DSR TK STS.

3. Keyboard TK CHG pushbutton — Depressed.

Note

Verify that TK CHG and INSERT pushbuttons are illuminated.

4. In sequence, press 0 pushbutton two times.

Note

Verify that TK CHG pushbutton is now flashing.

5. CDU display selector switch — Any position except DSR TK STS.

6. Keyboard TK CHG pushbutton — Depressed.

Note

Verify that TK CHG and INSERT pushbuttons are illuminated.

7. In sequence, press 0 pushbutton and then waypoint number selected in step 1. Search mode is now terminated.

Note

Termination is required before a new search pattern can be designated.

d. Search Modes Data Entry and Display. The three search patterns that have been mechanized in the INS are:

1. Ladder (creeping line)

2. Sector

3. Square (expanding square)

Any one of the three search modes is capable of being programmed into the INS (see Figure 2-130). Search mode data may be entered and displayed either on the ground or in flight, but only with the MSU mode selector switch positioned to NAV.

Search mode data must be entered and verified on the CDU prior to beginning the search pattern.

Note

- Recall of the original search mode data may be accomplished by momentarily depressing the CDU CLEAR pushbutton.

- If less than minimum values of track spacing, radius, or sweep width are entered into the INS, the CDU TK CHG and INSERT pushbuttons will flash at the time the search is initiated and erratic track leg switching may occur during execution of the search pattern.

e. Ladder Search Variables. Four variables are required to be inserted into the INS to define the ladder searchpath:

1. Major search axis-angle (0) with respect to true north in degrees and tenths of degrees. Range of variable is 0.0° to 359.9°.

2. Sweep width (W) in nautical miles. Range of variable is 0.0 to 999.9 nm.

3. Track spacing (S) in nautical miles. Range of variable is 0.0 to 99.9 nm.

4. Direction of first turn: right bank R, left bank L.

Note

Track leg switching will occur prior to each waypoint. Switching time is variable, depending on groundspeed.

f. Ladder Search Data Entry and Display. The ladder search data for the following example is major search axis (0) of 310.1°, a sweep width (W) of 40.0 nm, a track spacing (S) of 10.0 nm, and the first turn to the left. Enter the ladder search data as follows:

1. CDU function selector switch — MAN or AUTO.

2. CDU display selector switch — DSR TK STS.

Note

Verify that from-to display shows 00.

3. Keyboard TK CHG pushbutton — Depressed.

4. Keyboard pushbuttons — Depressed.

Note

Depress keyboard pushbutton 2, two times.

5. Keyboard INSERT pushbutton — Depressed.

Note

Verify that four zeros appear in both the left and right displays.

6. Keyboard pushbutton L — Depressed.

Note

Verify that left display blanks and INSERT pushbutton illuminates.

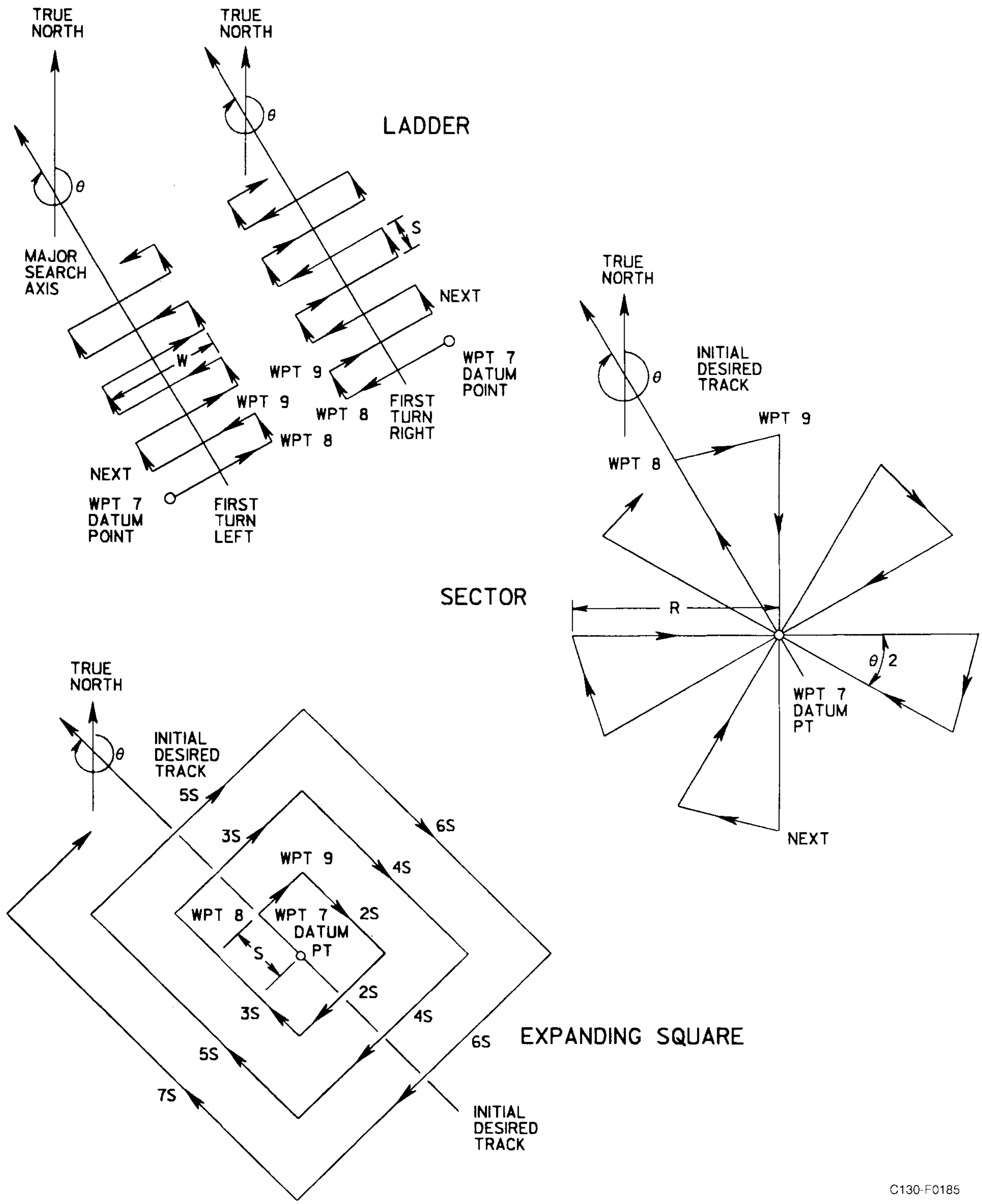


Figure 2-130. INS Search Patterns

7. In sequence, press 3, 1, 0, and 0 keyboard pushbuttons — Depressed.

Note

Verify that the left display is the major search axis angle entered.

8. INSERT pushbutton — Depressed.

9. Keyboard pushbutton R — Depressed.

Note

Verify that right display blanks and INSERT pushbutton illuminates.

10. In sequence, press 4, 0, and 0 keyboard pushbuttons — Depressed.

Note

Verify that the right display is the sweep width entered.

11. INSERT pushbutton — Depressed.

12. CDU function selector switch — RMT.

13. Keyboard pushbutton L — Depressed.

Note

L is pressed for the first turn left direction and R is pressed for first turn right direction. Also verify that INSERT pushbutton is on.

14. In sequence, press 1, 0, and 0 keyboard pushbuttons — Depressed.

Note

Verify that first turn direction and track spacing are correct on the display.

15. INSERT pushbutton — Depressed.

Note

CDU TK CHG and INSERT pushbuttons will flash if less than minimum values have been entered for search pattern track legs.

g. Sector Search Variables. Three variables are required to be inserted into the INS to define the sector searchpath:

Note

All turns are right bank.

1. Radius (R) in nautical miles; range of variable is 0 to 99 nm.

2. Leg separation angle (0_2) in degrees and tenths of a degree; range of variable is 0.0° to 99.9°. 10° minimum 0_2 is recommended for groundspeeds above 140 knots.

3. Initial desired track angle (0_1) with respect to true north in degrees and tenths of a degree. Range of variable is 0.0° to 359.9°.

Note

Track leg switching will occur prior to each waypoint. Switching time is a variable as a function of groundspeed.

h. Sector Search Data Entry and Display. The sector search data for the following example with an initial desired track angle (0_1) of 33°, a search radius (R) of 10 nm, and a leg separation angle (0_2) of 30.0°. For sector search patterns, all turns are right bank. Enter the sector search data as follows:

1. CDU function selector switch — MAN or AUTO.

2. CDU display sector switch — DSR TK STS.

Note

Verify that from-to display shows 00.

3. Keyboard TK CHG pushbutton — Depressed.

4. Keyboard pushbuttons — Depressed.

Note

Depress keyboard pushbutton 3, two times.

5. Keyboard INSERT pushbutton — Depressed.

Note

Verify that four zeroes appear in the left display and that five zeroes appear in the right display.

6. Keyboard pushbutton L — Depressed.

Note

Verify that left display blanks and INSERT pushbutton illuminates.

7. In sequence, press 3, 3, 0, and 0 keyboard pushbuttons — Depressed.

Note

Verify that the left display is the initial desired track angle entered.

8. Keyboard INSERT pushbutton — Depressed.

9. Keyboard pushbutton R — Depressed.

Note

Verify that right display blanks and INSERT pushbutton illuminates.

10. In sequence, press 1, 0, and then 3, 0, and 0 keyboard pushbuttons — Depressed.

Note

Verify that the right display shows the search radius and leg separation entered.

11. INSERT keyboard pushbutton — Depressed.

i. Expanding Square Search Variables. Two variables are required to be inserted into the INS to define the expanding square searchpath:

Note

All turns are right bank.

1. Sweep width (S) in tenths of a nautical mile; range of variable is 0.0 to 99.9 nm.

2. Initial desired track angle (0) with respect to true north in degrees and tenths of a degree; range of variable is 0.0° to 359.9°.

j. Expanding Square Data Entry and Display. The expanding square data for the following example is with an initial desired track angle (0) of 315.0° and sweep width (S) of 15.0 nm. For the expanding square search pattern, all turns are right bank.

Enter expanding square search data as follows:

1. CDU function selector switch — MAN or AUTO.

2. CDU display selector switch — DSR TK STS.

Note

Verify that from-to display shows 00.

3. Keyboard INSERT pushbutton — Depressed.

4. Keyboard pushbuttons — Depressed.

Note

Depress keyboard pushbutton 4, two times.

5. Keyboard INSERT pushbutton — Depressed.

Note

Verify that four zeroes appear in the left display and three zeroes appear in the right display.

6. Keyboard L pushbutton — Depressed.

Note

Verify that left display blanks and INSERT pushbutton illuminates.

7. In sequence, press 3, 1, 5, and 0 pushbuttons — Depressed.

Note

Verify that the left display is the initial desired track angle entered.

8. Keyboard INSERT pushbutton — Depressed.

9. Keyboard pushbutton R — Depressed.

Note

Verify that right display blanks and INSERT pushbutton illuminates.

10. In sequence, press 1, 5, and 0 pushbuttons — Depressed.

Note

Verify that the right display is the sweep width entered.

11. Keyboard INSERT pushbutton — Depressed.

2.21.25.4.24 After Landing Operations

a. Navigation Accuracy Check. The accuracy of the INS should be determined at the end of each INS flight prior to system shutdown. The check should be made when the aircraft is parked at a known location.

Check the INS accuracy as follows:

1. Using Update Removal or Position Update Check procedure, remove all position updates.
2. Verify correct parking position coordinates and enter as a waypoint.
3. CDU function selector switch — AUTO or MAN.
4. Enter TK CHG from present position (0) to parking position waypoint.
5. CDU display selector switch — DIS/TIME.
6. System error in nm/hr — Computed.

Divide distance display by the number of hours and tenths of an hour of flight time in the navigation mode.

b. In-Transit Stops. The system should be left in the navigation mode of operation during short in-transit stops when the navigation accuracy does not require improvement.

c. INS Shutdown. The system is shut down by pulling and rotating the MSU mode selector switch to the OFF position.

2.21.26 LTN-211 Omega Navigation System

Note

As of 1 October 1997, ONS is inoperative because of decommissioning of Omega stations worldwide.

2.21.27 True Airspeed Computer. The TAS computer provides TAS input to the No. 1, No. 2, or No. 3 INS. True airspeed is displayed on the TAS indicator on the navigator instrument panel (see Figure 2-131). The TAS computer and a transducer are

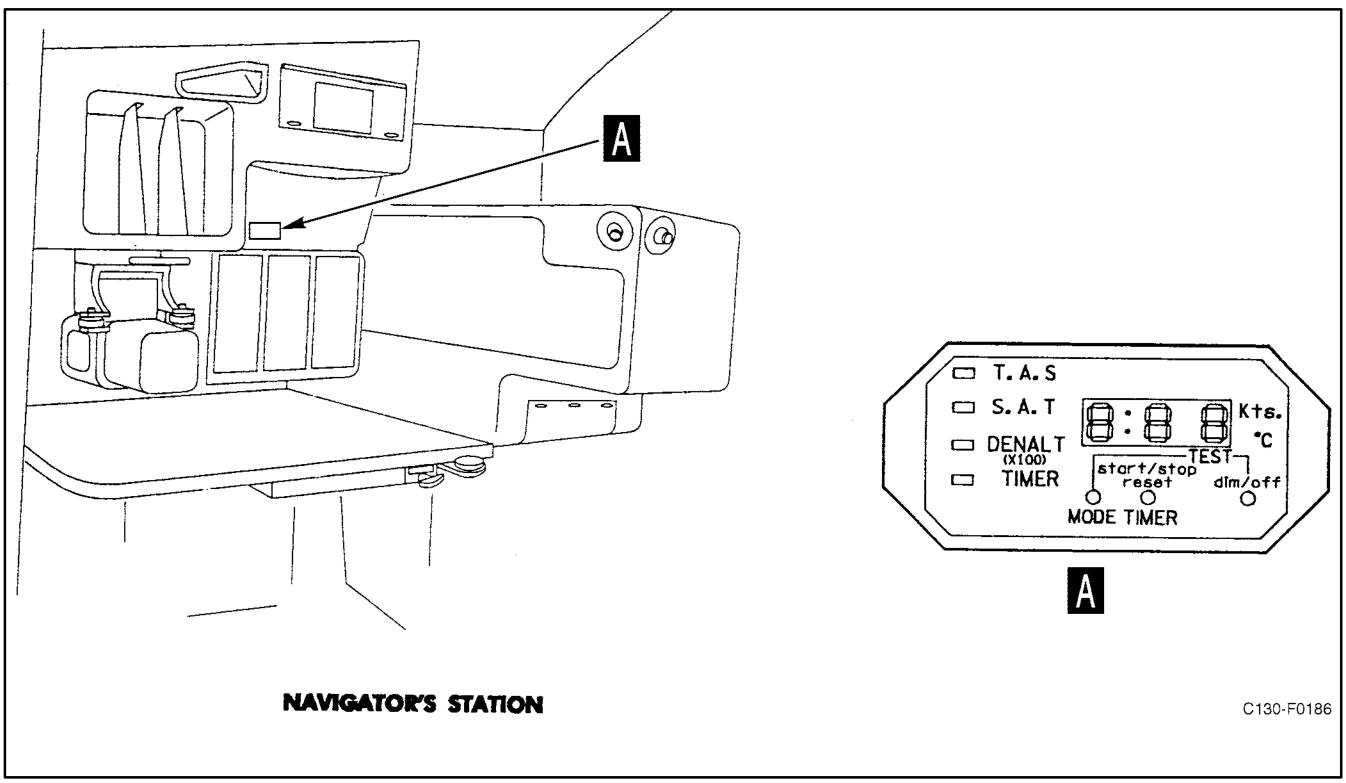


Figure 2-131. True Airspeed Computer Indicator

mounted on the right-hand underdeck rack (see Figure 2-83). Ram air pressure and atmospheric pressure to operate the TAS computer is provided by the pitot-static system (see Figure 2-80). Outside air temperature is provided from a total temperature probe installed on the left side of the aircraft above the crew entrance door. The TAS computer uses 26-Vac power from the essential ac bus through the TAS circuit breaker on the pilot upper circuit breaker panel. The TAS computer also uses 28-Vdc power from the essential dc bus through the TAS circuit breaker on the copilot upper circuit breaker panel.

2.21.27.1 True Airspeed Computer Indicator. The true airspeed computer indicator is mounted on the navigator instrument panel (see Figure 2-131). There are three pushbutton switches on the front of the indicator. Each switch is momentary and will continuously advance the operation until released. One pushbutton is for changing modes. One pushbutton is for starting, stopping, and resetting the timer. The other pushbutton is used to control the brightness of the display and for lamp test. Legends are backlighted for indicating the display operating mode and °C or knots.

To test the true airspeed computer indicator lights, depress the MODE and dim/off buttons simultaneously. Assure that the three displays indicate 8 and that the mode indicators, the colon, Kts, and °C annunciators flash.

2.21.28 AN/APS-133(M) Multimode Radar Set. The AN/APS-133(M) multimode color radar set consists of the following components: an antenna, a receiver-transmitter, a pilot and navigator indicator, an interface unit, a radar control panel, a display control unit, and a sector scan control panel (see Figure 2-132). The radar set operates on 28-Vdc power from the main dc bus and 115-volt primary ac power from the essential ac bus on aircraft prior to 165313 and from the essential avionics bus on aircraft 165313 and up through the RADAR circuit breakers on the copilot upper circuit breaker panel.

The multimode radar features include weather avoidance, long-range beacon homing incorporating marker and delay modes, ground and air-to-air mapping capability, IFF display, INS waypoint and course line overlays, refueling offset line, and target marker

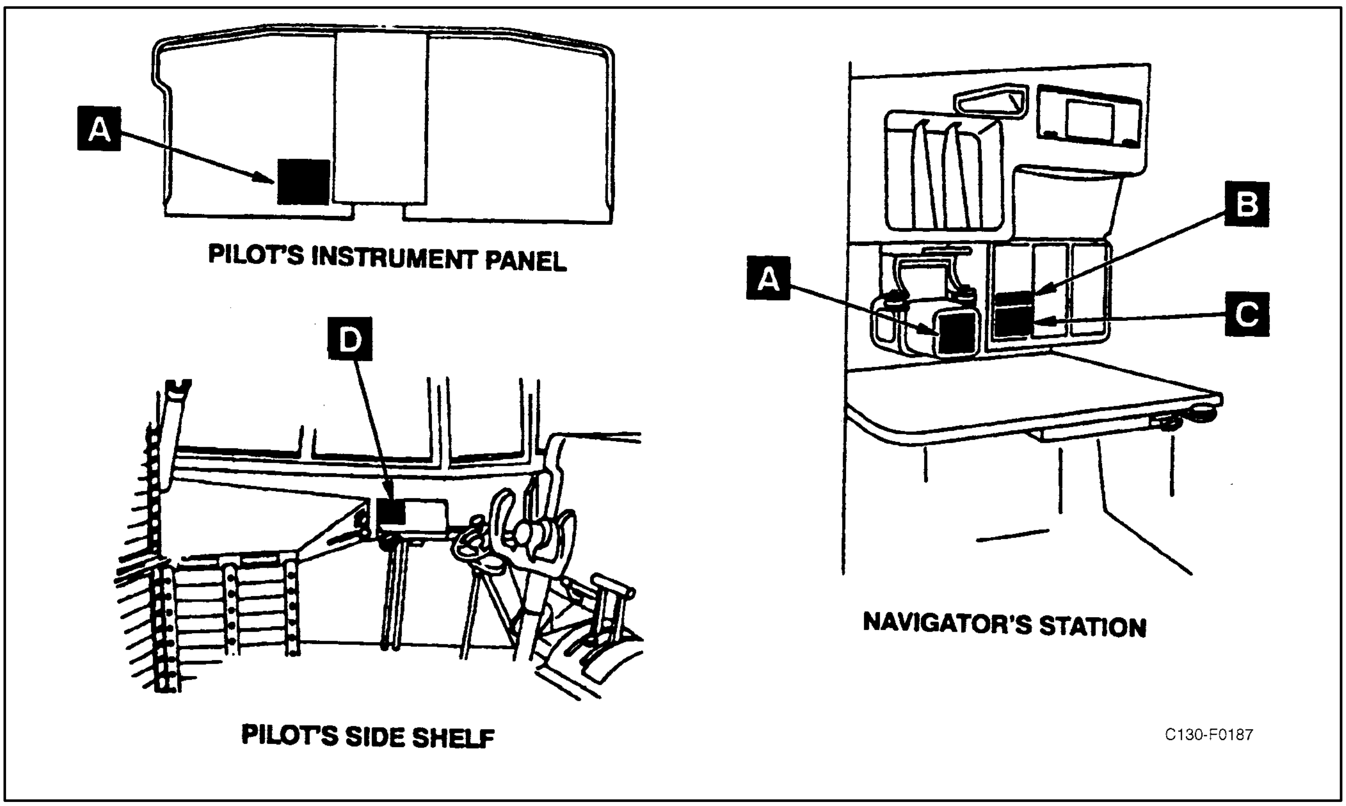


Figure 2-132. AN/APS-133(M) Multimode Radar Indicator Control Panels (Sheet 1 of 2)

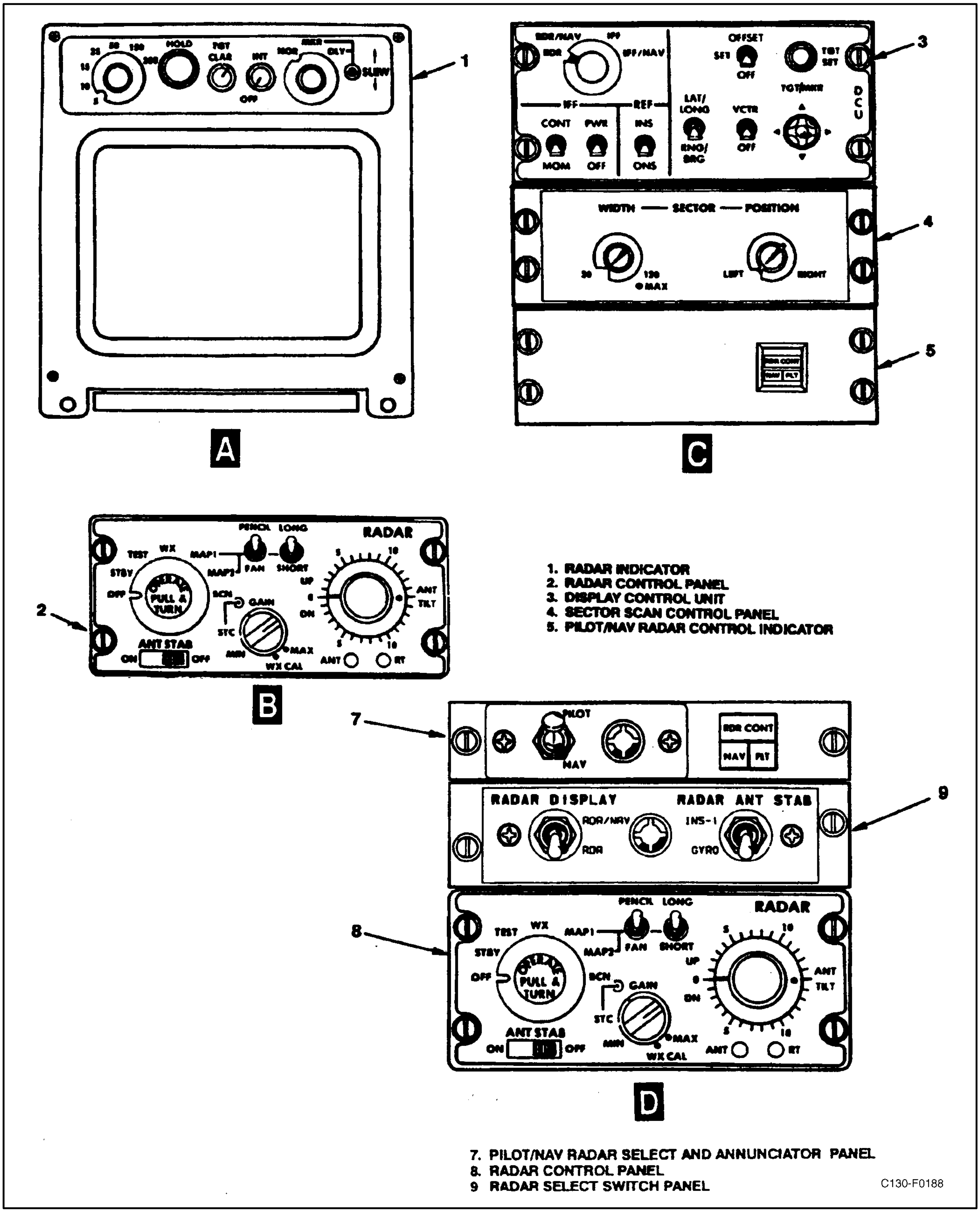


Figure 2-132. AN/APS-133(M) Multimode Radar Indicator Control Panels (Sheet 2)

providing either LAT/LONG coordinates or range/bearing data.

As a weather avoidance radar, the set detects and displays precipitation areas in red, yellow, and green. The red areas indicate heaviest precipitation or storm centers, yellow indicates lower precipitation rates, and green indicates lightest rainfall. Azimuth lines, fixed range marks, and alphanumerics are displayed in blue. Automatic penetration circuits prevent storm areas at close range from masking other storm areas at the same azimuth but longer range.

As a terrain mapping radar, the set scans a selected range of Earth and provides a display of prominent topographical features such as lakes, rivers, islands, high ground, bridges, cities, etc. These features are presented on the indicator in a display resembling an ordinary pilotage chart. The detected terrain features are displayed in red, yellow, and blue according to the strength of the target returns: red for strongest returns, yellow for medium, and blue for lowest. Azimuth lines, range marks, and alphanumerics are displayed in green.

In the air-to-air mapping function, the set presents a display of other aircraft in the immediate vicinity of the present flightpath. Detected aircraft are displayed in red, yellow, or blue: red for strongest returns, yellow for medium level, and blue for lowest level. Azimuth lines, fixed-range marks, and alphanumerics are displayed in green. The effective range in this function is limited by the size of the target aircraft, but detection of a large aircraft such as a C-130 could be expected at 10 nm.

As a beacon navigation radar, the set transmits an interrogation signal to trigger an X-band beacon. Operating beacons within range transmit a response pulse that is received by the radar set and displayed as an arc on the indicator at the relative bearing and distance to the beacon. The beacon response is displayed in green only. Azimuth lines, range marks, and internally generated alphanumerics are displayed in blue.

IFF codes from cooperating aircraft (green lines) can be displayed along with LAT/LONG or range/bearing when the target marker feature is used. Azimuth lines, range marks, and internally generated alphanumerics are displayed in blue.

INS waypoints and connecting course lines can be displayed in addition to IFF codes from cooperating aircraft. Azimuth lines, range marks, and internally generated alphanumerics are displayed in blue.

2.21.28.1 Controls and Indicators. The radar set operating controls and indicators are contained on the radar indicators and the following panels:

1. At the navigator station — Radar control panel, display control unit, sector scan control panel, and pilot/navigator radar control indicator.

2. At the pilot side panel — Pilot/navigator radar select and annunciator panel, radar control panel, and radar switch panel.

2.21.28.1.1 Radar Indicators. The radar indicators contain the following controls for radar indicator presentation.

a. Range Selector. The range selector selects the range in nautical miles displayed on the radar indicator and the distance between fixed-range markers: 5 nm with 1-nm range markers; 10 nm with 2-nm range markers; 15 nm with 3-nm range markers; 25 nm with 5-nm range markers; 50 nm with 10-nm range markers; 150 nm with 30-nm range markers; or 300 nm with 60-nm range markers. The selected range/range-marker combination is displayed in the upper right corner of the radar indicator scope.

b. HOLD Pushbutton. The HOLD pushbutton allows the operator to freeze the display. When HOLD is pressed in, the present display on the radar indicator is retained instead of being updated by subsequent azimuth scans. The notation HOLD flashes alternately with the function (WX, BCN, etc.) in the upper left corner of the radar indicator scope. Pressing HOLD again or changing range selector position resumes normal updating of the display.

c. TGT CLAR Control. The TGT CLAR control adjusts threshold for first-level radar returns (green data in WX and BCN, blue data in MAP1 and MAP2) and allows reduction of extraneous background noise.

d. INT Control. The INT control adjusts brightness (intensity) of presentation on the radar indicator for best signal visibility and contrast, and also contains the OFF switch for the indicator.

e. NOR-MKR-DLY Switch. The NOR-MKR-DLY switch selects the video presentation mode. In NOR, the normal video display is presented with zero range at the bottom center of the scope. In MARK, a yellow variable range marker is added. The position (range) of the variable marker is controlled by the SLEW control and is displayed in the upper right corner of the radar indicator. In DLY, the range sweep starts at the variable range marker setting, as displayed in the upper right of the indicator. The full range (with fixed-range marks) selected by the range selector switch on the indicator is displayed. The notation DLY is displayed in the upper left of the radar indicator and the minimum range is displayed in the upper right. For example, if the range scale selected is 50/10 and the variable marker is set at 100 nm, only the range from 100 nm to 150 nm would be displayed, with 100 nm at the bottom center of the indicator and the legends DLY and 100 would be displayed in the upper left and upper right, respectively.

2.21.28.1.2 Radar Control Panel. The radar control panel contains the following controls for the multimode radar set.

a. Function Selector Switch. The function selector is a seven-position, pull-and-turn action switch. In OFF, all power is removed from the radar set. In STBY, a 3-minute warmup time delay is activated. In TEST, the radar set radiates into a dummy load, a test pattern is displayed on the radar indicator (if 3-minute delay from OFF has expired), and the system executes an internal test sequence. The ANT and/or RT fault indicators may light to signal detected faults. In WX, the set displays weather detection information and the antenna radiates a narrow pencil beam. MAP1 and MAP2 are used for terrain mapping. The antenna beam pattern is selectable by the PENCIL/FAN switch. The MAP2 position is recommended for low-level mapping and for short-range, air-to-air operation. In BCN, bearing and distance information relative to responding beacon stations is displayed. In all positions except OFF and STBY the selected function is displayed on the upper left of the radar indicator scope.

b. PENCIL-FAN Switch. The PENCIL-FAN switch is enabled only in the MAP1 and MAP2 functions. When enabled, it selects the radiated beam shape. The pencil beam is a narrow, symmetrical beam approximately 3° in elevation and azimuth. The fan beam is broadened in the elevation plane.

c. LONG-SHORT Switch. The LONG-SHORT switch selects long (5.0 microseconds) or short (0.4 microsecond) pulse while in map modes.

d. ANT TILT Control. The ANT TILT control selects the tilt of the azimuth scan plane from +14° to –14° in relation to the selected 0° plane selected by the ANT STAB switch.

e. ANT STAB Switch. The ANT STAB switch enables or disables antenna stabilization. In ON, the antenna is roll and pitch stabilized within limits throughout azimuth scan so that 0° tilt is the true horizontal plane. In OFF, the 0° antenna tilt is the present plane of the aircraft.

CAUTION

> The ANT STAB switch should be in ON during all normal operation of the AN/APS-133(M). It may be turned to OFF if antenna stabilization fails during flight.

f. GAIN Control. The GAIN control provides manual control of receiver gain and has concentric knobs. The outer knob, when fully clockwise in the WX CAL position, provides preset calibrated functions such as contour and penetration compensation. The inner knob is for variable sensitivity time control. It is active in the MAP2 mode and LONG/SHORT pulse, and inactive in all other modes.

g. ANT and RT Indicators. In TEST function only, the ANT and RT indicators light to indicate detected faults.

2.21.28.1.3 Display Control Unit. Display control unit functions affect the navigator indicator only.

a. Display Mode Selection Switch. A four-position rotary switch selects one of four mutually exclusive display mode presentations; radar only (RDR), radar with navigation overlay (RDR/NAV), IFF only, and IFF with navigation overlay (IFF/NAV).

In the RDR display mode, the interface unit is turned off and transmits no data to the indicator. In this display mode, the indicator displays only the normal radar return as selected at the radar control panel and operation of any other controls on the display control unit will have no effect on the radar display.

In the RDR/NAV display mode, the radar returns are overlayed with navigation information obtained from an INS system. In this mode, the TGT MKR controls are active. Navigation data may be displayed on both the navigator and pilot indicators when the radar display switch on the pilot radar select switch panel is placed in the RDR/NAV position.

In the IFF display mode, only IFF targets and azimuth lines are displayed on the indicator. The TGT MKR and refueling OFFSET controls are functional in this mode.

In the IFF/NAV display mode, the IFF display is overlayed with navigation information obtained from an INS. The TGT MKR and refueling OFFSET controls are functional in this mode.

b. IFF Power Switch. The IFF power switch controls power to the AN/APX-76B IFF system.

c. IFF Challenge Switch. The IFF challenge switch controls the type of challenge to be enabled by the AN/APX-76B IFF system, either momentary (MOM) or continuous (CONT). The MOM position is spring loaded to return to the center (OFF) position.

d. REF Switch. The REF switch selects which navigation system is to be used for the radar.

2.21.28.1.4 Target Marker System. There are five selectors used to control the target marker system and associated information.

1. A four-position TGT/MKR left-right-up-down slew switch used to call up the target marker display and the marker position.

2. A two-position (LAT/LONG-RNG/BRG) switch to select the display format of the target marker coordinates in latitude/longitude or range/bearing.

3. A two-position (VCTR-OFF) mode switch to select vector mode display.

4. A momentary-contact pushbutton switch (TGT SET) used to select a variable origin for range and bearing data, when in the vector mode.

5. A three-position (OFFSET-SET-OFF) switch is used in the SET position to set a vertical offset line to facilitate tanker tracking during aerial refueling operations. Azimuth position of the offset line can be set with left or right movement of the TGT/MKR switch. The OFFSET position frees the TGT/MKR switch for other uses but retains the offset display.

TGT/MKR will not display if data is not received from the selected navigation system, or if the RDR mode is selected.

VCTR (ON)-TGT/MKR is displayed with VCTR selected. After the TGT/MKR switch is held for 1/2 second, it moves in the commanded direction within screen display limits. When the switch is released for 1 second, the coordinates in LAT/LONG are computed to one-tenth of a minute resolution and displayed. In RNG/BRG, the TGT/MKR initial point of reference is present position. A new point of reference (that point from which calculations are made) can be established by slewing the TGT/MKR over the new point and pressing TGT SET. A vector line will be drawn from this point to the next TGT/MKR position. The following information will be displayed in the lower left corner of the indicator:

1. MKR — Indicates vector mode.

2. R:XXX — Indicates range in nm.

3. TO:XXXx — Indicates magnetic or true heading to the target.

4. FR:XXXx — Indicates magnetic or true heading from the target.

5. OFF (VECTOR) — After the TGT/MKR switch is released, the LAT/LONG coordinates are displayed. In RNG/BRG, aircraft present position will always be the reference point and the TGT SET is disabled. The vector will be drawn from present position to the TGT/MKR positions, if in IFF or IFF/NAV.

2.21.28.1.5 Display Messages. If the radar is selected to a particular mode and the data is not supplied (i.e., IFF mode selected but the IFF switch is not turned to ON) the message NO IFF will be displayed on the indicator.

2.21.28.1.6 Sector Scan Control Panel. The sector scan control panel allows the operator to select a more narrow sector for antenna scanning. The WIDTH knob is detented to the 180° scan mode. As soon as this knob is moved from the detent, the antenna begins a 120° scan. By rotating the knob counterclockwise, the scan angle can be continuously reduced to 30°. The POSITION knob is used to select the centerline of the scan width. The scan centerline is continuously variable between 75° of the aircraft centerline.

2.21.28.2 Radar Select Switch Panel. The radar select switch panel contains the following controls for display selection and stabilization source selection.

1. RADAR DISPLAY switch — Selects the display to be presented on the pilot radar indicator. The two-position switch enables the pilot to select either RDR/NAV or RDR.
2. RADAR ANT STAB switch — Selects the source for stabilization of the radar antenna. In the GYRO position, stabilization is provided by the No. 2 flight director gyro (vertical reference). In the INS-1 position, stabilization is provided by the No. 1 INS.

2.21.28.3 Pilot/Navigator Radar Select and Annunciator Panel. The pilot/navigator radar select and annunciator panel (see Figure 2-132) located on the pilot side shelf extension has a two-position (PILOT-NAV) switch and a combination RDR CONT PLT-NAV annunciator. The PILOT-NAV switch permits the pilot to select the desired radar control panel (pilot or navigator) for control of the weather map or beacon functions. If the switch is positioned to NAV (navigator control panel) and the IFF or IFF/NAV position is selected on the display control unit, control of the radar is automatically switched to the pilot radar control panel. The annunciator on the panel indicates which control panel (pilot or navigator) has control of the radar. The PLT annunciator illuminates when the pilot has control of the radar, and the NAV annunciator illuminates when the navigator has control.

2.21.28.4 Pilot/Navigator Radar Control Indicator Panel. The pilot/navigator radar control indicator panel (see Figure 2-132) on the navigator control panel contains a combination PLT-NAV RDR CONT annunciator. The PLT portion of the annunciator illuminates when the pilot has control of the radar, and the NAV annunciator illuminates when the navigator has control.

2.21.28.5 Normal Operation of the Radar Set

WARNING

Before placing the function selector switch to WX, MAP1, MAP2, or BCN, ensure that a radiation pattern is clear (37 feet for personnel, 52 feet for possible flammable liquid ignition). Avoid directing the energy beam toward structures, personnel grouping areas, or areas where aircraft are being refueled/defueled.

CAUTION

The radar R/T unit and waveguide are pressurized by aircraft cabin pressure. The radar set may be operated without pressurization up to 20,000 feet cabin pressure. If cabin pressurization is lost above 20,000 feet, the function selector switch must be placed to STBY to prevent arc-over in the magnetron.

2.21.28.5.1 System Test. To place the radar system in the test function, proceed as follows:

1. Verify that the stabilization reference (No. 2 flight director) is operating. On aircraft 163022 and up, if the No. 2 flight director stabilization is not operating, place the RADAR ANT STAB switch on the pilot radar select switch panel to the INS-1 position after the No. 1 INS has been turned on. Set the following controls to the positions listed:
   a. Radar control panel
      (1) Function selector switch to TEST.
      (2) ANT TILT control to 0.
      (3) GAIN control to WX CAL.
      (4) STC control fully clockwise.
   b. Radar indicator
      (1) Range selector to 150.
      (2) TGT CLAR control to midrange.

(3) INT control to midrange.

(4) NOR-MKR-DLY switch to NOR.

Note

If the function selector switch was in the OFF position, there will be a 3-minute warmup delay before the test pattern can be evaluated. If the function selector switch is positioned to TEST before the expiration of the 3-minute warmup delay, the radar indicator will either remain dark or display a series of narrow, colored bands (“persian rug” effect).

2. After expiration of initial 3-minute warmup period, a test pattern should be displayed on the radar indicator.

3. Adjust the INT control on the radar indicator for a comfortable brightness of the test pattern display.

4. Check test pattern for:

   a. The presence of five distinct color bands in the lower third of the scope: green, yellow, red, yellow, green. The width of each band is not critical. Absence of these color bands indicates a probable fault in either the receiver-transmitter or antenna.

   b. A gradual increase of green test noise from the outer edge of the outer green test band to approximately 80 nm, and a fairly uniform band of test noise (green) from approximately 80 nm to 100 nm. Either a uniform noise level from 50 to 100 nm or the absence of all noise in this region indicates a failed RT unit.

   c. Some random noise may be displayed beyond the green test noise band. The TGT CLAR control may be used to adjust background and test noise level. Adjustment of TGT CLAR control should reduce background noise to only a few random dots.

   d. Alphanumerics (TEST and 150/30), five azimuth cursors, and five segmented range markers displayed in blue.

   e. A three-color bar (red, yellow, green) below the 150/30 in upper right.

5. After evaluating test pattern, set function selector switch on radar control panel to STBY.

2.21.28.5.2 Radar System — Standby. When the radar function selector switch is set to STBY from TEST, WX, MAP1, MAP2, or BCN, most of the system components remain warmed up; only the magnetron and high-voltage circuits are deenergized. Full operation is resumed immediately when the function switch is returned to TEST, WX, MAP1, MAP2, or BCN. When the function switch is set to STBY, the ANT STAB switch should be left in the ON position.

2.21.28.5.3 Operation Without Antenna Stabilization. Failure of the antenna stabilization will cause a portion of the display to be blanked out while in level flight or cause targets to fade during roll or pitch movements of the aircraft. If antenna stabilization fails, set the ANT STAB switch on the radar control panel to OFF. This switch disables antenna stabilization and locks the antenna so that 0° tilt is the preset plane of the aircraft.

2.21.28.5.4 Radar Turnoff. To turn off the radar system equipment after use, position the controls as follows:

1. Radar indicator — Mode switch to NOR.

2. Radar control panel

   a. ANT TILT control to 0.

   b. ANT STAB switch to ON.

   c. GAIN control to WX CAL.

   d. STC control fully clockwise.

   e. Function selector switch to OFF.

2.21.29 C-12 Compass System. Two individual C-12 compass systems are installed in the aircraft. Each system provides an accurate heading reference to aid in navigation, regardless of the latitude position of the aircraft. In addition to providing a visual heading reference, each system furnishes heading information to other navigation systems in the aircraft (see Figure 2-133). Normally the No. 1 C-12 compass system supplies heading to certain systems and instruments, and the No. 2 C-12 compass system supplies heading to other systems and instruments. However, if one C-12 compass system should malfunction, it is possible to use the other C-12 compass system to supply heading to instruments and systems normally connected to the failed compass. The COMPASS DISPLAY selector switch on the pilot instrument panel can be used to select the No. 1 or No. 2 compass system (see Figure 2-134). When the switch is in the NORM position, heading is supplied by both compass systems as shown in Figure 2-133. Operating controls and indicators for the No. 1 and No. 2 compass systems are located on the digital controllers (see Figure 2-134) for each system. The digital controllers are located on the navigator instrument panel. Each system is capable of operating in either one of two modes. In the magnetic heading mode, used in latitudes where no distortion of the Earth's magnetic field is encountered, the directional gyro in the system is slaved to the Earth's magnetic field and the indicators display magnetic heading of the aircraft. In the directional gyro mode, used in latitudes where the magnetic meridian is distorted or weak, the system gyro acts as a directional gyro and maintains the position manually selected by the operator. The indicators display the manually established heading. The No. 1 and No. 2 compass systems receive ac power from the essential ac bus through the COMPASS NO. 1 and NO. 2 circuit breakers on the pilot upper circuit breaker panel. The compass coupler receives ac power from the essential ac bus through the COMPASS TRANSFER circuit breakers on the pilot upper circuit breaker panel. The No. 1 and No. 2 compass select relays receive 28-Vdc power from the essential dc bus through the COMPASS TRANSFER circuit breaker on the copilot upper circuit breaker panel.

2.21.29.1 C-12 Compass System Controls. Controls and indicators for the compass systems are located on the respective system digital controller (see Figure 2-134). The following paragraphs list the controls and indicators and describe their function in the system.

2.21.29.1.1 LATITUDE N-S Switch. The LATITUDE N-S switch allows selection of north (N) or south (S) latitude correction, dependent on aircraft location.

2.21.29.1.2 Latitude Knob. The latitude knob is rotated to set the correct latitude location, in degrees, of the aircraft position. This setting allows the compass system to automatically correct the Earth rate and coriolis errors at the set latitude.

2.21.29.1.3 Mode Switch. The mode switch selects compass operating mode. When the switch is set in the MAG position, the directional gyro in the compass is slaved to a magnetic azimuth detector. The digital reading on the heading indicator will show magnetic heading. This switch position is used in latitudes where no distortion of the Earth's magnetic field is encountered. When the switch is set in DG, the gyro acts as an independent directional gyro. The digital reading in the heading indicator is manually set with the synchronizer knob. This mode of operation is normally used for short-range navigation in the upper latitudes where the magnetic meridian is distorted or weak.

2.21.29.1.4 Synchronizing Control. The synchronizing control is used in conjunction with the annunciator to provide fast system synchronization when the compass system begins initial operation in the magnetic heading (MAG) mode selection of the mode switch. The synchronizer knob is rotated in the direction indicated by annunciator needle deflection markings above the annunciator until the needle is centered. When the needle is centered, the compass is synchronized in magnetic heading mode and the digital drums in the heading windows display the magnetic heading of the aircraft. When the directional gyro mode has been selected with the mode switch, the synchronizer knob is used to manually set the digital drums in the heading windows to the desired course heading.

2.21.29.1.5 Annunciator. The annunciator provides visual indication of system synchronization when the compass system begins initial operation in the magnetic heading mode.

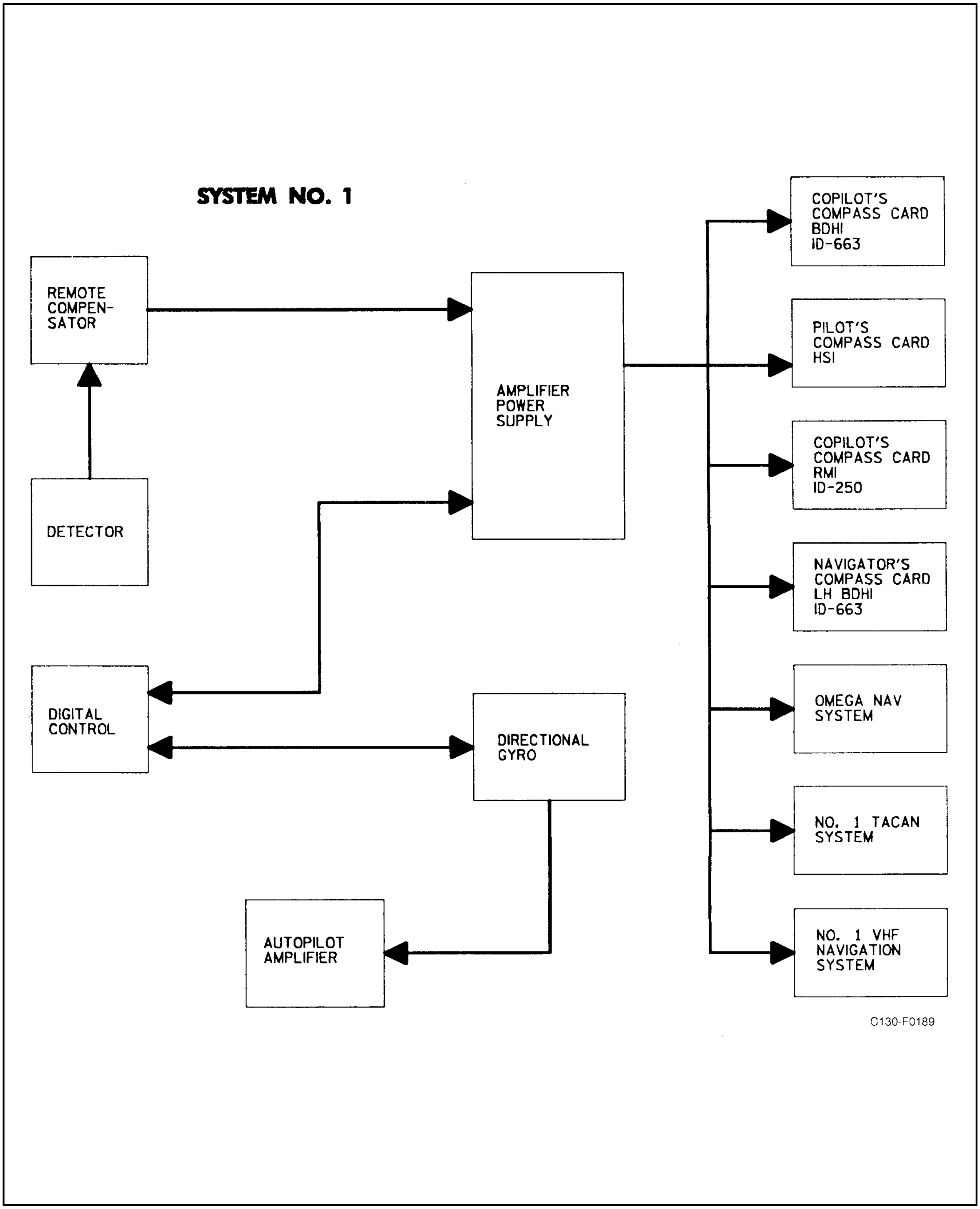


Figure 2-133. C-12 Compass System Tie-In (Sheet 1 of 2)

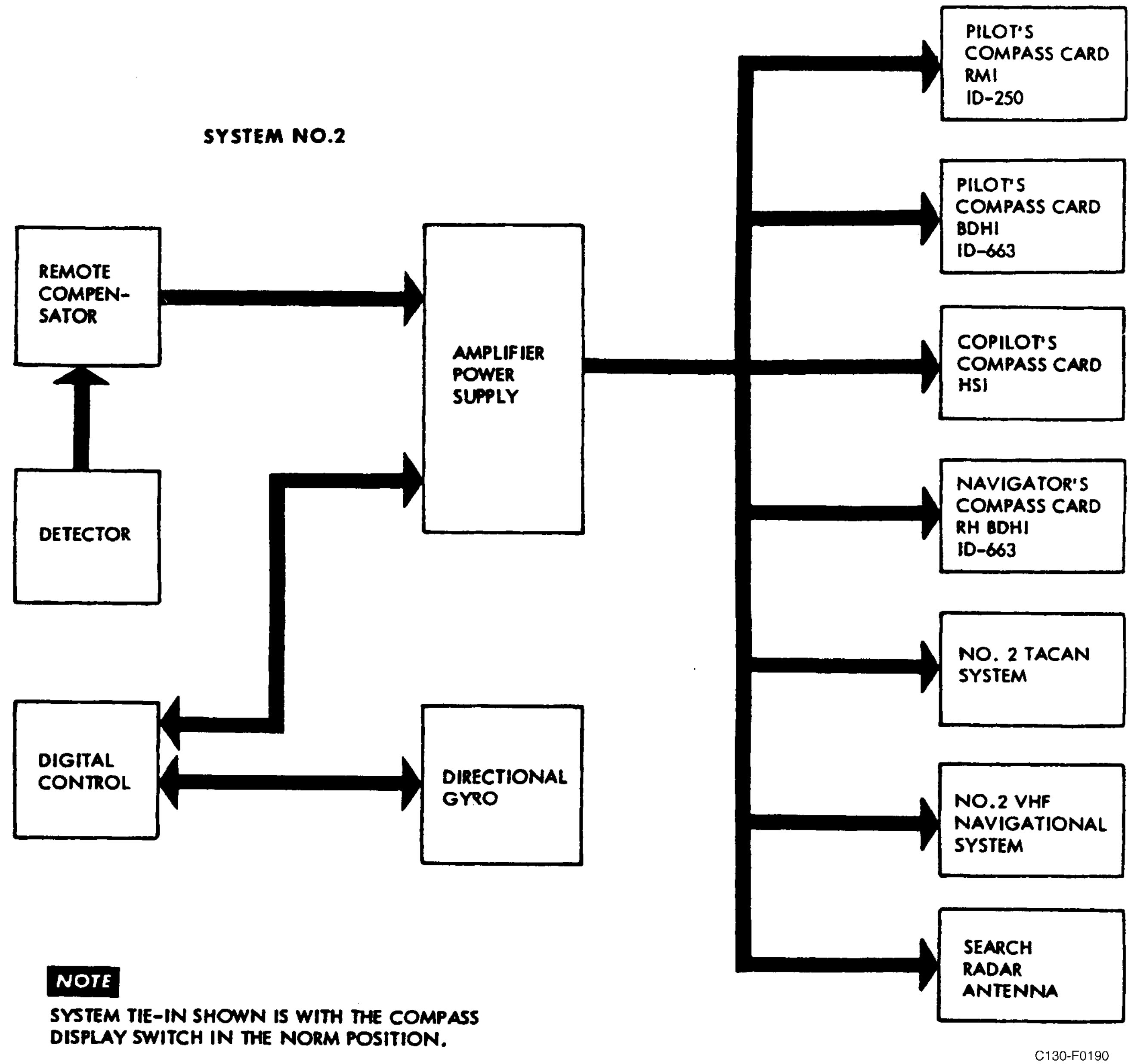


Figure 2-133. C-12 Compass System Tie-In (Sheet 2)

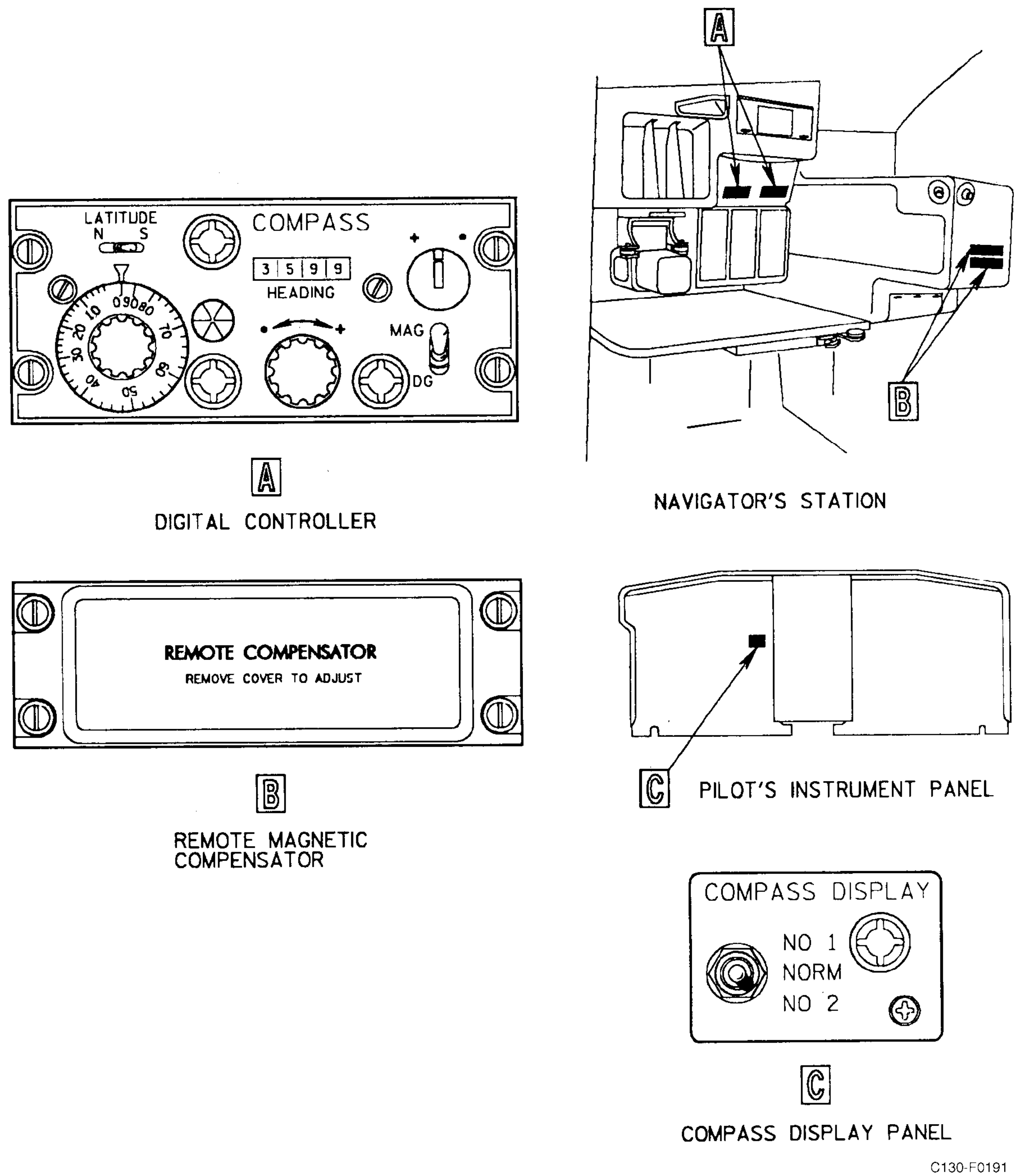


Figure 2-134. C-12 Compass System Control Panels and Magnetic Compensator

2.21.29.1.6 HEADING Indicator. The HEADING indicator provides digital readout of aircraft heading in 0.1° increments.

2.21.29.1.7 Power Adequacy Indicator. The power adequacy indicator gives a red indication to indicate that system power input has dropped below the safe operating level.

2.21.29.1.8 COMPASS DISPLAY Selector Switch. The COMPASS DISPLAY selector switch is located on the pilot instrument panel (see Figure 2-134). There are three switch positions: NO. 1, NORM, and NO. 2. Placing the switch in the NO. 1 position, operates the No. 1 compass select relay, which switches all instruments and systems to the No. 1 compass system. Placing the switch in the NO. 2 position, operates the No. 2 compass select relay, which switches all instruments and systems to the No. 2 compass system. In the NORM position, no switching occurs and heading is supplied by both compass systems as shown in Figure 2-133.

2.21.29.2 Normal Operation of the C-12 Compass System

Note

The C-12 compass systems begin to operate when power is supplied to the aircraft electrical ac buses. However, a 5-minute warmup is required for gyro stabilization.

To set the compass for desired aircraft heading:

1. Set the COMPASS DISPLAY switch to NORM.
2. Set LATITUDE N-S switch to correct latitude for aircraft position.
3. Rotate latitude knob to set present aircraft position degrees of latitude under the index. Additional settings may be required depending on direction and time in flight.
4. Set desired compass operating mode with the mode switch (MAG or DG).
5. If MAG has been selected in step 4, allow annunciator needle to center automatically or manually synchronize the system with the synchronizing control.
6. If DG position has been selected in step 4, set desired heading in the heading windows with the synchronizing control.

Note

During autopilot operation with the compass in DG, changing the heading with the synchronizer knob will cause a change only in the heading indicator and will not cause the aircraft to change heading.

2.21.29.2.1 Emergency Operation of the C-12 Compass. Emergency operation of the C-12 compass can be accomplished as follows:

1. The power adequacy indicator on the digital controller indicates that system power has dropped below safe operating level. Utilize the other C-12 compass system if it is still operable.
2. Position the COMPASS DISPLAY switch to select the C-12 compass system that is still operable.
3. In the event both systems become inoperable, the system may be operated as a directional gyro (DG mode), which will bypass coriolis and meridian convergency compensation since these circuits are applied to the magnetic slaving circuits.

2.21.30 AN/PRT-5E Emergency Transmitter. An emergency radio transmitter is stowed in each of the four liferafts (see Figure 11-1). The radio is a battery-powered emergency beacon transmitter. When properly activated, the radio transmits a tone-modulated radio frequency signal on the emergency guard frequencies of 8.364 MHz and 243.0 MHz simultaneously. The transmitting set includes an inflatable float assembly that allows the transmitting set to float at sea and provides a support platform for use on land. The entire set is packed in a carrying case.

2.21.30.1 Normal Operation of the Emergency Transmitter

2.21.30.1.1 Opening the Carrying Case

1. Unsnap and pull the self-adhering strap on the carrying case.
2. Remove the transmitting set assembly.
3. Attach the float assembly mooring-line snaphook to an eyelet on the liferaft.

2.21.30.1.2 Inflating the Float Assembly

1. Be sure the CO_2 bottle is firmly screwed into its valve.

2. Pull sharply on the CO_2 valve lanyard to pierce the end of the CO_2 bottle.

3. In the event the CO_2 bottle is empty, the float assembly can be inflated by blowing into the oral valve.

2.21.30.1.3 Operating Procedure

1. Pull the free end of the UHF antenna through the grommet in the float assembly to allow the antenna to stand vertically.

CAUTION

Any attempt to turn the antenna bushing assembly below the knurled knob will result in internal damage and failure of the transmitting set to transmit.

2. Unscrew the knurled cap located on top of the telescopic HF antenna housing and pull the antenna out to its full length (9 feet).

3. Pull out the switch safety pin.

4. Turn the power toggle switch to ON.

5. Place the entire assembly in the water and tow it behind the liferaft.

6. When operating on land, be sure the transmitting set is placed on level ground so that the antennas are vertical. Stand away from the transmitting set to avoid changes in the radiation pattern of the transmitted signals.

7. If desired, the safety pin can be replaced to prevent the transmitting set from being turned off accidentally.

To turn the transmitter off:

8. Turn the power switch to OFF, and replace the switch safety pin.

9. Lower the HF antenna completely and screw down the top section screwcap.

10. Put the free end of the UHF antenna through its retaining grommet in the float assembly.

2.22 LIGHTING SYSTEM

The lighting system is composed of exterior and interior groups of lights and their controls. Receptacles are also provided on the sides of the pilot and copilot side shelves for connecting a signal light. The pilot, copilot, and engine instrument lights operate on ac power and all others operate on dc power. The pilot, copilot, and engine instrument lights use 6-volt bulbs only. All other panel lights use 28-volt bulbs.

2.22.1 Exterior Lights. The exterior group of aircraft lights (see Figure 2-135 and Figure 2-136) comprises a landing light on the undersurface of each wing; 2 taxiing lights on the main landing gear doors; 11 formation, 6 navigation, and 2 anticollision lights disposed around the aircraft; 2 pod and hose illumination lights on the horizontal stabilizer tips; and a light on each side of the fuselage to illuminate the wing leading edges. Power for all these lights is supplied from the essential and main dc buses through the EXTERIOR LIGHTS circuit breakers on the copilot lower circuit breaker panel.

2.22.1.1 Landing Lights. A retractable landing light is mounted in the underside of each wing, in the leading edge and approximately midway between the inboard and outboard engine nacelles. Switches for extension and retraction and for illumination control are located on the landing lights control panel (see Figure 2-137). The two extension and retraction motor switches, labeled right and left, are three-position (EXTEND, HOLD, RETRACT) toggle switches. The right switch energizes the right-hand landing light actuator motor, retracting or extending the light when the switch is moved to the RETRACT or EXTEND positions. The left switch energizes the left-hand light actuator motor in the same manner. When either switch is moved to the HOLD positions the respective landing light actuator motor is deenergized, and the light will lock in position. Two two-position (ON, OFF) toggle switches control the illumination of the landing lights. When either switch is moved to the ON position, the corresponding light illuminates. When either switch is moved to OFF, the corresponding light is deenergized. Power for landinglight illumination is supplied from

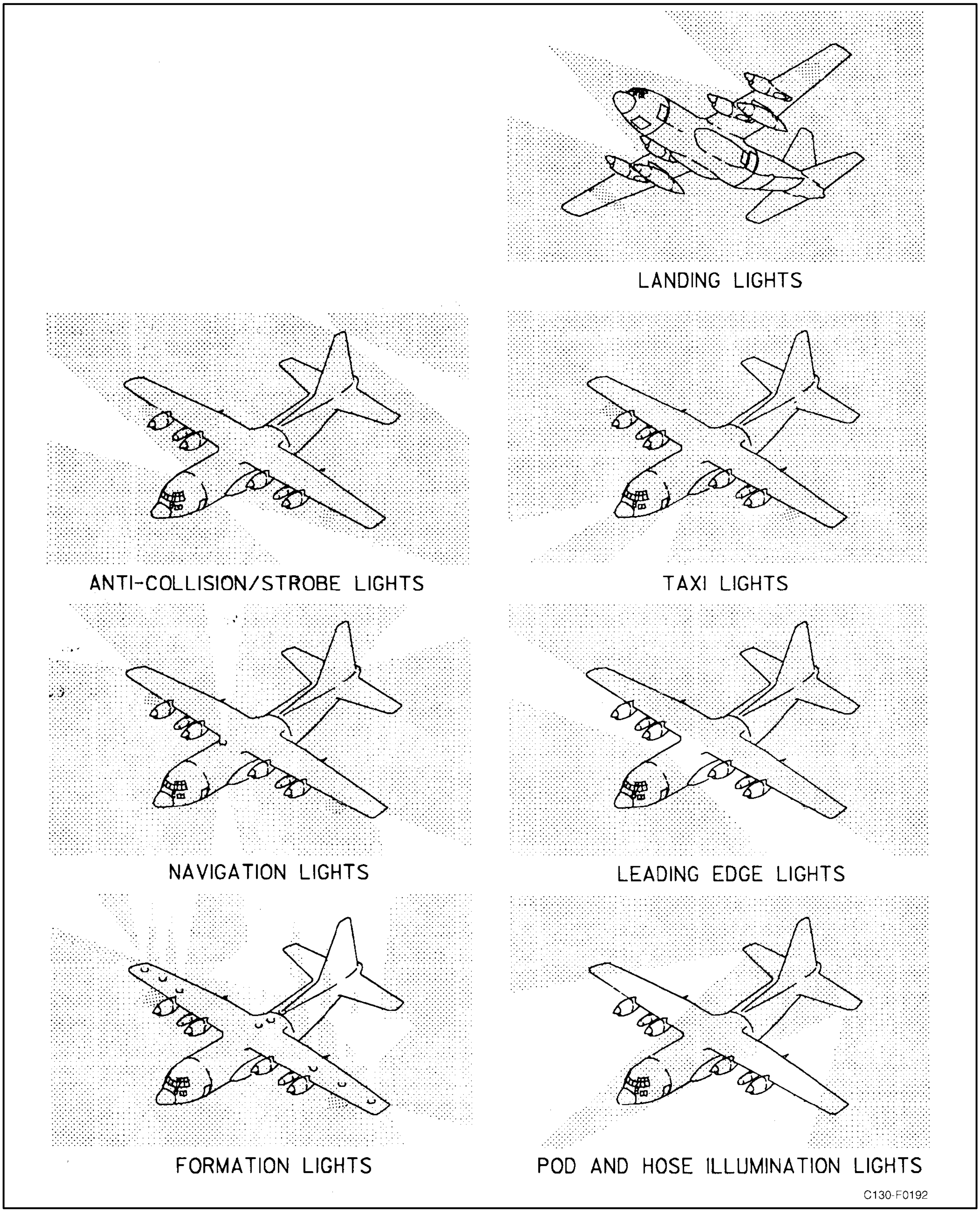


Figure 2-135. Exterior Lights Illumination Pattern

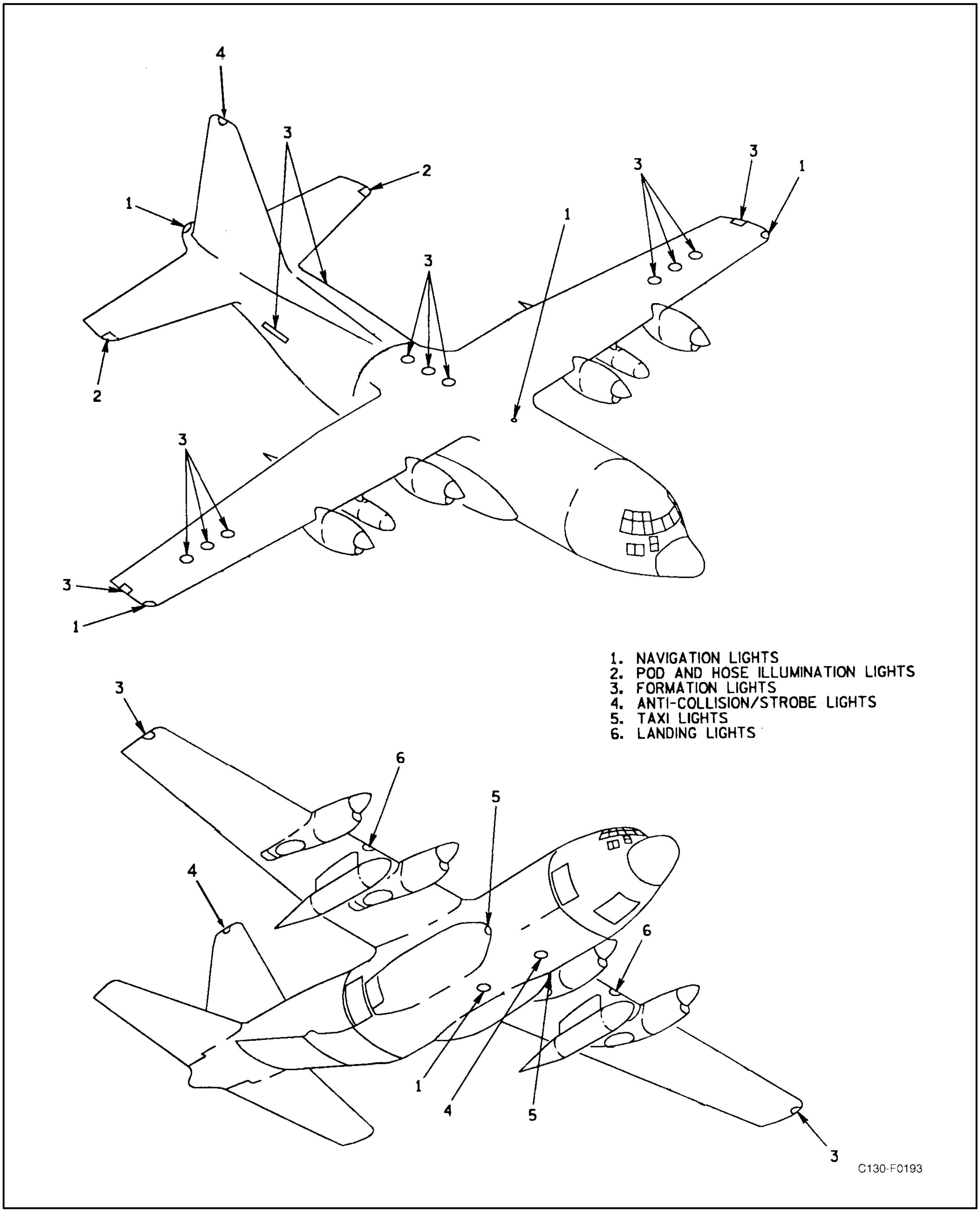


Figure 2-136. Exterior Lights Locations

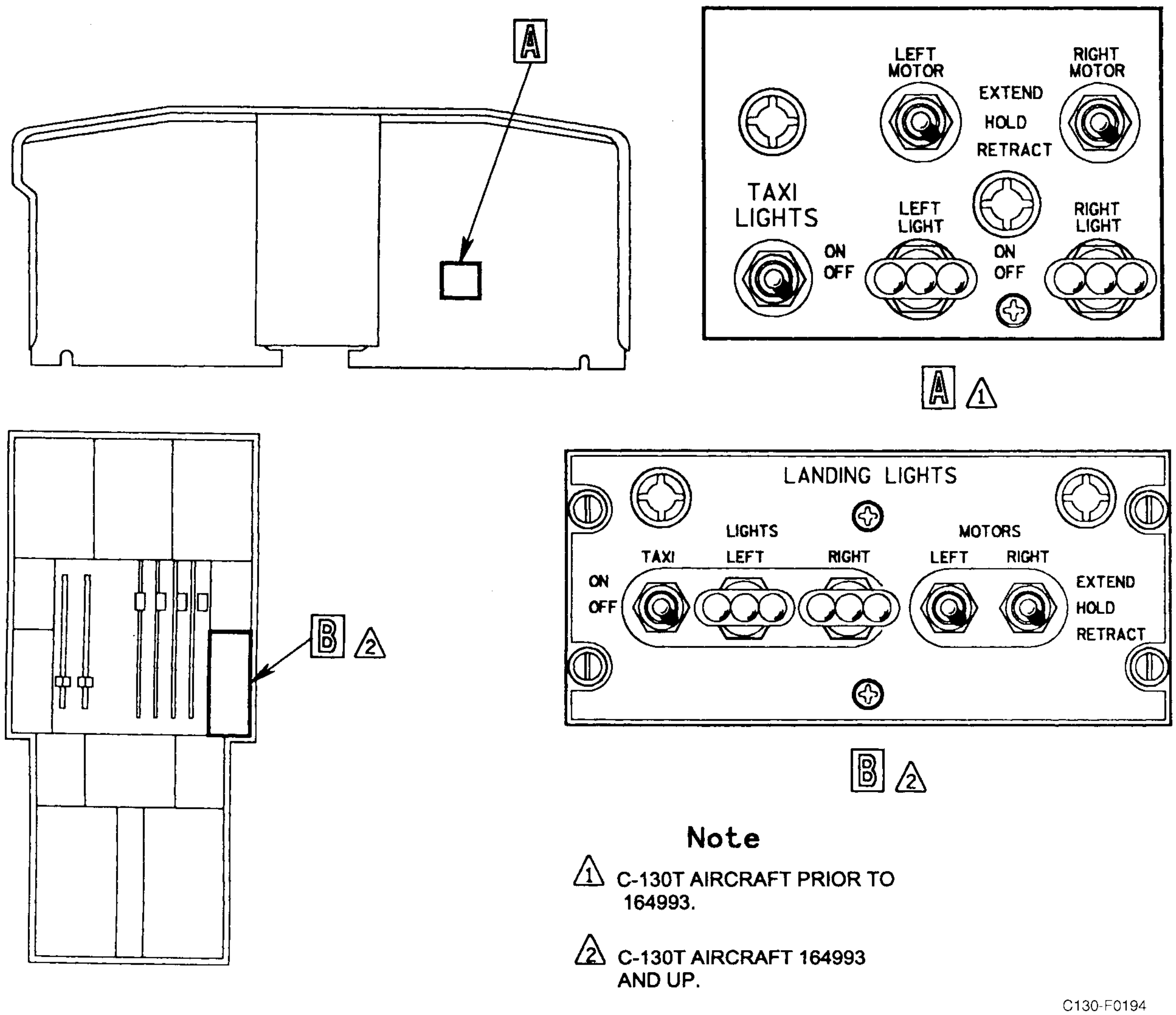


Figure 2-137. Landing and Taxi Lights Control Panel

the essential dc bus through the EXTERIOR LIGHTS LH and RH LANDING LIGHTS circuit breakers on the copilot lower circuit breaker panel, and for the light extension and retraction actuators through the EXTERIOR LIGHTS LH and RH LANDING LIGHTS MTR circuit breakers on the same panel.

CAUTION

Do not operate the landing lights for prolonged periods while the aircraft is on the ground since these lights have no cooling facility.

2.22.1.2 Taxiing Lights. Illumination of the two taxiing lights, one mounted on the inside of each main landing gear door, is controlled by a two-position (ON, OFF) toggle switch on the landing light control panel (see Figure 2-137). Power is supplied from the main dc bus through the EXTERIOR LIGHTS TAXI circuit breaker on the copilot lower circuit breaker panel.

2.22.1.3 Formation Lights. The thirteen formation lights comprise three on the outer panel of each wing, three on top of the fuselage aft of the wing, one on each side of the fuselage aft of the paratroop door, and one on each wingtip. The controls for the formation lights are located on the overhead panel next to the electrical control panel. A three-position switch (COLORED WING — FUS, center, BOTH) selects the exterior lights to be illuminated. The COLORED WING — FUS selects the fuselage formation lights and colored wingtip navigation lights; the center position selects only the top formation lights; BOTH selects top and bottom formation lights. The illumination and intensity of all thirteen formation lights is controlled simultaneously through a single rheostat switch on the exterior lights control panel (see Figure 2-138). The switch is turned clockwise from the OFF position to illuminate the lights and then further turned toward BRIGHT to increase the brilliance; rotation of the switch in the counterclockwise direction decreases the brilliance of the lights until the OFF position is reached. Power for the lights is supplied from the main dc bus through the EXTERIOR LIGHTS FORMATION circuit breaker on the copilot lower circuit breaker panel.

2.22.1.4 Navigation Lights. The navigation lighting system consists of six lights: a red light on the left wingtip, a green light on the right wingtip, two white lights on the trailing edge of the tailcone, a white light on top of the fuselage forward of the wing, and a white light on the lower surface of the fuselage. All lights can be set dim or bright. The red and green wingtip lights and the white tail lights can also be set to flash or to glow continuously. The white lights on the top and bottom of the fuselage, however, will only illuminate continuously. The navigation lights selector switch turns the lights on and off and controls the flashing mechanism, and the wing and tail navigation lights dimming switches control the intensity of the lights. The selector switch is a three-position (STEADY, OFF, FLASH) toggle switch, located on the exterior lights control panel (see Figure 2-138). When the switch is in the STEADY position, the lights glow continuously. When the switch is in the FLASH position, the wingtip lights and the white taillights flash simultaneously. The wing and tail navigation lights dimming switches are three-position (BRIGHT, OFF, DIM) toggle switches and are located on the exterior lights control panel. The white lights on the top and bottom of the fuselage are controlled by a separate three-position (BRIGHT, OFF, DIM) toggle switch located on the exterior lights control panel. Power for the lights is supplied from the essential dc bus through the EXTERIOR LIGHTS NAVIGATION and POSITION circuit breaker on the copilot lower circuit breaker panel.

2.22.1.5 Anticollision/Strobe Lights. The aircraft is equipped with two combination anticollision/strobe lights, one on top of the vertical stabilizer and the other on the underside of the center fuselage. Each light contains a high-intensity, white, xenon arc-discharge light and a high-intensity red light. The dual anticollision/strobe lights are controlled by two toggle switches on the exterior lights control panel (see Figure 2-138). The left-hand select switch has three positions (GRD TEST, T & B, TOP). When the select switch is placed to the T & B position, both upper and lower red or white lights will function in flight, but only the upper red light will function when the aircraft is on the ground. Auxiliary touchdown relay No. 3 disables the upper white light and the lower red and white lights when the aircraft is on the ground. When the select switch is placed to the TOP position, only the upper light will function. When the select switch is placed to the GRD TEST position, both upper and lower red or white lights will function on the ground. The right-hand control switch has three positions (OFF, RED, WHT) and is used along with the select switch to control the light color under various weather conditions. In the

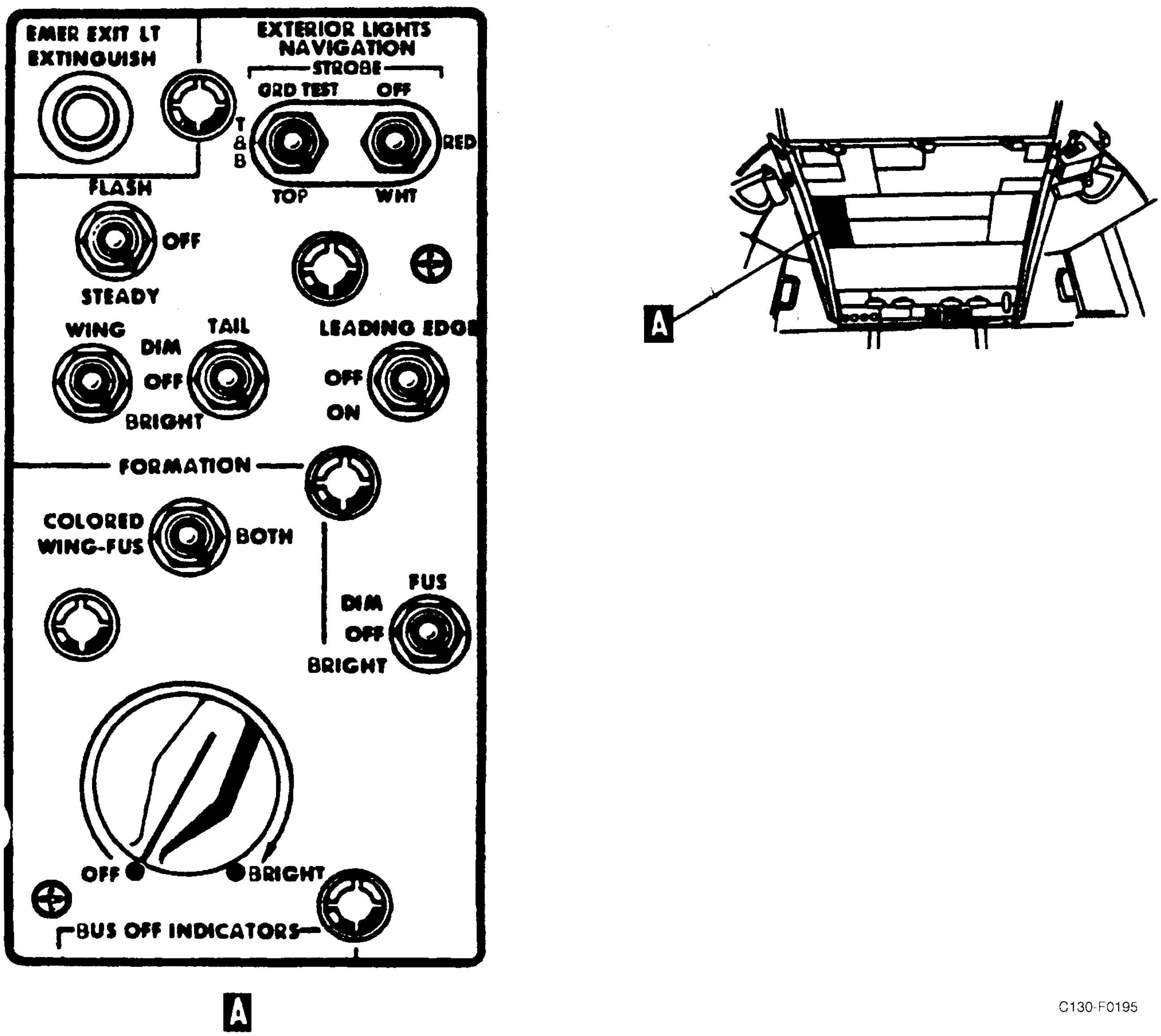


Figure 2-138. Exterior Lights Control Panel

OFF position, the lights are deenergized. Power for the anticollision/strobe lights is supplied from the essential dc bus through the ANTICOLLISION LIGHT circuit breaker on the copilot lower circuit breaker panel and the essential ac bus through the STROBE LT BOTTOM and TOP circuit breakers on the pilot side circuit breaker panel.

2.22.1.5.1 Wing Leading Edge Lights. A light is installed on each side of the fuselage in a position that will illuminate the engine nacelles and the immediate leading edge area of each wing. The lights are controlled through a two-position (ON, OFF) toggle switch on the exterior lights control panel (see Figure 2-138) and are powered from the main dc bus through the EXTERIOR LIGHTS WING LEADING EDGE circuit breaker on the copilot lower circuit breaker panel.

2.22.1.6 Pod and Hose Illumination Lights. A white pod and hose illumination light is located in the forward edge of each horizontal stabilizer tip. These lights are positioned to illuminate the in-flight refueling pods. A two-position (ON, OFF) pod and hose illumination switch located on the auxiliary fuel control panel (Figure 14-2) controls the operation of the lights. When the switch is placed to the ON position, the lights will illuminate. Placing the switch to the OFF position de-energizes the lights. Power for the pod and hose illumination is supplied from the essential dc bus through the POD & HOSE ILLUM circuit breaker on the copilot side circuit breaker panel.

2.22.1.7 Signal Lamp. A portable signal lamp and a case containing four colored lenses (red, amber, blue, and green) are stowed at the navigator station. An extension cord permits the lamp to be plugged into receptacles on either the pilot or copilot side shelves. The lamp is illuminated by depressing a trigger switch. Power is supplied from the main dc bus through the INTERIOR LIGHTS PILOT and COPILOT SIGNAL OUTLETS circuit breakers on the copilot lower circuit breaker panel.

2.22.2 Interior Lighting. Interior lighting consists of flight station and cargo compartment lighting. The various types of lighting, location of controls, and locations of circuit breakers for the light circuits are listed in Figure 2-139. Interior lighting control panels and their locations are shown in Figure 2-140. The pilot and copilot instrument lights and the engine instrument lights are ac powered from the essential ac bus and protected by fuses on the ac distribution panel aft of the upper bunk and by circuit breakers located adjacent to the respective switches. The copilot secondary lights are powered by the isolated dc bus through a COPILOT SECONDARY LIGHTS circuit breaker on the pilot side circuit breaker panel. The pilot and engine secondary instrument lights are powered by the essential dc bus through a PILOT & ENG SEC INST LIGHTS circuit breaker on the copilot lower circuit breaker panel. All other interior lighting is dc powered from the main dc bus and protected by circuit breakers on the copilot lower circuit breaker panel.

After AFC-374, the copilot secondary lights are powered by the essential dc bus through a COPILOT SECONDARY LIGHTS circuit breaker on the copilot's lower circuit breaker panel. The pilot and engine secondary instrument lights are powered by the isolated dc bus through a PILOT & ENG SEC INST LIGHTS circuit breaker on the pilot's side circuit breaker panel.

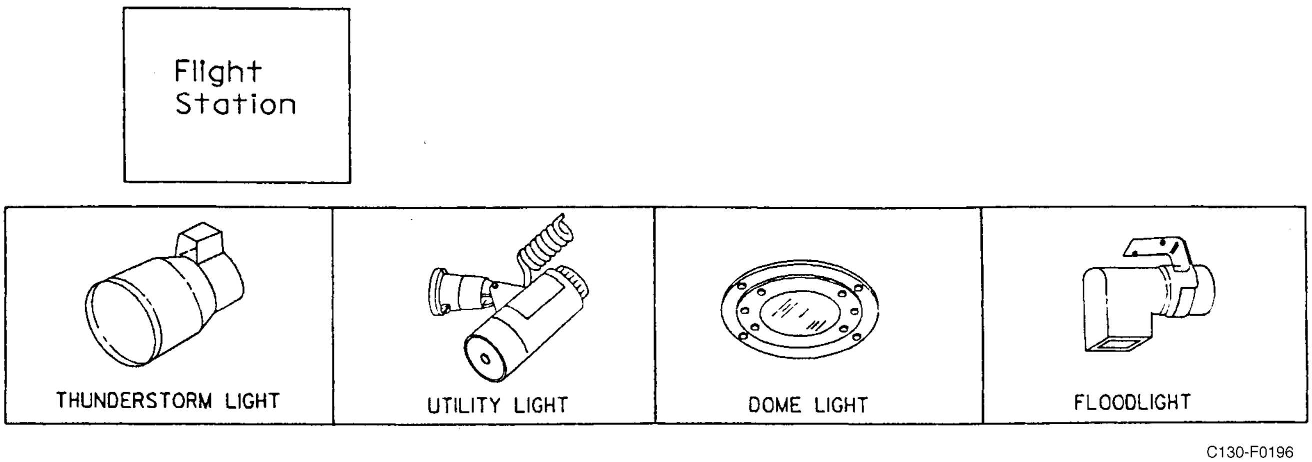
2.22.2.1 VSI/TRA Indicator Intensity Lighting Control (Aircraft with AFC-374). Lighting and dimming control for pilot and copilot VSI/TRAs are controlled by a combination of three methods:

1. An integral light sensor located in the upper left-hand corner of the bezel which detects the ambient light and adjusts VSI/TRA luminosity accordingly.

2. Via general instrument panel lighting controlled by either the pilot or copilot INSTRUMENT PANEL LIGHTS/INSTRUMENT rheostat on the respective side shelf.

3. The VSI/TRA Dimmer Control which is located on the respective side shelf.

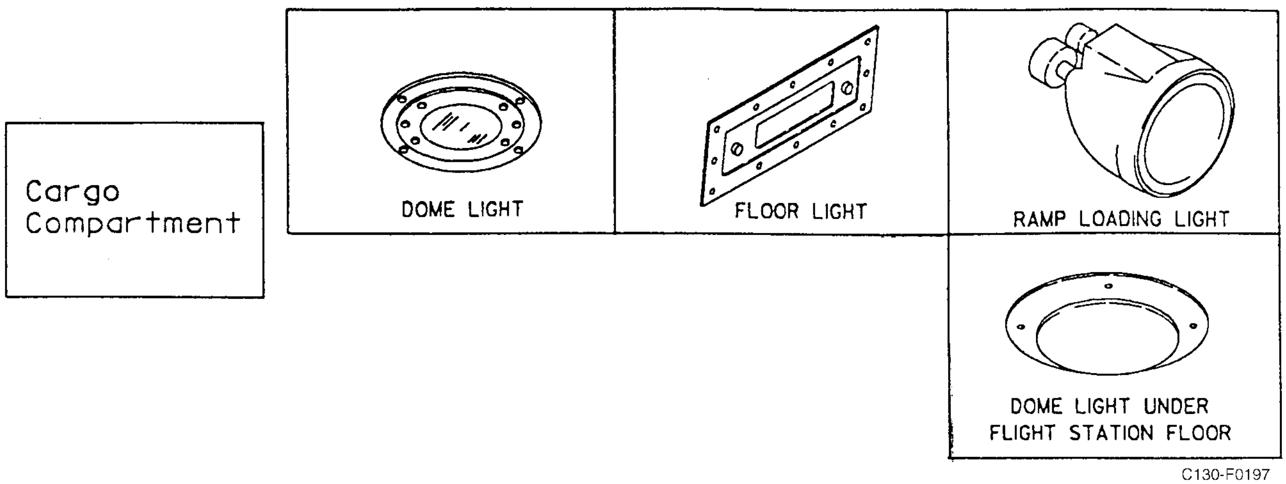
The integral light sensor is the primary controller as it adjusts for ambient light settings. Instrument panel lighting will also control backlighting in a dark cockpit with a fine adjustment available through the use of the individual VSI/TRA dimmer controls. The dimmer controls have no effect if there is ambient lighting on the light sensor or if the instrument panel light control rheostat is not in use.



LIGHTS	CONTROLS LOCATION	CIRCUIT BREAKER LOCATION
PILOT		
Instrument Lighting	Pilot Side Shelf	Fuse on Main Ac Distribution Panel
Engine Instrument Lighting	Pilot Side Shelf	Fuse on Main Ac Distribution Panel
Pedestal and Pilot Side Shelf Lighting	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
Instrument Panel Lighting	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
Pilot Circuit Breaker Panel Lights	Pilot Circuit Breaker Panel	Copilot Lower Circuit Breaker Panel
Pilot Utility Light	On Light	Copilot Lower Circuit Breaker Panel
Thunderstorm lights switch turns on these lights ▼		
Two White Thunderstorm Lights	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
Four White Dome Lights	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
Instrument Floodlights	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
Dome lights switch turns on these lights ▼		
Four White Dome Lights and Two White Thunderstorm Lights	Pilot Side Shelf	Copilot Lower Circuit Breaker Panel
COPILOT		
Instrument Lighting	Copilot Side Shelf	Fuse on Main Ac Distribution Panel
Copilot Instrument Panel Floodlighting	Copilot Side Shelf	Pilot Side Circuit Breaker Panel
Overhead Panel Lighting	Copilot Side Shelf	Copilot Lower Circuit Breaker Panel
Overhead Panel Floodlighting	Copilot Side Shelf	Copilot Lower Circuit Breaker Panel
Copilot Side Shelf Lighting	Copilot Side Shelf	Copilot Lower Circuit Breaker Panel
Copilot Circuit Breaker Panel Lighting	Copilot Circuit Breaker Panel	Copilot Lower Circuit Breaker Panel
Copilot Utility Light	On Light	Copilot Lower Circuit Breaker Panel

Figure 2-139. Interior Lighting (Sheet 1 of 2)

LIGHTS	CONTROLS LOCATION	CIRCUIT BREAKER LOCATION
NAVIGATOR		
Navigator Instrument and Control Panel Lighting	Navigator Lights Control Panel	Copilot Lower Circuit Breaker Panel
Navigator Utility Light	ON Light	Copilot Lower Circuit Breaker Panel
Navigator Console Instrument Lights	Navigator Console	Copilot Lower Circuit Breaker Panel
FLIGHT ENGINEER		
Flight Engineer Utility Light	ON Light	Copilot Lower Circuit Breaker Panel
Fuel Quantity Indicator Lights	Copilot RH Distribution Box	Copilot Lower Circuit Breaker Panel
IFR Panel Lights	Overhead Control Panel	Copilot Lower Circuit Breaker Panel
IFR Panel Floodlighting	Overhead Control Panel	Copilot Lower Circuit Breaker Panel



LIGHTS	CONTROLS LOCATION	CIRCUIT BREAKER LOCATION
Floor Lights	Forward Cargo Compartment Light Panel	Copilot Lower Circuit Breaker Panel
Forward Dome Lights	Forward Cargo Compartment Light Panel	Copilot Lower Circuit Breaker Panel
Center Dome Lights	Forward Cargo Compartment Light Panel	Copilot Lower Circuit Breaker Panel
Aft Dome Lights	Aft Fuselage Junction Box	Aft Fuselage Junction Box
Ramp Dome Lights	Aft Fuselage Junction Box	Aft Fuselage Junction Box
Two White Ramp Loading Lights	Aft Fuselage Junction Box	Aft Fuselage Junction Box
Crew Door Entrance Light	Crew Door Warning Light Panel	Copilot Lower Circuit Breaker Panel
Under Deck Light	Crew Door Warning Light Panel	Copilot Lower Circuit Breaker Panel
Left Observer Panel Lights	Left Observer Panel	Aft Fuselage Junction Box
Right Observer Panel Lights	Left Observer Panel	Aft Fuselage Junction Box

Figure 2-139. Interior Lighting (Sheet 2)

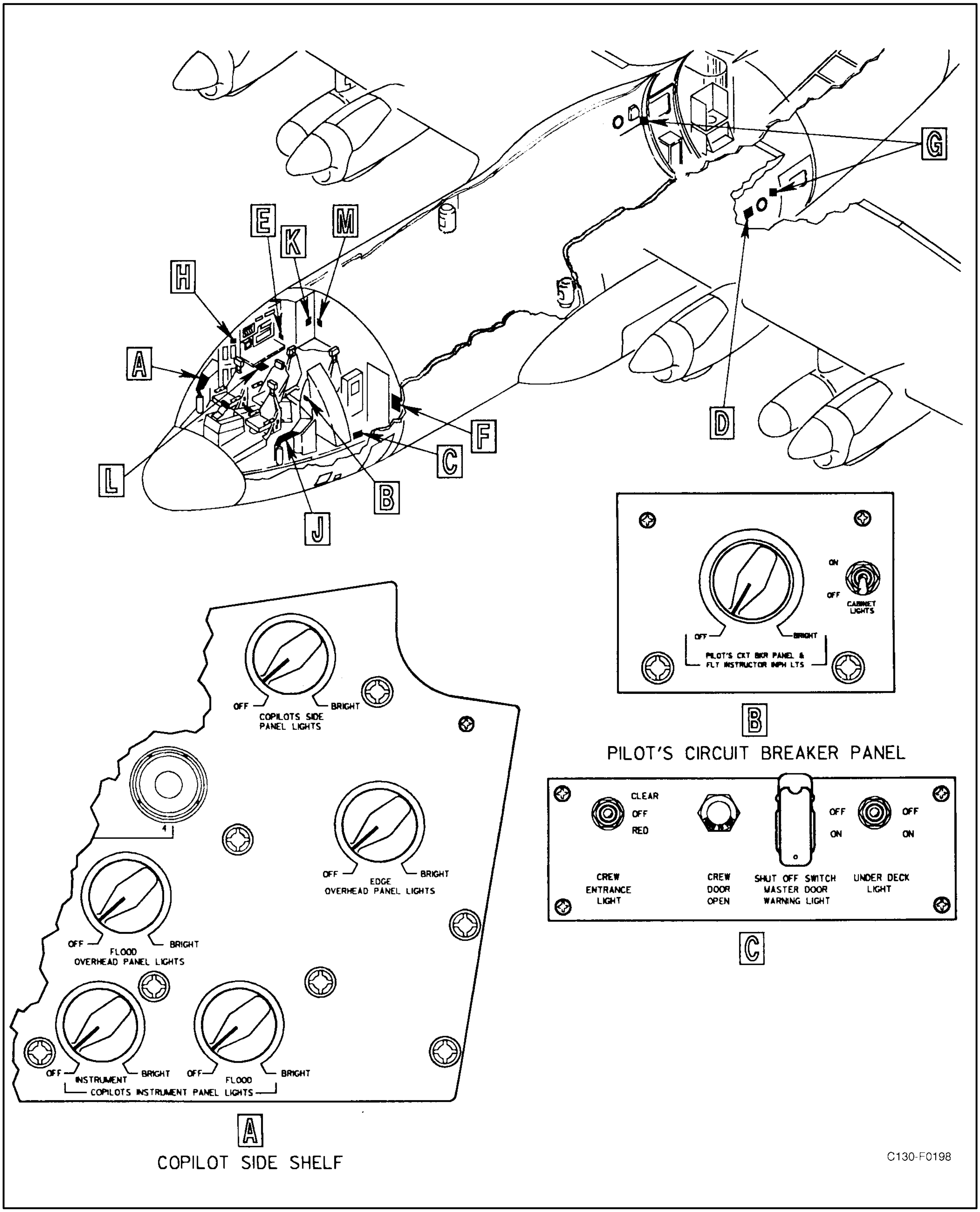


Figure 2-140. Lighting Controls (Typical) (Sheet 1 of 4)

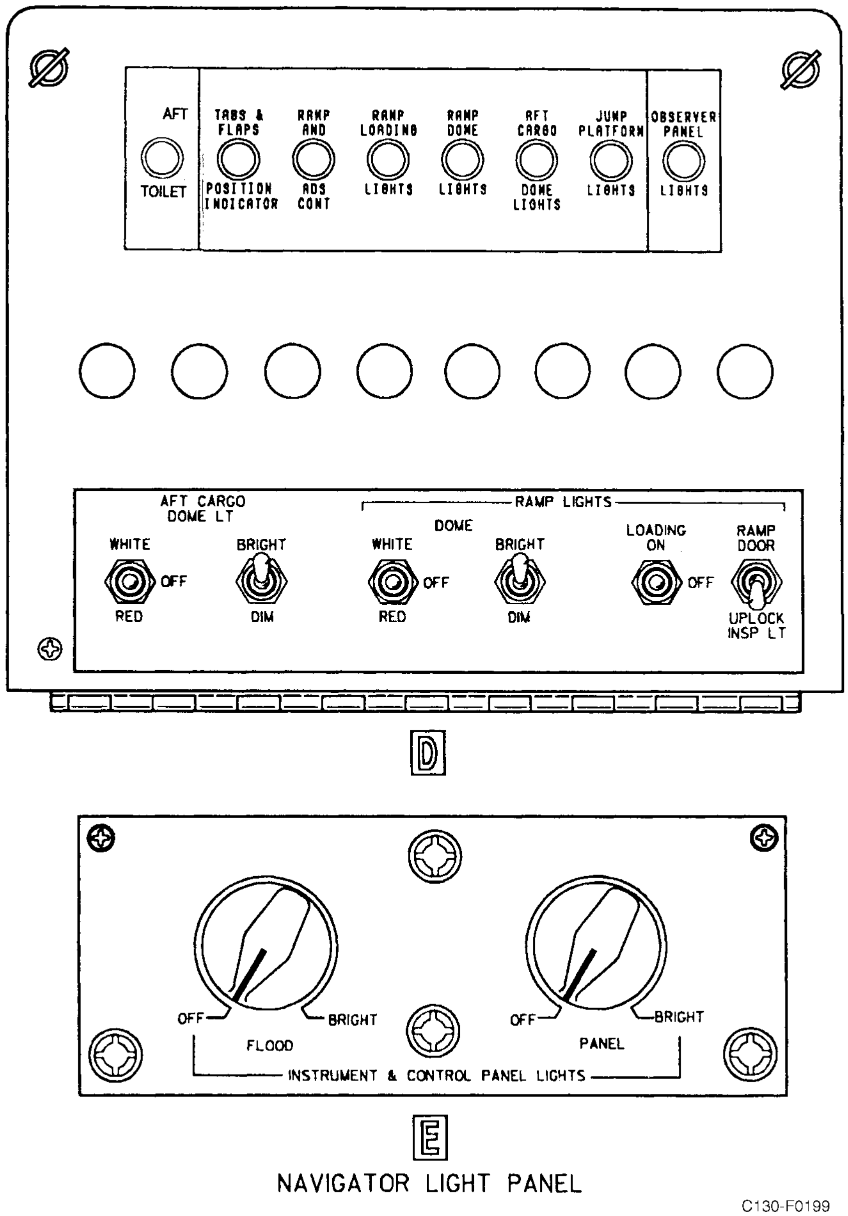


Figure 2-140. Lighting Controls (Typical) (Sheet 2)

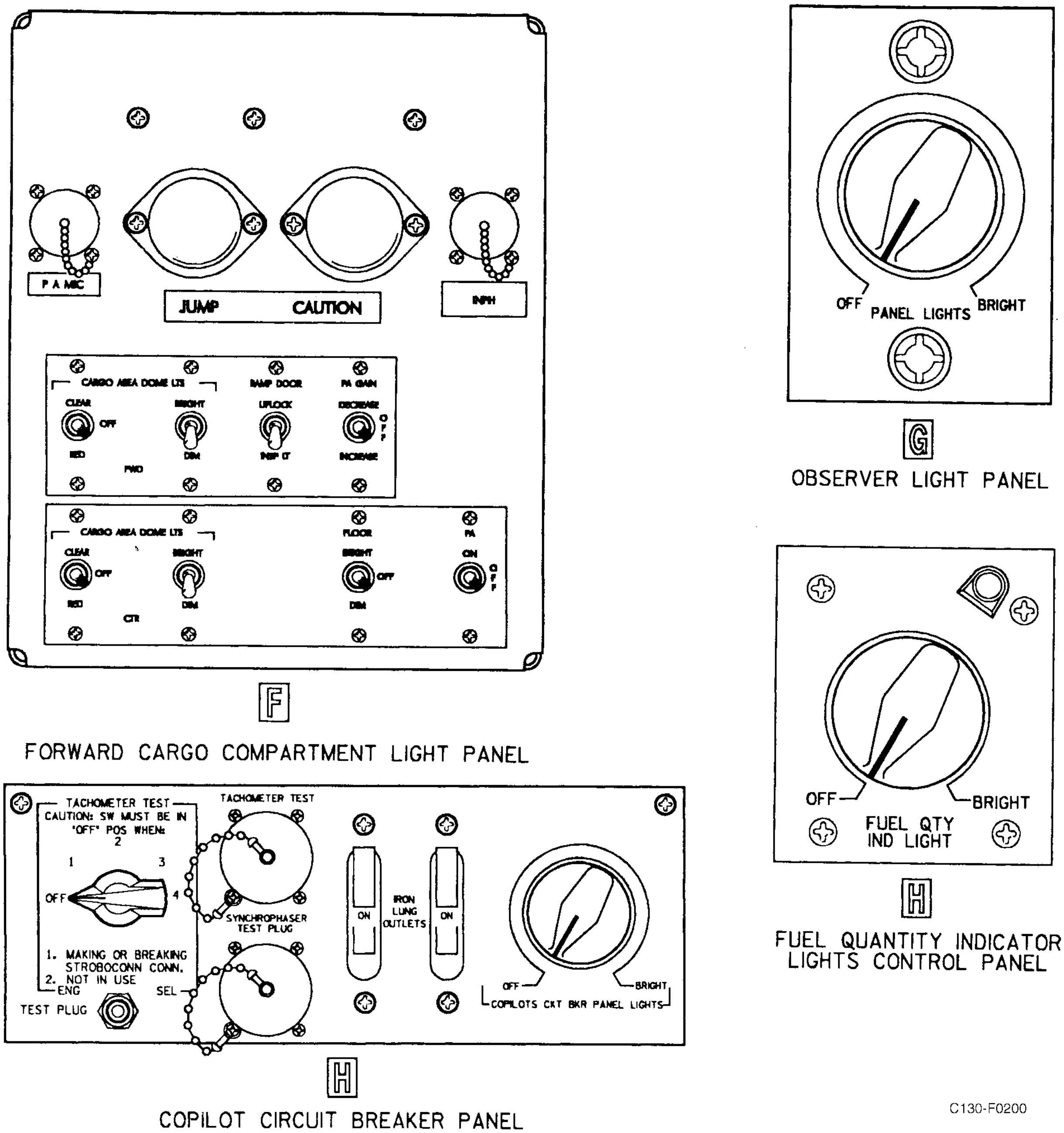


Figure 2-140. Lighting Controls (Typical) (Sheet 3)

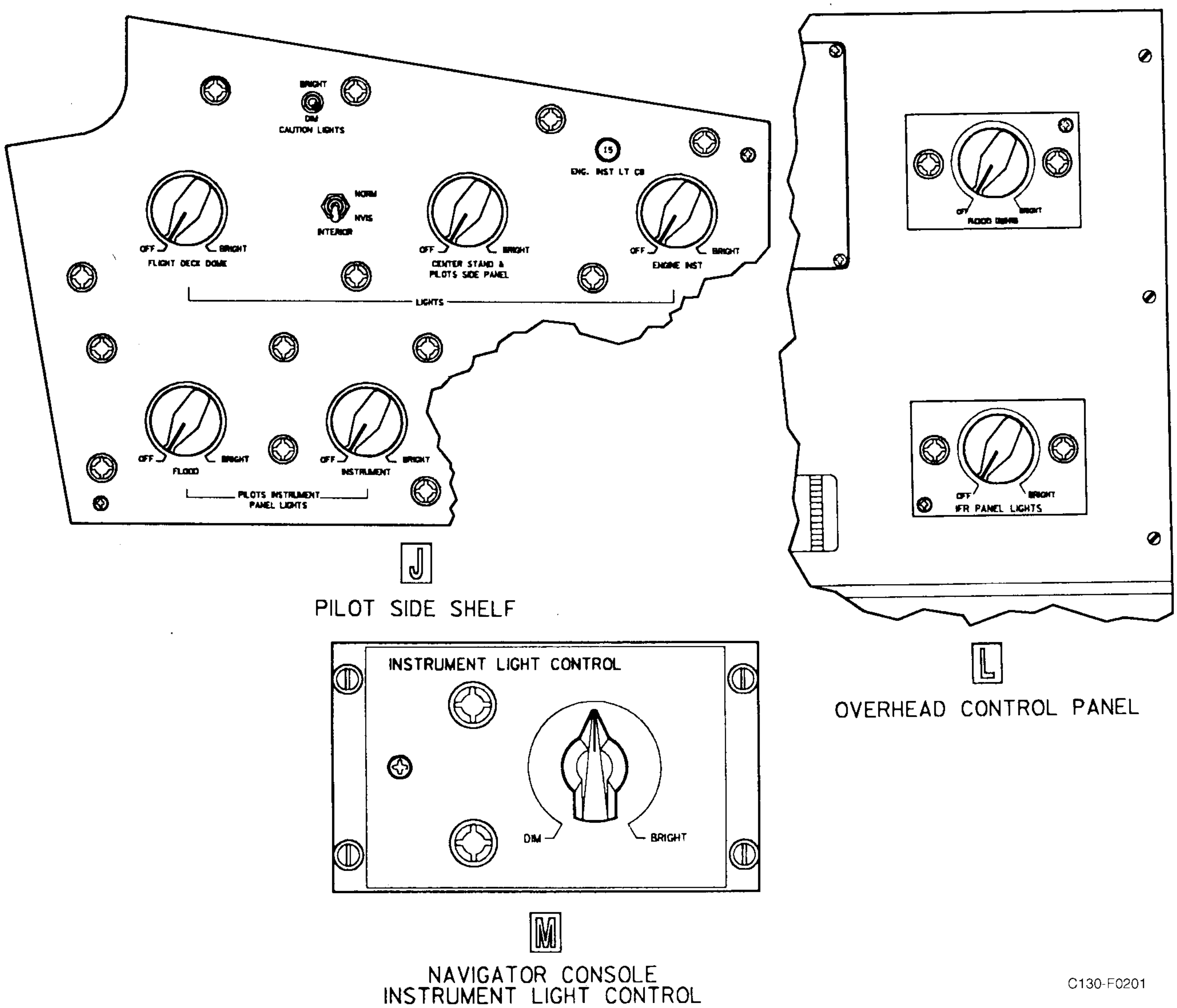


Figure 2-140. Lighting Controls (Typical) (Sheet 4)

2.22.2.2 Thunderstorm Lights. Thunderstorm lighting is provided by four white dome lights, two white thunderstorm floodlights, and main instrument panel white floodlights. These lights are controlled by a two-position (ON, OFF) THUNDERSTORM LIGHTS switch on the pilot side shelf (see Figure 1-3). Also, when the THUNDERSTORM LIGHTS switch is placed in the ON position, the circuits to the warning instrument lights dimming relays are opened, thereby preventing the warning lights from being dimmed.

2.23 OXYGEN SYSTEM

The aircraft is equipped with a 300-psi liquid oxygen system (see Figure 2-141). The system uses diluter-demand automatic pressure-breathing regulators and operates at an indicated pressure of 270 to 455 psi in a static system under a no-flow condition. Under a continuous breathing condition, the pressure should indicate 270 to 340 psi. Manual selection enables the system to provide oxygen diluted in varying proportions corresponding to changes in cabin altitude or, for emergency use, 100-percent oxygen. Four portable units, chargeable through the main system, also are provided for use by crewmembers moving around within the aircraft or for emergency use. Oxygen is supplied from a 25-liter liquid oxygen converter in the right-hand side of the nose wheelwell which is filled through an externally accessible valve. The oxygen supply is fed from the converter through two heat-exchanger units to six supply regulators in the flight station and four in the cargo compartment. The system also supplies four portable-unit charging outlets, one outboard of each pilot seat, one on the right side of the cargo compartment forward bulkhead, and one on the right side of the cargo compartment, aft of the wheelwell.

Note

When 100 percent is being supplied, less oxygen is consumed per person as altitude increases; therefore, the oxygen duration increases with an increase in cabin altitude (see Figure 2-142).

The oxygen system flow rate can vary widely depending on both the aircrew's consumption of oxygen and the system's ability to convert the liquid oxygen into a gas. Crew consumption rates will vary depending on a number of factors; in particular, use of either the emergency or 100-percent oxygen settings on the regulator will greatly increase oxygen consumption. The oxygen supply flow rate is limited by the heat exchanger's ability to warm gaseous oxygen to a breathable temperature. The temperature of the oxygen gas supplied to the aircrew will normally decrease as the flow rate increases. However, when flow rate begins to exceed the capacity of the heat exchanger, the temperature will decrease markedly and the system pressure at the regulators may decrease. The aircrew may be starved for oxygen even though an adequate supply of oxygen remains within the converter (see OXYGEN FLOW DEGRADATION EMERGENCY PROCEDURE).

WARNING

Failure to adequately monitor oxygen regulator gauge pressure may allow an undetected oxygen flow degradation situation to develop.

When the aircrew is breathing 100-percent oxygen, the oxygen system is capable of sustaining five crewmembers above 15,000 feet for most flight activities. At lower altitudes, the oxygen system maximum flow rate may not sustain the entire crew on 100-percent oxygen. The worst case occurs at sea level in a threat or emergency environment with aircrew on 100-percent oxygen.

WARNING

Whenever the aircrew is operating on 100-percent oxygen below 15,000 feet cabin altitude, oxygen quantity, temperature and pressure should be closely monitored for both the oxygen consumption rate and oxygen flow degradation.

2.23.1 Oxygen Regulator. A diluter-demand automatic-pressure breathing regulator is located at each crewmember station. Two additional regulators are located in the cargo compartment. The crewmember regulators are located as follows: on the pilot and copilot side shelves, the flight engineer overhead panel, the navigator control panel and the observer panels forward of the left and right paratroop doors. Two regulators are located at the forward right side of the

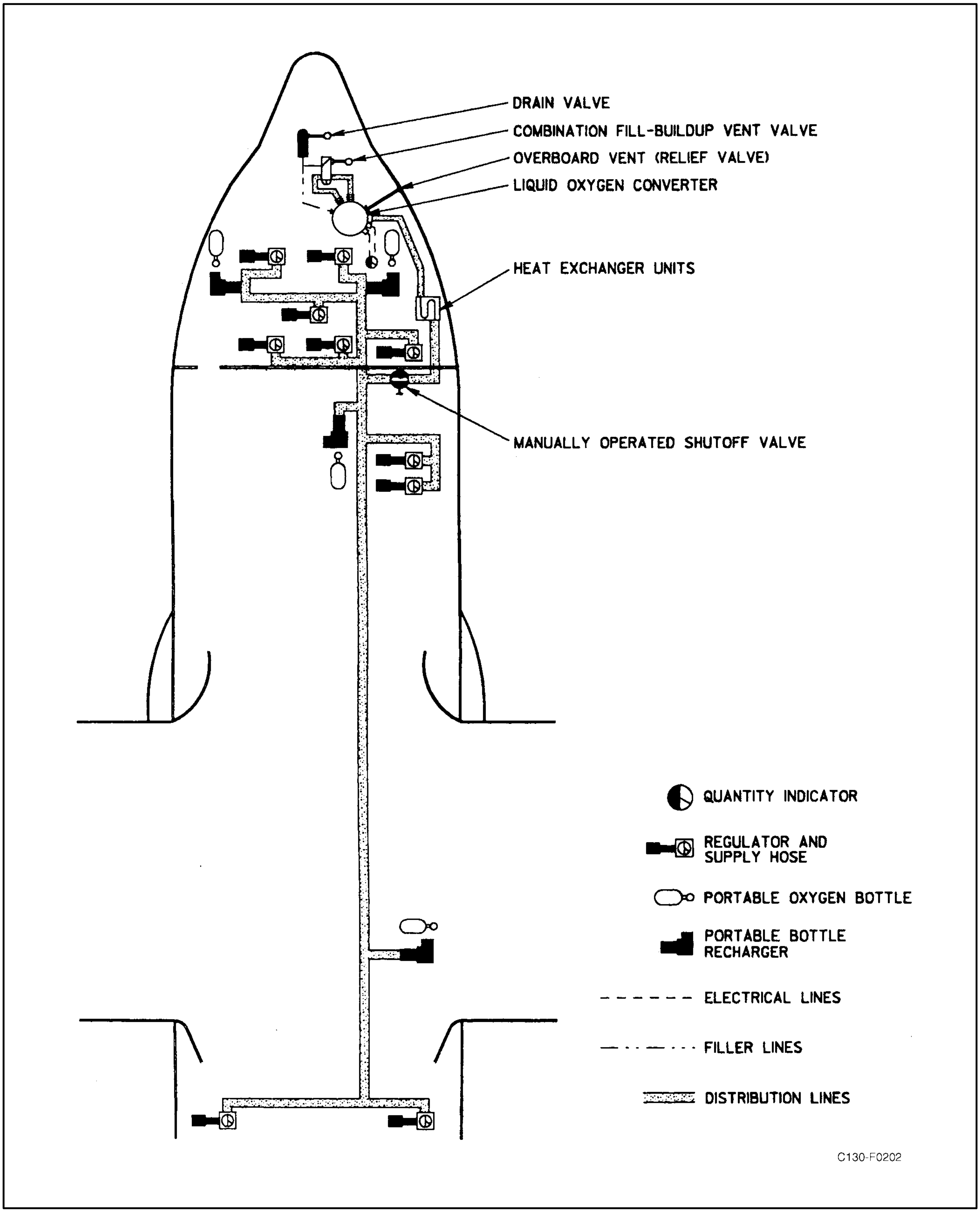
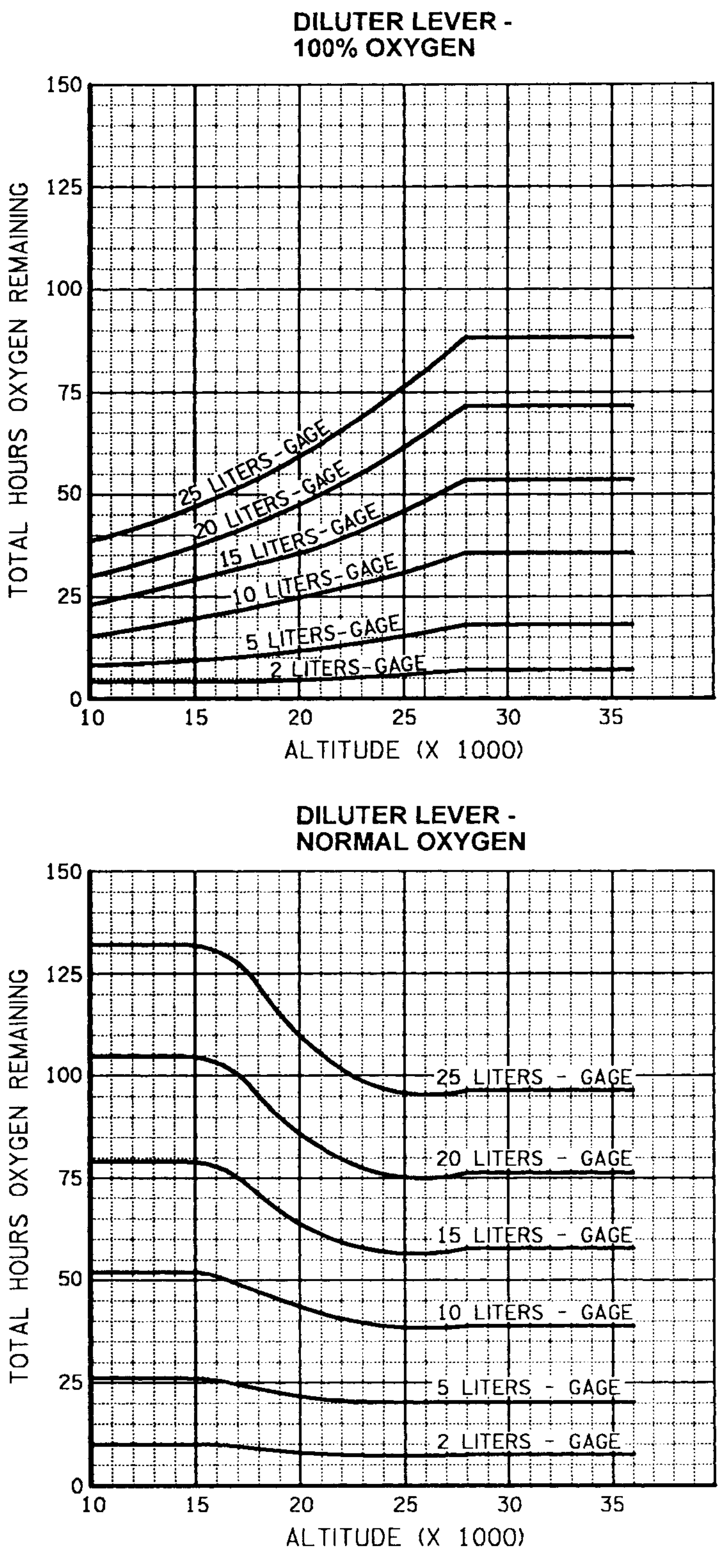


Figure 2-141. Oxygen System



CHARTS HAVE BEEN DETERMINED TO BE INEXACT IN MANY SITUATIONS BUT ARE RETAINED FOR USE UNTIL MORE ACCURATE INFORMATION IS AVAILABLE. CHARTS SHOW HOURS OF OXYGEN AVAILABLE AT ANY PARTICULAR ALTITUDE FOR THE OXYGEN SUPPLY QUANTITY GAUGE READING. TO DETERMINE THE BEST ESTIMATE OF ACTUAL HOURS OF OXYGEN REMAINING, FIRST DETERMINE A BASELINE FIGURE BY DIVIDING THE TOTAL OXYGEN SUPPLY HOURS AVAILABLE BY THE NUMBER OF AIRCREW. THEN DIVIDE THE BASELINE FIGURE BY THE APPLICABLE ACTIVITY FACTOR FROM THE TABLE BELOW TO ESTIMATE THE ADJUSTED TOTAL HOURS OXYGEN REMAINING.

FLIGHT ACTIVITY	ACTIVITY FACTOR
PRESSURE BREATHING	1.10
TERRAIN FOLLOWING	1.25
TAKEOFF AND LANDING	1.50
AERIAL COMBAT/THREAT/ EMERGENCY CONDITIONS	1.75

WARNING

- THE ADJUSTED TOTAL HOURS OXYGEN REMAINING IS ONLY AN ESTIMATE. ACTUAL CONSUMPTION SHOULD BE CONTINUALLY MONITORED.
- THE OXYGEN SUPPLY QUANTITY GAUGE MAY INDICATE THAT OXYGEN IS AVAILABLE; YET, IF THE FLOW RATE EXCEEDS THE CAPACITY OF THE HEAT EXCHANGER, OXYGEN FLOW DEGRADATION WILL OCCUR AND THE AIRCREW MAY BE STARVED FOR OXYGEN.

C130-F0203

Figure 2-142. Oxygen Duration

cargo compartment. Regulators are provided at each end of the flight station lower crew bunk (see Figure 2-141). Each regulator is equipped with a flow indicator, a pressure gauge, three toggle-type switches to control regulator operation, and an inlet filter to prevent the entry of foreign particles into the system.

2.23.1.1 Oxygen Supply Lever. A manual, two-position supply lever is located at the lower right corner of each regulator. When the lever is set to ON, oxygen is supplied to the regulator unit; when the lever is at OFF, the oxygen supply to the regulator is shut off to prevent any waste of oxygen from the regulator unit when not in use.

2.23.1.2 Diluter Lever. The two-position diluter lever on each regulator unit may be used to shut off the air port manually and allow the regulator to deliver pure oxygen at all altitudes or to provide automatic mixing of air and oxygen as required to maintain normal body oxygen needs at all altitudes. When set to 100% OXYGEN, the regulator supplies pure oxygen without air dilution; with the lever at NORMAL OXYGEN, the normal air/oxygen dilution characteristics of the regulator are maintained. The lever is designed to prevent intermediate settings between 100% OXYGEN and NORMAL OXYGEN.

2.23.1.3 Emergency Toggle Lever. The emergency toggle lever on each regulator has three positions: EMERGENCY, NORMAL, and TEST MASK. With the lever at EMERGENCY, oxygen is supplied to the mask at continuous positive pressure for emergency use. With the lever at NORMAL, oxygen flow is controlled automatically by the regulator. The spring-loaded TEST MASK position is used when a positive pressure is required at any altitude to test the fit of the mask around the face.

CAUTION

When positive pressure is required, it is mandatory that the oxygen mask be well fitted to the face. Unless special precautions are taken to ensure no leakage, the continued use of positive pressure under these conditions will result in rapid depletion of the oxygen supply. Except when unscheduled pressure increase is required, the emergency toggle lever should remain in the center NORMAL position.

2.23.1.4 Visual Flow Indicator. The visual flow indicator on each regulator is a slide-and-window device in which, during normal use of the oxygen mask, the indicator shows oxygen flow by blinking with the breathing cycle of the user. Oxygen flow ceases when the blinker is not visible.

2.23.1.5 Pressure Gauge. The pressure gauge on the regulator is a dial-type instrument indicating system pressure in pounds per square inch.

2.23.2 Liquid Oxygen Converter. The 25-liter liquid oxygen converter, enclosed within a removable fiberglass cover, is mounted in the right side of the nose wheelwell. It is filled through a combination filler-buildup-vent valve contained in a filler box adjacent to the converter but accessible through a door on the right side of the nose fuselage. The converter is also connected to a drain valve in the lower side of the nose wheelwell skin. The function of the combination filler-buildup-vent valve is automatic, and charging of the oxygen system is accomplished automatically on completion of the filling operation.

2.23.3 Heat Exchanger Units. Two heat exchanger units, installed in the system below the flight station floor, ensure the delivery of oxygen within the required temperature range to all regulators. The oxygen is warmed by passing through the heat exchangers and not by any form of controllable system heating.

WARNING

When opening the oxygen shutoff valve after it has been turned to the OFF position, open slowly to the ON position. A sudden rush of pressurized oxygen into a depleted system could cause a fire and subsequent explosion.

2.23.4 Oxygen Manual Shutoff Valve. A manual shutoff valve is mounted on the right side of the cargo compartment forward bulkhead above the air-conditioning unit. The valve is normally in the open position and is used to shut off the oxygen supply to the regulator distribution lines.

2.23.5 Liquid Oxygen Quantity Indicator and Test Switch. A capacitance-type quantity indicator, which permits monitoring of the total aircraft supply of liquid oxygen available in the converter, is installed at the lower right side of the copilot instrument panel. (See Figure 2-78.) A press-to-test switch adjacent to the quantity indicator allows functional checking of the indicator. The indicator is powered by the ac instruments and engine fuel control bus through the LIQUID OXYGEN LOW LEVEL circuit breaker on the pilot lower circuit breaker and fuse panel.

2.23.6 Low-Level Warning Light. A LIQ OXY QTY LOW warning light, which illuminates to indicate that the supply of liquid oxygen remaining within the converter has reached a low level of approximately 2.5 liters, is mounted on the copilot instrument panel adjacent to the oxygen system quantity indicator. The warning light is powered by the essential dc bus through the LIQUID OXYGEN LOW LEVEL circuit breaker on the copilot lower circuit breaker panel.

2.23.7 Portable Oxygen Bottles. Four portable oxygen bottles, shown in Figure 2-141, are provided for use by crewmembers at high altitudes to facilitate movement within the aircraft or for emergencies. The portable bottle consists of a cylinder and a pressure-demand regulator. Two of the bottles are stowed within the flight station, one outboard of the pilot and the other outboard of the copilot; the third is mounted on the right side of the forward bulkhead in the cargo compartment; and the fourth is mounted on the right side in the aft section of the cargo compartment. Adjacent to each stowage location is a recharging outlet fed from the main oxygen supply system. Recharging of the portable bottles is accomplished at the normal system pressure of 300 psi through a filler valve and flexible hose stowed in a clip at the recharging point. The four-position selector knob on the regulator allows for increasing continuous positive pressure to the user. The settings, 30M, 42M, and EMER, deliver 100-percent oxygen at continuous positive pressure.

2.23.8 Flightcrew Quick-Don Oxygen Masks. Each quick-don unit consists of a quick-don suspension device and oxygen mask that contains an integral microphone assembly that connects to the crewmember headset and the aircraft communications system. Microphone switching from the headset to the oxygen mask is accomplished automatically as the suspension device is donned.

2.23.9 Oxygen System Operation. For normal operation of the system, the oxygen supply lever is placed to ON and the diluter lever is placed to NORMAL. The diluter lever should be placed to 100-percent oxygen if any symptoms of hypoxia are present or if doubt exists that the diluter mixture is sufficient. The emergency position of the diluter lever is not currently used.

2.23.10 Oxygen Duration. The oxygen duration chart (see Figure 2-142) is based on the 25-liter converter furnishing 670 cubic feet of oxygen and shows duration for 100% OXYGEN and NORMAL OXYGEN selections of the oxygen regulator diluter lever.

2.24 CARGO LOADING EQUIPMENT

Cargo loading equipment includes a hydraulically operated cargo door and loading ramp and miscellaneous equipment for loading and securing vehicles, cargo, litters, and troop seats.

2.24.1 Tiedown Fittings. Tiedown fittings are installed on the cargo floor, ramp, and sidewalls. The floor fittings are flushmounted and consist of tiedown rings and attachment studs. The floor rings have a rated strength of 10,000 pounds. The ramp and sidewall fittings are tiedown rings with a rated strength of 5,000 pounds. Threaded sockets are distributed along the edges of the cargo floor for the attachment of 25,000-pound fittings. Twelve 25,000-pound fittings are stowed in a box on the aft cargo door.

2.24.2 Cargo Nets. Three cargo nets are supplied for tying down palletized cargo and small items stacked together. These nets have hooks and rings for attaching to the cargo floor and for the installation of tiedown devices. The cargo nets are stowed in boxes on the left and right sidewall above the ramp and on the aft cargo door.

2.24.3 Snatch Blocks. Two removable snatch blocks are stowed in the stowage box at the forward cargo compartment bulkhead. Refer to the applicable loading manual for use of snatch blocks.

2.24.4 Wheeled Pry Bars. Two wheeled pry bars are provided on the aircraft. These pry bars are used for handling boxes and crates in the cargo compartment and may be used either singly or in pairs.

CAUTION

Although the wheeled pry bar has a capacity of 5,000 pounds, the cargo floor will not withstand this load on the small area of contact of the wheels. Refer to the applicable loading manual for pry-bar limitations.

2.24.5 Tiedown Devices. Two types of tiedown devices are supplied with the aircraft for securing cargo. One type is a turnbuckle arrangement for tightening the tiedown chains. These devices are stowed in racks aft of the flight station and on the right and left sidewalls of the cargo compartment. The other type consists of webbing straps with hooks for attaching the straps to the tiedown fittings. These devices are stowed in a box on the aft cargo door.

2.24.6 Tiedown Chains. Chains for use with the tiedown devices for securing cargo are supplied with the aircraft. These chains are stowed in boxes on the left and right sidewalls above the ramp.

2.24.7 Auxiliary Ramps. Four auxiliary ramps are supplied with the aircraft. The two truck loading ramps are used when loading from the bed of a truck or support equipment, these are stowed on the right sidewall above the ramp. The two ground loading ramps are used when the ramp is extended to ground level, these are stowed on the cargo door.

2.24.8 Portable Winch. A portable winch is available for each aircraft. The winch is located in the cargo compartment and is secured to the cargo floor by hooking it to two 10,000-pound tiedown rings. The winch is powered by main ac or main dc through a receptacle on the electronic equipment rack aft of the 245 bulkhead.

2.24.9 Loading Instructions. For detailed information concerning cargo loading and tiedown, and aerial delivery instructions, refer to the applicable loading manual.

2.25 TROOP CARRYING EQUIPMENT

When the C-130T aircraft is used as a troop carrier, seating accommodations are provided for 64 paratroops or 78 ground troops (see Figure 2-143). By using the seat attachment provisions on the wheelwell walls, 14 additional ground troops can be carried. For paratroop airdrop missions, the seats are installed on a 24-inch spacing. For ground troops or personnel transport, the seats are installed with a 20-inch spacing. The installed seats form a single row down each side of the cargo compartment and a double row (back-to-back) down the center of the cargo compartment. When the aircraft is not being used for transporting troops, the seats are rolled up and stowed. The method of installation and stowing the seats is given on the instruction placards located on the center seat stanchions, and the cargo compartment left wheelwell wall. For detailed information, see the applicable loading manual.

2.26 CASUALTY CARRYING EQUIPMENT

Casualty transport facilities for 70 litters and 6 attendants, or 74 litters and 2 attendants, are provided with the C-130T aircraft. The litters are carried aboard the aircraft through the aft cargo door; they are installed in four rows in the cargo compartment (see Figure 2-144). For detailed instructions on litter installation and stowage, see the applicable loading manual.

2.27 PARATROOP EQUIPMENT

Paratroop equipment consists of seats, paratroop doors, jump platforms, anchor lines, jump signals, and air deflectors.

2.27.1 Seats. Seats are provided for installation in the cargo compartment. When the seats are in use, they are installed in a single row down each side of the cargo compartment and a double row (back-to-back) down the center of the cargo compartment. Seatbelts are provided and may be installed with 24-inch spacing to accommodate paratroops or with 20-inch spacing to accommodate ground troops or personnel. The number of seats available is as follows:

1. Ground troops — 78.
2. Ground troops (including wheelwell seats) — 92.
3. Paratroops — 64.

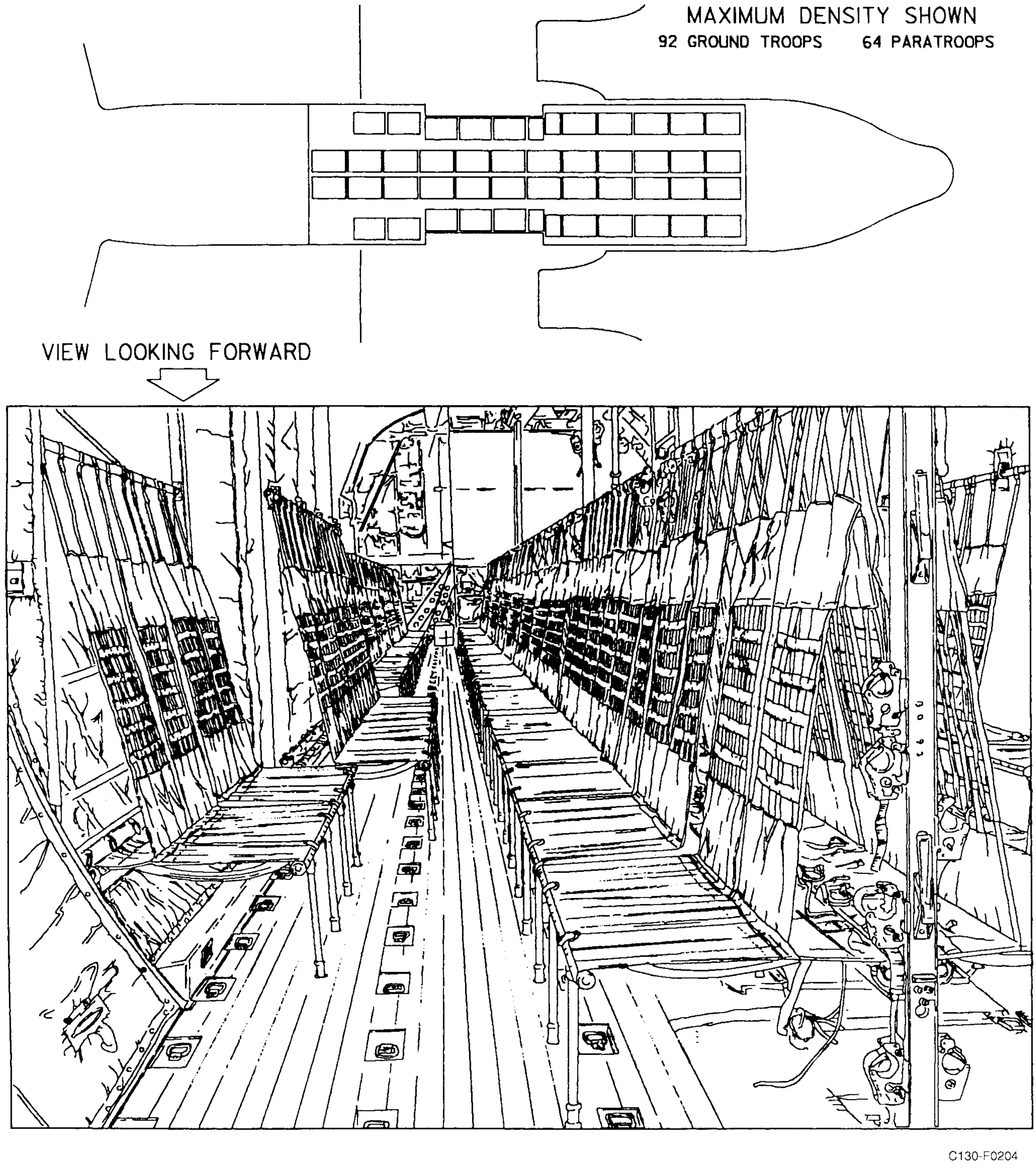


Figure 2-143. Typical Troop Seating Arrangement

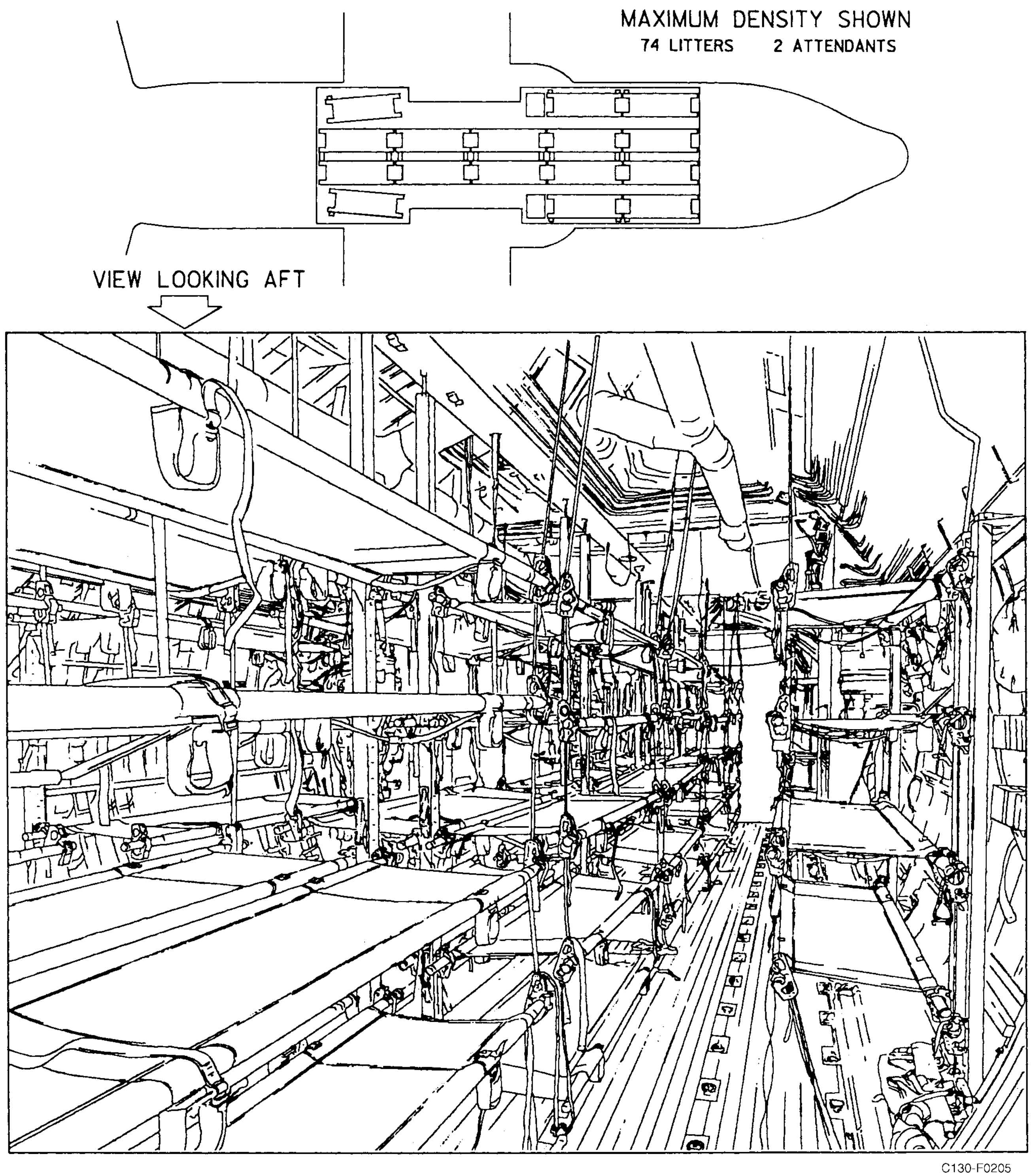


Figure 2-144. Typical Litter Arrangement

When the seats are not in use, they are rolled and stowed in the cargo compartment. For detailed installation and stowage instructions, refer to the applicable loading manual.

2.27.2 Paratroop Doors. A paratroop door is located on each side of the fuselage forward of the ramp. Each door is unlocked by a handle located in the center of the door. After the latch pins are released, the door is raised manually with an inward and upward movement. The door is held in the open position by a spring-loaded latch that must be released manually before the door can be closed.

2.27.3 Paratroop Jump Platforms. Two metal, nonskid jump platforms are used in the paratroop door openings for paratroop jump operation. Install and use the jump platforms in accordance with the applicable loading manual.

2.27.4 Anchor Lines. Four metallic-cable anchor lines are installed on reels in the aft section of the cargo compartment. They are installed by attaching the aft end of each anchor-line to a u-bolt on the anchor line supporting arm. Each arm is electrically controlled by an individual aft anchor-line arm switch on the left side of the cargo compartment forward bulkhead (see Figure 14-6). Electrical power is furnished by the 28-volt main dc bus, through the LH and RH AFT ANCHOR LINE ARM circuit breakers on the copilot lower circuit breaker panel. The forward end of the anchor line is attached to similar u-bolts on the cargo compartment forward bulkhead. Refer to the applicable loading manual for installation procedures.

CAUTION

The electrical control system of the cargo door and ramp is inactivated when the anchor line support arms are not in the up position. If the anchor line support arms are extended prior to the cargo door reaching the up-and-locked position, the door will free fall onto the arms.

2.27.5 Jump Signals. Jump signals consist of red and green lights. A jump signal is located on the forward and aft frame of each paratroop door, on each aft anchor arm, and on the forward cargo compartment light panel. Two indicator lights are located on the pilot and copilot side shelf. The jump signals are controlled from the pilot and copilot paratroop panels (see Figures 2-145 and 2-146) by two two-position (ON, OFF) toggle switches. A cam is installed between the switches so the JUMP switch cannot be actuated until the CAUTION switch is placed in the ON position. When the CAUTION switch is placed in the ON position, the red lights go on; when the JUMP switch is placed in the ON position, the green lights go on and the red lights go off. The jump signals are powered by 28-Vdc power from the battery bus through the TROOP JUMP LIGHTS circuit breaker on the pilot side circuit breaker panel.

2.27.6 Air Deflectors. Air deflectors are located on each side of the fuselage, forward of the paratroop doors, forming the rear section of the main landing gear wheelwell fairing. The air deflectors are opened to approximately 30° by actuation of a three-position (OPEN, OFF, CLOSE) guarded toggle switch on the pilot and copilot paratroop panel (see Figures 2-145 and 2-146). A warning light above the AIR DEFLECTORS switch is illuminated when the doors are not closed. The AIR DEFLECTORS switch and the warning light are energized by 28-Vdc power from the main dc bus through the PARATROOP AIR DEFLECTOR circuit breakers on the copilot lower circuit breaker panel.

2.27.7 AN/ASH-37 Structural Data Recording Set (SDRS). The Structural Data Recording Set (SDRS) is used to measure and increase the accuracy of structural fatigue data for the airframe and critical components. The system consists of Data Entry Keyboard on the starboard side of FS245, a Recorder Converter and Memory Unit in the RH under deck area, a Motion Pickup Transducer, and Strain Sensors located in the left wing. The system also incorporates an AN/UYQ-76 ground support unit used primarily to download recorded flight data. The system receives 28 Vdc power from the essential dc bus through the SDRS circuit breaker on the copilot's lower circuit breaker panel.

2.28 EMERGENCY EQUIPMENT

Various types of emergency equipment are furnished to minimize hazards to the aircraft and to personnel in case of fire or accident.

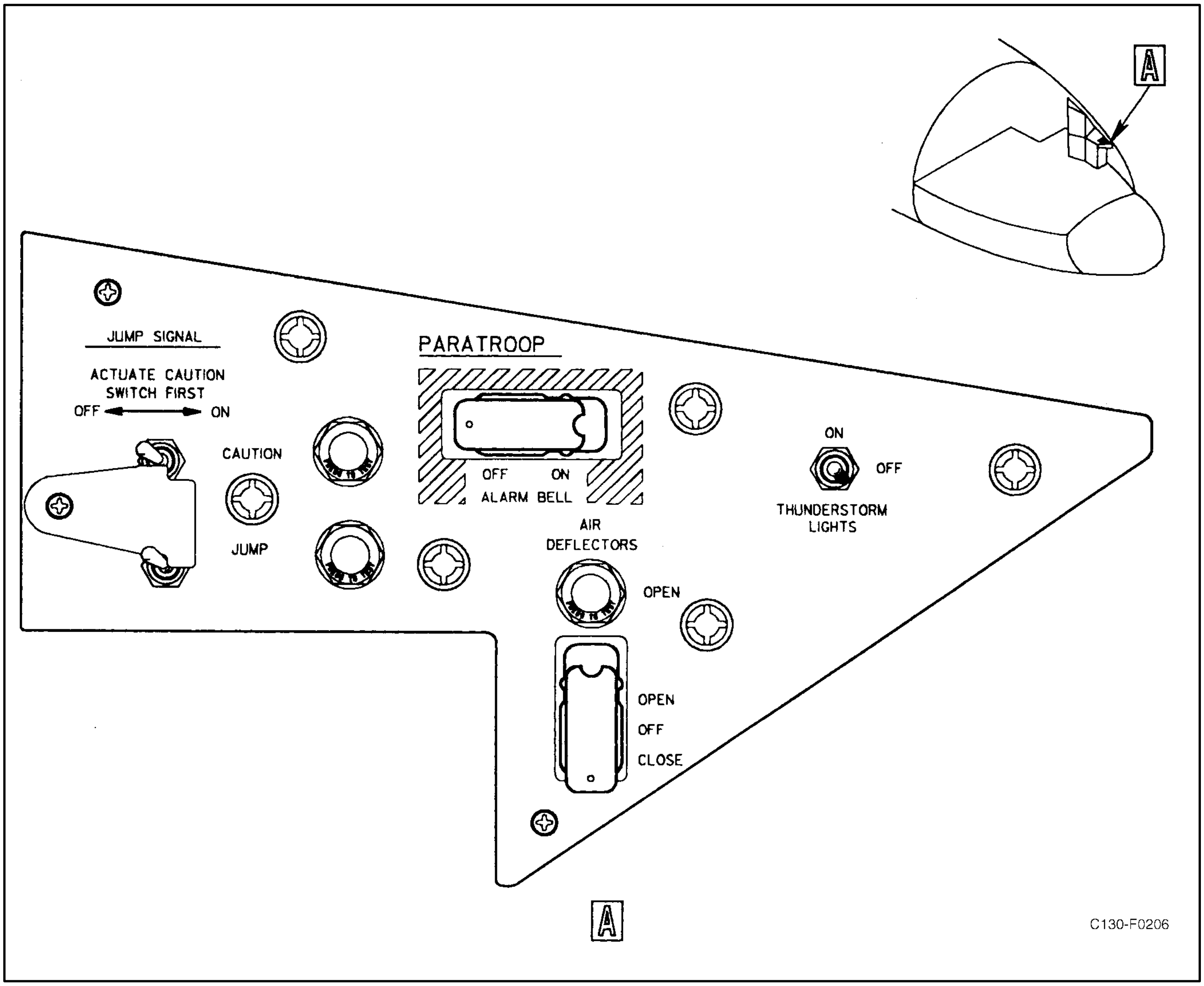


Figure 2-145. Pilot Paratroop Panel

2.28.1 Hand-Operated Fire Extinguishers. CO_2 fire extinguishers for fighting interior fires are located as follows (see Figure 11-1).

1. Flight station aft bulkhead — 1.
2. Cargo compartment forward bulkhead — 1.
3. Rear of left wheelwell — 1.
4. Aft of left paratroop door — 1.

2.28.2 Alarm System. The alarm system consists of four alarm bells in the cargo compartment and two switches, one on the pilot side shelf and the other on the copilot side shelf. The alarm system is used for crew and passenger warning or paratroop warning. All the bells sound when either guarded switch is ON. Power for operation of the bells is supplied from the battery bus through the ALARM BELL circuit breaker on the pilot side circuit breaker panel.

2.28.3 Door-Open Warning System. The door-open warning system (see Figure 2-147) consists of a master DOOR OPEN warning light on the pilot glareshield and a light and master light shutoff switch for each door. Power for operation of the door warning system is supplied from the main dc bus through the DOOR WARNING LIGHT circuit breaker on the copilot lower circuit breaker panel.

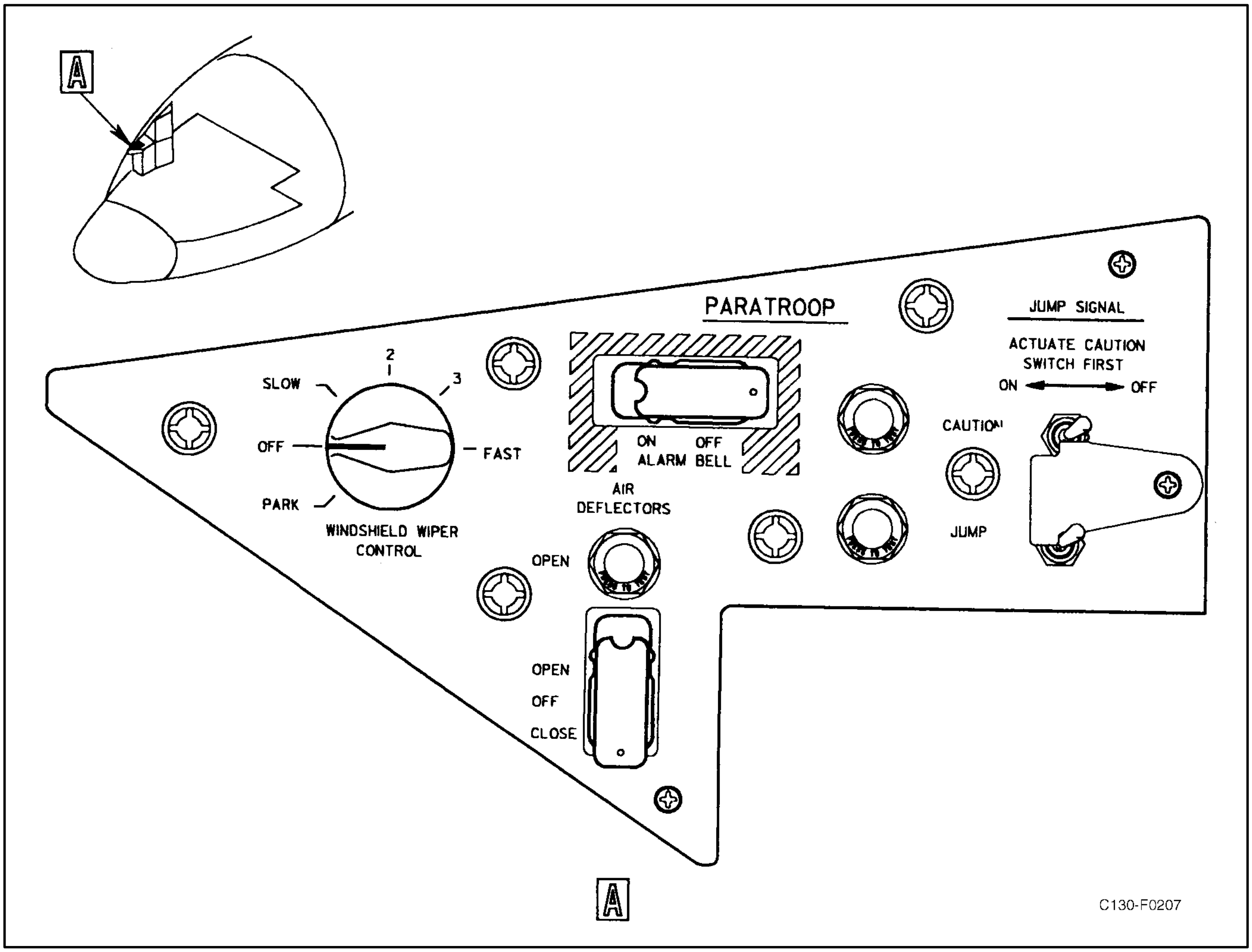


Figure 2-146. Copilot Paratroop Panel

2.28.3.1 Master DOOR OPEN Warning Light. The master DOOR OPEN warning light is located on the pilot glareshield. It will go on whenever any one of the doors is not closed and locked.

2.28.3.1.1 Door Open Warning Lights. A door open warning light is provided for each door. Any one of these lights will go on when the corresponding door is not closed and locked and cannot be turned off except by securing the door.

2.28.3.2 Master Light Shutoff Switches. Each door is provided with a master door warning light shutoff switch. The switches are located with each individual door-open light. The switches are used to turn off the master door-open light on the pilot glareshield after it has gone on to indicate that one of the doors is not securely locked. This will provide for another indication for the flightcrew should another door become insecure.

2.28.4 First-Aid Kits. Mounting provisions are included for the installation of 23 first-aid kits as follows:

1. Flight station aft bulkhead — 2.
2. Forward of right wheelwell — 6.
3. Forward of left wheelwell — 7.
4. Forward of right paratroop door — 4.
5. Forward of left paratroop door — 4.

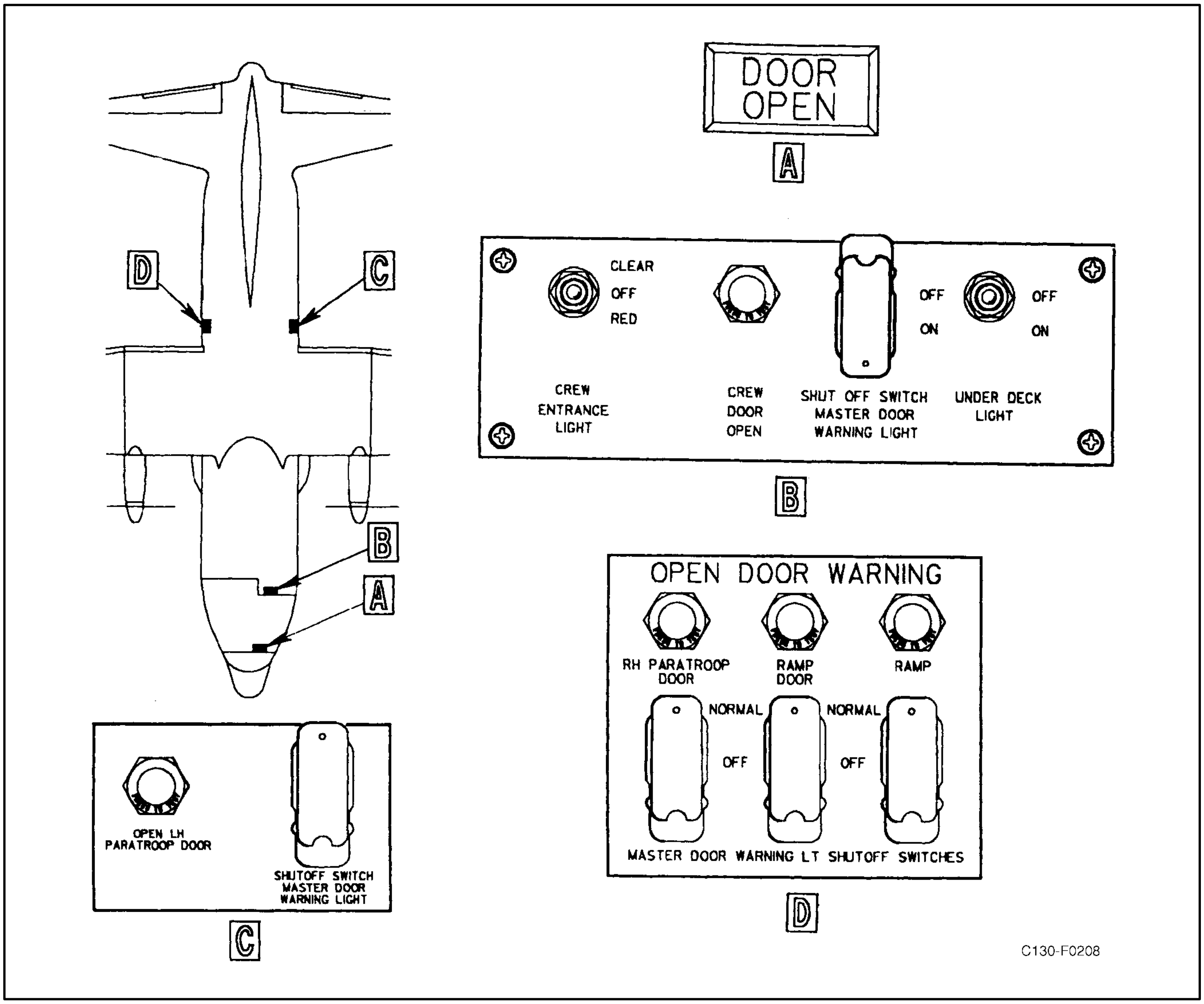


Figure 2-147. Door-Open Warning Lights and Control

2.28.5 Hand Axes. Three hand axes (Figure 11-1) are installed in the aircraft, one on each side of the 245 bulkhead, and one aft of the left-hand paratroop door.

2.28.6 Emergency Lights. Portable, battery-operated emergency lights (Figure 11-1) are installed on stationary terminal blocks located near each normal or emergency exit. The lights are located as follows:

LOCATION	NO. OF LIGHTS
Crew entrance door	1
Paratroop doors	2
Overhead emergency escape hatches	3
Right-side exit	1
Left-side exit	1

When installed, the lights can be either individually controlled by the three-position (ON, OFF, ARM) switch on each light assembly or collectively extinguished by the EMER EXIT LT EXTINGUISH pushbutton on the overhead electrical control panel. In order for the EMER EXIT LT EXTINGUISH pushbutton to be able to extinguish a light, however, the associated light assembly switch must be positioned to ARM. An inertia switch in each of the light assemblies actuates the light when the aircraft is subjected to a decelerating force exceeding 2-1/2g. The lights will also illuminate if power on the essential dc bus fails. An individual light assembly can be removed for emergency portable use by pulling the release handle on the light assembly. The control system for the installed system is supplied 28-Vdc power from the essential dc bus through the EMER EXIT LIGHT CONTROL circuit breaker on the copilot lower circuit breaker panel and from the battery bus through the EMER EXIT LIGHT EXTINGUISHER circuit breaker on the pilot side circuit breaker panel. The batteries are not recharged by the exit light control circuit.

2.28.7 Liferafts. Stowage provisions are provided for installation of four 20-man pneumatic liferafts (Figure 11-1) in the trailing edge of the center wing section. Liferaft release handles (Figure 11-13) are located as follows: two on the flight station bulkhead, below the escape hatch; two on the fuselage structure, aft of the right paratroop door; and two on the wing upper surface, inboard of each raft stowage compartment. The release handles on the wing upper surface can be reached by removing the protective canvas covering over the handle openings. The rafts are automatically inflated upon actuation of the release handles.

2.28.8 Emergency Transmitters. An emergency radio transmitter (Figure 11-1) is stowed in each of the four liferafts.

2.28.9 Lifevests. Stowage provisions are provided for 10 lifevests (see Figure 11-1).

2.28.10 Antiexposure Suits. Stowage provisions are provided for seven antiexposure suits (see Figure 11-1).

2.28.11 Crash Survivable Flight Incident Recorder (CSFIR). The Crash Survivable Flight Incident Recorder (CSFIR) is installed to provide a combination flight incident and cockpit voice recorder. The CSFIR receives and stores flight data, navigation data, and engine performance data into crash-survivable memory for analysis in the event of an aircraft incident or mishap. Memory capacity provides for recording two hours of flight data and thirty minutes of audio data. The memory is continuously overwritten with the most recent two hours of flight data and 30 minutes of voice data. The CSFIR does not require operator input and is operational when aircraft electric power is applied. The system's primary components are a Signal Data Recorder-Reproducer (SDRR) and Voice and Data Recorder (VADR) located in the aft overhead tail section and a Cockpit Control Indicator located on the flight station pedestal (Figure 2-4). The system receives 115-Vac power from the essential ac bus through the CSFIR TMU 115VAC circuit breaker on the pilot's lower circuit breaker panel and 28-Vdc power from the essential dc bus through the CSFIR 28VDC circuit breaker on the copilot's lower circuit breaker panel.

2.29 ENTRANCE DOORS

Entrance to the aircraft can be gained through the crew entrance door or the paratroop doors.

2.29.1 Crew Entrance Door. The crew entrance door (see Figure 2-148) is located on the forward left side of the aircraft. The door is opened from the outside by rotating the door handle downward. The door should be allowed to swing slowly downward until the spring-loaded telescoping counterbalance and door stop holds the door at the proper angle for use.

WARNING

Stand clear of the door when operating the handle so as to prevent personal injury if the door should fall free.

Steps on the inside of the door facilitate entrance to the aircraft. A hand lanyard on the aft side of the inside face of the door is provided for pulling the door closed preparatory to flight. To open the door from the inside, turn the inside handle in a counterclockwise direction.

CAUTION

When opening the door from the inside, use the hand lanyard so as to restrain the door if it should fall free.

2.29.1.1 Crew Door Jettison Handle. The crew door jettison handle (see Figure 2-149), painted yellow, is located on the ceiling of the flight station, 3 feet to the left of the centerline of the aircraft and slightly aft of the pilot seat. Pulling the handle down actuates a cable through a bellcrank assembly to pull the locking pins from the top of the door at the same time that the hinge pins drop from the bottom hinge and the telescoping counterbalance is released.

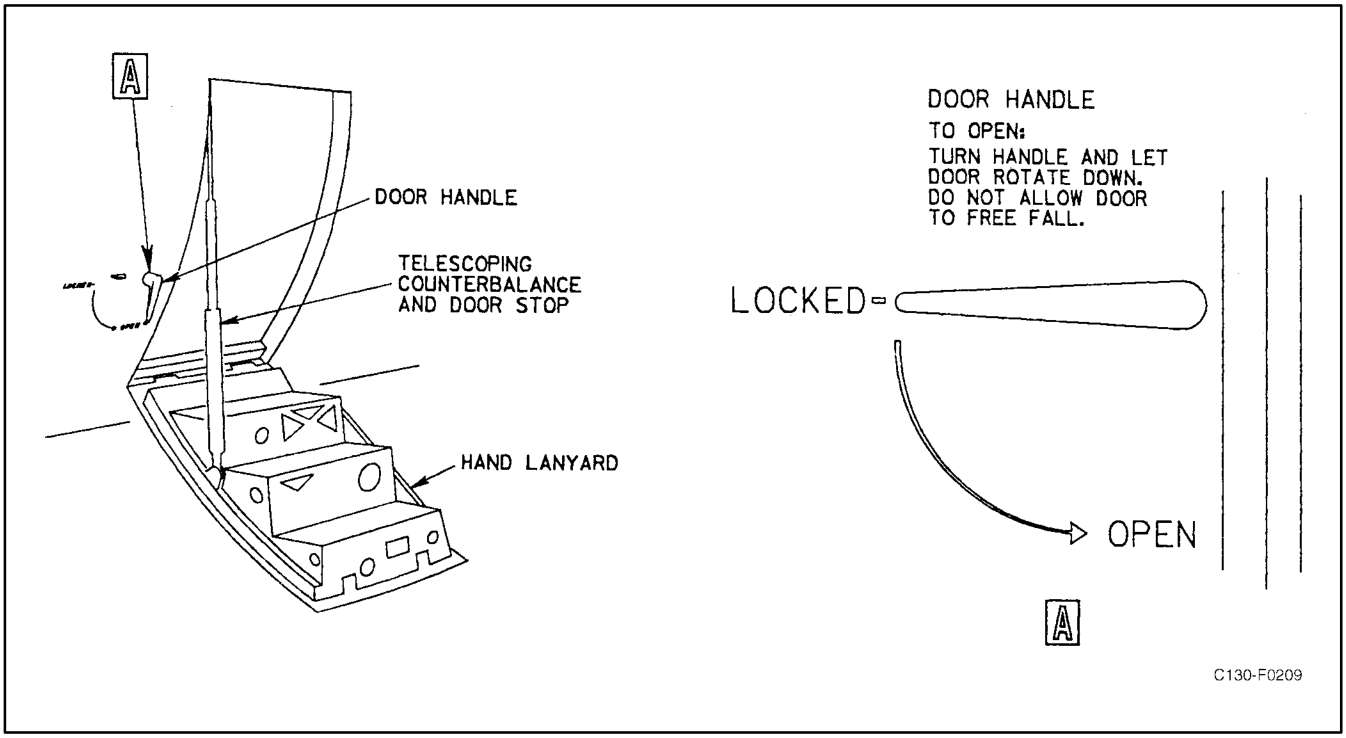


Figure 2-148. Entrance to Aircraft

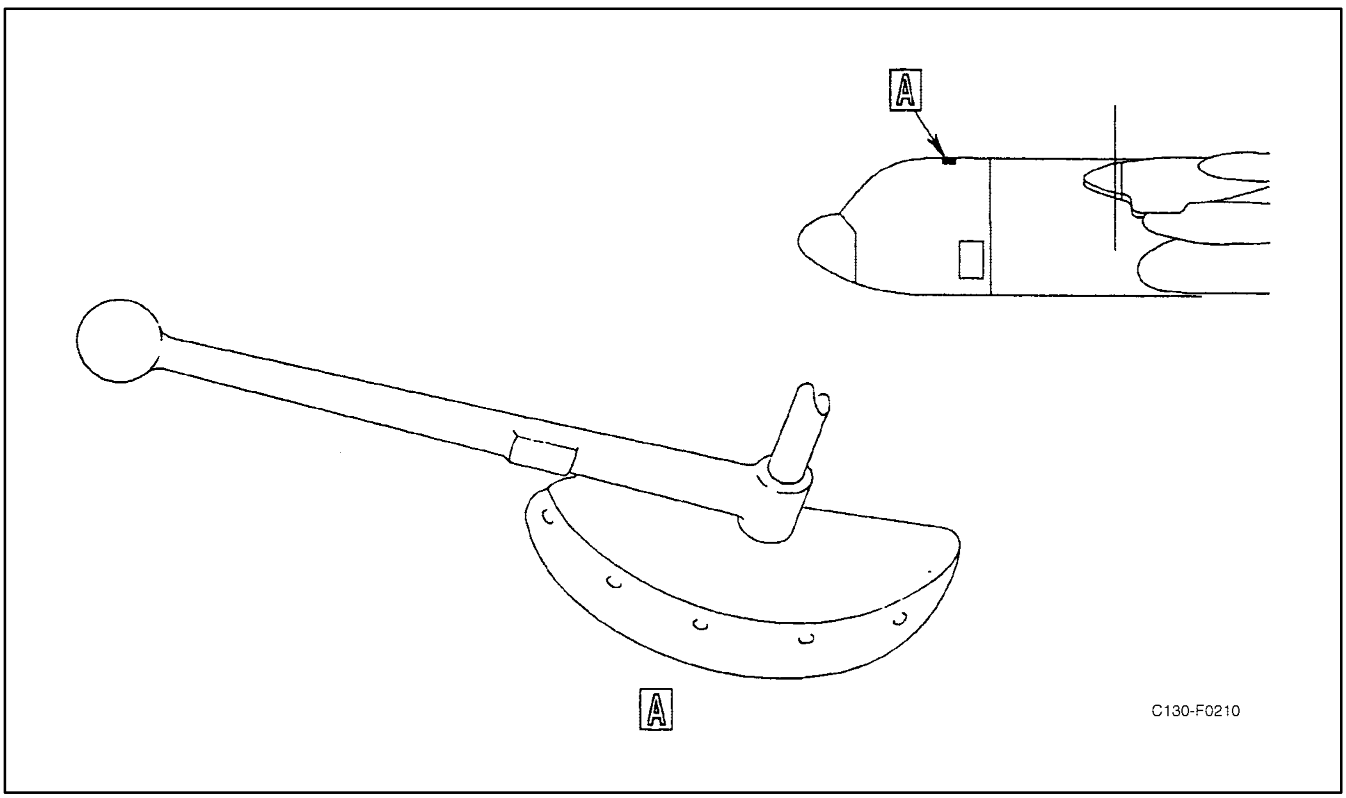


Figure 2-149. Crew Door Jettison Handle

Note

Do not attempt to jettison the crew door when cabin pressure is greater than 3.1 inches Hg. Above 3.1 inches Hg, the load on the door is too great for the jettison mechanism to operate. In addition, should the door jettison at a greater pressure differential, there may be some explosive decompression effects.

2.29.2 Paratroop Doors. A paratroop door is located on either side of the fuselage just aft of the wheelwell fairing. These doors are normally used for loading paratroops or passengers. The doors are opened by turning the door handle clockwise, pushing in, and sliding the door upward. Two paratroop door ladders are provided to aid personnel entering the aircraft from ground level.

2.30 SEATS

2.30.1 Crew Seats. The crewmembers in the flight station are provided with seats designed for use with back-style parachutes (see Figure 2-150). The seats are adjustable both fore and aft and up and down. Headrests are an integral part of the seat and adjust vertically. Use of the vertical adjustment lever on the side of the seat permits vertical movement of the seat, and use of the horizontal adjustment lever on the opposite side of the seat permits fore and aft movement of the seat. Moving a swivel release lever on the navigator and flight engineer seats releases a locking device and permits the seats to be swiveled. Both observers are provided with platform-type seats attached to the paratroop doors. These seats can be folded and stowed against the paratroop doors.

2.30.1.1 Seat Controls. Seat controls are designed to adjust the seat position and contour to the physical build of the individual crewmember. They are easily adjusted to the comfort of the crewmember and lock in any desired position.

2.30.1.1.1 Horizontal Adjustment Lever. A horizontal adjustment lever locks and unlocks the seat adjustment mechanism, allowing the seat to be adjusted from an aft to a forward position. Moving the lever aft unlocks the adjustment mechanism, and the seat can be moved in either direction. Moving the lever forward locks the adjustment mechanism.

2.30.1.1.2 Vertical Adjustment Lever. A vertical adjustment lever, which has a button to release the lever from the locked position, is located at the side of each seat. The seat itself is spring loaded to the up position. To adjust the seat for height, sit down in the seat and press the button. With less weight on the seat, the button releases more easily. The seat will tend to move up or down, depending on the weight applied to it. When the desired height is obtained, release the button, and the seat will lock in the nearest detented position.

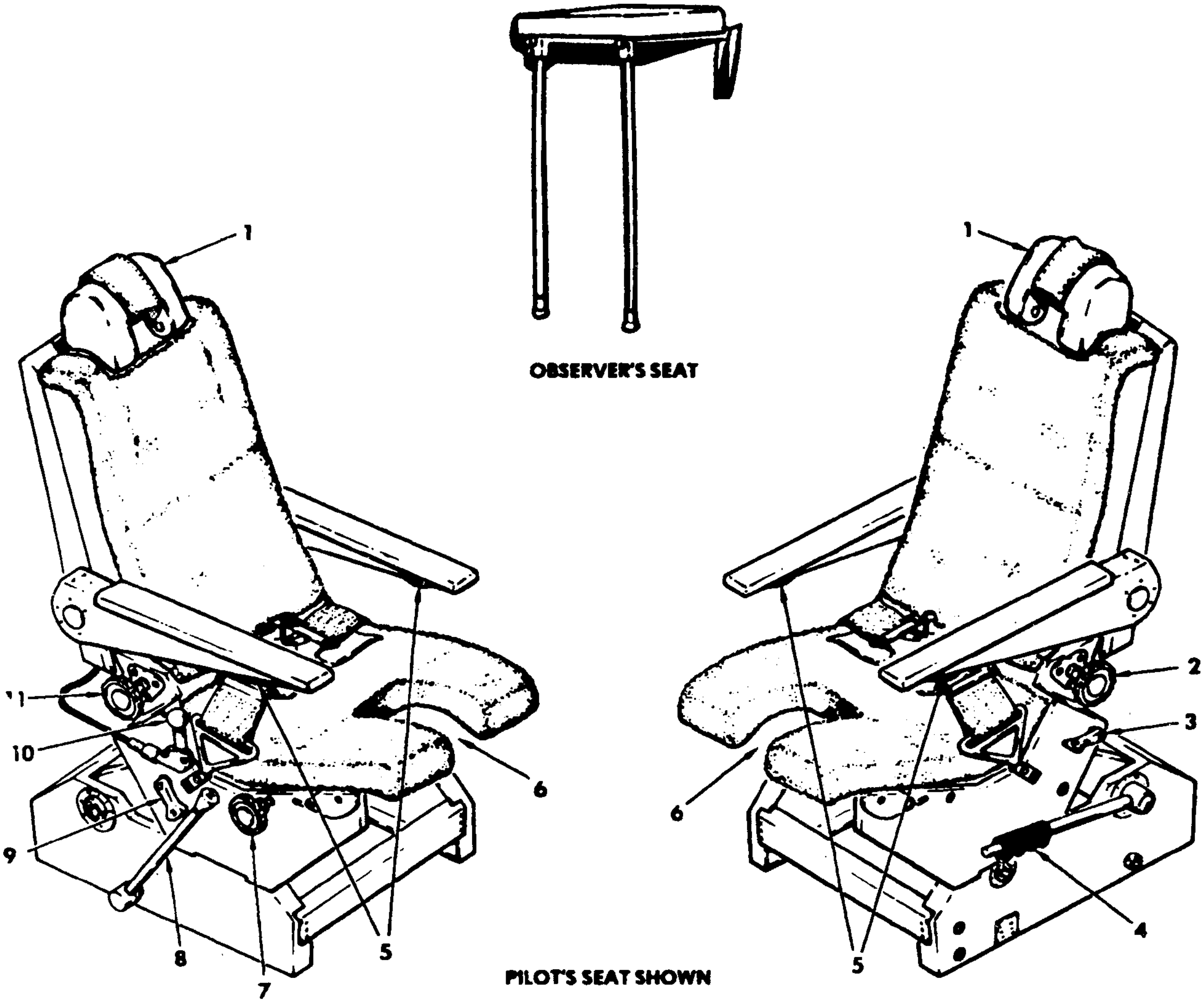
2.30.1.1.3 Recline Lever. A seat recline lever, located on the side of the seat, is a manual control that allows the back of the seat to be tilted forward or aft.

2.30.1.1.4 Armrest Adjustment Knob. The armrest adjustment knob, when rotated, sets the desired vertical angle of the individual armrest. The armrests may be rotated to the stowed position (full up) where they must be physically pushed into the side of the seat. To unstow, the armrests must be pulled out away from the side of the seat and rotated down to their last adjusted position.

2.30.1.1.5 Thigh Support Control. The thigh support control, located on the side of the seat, is rotated to adjust the forward edge of the seat vertically to match the position of the thigh. This will provide the crewmember with the most comfortable thigh support.

2.30.1.1.6 Horizontal Lumbar (Lumbar In-Out) Adjustment Control. The horizontal lumbar adjustment control, located on the aft side of the seat, is rotated to adjust the back of the seat (lumbar area) fore and aft. This, coupled with the vertical lumbar support adjustment, will provide the crewmember with the most comfortable back support.

2.30.1.1.7 Vertical Lumbar (Lumbar Up-Down) Adjustment Control. The vertical lumbar adjustment control, located on the opposite side of the seat from the horizontal lumbar adjustment control, is rotated to adjust the back of the seat (lumbar area) up and down. This, coupled with the horizontal lumbar support adjustment, will provide the crewmember with the most comfortable back support.



1. ADJUSTABLE HEADREST
2. VERTICAL LUMBAR ADJUSTMENT CONTROL
3. SEAT RECLINE LEVER (3)
4. VERTICAL ADJUSTMENT LEVER (3)
5. ARMREST ADJUSTMENT KNOB
6. CONTROL COLUMN SLOT (1)
7. THIGH SUPPORT CONTROL (3)
8. HORIZONTAL ADJUSTMENT LEVER (3)
9. SWIVEL RELEASE LEVER (2)
10. INERTIA REEL LEVER (3)
11. HORIZONTAL LUMBAR ADJUSTMENT CONTROL

NOTE

(1) PILOT AND COPILOT SEAT ONLY.

(2) ENGINEER AND NAVIGATOR SEATS ONLY.

(3) CONTROL LOCATED ON OPPOSITE SIDE OF SEAT FOR COPILOT.

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Figure 2-150. Crew Seats

2.30.1.1.8 Flight Engineer and Navigator Seat Swivel Release Lever. A swivel release lever(s), located on the flight engineer and navigator seats underneath the inertia-reel lock control, controls the rotational movement of the seat. When the swivel release lever is rotated, the seat locking device is released and the seat can be rotated to any detented position. When the lever is released, the locking device engages, keeping the seat in the selected detent.

2.30.2 Safety Belt and Shoulder Harness. All crew seats are provided with a conventional seatbelt and shoulder harness to retain the crewmember in the seat in the event of a crash landing.

2.30.3 Shoulder Harness Inertia-Reel Lock Lever. A two-position (forward LOCK, aft UNLOCKED) shoulder harness inertia-reel lever is located on the pilot, copilot, navigator, and flight engineer seats (see Figure 2-150). The inertia-reel lever may be moved without pressing down. When the lever is in the aft (UNLOCKED) position, the reel harness cable will extend to allow a crewmember to lean forward in the seat; however, the reel harness cable will automatically lock when an impact force of 2g to 3g on the aircraft is encountered. When the reel is locked in this manner, it will remain locked until the lever is moved to the forward position and then returned to the aft position. When the lever is in the forward (LOCK) position, the reel harness cable is manually locked so that the seat occupant is prevented from moving forward.

The LOCK position is used during takeoffs and landings and whenever a ditching or crash is imminent. This position provides an added safety measure over and above that of the automatic safety lock.

WARNING

The seats must be facing forward for the inertia reel to function automatically.

2.31 MISCELLANEOUS EQUIPMENT

Miscellaneous equipment consists of windshield wipers, sextant step, toilet facilities, galley provisions, ladders, protective covers, blackout curtains, and alarm bells.

2.31.1 Windshield Wipers. Two electrically operated windshield wipers are installed: one on the pilot windshield panel and one on the copilot windshield panel. The windshield wipers are controlled by a six-position (PARK, OFF, SLOW, 2, 3, FAST) rotary-type WINDSHIELD WIPER CONTROL switch on the copilot side shelf (see Figure 1-4). The windshield wipers are powered by 28-Vdc power from the main dc bus through the WINDSHIELD WIPER circuit breaker on the copilot lower circuit breaker panel.

2.31.2 Toilet Facilities. Toilet facilities consist of an electrically powered flush-type toilet and two carry-on/off-type urinal-holding tanks. The flush toilet is a fixed type, located aft of the right paratroop door, which folds up to clear the cargo loading envelope. It empties into an integral waste container and is serviced through an external adapter on the right aft fuselage. The toilet is powered by 28-Vdc power from the main dc bus through the AFT TOILET circuit breaker on the aft fuselage junction box. The urinal facilities are located on the cargo compartment forward bulkhead.

2.31.3 Galley Equipment. Crew galley provisions, installed on the left side of the flight deck, are as follows: a 4-gallon water tank and sink, two 2-gallon liquid containers, a cup dispenser, an electrically operated oven or microwave oven (aircraft 165378 and 165379) and two food-warming cups, a cold storage drawer and frozen food compartment, a refuse container, and storage compartments. Additional liquid containers are installed in the cargo compartment aft of the paratroop doors. Electrical outlets for connecting portable galley equipment are installed forward of the left paratroop door and on the right sidewall aft of the forward cargo compartment bulkhead. Power to the galley is supplied from the left-hand ac bus through the CARGO COMPT and FLIGHT DECK GALLEY power circuit breakers on the pilot upper circuit breaker panel.

2.31.4 Airborne Ladders. One maintenance ladder and two paratroop door ladders are installed on the aircraft. The paratroop door ladders are stowed in compartments of the cargo door. The maintenance ladder has no specific area in which to be stowed, however, it is usually stowed in the cargo compartment forward of the utility hydraulic reservoir.

2.31.5 Protective Covers. Protective covers for the engine tailpipes are stowed in a container attached to the left side of the cargo compartment above the ramp.

Covers for the engine inlet air ducts and APU exhaust are stowed on the left side of the forward cargo compartment. Protective covers for the pitot tubes are stowed in the miscellaneous stowage container.

2.31.6 Blackout Curtains. Blackout curtains for the windows in the cargo compartment are stowed in pockets next to each window.

CHAPTER 3

Aircraft Servicing

3.1 GROUND SERVICING AND SUPPORT EQUIPMENT

The ground support equipment for the aircraft shall be those items pertaining to ramp dispatch and operation of the aircraft. A servicing diagram (see Figure 3-1) identifies the location of items for servicing.

3.2 EXTERNAL POWER REQUIREMENTS

The external power source should provide a 200-/115-volt, three-phase, 400-Hz, ac source at a capacity of 40 kVA, but preferably 60 kVA. Its phase must be A-B-C. The 28-Vdc external source should have a capacity of at least 400 amperes.

CAUTION

When external ground equipment is used, the units will be placed the maximum distance from the aircraft that cords or ducts will permit.

3.3 EXTERNAL AIR REQUIREMENTS

Engine ground starting may be accomplished with a standard airstarting unit that will deliver a minimum of 90 ppm airflow at 25-psi pressure. The ground airstart connection is located aft, and adjacent to, the APU access door.

3.4 NORMAL OPERATION OF THE SINGLE-POINT REFUELING SYSTEM

At times it may be necessary for the flightcrew to perform the refueling. Use only the fuels specified for this aircraft. If a single-point refueling truck or fuel pit is available, the single-point refueling system may be used. If a single-point fuel source is not available, refueling must be accomplished through the individual wing-tank filler ports.

3.4.1 Refueling or Defueling Operation

Note

At times it may be necessary for the flightcrew to perform refueling and defueling operations. Under these conditions, refer to NAVAIR 01-75GAA-2-1.

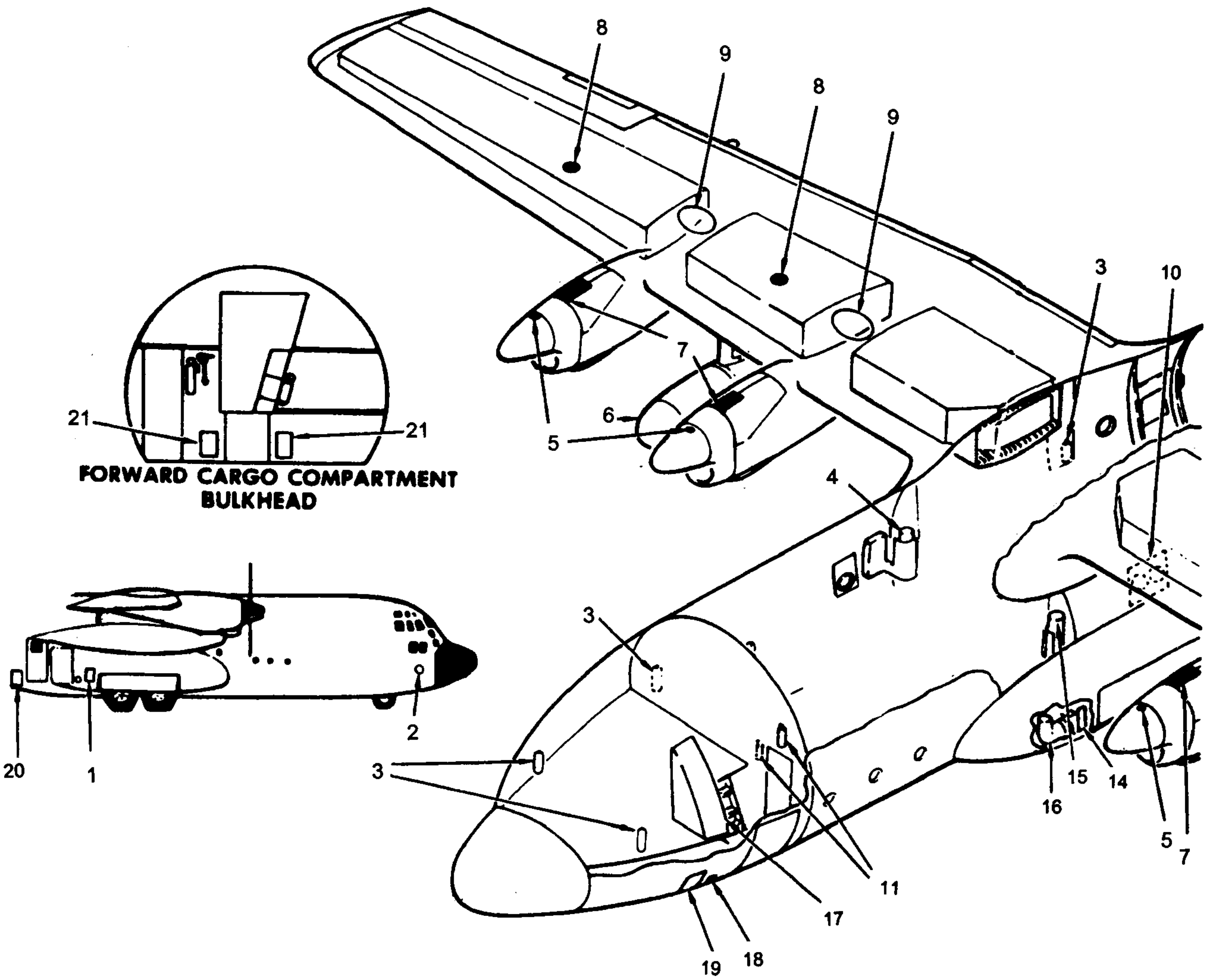
3.5 AIRFIELD CONDITIONS

3.5.1 High-Strength Airfields. Where airfield runway strength data are available in terms of any of the methods shown in Figure 3-2, the chart should be used as a guide to airfield-aircraft comparability. Where airfield/runway data are not available, the aircraft can operate satisfactorily from most smooth, relatively hard surfaced airfields. Permanent-type (paved) airfields listed in the USAF/USN Flight Information Publications are adequate for most aircraft operations. For normal operation, tire pressure for a nominal tire deflection of 32 percent is recommended as shown by the high-strength airfield line on Figure 3-2.

3.5.2 Marginal-Strength Airfields. This category includes marginal-strength airfields, temporary airfields such as airfields with minimum surfacing, or unsurfaced airfields such as would be encountered at forward-area airfields used in air head operations or airfields in remote areas of the world. The minimum soil strength required for aircraft operation is within the CBR values of 3 to 5. Operational feasibility on unsurfaced airfields depends upon the soil type, soil moisture content, and operational frequency. For marginal-strength airfields, a tire deflection of 39 percent is used as shown on Figure 3-2.

CAUTION

Do not exceed 39-percent tire deflection.



1. SINGLE-POINT REFUELING ADAPTER
2. LIQUID OXYGEN FILLER VALVE
3. PORTABLE OXYGEN BOTTLES (4)
4. BOOSTER HYDRAULIC SYSTEM RESERVOIR
5. PROPELLER RESERVOIR
6. EXTERNAL FUEL TANKS (2 PLACES)
7. ENGINE STARTER OIL
8. FUEL FILLER POINTS
9. DRY BAYS
10. FIRE EXTINGUISHER AGENT BOTTLES

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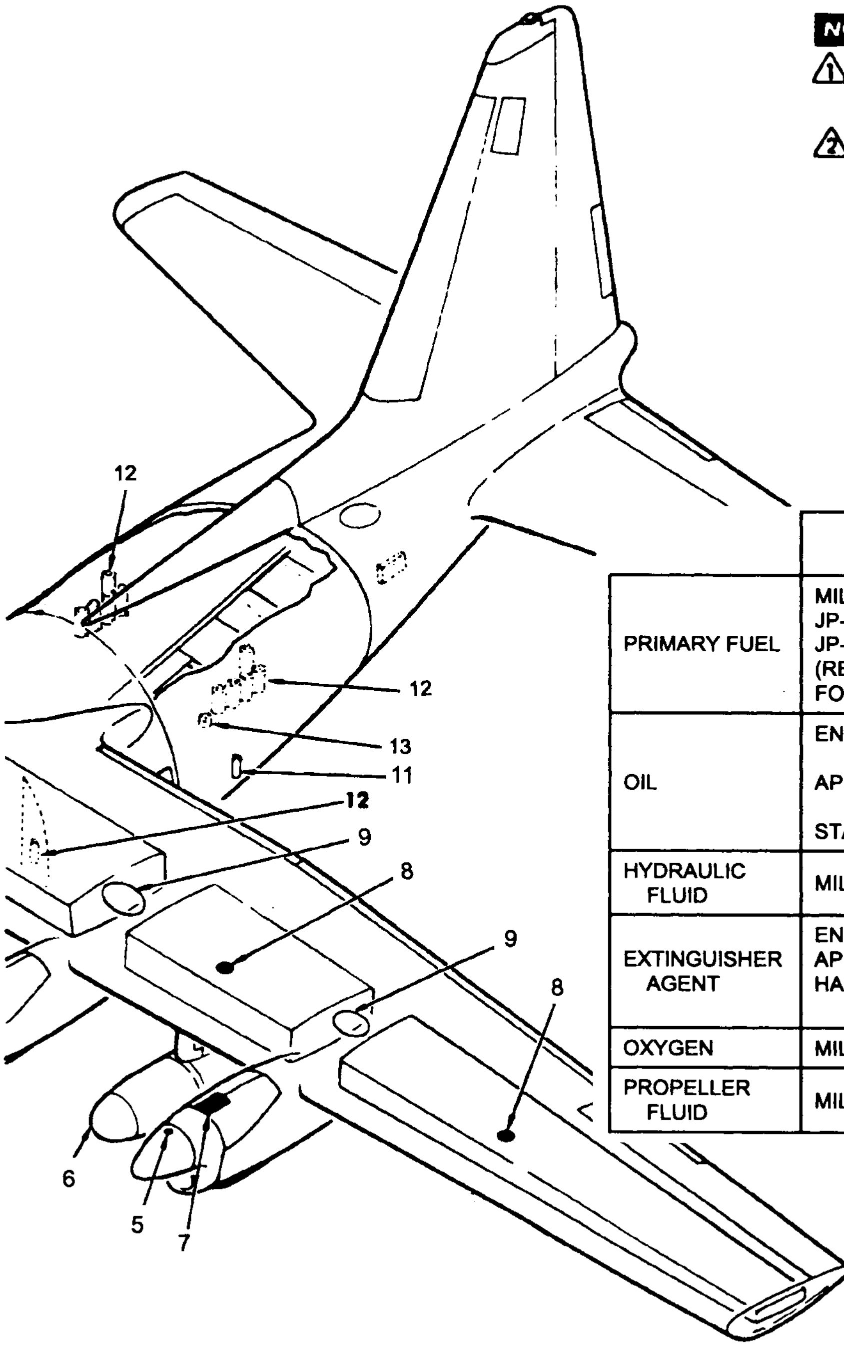
Figure 3-1. Servicing Diagram (Sheet 1 of 2)

NOTE

⚠1 BENDIX STARTERS ARE PERMANENTLY LUBRICATED.

⚠2 REFER TO DETROIT DIESEL ALLISON COMMERCIAL SERVICE LETTER T56-A-15LFE CSL 1502 FOR APPROVED ENGINE OILS.



	SPECIFICATIONS	NATO SYMBOL
PRIMARY FUEL	MIL-T-5624 JP-4 JP-5, JP-8 (REFER TO CHAPTER 4 FOR ALTERNATE FUELS)	F-34 F-40 F-44
OIL	ENGINE ⚠2 MIL-L-7808 APU ⚠2 MIL-L-23699 STARTER ⚠1	0-148 0-156
HYDRAULIC FLUID	MIL-H-83282	H-537
EXTINGUISHER AGENT	ENGINE AND APU MIL-D-4540 HAND EXTINGUISHERS MIL-E-52031	
OXYGEN	MIL-0-27210	
PROPELLER FLUID	MIL-H-83282	H-537

11. HAND OPERATED FIRE EXTINGUISHERS (4)
12. WATER BOTTLES
13. AUXILIARY SYSTEM HYDRAULIC RESERVOIR
14. APU OIL RESERVOIR
15, UTILITY HYDRAULIC SYSTEM RESERVOIR
16. APU
17. GALLEY
18. EXTERNAL POWER RECEPTACLES
19. BATTERY COMPARTMENT
20. TOILET SERVICING PANEL
21. URINAL WITH HOLDING TANK

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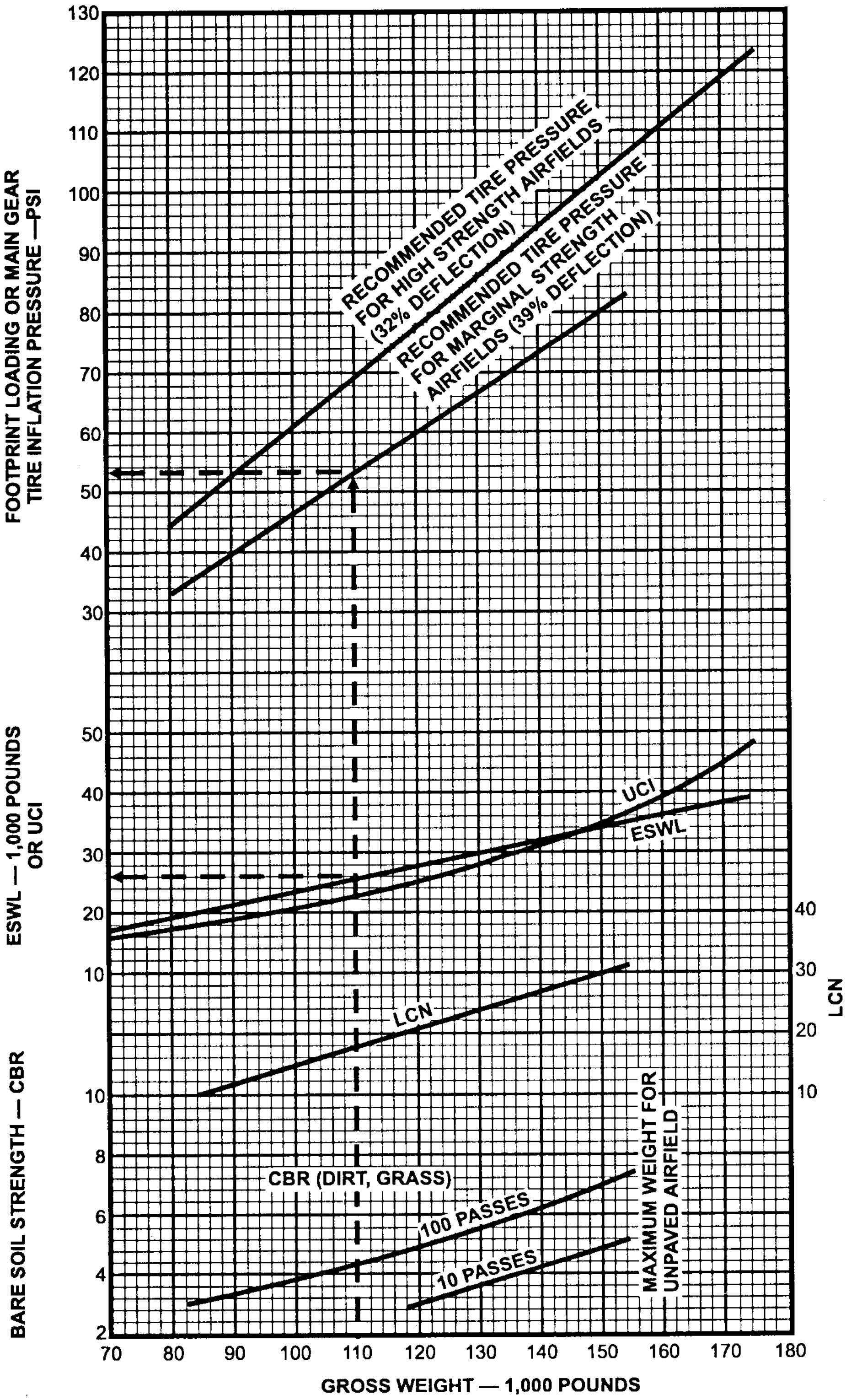
Figure 3-1. Servicing Diagram (Sheet 2)



NOTE

1. FOR SOFT FIELD OPERATION REDUCE THE VALUES OF ESWL AND UCI BY 10 PERCENT.
2. AT WEIGHTS ABOVE 155,000 POUNDS, INFLATE TIRE TO THE HIGH STRENGTH AIRFIELDS LINE.
3. LCN IS BASED ON LOWER TIRE PRESSURE WITH THE DEFLECTION APPROXIMATELY 39 PERCENT ASSUMING RIGID PAVEMENT STIFFNESS OF L=30 AND FLEXIBLE PAVEMENT THICKNESS OF 20 INCHES OVER CBR 6.
4. SOIL STRENGTH IS BASED ON LOWER INFLATION PRESSURE.

COMPARATIVE AIRPLANE DATA

AIRPLANE	WEIGHT (LB)	UCI
AVRO-748	46,000	20
C-7	28,500	11
C-8	49,200	23
C-47	33,000	18
C-54	82,000	27.2
C-119	74,000	26
C-124	170,000	30.2
F-27	45,000	22
P-2	64,900	33.2

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Figure 3-2. Ground Flotation Characteristics

3.5.3 Using the Chart

3.5.3.1 Example 1

GIVEN: A C-130T aircraft is required to operate into an unsurfaced airfield with a gross weight of 110,000 pounds.

FIND: Footprint loading and ESWL for soft field operation.

SOLUTION: Enter Figure 3-2 at the bottom of the chart on the vertical line representing 110,000-pound gross weight. Proceed upward to the point of intersection with the footprint loading line for marginal strength airfields and read 53 psi (minimum) for main gear inflation pressure. Where the vertical line representing 110,000-pound gross weight crosses the ESWL line, read 26,000 pounds; then reduce this value by 10 percent for soft-field operation to obtain a final ESWL value of 23,400 pounds.

3.5.3.2 Example 2

GIVEN: A C-130T is required to operate into an airfield with an LCN of 25.

FIND: Footprint loading and maximum gross weight for unpaved runway operation.

SOLUTION: Enter Figure 3-2 on the horizontal line representing an LCN value of 25; where this line crosses the LCN line, proceed vertically down from this point to read a maximum gross weight of 133,000 pounds. Proceed upward on the 133,000-pound gross weight line to the marginal-strength airfield footprint loading line; then, at the intersection of these lines, proceed horizontally to obtain a minimum main landing gear inflation pressure of 69 psi.

CHAPTER 4

Aircraft Operating Limitations

4.1 INTRODUCTION

This aircraft has certain well-defined limitations to its operation. Maximum performance requires careful consideration of these limitations. The instrument marking illustration (see Figure 4-1) and the engine and propeller limitations illustration (see Figure 4-2) contain certain limitations that are not repeated in text. This fact should be remembered when using this chapter. A summary of limitations is shown in Figure 4-11.

4.2 INSTRUMENT MARKINGS

Flight and engine instrument markings are shown in Figure 4-1 and are not repeated in text.

Note

The markings shown in this part are for flight station indications and are not to be confused with limits shown in the Technical Manual of Maintenance Instructions.

4.3 ENGINE AND PROPELLER LIMITATIONS

Operating time limits, allowable observed TIT ranges, oil temperature, oil pressure, engine speed, propeller governing, and starter operation limits, respectively, are tabulated in Figure 4-2 and are not repeated in text.

Note

All limits given in Figure 4-2 are flight station indicated limits and are not to be confused with maintenance manual limits.

4.4 AUXILIARY POWER UNIT LIMITATIONS

In-flight use of the APU is limited to ac generator operation. Do not attempt to use APU bleed air during flight.

The APU must be on speed and warmed up a minimum of 1 minute before applying a bleed-air load.

The APU starter duty cycle is limited to 1 minute on and 4 minutes off.

The APU must be allowed to stabilize a minimum of 1 minute without a bleed-air load before placing the APU control switch to STOP.

CAUTION

During cold-weather operations, allow a minimum of 4 minutes before applying a bleed-air load.

Note

The APU generator is not considered a load on the APU for warmup after start or stabilization prior to shutdown.

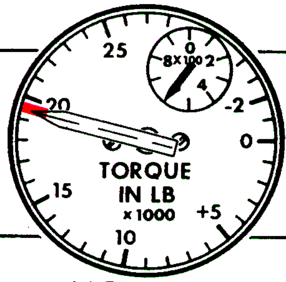
4.5 FUEL UNBALANCE LIMITS

If fuel weight becomes unbalanced through varied rates of consumption or from having an engine shut down, periodic trimming is required. The fuel unbalance limits are:

1. 1,000 pounds between tanks of a symmetrical pair (main or external).

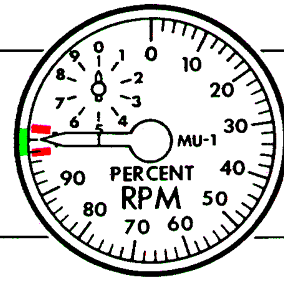
2. 1,500 pounds between the left and right wings except as stated in item 3.

3. One auxiliary tank full and the other auxiliary tank empty, provided all other tanks are symmetrically fueled or unbalanced toward the opposite side within the above limits.



NOTE

Instrument markings should reflect the corresponding numerical values. Actual numerical values govern.



TORQUEMETER

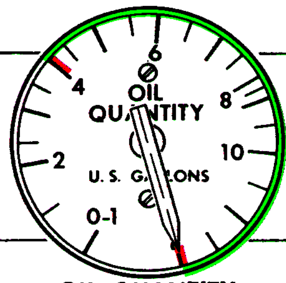
19,600 In. Lb. Maximum Allowable

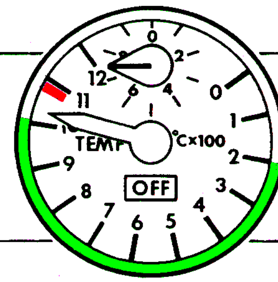
TACHOMETER

102 Pct Maximum Allowable.

98 Pct To 102 Pct Normal.

98 Pct Minimum Allowable.





OIL QUANTITY

12 Gallons Maximum.

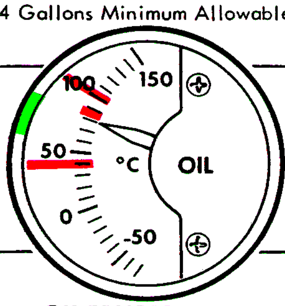
4 To 12 Gallons Normal.

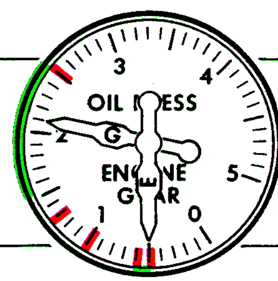
4 Gallons Minimum Allowable.

TURBINE INLET TEMPERATURE

1083° C Maximum Allowable.

200° C To 1010° C Normal (continuous).





OIL TEMPERATURE

85°C To 100°C Taxi Maximum
(30 Min.) And Inflight 5-Minute Maximum.

85°C Maximum Continuous.

60°C To 85°C Normal.

40°C (And Increasing)
Minimum Allowable.

OIL PRESSURE

Both Power Section And Gear Section Oil Pressure Are Indicated On This Instrument: Power Section Pressure By The Front Pointer; Gear Section Pressure; By The Rear Pointer.

GEAR SECTION

250 PSI Maximum Allowable–Except Start And Warmup
(250 PSI May Be Exceeded During Start And Warmup
With Ambient Temperature Below 15° C)

150 PSI to 250 PSI Normal

150 PSI Minimum Allowable (100% RPM, Oil Temp. Normal)

POWER SECTION

100 PSI Maximum Allowable – Start and Warmup

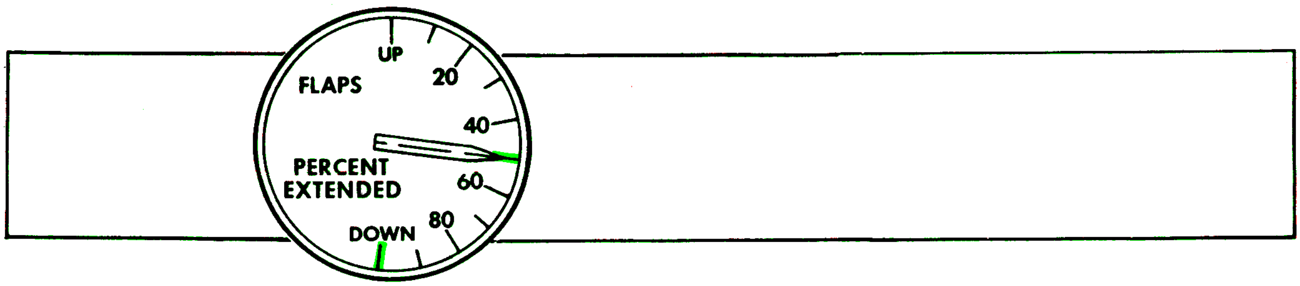
60 PSI Maximum – Except Start and Warmup

50 PSI to 60 PSI Normal

50 PSI Minimum Allowable (100% With Oil Temp. Normal)

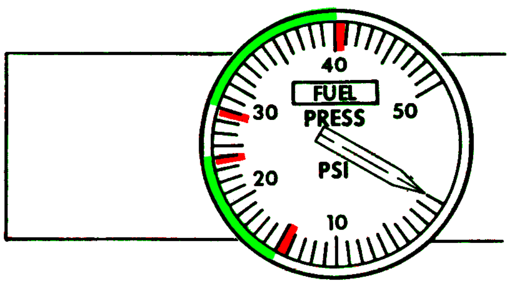
C130-F0215

Figure 4-1. Instrument Markings (Sheet 1 of 5)



FLAP POSITION

- (green) Flaps 50% Down
- (green) Flaps 100% Down

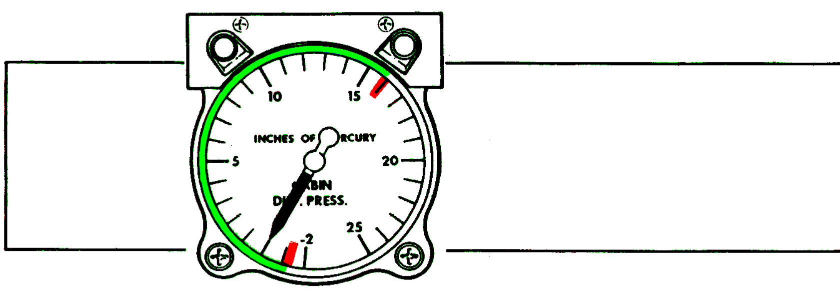


NOTE

The markings on this instrument are for preflight reference only. Inflight low-pressure warning is supplied by the pressure warning lights on the control panel. The fuel pressure limits are for no flow condition and with 200/115 volt, 400 Hz electrical power operating the pump. Pressure below these limits is acceptable with engines operating, provided the pressure is within limits with no flow.

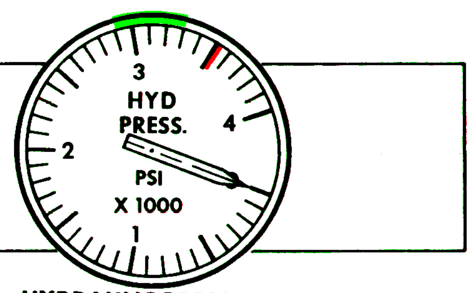
FUEL PRESSURE TEST INDICATOR

- (red) 40 PSI Maximum Allowable – Aux And Ext Tanks.
- (green) 28 PSI To 40 PSI Normal – Aux And Ext Tanks.
- (red) 28 PSI Minimum Allowable – Aux And Ext Tanks.
- (red) 24 PSI Maximum Allowable – Main Tanks.
- (green) 15 PSI To 24 PSI Normal – Main Tanks.
- (red) 15 PSI Minimum Allowable – Main Tanks.



CABIN DIFFERENTIAL PRESSURE GAGE

- (red) 15.8 In. Hg. Maximum Allowable
- (green) -1.2 In. Hg. to 15.8 In. Hg. Normal
- (red) -1.2 In. Hg. Minimum Allowable



HYDRAULIC PRESSURE (AUXILIARY)

- (red) 3,500 PSI Maximum Allowable Pressure
- (green) 2,900 To 3,300 PSI Normal.

C130-F0216

Figure 4-1. Instrument Markings (Sheet 2)

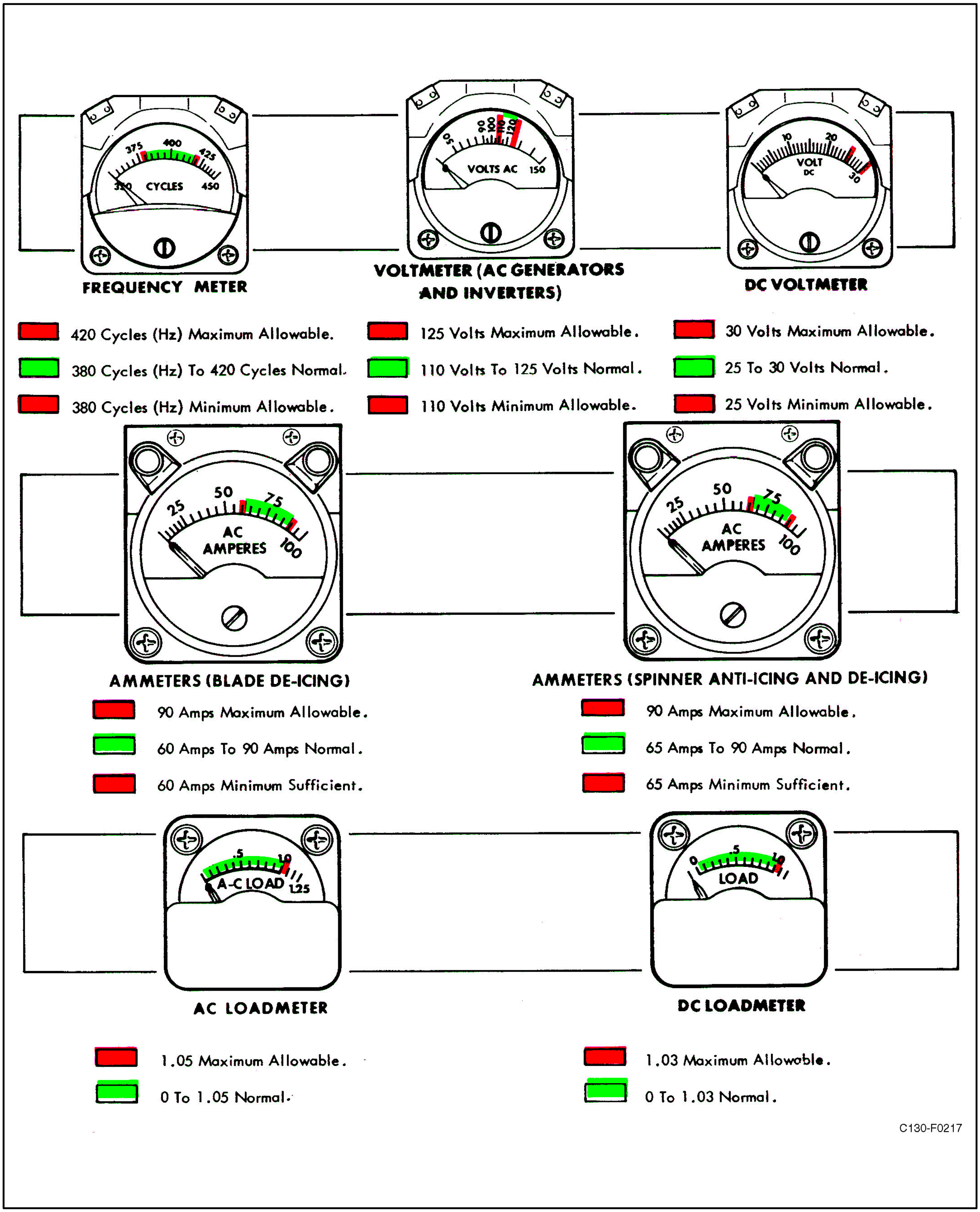
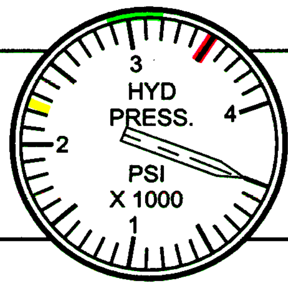


Figure 4-1. Instrument Markings (Sheet 3)

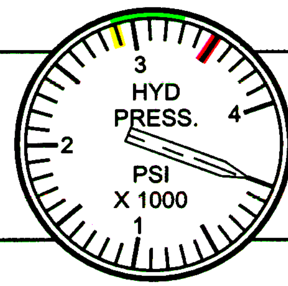


NOTE

All hydraulic instrument markings are for static system conditions.

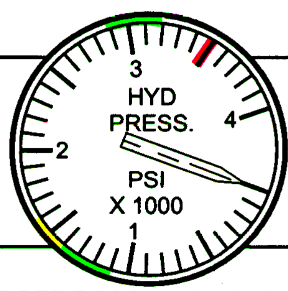
NORMAL BRAKE PRESSURE

- (Red) 3,500 PSI Maximum Allowable.
- (Green) 2,900 PSI To 3,200 PSI Normal.
- (Yellow) 2,250 PSI Minimum Pressure, One Brake Application Remaining.



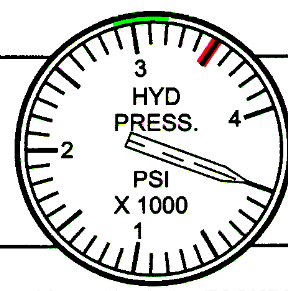
EMERGENCY BRAKE PRESSURE

- (Red) 3,500 PSI Maximum Allowable Pressure.
- (Green) 2,900 PSI To 3,300 PSI Normal.
- (Yellow) 2,900 PSI Minimum Pressure, One Brake Application Remaining.



RUDDER BOOSTER PRESSURE (UTILITY AND BOOST)

- (Red) 3,500 PSI Maximum Allowable Pressure (15% To 100% Flaps).
- (Red) 1,600 PSI Maximum Allowable Pressure (0% To 15% Flaps).
- (Green) 2,900 To 3,200 PSI Normal (15% To 100% Flaps).
- (Green) 1,100 PSI To 1,400 PSI Normal (0% To 15% Flaps).
- (Yellow) 1,400 PSI To 1,600 PSI Caution (0% To 15% Flaps).



HYDRAULIC PRESSURE (UTILITY AND BOOST)

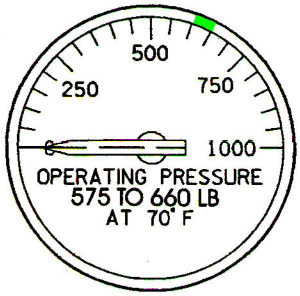
- (Red) 3,500 PSI Maximum Allowable.
- (Green) 2,900 PSI To 3,200 PSI Normal.

NOTE

The normal hydraulic pressure range is based on the following conditions: 100 percent RPM, all flight controls in neutral, suction boost pumps ON, and no system actuation. Pressure as low as 2,550 PSI may be experienced in low speed ground idle and is acceptable as long as the normal limits are attained as specified above.

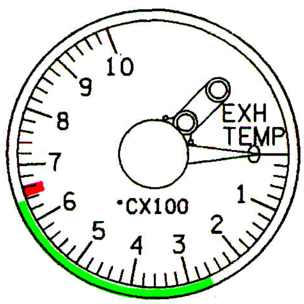
C130-F0218

Figure 4-1. Instrument Markings (Sheet 4)



FIRE EXTINGUISHER SYSTEM PRESSURE GAUGE

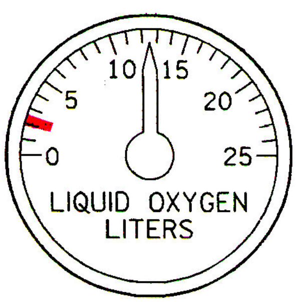
575 to 660 PSI Normal Pressure At 70° F



APU EXHAUST GAS TEMPERATURE

650°C Maximum Allowable

260°C to 650°C Normal



LIQUID OXYGEN QUANTITY

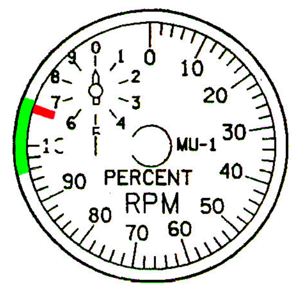
25 Liters (Full)

2.5 Liters (Minimum For Normal Use)

Note

IN CASE OF EMERGENCY, OXYGEN USAGE MAY BE CONTINUED UNTIL SYSTEM IS EMPTY.

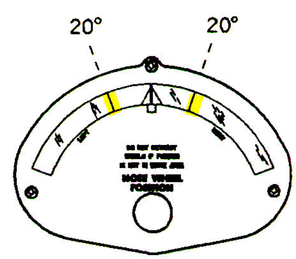
FIRE EXTINGUISHER SYSTEM PRESSURE GAUGE READINGS			
TEMPERATURE		GAUGE READING, PSI BROMOTRIFLUOROMETHANE	
C	(F)	MINIMUM	MAXIMUM
-23	(-10)	335	415
-12	(10)	355	435
-7	(20)	410	490
-1	(30)	440	515
4	(40)	470	550
10	(50)	500	585
16	(60)	540	620
21	(70)	575	660
27	(80)	615	770
32	(90)	655	735
38	(100)	695	775
43	(110)	735	815
49	(120)	775	860



APU TACHOMETER

106 Pct. Maximum Allowable

95 Pct. to 105 Pct. Normal (Generator Operation)



NOSE WHEEL POSITION INDICATOR

CAUTION

TURN LIMIT IS 20 DEGREES WHEN GROSS WEIGHT EXCEEDS 155,000 POUNDS OR TAXI SPEED IS 20 KNOTS OR HIGHER REGARDLESS OF RUNWAY TERRAIN CONDITIONS.

C130-F0219

Figure 4-1. Instrument Markings (Sheet 5)

ENGINE LIMITS						
ENGINE CONDITION	TIT °C	RPM %	OIL PRESSURE (PSIG) R/G △1	P/S △1	OIL TEMP °C	MAXIMUM INDICATED TORQUE IN-LB
GROUND OPERATION						
START LIMITS	720 °C – 830 °C		Positive oil pressure indicated by 35% rpm		100 –40 △5	
LOW SPEED GROUND IDLE (start position)		75.5 69	250 △2 50	100 (warmup only)	100 For 30 minutes (flight idle and below) then 85 60 to 85 **Note** –54 to –40 for start and warmup only. △5	Minimum until oil temperature is above 0 °C
HIGH SPEED GROUND IDLE (start position)		102 94	250 △2	60		
MAXIMUM REVERSE (0°)		106 96			100 maximum for 30 minutes then 85	
FLIGHT IDLE (34°)		100.5 92.5	150 △3	50 △4	0	4,500 maximum at oil temperature 0 to +40 °C.
TAKE-OFF						
TAKE-OFF 90° throttle position	1083 (5 minutes max) 1067	102 98	250 150	100 (warmup only) 60 50	100 for 5 minutes, then: 85 60 – 85 40 and increasing	19,600
FLIGHT OPERATION						
MILITARY	1049 (30 minutes) △6	102	250	100 (warmup only)	100 for 5 minutes, then: 85	19,600
CLIMB	1010			60	60 – 85	19,600 **Note** DURING AIR-START, 4,500 IS MAXIMUM AT OIL TEMPERATURE OF 0 TO +40 °C
MAXIMUM CONTINUOUS	1010	98	150	50	40 and increasing	

Figure 4-2. T56-A-16 Engine and Propeller Limitations (Sheet 1 of 2)

OVERTEMPERATURE OPERATION

STARTING OVERTEMPERATURE

CONDITION	ACTION REQUIRED
TIT exceeds 830 °C (excluding momentary overshoot and peak at 94% rpm)	Record the discrepancy.
TIT exceeds 850 °C (excluding momentary peak at 94% rpm)	Discontinue the start and record the discrepancy. One restart is permitted after cooling to below 200 °C TIT. If TIT exceeds 850 °C on second start, discontinue start and record. Restart is not recommended.
TIT exceeds 965 °C	Discontinue the start and record the discrepancy. (An overtemperature inspection is required.)

A torch other than normal enrichment burst requires an overtemperature inspection.

POWER ACCELERATION PEAK

Exceeds 1083 °C for more than 5 seconds or exceeds 1175 °C momentarily.	Reduce power to hold temperature within limits. Record the discrepancy. (Overtemperature inspection required before next flight.)

STARTER OPERATING LIMITS

1 minute ON, 1 minute OFF, 1 minute ON, 5 minutes OFF, 1 minute ON, 30 minutes OFF.
Release starter switch at 60% rpm. Start valve open light should extinguish within 15 seconds after switch is released.

PROPELLER GOVERNING LIMITS

NORMAL LIMITS (Normal Or Mechanical Operation) 98.0 – 102.0 percent.

If stable rpm cannot be maintained (excluding allowable fluctuation of ±0.5 percent), refer to PROPELLER MALFUNCTIONS in Part V.

PROPELLER AUXILIARY PUMP OPERATING LIMIT

1 minute ON, 1 minute OFF, not to exceed 2 minutes operation in any 30 minute period.

Notes

⚠1 Under stabilized conditions, allowable fluctuation is ±10 psi for the power section and ±20 psi for the reduction gear section.

⚠2 250 psi may be exceeded during start and warmup with ambient temperature below 15 °C.

⚠3 Operation below 150 psig when rpm is below 100 percent is permitted if 150 psig can be maintained at 100 percent rpm.

⚠4 If pressure is below 50 psig at low-speed ground idle, condition is acceptable provided pressure is within limits at 100 percent rpm.

⚠5 –54 °C is the minimum oil temperature for MIL-L-7808 oil. –40 °C is the minimum oil temperature for MIL-L-23699 oil.

⚠6 Use only when mission requirements demand higher power.

7. Underscored values on sheet 1 denote limits; values not underscored on sheet 1 denote normal operating values. All limits on this Figure are flight station limits and are not to be confused with maintenance manual limits.

Figure 4-2. T56-A-16 Engine and Propeller Limitations (Sheet 2)

4.6 FUEL

The approved emergency fuels for the T56-A-16 engine are listed in order of preference in Figure 4-3. Mixing of these fuels with each other is permissible. In this case, the mixture will be considered as the grade that predominates in the mixture if it is at least 95 percent, and all operations will be in accordance with the operating instructions for that grade. If the mixture is less than 95 percent, consider the fuel to be the one with the least desirable characteristics. If it is necessary to use aviation gasoline with turbine fuels, foaming may occur.

CAUTION

- NATO fuels F-34, F-35, F-42, and F-44 should not be used if operating temperatures below –55 °F are anticipated.
- The presence of even relatively small quantities of TCP result in severe erosion, scaling, and pitting of the first-stage turbine nozzle vanes and the turbine inlet thermocouples. Automotive gasoline is not acceptable because of common use of TCP and a variety of other undesirable additives. The use of aviation gasoline containing tetraethyl lead (grades 80/87, 100/130, and 115/145) should be held to the minimum necessary because of the heat-absorbing quality of the lead coating that is deposited in the turbine section. If engines are operated for 50 hours with leaded gasoline, the turbine blades must be inspected for possible overheat damage. When aviation gasoline is used, decreased lubrication of all fuel components can be expected. Further, continued use of aviation gasoline will result in engine power loss and decreased engine operating efficiency.

The engine power available when using different fuels is not affected in electronic fuel scheduling since a specific TIT is scheduled for each throttle position. However, external temperature datum valve adjustment may be necessary for consistent engine starts when using JP-5/JP-8-type fuels (F-44 or F-34).

WARNING

When attempting a start with JP-5/JP-8 and kerosene-type fuels at ambient temperatures below –37 °C, the TIT and rpm should be closely monitored since stall and over-temperature may be experienced during the start.

CAUTION

When ambient temperature is below –25 °F and it is anticipated that JP-5/JP-8 will be used, some JP-4 should be reserved for starting the engines and APU. If JP-4 is not available, the JP-5/JP-8 should be mixed with at least 10-percent aviation gasoline. To do this, add the aviation gasoline first, then finish filling with JP-5/JP-8.

4.6.1 High Rates of Climb. When using high-volatility fuels, high rates of climb may create a fuel boiling-venting problem. The rate of climb should be restricted to the values shown in Figure 4-4, depending on the fuel used and the fuel temperature (all figures estimated).

Note

The presence of small quantities of aviation gasoline in turbine fuel can trigger foaming.

4.6.2 Effect of Emergency Fuel on Range. The BTU content per pound of all fuels does not vary significantly; therefore, the range will depend on the pounds of fuel aboard.

4.6.3 Fuel Boiloff. When using high-volatility fuels, loss of fuel can be incurred during climb by boiloff because of volatility and by slugging. Slugging occurs as a result of fuel frothing and departing vapors entraining large quantities of froth while spewing from the vents. Foaming tendencies are aggravated by high initial fuel temperatures, high rates of climb, and at high altitude.

JP-4 is a relatively low-volatility fuel; however, at very high fuel temperatures, high rates of climb, and high altitude, boiloff and slugging can occur.

		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 BTU/GAL
		MIL	COMM					°F	°C		1000	1000
APPROVED FUELS	PRIMARY	J5		(3) JP-5	F-44		(3) AVCAT	-51	-46	6.79	18.45	125
		J4		(3) JP-4	F-40	(4) JET B	(3) AVTAG	-72	-58	6.46	18.60	120
		J8		(3) JP-8	F-34		(3) AVTUR	-58	-50	6.79	18.45	125
			1A1		F-35	JET A-1 JP-1	AVTUR	-58	-50	6.79	18.45	125
	ALTERNATE	(5)			F-43		AVCAT	-51	-46	6.79	18.45	125
			TA		F-35	JET A		-40	-40	6.79	18.45	125
EMERGENCY FUELS	LEAD NO TCP	C	C1	80/87	F-12	80		-76	-60	5.90	18.90	112
		A	A1	100/130	F-18	100LL		-76	-60	5.82	18.90	111
			G			100		-76	-60	5.81	18.90	110
		A+	A+1	115/145	F-22			-76	-60	5.80	18.90	110

Note

1. FUELS LISTED FROM TOP TO BOTTOM IN ORDER OF PREFERENCE.
2. REFER TO NAVAIR INST 10341.1 FOR CHANGES TO THE AIRCRAFT FUELS.

(3) CONTAINS FSII.
(4) FREEZING POINT - 58°F (-50°C).
(5) JP-5 TYPE.

C130-F0278

Figure 4-3. Fuel Performance and Cross-Reference/Aviation Turbine Fuel Brand Names (Sheet 1 of 2)

OIL COMPANY	PRODUCT NAME	ASTM DESIGNATION
AMERICAN	AMERICAN JET FUEL TYPE A AMERICAN JET FUEL TYPE A-1	JET A JET A-1
ATLANTIC RICHFIELD	ARCOJET A ARCOJET A-1 ARCOJET B	JET A JET A-1 JET B
BP TRADING	BP A T K BP A T G	JET A-1 JET B
BRITISH AMERICAN	B-A JET, FUEL JP-1 B-A JET, FUEL JP-4	JET A JET B
CALIFORNIA TEXAS	CALTEX JET A-1 CALTEX JET B	JET A-1 JET B
CITIES SERVICE	TURBINE TYPE A	JET A
CONTINENTAL	CONOCO JET-40 CONOCO JET-50 CONOCO JET-60 CONOCO JP-4	JET A JET A JET A-1 JET B
EXXON	EXXON (ESSO) TURBINE FUEL A EXXON (ESSO) TURBINE FUEL A-1 EXXON (ESSO) TURBINE FUEL B	JET A JET A-1 JET B
MOBIL	MOBIL JET A MOBIL JET A-1 MOBIL JET B	JET A JET A-1 JET B
PHILLIPS	PHILJET A-50 PHILJET JP-4	JET A JET B
PURE	PUREJET TURBINE FUEL TYPE A PUREJET TURBINE FUEL TYPE A-1	JET A JET A-1
SHELL	AEROSHELL TURBINE FUEL 640 AEROSHELL TURBINE FUEL 650 AEROSHELL TURBINE FUEL JP-4	JET A JET A-1 JET B
STANDARD OF CALIFORNIA	CHEVRON JET FUEL A-1 CHEVRON TURBINE FUEL B	JET A-1 JET B
STANDARD OF TEXAS	STANDARD TURBINE FUEL A-1 STANDARD TURBINE FUEL B	JET A-1 JET B
STANDARD OIL CO	STANDARD JET A STANDARD JET A-1 STANDARD JET B	JET A JET A-1 JET B
STANDARD (OHIO)	JET A KEROSENE JET A-1 KEROSENE	JET A JET A-1
TEXACO	TEXACO AVJET A TEXACO AVJET A-1 TEXACO AVJET B	JET A JET A-1 JET B
UNION OIL	76 TURBINE FUEL UNION JP-4	JET A-1 JET B

Figure 4-3. Fuel Performance and Cross-Reference/Aviation Turbine Fuel Brand Names (Sheet 2)

TYPE OF FUEL	FUEL TEMPERATURE, START OF MISSION	RATE OF CLIMB	NATO SYMBOL
JP-8	Up to 135 °F	Not restricted	F-34
JP-5	Up to 135 °F	Not restricted	F-44
JP-4 JP-4	Up to 125 °F 125 to 135 °F	Not restricted Maximum rate of climb to 29,000 feet. Above 29,000 feet, 300 feet per minute.	F-40
Aviation Gasoline Aviation Gasoline Aviation Gasoline Aviation Gasoline	80 to 90 °F 90 to 100 °F 100 to 110 °F 110 to 120 °F	Maximum rate of climb to 30,000 feet. Above 30,000 feet, 300 feet per minute. Maximum rate of climb to 24,000 feet. Above 24,000 feet, 300 feet per minute. Maximum rate of climb to 18,000 feet. Above 18,000 feet, 300 feet per minute. Maximum rate of climb to 14,000 feet. Above 14,000 feet, 300 feet per minute.	F-12 F-18 F-22

Figure 4-4. Fuel Versus Rate of Climb

JP-5/JP-8 fuel is characterized by low volatility; therefore, boiloff and slugging are unlikely. The following demonstrates the estimated loss of range because of boiloff when using aviation gasoline:

Fuel Temperature	Approximate Loss of Range When Climbing to These Cruise Altitudes	
	25,000	35,000
125 °F	12 percent	20 percent
110 °F	8 percent	15 percent
90 °F	3 percent	10 percent
70 °F	0 percent	5 percent

4.7 AIRSPEED LIMITATIONS

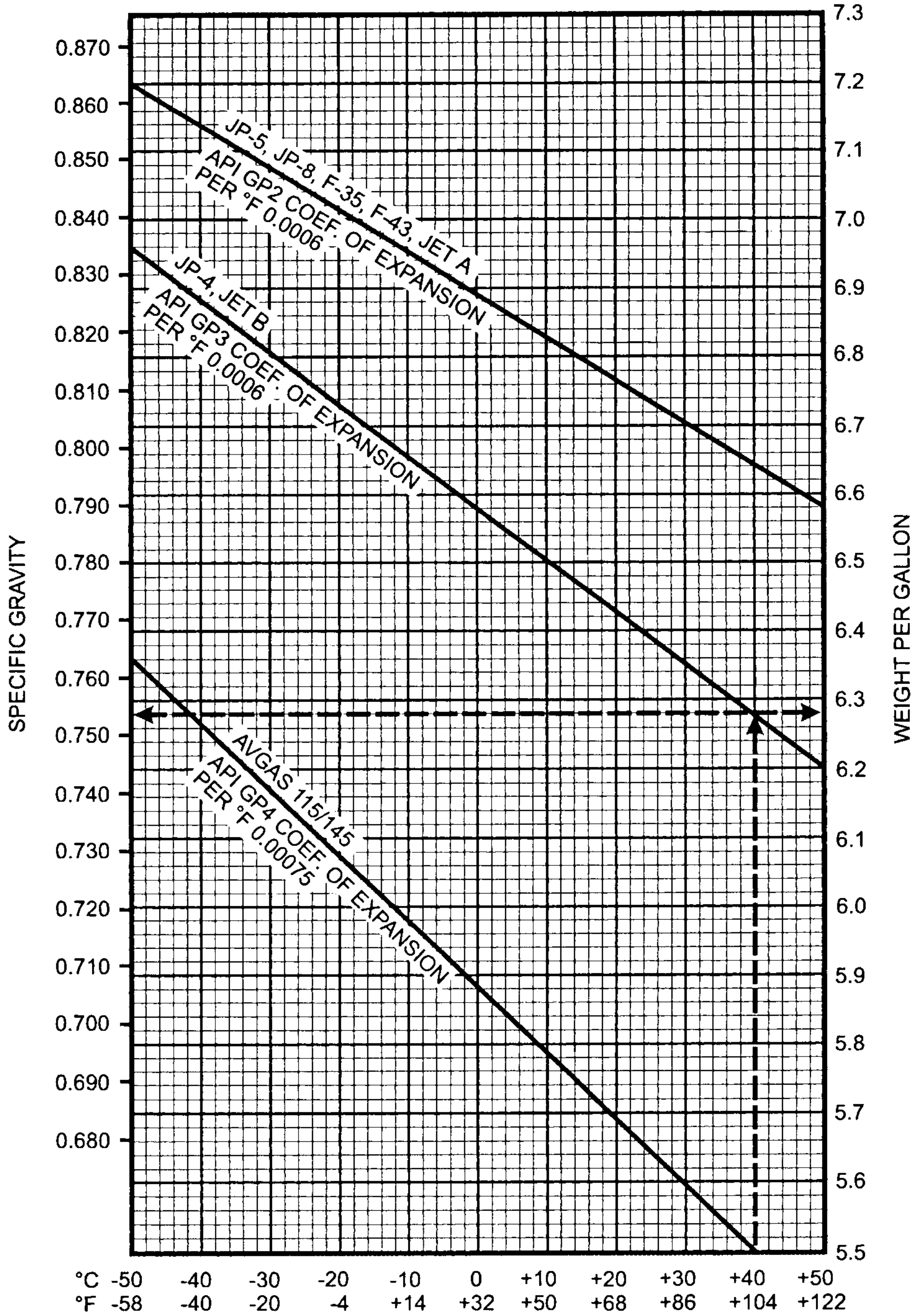
The limiting airspeed for a mission is interrelated with the cargo weight and maneuver load factors required for the mission and the gust load that may be encountered in turbulence. Recommended and maximum airspeeds are shown in Figure 4-6. These speeds are referenced to specific cargo-fuel (see Figure 4-5) combinations or gross weights on the weight limitations charts and to the allowable maneuver load factors. Any cruise speed up to the recommended speed may be utilized up to and including moderate turbulence.

WARNING

The maximum speed should never be exceeded. The maneuver load factors and the weight distribution shown on the weight limitations charts (see Figure 4-6) should also be observed carefully.

Note

- If more than 2.5° of aileron tab deflection is required to trim unsymmetrical fuel at speeds faster than 200 KIAS, reduce V_H to 5 KIAS less than shown in Figure 4-6, as applicable.
- Operation in the areas between recommended speed limits and maximum speed limits is permissible for initiating penetrations from 20,000 feet at 250 KIAS, provided the corresponding maneuver load factors are not exceeded.



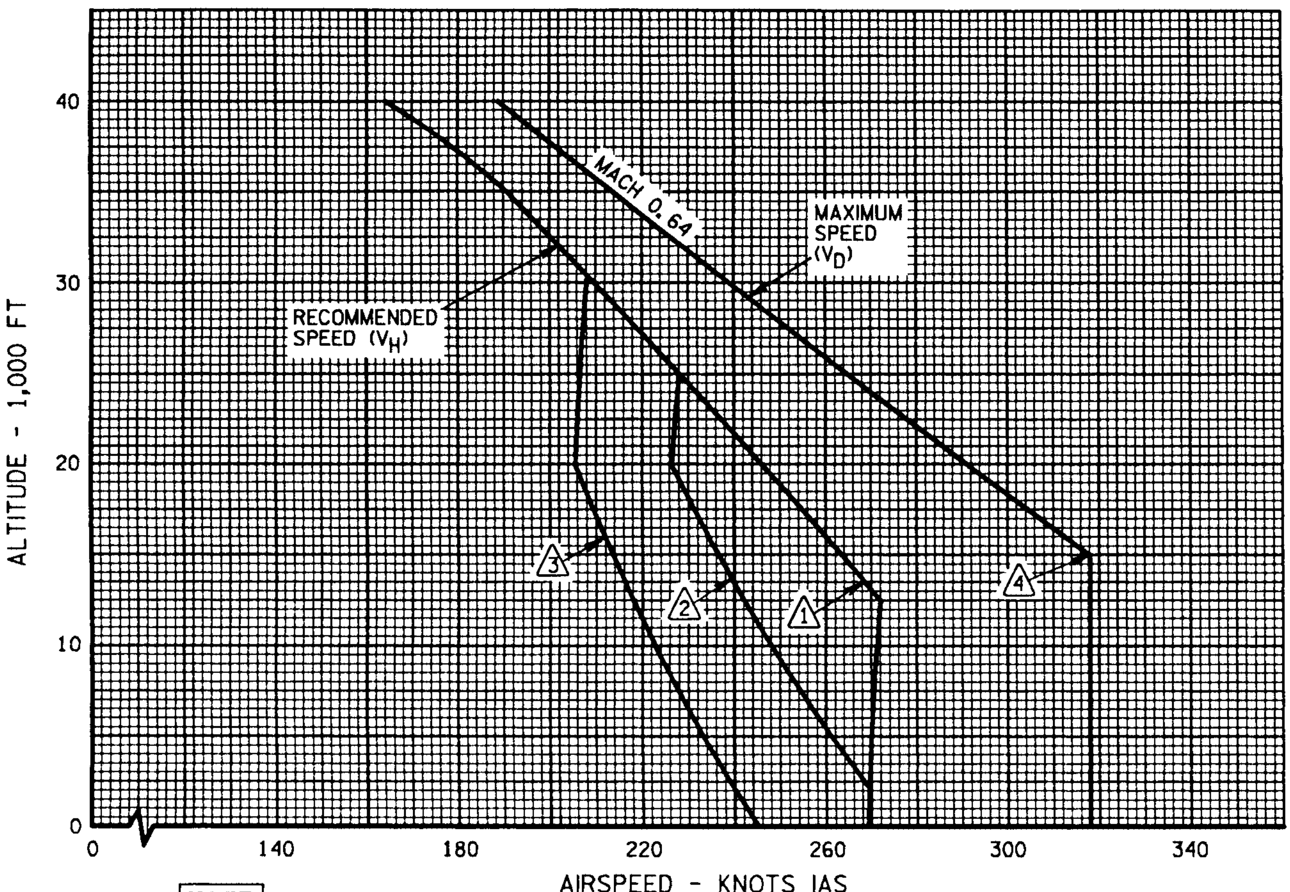
NOTE

TO CONVERT SPECIFIC GRAVITY TO WEIGHT PER GALLON, MULTIPLY SPECIFIC GRAVITY BY 8.3.

EXAMPLE	
FUEL	JP-4
FUEL TEMP	+40°C
WT PER GAL (U.S.)	6.271
SPECIFIC GRAVITY	0.753

C130-F0220

Figure 4-5. Average Fuel Weight/Specific Gravity Temperature



NOTE

RECOMMENDED SPEED

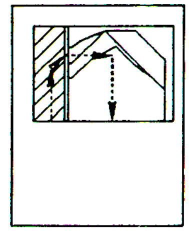
1. V_H - MAXIMUM RECOMMENDED SPEED FOR AREA A OF WEIGHT LIMITATIONS CHART.
2. V_H - MAXIMUM RECOMMENDED SPEED FOR AREA B OF WEIGHT LIMITATIONS CHART.
3. V_H - MAXIMUM RECOMMENDED SPEED FOR AREAS C AND D OF WEIGHT LIMITATIONS CHART.

MAXIMUM SPEED

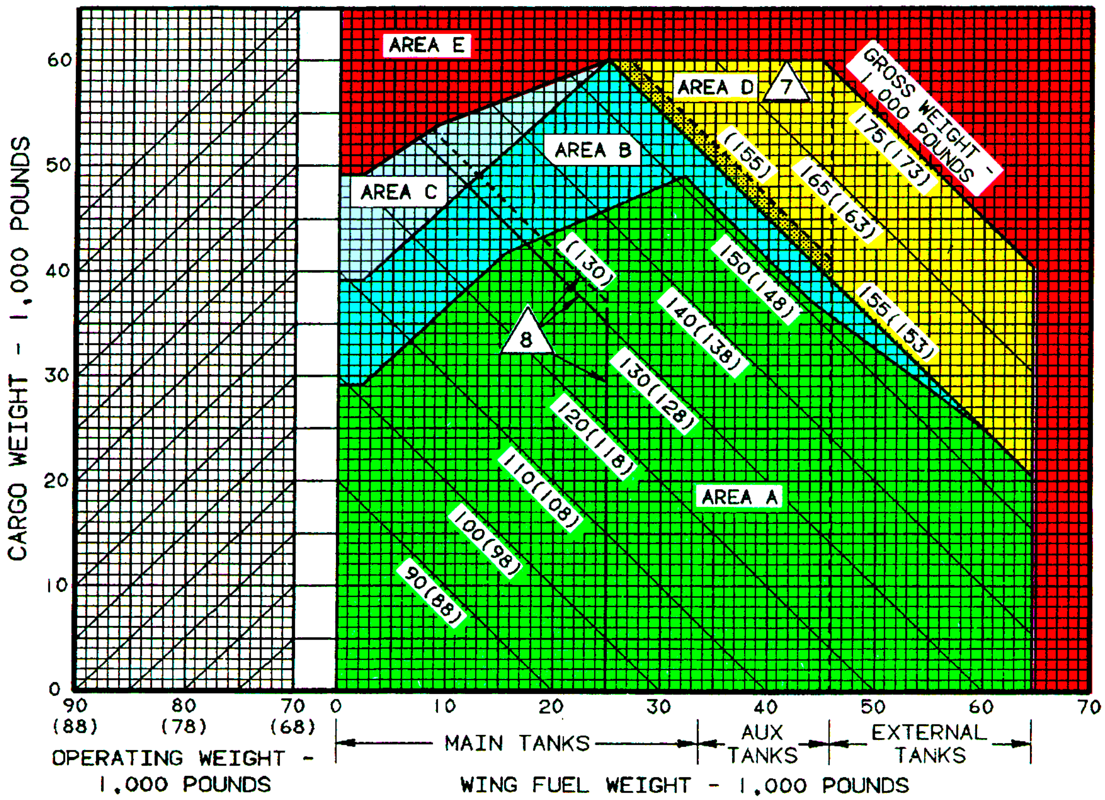
4. V_D - MAXIMUM SPEED FOR AREAS A, B, C AND D OF WEIGHT LIMITATIONS CHART.
5. THIS FIGURE IS BASED ON A SYMMETRICAL FUEL LOAD OF JP-4 (6.5 POUNDS/GAL.) AND JP-5 (6.8 POUNDS/GAL.).

C130-F0221

Figure 4-6. Limit Flightspeed Versus Altitude and Weight Limitations (Sheet 1 of 3)



(PRIMARY FUEL MANAGEMENT)



AREA		STATUS	MANEUVER	LOAD FACTOR LIMITS FLAPS UP UP TO V_H	LOAD FACTOR LIMITS FLAPS UP V_H TO V_D	MAX RECOMMENDED SPEED OF SHEET 1
A		RECOMMENDED	SYMMETRICAL UNSYMMETRICAL	0.0 TO 3.0G 0.0 TO 2.33G	0.0 TO 2.5G 0.0 TO 2.0G	V_H 1
B		RECOMMENDED	SYMMETRICAL UNSYMMETRICAL	0.0 TO 2.5G 0.0 TO 2.0G	0.0 TO 2.5G 0.0 TO 2.0G	V_H 2
C		RECOMMENDED	SYMMETRICAL UNSYMMETRICAL	0.0 TO 2.5G 0.0 TO 2.0G	0.0 TO 2.5G 0.0 TO 2.0G	V_H 3
D		CAUTIONARY	SYMMETRICAL UNSYMMETRICAL	0.0 TO 2.25G 0.0 TO 1.83G	0.0 TO 2.25G 0.0 TO 1.83G	V_H 3
B/D		THIS IS AREA D FOR AIRCRAFT WITH EXTERNAL TANKS AND AREA B FOR AIRCRAFT WITHOUT EXTERNAL TANKS				
E		NOT RECOMMENDED				

NOTE CONTINUED

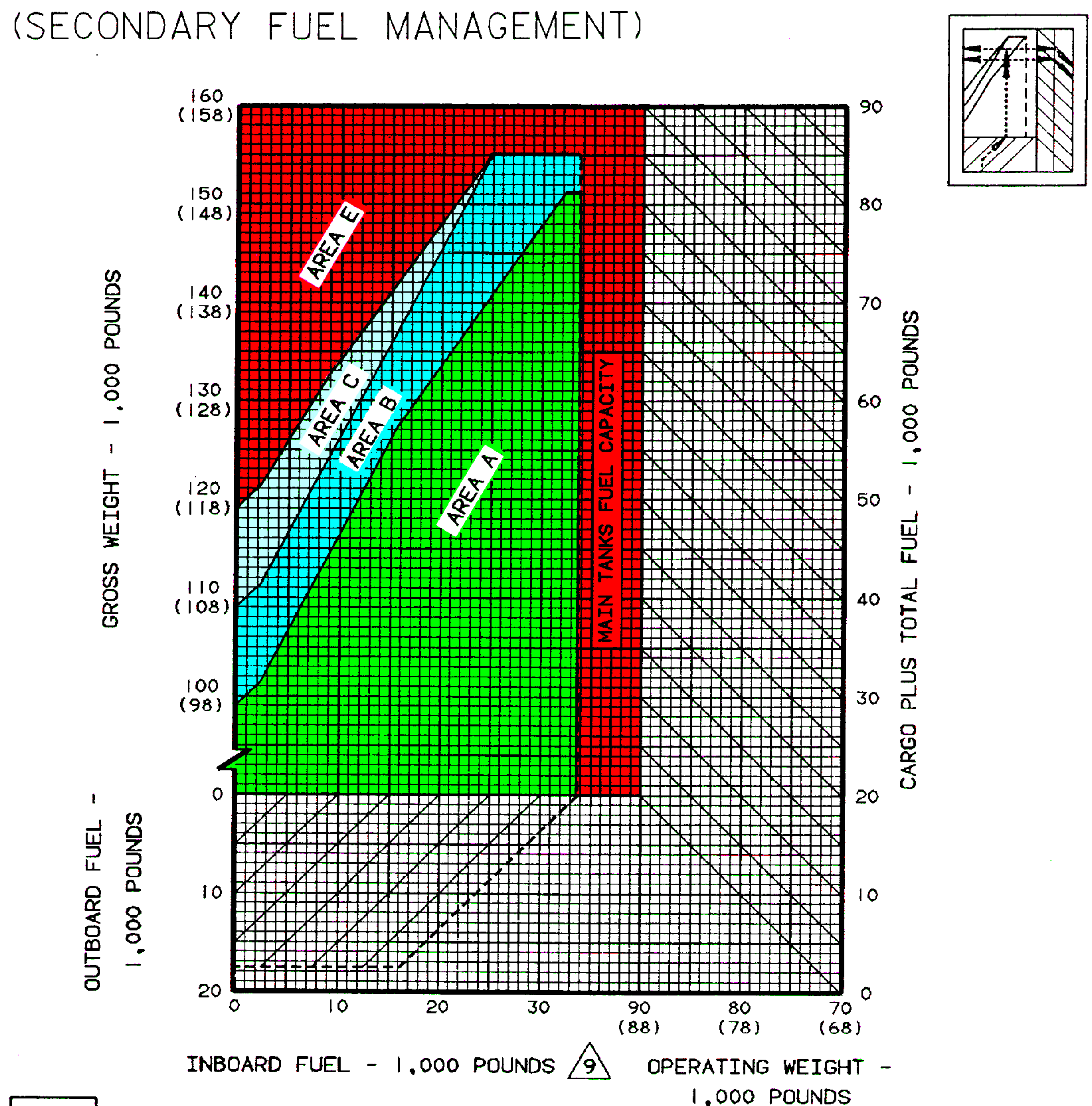
6. WEIGHTS IN PARENTHESES AND DASHED LINES ARE FOR AIRCRAFT WITHOUT EXTERNAL TANKS

7 EXCEEDING THE LIMIT LOAD FACTOR OR PERMISSIBLE AIRSPEED CAN RESULT IN STRUCTURAL DAMAGE TO THE AIRCRAFT. OBSERVE THE TAXI AND GROUND LIMITATIONS IN THIS SECTION FOR OVERLOAD GROSS WEIGHTS.

8 MAXIMUM LANDING RATE OF SINK IS 540 FPM UP TO THE FOLLOWING LIMITS: GROSS WEIGHT - 130,000 LB, FUEL IN TANK NO. 1 OR NO. 4 - 6,600 LB, FUEL IN ALL MAIN TANKS - 25,000 LB. IF ANY OF THESE LIMITS IS EXCEEDED, MAXIMUM RATE OF SINK IS 300 FPM.

C130-F0222

Figure 4-6. Limit Flightspeed Versus Altitude and Weight Limitations (Sheet 2)



NOTE CONTINUED

9 ENTER ON THE INBOARD FUEL SCALE AT THE SMALLER OF:

a. ACTUAL WEIGHT OF FUEL IN TANKS NO. 2 AND NO. 3.

b. WEIGHT OF FUEL IN TANKS NO. 1 AND NO. 4 MINUS 1,300 POUNDS.

10. WEIGHTS IN PARENTHESES ARE FOR AIRCRAFT WITHOUT EXTERNAL TANKS .

11. AREA COLOR CODE AND STATUS FOR MANEUVER LOAD FACTOR LIMITS AND MAXIMUM RECOMMENDED SPEED DATA ARE THE SAME AS DEFINED FOR PRIMARY FUEL MANAGEMENT.

12. LIMITS FOR MAXIMUM LANDING RATE OF SINK OF 540 FPM ARE THE SAME AS GIVEN BY NOTE 8 EXCEPT AUXILIARY TANKS MAY CONTAIN ANY FUEL UP TO CAPACITY.

C130-F0223

Figure 4-6. Limit Flightspeed Versus Altitude and Weight Limitations (Sheet 3)

The aircraft should not be operated in conditions of severe turbulence because gusts can be encountered that may impose excessive loads. However, if flight in severe turbulence cannot be avoided, flight should be in the range of 65 knots above power-off stalling speed for the operating gross weight, not to exceed 180 KIAS (see Figure 10-1).

Never exceed the following airspeeds for the condition noted:

1. Flaps extended.

Percentage	Airspeed (KIAS)
CAUTION Avoid abrupt or full-rudder deflection with the flaps lever positioned 15 percent or greater (high rudder boost) and airspeed 210 KIAS or greater.	
10	220
20	210
30	200
40	190
50 (takeoff)	180
60	165
70	155
80	150
90	145
100 (landing)	145

2. Landing gear extended — Do not exceed 170 KIAS with the landing gear extended.

3. Landing lights extended — 250 KIAS.

4. Autopilot operation.

   a. Do not operate with the autopilot engaged during takeoff and landing.

   b. During ILS coupled approach, do not operate with the autopilot engaged below 200 feet AGL.

   c. Do not operate with the autopilot engaged at gross weights above 155,000 pounds.

5. Fuel distribution.

CAUTION

If the total fuel in both external tanks exceeds 9,355 pounds in combination with less than 25,000 pounds of internal wing tank fuel, do not exceed 290 KIAS.

6. Painted flight control surfaces.

   a. Do not exceed 250 KIAS when any flight control surface is painted, unless the following has been accomplished:

      (1) The underside of the ailerons and elevators and either side of the rudder have been stenciled as follows:

CAUTION

Subsequent repainting restricted to minor touchup unless performed at depot level.

OR

      (2) An entry has been made in the aircraft form that, after painting, rebalance has been accomplished in accordance with NAVAIR 01-75GAA-2-2, NAVAIR 01-75GAA-3, and NAVAIR 01-1A-509.

7. Cargo door and/or ramp open — Do not exceed 150 KIAS with the ramp (or ramp and cargo door) open regardless of whether the paratroop doors are open or closed or the position of the paratroop air deflectors. Do not exceed 185 KIAS with the ramp up and locked and the cargo door open.

8. Paratroop air deflectors — Do not exceed 150 KIAS when operating the paratroop air deflectors or with the air deflectors extended, regardless of whether the paratroop doors are open or closed.

9. Paratroop doors — Do not exceed 150 KIAS when operating the paratroop doors or when operating with the paratroop doors open.

10. Flight without landing gear doors — Do not exceed 200 KIAS with landing gear up or 170 KIAS with landing gear down if any landing gear door is removed. Flight is permitted with the doors removed in the following manners only:

    a. Main landing gear — All doors of the affected wheelwell must be removed.

    b. Nose landing gear — Both forward and aft doors removed or aft door removed with forward door installed.

CAUTION

Flight is not permitted with the forward door removed and the aft door installed.

11. Inoperative windshield anti-icing — Do not exceed 187 KIAS with inoperative windshield anti-icing below 10,000 feet altitude.

12. Maximum tire speed.

TYPE III TIRES	KNOTS TRUE GROUNDSPEED
12.50-16 12-ply rating (nose)	139
20.00-20 26-ply rating (main)	174
TYPE VII TIRES	**KNOTS TRUE GROUNDSPEED**
39 × 13 14-ply rating (nose)	174
56 × 20.0 – 20 24-ply rating (main)	174

4.8 MANEUVER LOAD FACTOR LIMITS

Never exceed the structurally safe maneuver load factors for the applicable flight conditions and for the aircraft load distribution. The limit load factors for fuel load and cargo load combinations are given in Figure 4-6 for symmetrical and unsymmetrical maneuvers with the flaps retracted. Symmetrical maneuvers (pullups and pushdowns) involve no aileron deflections. Unsymmetrical maneuvers include a combination of aileron and elevator inputs (turns and rolling pullouts). The aircraft accelerometer indicates the acceleration (g) at its location that is quite different from the g at the cg or other locations. The accelerometer should be used as an indicator of cg load factor only for sustained turns or pullups. Since feel is often misleading, particularly when the pilot attention is diverted or distracted, abrupt and unnecessary maneuvering must always be avoided.

CAUTION

With any flap extension, the maximum maneuver load factor is 2.0g in symmetrical maneuvers and 1.5g in unsymmetrical maneuvers.

4.9 WEIGHT LIMITATIONS

Aircraft weight limits may be divided into two categories: gross weight limits and limits on cargo-fuel combinations. The gross weight limits in this chapter are design weights on which airframe strength is based. Taxi and landing gross weights are limited by the strength of the landing gear and the related fuselage structure. Takeoff and flight gross weights and cargo weight are limited by wing strength and the effects of fuel weight and distribution, airspeed, maneuver, and turbulence. Takeoff and flight gross weights may be further limited by performance capability. Alternatively, airspeed and maneuver load factor may be limited by wing and empennage strength, cargo weight, and fuel weight and distribution. Fuel weights for taxiing and landing are limited by wing strength and landing gear shock-strut reaction.

4.9.1 Gross Weight Limits. Aircraft gross weight limits are summarized in Figure 4-7 for the conditions indicated. Gross weight in excess of those recommended must be authorized by the commanding officer.

4.9.1.1 Maximum Takeoff Gross Weight. Takeoff gross weights must take into account the available runways, surrounding terrain, airfield elevation, atmospheric conditions, mission requirements, and the urgency of the mission.

CONDITION	GROSS WEIGHT — POUNDS EXTERNAL TANKS ON	LIMITATIONS
MAXIMUM TAXI		
Recommended	155,000	Refer to taxi and ground limitations.
Overload	175,000	
MAXIMUM TAKEOFF		
Recommended	155,000	2.25g maneuver load factor
Overload	175,000	
MAXIMUM LANDING		
Recommended	155,000	300 fpm rate of sink
Overload	175,000	
NORMAL LANDING	130,000	540 fpm rate of sink. See Figure 4-5 for fuel limits.

Figure 4-7. Gross Weight Limits

CAUTION

Gross weights exceeding those required for the mission will result in unnecessary risk and wear of the aircraft.

4.9.2 Landing Gross Weights. Observe the landing gross weight limits and the respective landing rate-of-sink limits shown in the following table. If required, the aircraft can be landed at rates of sink up to 300 fpm with all tanks full, including the external tanks. For rates of sink from 300 to 540 fpm, usable fuel limits are as follows:

1. Main tank
   a. Total fuel — 25,000 pounds.
   b. Tank Nos. 1 and 4 — 6,600 pounds each.
2. External tanks — 500 pounds each.
3. Auxiliary tanks
   a. Primary management — 500 pounds each.
   b. Secondary management — Full.

CAUTION

The gross and fuel weight limitations for a maximum-effort landing are those corresponding to a landing sink rate of 540 fpm.

Note

- Although the aircraft can be landed at a 300-fpm rate of sink at the maximum overload landing gross weight, overload gross weight landing should be limited to emergency situations. Consideration should be given to dumping fuel to reduce landing weight.
- The aircraft can be landed at a rate of sink of 300 fpm with all fuel tanks full. However, it is recommended that landings be made with little, if any, usable fuel in the external tanks.

4.9.3 Weight Limitations Chart. The weight limitations chart graphically presents the cargo/fuel carrying capability of the aircraft as a function of varying operating weights, airspeeds, and maneuver load factors (see Figure 4-6).

Airspeed limitations are shown on sheet 1 of Figure 4-6. Weight limitations for primary fuel management are shown on sheet 2 of Figure 4-6. Weight limitations for secondary fuel management are shown on sheet 3 of Figure 4-6.

4.9.3.1 Operating Weight Effects. To account for variations in operating weight, operating weight scales are provided on the weight limitations charts.

4.9.3.2 Primary Fuel Management. Primary fuel management is based on JP-4 fuel at the standard day density of 6.5 pounds per gallon, except that maximum fuel weight (per tank and total) is based on JP-5 fuel at the standard day density of 6.8 pounds per gallon. The following distribution requirements define the primary fuel management.

1. Maximum usable fuel weights for the wing tanks are those shown in Figure 2-20 for JP-5/JP-8 fuel.

2. Tank Nos. 1 and 4 always contain 500 to 1,000 pounds more fuel per tank than tank Nos. 2 and 3, except when total usable fuel is less than 1,000 pounds.

3. The main tanks are full, except for fuel used for taxi and takeoff when the external and/or auxiliary tanks contain usable fuel.

4. Fuel asymmetry is within the limits specified in paragraph 4.5.

4.9.3.3 Secondary Fuel Management. Any fuel management that fails to meet the requirements for primary fuel management is defined as a secondary fuel management. This will occur anytime there is usable fuel in the external and/or auxiliary tanks and the main tanks are partly filled, or when the prescribed fuel weight difference between each inboard and outboard main tank is not observed. An extreme case would be operation with tank Nos. 1 and 4 or tank Nos. 2 and 3 empty. The fuel asymmetry limits for secondary fuel management are the same as for primary fuel management.

CAUTION

The aircraft should be flown with tank Nos. 1 and 4 empty only in an emergency or when it must be ferried to another facility for repair of a fuel leak in either of these tanks.

Note

- Although not required for secondary fuel management, it is recommended that the prescribed fuel weight difference between each inboard and outboard main tank for primary fuel management be observed for secondary fuel management whenever possible.

- Effects of secondary fuel management on service life and inspection requirements have not been established; therefore, secondary fuel management should be used advisedly, especially when operating near the gross weight limit for the applicable maneuver or airspeed.

4.9.3.4 Weight Limitations Charts (Primary Fuel Management). The weight limitations charts (primary fuel management) (sheet 2 of Figure 4-6) shows the design weight capabilities of the aircraft. The chart may be used in three ways:

1. With operating weight, cargo weight, and fuel weight established, determine airspeed and maneuver limitations.

2. With operating weight, cargo weight, and airspeed and/or maneuver requirements established, determine maximum and minimum fuel or gross weight.

3. With operating weight, fuel weight, and airspeed and/or maneuver requirements established, determine maximum cargo weight.

4.9.3.5 Weight Limitations Charts (Secondary Fuel Management). The weight limitations charts (secondary fuel management) (sheet 3 of Figure 4-6) are derived from the weight limitations charts (primary fuel management). Airspeed and maneuver limitations for areas A, B, and C of the chart for secondary fuel management are the same as depicted on the chart for primary fuel management. Landing gross weight and fuel weight limits for secondary fuel management are the same as for primary fuel management.

The weight limitations charts (secondary fuel management) are entered on the inboard fuel scale. For aircraft with refueling pods removed, the entry fuel weight on sheet 3 is the smaller of (1) the actual weight of fuel in tank Nos. 2 and 3, or (2) the weight of fuel in tank Nos. 1 and 4 minus 1,300 pounds. The latter corresponds to the design difference of 650 pounds less fuel per tank in tank Nos. 2 and 3 than in tank Nos. 1 and 4, which is used to define the weight limitations charts (primary fuel management). In the latter case, with or without refueling pods installed, any additional fuel in tank Nos. 2 and 3 is included in the gross weight and total fuel, although it is not included in the entry fuel weight.

4.9.3.6 Recommended Loading Limits. The weight limitations charts, sheets 2 and 3 of Figure 4-6, have three areas of recommended cargo-fuel combinations, provided the associated limits on maneuver load factor and airspeed are observed. These recommended areas are shown in different shades of green. Area A encompasses those cargo-fuel combinations for which the maximum symmetrical maneuver load factor is 3.0g at speeds up to the highest recommended speed V_H ⚠1 in Figure 4-6. Areas B and C encompass those cargo-fuel combinations or gross weights for which the maximum symmetrical maneuver load factor is 2.5g and, to preclude excessive forces because of turbulence, the recommended speed is V_H ⚠2 for area B and V_H ⚠3 for area C.

4.9.3.7 Cautionary Loading Limits. On sheet 2 of Figure 4-6, the cautionary area, area D (shown in yellow), encompasses those cargo-fuel combinations that are permissible for overload gross weight operations but require extra caution to avoid damaging the aircraft. For area D, the recommended speed is V_H ⚠2 shown on sheet 1 of Figure 4-6, and the maximum maneuver load factor is 2.25g. Limitations given in paragraph 4.13 must be observed.

4.9.3.8 Loading Area Not Recommend

WARNING

Operation of the aircraft in the red area should be avoided. If flight is conducted in this area, an entry must be made in the aircraft records.

The red area, area E of the weight limitations chart, encompasses those cargo-fuel combinations or gross weights that present a high degree of risk of structural damage. Under conditions of extreme emergency when the risk of damage to the aircraft is secondary, the commander will determine if the degree of risk warrants operation of the aircraft at loadings appearing in the red area. Fuel weights in the red area on the right of the chart represent a high risk of damage to the wing structure during ground operation. Cargo weights in the red area at the top of the chart represent a high risk of damage during flight; if used, the maximum maneuver load factor is 2.0g and flight through severe turbulence is prohibited. Exceeding the maximum gross weight shown on the chart imposes a high risk of damage to the landing gear and supporting structure during taxi.

4.10 CENTER OF GRAVITY LIMITATIONS

The location of the center of gravity for any gross weight configuration, determined from NA 01-1B-40, Handbook of Weight and Balance Data, must fall within the percent of the mean aerodynamic chord shown in Figure 4-8.

These limitations represent the combined structural, aerodynamic, and control limitations that must be observed to obtain safe and effective aircraft performance. For information and method of calculating the aircraft center of gravity, refer to the applicable Cargo Loading Handbook and NA 01-1B-40, Handbook of Weight and Balance Data.

WARNING

When mixing passengers and cargo on aircraft, caution should be exercised during ground operations to prevent aircraft tipping aft because of possible aft cg with no passengers on board.

The center of gravity of fuel in the external tanks shifts fore and aft with changes in aircraft attitude. The zero fuel weight consists of the operating weight plus any payload.

4.11 PROHIBITED MANEUVERS

Although the aircraft structure is designed for 1.0g maneuvers when loaded within area A of Figure 4-6, sustained pushovers to a zero or negative condition will cause loss of hydraulic pressure and thus loss of control boost.

NOTE

1. LOAD SUFFICIENTLY BEHIND THE FORWARD CG LIMIT SO THAT WEIGHT REDUCTION THROUGH FUEL CONSUMPTION WILL NOT BRING CG LOCATION OUT OF ALLOWABLE RANGE.
2. THIS CHART IS APPLICABLE FOR ALL CARGO WEIGHTS WITHIN THE LIMITS OF THE WEIGHT LIMITATIONS CHART.
3. DASHED LINES INDICATE CG LIMITS WITH USABLE FUEL IN THE EXTERNAL TANKS. EXTERNAL TANKS MUST BE EMPTY WHEN FUEL IS LESS THAN 20,000 POUNDS.

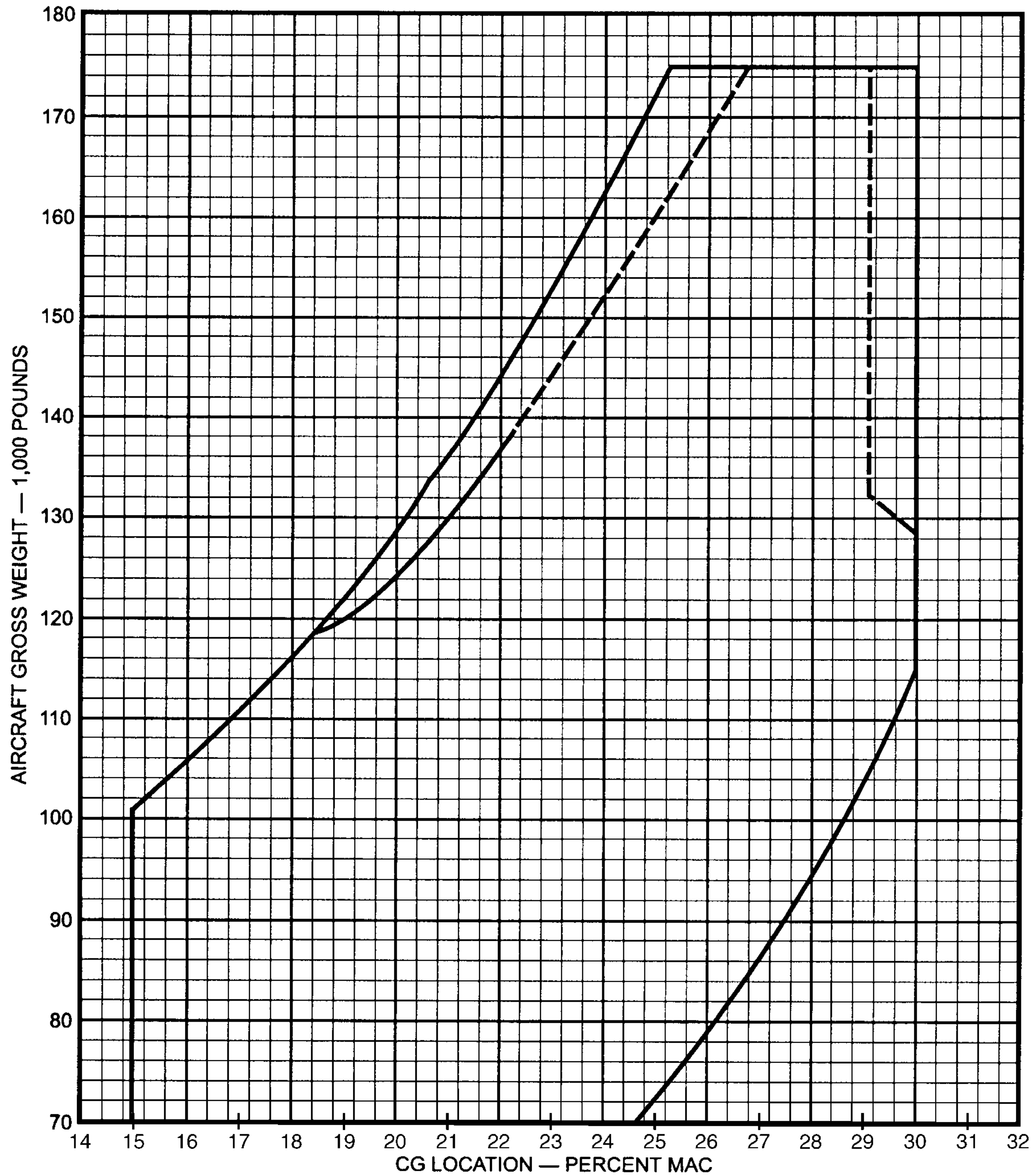


Figure 4-8. Center of Gravity Limitations

Aerobatics of any kind (including those that produce a negative-g condition), intentional spins, excessively nose-high stalls, steep dives, and any other maneuvers resulting in excessive accelerations are strictly prohibited. Do not make hard rudder kicks that result in large angles of yaw. Do not exceed a 60° angle of bank with flaps retracted or a 45° angle of bank with flaps extended. The bank angle limits provide an indication of load factor during turns. A constant altitude turn with 60° of bank corresponds to a load factor of 2.0g, and 45° of bank corresponds to 1.4g.

4.12 RAMP LOADING LIMITATIONS

The ramp loading limitations are contained in the applicable loading manual.

4.13 TAXI AND GROUND LIMITATIONS

CAUTION

Turns with brakes locked on one side or pivoting are prohibited. While turning the aircraft, avoid hard or abrupt brake applications or braking to a stop since damage to the nose landing gear and supporting structure may result. If any of the above is required during a turn, record it in the aircraft records.

Do not exceed the following taxi speeds, regardless of runway conditions.

1. Five knots with nosegear deflected 60°.

2. Twenty knots with nosegear deflected 20°.

Fuel tanks may be filled to the fuel weights shown in Figure 2-22 for JP-5/JP-8 fuel. However, when the fuel weight per tank exceeds that shown for JP-4, the following limitations apply:

1. Taxi and takeoff are permissible only on surfaces where qualities of smoothness and freedom from dips, depressions, and holes are comparable to those of a major airbase.

2. Maximum taxi speed is 20 knots.

Note

For taxi limitations on rough-terrain airfields, see paragraph 4.14. At gross weights up to 155,000 pounds, taxiing over rough terrain should be avoided. If this is unavoidable, extreme caution must be exercised and very low taxi speeds observed.

For overload gross weights above 155,000 pounds, observe the following taxi limitations:

1. Taxi and takeoff are permissible only on surfaces where qualities of smoothness and freedom from dips, depressions, and holes are comparable to those of a major airbase.

2. Maximum taxi speed is 10 knots.

3. Taxi shortest distance possible.

4. Use minimum braking during all taxi operations.

5. Use only light braking while turning.

6. Limit nosegear steering angle to 20°.

7. Avoid abrupt or uneven application of brakes.

4.14 SUBSTANDARD AIRFIELD OPERATIONS

Substandard airfields are defined as those that lack the flotation properties necessary for everyday normal operations or that have unusually rough, undulating, pitted, or rutted runways and/or taxiways. They may be either paved or unpaved. Conversely, unpaved surfaces (gravel, dirt, etc.) need not be considered substandard if the surface is hard and smooth. Any airfield on which the tires produce easily visible ruts should be considered substandard.

Note

Planning for substandard airfield operations should allow for increased maintenance and accelerated inspections according to the severity of the environment and the frequency of such operations.

Figure 4-9 defines the weight limitations for operating on substandard airfields. Contact rates of sink should be expected to be significantly higher on substandard airfields than on standard airfields. Thus the “recommended” landing gross weights and fuel weights shown in Figure 4-9 are within the structural limits for touchdown at 540 fpm. The “recommended” weights of Figure 4-9 are considered safe for the specified limits of roughness. The “allowable with caution” weights incur unknown risks that increase with an increase in weight and/or airfield roughness specified in Figure 4-9. The decision to use the “allowable with caution” weights shall be made by proper authority.

Where Figure 4-9 shows a fuel weight limit less than the capacity of the main tanks, additional fuel, if needed to meet mission requirements, is allowed in the auxiliary tanks. Since the gross weight is limited, the fuel in the auxiliary tanks will be at some sacrifice of cargo capability. Following takeoff, use the fuel in the auxiliary tanks before using the fuel remaining in the main tanks.

In addition to the weight limitations of Figure 4-9, observe the following to minimize maintenance and the chance of damaging the aircraft:

1. Service main gear tires as shown on Figure 3-2.

2. External tanks (if installed) must be empty.

3. Maximum taxi speed is 10 knots.

4. Minimize braking if porpoising results.

5. Minimize nosegear loads by use of elevator during takeoff and landing rollout and by loading the aircraft to a mid or aft center of gravity.

6. In addition, when operating on unpaved surfaces, the flight station and cargo compartment refrigeration units should be shut off to prevent clogging of the heat exchanger by debris.

4.15 MAXIMUM PASSENGER LOAD FOR EXTENDED OVERWATER FLIGHTS

In order to ensure sufficient liferaft capacity, no more than 80 persons, including crewmembers, may be carried on extended overwater flights that operate more than 50 nm from the nearest shoreline. Extended over-water operations with mixed cargo/passenger loads are restricted to a maximum of 35 occupants per unobstructed overhead exit. When normal egress routes are obstructed by cargo tiedown arrangements, passenger capacity shall be reduced accordingly.

4.16 GROUND FLOTATION

Figure 3-2 is provided for generalized operational planning. This chart permits matching the load that the aircraft imposes on an airfield to the strength capability of the airfield. Ground flotation characteristics are correlated for the following five methods of evaluating airfield/runway strength.

4.16.1 Footprint Loading (Pressure). For operational planning purposes, footprint loading is the same as tire inflation pressure. Figure 3-2 shows tire pressure values versus gross weights for normal operation from either high-strength airfields or marginal-strength airfields.

4.16.2 Unit Construction Index. UCI values are used to determine relative flotation characteristics of comparative aircraft and are seldom used in operational planning.

4.16.3 Equivalent Single-Wheel Load. Values of ESWL are determined from the geometry of the multiple-wheeled landing gears, the number and size of the tires, and the aircraft gross weight. Where airfield strength data are given in terms of ESWL, values of UCI and LCN can be calculated from these ESWL values, when required.

4.16.4 Load Classification Number. When LCN airfield strength data are used (primarily outside the United States) the data shown on the ground flotation chart can be used to estimate the capability of the aircraft to operate from a given airfield.

4.16.5 California Bearing Ratio. Values of CBR shown in Figure 3-2 represent the required airfield surface hardnesses for operation of the aircraft in terms of gross weight and number of passes. Only unpaved surface (dirt, grass, gravel, coral, etc.) can be evaluated in terms of CBR.

ROUGHNESS CHARACTERISTICS △1		A		B		C	
		RECM	ALLOWABLE WITH CAUTION	RECM	ALLOWABLE WITH CAUTION	RECM	ALLOWABLE WITH CAUTION
LANDING	GROSS WT (LB)	130,000 △2	155,000 △3	120,000 △2	______	______	111,000
	FUEL (LB)	25,000	△5	25,000	______	______	6,600 △4
TAKE-OFF	GROSS WT (LB)	155,000	______	120,000	135,000	______	111,000
	FUEL (LB)	△5	______	25,000	△5	______	6,600 △4

PARAMETER	ROUGHNESS CHARACTERISTICS		
	A — SMOOTH (REGULARLY MAINTAINED)	**B — INTERMEDIATE (MAINTAINED ONLY AS NECESSARY)**	**C — EMERGENCY (NO PREPARATION OR MAINTENANCE)**
DEVIATION FROM SURROUNDING SURFACE LEVEL	±2 INCHES IN 50 FEET	±4 INCHES IN 25 FEET	±6 INCHES IN 25 FEET
MAXIMUM GRADIENT			
LONGITUDINAL	±2%	±4%	±6%
TRANSVERSE	±2%	±3%	±3%
MAXIMUM CHANGE IN LONGITUDINAL ELEVATION	2 FT IN 100 FT 4 FT IN 200 FT 8 FT IN 400 FT 2% OVER 400 FT	3 FT IN 100 FT 6 FT IN 200 FT 10 FT IN 400 FT 2% OVER 400 FT	3 FT IN 100 FT 6 FT IN 200 FT 10 FT IN 400 FT 2% OVER 400 FT
MAXIMUM CHANGE IN GRADIENT	2% IN ANY 50 FT LENGTH	3% IN ANY 50 FT LENGTH	4% IN ANY 50 FT LENGTH
MAXIMUM ALLOWABLE RUTTING (MEASURED FROM SURROUNDING SURFACE — NOT EDGES OF RUT)	2 IN.	4 IN.	6 IN.
SOLID OBJECTS PROJECTING FROM SURFACE	NONE	3 IN. FROM FIRM OR UNDISTURBED SURFACE	6 IN. FROM UNDISTURBED SURFACE
POT HOLES OR DEPRESSIONS	2 IN. DEPTH MAXIMUM FOR ALL DIAMETERS	6 IN. DEPTH, 15 IN. MAX DIA; 4 IN. DEPTH, ANY DIA	8 IN. DEPTH, 2 FT MAX DIA
LOOSE OR SOFT FILL	NONE	NONE ADJACENT TO ROCKS, STUMPS, OR RIGID SURFACES	AS NEEDED TO FILL DITCHES OR HOLES. PACK WITH FEET OR USE HAND TAMPER

Notes

△1 THE LOWER TABLE DEFINES ROUGHNESS CHARACTERISTICS WHICH IMPOSE THE GROSS WEIGHT AND FUEL WEIGHT LIMITS OF THIS TABLE.

△2 MAXIMUM TOUCHDOWN RATE OF SINK IS 540 FPM. OUTBOARD TANK FUEL IS LIMITED TO 6,600 POUNDS PER SIDE.

△3 MAXIMUM TOUCHDOWN RATE OF SINK IS 300 FPM.

△4 OUTBOARD TANK FUEL IS LIMITED TO 2,000 POUNDS PER SIDE.

△5 MAXIMUM FUEL WEIGHTS FOR MAIN AND AUXILIARY TANKS ARE THOSE WEIGHTS SHOWN IN FIGURE 2-22 FOR JP-4 FUEL.

Figure 4-9. Gross Weight and Fuel Weights for Substandard Airfield Operations

4.16.6 Aircraft Classification Number/ Pavement Classification Number. The ACN/ PCN is a method of reporting the load-bearing capability of a runway. When the ACN is greater than the PCN, then the aircraft is normally not allowed to land on the runway. The ACN depends on the aircraft gross weight, the subgrade code, and the flexibility of the runway. The subgrade code is “A” for high, “B” for medium, “C” for low, and “D” for very low strength of the soil-bearing runway. The runway pavement will either be “R” for rigid or “F” for flexible. Each runway should have a PCN, a subgrade code, and a flexibility reported before the ACN/PCN is used.

Example problem for all C-130 aircraft using the charts in Figure 4-10.

GIVEN:

1. Gross weight = 120,000 pounds.
2. PCN = 21.
3. Subgrade code = C.
4. Flexible pavement.

FIND:

1. ACN.
2. Is the aircraft allowed to land on the runway?

SOLUTION:

1. Enter Figure 4-10 at 120,000 pounds. Move up to line C and left to read an ACN of 23.5.
2. The aircraft should not land since 23.5 is greater than the PCN of 21.

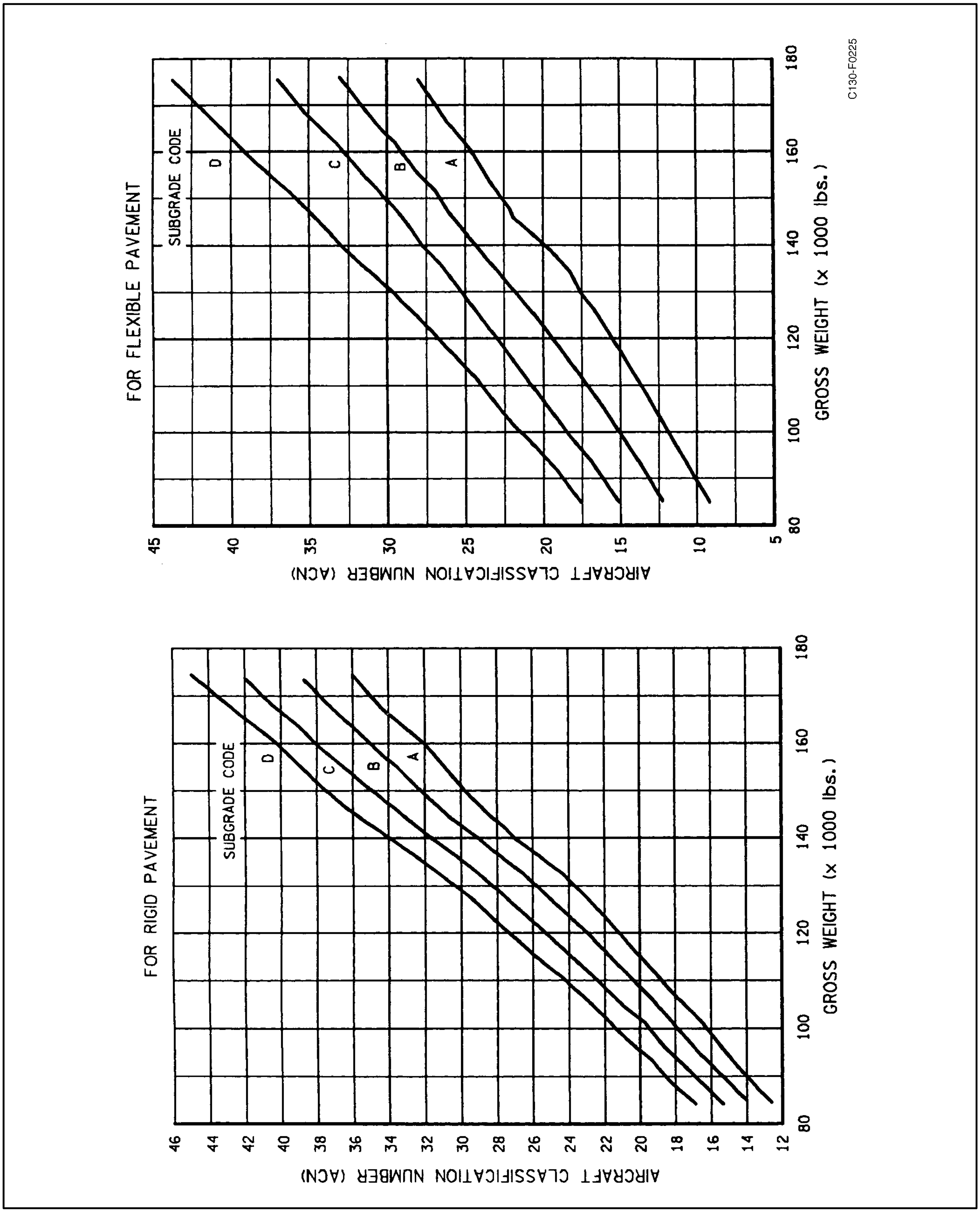


Figure 4-10. Aircraft Classification Number

NOTE

REFERENCE SHOULD BE MADE TO APPLICABLE DISCUSSIONS WITHIN THIS SECTION FOR THE VALUES SHOWN BELOW.

WEIGHTS — POUNDS		
C-130T		
CONDITION	EXTERNAL TANKS ON	LANDING RATE OF SINK
MAXIMUM TAXI		
RECOMMENDED	155,000	
OVERLOAD	175,000	
MAXIMUM TAKEOFF		
RECOMMENDED	155,000	
OVERLOAD	175,000	
MAXIMUM LANDING		300 FPM RATE OF SINK
RECOMMENDED	155,000	
OVERLOAD	175,000	
NORMAL LANDING	130,000	540 FPM RATE OF SINK

SPEEDS — KNOTS INDICATED AIRSPEED

LANDING GEAR EXTENDED	170	AFT CARGO DOOR AND RAMP OPEN	150
PARATROOP AIR DEFLECTORS OPEN	150	PARATROOP DOORS (OPENING OR CLOSING)	150
LANDING LIGHTS EXTENDED	250	THUNDERSTORM OPERATION 65 KNOTS ABOVE POWER OFF STALL NOT TO EXCEED 180 KIAS	

FLAPS EXTENDED:

10%	220	60%	165
20%	210	70%	155
30%	200	80%	150
40%	190	90%	145
50%	180	100%	145

SYSTEM LIMITS

FUEL

MAIN TANK BOOST PUMP PRESSURE	MINIMUM 15 PSI — MAXIMUM 24 PSI
AUXILIARY AND EXTERNAL TANK BOOST PUMP PRESSURE	MINIMUM 28 PSI — MAXIMUM 40 PSI

HYDRAULIC

UTILITY SYSTEM	NORMAL 2,900 TO 3,200 PSI — MAXIMUM 3,500 PSI
BOOSTER SYSTEM	NORMAL 2,900 TO 3,200 PSI — MAXIMUM 3,500 PSI
AUXILIARY SYSTEM	NORMAL 2,900 TO 3,300 PSI — MAXIMUM 3,500 PSI

RUDDER BOOST:

0% TO 15% FLAPS NORMAL, 1,100 TO 1,400 PSI — MAXIMUM 1,600 PSI

15% TO 100% FLAPS NORMAL, 2,900 TO 3,200 PSI — MAXIMUM 3,500 PSI

ACCUMULATOR PRELOAD

UTILITY SYSTEM	1,500 PSI ±100	NORMAL BRAKE	1,500 PSI ±100
BOOSTER SYSTEM	1,500 PSI ±100	EMERGENCY BRAKE	1,000 PSI ±100
		SURGE SUPPRESSOR	40 PSI ±5

Figure 4-11. Summary of Limitations (Sheet 1 of 2)

PRESSURIZATION	
CABIN DIFFERENTIAL PRESSURE	MINIMUM 1.2 IN HG — MAXIMUM 15.8 IN HG
OXYGEN	
MINIMUM PRESSURE FOR NORMAL USE	50 PSI
STARTER	
1 MINUTE ON, 1 MINUTE OFF, 1 MINUTE ON, 5 MINUTES OFF, 1 MINUTE ON, 30 MINUTES OFF. RELEASE SWITCH AT 60 PERCENT RPM. START VALVE OPEN LIGHT SHOULD EXTINGUISH WITHIN 15 SECONDS AFTER SWITCH IS RELEASED.	
PROPELLER AUXILIARY PUMP	
1 MINUTE ON, 1 MINUTE OFF, NOT TO EXCEED 2 MINUTES OF OPERATION IN A 30-MINUTE PERIOD.	
ELECTRICAL	
FREQUENCY	MINIMUM 380 HZ — MAXIMUM 420 HZ
AC VOLTS (GENERATOR AND INVERTER)	MINIMUM 110 VOLTS — MAXIMUM 125 VOLTS
DC VOLTS	MINIMUM 25 VOLTS — MAXIMUM 30 VOLTS
AC LOAD	MAXIMUM CONTINUOUS 1.050
DC LOAD	MAXIMUM CONTINUOUS 1.030
PROPELLER BLADE DEICING	MINIMUM SUFFICIENT 60 AMP — MAXIMUM 90 AMP
PROPELLER SPINNER ANTI-ICING AND DEICING	MINIMUM SUFFICIENT 65 AMP — MAXIMUM 90 AMP

Figure 4-11. Summary of Limitations (Sheet 2)

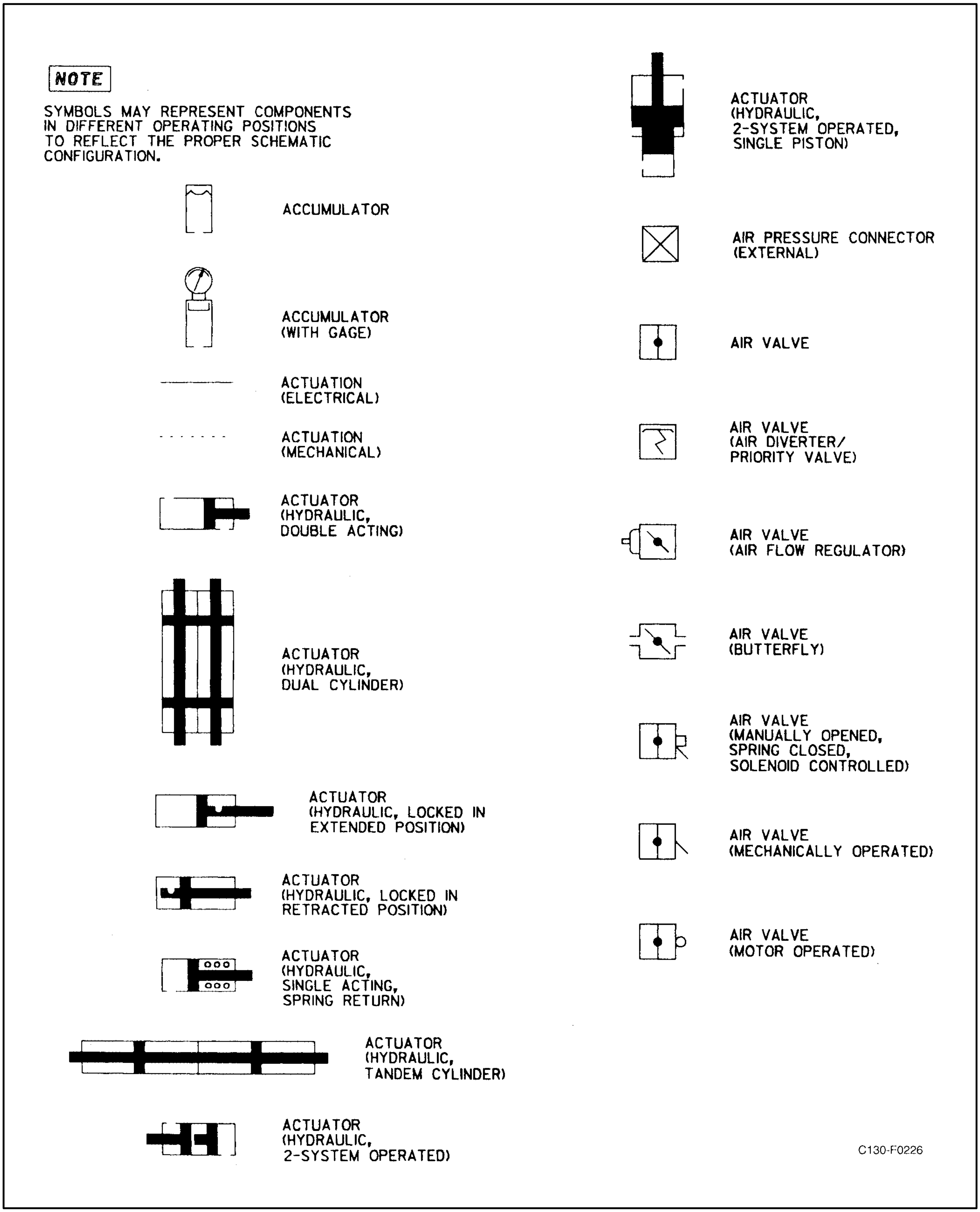


Figure 4-12. Standard Symbols (Sheet 1 of 5)

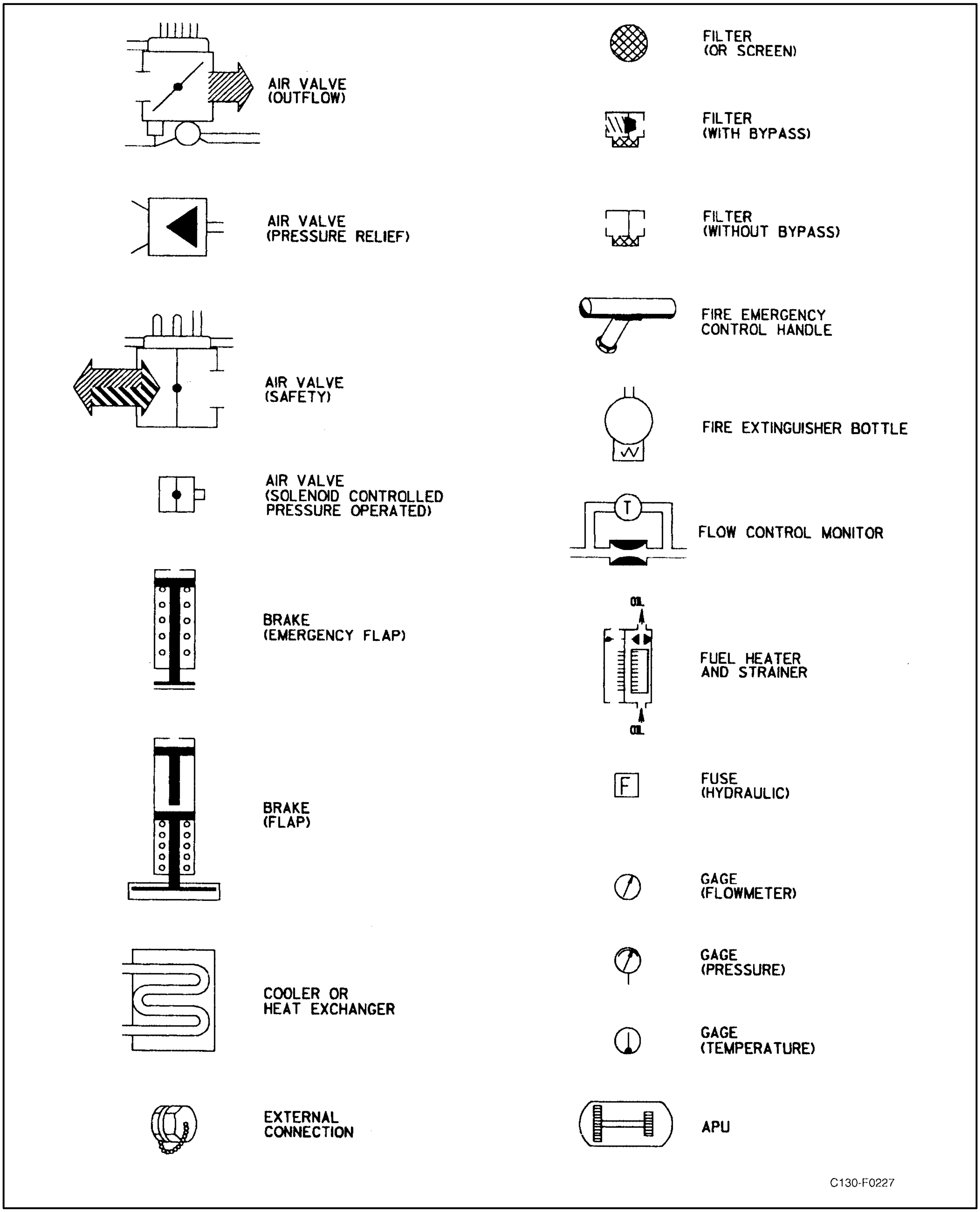


Figure 4-12. Standard Symbols (Sheet 2)

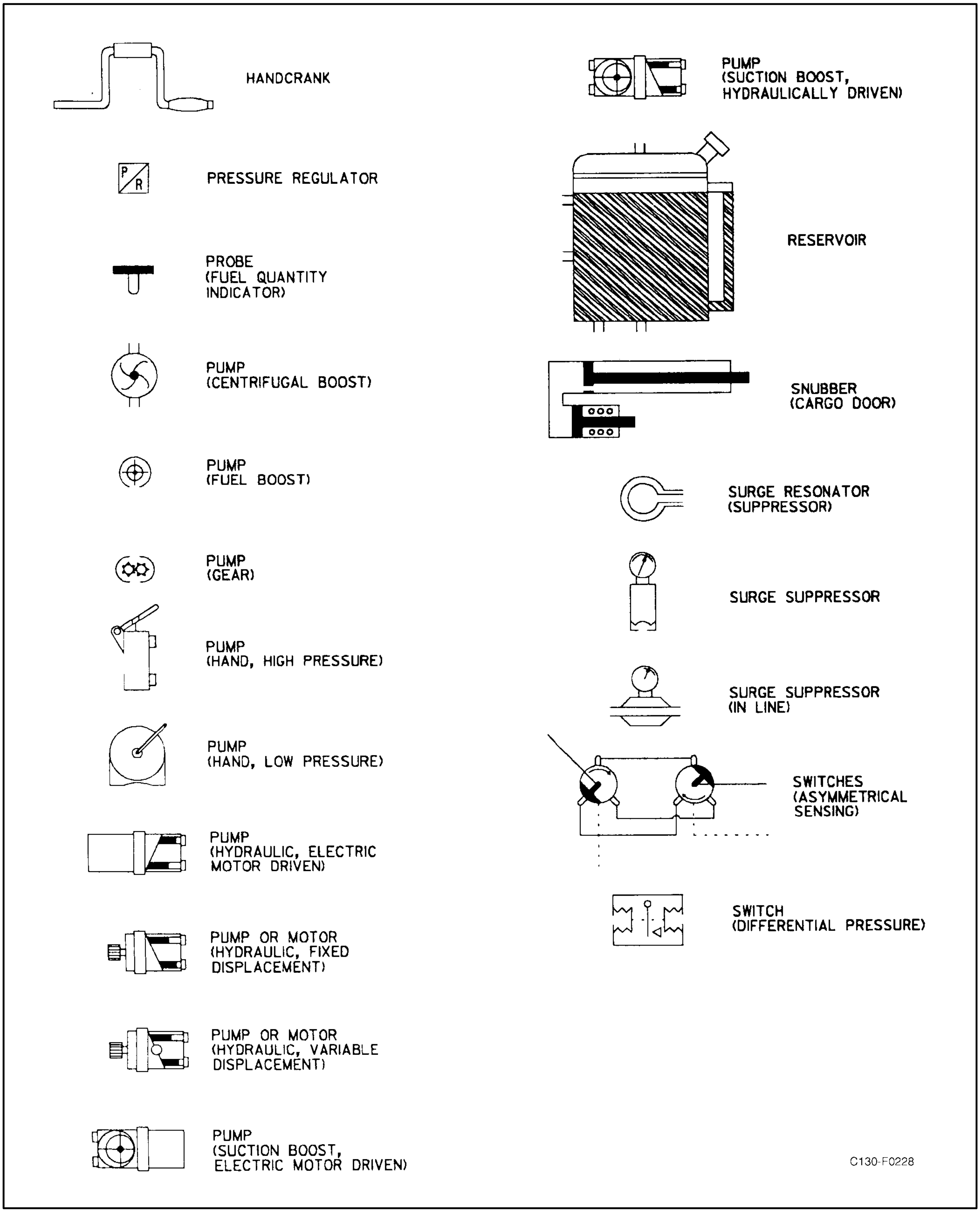


Figure 4-12. Standard Symbols (Sheet 3)

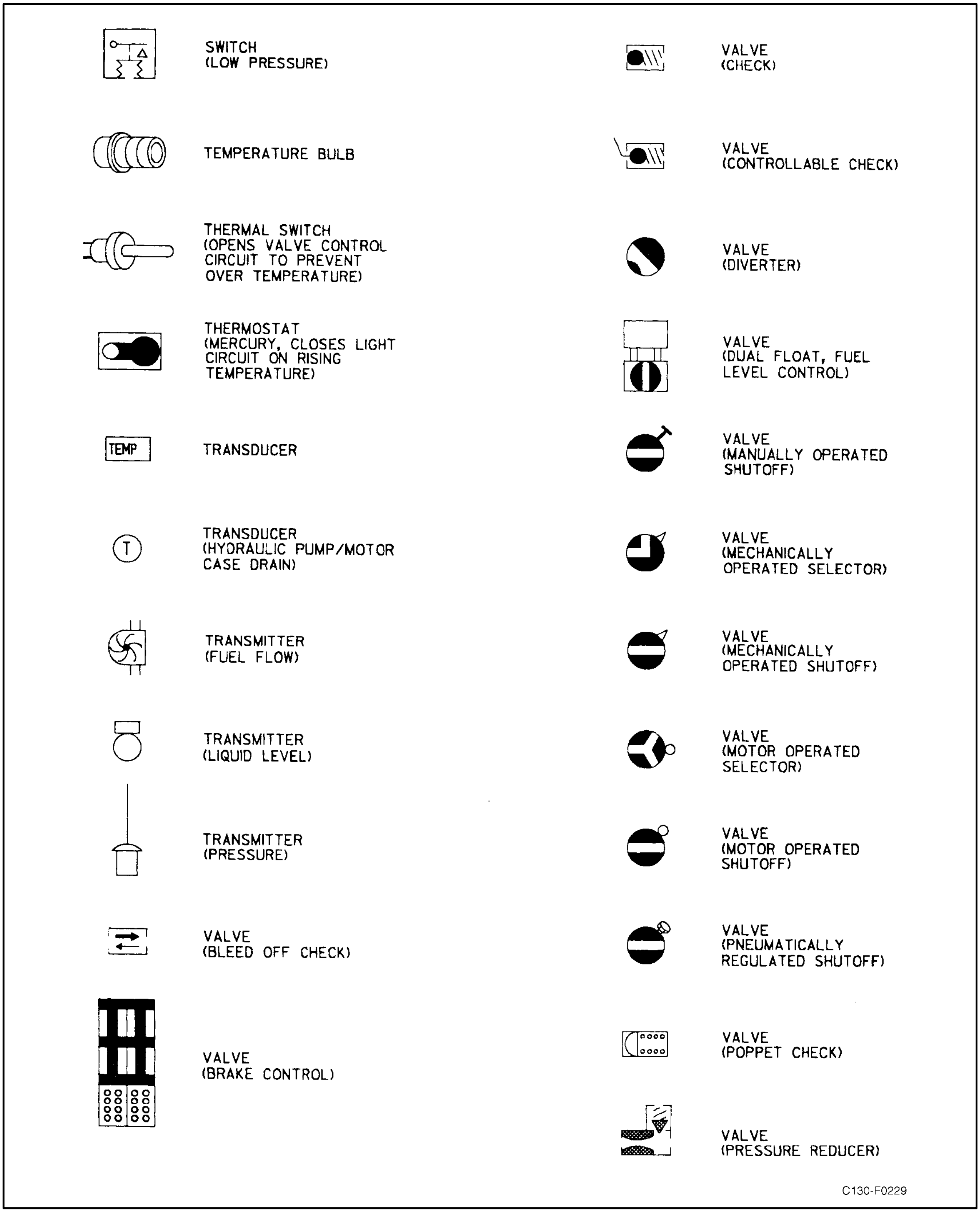


Figure 4-12. Standard Symbols (Sheet 4)

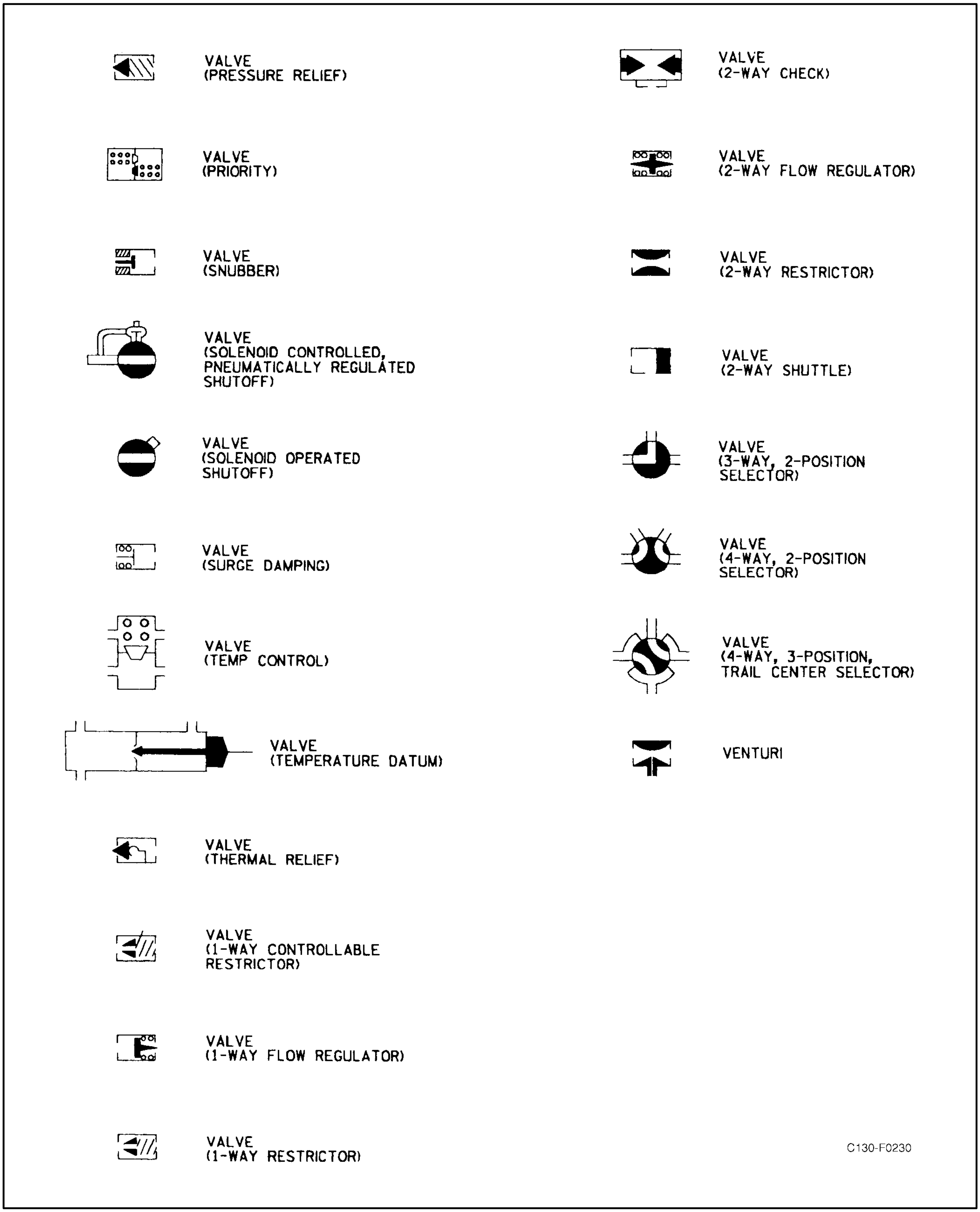


Figure 4-12. Standard Symbols (Sheet 5)

PART II

Indoctrination

CHAPTER 5

Indoctrination

5.1 INDOCTRINATION

This chapter provides general information on the operation of the aircraft and prescribes minimum aircrew training and operating procedures and techniques. This chapter will be the primary directives for training and maintaining standardized operating procedures. As a crewmember, you have the ultimate responsibility of fulfilling the mission of your command. This is the crucial test of your training and judgment. To be successful, you must accomplish your tasks with professional competence and strive for perfection in the operation of your aircraft system. Information in this chapter has been developed to aid you in the attainment of this goal. Be familiar with the established procedures, with your mission, and with your aircraft. Constantly evaluate yourself and your skill to perform the mission assigned to you.

5.2 GROUND-TRAINING SYLLABUSES

The ground-training syllabuses contained in this section are considered the minimum prerequisites to attain qualification for all aircrewmembers not previously qualified in the aircraft. Aircrewmembers previously qualified in the aircraft will, prior to being requalified for the crew position previously held, complete such portions of the syllabus as may be deemed necessary by the unit commander. Ground training will be conducted by squadron personnel or by outside agencies, such as naval aid mobile trainers or factory training, if available. Flight simulator training shall be conducted every 12 to 24 months for all pilots and flight engineers. Simulator training is considered extremely valuable and should not be waived if at all possible. Ground and Phase 1 training shall be completed prior to the first flight as an aircrewmember.

5.2.1 Pilot Ground-Training Syllabus. A formal course of instruction will be completed, utilizing the following outline:

1. Aircraft general
2. Electrical systems
3. Radio/radar/navigation equipment
4. Auxiliary power unit
5. Instruments and autopilot
6. Hydraulics/brakes/cargo ramp and door
7. Pneumatics
8. Fuel system
9. Engines
10. Propellers
11. Aerial delivery system
12. Normal and emergency procedures
13. Weight and balance
14. Performance and cruise charts
15. Fire and overheat detection/fire extinguishing
16. Oxygen system
17. Air-route traffic-control procedures.

5.2.1.1 Basic Simulator Course. A basic course in the flight simulator will be completed, utilizing the following lesson outline.

5.2.1.1.1 Period I (To Be Conducted in Aircraft or Simulator)

1. Description of cockpit to include:
   a. Operation of crew seats
   b. Operation of parking brake
   c. Operation of trim tab controls
   d. Operation of rudder pedal adjustments

e. Operation of microphone buttons, radios, and radio jack boxes

f. Operation of throttles and condition levers

g. Operation of cockpit and external lights

h. Identity of pertinent panels and switches (i.e., ice control panel, fuel panel, pressurization panel, electrical panel, APU panel, fire control panel).

2. Description of checklists, using the flight manual and pocket checklist, to include:

   a. Basic structure

   b. Responsibilities for various sections of checklist

   c. Adaptability of checklist to various climatic conditions and various pieces of ground equipment.

5.2.1.1.2 Period II

1. Complete coverage of flight station checks.

2. Before Start Checklist (explain difference in operation with and without external power).

3. Engine start to include:

   a. Coverage of instrument indications.

   b. Limitations of the following:

      (1) Starters

      (2) Oil pressure/temperatures

      (3) TIT

      (4) Hydraulic pressure

      (5) Light-off

      (6) Starting time.

   c. Functions of speed-sensitive control.

   d. Discuss use of fuel enrichment.

   e. Before Taxi Checklist.

   f. Complete coverage of Taxi Checklist.

5.2.1.1.3 Period III

1. Compute performance prior to entering simulator.

2. Complete coverage of flight station checks and Before Start Checklist.

3. Engine start to include:

   a. Coverage of instrument indications

   b. Limitations of the following:

      (1) Starters

      (2) Oil pressure/temperatures

      (3) TIT

      (4) Hydraulic pressure

      (5) Light-off

      (6) Starting time.

   c. Functions of speed-sensitive control.

4. Description of engine-driven fuel pump and operation during engine start.

5. Coverage of Taxi Checklist.

6. Engine Runup Checklist.

7. Before Takeoff Checklist to include comprehensive briefing (takeoff performance computed prior to entering simulator).

8. Normal takeoff.

9. Normal operation of the following:

   a. Pressurization

   b. Anti-icing and deicing

   c. Fuel system

   d. Propeller controls

   e. Electronic fuel correction system.

10. Discuss negative torque system and decoupling.

11. Landing and engine secure, using normal checklist.

5.2.1.1.4 Period IV

1. Compute performance prior to entering simulator.

2. Before Start Checklist.

   a. Explanation of APU operation.

      (1) Starter limits.

      (2) Power source for starter and fuel control.

      (3) Speed switch functions.

3. Engine start to include the following:

   a. Coverage of instrument indications.

   b. Limitations of the following:

      (1) Starters.

      (2) Oil pressure/temperatures.

      (3) TIT.

      (4) Hydraulic pressure.

      (5) Light-off.

      (6) Starting time.

   c. Functions of speed-sensitive control.

4. Question student on meaning of parallel light during start and on speed.

5. Question student on battery APU start.

6. Hydraulic pump failure during start.

7. Simulate starter control valve failure by pulling air/oil circuit breaker.

8. Taxi Checklist.

9. Engine runup (test student on rpm and TIT limits).

   a. Demonstrate propeller reindexing.

10. Before Takeoff Checklist.

    a. Discuss autopilot checklist.

    b. Comprehensive briefing to include performance data.

11. Normal takeoff, with air-conditioning and pressurization off for maximum available power.

12. Discuss maximum allowable torque on takeoff.

13. Emergency operation of the following:

    a. Pressurization.

    b. Anti-icing and deicing (manual).

    c. Electrical systems.

    d. Propeller controls (discuss switch positions and synchronization).

14. Normal Landing, After Landing, Engine Secure, and Before Leaving the Aircraft, using normal checklists.

5.2.1.1.5 Period V

1. Compute performance prior to entering simulator.

2. Before Start checklist.

3. Discuss brake selector valves.

4. Discuss dc electrical power failure during engine start.

5. Introduce hot start.

6. Discuss failure of 94-percent speed switch.

7. Taxi Checklist.

8. Discuss possibility of an anti-icing valve sticking open and corrective action.

9. Engine warmup (while above crossover, discuss relationship among TIT, fuel flow, and torque, and explain how faulty TIT indications may be detected).

10. Before Takeoff Checklist to include comprehensive crew briefing.

11. Cause student to abort on takeoff by flaming out engine (discuss refusal speed).

12. Normal takeoff.

13. Failure of gear to retract, using normal system (discuss manual operation of normal selector valve).

14. Precautionary engine shutdown.

15. Fire emergency engine shutdown.

16. Airstart procedure.

17. Emergency operation of electrical systems.

18. Failure of gear to extend.

19. Landing and engine secure, using normal checklist.

20. Discuss the NTS lockout feature.

21. Discuss the mechanics of the NTS shutdown.

5.2.1.1.6 Period VI

1. Perform Flight Station Checks, using the abbreviated checklist.

2. Before Start Checklist (test student knowledge of limitations).

3. Stalled start.

4. Simulate failure of ignition relay by pulling fuel and ignition relay circuit breaker.

5. Taxi Checklist.

6. Engine Runup Checklist.

7. Before Takeoff Checklist to include comprehensive crew briefing (discuss definition of critical engine failure speed and critical field length).

8. Normal takeoff.

9. Discuss acceleration limits of TIT during takeoff.

10. Discuss failure of one engine generator and also failure of a bus system.

11. Individually fail each inverter system, discussing what equipment is affected by each.

12. Failure of booster hydraulic system (discuss restarting of engines before landing).

13. Reinstate booster hydraulic system and fail utility hydraulic system (discuss use of auxiliary hydraulic system for emergency brake pressure).

14. Landing and engine secure, using normal checklist.

5.2.1.1.7 Period VII. This period shall be utilized to conduct a thorough briefing and for demonstrating the use of the following:

1. Communications, navigation, and radar equipment.

2. Pointer selector switches

3. Flight director switches

4. NAV selector switches

5. Horizontal situation indicator

6. Attitude director indicator.

5.2.1.1.8 Period VIII. For cruise-control flight, plan a mission requiring maximum range at maximum gross weight.

5.2.2 Flight Engineer Ground Training Syllabus. A formal course of instruction shall be completed, utilizing the following outline:

1. Aircraft general

2. Emergency equipment

3. Flight controls

4. Cargo door and ramp

5. Aerial delivery system

6. Hydraulic systems

7. Brakes and antiskid system

8. Landing gear system

9. Fuel system

10. Oil system

11. Air-conditioning and pressurization

12. Anti-icing, deicing, and defogging system

13. Electrical systems

14. Instruments and autopilot

15. Power plant and associated system

16. Auxiliary power unit

17. Propeller system

18. ATO auxiliary propulsion system

19. Engine overheat, fire detection, fire isolation, and fire extinguisher system

20. Oxygen system

21. Performance and cruise charts

22. Weight and balance

23. Forms and publications

24. Preflight and postflight inspection requirements

25. Comprehensive oral examination

26. Final written examination.

5.2.2.1 Basic Simulator Course. A basic simulator course, similar in nature to the pilot basic simulator course, shall be completed by all flight engineers. Because of its similarity, it is recommended that the two be integrated and conducted simultaneously, if at all possible.

5.2.3 Loadmaster Ground Training Syllabus. The ground training syllabus for the loadmaster is designed to familiarize a loadmaster with the equipment in the aircraft. Qualification as a loadmaster assumes completion of a local loadmaster course conducted by the parent squadron and completion qualification as a second loadmaster. Minimum requirements shall be established by the Unit commander, but should contain the following:

1. Weight and balance

2. Forms and publications

3. Checklists and ICS procedures

4. Ramp and cargo door operation

5. Cargo loading procedures

6. Securing cargo in accordance with established restraint procedures

7. Rigging of seats and litters

8. Passenger briefing

9. Preflight

10. Location of emergency equipment

11. Emergency procedures

12. Cargo offloading procedures

13. Hazardous material handling procedures

14. Wheeled vehicles

15. Limitations.

5.2.4 Second Loadmaster Ground Training Syllabus. The ground training syllabus for second loadmaster is designed to familiarize a second loadmaster with the aircraft basics and associated equipment. Qualification as a second loadmaster assumes completion of a local second loadmaster course conducted by the parent squadron. Minimum requirements shall be established by the unit commander but should contain the following:

1. Basic aircraft and GSE familiarization

2. Checklists and ICS procedures

3. Hydraulic and oxygen systems

4. Emergency entrances, exits, and equipment

5. Interior preflight

6. Emergency procedures

7. Passenger movement procedures

8. Cargo movement familiarization.

5.3 FLIGHT TRAINING SYLLABUSES

The flight training syllabus sets forth the minimum requirements for transitioning aircrewmembers to the aircraft. Aircrewmembers who are engaged in any part of the training program shall be considered “in-training” until satisfactorily completing a flight check, after which they shall be designated, in writing. Although minimum hours for each phase are shown. Commanding officers may increase or decrease the training requirements as necessary to fit the individual qualifications and previous experience.

5.3.1 Pilot Flight Training Syllabus. The pilot flight training syllabus is designed to train a naval aviator as a copilot in the aircraft. Phase I training, as outlined in this section, is considered the minimum required to accomplish this task; however, unit commanders may accelerate or decelerate the training consistent with the ability and experience of the pilot concerned.

Because of the versatility of the aircraft, Phase II training is dictated by the mission of the command, and, therefore, no minimum requirements are established. Qualification in any or all of the Phase II flight syllabus is left to the prerogative of the unit commander.

5.3.1.1 Phase I

1. Familiarization (7 periods, 14 hours)

   a. Cockpit familiarization

   b. Use of checklists

   c. Starting engines

   d. Taxi

   e. Takeoffs

      (1) Normal emergencies before refusal speed

      (2) Emergencies after refusal speed

      (3) Obstacle takeoff

   f. Air work and power control

   g. Stalls and recovery

   h. Landings

      (1) Normal

      (2) Half flap

      (3) No flaps

      (4) Short field

      (5) Obstacle landing

      (6) Simulated one and two engines out

   i. Use of reverse pitch

      (1) Symmetrical

      (2) Asymmetrical

   j. Engine shutdown

   k. Airborne discussion of the following:

      (1) Hydraulic system

      (2) Engines and propellers

      (3) Air-conditioning and pressurization system

      (4) Anti-icing, deicing, and ice detector system

      (5) Electrical system

      (6) Fuel system and in-flight refueling system

      (7) Radios, navigation and flight instruments.

2. Instruments (5 periods, 10 hours)

   a. Instrument takeoffs

   b. Climbout

c. Holding patterns and entry

d. Penetrations

e. GCA

f. ILS

g. AACS

3. Night familiarization (2 periods, 4 hours)

   a. Normal takeoffs and landings

4. Navigation (4 periods, 16 hours)

   a. Use of performance and cruise control charts

   b. ARTC procedures

   c. Strange field approaches and landings

   d. Instrument cross-country procedures

   e. Complete review of all aircraft systems

   f. Induced emergencies (S or A, as appropriate)

   g. Use of navigation and flight instruments.

5. Flight evaluation check (6 hours).

5.3.1.2 Phase II

1. Advanced navigation

2. Aerial delivery

3. Combat unit movement

4. Casualty air evacuation

5. Formation tactics

6. Three-engine takeoff with simulated inoperative engine in flight idle

7. Windmill taxi start.

5.3.2 Flight Engineer Flight Training Syllabus. The flight training syllabus is designed to correlate information received during ground training and simulator training and to integrate the flight engineer as an aircrewmember. Therefore, this syllabus deals with the use of checklists and crew coordination, the diagnosis of airborne malfunctions, and the remedial action that can be accomplished while airborne. It is imperative that prospective flight engineers be completely proficient and have demonstrated a thorough working knowledge of all the aircraft systems and auxiliary equipment prior to flight training. The syllabus shall cover the following:

1. Preflight inspections

2. Cockpit familiarization

3. Use of checklists

4. Engine start

   a. Starting sequence

   b. Correct and incorrect indications during start

   c. Reasons for aborting a start and troubleshooting.

5. Engine and propeller runup

   a. Correct runup procedure

   b. Reindexing

   c. Allowable engine and propeller indications

   d. Generator and load checks

   e. Temperature controlling check.

6. Crew duties during start, taxi, runup, takeoff, cruise, landing, and after landing

7. Airborne systems checkout

   a. Engine malfunctions

   b. Propeller malfunctions

   c. Fuel system and fuel management

   d. Electrical system

   e. Pneumatic system

   f. Air-conditioning and pressurization system

g. Anti-icing, deicing, and defogging system

h. Hydraulic systems

i. Aerial delivery system.

8. Emergency procedures

a. Emergency equipment

b. Engine failure

c. Engine fire during start, ground operation, and flight

d. APU fire

e. Generator failure and bus failure

f. Hydraulic failure, emergency extension of landing gear

g. Propeller overspeed, low oil quantity

h. Fuselage fire, cargo compartment refrigerator overheat warning

i. Wing fire

j. Electrical fire

k. Smoke and fumes elimination

l. Loss of pressurization

m. Door warning light

n. Wing and/or empennage overheat warning light

o. Loss of inverters.

9. Descent and Landing Checklists

10. After Landing Checklist

11. Engine secure and NTS check

12. Securing the aircraft

13. Postflight inspection.

5.3.3 Loadmaster Flight Training Syllabus. The flight training syllabus for the loadmaster is designed to familiarize a qualified loadmaster with the equipment in the aircraft. Qualification as a loadmaster assumes completion of a local loadmaster course conducted by the parent squadron. Minimum requirements shall be established by the unit commander.

1. Operation of cargo door and ramp
2. Cargo loading procedures
3. Securing cargo in accordance with established restraint criteria
4. Rigging of seats and litters
5. Passenger briefing
6. Location of door warning light switches
7. Correct interphone procedures
8. Location of all emergency equipment
9. Emergency landing gear and flap extensions
10. Explosive decompression
11. Offloading procedures
12. Aerial delivery procedures.

5.3.4 Second Loadmaster Flight Training Syllabus. The flight training syllabus of the second loadmaster is designed to familiarize a second loadmaster with flight operation of the aircraft systems. The flight training syllabus will cover the following subjects:

1. Basic aircraft and GSE familiarization
2. Checklist and ICS procedures
3. Hydraulic and oxygen systems
4. Emergency entrances and exits and equipment
5. Emergency procedures
6. Rigging seats and litters
7. Passenger briefing

8. Forms and paperwork

9. Cargo restraint and tie-down familiarization

5.4 MINIMUM EXPERIENCE REQUIREMENTS

Minimum requirements for qualification in crew position are listed in Figure 5-1. In addition to these requirements, specific requirements for demonstrating maturity and leadership ability are established by the current OPNAV Instruction 3710.7.

Training prior to requalification for previously qualified individuals who have not flown the aircraft in the previous 90 days will be determined on an individual basis by the unit commander.

5.5 FLIGHT CREW REQUIREMENTS

5.5.1 Normal Crew. A normal crew shall consist of one aircraft commander, one T2P, one flight engineer, one loadmaster, and one second loadmaster.

5.5.2 Functional Checkflight Crew. The minimum crew required for a functional checkflight is one aircraft commander, one T2P, one flight engineer, and one loadmaster or second loadmaster.

5.5.3 Essential Crew. The essential crew required for aircraft operation is one aircraft commander, one T2P, one flight engineer, and one loadmaster or second loadmaster.

Note

- A second loadmaster may carry up to a maximum of 1000 lbs. loose cargo and 10 passengers. In this case, the flight engineer shall ensure accuracy of the Form-F. This cargo shall not include palletized, hazardous, rolling stock and/or individual bulk containers exceeding 100 lbs.

- With only one LM assigned, the maximum number of passengers shall be limited to 35.

	TAC	T2P	FE	LM/2LM
1. Pilot Hours	1,200	500	–	–
2. Hours in Model	250	45(3)	100	100/50
3. Instrument Hours	100	50	–	–
4. Night Hours	100	50	–	–
5. Instrument Rating	STD	STD	–	–
6. Basic Ground School	X	X	X	X
7. Simulator Course	X	X	X	–
8. NATOPS Open-/Closed-Book Exam	X	X	X	X
9. Oral Flight Evaluation	X	X	X	X
10. Route Evaluation	X	–	–	–

Notes:

1. Commander, Fleet Logistics Support Wing may waive, in writing, requirements 1 through 4 where previous experience warrants.
2. Pilot's senior to the designating authority shall be designated by the next superior in the chain of command.
3. Fifteen hours minimum in the aircraft (nonsimulator time).

Figure 5-1. Minimum Military Experience Requirements

5.5.4 Augmented Crew. An augmented crew consists of the following:

1. One aircraft commander
2. Two additional qualified pilots
3. Two flight engineers
4. Two loadmasters
5. One second loadmaster.

5.5.5 Crew Scheduling. Squadron commanding officers shall ensure crew scheduling is adjusted to satisfy training, proficiency, and operational requirements. Crew experience, currency, and proficiency shall be closely monitored to maximize operational risk management.

5.5.6 Crew Duty, Rest, and On-Deck Time

1. Crew duty

   a. Crew duty commences at preflight showtime (normally 2 hours prior to blockout) and terminates at block in on the final leg of the day.

   b. Crew duty limits:

Parameter	Crew Duty	Extendible*
0700–1459 show	16 hours	18 hours by aircraft commander
1500–0659 show	13 hours	15 hours by aircraft commander
Augmented crew	24 hours	Not extendible
Autopilot inoperative	12 hours	Not extendible
*Crew duty can be extended for a maximum of 2 consecutive days.		

2. Crew rest.

   a. Crew rest is that time during which no duties may be performed.

   b. Crewmembers shall be provided a crew rest period commencing 12 hours prior to reporting for a mission.

3. On-deck time

   a. On-deck time is block in to block out.

   b. On-deck time limits:

Parameter	On-Deck Time	Reducible
RON	17 hours	12 hours by aircraft commander provided 8 hours of crew rest is allowed and only if previous crew duty was not extended

   c. Reduction of crew duty may be required because of crew fatigue resulting from time zone changes, multiple maximum-hour days, and “back side of the clock” flying. It is the aircraft commander’s prerogative to shorten crew duty.

5.5.7 Minimum Currency Requirements. Currency shall be in accordance with OPNAVINST 3710.7 for semi-annual and annual minimums, and in accordance with applicable TYCOM/WING directives for monthly requirements.

5.5.8 Ferry Pilots. Training requirements, checkout procedures, evaluation procedures, and weather minima for ferry squadrons are governed by the provisions contained in the current OPNAV Instruction 3710.7.

5.6 PERSONAL FLYING EQUIPMENT REQUIREMENTS

All safety and survival equipment shall be utilized as prescribed by the current OPNAV Instruction 3710.7.

PART III

Normal Procedures

CHAPTER 6

Briefing and Debriefing

6.1 BRIEFING

Prior to any flight, it is the responsibility of the aircraft commander to ensure that the entire crew has been properly briefed for the mission. All pertinent points related to the specific flight must be covered. The length of time for each briefing may vary, depending on the nature of the flight. This briefing should include the following applicable items:

1. General
   a. Aircraft assignments and call signs
   b. Starting, taxiing, loading, and takeoff times.
2. Mission
   a. Destination
   b. Intermediate stops
   c. Load.
3. Weather
4. Navigational and flight planning
5. Emergency procedures
6. Intelligence and special instructions.

All in-flight refueling, formation, and special missions require a detailed briefing for the flightcrews involved by a qualified individual to include all pertinent information related to the flight.

6.1.1 Passenger Briefing

1. Flight number/aircraft commander's name/crewmember's name.
2. Origin/destination/en route stops.
3. Flight duration.
4. En route weather.
5. Seatbelts.
   a. Seatbelts shall remain fastened while seated.
6. Illness.
   a. Inform crewmember
   b. Airsickness bags available.
7. Ground evacuation.
   a. Primary/secondary exits
   b. Follow crewmember's instructions.
8. Ditching.
   a. Proper seat position
   b. LPP demonstration
   c. Liferaft distribution
   d. Exits
   e. Distribution of emergency equipment.
9. Head facilities.
   a. Urinals
   b. Aft toilet.
10. Coffee, water, lunches (if available).
11. Passenger movement.
    a. One passenger at a time on flight station escorted by crewmember (visits are at the discretion of the aircraft commander).
12. Aircraft cleanliness.
    a. Garbage can/trash bag location(s).

13. Destination information.

    a. Transportation/quarters/messing.

    b. Customs/agriculture (if required).

    c. RON (give ETD and muster location).

    d. Time zone update.

14. No pyrotechnics, ammunition, BIC-type lighters, or use of cellular phones. In accordance with the current OPNAVINST 3710, the use of tobacco products is prohibited. The use of electronic devices is prohibited during the takeoff and landing phase.

6.2 DEBRIEFING

6.2.1 All Flights. After each flight, it is the responsibility of the aircraft commander to bring to the attention of the flightcrewmembers any discrepancies noted during the flight. Any deviation from the standardized procedures, as outlined in this manual, will be thoroughly reviewed and corrected. It is the responsibility of the aircraft commander to ensure that all reports required have been completed, that the flight plan has been closed out, and that all aircraft discrepancies have been listed on the VIDS/MAF or NALCOMIS.

6.2.2 Special Flights. Additional debriefings may be scheduled, as necessary, to cover flights of a special nature requiring detailed reports and information concerning the flight.

CHAPTER 7

Mission Planning

7.1 INTRODUCTION

Refer to the performance chart to determine the capability of the aircraft for takeoff, climb, cruise, descent, and landing for a complete mission under any combination of conditions and circumstances. Mission planning requires consideration of all factors affecting the successful completion of the assigned mission. Most commonly, mission planning determines the fuel load necessary for the safe accomplishment of a given mission for which cargo load and distance are known. The aircraft has a three-fold capability: use as an air refueler, use as a cargo/passenger carrier, and use on special missions, such as search-and-rescue and aerial delivery. The mission requirements will, of necessity, dictate the planning considerations. Survival equipment for crew and passengers must be compatible with the mission to be flown.

Note

Mission requirements permitting, the escape ladder leading to the center overhead cargo compartment escape hatch will be installed when passengers are embarked.

7.2 WEIGHT AND BALANCE

It is the pilot in commmand's responsibility to ascertain that the takeoff and anticipated landing gross weights have been determined and that center of gravity limits are not exceeded. Refer to Handbook of Weight and Balance, NA 01-1B-40, and Chapter 4 of this manual for information on weight limitations. Make certain that the weight and balance clearance (Form F) is complete.

Note

Accurate cargo weights must be obtained prior to the loading of the aircraft and the computation of Weight and Balance Clearance Form. Accurate passenger and baggage weights should be obtained whenever possible. If accurate passenger and baggage weights cannot be obtained, the estimated passenger weight of 200 pounds per person and baggage weight of 70 pounds per person should be utilized.

7.3 FLIGHT PLANNING PROCEDURES

Determine the type of flight and whether long-range or high-speed cruise is dictated by the mission requirements.

7.3.1 Long-Range Cruise (Utilizing Constantly Decreasing Torque with Decrease in Weight)

1. To establish long-range cruise, set fuel flow and cross-check torque from the operating chart for the particular flight gross weight and altitude. For nonstandard temperature conditions, hold constant the standard day fuel flow. Torque and IAS will remain approximately the same.

2. For constant-altitude operation, decrease power settings for each 5,000 pounds of fuel burnoff. Establish power settings at a gross weight 2,500 pounds higher than the weight shown in the operating chart. For example, the settings for 105,000-pound gross weight would be used from 107,500 pounds down to 102,500 pounds, thus averaging the speed, torque, and fuel flow values given. Airspeed initially will be slightly below and will gradually increase to slightly above the value shown.

7.3.2 Long-Range Cruise (Utilizing Constant True Airspeed). To establish cruise at a constant true airspeed, maintain climb power on the aircraft until the desired indicated airspeed is obtained. Reduce torque for the remainder of the flight to maintain this true airspeed as the aircraft becomes lighter in weight.

7.3.3 High-Speed Cruise. Fly maximum continuous TIT for all gross weights, attitudes, and outside air temperatures. Power settings for standard temperature and correction factors for non-standard temperature are given in the operating chart.

CAUTION

Do not exceed maximum level-flight speed.

Note

- Engine sulfidation occurs when engines are run at high temperatures for long periods of time. Operating engines at less than maximum conditions will greatly extend turbine life.

- The use of maximum-range operating tables extends turbine life as long as an appropriate altitude is selected for initial cruise.

7.3.4 Maximum Endurance. When maximum endurance is required, use power settings to maintain the airspeed from the performance charts for the gross weight and the flight altitude.

7.4 FACTORS AFFECTING RANGE

7.4.1 Effect of Altitude on Range. Since engine-specific fuel consumption improves with increasing altitude, maximum range is obtained by four-engine cruise-climb operation. Cruise-climb operation provides greater range than can be obtained by flying at a constant altitude or with partial power operation (three or two engines) at a lower altitude. One exception is under conditions of high wind shear, when operation at a lower altitude may provide greater ground miles per pound of fuel. Also, some missions may be restricted below optimum range altitude because of traffic control, passengers, oxygen, or pressurization considerations. The determination of optimum cruise altitude for maximum-range capability requires a comparison of the actual ground miles per pound of fuel for the existing wind/altitude conditions under consideration.

7.4.2 Effect of Nonstandard Temperature on Range

1. For long-range cruise, utilizing the performance charts, fly constant standard-day fuel flow. Range will increase 2 percent for each 10 °C above standard temperature, and decrease 2 percent for each 10 °C below standard temperature.

2. For high-speed cruise, fly constant maximum-cruise power. Range will increase 5 percent for each 10 °C above standard temperature, and decrease 5 percent for each 10 °C below standard.

3. The performance charts provide correction factors for temperature effects.

7.4.3 Effect of Wind on Range. The specific range charts are predicted on a zero-wind condition, so that long-range cruise may be defined as that airspeed that gives 99 percent of maximum range in still air. To maintain 99-percent long-range cruise, as headwind is encountered, airspeed should be increased 1.5 percent for each 10 knots of headwind. However, in practice, this factor can be neglected with conservatism.

7.4.4 Effect of Gross Weight on Range. For constant-altitude operation, specific range increases with decreasing gross weights. Since maximum range is achieved by decreasing power settings and indicated airspeed with decreasing gross weights, it is recommended that a new power setting be established for each 5,000 pounds of fuel burnoff if utilizing the performance charts.

7.4.5 Effect of Partial-Power Cruise on Range. Maximum range is obtained by four-engine operation at optimum cruise altitude. At altitudes below the optimum cruise altitude for any gross weight, specific range may be increased by partial-power cruise, three- or two-engine operation. At lower altitudes (25,000 feet and below) range can possibly be extended by three- or two-engine operation; however, this consideration should be carefully planned, as any improvement in specific range is a function of gross weight, altitude, and headwind component. A false sense of fuel saving could easily result in a loss of range.

7.4.6 Effect of Icing on Range. Since the aircraft pressurization and wing and empennage anti-icing is accomplished with hot-air bleed from the engine compressor, a power loss occurs when these systems are used. The pressurization power loss is small, but the anti-icing power loss, under severe conditions, can result in losses up to 25 to 30 percent. Normally, the aircraft will cruise at altitudes at which most icing weather can be overflown. However, if operation is at an altitude where continuous icing is encountered, the effect on cruising is considerable. Maximum anti-icing has the following effects on cruise control:

1. True airspeed is decreased 20 percent.
2. Fuel flow is decreased 6 percent.
3. Range is decreased 16 percent.

7.4.7 Effect of Fuel Temperature on Range. Maximum range is affected by fuel temperature variation because of the change in fuel density, pounds per gallon. For example, 1 gallon of JP-4 fuel at a temperature of 30 °F weighs 6.65 pounds, whereas 1 gallon of JP-4 fuel at a temperature of 80 °F weighs 6.34 pounds.

7.4.8 Effects of Alternate Fuel On Range. Alternate fuels, because of their density, also vary range capabilities. For example, at 60 °F without the fuselage tank, the aircraft has a maximum single-point refueling capacity of 9,316 gallons of any fuel, which equates to 63,349 pounds of JP-5 but only 53,567 pounds of 115/145 aviation gasoline for aircraft with pods. See Figures 4-3 and 4-4 for alternate fuel preference and weight per gallon.

CAUTION

Do not refuel the aircraft to its volume capacity with JP-5/JP-8 (standard-day density of 6.79 ppg), since the maximum permissible fuel weight will be exceeded.

7.4.9 Effect of Increased Headwind Versus Higher Altitude. For planning purposes, when maximum range becomes a consideration and the specific range performance charts are utilized, an increase of more than 5 knots of headwind component for each additional 1,000 feet of altitude climbed will result in a reduction of maximum range.

7.5 FUEL REQUIREMENTS

Careful analysis of fuel requirements must be made for all flights. In addition to the fuel requirements set forth by the current OPNAV Instruction 3710.7 and other controlling instructions, it is recommended that the fuel requirements be in accordance with the following:

1. Average fuel for taxi and runup prior to takeoff is 1,000 pounds. For taxi without runup, the average fuel requirement is 500 pounds.
2. Sufficient fuel to fly from takeoff point to preplanned altitude over destination and thence to alternate, if one is required, plus 10 percent.
3. Approach fuel of 1,000 pounds.
4. Holding fuel of 1,034 pounds (20 minutes of fuel at 10,000 feet maximum endurance, four engines operating).
5. On overwater flights where no alternate is available, item 4 (holding fuel) will be increased to 2 hours at maximum endurance, four engines operating, at 20,000 feet. Determine fuel from the maximum endurance performance charts using the anticipated gross weight of the aircraft upon arrival at the holding fix.

7.6 ADDITIONAL OVERWATER REQUIREMENTS

On all overwater flights, time to ETP will be figured at flight-plan cruise altitude and 10,000 feet, on four engines, and entered in the remarks section of the DD175. ETP is defined as the point (either in distance or time) at which the aircraft will be required to spend the same amount of time continuing to destination or returning to its departure point. Since it is obvious that depressurization is possible and descent to a lower altitude may be mandatory, the distance for ETP should be computed at 10,000 feet of altitude. A TAS for ETP distance computations of 245 knots is recommended, as this is the average TAS at 10,000 feet on four engines, long-range cruise.

WARNING

The first reading after departure may fall above the maximum curve. This may be caused by additional amounts of fuel used in an unexpected departure climb or by stronger winds than were forecast for the first hour. The maximum curve line is based on actual takeoff fuel. The actual-fuel-used curve should fall below the maximum curve prior to reaching ETP. If the actual-consumption curve falls above the maximum-consumption curve two consecutive times prior to ETP, a return to the departure point or a change of destination shall be accomplished.

PSR will be figured for the directed mission profile(s). Generally PSR is a decision point along the planned route of flight where a divert destination is achievable with the minimum required fuel reserve. PSR is based on actual takeoff fuel.

7.7 FORMS

Standard navigational forms will be utilized on all flights. Flight clearance will normally be filed on military form (DD175) but may be on the Federal Aviation Agency form USAFE Form 249 or on the International Civil Aviation Organization form, as required. On overwater flights, the pilot should use standardized local/Navy flight plans and range control logs.

CHAPTER 8

Inspections, Checklists, and Procedures

8.1 PREPARATION FOR FLIGHT

8.1.1 Aircraft Status Check. All crewmembers shall review previous discrepancies to ensure that the aircraft is safe for flight. The flight engineer will ensure that the aircraft has been serviced with the required amount of fuel, oil, and oxygen for the assigned mission. It is the responsibility of the aircraft commander to ensure that the inspections required by NAVAIR 01-75GAA-6-1 are completed. The aircrew inspections are based on the assumption that these inspections have been completed. Therefore, duplicate inspections and system checks have been eliminated, except for items required in the interest of safety.

8.1.2 Checklists. The aircraft commander is responsible for ensuring that all preflight checks are accomplished. The actual accomplishment may be delegated as required. Starting with the Before Start Checklist, the remaining checklists through the Secure Checklist in this section are of the challenge and response type. Only circled (○) items need to be checked when taxiing back for takeoff after landing with all engines operating and crewmembers remaining at their crew positions. The copilot reads the item in the checklist aloud as a challenge, and the response listed is given by the crewmember indicated. When more than one crewmember has the same response to the same item, each crewmember subsequent to the initial crewmember responding need respond only with the crew position. Before answering the challenge that indicates a complete control panel, the responsible crewmember will check that all switches and controls on the panel are in the positions indicated in the response. When the response is listed "as required," the crewmember will respond by stating the present operating status of the system. The codes: P, CP, FE, LM, and 2LM stand for pilot, copilot, flight engineer, loadmaster, and second loadmaster, respectively.

8.1.2.1 Through-Flight Operations. When the aircraft is flown on the same mission and no maintenance or servicing is required, it is unnecessary for the preflight checks to be performed after the first flight of the day. When maintenance or servicing is required, only those items or systems affected need be checked prior to the next flight. The checklists have been designed so that, for through-flight operation, the crew may begin with the Before Start Checklist to assure a safe flight.

8.2 AIRCRAFT PREFLIGHT

8.2.1 Prior to Entrance Inspection

1. Prior to commencing the preflight checks, the flight engineer will check:

   a. Aircraft discrepancy book — Reviewed.

   b. Chocks — In Place.

   c. Ground wire — Attached.

   d. Portable fire bottle — In Place.

   e. Nose landing gear pin — Installed.

   f. External power unit — As Required.

   g. Plugs and covers — Removed/Stowed.

   h. Intakes and exhausts — Checked.

   Note

   A workstand or ladder will be required to accomplish the check of the engine intakes, exhaust areas, aircraft fire bottles, external fuel tank levels, and auxiliary fuel tank magnetic sight gauges.

   i. Aircraft fire bottles — Checked.

j. APU oil level — Checked.

k. Auxiliary/external fuel quantity — Checked/Noted.

l. Battery — Connected.

CAUTION

Ensure the dc power switch is in the OFF position prior to connecting the battery.

8.2.2 Prior to External Power Application

1. Cargo compartment

 a. Nose landing gear emergency extension valve — Normal/Shearwired.

 b. Utility hydraulic reservoir condition, fluid level, accumulator pressure — Checked.

 c. Left main landing gear and flap emergency engaging handles — Disengaged.

 d. Ramp and cargo door controls — 6N/Neutral.

 e. Auxiliary hydraulic reservoir condition, fluid level — Checked.

 f. Bleed-air divider valve — Checked.

 g. Booster hydraulic reservoir condition, fluid level, accumulator pressure — Checked.

 h. Oxygen manual shutoff valve — ON/Shearwired.

2. Flight station

 a. Landing gear lever — DOWN.

 b. Hydraulic control panel — Checked.

  (1) Engine-driven pump switches — ON.

  (2) SUCTION BOOST PUMP switches — OFF.

  (3) Auxiliary pump switch — OFF.

  (4) ANTI-SKID switch — OFF.

  (5) BRAKE SELECT switch — EMERGENCY.

 c. Copilot side circuit breakers — In/Set.

WARNING

Circuit breakers pulled by maintenance and flightcrew personnel shall be clamped and not reset until the proper repairs have been made. Circuit breakers that are tripped and not clamped shall be investigated.

 d. Copilot alarm bell — Checked.

 e. Navigator station — Checked.

  (1) Radar switch — OFF.

  (2) Antenna stab — ON.

  (3) IFF interrogator — OFF.

  (4) INS/GPS — OFF.

  (5) Radar scope — OFF.

  (6) Electrical spares — Checked.

  (7) Navigator oxygen regulator — OFF.

 f. Crew bunk oxygen regulators (two) — OFF.

 g. Upper main distribution panel — Checked.

 h. Liferaft release handles — In/Shearwired.

 i. Emergency exit light — Checked/Armed.

 j. Escape rope — Checked.

 k. PRC-90 radios (five) — Stowed/Secure.

 l. First-aid kits (two) — Checked.

 m. Fire extinguisher — Checked.

 n. Restraint harness — Checked/Fitted.

 o. Auxiliary fuel control panel — Checked.

  (1) Pod lights — OFF.

  (2) SPR drain switch — OFF.

(3) DUMP MAST switches — OFF/ Shearwired.

(4) Interconnect valves — Closed.

(5) All remaining switches — OFF/Normal/ Closed.

p. Air-conditioning/pressurization control panel — Set.

(1) AIR CONDITIONING master switch — OFF.

(2) Flow control shutoff switches — Normal.

(3) Temperature controls — Fixed.

(4) Underfloor heat/recirculation fan switches — OFF.

(5) EMERGENCY DEPRESSURIZATION switch — Normal.

q. Auxiliary power unit panel — Set.

(1) BLEED AIR VALVE — Closed.

(2) APU CONTROL switch — STOP.

r. Anti-ice/deice control panel — Checked.

(1) NESA switches — OFF.

(2) PITOT HEAT switches — OFF.

(3) PROP & ENGINE ANTI-ICE MASTER switch — AUTO.

(4) Engine inlet anti-ice switches — OFF.

(5) PROPELLER ICE CONTROL switches — OFF.

(6) WING and EMPENNAGE ANTI-ICING switches — OFF.

(7) ENGINE BLEED AIR switches — OFF.

(8) BLEED AIR DIVIDER VALVE switch — Normal.

s. Electrical panel — Checked.

(1) Generator switches — OFF.

(2) Generator disconnect — OFF, Shearwired.

(3) BUS switches — As Required.

(4) External power switch — OFF.

(5) Inverter switches — OFF.

(6) Ac BUS TIE switch — OFF.

(7) BATTERY switch — OFF.

(8) Dc BUS TIE switch — NORMAL.

t. Fuel panel — Set.

(1) Dump pump switches — OFF.

(2) BOOST PUMP switches — OFF.

(3) CROSSFEED VALVE switches — CLOSED.

u. Fire emergency control panel — Checked.

(1) Fire control handles — In.

(2) AGENT DISCHARGE switch — OFF.

v. Fuel enrichment switches — OFF.

w. Control boost switches — ON/Shearwired.

x. OIL COOLER FLAP switches — Fixed.

y. Flight control pedestal — Checked.

(1) All radios — OFF.

(2) INS/GPS — OFF.

(3) Throttles — GROUND IDLE.

(4) Condition levers — GROUND STOP.

(5) SYNCHROPHASE MASTER switch — OFF.

(6) PROP RESYNCHROPHASE switch — NORMAL, Shearwired.

(7) TEMP DATUM CONTROL VALVE switches — NULL.

z. Pilot side circuit breakers — In/Set.

WARNING

Circuit breakers that are pulled by maintenance and flightcrew personnel shall be clamped and not reset until the proper repairs have been made. Circuit breakers that are tripped and not clamped shall be investigated.

aa. Pilot alarm bell — Checked.

ab. Electrical surge suppressor — Checked.

8.2.3 External Power Application

1. Dc voltmeter — Battery/Check Volts.
2. Dc power switch — BATTERY.
   a. All bus off lights illuminate.
3. Dc BUS TIE switch — Tied/Ground.
   a. Top row of bus off lights extinguish.
4. Dc Power switch — OFF.
   a. Emergency exit lights — Illuminated.
   b. Emergency exit light extinguish switch — Depress.
   c. Emergency exit lights — Extinguished.

Note

The bulbs of the emergency exit lights receive power from batteries contained within the lights. The check for bulb illumination should be accomplished as quickly as possible to conserve the batteries.

5. Dc power switch — BATTERY.
6. External power volts and frequency — Checked.
7. External power switch — ON.

Note

- Before placing the external power switch to ON, check voltage and frequency within limits and illumination of the external power light.
- If external power is not available, the APU may be used for ac power-on checks. A radio check and a fire warning system test shall be performed prior to starting the APU.

8. Inverter switches — STANDBY/ESS DC.
   a. Check the copilot inverter through the phase A, and the ac instrument and engine fuel control inverter through the phase C on the phase selector switch and the voltage and frequency selector switch.

CAUTION

Ensure that both attitude select switches are in GYRO, prior to switching the copilot inverter to STANDBY.

Note

The power-on portion of this preflight shall be started from the copilot position.

9. Inverter switches — ESS AC/ESS AV BUS.

8.2.4 Interior Inspection (Flight Station)

1. No. 1 INS alignment — Enter/Align.
2. GPS — ON.

Note

CDNU1 receives electrical power from the isolated dc bus and shall be turned on first to ensure that it serves as the bus controller in the event of power loss or fluctuations to the essential dc bus.

3. Emergency NLG release handle — Checked/Shearwired.

4. Engine instrument panel — Checked.

   a. Oil cooler augmentation lights — Checked.

   b. Master ENG/PROP LOW OIL lights — Checked.

5. Copilot instrument panel — Checked.

   a. Nacelle overheat lights — Test, Press.

   b. Landing gear lever — Down, Indicating, Light Test.

   c. Clock — Wind/Set.

   d. Liquid oxygen quantity — Noted.

   e. Liquid oxygen quantity low light — Test.

6. Hydraulic control panel — Set.

   a. BRAKE SELECT switch — EMERGENCY.

   b. Auxiliary hydraulic pump switch — OFF.

   c. ANTI-SKID switch — OFF.

   d. Engine-driven pump switches — ON, Lights ON.

   e. SUCTION BOOST PUMP switches — ON, Lights OFF.

   f. SUCTION BOOST PUMP switches — OFF, Lights ON.

7. Copilot side panel — Checked.

   a. No. 2 UHF radio — ON, Tuned.

   b. No. 2 Tacan — ON.

   c. Copilot portable oxygen bottle — Serviced/ Secured.

   d. WINDSHIELD WIPER CONTROL — OFF.

   e. Alarm bell and jump lights — Checked/OFF.

   f. FEATHER VALVE AND NTS CHECK switch — VALVE, Lights Checked.

   g. PROPELLER LOW OIL WARNING lights — Checked.

   h. PROPELLER GOVERNOR CONTROL — As Required.

   i. Instrument lights — As Required.

8. Tachometer test switch — OFF.

9. Bleed-air manifold gauge — Zero Pressure.

10. Electrical spares — Checked.

11. Navigator station — Checked.

    a. Radar display control switch — RDR/NAV.

    b. Oxygen — NORMAL, 100%, OFF.

    c. No. 1 and No. 2 C-12 compass controllers — Correct LAT, MAG/DG, Slewed.

12. No. 2 INS alignment — Enter/Align.

13. No. 3 INS alignment (if installed) — Enter/Align.

14. Crew bench oxygen (two) — NORMAL, 100%, OFF.

15. Safety equipment — Checked.

    a. Liferaft release handles — In, Shearwired.

    b. Escape rope — Checked.

    c. Emergency exit light — Checked, Arm.

    d. PRC-90s — Stowage, Security.

    e. First-aid kits — Checked.

    f. Fire extinguisher — Checked.

    g. Crew door jettison handle — In, Shearwired.

    h. Restraining harness — Checked, Fitted.

WARNING

Ensure harness is fitted to allow the Flight Engineer to physically inspect the crew entrance door without falling from the aircraft.

16. Flight engineer oxygen — Checked.

Note

Refer to paragraph 8.4 item 16 in this chapter for inspection/testing of oxygen regulator.

17. Fuel governor check switches — Safetywired.

18. Oil cooler augmentation — OFF.

19. Pressurization test valves — Open/Safetywired.

20. Emergency depressurization handle — In/Shearwired.

21. Pilot side panel — Checked.

    a. Instrument lights — As Required.

    b. Alarm bell and jump lights — Checked, OFF.

    c. Portable oxygen bottle — Serviced/Secured.

22. Nosewheel steering — Centered.

23. Pilot instrument panel — Checked.

    a. Door-open light — Checked.

    b. Clock — Wind/Set.

    c. Electronic fuel correction lights — Checked.

    d. Marker beacon lights — Checked.

    e. Compass display — As Required.

24. Ground proximity warning system test — Completed.

    a. CARA — ON.

    b. Flap override switch — NORMAL.

    c. Flap lever — Up.

    d. PULL UP/test switch/light — Depressed.

Note

A good GPWS test is indicated by the "GLIDESLOPE" message once, followed by "WHOOP WHOOP, PULL UP" three or four times. The GPWS INOP light and BELOW G/S lights turn on, and the PULL UP light flashes. The lights extinguish when the PULL UP/test switch/light is released.

    e. PULL UP/test switch/light — Released.

    f. CARA — OFF.

25. TCAS/IFF self test — Completed (aircraft modified by AFC-374).

    a. CARA — ON and functioning.

    b. TCAS/IFF Control Panel Master Switch — OFF.

    c. Mode 1/2 SEL — 1 + 2.

    d. Mode Select and TCAS Enable Switch — TA/RA.

    e. Mode 4 — ON/OFF (as desired).

    f. Display Select Switch — STAT.

    g. TCAS/IFF Control Panel Master Switch — STBY.

    h. Depress TEST switch:

        (1) All LCD segments, GO, NOGO, REPLY annunciators and IFF CAUTION light illuminate while the TEST pushbutton is depressed.

        (2) "TCAS TEST" audio shall be heard from the cockpit speaker.

        (3) TCAS TEST display shall be present on the pilot's and copilot's VSI/TRA displays.

        (4) GO annunciator is illuminated and CP PASS should be displayed for 5 seconds.

        (5) "TCAS PASS" should be heard from the cockpit speaker.

    i. CARA — OFF.

    j. TCAS/IFF Control Panel Master Switch — OFF.

26. Air-conditioning control panel — Set.

    a. Shutoff switches — NORMAL.

    b. Master switch — OFF.

c. Flight station airflow switch — NORMAL.

d. Underfloor heat switch — OFF.

e. Fan switch — OFF.

f. EMERGENCY DEPRESSURIZATION switch — NORMAL/Shearwired.

27. APU control panel — Set.

a. APU CONTROL switch — RUN.

b. APU BLEED AIR VALVE switch — CLOSE.

c. APU lights — Checked.

28. Anti-icing and deicing control panel — Checked.

a. NESA windshields — Checked, OFF.

CAUTION

Do not check NESA when OAT is above 27 °C (81 °F).

29. Overhead electrical control panel — Set.

a. Generator indicating lights — Checked.

b. Generator disconnect — Test.

c. Loadmeters — Checked.

30. Fuel quantity and distribution — Checked.

a. Fuel quantity gauges — Checked.

b. Fuel distribution — Checked, Within Limits.

WARNING

Failure of the indicator to test is indicative of a malfunction in the fuel quantity system. If maintenance is not completed prior to flight, the circuit breaker for that indicator shall be pulled and clamped.

Note

Refer to Chapter 2 for fuel quantity error codes.

31. Fuel control panel — Checked.

a. Low pressure lights — Checked.

b. TANK EMPTY lights — Checked.

c. Bypass open lights — Checked.

d. Fuel boost pump and crossfeed valve operation — Checked.

(1) Open all CROSSFEED VALVE switches, except for the crossfeed separation valve.

(2) Turn the No. 1 boost pump on; the No. 1 and 2 low-pressure warning lights should extinguish. The No. 3 and 4 lights should remain illuminated. No pressure should be indicated on the manifold pressure indicator.

(3) Open the crossfeed separation valve. Check that the No. 1 boost pump pressure is within limits and that the No. 3 and 4 low-pressure warning lights extinguish.

(4) Close the No. 1 crossfeed valve. Deplete manifold pressure by pressing the primer button. Turn the No. 1 boost pump off.

(5) Turn the No. 2 boost pump on. Check that the pressure is within limits. Close the crossfeed valve and deplete the pressure. Turn the No. 2 boost pump off.

(6) Turn the left auxiliary pump on. Check the pressure limits. Close the crossfeed valve.

(7) Open the left bypass valve. Check for an indication that the valve opened. Close the bypass valve and deplete the pressure. Turn the left auxiliary pump off.

(8) Turn the left external forward pump on. Check that the pressure is within limits. Turn the left external forward pump off and deplete the pressure.

(9) Turn the left external aft pump on. Check that the pressure is within limits. Close the crossfeed valve and deplete the pressure. Turn the left external aft pump off.

(10) Turn the right external forward pump on. Check that the pressure is within limits. Turn the right external forward pump off and deplete the pressure.

(11) Turn the right external aft pump on. Check that the pressure is within limits. Close the crossfeed valve and deplete the pressure.

(12) Open the right bypass valve. Check for an indication that the valve opened. Close the bypass valve and deplete the pressure. Turn the right external aft pump off.

(13) Turn the right auxiliary pump on. Check that the pressure is within limits. Close the crossfeed valve and deplete the pressure. Turn the right auxiliary pump off.

(14) Turn the No. 3 boost pump on. Check that the pressure is within limits. Close the crossfeed valve and deplete the pressure. Turn the No. 3 boost pump off.

(15) Turn the No. 4 boost pump on. Check that the pressure is within limits. Press and hold the primer button for 30 seconds to allow any trapped air to be forced out of the manifold. Close the crossfeed valve and deplete the pressure. Turn the No. 4 boost pump off.

(16) Close the crossfeed separation valve.

32. Bleed Air Duct Overheat Detection System Panel — Checked.

a. Place the NORMAL/TEST switch on the ODS panel to the TEST position. Eleven indicator lights should illuminate and the warning horn should sound in a pulsing mode.

b. While the NORMAL/TEST switch is in the TEST position, momentarily depress the HORN SILENCE switch. The horn should silence and the indicator lights remain illuminated.

c. Release the NORMAL/TEST switch and ensure all eleven indicator lights are extinguished.

33. Fire emergency control panel — Checked.

a. Warning system test — Checked.

b. Turbine overheat — Test.

c. Engine fire — Test.

34. Engine starting control panel — Checked.

a. Secondary fuel pump pressure lights — Checked.

b. Start valve open lights — Checked.

35. Ice detection panel — Checked.

a. ON light — Checked.

b. NO ICE light — Checked.

36. Control boost shutoff switch panel — Checked.

a. Booster off lights — Checked.

37. Oil cooler flap control panel — Checked.

a. Oil cooler flap operation — Checked.

(1) Check oil coolers in AUTO and MANUAL control and then open the oil cooler flaps fully and return the switch to FIXED.

38. Flight control pedestal — Checked.

a. Radios — As Required.

WARNING

Ensure the top of the aircraft is clear and fueling/defueling operations are terminated prior to the operation of either HF radio.

b. Flap control handle — Set to Match Indicator.

c. ADS control panel — Checked.

(1) Ramp and door control switch — OFF.

(2) Ramp and door open light — Checked.

d. IFF system control panel — OFF, Press to Test Lights.

e. ATO control panel — Safe.

39. Coordinated checks (LM/2LM required) — Complete.

Note

The following checks will be performed from the pilot position.

a. Exterior lights — Checked/Set.

(1) Landing lights — Extended, ON, Checked, OFF.

(2) Taxi lights — Checked.

(3) Strobe lights — Checked.

(a) Check both top and bottom lights for RED and WHITE.

(4) Leading edge lights — Checked.

(5) Position lights — Checked (DIM and BRIGHT).

(a) Wingtip — STEADY, FLASH.

(b) Tail — STEADY, FLASH.

(6) PITOT HEAT switches — ON, Checked, OFF.

CAUTION

Do not allow the pitot heat to remain on for more than 30 seconds on the ground.

(7) BATTERY switch — ON.

(8) Dc BUS TIE switch — TIED.

(9) Radio check — Complete.

(a) Use either VHF 1 or UHF 1.

(10) APU clear and fireguard posted — Clear and Posted.

(11) Start APU — Started.

Note

When the APU is on speed, continue with steps (12) and (13).

(12) Bleed-air system — Checked.

(a) Make sure that the bleed-air circuit breakers on the copilot side circuit breaker panel are closed.

(b) Place the ENGINE BLEED AIR switches to OVRD and turn off all systems that use bleed air.

(c) Open the APU bleed-air valve.

(d) Check the system pressure for a minimum reading of 35 psi. Failure to reach this pressure indicates that some valve in the system has not closed, that a duct is leaking, or that the compressor output is low.

(e) Close the APU bleed-air valve.

(f) As pressure in the system drops, time the drop from 30 to 15 psi. This time should not be less than 16 seconds.

Use the following steps to check out the bleed air system with air supplied by an engine.

(a) Place the ENGINE BLEED AIR switches to OFF and turn off all systems that use bleed air.

(b) Place the bleed-air switch for one operating engine and all engines not operating to OVRD.

(c) When the system pressure reaches 70 psi or higher, place the bleed-air switch of the operating engine to OFF. Pressure should begin to drop almost immediately. If pressure does not drop, the engine bleed air has failed to shut off.

(d) The time required for the pressure to drop from 65 to 35 psi should not be less than 30 seconds.

(13) APU generator — Checked, OFF (if not required).

(14) APU shutdown — Complete.

(a) Bleed-air valve — Close.

(b) APU switch — STOP.

(15) Hydraulic control panel — Set.

(a) Auxiliary pump — OFF.

(b) Suction boost pumps — OFF.

(c) Pressures — Depleted.

(16) Ground test valve — Tied.

(17) Ramp and cargo door controls — 6N, NEUTRAL.

(18) Flap control handle — Set to Match Indicator.

(19) Auxiliary hydraulic pump — ON.

(20) Flaps — Clear, DOWN, 100%.

(21) Flight controls and trim tabs — Checked.

(a) Movement and proper direction — Free, Checked.

(b) Elevator, aileron, and rudder trim tabs — Checked.

(c) Ensure proper operation and direction.

Note

Elevator trim tabs shall be operated in both normal and emergency positions.

(22) FCS 105 flight control system check — Completed.

(a) FCS 105 annunciator lights control panel — Test, BRIGHT.

(b) ADI test button — Depressed.

Note

ADI should indicate 10° ± 3° pitchup and 20° ± 5° right bank. The gyro flag will also appear.

(c) Heading — Selected.

(d) Heading and course knobs — Rotate.

(e) Autopilot and yaw damper — Engaged.

(f) Go-around button and pitch sync — Depress.

Note

When the go-around button is depressed, the command bars in the ADI should indicate approximately 7° pitchup attitude and the autopilot/yaw damper will disengage. When the pitch sync button is depressed, the command bars should go out of view.

(g) Autopilot and yaw damper — Engaged.

(h) Trim monitor test — Tested.

(i) Autopilot — Engaged.

(j) Pull back on the control column. After a delay (2.7 seconds), the elevator trim light illuminates. Press the trim monitor test switch. The trim fail annunciator flashes at 1-second intervals and elevator trim drives the nose up at 1-second intervals. Release the test switch, and the indications return to normal.

(k) Autopilot disengage switch — Depressed.

Note

Repeat steps (22)(g) through (22)(k) for the copilot side.

(23) Auxiliary hydraulic pump — OFF.

(24) BRAKE SELECT switch — NORMAL, Deplete Pressure.

(25) BRAKE SELECT switch — EMERGENCY, Deplete Pressure.

(26) Hydraulic system pressures — Depleted.

(27) Ground test valve — Untied, Pinned, Panel Secured.

(28) Air deflector doors — Checked (if required).

(29) Propeller feather checks — Complete.

CAUTION

Do not statically change the blade angle of a propeller that has been exposed to prolonged temperatures of 0 °C (32 °F) or below. Warm the propeller hub fluid using warm air or by running the engine at ground idle until the engine oil temperature is within 60 to 80 °C. Propeller blade seal damage and fluid leakage may occur if this is not observed. During cold-weather operations, perform this check during the postflight.

(a) FEATHER VALVE & NTS CHECK switch — VALVE.

(b) #1 Throttle — MAXIMUM REVERSE.

(c) #1 Condition lever — AIRSTART.

Blade angle shall move toward MAXIMUM REVERSE.

Note

Cycling time must not exceed 23 seconds. Begin timing of feathering cycle when condition lever is moved to “FEATHER position.” The feather override button shall pull in while blades are moving toward feather position. The valve light must be illuminated during the entire feather cycle, but may not remain illuminated after completion of the feather cycle.

(d) #1 Condition lever — FEATHER.

Blade angle shall move to FEATHER position and the feather override button shall pop out.

(e) #1 Throttle — GROUND IDLE.

(f) #1 Condition lever — AIRSTART.

Blade angle shall move to ground idle with a slight hesitation at flight idle.

(g) #1 Throttle — Full travel and unrestricted movement.

(h) Repeat steps (a) through (g) for propellers 2, 3, and 4.

WARNING

If hesitation is not observed, a malfunction exists in the mechanical low pitch stops which could allow the propeller to enter the ground range during flight. Maintenance action shall be completed prior to flight.

(30) Loadmaster/Second loadmaster — Released.

(31) All unnecessary equipment — OFF/As required.

(a) Inverters — OFF/As required.

(b) Dc power switch — OFF/As required.

(c) Dc BUS TIE switch — Untied/As required.

(d) Radios — OFF/As required.

8.2.5 Interior Inspection (Cargo Compartment). Paragraphs 8.2.5.1 through 8.2.5.4 shall be completed by the loadmaster and/or the second loadmaster. Flight engineers shall be familiar with this inspection.

8.2.5.1 Crew Entrance Area

1. Crew entrance door warning light, master door warning light shutoff switch — Checked.

WARNING

Visually check the hooks on the crew entrance door to see that they engage the eyebolts.

2. Crew entrance door latch mechanism — Checked.
3. Galley
   a. Galley power — OFF.
   b. Provisions — Checked.
4. Radio and electrical equipment racks — Checked.
5. Emergency equipment
   a. Lifevest — Checked.
   b. Fire extinguisher — Checked.
   c. First-aid kits — Checked.
   d. Emergency exit lights — Arm.

8.2.5.2 Left-Side Cargo Compartment

1. ICS panel/cord, lighting controls, and PA system — Checked.
2. Nose landing gear emergency extension valve — NORMAL, Shearwired.
3. First-aid kits (seven) — Checked.
4. Emergency exit light — Arm.
5. Side emergency exit and windows — Checked.
6. Cargo compartment temperature sensor — Checked.
7. Main landing gear emergency extension wrench and handcrank — Checked.
8. Utility hydraulic system
   a. General condition — Checked.
   b. Quantity — Checked.
   c. Accumulator pressure — Checked.
   d. Control and drain valves — Checked.
   e. Suction boost pump — Checked.
9. Left main landing gear and flap emergency engaging handles — In.

CAUTION

The main landing gear emergency engaging handles shall not be pulled while the aircraft is on the ground.

10. Manual flap drive — Pinned.
11. Left main landing gear inspection windows, pins, and bolts — Checked.
12. Flap drive motor, gearbox, aileron booster package and autopilot servo — Checked.
13. Fire extinguisher, first-aid kits (four) and restraining harness — Checked.

WARNING

Ensure harness is fitted to allow physical inspection of doors.

14. ICS panel/cord, aft fuselage junction box, light control switches, and circuit breakers — Checked.

CAUTION

Circuit breakers that are pulled by maintenance and flightcrew personnel shall be clamped and not reset until the proper repair has been made. Circuit breakers that are tripped and not clamped shall be investigated.

15. Oxygen regulator — NORM, 100 %, OFF.

Note

Refer to paragraph 8.4 item 16 in this chapter for inspection/testing of oxygen regulator.

16. Lower seat supports (four) and windows — Checked.

17. Left paratroop door, warning light, master door warning light shutoff switch — Checked.

18. Emergency exit light — Arm.

19. Static line retriever control handle and stowed PA cord — Checked.

WARNING

The static line retrievers shall not be used to winch cargo loads.

8.2.5.3 Cargo Ramp and Door Area

1. Ramp and cargo door manual control valves — 6N, NEUTRAL.

WARNING

During ground operation, clear the area of personnel and equipment prior to operation of the aft cargo door and ramp.

CAUTION

- The aft cargo door and ramp shall not be operated unless the anchor cable supports are in the stowed position.
- After closing the ramp, inspect all ramp locks to ensure they are properly engaged.
- When operating the ramp control, ensure the ramp control is rotated in a clockwise condition to prevent adverse lock sequence action.

2. Auxiliary hydraulic system reservoir, handpump, auxiliary hydraulic pump, and drain valves — Checked.

3. Fire extinguisher, hand ax, and cargo door manual uplock release handle — Checked.

4. Ten-thousand-pound chains (minimum 14), 10,000-pound devices (minimum 6) and cargo straps — Checked.

5. Left-side ramp locks, ADS arm and ramp telescoping arm — Checked.

WARNING

Prior to flight, ensure the ADS arms are connected.

6. Left-side anchor cable and anchor arm — Up/Stowed.

7. Emergency water bottles (five) — Checked.

8. Left-side cargo door locks — Checked.

9. Aft escape hatch, emergency escape rope — Checked.

10. Emergency exit light — Arm.

11. Pressurization safety valve — Checked.

12. Elevator booster package, rudder booster package, rudder diverter panels, and autopilot servos — Checked.

13. Bleed-air ducts, cargo door actuator, snubber, cargo door uplock (unlocked), and pendulum release system — Checked.

14. Cargo door stowage bins, auxiliary ground loading ramps, emergency tiedown fixtures, and engine oil (6 gallons)/hydraulic fluid (6 gallons) — Checked.

WARNING

Stowage of excessive equipment in the door may cause the door to come out of the uplock.

15. Right-side cargo door locks — Checked.

16. Right-side anchor cable and anchor arm — Up/Stowed.

17. Right-side ramp locks, ADS arm, and ramp telescoping arm — Checked.

WARNING

Prior to flight, ensure the ADS arms are connected.

18. Emergency water bottles (five) — Checked.

19. Twenty-five-thousand-pound tiedown chains (six), 25,000-pound connectors (two), 25,000 pound D-rings, and auxiliary truck loading ramps (two) — Checked.

20. Ramp support (milk stool), seat support ends, and crowbar/prybars — Checked/Stowed.

21. Toilet facilities — Checked.

22. Liferaft release handles — In, Shearwired.

8.2.5.4 Right-Side Cargo Compartment

1. Static line retriever control handle — Checked.

WARNING

The static line retrievers shall not be used to winch cargo loads.

2. Right paratroop door, cargo door, ramp warning lights, and master door warning light shutoff switches — Checked.

3. Emergency exit light — Arm.

4. First-aid kits (four), restraining harness, portable oxygen bottle, and filler port — Checked.

5. ICS panel/cord — Checked.

6. Oxygen regulator — NORM, 100 %, OFF.

Note

Refer to paragraph 8.4 item 16 in this chapter for inspection/testing of oxygen regulator.

7. Lower seat supports (four) and windows — Checked.

8. Overhead escape hatch, ladder (as required), depressurization hatch — Checked.

9. Emergency exit light — Arm.

10. Right main landing gear inspection windows, pins, and bolts — Checked.

11. Booster hydraulic system

    a. General condition — Checked.

    b. Quantity — Checked.

    c. Accumulator pressure — Checked.

    d. Control and drain valves — Checked.

    e. Suction boost pump — Checked.

12. Right main landing gear emergency engaging handles and handcrank — Checked.

CAUTION

The main landing gear emergency engaging handles shall not be pulled while the aircraft is on the ground.

13. Bleed-air divider valve — Open.

14. Single-point hydraulic servicing unit — Checked.

15. Side emergency exit and windows — Checked.

16. Emergency exit light — Arm.

17. Upper center seat supports (eight) — Checked.

18. First-aid kits (six) — Checked.

19. Oxygen regulators — NORM, 100%, OFF.

Note

Refer to paragraph 8.4 item 16 in this chapter for inspection/testing of oxygen regulator.

20. Oxygen manual shutoff valve — Open, Shearwired.

WARNING

When opening the oxygen shutoff valve after it has been turned to the OFF position, open slowly to the ON position. A sudden rush of pressurized oxygen into a depleted system could cause a fire and subsequent explosion.

21. Jackpads — Checked.

22. Portable oxygen bottle and filler port — Checked.

23. Center seat stanchions (eight) — Checked.

24. Static line retrievers, controls, and anchor arm controls — Checked.

25. Overhead electrical equipment racks — Checked.

26. A/A32H-4A cargo-handling system preflight checklist core bolts — Checked.

WARNING

All restraint rail sections must have all attachment bolts/washers installed and properly torqued. If attachment bolts/washers are loose or missing from the restraint rail sections, the aircraft will be restricted from flight in accordance with missing bolt criteria specified in NA 01-75GAA-9.

27. Cargo winch — Secured.

WARNING

Do not leave the winch unattended unless it is tied down. An unsecured winch will roll on the slightest incline.

28. Lifevests, parachutes, antiexposure suits — Checked.

8.2.6 Exterior Inspection

WARNING

- Conducting this inspection during high winds or other severe weather conditions can be dangerous. Under these circumstances, the aircraft commander may waive this inspection.

- Ensure that the APX 76 is off and that HF transmissions are not being conducted while the topside of the aircraft is being preflighted.

CAUTION

Use extreme care at all times to avoid scratching or denting the skin while walking on the fuselage.

8.2.6.1 Top of Aircraft. Conduct a walkaround inspection following the route shown in Figure 8-1.

Note

This inspection shall be started at the forward escape hatch.

1. Antennas — Checked for Security.
2. Dry bay areas — Checked.
   a. Fuel or hydraulic leaks.
   b. Fumes.
   c. Fire extinguisher control valves — Proper Operation.
3. Engine nacelles — Checked.
   a. Oil servicing access panels — Secured.
   b. Propeller servicing panels — Secured.
   c. Propellers — Checked for Damage to Blades and Deice Boots.
   d. Access panels for loose or missing fasteners.
4. Fuel tank quantity and caps — Checked, Secured.
5. Ailerons — Checked.
6. Flaps — Checked.
7. Liferaft access doors for security — Checked.
8. Empennage — Checked.
9. Elevators — Checked.
10. Rudder — Checked.

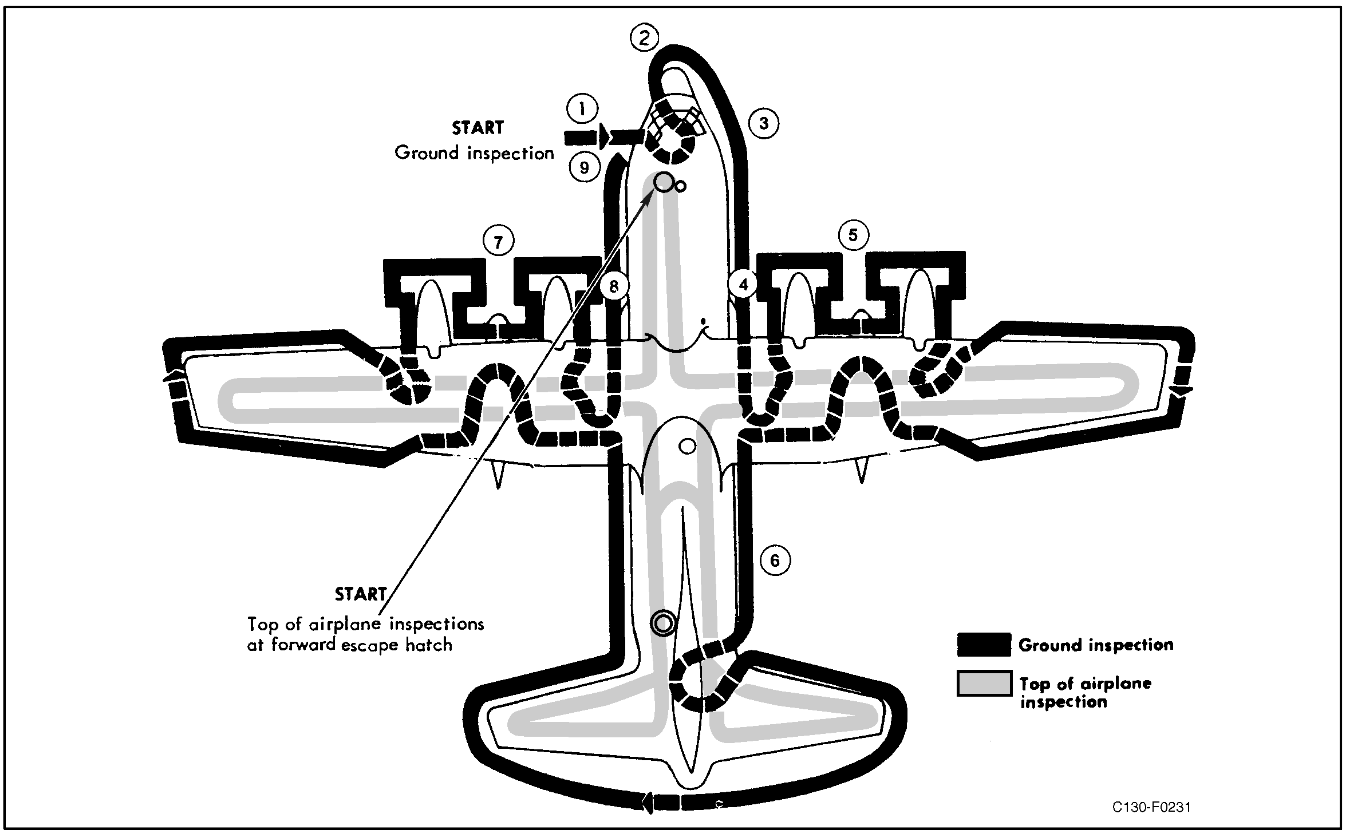


Figure 8-1. Inspection Diagram

11. Escape hatches — Checked.

    a. Security — Secured.

    b. Release handles — Clean and Free.

12. Top exterior lights — Checked.

13. Upper wing surface — Checked.

    a. Missing fasteners.

    b. Bare metal/corrosion.

    c. Leakage from fuel tank access panels.

8.2.6.2 Exterior of Aircraft Inspection. Conduct a walkaround inspection following the route shown in Figure 8-1.

1. Nose section — Checked.

    a. Crew entrance door — Checked for Security and ease of operation.

    b. Battery compartment.

WARNING

Do not operate the aircraft without a serviceable battery.

(1) Battery.

(2) Vent lines.

(3) Properly secured.

    c. Pitot tubes.

(1) Obstructions.

(2) Damage.

    d. Windshields.

(1) Delamination.

(2) Crazed and cracks.

    e. Radome.

2. Nose wheelwell — Checked.

Note

Always enter and exit on the left side.

    a. Nosegear assembly.

(1) Actuating cylinders.

(2) Scissors.

(3) Overall condition.

(4) Steering cables.

    b. Brake accumulators.

    c. Radome attaching bolts.

    d. Liquid oxygen converter — Check for Icing of Lines.

    e. Hydraulic lines — Check for Leakage.

    f. Landing gear doors.

3. Forward fuselage right side and bottom — Checked.

    a. Radome.

    b. Windshields.

(1) Delamination.

(2) Crazed and cracks.

    c. Pitot tubes.

(1) Obstructions.

(2) Damage.

    d. Liquid oxygen filler access panel.

    e. Flight deck air-conditioning.

(1) Intake and exhaust.

(2) Oil level.

    f. Static ports.

    g. Outflow valve exhaust.

h. Antennas.

i. Strobe light.

j. Exterior structure — General Condition.

4. Right wheelwell and center fuselage — Checked.

    a. Cargo compartment air-conditioning.

        (1) Intake and exhaust.

        (2) Oil level.

    b. Right main landing gear, wheelwell area.

        (1) Wheels, tires.

        (2) Struts, jackscrews.

        (3) Brakes, hydraulic lines.

        (4) Structure general condition.

    c. Single-point refueling panel.

        (1) Drain lines, vents.

        (2) Gauges, switches.

    d. Exterior structure — General Condition.

5. No. 3 and 4 engines, nacelles, propellers, right wing — Checked.

    a. Nacelle exterior structure — General Condition, Fluid Leaks.

    b. Propeller spinner and blades.

    c. Wing structure, aileron, trim tab.

    d. Flaps, flapwell.

    e. Engine exhaust areas.

    f. External fuel tank.

        (1) General condition, fuel leaks.

    g. Liferafts (visual scan).

6. Aft fuselage and empennage — Checked.

    a. Paratroop doors.

    b. Tailskid.

    c. Exterior structure.

    d. Cargo ramp and door.

    e. Tail structure and control surfaces.

    f. Safety valve.

7. No. 1 and 2 engines, nacelles, propellers, left wing — Checked.

    a. Liferafts (visual scan).

    b. External fuel tank — General Condition, Fuel Leaks.

    c. Engine exhaust areas.

    d. Flaps, flap well.

    e. Wing structure, aileron, trim tab.

    f. Propeller spinner and blades.

    g. Nacelle exterior structure — General Condition, Fluid Leaks.

8. Left wheelwell and center fuselage — Checked.

    a. Hydraulic ground test valve — Pinned, Door Secured.

    b. Left main landing gear, wheelwell area.

        (1) Wheels, tires.

        (2) Struts, jackscrews.

        (3) Brakes, hydraulic lines.

        (4) Structure — General Condition.

    c. Exterior Structure — General Condition.

    d. APU area — Intake, Exhaust.

9. Forward fuselage, left side and bottom — Checked.

    a. Exterior structure — General Condition.

8.3 COCKPIT CHECKLIST

This checklist will be completed prior to the Before Start Checklist and will be completed by the flight engineer prior to other crewmembers assuming their respective crew positions. A crewmember will remain at the aircraft after completion of this checklist. If this checklist is completed and the aircraft does not fly, complete the After Landing, Secure, and the Before Leaving the Aircraft Checklists.

1. Nose landing gear pin and ground wire — Removed.

2. Propeller panel — Set.

   a. FEATHER VALVE & NTS CHECK switch — VALVE.

   b. Propeller feather override buttons — Out.

   c. Propeller governing switches — As Required.

CAUTION

Circuit breakers that are pulled by maintenance personnel shall be clamped and not reset until the proper repair has been made. Circuit breakers that are out and not clamped shall be investigated.

Note

If the SURGE SUPPR PROT DEV FUSE on the pilot lower circuit breaker panel has blown, indicated by the red pin appearing in the indicator window, initiate maintenance action.

3. Circuit breakers — Checked.

4. Fuel panel — Set.

Note

Fuel boost pump pressure is required for all engine starts. If auxiliary/external tank fuel is available, it may be utilized for start and taxi.

   a. Dump pump switches — OFF.

   b. Main tank BOOST PUMP switches — ON.

   c. AUX/EXT tank BOOST PUMP switches — As Required.

   d. Main tank crossfeed valves — OPEN.

   e. Auxiliary/external/bypass crossfeed valves — As Required.

   f. Crossfeed separation valve — OPEN/As required.

5. Throttles — GROUND IDLE.

6. Condition levers — GROUND STOP.

7. SYNCHROPHASE MASTER switch — OFF.

8. Temperature datum control valve switches — As Required.

8.4 BEFORE START

1. Hot mike — ON (P) (CP) (FE).

2. Cockpit Checklist — Complete (FE).

3. Passengers — Briefed (LM).

4. Electrical panel — Set (FE).

   a. Engine generators — OFF.

   b. Inverters — As required.

   c. Dc power switch — BATTERY.

   d. Dc BUS TIE switch — Tied.

   e. External ac power switch — External Ac Power (if available).

5. Radios — ON, _____ Primary (CP).

Note

- The copilot will state over the ICS which radio is being utilized for primary communication prior to transmitting. All other crewmembers will select the primary radio on their respective ICS panel.

- When performing a self-contained start only, the radio required for communication to ground will be turned on. With isolated dc as the only power source available, only UHF 1 and VHF 1 will operate.

6. Lights — Set (FE).

   a. Interior — As Required.

   b. Exterior

      (1) Anticollision — ON.

      (2) Navigation — FLASH.

      (3) Other lights — As Required.

7. Clear APU — Clear (LM).

CAUTION

- When starting the APU with battery power only, leave the dc BUS TIE switch untied until the APU reaches 35 percent (start light out), then tie the DC bus to arm the APU fire detection system.

- When operating the APU, monitor the wing and empennage anti-icing indicators. An indication of a temperature rise means that an anti-icing valve is open. The APU should be shut down as damage to a heated surface or fuel tank sealant may occur.

Note

Once the loadmaster has cleared the APU, the flight engineer will start the APU.

8. APU panel — Set (FE).

Note

- Place the bleed-air switch to open 1 minute after the on-speed light has illuminated.

- If the APU cannot be started, an external air source can be connected to the external pressure connection for use in starting engines. Refer to this chapter for external airstart procedures.

9. APU generator — As Required (FE).

WARNING

When switching on the APU generator, ensure the external power switch automatically switches off. If the external power switch does not automatically switch off, manually place the switch to off and record the discrepancy. Failure of the external power switch to be switched off automatically or manually will damage the switch and may lead to an electrical fire.

10. Inverters — Set (FE).

   a. Copilot ac instruments inverter switch — ESSENTIAL AC BUS/ESS AV BUS.

   b. Ac instrument and engine fuel control inverter switch — ESSENTIAL DC BUS.

11. Fuel quantity and distribution — Checked, ____ LBS (P) (FE).

WARNING

Do not pull and clamp associated fuel quantity circuit breakers unless the gauge is blank or the display is unusable. Refer to Chapter 2 for error codes.

Note

The pilot will verify proper fuel distribution and state the total fuel. Refer to Chapter 4 for fuel management and distribution.

12. Oil cooler flaps — As Required (CP).

Note

- On aircraft 165313 and up, the oil cooler flaps should be in the AUTO position for engine starts.

- On aircraft prior to 165313, the oil cooler flaps should be in the OPEN/FIXED position for engine starts when the temperature is 27 °C (81 °F) or above.

13. Ramp and door selector — 6N, NEUTRAL (LM).

14. Hydraulic panel — Set (CP).

Note

If utility system hydraulic pressure is indicated after the auxiliary hydraulic pump is turned on and before starting the No. 2 engine, a malfunction of the hydraulic ground test valve is indicated. The ground test valve may still be open.

a. BRAKE SELECT switch — EMERGENCY.

b. Auxiliary pump switch — ON/Pressure Up.

c. ANTI-SKID switch — OFF.

d. Engine pump switches — ON.

e. SUCTION BOOST PUMP switches — ON/Lights Out.

CAUTION

Starting an engine with an inoperative suction boost pump may result in damage to the engine-driven hydraulic pump.

15. Parking brake — Set, Remove Chocks (P).

CAUTION

- To avoid engaging the brakes on only one side of the aircraft, the brakes must be firmly depressed and held until the parking brakes are engaged. Brakes are difficult to actuate and set because of the angle of the brake pedals to the operator's feet.

- The parking brake handle shall be held firmly until the brakes are set. Do not allow the handle to release and slam against the stops.

Note

Depress pedals individually and monitor the emergency brake pressure gauge for a pressure drop as each pedal is depressed.

16. Oxygen — Checked, OFF (All).

Note

To expedite checklist completion, the oxygen system check should be performed upon arrival at the aircraft.

a. Inspect hose, mask, and regulator for cleanliness and damage.

b. Hold mask facing away from yourself.

c. Position the supply lever to ON.

d. Connect the ICS cord. Hold the emergency lever to the TEST MASK position and key the ICS button. Release the ICS button and emergency lever and disconnect the ICS cord. The pilot, copilot, and flight engineer ICS cords shall remain connected.

e. Disconnect the mask from the hose assembly and blow slightly into the hose.

Note

Back pressure indicates a properly functioning regulator.

f. Reconnect hose to mask.

g. Diluter lever — 100%.

h. Emergency toggle lever — EMERGENCY.

i. Place mask over nose and mouth and breathe for a minimum of three cycles. The blinker shall show alternately black and white.

j. Hold breath momentarily; blinker should remain black. Return the emergency toggle lever to NORMAL. The blinker should remain black.

k. Breathe for a minimum of three cycles. Leave the regulator in the following positions:

(1) Emergency toggle lever — NORMAL.

(2) Diluter lever — 100%.

(3) Supply lever — OFF.

(4) Oxygen mask — Connected.

17. GROUND IDLE buttons — LOW (FE).

18. Flap lever — Set (CP).

Note

Set flap lever to correspond with flap position indicator.

19. Chocks, nose pin — Removed (LM).

Note

The aircraft commander and flight engineer shall visually confirm nose pin removal and placement in the flight station.

20. INS, GPS — As Required (CP) (FE).

8.5 STARTING ENGINES

The normal engine starting sequence is 3, 4, 2, 1. If at any time a “stop start” is required, the condition lever will be placed to GROUND STOP prior to releasing the START switch. The term “on speed” is used to indicate that the engine is stabilized in low-speed ground idle.

1. Clear No. 3 engine — No. 3 Clear (LM); Turning 3 (P).

a. ENGINE BLEED AIR switch — OVERRIDE.

b. Condition lever — RUN.

CAUTION

- Do not start an engine if the start valve open light is illuminated prior to actuating the ENGINE GROUND START switch.
- If the start valve open light does not illuminate within 5 seconds after the ENGINE GROUND START switch is placed in START, discontinue the start. Maintenance action is required.
- If the propeller does not rotate within 5 seconds after the ENGINE GROUND START switch is placed in START and the start valve open light is illuminated, stop start. Maintenance action is required prior to another start attempt. Repeated attempts to start may result in internal starter damage.

c. ENGINE GROUND START switch — START.

(1) Place the ENGINE GROUND START switch to the START position and hold. The start valve open light should illuminate within 5 seconds.

(2) The starting cycle is automatic and requires no further action if the engine accelerates smoothly and continuously, TIT is normal (720 to 830 °C), and the engine stabilizes on speed within 1 minute.

(3) Monitor the engine instruments continuously during start. Keep one hand on the condition lever and the other on the START switch of the engine being started. Be prepared to stop start immediately if an abnormal indication is observed.

(4) The loadmaster will monitor the propeller. If no rotation is observed within 5 seconds after the pilot states, “Turning,” the loadmaster will state, “Negative rotation.”

Note

- During start of the first engine, check the bleed-air manifold pressure at 10- to 16-percent rpm. If the pressure is less than 32 psi but equal to or more than 22 psi, continue the start and record the discrepancy. If the pressure is less than 22 psi, stop start and initiate maintenance action. The engine start time limit is 60 seconds from propeller rotation to low-speed ground idle.

- Do not perform an engine start if the TIT is above 200 °C. TIT may be brought below 200 °C by motoring the engine with the starter while the condition lever is in GROUND STOP.

- If a malfunction occurs that requires discontinuing the start, the pilot, copilot, flight engineer, or loadmaster shall call "Stop start" and state the malfunction.

- If the propeller does not rotate, reduce bleed-air manifold pressure below 45 psi and attempt another start. The bleed-air manifold pressure may be reduced by turning off engine bleed air and using APU bleed air.

- If the engine does not light-off before 35-percent rpm or maximum starter-motor rpm is reached, discontinue the start.

- If the propeller rpm stagnates or begins to decay, a stalled start is occurring. Stop start. Do not engage the starter again unless the propeller has stopped rotating. Motor the engine to approximately 25-percent with the condition lever in GROUND STOP to remove unburned fuel from the turbine before attempting another start.

- The sequence of events on a stalled start is the same as a normal start until the beginning of a stall, which is indicated by slower than normal acceleration in the 36- to 50-percent range. TIT will be at or close to the start-limiting temperature of 830 °C, and fuel flow will decrease as the temperature datum system performs a take operation to prevent TIT from exceeding 830 °C. Rpm will usually stagnate during this take operation, and when the temperature datum system has taken fuel to its full capability, an over-temperature may occur and rpm will begin to decay. Stop start immediately to prevent engine damage. If the rpm has not reached starter-release speed, the starter may be left engaged after the condition lever has been placed to GROUND STOP to continue airflow through the engine.

(5) During normal start, the following sequence (b) through (j) shall be observed and called on the ICS by the flight engineer. The loadmaster shall call rotation.

(a) Rotation — Rotation should be indicated on the tachometer within 5 seconds of switch actuation.

(b) Fuel flow — If fuel enrichment is not selected, fuel flow will increase to approximately 300 pph followed by a rise in TIT. If fuel enrichment is selected, fuel flow will be approximately 500 to 1,500 pph.

(c) Ignition — Ignition should follow fuel flow indication and be indicated by a rise in TIT by 35-percent rpm.

(d) Oil pressures — Positive oil pressures will be indicated by 35-percent rpm.

(e) Hydraulic pressure — Indication of pressure by propeller on speed in low-speed ground idle.

(f) Parallel — Engine fuel pumps in parallel operation, indicated by secondary fuel pump pressure light ON.

(g) Starter — Release switch at 60-percent rpm.

(h) Series — Engine fuel pumps in series operation, indicated by the secondary fuel pump pressure light out and a drop in TIT at approximately 65-percent rpm.

(i) Peak TIT — Peak TIT is the highest indicated temperature observed during the slow steady increase of indicated temperature and is exclusive of the momentary overshoot normally experienced at approximately 94-percent rpm.

(j) Stable start.

CAUTION

- If there is no positive indication of oil pressure from the reduction gearbox or engine power section by 35-percent rpm, immediately stop start.
- After moving a condition lever to GROUND STOP, do not move the lever again until propeller rotation has ceased. Moving a condition lever from GROUND STOP to RUN while the engine rpm is decreasing could result in damage to the engine. Do not reengage the starter until rotation has stopped.
- Throttles must not be moved out of the GROUND IDLE detent during engine ground start. The resultant increase in propeller blade angle will reduce the engine acceleration.

(6) At approximately 16-percent rpm, fuel flow will be indicated and light-off will follow. The secondary fuel pump pressure light may illuminate momentarily, then go out. The light will illuminate again before the engine reaches 65-percent rpm.

Note

If light-off is not achieved on the first start attempt, fuel enrichment may be used on the second start. Do not use fuel enrichment if the engine indicates a TIT of 100 °C or more prior to start. TIT may be brought below 100 °C by motoring the engine. Do not select fuel enrichment after starter engagement.

(7) The ENGINE GROUND START switch shall be released at 60-percent rpm.

CAUTION

- The starter regulator valve is deenergized when the START switch is released. When the START switch is released, look for a rise in bleed-air manifold pressure or a cutback in TIT in the engine supplying air to confirm that the starter regulator valve has closed. Verify that the start valve open light extinguishes within 15 seconds of switch release.
- If a positive rise in bleed-air manifold pressure or a cutback in TIT is not noted when the START switch is released, move the condition lever to GROUND STOP and close the respective engine bleed-air valve. To determine whether the starter regulator valve closed, ensure that the propeller is not rotating and reopen the bleed-air valve with the condition lever in GROUND STOP. If the propeller begins to rotate, the starter regulator valve is stuck open and the engine cannot be started without damage. If the propeller does not rotate when the engine bleed-air valve is opened, it may be assumed that the starter regulator valve is closed. In this case, an engine start may be performed if a positive rise in the manifold bleed-air pressure or a cutback in TIT occurs after the START switch is released.

(8) The secondary fuel pump pressure light will go out at approximately 65-percent rpm.

Note

Refer to Chapter 4 for engine start limitations.

(9) The engine should accelerate to low-speed ground idle within 1 minute. If the engine rpm does not stabilize on speed within 1 minute, discontinue the start.

During extreme ambient conditions (high altitude, high temperature), the starting air supply may be inadequate to stabilize the engine within the time limit at low-speed ground idle (while start temperature remains within limits). Under these conditions, the start may be continued beyond 60 seconds to 70 seconds, provided that the engine is accelerating smoothly and at a constant rate. Discontinue start after 70 seconds (move condition lever to GROUND STOP and record the discrepancy). If engine acceleration hesitates or appears to be stagnating, the engine must be shut down immediately to avoid turbine damage since overtemperature may exist downstream of the thermocouples.

d. Hydraulic pump and pressure — Pressure Up/Checked (CP).

Note

A positive indication of hydraulic pressure should be noted by the time the engine is on speed, and normal operating pressure shall be indicated within 30 seconds after the engine is on speed. This check shall be accomplished on the first flight of the day.

(1) After the No. 3 engine is on speed, check the No. 3 hydraulic pump by operating the flight controls. Stabilize the controls and check that the static pressure is within limits.

(2) Turn the No. 3 hydraulic pump off and cycle the flight controls to bleed off residual pressure. Leave the pump off.

(3) After the No. 4 engine is on speed, check the No. 4 hydraulic pump as indicated in steps 1 and 2 above. Turn the No. 3 and No. 4 hydraulic pumps on.

(4) After the No. 2 engine is on speed, check the No. 2 hydraulic pump as indicated in steps 1 and 2 above.

(5) After the No. 1 engine is on speed, check the No. 1 hydraulic pump as indicated in steps 1 and 2 above. Turn the No. 1 and No. 2 hydraulic pumps on.

e. Low-speed ground idle — As Required (P) (FE).

Note

After the first engine is started and stabilized in low-speed ground idle and all instruments indicate normal, reset the engine to normal ground idle and allow the engine to stabilize. Use this engine as the starting air source for the other engines.

f. Engine generator switch — ON (FE).

WARNING

When switching on the engine generator, ensure the external power switch automatically switches off. If the external power switch does not automatically switch off, manually place the switch to off and record the discrepancy. Failure of the external power switch to be switched off automatically or manually will damage the switch and may lead to an electrical fire.

Note

- When the engine is on speed, the flight engineer shall ensure that the engine generator is developing proper voltage, place the engine generator switch to ON, and state, “Generator on.” This indicates the copilot is clear to continue the checklist.
- On aircraft 165313 and up, the engine generator must be placed on prior to checking voltage.

2. APU generator — ON, Checked (FE).

WARNING

When switching on the APU generator, ensure the external power switch automatically switches off. If the external power switch does not automatically switch off, manually place the switch to off and record the discrepancy. Failure of the external power switch to be switched off automatically or manually will damage the switch and may lead to an electrical fire.

Note

Check the voltage and frequency of the APU generator and place the switch to ON. On aircraft 165313 and up, the APU generator must be placed on prior to checking voltage. The APU generator must be on for low-speed ground idle operation if the engine-driven generators are off line. If the APU generator fails, the low-speed ground idle buttons must be disengaged in order to prevent a drain on the battery.

3. Dc power switch — BATTERY, Remove External Power (FE).

4. Clear No. 4 engine — No. 4 Clear (LM); Turning 4 (P).

Note

Repeat steps 1a. through 1f. for all engines.

5. AIR CONDITIONING master switch — NO PRESS (FE).

Note

After stabilization of the flight deck and cargo compartment temperatures, the temperature controls may be operated in AUTO or MANUAL.

6. External power and ground equipment — Removed, Clear (LM).

7. Clear No. 2 engine — No. 2 Clear (LM); Turning 2 (P).

8. Clear No. 1 engine — No. 1 Clear (LM); Turning 1 (P).

9. ENGINE BLEED AIR switches — Set (FE).

Note

Check each engine bleed air regulator individually using the following procedure.

a. ENGINE BLEED AIR switches (for regulators not being checked) — OFF.

b. Throttles — GROUND IDLE/Normal Ground Idle Rpm.

c. Cargo compartment air-conditioner — ON.

d. Flight station air-conditioner — OFF.

e. APU bleed air — OFF.

f. Bleed-air pressure — Checked.

Note

If individual regulator pressures are not within approximately 3 psi of each other, place all engine bleed-air switches to OVERRIDE or OFF as required for takeoff.

g. ENGINE BLEED AIR switches — As Required.

Note

Bleed-air pressure should be approximately 50 psi with all regulators in the ON position.

10. Fuel panel — Set (FE).

Note

All fuel boost pumps and crossfeed valves shall be checked (if not previously checked) prior to performing the following steps.

a. Crossfeed valves — Closed.

b. Crossfeed separation valve — Closed.

c. Boost pumps — OFF.

8.6 BEFORE TAXI (ONLY CIRCLED ITEMS NEED TO BE CHECKED AT OPERATIONAL STOPS)

CAUTION

During prolonged ground operation at high ambient temperatures, engine oil temperature must be monitored constantly. Use oil cooler augmentation to maintain lower oil temperatures. If engine oil temperatures approach the upper limit, throttle settings must be increased to improve air circulation.

Note

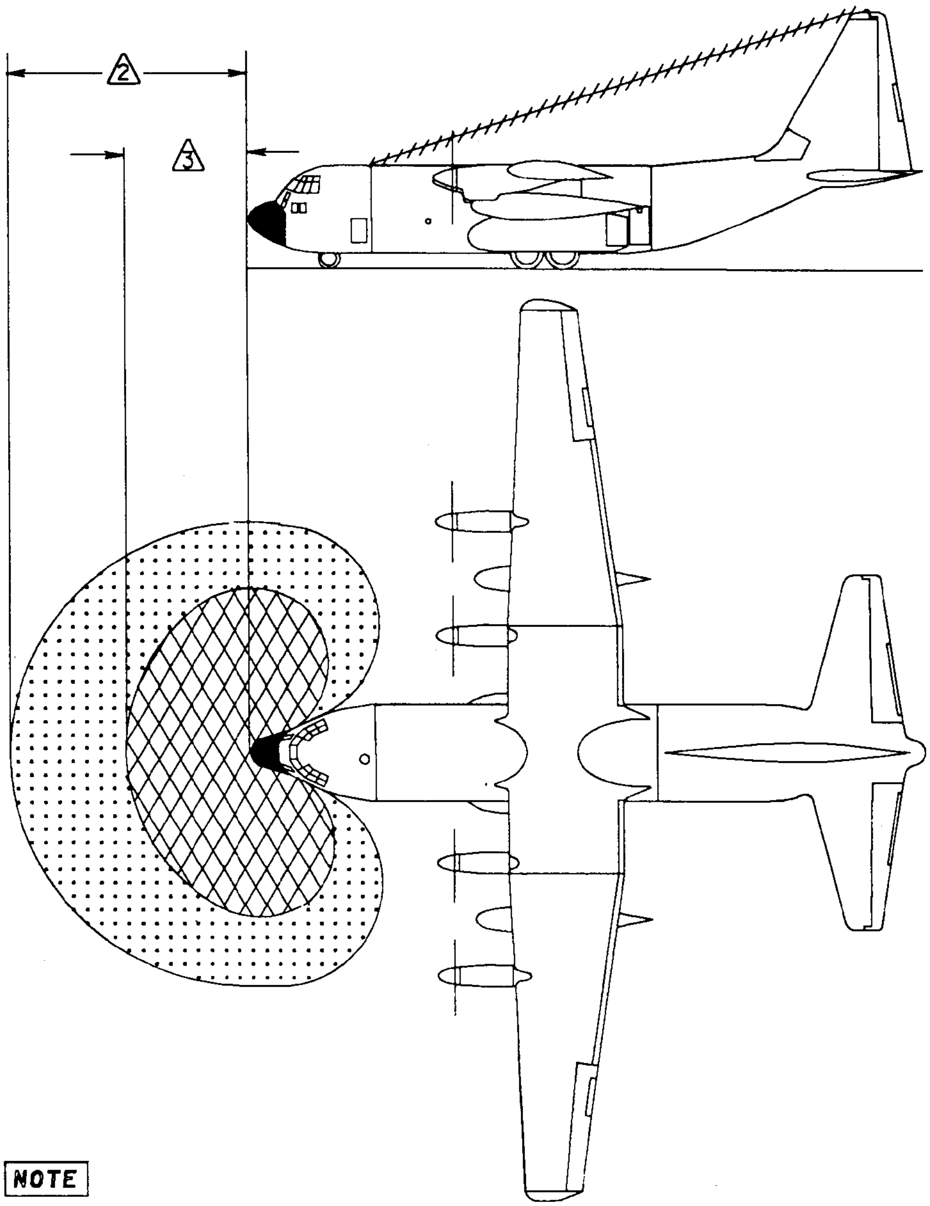
- Refer to Chapter 4 for engine limitations.
- See Figure 8-2 for radiation hazard area.

1. Wing and empennage anti-icing indicators — Normal (FE).
2. Radar and IFF transponder — STANDBY (P) (CP) (FE).
   a. The pilot will verify that the radar is in STANDBY and that the radar indicator (screen) is on and operational.
   b. The copilot will verify that the IFF transponder is in STANDBY.
   c. The flight engineer will verify that the navigator station radar is in STANDBY.
3. Compasses — Checked (state heading) (P) (CP).
   a. The pilot will compare the headings of the No. 1, No. 2, and magnetic compasses and will state the heading of the No. 1 compass. The pilot will also verify that the compass display switch is in the NORM position.
   b. The copilot will compare the headings of the No. 1 and 2 compasses and will state the heading of the No. 2 compass.
   c. The flight engineer will verify that the latitude N-S switch is in the appropriate hemisphere, the latitude knob is set to the local latitude, and the No. 1 and 2 compass headings match those displayed at the navigator station. No flight engineer response is required unless a discrepancy exists.
4. Attitude select switches — Checked ____ (P) (CP).
   a. Press the attitude select switches. Check that the GYRO ATT lights illuminate, ADI flags are not in view, and proper attitude references are displayed.
   b. Press the attitude select switches and observe that normal INS ATT indications return.
   c. The pilot and copilot will select separate attitude sources (INS or GYRO) and state the selected source.
5. Ground proximity warning system — Set (CP).
   a. Flap override switch — NORM.
6. Flaps — 50 Percent (CP).
   a. Move the flaps to 0 percent then to 50 percent and note normal operation of the rudder boost system.
7. Ground equipment — Clear (P) (CP) (LM).
8. Crew aboard — Aboard, Doors Closed and Checked (LM).

WARNING

Check the hooks on the crew entrance door to see that they contact the eyebolts. The hooks may be slightly loose as long as contact is made.

9. Hydraulic pressures and quantities — Checked (CP) (LM).
10. Oil cooler augmentation — As Required (FE).

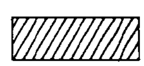


NOTE

1. THE RADIATION HAZARD AREAS SHOWN ARE AROUND THE ANTENNAS. ACCIDENTAL ENTRY INTO THE HAZARD AREAS DOES NOT RESULT IN INJURY. IT IS ONLY THROUGH PROLONGED EXPOSURE THAT THE POSSIBILITY OF DANGER EXISTS.


EXPLOSIVES PROHIBITED AREA AND POSSIBLE FUEL IGNITION AREA (DO NOT OPERATE RADAR IN REFUELING AREAS OR NEAR FUEL SPILLS).


AREA HAZARDOUS TO PERSONNEL


HF RADIO HAZARD APPROXIMATELY 5 FEET

FT	RADAR AN/APS-133
2	52
3	37

C130-F0232

Figure 8-2. Radiation Hazard Area

CAUTION

On aircraft prior to 165313, the oil cooler flaps shall be fully open and switches FIXED before activating oil cooler augmentation. On aircraft 165313 and up, the oil cooler flap switches must be in AUTO for oil cooler augmentation to work.

11. Passengers, cargo, SDRS — Set (LM).

   a. Ensure SDRS circuit breakers closed and apply 28-Vdc power to aircraft.

   b. Display powers up in night vision mode, press DIM to restore. Keypad performs self-test and will momentarily display READY indicating bit pass.

   c. Display will show aircraft type C-130. If another type aircraft is shown, reconfiguration is required using AN/UYQ-76.

   d. Display will show Julian date. If correct, press SCROLL key. If incorrect, use numeric keys to enter correct date and press ENTER.

   e. Display will show military time. If correct, press SCROLL key. If incorrect, use numeric keys to enter correct time and press ENTER.

   f. Display will show WFW. Enter correct Wing Fuel Weight to nearest thousand pounds and press ENTER. Valid range is 0 to 65K WFW (includes all internal fuel tanks, both auxiliary tanks and both external tanks).

   g. Display will show FFW. Enter the Fuselage Fuel Weight to the nearest thousand pounds and press ENTER. Valid range is 0 to 25K.

   h. Display will show GW. Enter the Gross Weight to the nearest thousand pounds and press ENTER. Valid range is 50 to 200K.

   i. Display will show MC. Enter appropriate Mission Code from placard and press ENTER.

   j. If BIT PASS is shown, press ENTER. If BIT FAIL is shown, MU should be downloaded using AN/UYQ-76.

   k. If MU READY is displayed, press SCROLL to verify entries and press SEND. If MU>80% is shown, MU should be downloaded using AN/UYQ-76.

   l. When data transmission is complete, display will show COMPLETE. If FAILURE appears on display, wait ten seconds and press SEND again. If FAILURE appears again, system must be repaired.

8.7 TAXI

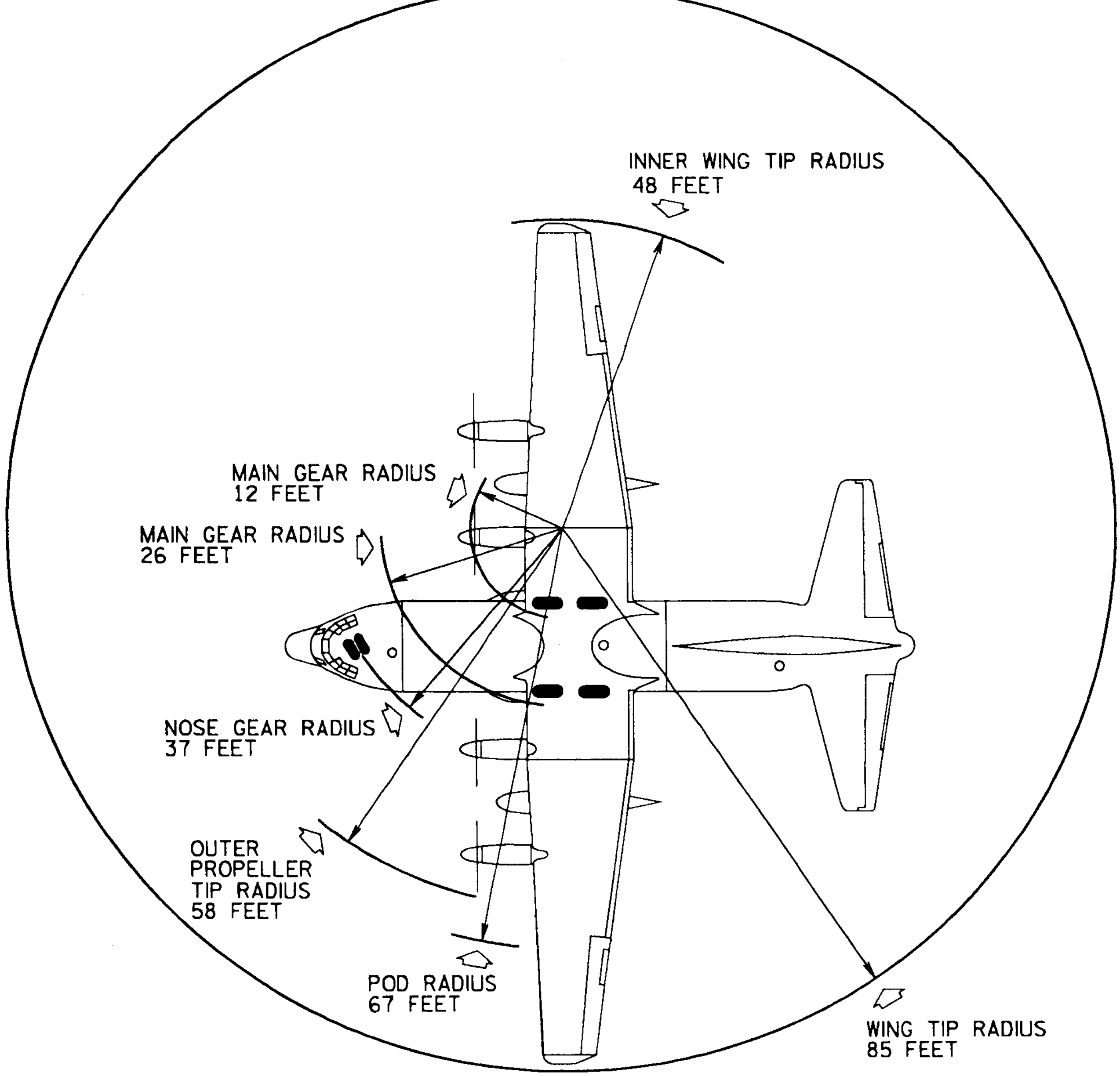
Flight engineer items not requiring coordination may be accomplished prior to the checklist challenge. This does not preclude response to the checklist when an item is called by the copilot.

CAUTION

- Landing gear and tire damage may result from any attempt to pivot on a locked wheel. See Figure 8-3 for the minimum space and clearance required for turning.

- Turning with brakes locked on one side or pivoting is prohibited. While turning the aircraft, avoid hard or abrupt brake applications or braking to a stop in a turn since damage to the nose landing gear and/or supporting structure may result. If any of the above is required in a turn, initiate maintenance action.

- Extreme caution must be exercised and very low taxi speeds observed when taxiing over soft terrain because of landing gear loads and aircraft taxi load factors.



VERTICAL CLEARANCES

WING TIP	12 FEET	
VERTICAL STABILIZER TIP	38 FEET	6 INCHES
INBOARD PROPELLER	5 FEET	9 INCHES
OUTBOARD PROPELLER	6 FEET	5 INCHES
REFUELING PODS	7 FEET	11 INCHES

CAUTION

MINIMUM SPACE REQUIRED FOR TURNING IS 170 FEET WITH THE NOSE GEAR TURNED TO THE MAXIMUM OF 60 DEGREES.

C130-F0233

Figure 8-3. Turning Radii

CAUTION

- Engines shall be changed to normal ground-idle operation by disengaging the LOW SPEED GROUND IDLE buttons rather than by throttle movement. Movement of the throttles beyond the limits of 9° to 30° coordinator angle (at ambient temperatures above 27 °C) may cause rpm stall and overtemperature. These parameters are roughly equal to the throttle positions of two throttle knob widths forward to one knob width aft of GROUND IDLE. Should the LOW SPEED GROUND IDLE buttons be inadvertently released by throttle movement, return the throttles to GROUND IDLE. The engine should accelerate to normal ground-idle rpm. When downshifting from normal to low-speed ground idle, the copilot will monitor the engine instruments and be prepared to shutdown the engine if a stall and/or overtemperature of 850 °C or greater occurs. If a popping noise (compressor stall) occurs when changing from normal ground idle to LOW SPEED GROUND IDLE or from LOW SPEED GROUND IDLE to normal ground idle, maintenance action is required prior to flight.

- Low-speed ground idle shall be used to the maximum extent possible during all taxi operations.

- Avoid the use of brakes as much as practical during taxi, particularly after a landing that involved braking. Care should be taken not to ride the brakes by inadvertent toe pressure. Placing the heels on the floor should preclude inadvertent brake application.

- Skidding or skipping of the nosewheel may occur when the aircraft is turning because of either wet pavement or an aft center of gravity. These movements can be avoided by using asymmetrical power and avoiding abrupt steering changes.

- After turning, move the aircraft approximately 5 feet in a straight line to realign the main landing gear before stopping.

- Excessive oil temperatures and overheated brakes may be interrelated during ground operation. If throttles are advanced to provide better oil cooling, the higher thrust may increase taxi speed and require the pilot to drag the brakes. If oil temperatures exceed limits, engine life is adversely affected. If the brakes are overheated, wheel failures and brake fires may result. The use of low-speed ground idle will normally maintain oil temperatures within desired limits, reduce taxi speeds, reduce noise levels, and conserve fuel. Use oil cooler augmentation to maintain lower oil temperatures. During taxi, the oil temperatures should be monitored closely to avoid exceeding limits.

1. Brakes — Checked (P) (CP).

CAUTION

Do not switch from the emergency to normal brake system until the aircraft is clear of obstructions or stopped.

a. BRAKE SELECT switch — EMERGENCY.

b. Test brakes.

c. BRAKE SELECT switch — NORMAL.

d. Test brakes.

e. ANTI-SKID switch — ON.

f. Test brakes.

Note

The pilot will conduct the brake checks, and the copilot will operate the hydraulic control panel switches.

2. Generators and loads — ON, Checked (FE).

CAUTION

Ensure that the ac BUS TIE switch is off before powering the main ac bus with an engine-driven generator.

a. Place the APU generator switch to the OFF position and note that the No. 2 engine generator assumes the essential ac bus load.

b. Rotate the voltage and frequency selector switch to each engine generator position and note that voltage and frequency of each phase are within limits.

c. Rotate the phase selector switch to each phase position and check each engine generator loadmeter for an indication of a load within limits.

d. Check each TR unit loadmeter for an indication of a load within limits.

e. Rotate the dc voltmeter selector switch to each position and check that the voltage is within limits.

f. Place APU generator to the ON position and note that the APU generator assumes the essential AC bus load.

3. Ice detection — Checked (FE).

CAUTION

Do not hold the ice detector test switch in the No. 2 or No. 3 position longer than 5 seconds. The test cycle may be repeated once; wait 5 minutes for the ice detector to cool before performing the test sequence again. Failure to comply may result in damage to the ice detector probe.

a. Place the ice detector test switch in the No. 2 position. Note that the icing conditions ON light illuminates. Wait at least 12 seconds, during which the icing conditions ON light should remain illuminated. Place the PROP & ENGINE ANTI-ICING MASTER switch to the RESET position and note that the icing conditions ON light is extinguished.

b. Place the ice detector test switch in the No. 3 position and note that the icing conditions ON light illuminates. Wait at least 12 seconds, during which the icing conditions ON light should remain illuminated.

c. Place each ENGINE INLET AIR DUCT ANTI-ICING switch ON (one at a time). Note a slight decrease in torque and/or rise in TIT. Place the switches off (one at a time) and note a slight increase in torque and/or decrease in TIT.

d. Check the propeller blade, spinner, and spinner base as follows:

WARNING

If the BLADE DEICING ammeter falls below the limits specified in Chapter 4, do not fly into icing conditions.

CAUTION

When the aircraft is on the ground, do not operate propeller anti-icing or deicing for an engine that is not running. The propeller must be operating to dissipate the heat generated by the heating elements and prevent damage to the elements. Never operate the system for more than two cycles while the aircraft is on the ground. Anti-icing and deicing may be used for a propeller feathered in flight.

Note

The solid-state deicing timer will reset to start with the No. 4 propeller when first activated and progressively energize the circuits for propeller Nos. 1, 2, 3 and 4.

(1) Place the No. 4 PROPELLER ICE CONTROL switch to ON and observe that a load is indicated on all three ammeters

(SPINNER ANTI-ICING, SPINNER DEICING, and BLADE DEICING).

(2) Leave the PROPELLER ICE CONTROL switch ON until the heating cycle is completed, indicated by a drop on the deicing ammeters. The spinner anti-icing ammeter will indicate continuously.

(3) Place the next switch in sequence to ON and check for approximately a 20-ampere increase on the SPINNER ANTI-ICING ammeter, 65 to 90 amperes on the SPINNER deicing ammeter, and 60 to 90 amperes on the BLADE DEICING ammeter.

(4) Repeat step (3) for each propeller.

(5) When all propellers have been checked and the NO ICE light is illuminated, place the PROP & ENGINE ANTI-ICING MASTER switch to RESET, and observe that the NO ICE light is extinguished and there is no load on any of the anti-icing or deicing ammeters.

(6) Place all four PROPELLER ICE CONTROL switches OFF.

4. Propeller reversing — Checked (P) (FE).

Note

- Reverse propellers in symmetrical pairs and check that rpm, torque, fuel flow, and TIT are within limits. Check the reverse power differential between engines; if greater than 1,000 inch-pounds, compensate for the differential during subsequent reverse operation and record the discrepancy for maintenance action. During the reverse checks, the pilot should keep left hand lightly on the nosewheel steering to feel for any pull.
- Propeller reversing shall be checked prior to the first flight of the day.

8.7.1 Crosswind Taxiing. The aircraft can be taxied, with four engines operating, in a 30-knot, 90° crosswind by use of nosewheel steering and rudder control only. Taxiing, with four engines operating, can be accomplished in up to a 60-knot, 90° crosswind by use of nosewheel steering, rudder and aileron control, differential braking, and differential power. Turns to a crosswind heading shall be performed with great caution and at slow speeds to prevent centrifugal force from aiding the wind in tipping the aircraft. Statically, the aircraft is capable of withstanding a 70-knot, 90° crosswind without tipping over.

8.7.2 Backing the Aircraft

CAUTION

Brakes shall not be used during backing operations because of the possibility of the aircraft sitting on its tail and causing structural damage.

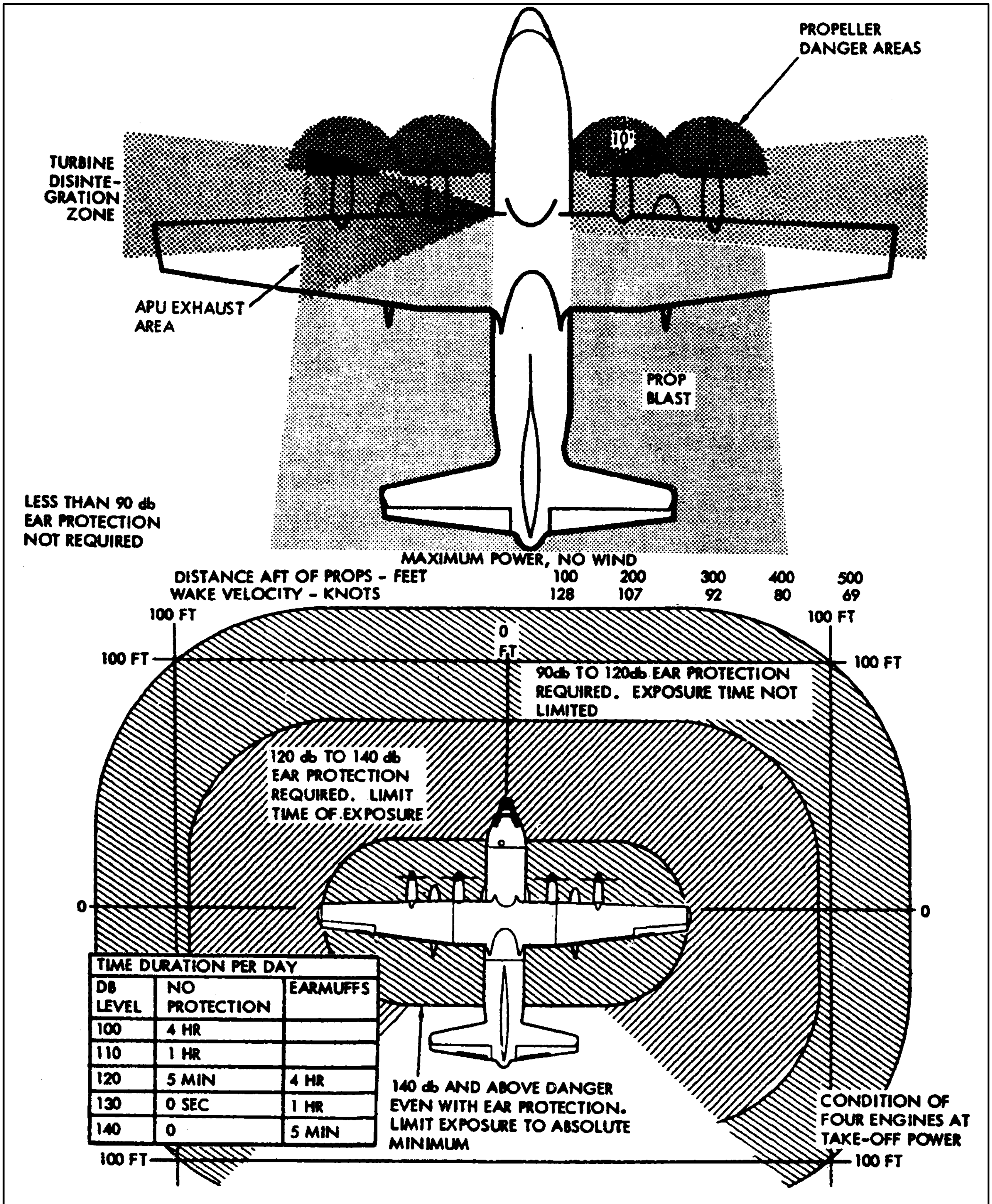
Note

Monitor engine oil temperature during backing operations. Use oil cooler augmentation if necessary.

1. Ensure that the maneuvering area is free of all debris that could damage the propellers or injure ground personnel.
2. Conduct a thorough brief to include pilot feet placement, direction of turns (if required), and which crewmember will direct the evolution from the cargo compartment.
3. Both pilots shall place their feet flat on the deck throughout the evolution.
4. Reverse symmetrical propellers simultaneously. Simultaneous full-reverse power on all engines may lift the nosewheel off the ground.
5. Use forward thrust to stop the backward movement of the aircraft.
6. After backing, taxi the aircraft forward in a straight line approximately 5 feet to realign the main landing gear.

8.8 ENGINE RUNUP (OPTIONAL)

Select an area that is free of foreign objects. Head the aircraft into the wind. See Figure 8-4 for danger areas.



TIME DURATION PER DAY		
DB LEVEL	NO PROTECTION	EARMUFFS
100	4 HR	
110	1 HR	
120	5 MIN	4 HR
130	0 SEC	1 HR
140	0	5 MIN

Figure 8-4. Danger Areas

CAUTION

- To prevent excessive stresses on the propeller and to prevent wing lift and resultant severe structural damage because of a propeller contacting the ground, the aircraft will be headed into the wind within 30° of wind direction for engine power settings in excess of 7,000-inch-pounds of torque when the wind velocity is in excess of 10 knots.
- Do not runup the engines where the propeller blast will blow across an area used by other aircraft.
- Do not runup all four engines to takeoff power simultaneously. The thrust available is sufficient to skid locked wheels and chocks. Do not runup two engines on one side simultaneously. The thrust available is sufficient to skid the nosewheel sideways. Simultaneous full reverse power on all engines may result in lifting the nosewheels off the ground.
- For operation on snow-covered surfaces at temperatures near freezing or on slippery surfaces, deviations must be made for engine and propeller check procedures. Check engines in symmetrical pairs when necessary. Use reverse thrust on the remaining pair of engines to prevent the aircraft from sliding forward. Brakes alone will not prevent the aircraft from moving forward if each of the four engines is producing more than approximately 8,000-inch-pounds of torque. Avoid parking the aircraft close together during ground test. When runup must be conducted on slippery surfaces, do not attempt to make full-power checks until the aircraft is lined up on the runway ready for takeoff.

Note

The copilot will stabilize the yoke, monitor the outside of the aircraft for movement, and guard the brakes for inadvertent release or failure.

1. Nosewheel, parking brake — Centered, Set (P).
2. Engine runup — Complete (FE).
   a. Check that idle rpm is within limits.
   b. Advance the throttles to FLIGHT IDLE and note the torque.
   c. Advance the throttles to the flight range and observe the TIT change as electronic fuel controlling is reached (as indicated by the electronic fuel correction lights going out). The TIT at this point should be 800 to 840 °C. If no change in TIT is observed, refer to temperature datum system checks in this chapter.
   d. Propeller operation — Set the throttles between 8,000- and 9,000-inch-pounds of torque.

Note

Gusty or strong wind conditions may cause excessive rpm fluctuations.

   (1) Check that propeller rpm is within limits in normal and mechanical governing. If reindexing is required to bring rpm within limits, refer to reindexing procedures in this chapter.

   e. Retard all throttles to FLIGHT IDLE and check that rpm and torque are within limits.

WARNING

Torque should be at least 200 inch-pounds higher per engine than those values observed in step 2b. If not, a low pitchstop malfunction exists. Maintenance action is required prior to flight.

   f. Retard throttles to GROUND IDLE.

CAUTION

If a decrease in torque is not indicated when throttles are moved to GROUND IDLE, shut down the engine by placing the condition lever to GROUND STOP. Maintenance action is required prior to flight.

8.9 TAKEOFF (ONLY CIRCLED ITEMS NEED TO BE CHECKED AT OPERATIONAL STOPS)

1. Exits — Secure (ALL).

2. Fuel panel — Set (FE).

   a. Main tank fuel boost pumps — ON.

   b. All crossfeed valves — Closed.

   c. Auxiliary/external tank pumps — OFF.

3. Flaps — 50 Percent (P) (CP) (LM).

4. Flight controls — Checked (P) (CP).

CAUTION

If restricted or jammed flight controls are detected or suspected, no attempt should be made to free the controls. Maintenance action is required prior to flight.

5. Hydraulic quantities — Checked (LM).

6. Trim tabs — Set (P).

   a. Elevator tab power switch — NORMAL.

   b. Trim tab position indicators — Zero/As Required.

7. Seatbelts — Fastened (All).

Note

Shoulder harnesses shall be used on all seats so equipped.

8. Crew — Briefed (P).

   a. Air minimum control speeds.

   b. Refusal speed.

   c. Rotation and takeoff speeds.

   d. Pilot intentions should an emergency arise.

   e. Radio and NAVAID setup to include primary departure radio, all VOR, tacan, and ADF settings, the IFF code, and the NAV select panel setting.

   f. Specifics (where applicable) — Critical field conditions, snow or ice, wet runway, obstacle clearance and terrain considerations, heavy gross weight takeoff, and SID.

   g. Confirm crew understanding of clearance and, when applicable, instrument departure.

9. Instruments, altimeters — Checked, Set (state setting of the barometric altimeter and radar altimeter) (P) (CP) (FE).

Note

This step will be performed with the engines in normal ground idle.

   a. The pilot will check the engine instruments and pilot instrument panel and will state the settings of the pilot barometric altimeter and radar altimeter.

   b. The copilot will check the engine instruments and copilot instrument panel and will state the settings of the copilot barometric altimeter and radar altimeter.

   c. The flight engineer will check the engine instruments.

10. Electrical panel — Set (FE).

   a. Engine generators — ON.

   b. Ac BUS TIE switch — OFF.

   c. APU generator — OFF.

   d. Ac instrument and engine fuel control switch — ESSENTIAL AC BUS/ESS AV AC BUS (some aircraft).

   e. Dc BUS TIE switch — NORMAL.

11. APU panel — Set (FE).

12. Pressurization — Set (FE).

13. Antiskid — Checked (FE).

WARNING

After the ANTI-SKID TEST switch is actuated to either the FWD or AFT position, wait at least 3 seconds before moving the test switch to the opposite set of wheels. A more rapid actuation of the test switch could result in a momentary loss of brakes with the normal brake system selected. Faster actuation of the test switch will also result in erroneous test light indications.

CAUTION

Do not attempt to test the antiskid system while the aircraft is being taxied.

a. With the ANTI-SKID INOPERATIVE light out, fully depress and hold the brake pedals.

b. Check that all four ANTI-SKID test lights are out.

c. Place the test switch in the FWD position and release. The two FWD lights should illuminate and then go out. A slight bump may be felt in the brake pedals, indicating the antiskid control valves are functioning.

d. Place the test switch in the AFT position and release. The two AFT lights should illuminate and then go out. A slight bump may be felt in the brake pedals.

e. Ensure that the test switch is in the OFF position.

14. Radar, IFF transponder — As Required (P) (CP).

15. Oil cooler augmentation — OFF (FE).

CAUTION

Ensure that oil cooler augmentation is off before operating the oil cooler flaps.

16. Oil cooler flaps — AUTO (CP).

17. Lights — Set (CP) (FE).

a. Landing and taxi lights — ON.

b. Navigation light — STEADY.

c. Strobe — As Required.

18. Anti-icing panel — Set (FE).

a. NESA WINDSHIELD switches — NORMAL.

CAUTION

Pitot heat shall not be left ON for an extended period while the aircraft is on the ground.

b. PITOT HEAT switches — ON.

c. ENGINE INLET AIR DUCT ANTI-ICING switches — ON.

d. PROPELLER ICE CONTROL switches — ON.

e. PROP & ENGINE ANTI-ICING MASTER — As Required.

19. Lineup — Complete (P) (CP) (FE).

a. Flaps — 50 Percent.

b. Attitude indicators — ON/Normal Indication.

c. Compass heading — Aligned With Runway.

d. Trim — Set.

8.10 TAKEOFF PROCEDURES

The following paragraphs discuss normal, maximum-effort, obstacle clearance, and crosswind takeoffs. Use the performance charts to predict aircraft performance. Refer to Chapter 4 for limitations and Chapter 11 for emergency procedures during takeoff. See Figure 8-5 for takeoff and initial climb pattern.

Note

When takeoff performance is critical, cabin pressurization and air-conditioning bleed air should be turned off to achieve maximum power.

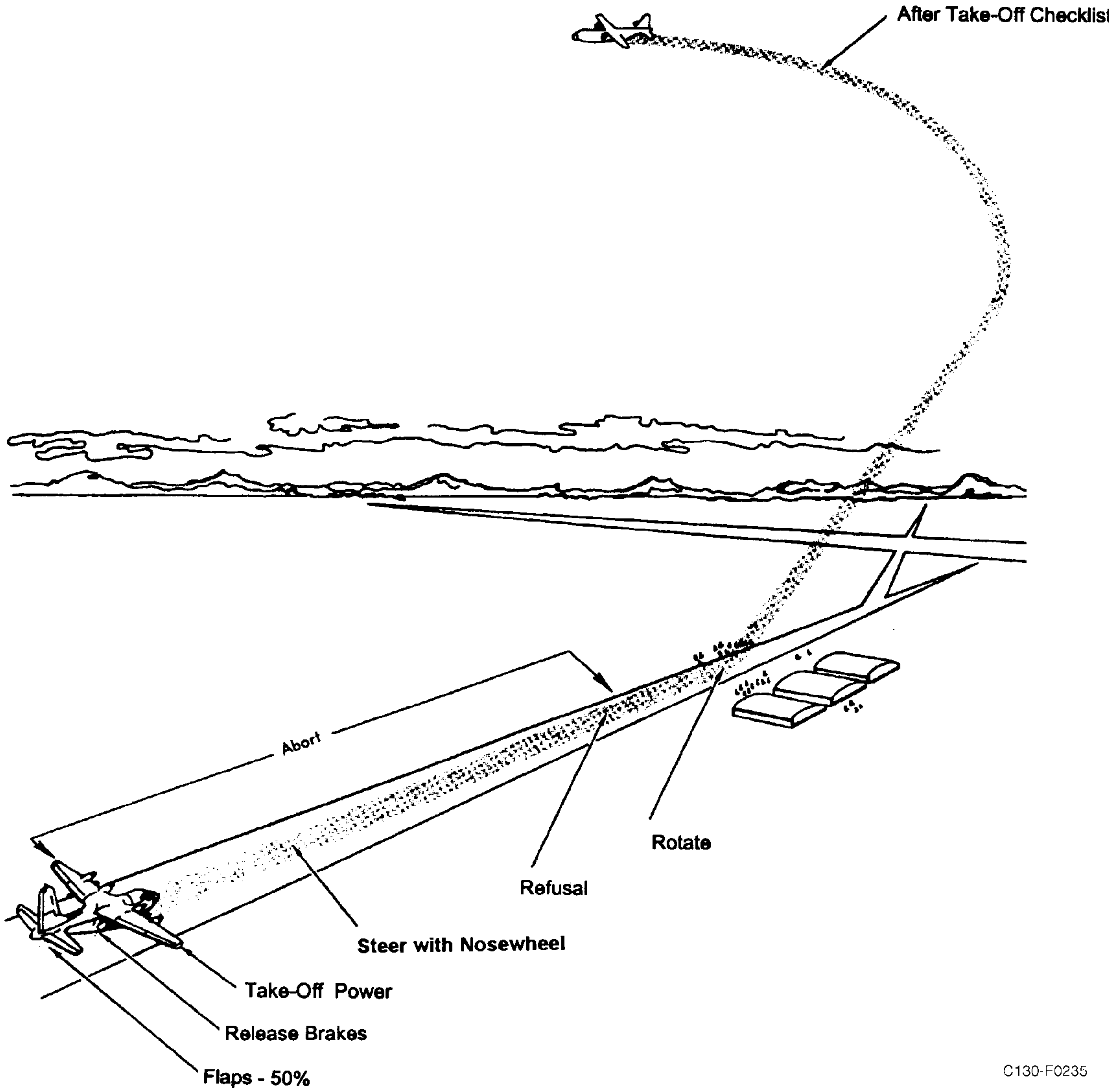


Figure 8-5. Normal Takeoff and Initial Climb

8.10.1 Normal Takeoff. The throttles are gradually advanced toward maximum power, and the crew monitors the engine instruments to ensure maximum power is not exceeded. Normal takeoffs are made with 50-percent flaps. Anytime charted performance is desired, power should be applied before the brakes are released. A rolling takeoff is permitted provided charted takeoff power is established within 5 seconds after the aircraft begins its takeoff roll.

CAUTION

- During low ambient temperatures, it is possible to exceed the maximum allowable torque before reaching the TIT specified in Chapter 4. Additionally, ram air effect during takeoff will increase torque for any fixed TIT. Torque must either be set below maximum allowable when setting power for takeoff or it must be reduced as airspeed builds during the takeoff roll.

- During the takeoff, the pilot will set takeoff power and maintain directional control with the nosewheel steering until rudder controls become effective (50 to 60 KIAS). Concurrently, the copilot will hold the control column forward, keeping the wings level with the ailerons and will monitor throttle positions. As speed increases, the pilot maintains aircraft control by coordinated flight control use. At 80 KIAS, the copilot will call “80 knots” and the pilot will crosscheck the airspeed indicator to ensure concurrence. The copilot will call “Refusal” when required and “Rotate” at the briefed rotate airspeed. The word “Abort” may be called by any flight station crewmember detecting a discrepancy affecting safety of flight prior to refusal/rotate (as required).

Note

- When air minimum control speed (one-engine inoperative, in ground effect) is greater than the chart takeoff speed, use this air minimum control speed for takeoff speed. The obstacle clearance speed for this condition is the chart speed or air minimum control speed (one engine inoperative, in ground effect) whichever is greater. It is desirable to accelerate to the two-engine inoperative air minimum control speed as soon after takeoff as feasible and before retracting flaps above the 15-percent position.

- For all operations below 1,000 feet AGL, the pilot not flying shall place his/her hand at the base of the throttles. This does not preclude removal for landing gear and/or flap actuation.

- If the aircraft is loaded to an aft center of gravity, forward pressure on the control column will aid in steering effectiveness.

8.10.2 Maximum-Effort Takeoff and Obstacle Clearance

Note

If the runway or runway environment require maximum-effort performance, all engine bleed air should be shut off.

A maximum-effort takeoff is made by holding the brakes until the engines are stabilized at maximum power. For maximum-effort takeoff, accelerate on the runway to takeoff speed and pull up the nose until the aircraft leaves the ground. Takeoff speed will be such that minimum control speed is disregarded. Retract the landing gear and adjust the aircraft attitude to attain obstacle-clearance speed. After clearing the obstacle, slowly retract the flaps while maintaining altitude and accelerate to best climb speed. Refer to NAVAIR 01-75GAI-1.1 (performance manual) for maximum-effort takeoff data.

Note

The minimum flap retraction speed for a maximum-effort takeoff is obstacle clearance speed plus 10 knots.

8.10.3 Crosswind Takeoff. Crosswind takeoffs, with regard to directional control of the aircraft, are made essentially the same as normal takeoffs. Initially, the pilot maintains directional control with nosewheel steering and differential power while the copilot maintains a wings-level attitude with the ailerons. In higher crosswinds, a greater amount of differential power and ailerons must be applied. After takeoff, the line of flight should be aligned with the runway until crossing the airfield boundary. Refer to NAVAIR 01-75GAI-1.1 for crosswind performance data.

8.11 AFTER TAKEOFF

As soon as airborne (and at the command of the pilot), retract the landing gear. When a safe altitude is reached and at no less than 20 KIAS above takeoff speed, retract the flaps.

WARNING

- When the flaps are retracted, the aircraft will lose lift and tend to sink. The pilot shall react by pulling the aircraft nose up as necessary to continue climbing and accelerating to maintain a safe margin above the stall speed for the changing configuration. Flap retraction should not be accompanied by a combination of banked turns and power reduction because of the danger of stall at flap retraction speed. The effect of flap retraction on available rudder deflection and the consequent increase in air minimum-control speed should also be considered.

- Retracting the landing gear and flaps simultaneously will result in an increase in air minimum-control speed.

Note

- Retracting the landing gear and flaps simultaneously will result in slower than normal operation of both and may cause the hydraulic low-pressure warning light to come on.

- After airborne, accelerate to the desired climb speed determined from the performance charts.

- To prevent excessively high nose attitudes and to allow for better visibility during VMC climbs, climb speeds greater than performance chart data are permissible.

1. Gear, flaps, lights — Checked (CP) (FE).

   a. Landing gear up and locked.

   b. Flaps up and indicating up.

   c. Taxi lights off, landing lights on/extended until 10,000 feet MSL.

2. Hydraulic panel — Checked, Set (CP).

   a. Auxiliary hydraulic pump — OFF.

   b. Rudder boost pressure — LOW.

3. SYNCHROPHASE MASTER switch — As Required (FE).

   a. Set to engine nearest 100-percent rpm.

4. Pressurization — Checked (FE).

   a. Ensure aircraft is pressurizing.

   b. Set pressure controller to cruise altitude.

5. Wings and aircraft interior — Checked (LM).

WARNING

Prior to performing anti-icing checks, a thorough inspection of the wings and aircraft interior shall be conducted.

6. Leading edge anti-icing — Checked, Set (FE).

Note

Leading edge anti-icing shall be checked on the first flight of the day. Turn the wing and empennage anti-icing ON until a temperature rise is noted on the indicators. This will eliminate any moisture in the system. The wing and empennage check shall be coordinated with the pilot.

7. Fuel panel — As Required (FE).

8. Galley floor — Set (LM).

9. Hot mike — As Required (P) (CP) (FE).

8.12 DESCENT

This check will be accomplished prior to initial VFR or instrument pattern entry.

Note

Flight idle torque at slow descent and approach speeds may result in negative torque and produce an NTS signal on one or more engines. The resulting rpm and power fluctuations will cause the aircraft to yaw. To correct this condition, move the throttle(s) forward to bring torque out of the NTS range. The use of wing and empennage anti-icing may further decrease flight-idle torque.

1. Crew — Briefed (P/CP).
   a. Distance and time to landing.
   b. Weather.
   c. Approach
      (1) Primary and alternate approach.
      (2) NAVAID set up.
      (3) Minimum safe altitude.
      (4) Final approach course.
      (5) DH/MDA and missed approach point.
      (6) Timing (if required).
      (7) Missed approach instructions.
      (8) Flap setting.
      (9) Approach and landing speeds.
2. Passengers, cargo — As Required (LM).
3. Pressurization — Set (FE).
4. Barometric altimeter — Set (state setting) (P) (CP).

Note

Barometric altimeters will be set to station pressure (QNH) if available when transiting the transition level. Altimeters may be set when above but cleared through the transition level.

5. Temperature datum control valves — As Required (FE).

Note

Temperature datum control valves, if locked, should be reset prior to an altitude change of 5,000 feet.

6. Ground proximity warning system — Set (CP).

8.12.1 Normal Descent. This descent is made by retarding the throttles to flight idle with the gear and flaps retracted and descending at maximum level-flight (V_H) speeds. The normal descent chart presented in the NAVAIR 01-75GAI-1.1 is based on maximum level-flight (V_H) speeds. Refer to Chapter 4 for airspeed limitations.

8.12.2 Maximum-Range Descent. This descent is made by retarding the throttles to flight idle with gear and flaps retracted and descending at maximum lift-over-drag speeds. This descent will provide a moderate sink rate (approximately 1,500 fpm) for en route let down.

8.12.3 Rapid Descent — Clean. At high airspeeds, the highest descent rates are obtained by retarding the throttles to flight idle with the gear and flaps retracted and descending at maximum allowable airspeeds, listed in Chapter 4. The rapid descent chart with gear and flaps retracted is based upon maximum allowable speeds for 35,000 pounds of cargo or less.

8.12.4 Rapid Descent — Dirty. At low airspeeds, the highest descent rates are obtained by retarding the throttles to flight idle, decreasing airspeed to 145 knots, and extending landing gear and full flaps. Descend at or below 145 knots.

8.13 APPROACH

1. Galley floor — Set (LM).
2. Fuel panel — As Required (FE).
3. Seatbelts — Fastened (All).

Note

Shoulder harnesses shall be used on all seats so equipped.

4. Altimeters — Set (state setting of both barometric altimeter and radar altimeter) (P) (CP).

WARNING

This step shall not be completed until the QNH has been set.

5. NAV SEL switch — As Required (P) (CP).

WARNING

This checklist shall not be completed until the NAV SEL switch is selected for the final approach NAVAID and the final approach course has been selected on the HSI.

CAUTION

All visual approaches shall be backed up with an instrument approach serving the airfield of intended landing.

Note

True heading is presented on the HSI whenever the INS position is selected. All runways, instrument approaches, and radar vectors are based on magnetic headings.

8.14 LANDING

WARNING

To preclude landing with the yaw damper engaged, this checklist shall not be commenced until the autopilot controller is fully disengaged. If a coupled approach is being executed, the autopilot shall be disengaged no lower than 200 feet AGL.

1. Hot mike — ON (P) (CP) (FE).

2. Flaps — As Required (P) (CP).

3. Landing gear — Down, Checked, Centered (P) (CP) (FE).

4. Hydraulic panel — Checked, Set (CP).

   a. Auxiliary hydraulic pump — ON.

   b. Hydraulic pressures — Checked.

5. Lights — Set (CP).

   a. Landing lights — Extended, ON.

   b. Taxi lights — ON.

6. SYNCHROPHASE MASTER switch — OFF (FE).

7. Pressurization — Checked (FE).

   a. Ensure aircraft is depressurizing.

8. Antiskid — Checked (FE).

   a. Check that all four ANTI-SKID lights illuminate after wheel rotation stops.

   b. Place the test switch to the FWD position. All four lights should go out.

   c. Release test switch to OFF. The two FWD lights should illuminate momentarily. After 2 to 3 seconds, all four lights should illuminate and remain illuminated.

   d. Repeat steps b and c for the aft wheels.

8.15 LANDING PROCEDURES

See Figure 8-6 for the landing pattern.

8.15.1 Normal Landing. The normal landing configuration is with 50- or 100-percent flaps. Refer to NAVAIR 01-75GAI-1.1 for landing speeds and distances.

CAUTION

It is possible to scrape the aft bottom of the aircraft when landing with extreme nose-high attitudes.

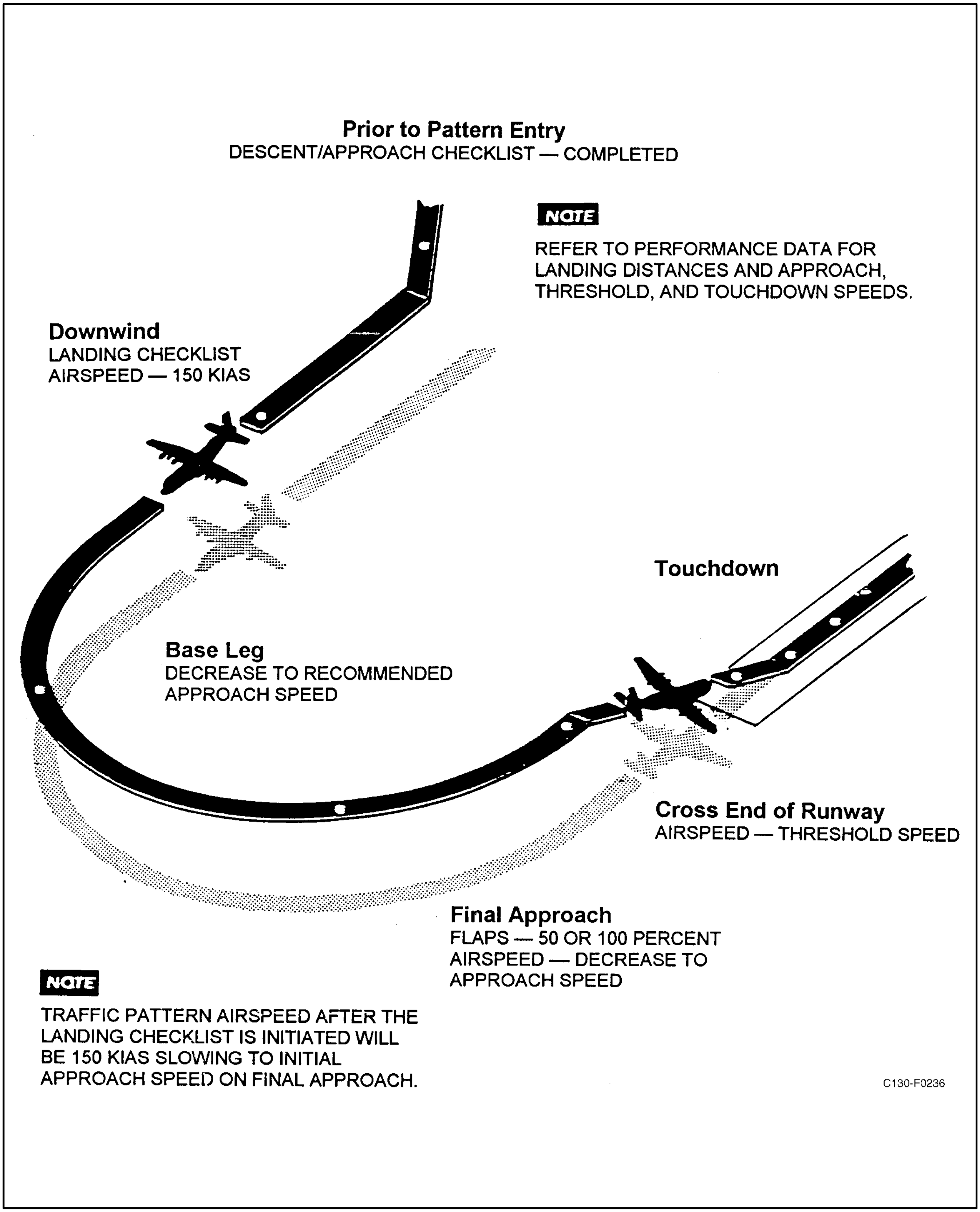


Figure 8-6. Normal Approach and Landing

Every landing should be planned according to runway length available and the general prevailing operating conditions. Normal landings should also be planned to use all of the available runway length to promote safe, smooth, and unhurried operating practices; to preclude abrupt reverse power changes; and to save wear on the brakes. The VFR pattern downwind airspeed is 150 KIAS or computed approach speed, whichever is higher. On final approach, begin to decrease airspeed from approach speed at a point that will allow a gradual slowup to cross the runway threshold at the threshold speed. Touchdown should be planned at the speed computed from the appropriate landing speed chart. After the main wheels touch down, smoothly lower the nosewheel to the runway. When the main and nose landing gear are firmly on the runway, the copilot must hold forward pressure on the control column and maintain a wings-level attitude with ailerons, as needed. Concurrently, the pilot maintains directional control and decelerates the aircraft using rudder, differential power, nosewheel steering, and differential brakes according to speed, wind, and runway conditions. Reverse thrust is applied by moving the throttles from FLIGHT IDLE to GROUND IDLE and then into the reverse range in coordination with nosewheel steering. Brakes must be checked during the landing roll.

8.15.2 Propeller Reversing. Every landing should be planned as though reverse thrust were not available. Do not use the brakes more than necessary as sustained braking will overheat the brake assemblies. On a long runway, allow the aircraft to roll until it loses speed. Check the brakes to ensure braking action is available.

WARNING

Retarding the throttles below FLIGHT IDLE at airspeeds above 115 KIAS could result in power loss/bogdown or flameout on one or more engines, particularly when operating in high ambient temperatures. This consideration does not prohibit the use of full reverse at higher airspeeds when reversing action is essential to stopping within the confines of the runway. If power loss/bogdown or flameout occurs, maintenance action is required prior to subsequent flight.

WARNING

The failure of one or more propellers to reverse may result in complete loss of directional control. After touchdown, if the throttles are moved into the ground range too rapidly, it is possible to lose control of the aircraft before a propeller malfunction can be detected. The movement from the flight range into the ground range should be made at a reasonable rate that will allow malfunction detection, such as failure of a low pitchstop to retract. At the first indication of directional control difficulty during reversing, immediately return all throttles to GROUND IDLE. Maintain directional control with flight controls, differential braking, and nosewheel steering as required. After identifying the affected propeller, symmetrical propellers may be reversed and the affected engine shut down while it is in ground idle. Rudder, differential power, and brakes are the primary means of directional control.

CAUTION

- Propeller reversing with an unbalanced fuel load can cause an extreme wing-low attitude and undesirable control characteristics.

- During the final stage of landing roll, reduce reverse thrust if conditions permit to prevent debris from causing restriction to visibility or engine damage.

8.15.3 Crosswind Landing. NAVAIR 01-75GAI-1.1 contains maximum allowable crosswind information. Landing with a crosswind in excess of 35 knots is not recommended. Use normal approach speeds if the wind is steady. When winds are gusty, a slight increase in approach airspeed is recommended. Immediately after the main wheels touch down, lower the nosewheels and hold in firm contact by using the elevators. During landing roll, control the aircraft directionally by using the following methods, listed by priority:

1. Aileron and rudder control
2. Nosewheel steering
3. Differential braking
4. Differential power.

The upwind wing has a tendency to rise when reverse thrust is applied. Since this tendency is most pronounced when the flaps are extended 100 percent, flaps should be raised before applying reverse power on landing in severe crosswinds.

CAUTION

An engine-out condition may add difficulty to a crosswind approach and landing by adding to the drift and weathervaning.

8.15.4 Gust Correction. Increase rotation speed, approach speed, threshold speed, and landing speed by the full gust increment, not to exceed 10 knots.

Note

Use of a correction factor for gusts or other accelerations which may affect the aircraft should be undertaken with consideration of all the factors involved. If a correction is required to compensate for a given gust velocity, the value of the correction must be the same regardless of wind direction. This is true because the objective is to provide a safety margin for maneuver loads while flying the aircraft through a series of accelerations. The accelerations can be equally severe whether they are produced by headwind, crosswind, or tailwind. However, since a pilot cannot estimate the frequency or timing of gusts with practical accuracy, it is possible for the aircraft to arrive at the flare point with gust correction added during an interval when gusts have stopped momentarily. Under such conditions, the distance consumed dissipating excess airspeed could move the touchdown point farther down the runway than planned. Therefore, whenever a correction factor is added for gusts or other accelerations, the pilot must be prepared to accept a correspondingly higher approach speed with the possibility of increased landing distance. If stopping distance available beyond the maximum estimated touchdown point is marginal, the pilot should select a longer runway or proceed to an alternate base.

8.15.5 Wind Shear. Wind shear is a complex phenomenon. It can affect the airplane in all phases of flight, but is most critical during the approach and landing phase. Wind shear can exist as a rapid change in wind velocity and direction as well as vertical air movement. There are certain conditions which indicate the possibility of wind shear being present. As a general rule, the amount of shear is greater ahead of warm fronts although the most common occurrences follow the passage of cold fronts during periods of gusty surface winds. When a temperature change of 10 °F or more is reported across the front or if the front is moving at 30 knots or more, conditions are excellent for wind shear. In addition, when thunderstorms are present in the area of intended landing, the possibility of encountering wind shear is increased. The power required, vertical speed, and pitch attitude, used in conjunction with the wind reported on the ground, provide an indication of potential wind shear.

In relation to a known surface wind, be alert for:

1. An unusually steep or shallow rate of descent required to maintain glidepath.
2. An unusually high or low power setting required to maintain approach airspeed.
3. A large variation between actual and computed ground speed.

When a reported surface wind would not justify an increased airspeed (for example: calm wind on the surface), but wind shear is suspected, adjustment of approach speed may be used to provide an increased speed margin. The following are two wind shear phenomena which are commonly found on final approach.

8.15.6 Decreasing Headwind. Initial reaction of the airplane when suddenly encountering a decreasing headwind (or an increasing tailwind) is a drop in indicated airspeed and a decrease in pitch attitude resulting in a loss of altitude. The pilot must add power and increase pitch to regain the proper glidepath. Once speed and glidepath are regained, however, prompt reduction of power is necessary. It will now require less power and a greater rate of descent to maintain the proper profile in the decreased headwind. If the initial corrections of increased power/pitch are not promptly removed after regaining glidepath and airspeed, a long landing at high speed will result.

8.15.7 Increasing Headwind. The initial airplane reaction to an increasing headwind (decreasing tailwind) is an increase in indicated airspeed and an increase in pitch attitude resulting in a gain in altitude. The pilot should reduce pitch and power to regain the proper glidepath. As glidepath is regained, the pilot must immediately compensate for the increasing headwind by increasing pitch and power. It will now require more power and a decreased rate of descent to maintain the proper profile. Be very cautious in making reductions of power and pitch to avoid a low-power, high-sink condition which could lead to a correction through the glidepath from which a recovery could not be made.

WARNING

If the airplane becomes unstable on final approach due to wind shear and the approach profile can not be promptly reestablished, a go-around should be immediately accomplished.

8.15.8 No-Flap Landing

1. Place the GPWS switch to OVERRIDE.

WARNING

Ensure the GPWS switch is returned to NORMAL prior to performing subsequent touch-and-go or full-stop landings.

2. Fly a slightly wider, slightly longer pattern to compensate for the higher no-flap airspeeds.

3. Do not flare but rather allow the aircraft to fly onto the runway.

CAUTION

If the touchdown is lower than the charted speed, it is possible for the aft end of the fuselage to contact the ground.

4. When applying reverse thrust at high speed, pull the throttles into reverse slowly.

5. Longer ground rolls will result from the higher touchdown speeds.

8.15.9 Minimum Run Landing. Fly a normal pattern, slowing the aircraft to arrive over the threshold at the maximum effort threshold speed with 100-percent flaps. This threshold speed is approximately 6 knots below the normal threshold speed when aircraft weight exceeds 105,000 pounds. Fly the aircraft onto the ground, touching down as close to the end of the runway as possible. Immediately touch down the nosewheel. Reverse the propellers and apply full antiskid braking as required.

8.15.10 Landing on Wet Runways. Reverse thrust, antiskid braking, and nosewheel steering capabilities minimize normal hazards associated with wet runways.

8.15.11 Landing on Icy Runways. Operation on ice is hazardous and should be attempted only when necessary. Use of nosewheel steering should be minimized, and taxi speed must be slow. Directional control can be maintained with asymmetrical power and nosewheel steering at taxi speeds, and with asymmetrical power and rudder at speeds above rudder effectiveness. Touchdown should be made at the minimum safe speed possible, and maximum aerodynamic drag is obtained by holding the nosewheel off of the ground for as long as possible. Use symmetrical power and reverse thrust as the primary means to obtain braking action and to prevent yawing and skidding.

WARNING

Landing should not be attempted on ice-covered runways if crosswinds require large corrections.

8.15.12 Touch-and-Go Landing. Before the first touch and go, all normal checklists shall be completed through the Landing Checklist. After the first touch and go, the Touch-and-Go Landing Checklist may be used until the aircraft departs the airport traffic/approach control area. The operational stop portions of the After Landing, Before Taxi, and Takeoff Checklists shall be used for full-stop landings when hatches/doors are opened and/or flaps and/or trim tabs are operated.

Touch-and-go landings require a significant element of caution because of the many actions that must be executed while rolling on the runway. The actions required during touch-and-go landings are divided into three categories: on the runway, after takeoff, and landing.

After the aircraft has touched down (both main and nosewheels), the pilot flying the aircraft will call for flaps to be set at 50 percent by stating "Flaps 50"; the other pilot will complete the checklist. When the trim is set for takeoff, the pilot not flying will state "Flaps 50, trim set, throttles." The pilot flying will smoothly advance the throttles to the briefed setting. The flight engineer will state the torque values in 5,000-inch-pound increments up to 15,000-inch-pounds and will then state "Power set" upon reaching the briefed setting.

Note

If repeated touch-and-go landings are planned, leave the landing gear extended to cool the wheels and brakes.

8.15.12.1 On the Runway

1. Flaps — 50 Percent (P/CP).
2. Trim tabs — Set (P/CP).
3. Throttles — As Required (P/CP).

8.15.12.2 After Takeoff

1. Gear, flaps, lights — Checked (P/CP) (FE).

8.15.12.3 Landing

1. Crew — Briefed (P/CP).
   a. Type approach.
   b. Type landing (flap setting, simulated engine(s) out).
   c. Touch and go/full stop.
2. Flaps — As Required (P) (CP).
3. Landing gear — Down, Checked, Centered (P) (CP) (FE).
4. Hydraulic panel — Checked (P/CP).
   a. Auxiliary hydraulic pump — As Required.
   b. Hydraulic pressures — Checked.

8.16 GO-AROUND

When a go-around is anticipated, alert the crew, delay full flap extension, and keep the airspeed higher than normal. When a go-around is decided upon, proceed as follows:

1. "Go around" command given to crew.
2. Advance throttles as required.
3. "Flaps 50" percent (speed and altitude permitting).

WARNING

Retracting flaps from 100 to 50 percent will increase stall speed. Without proper power and attitude corrections, sink rate will also increase. This is particularly noticeable at lower than normal airspeeds. If safe altitude and airspeed are not attained, inadvertent touchdown and/or stall may occur.

4. "Gear up" (when certain the aircraft will not touch down).

5. Proceed with normal After Takeoff Touch-and-Go procedures.

8.17 AFTER LANDING (ONLY CIRCLED ITEMS NEED TO BE CHECKED AT OPERATIONAL STOPS)

Flight engineer items not requiring coordinated action may be accomplished after the pilot has called for the After Landing Checklist. This does not preclude response to the checklist when called by the copilot.

WARNING

No door or hatch may be opened without the aircraft commander's permission. The aircraft commander shall not allow a door or hatch to be opened until the aircraft is verified to be unpressurized. If any doubt exists, the copilot shall open the right swing window.

1. Flaps — As Required (CP).

2. Oil cooler flaps, augmentation — As Required (FE).

CAUTION

On aircraft prior to 165313, ensure that the oil cooler flaps are open and the switches are FIXED before activating oil cooler augmentation. On aircraft 165313 and up, the switches must be in AUTO.

3. Lights — Set (CP) (FE).

Note

Use of the taxi and landing lights will be at the aircraft commander's discretion. The lights will normally be turned off except during operations at night or in reduced visibility.

4. Radar, IFF transponder — STANDBY (P) (CP) (FE).

5. Pressurization — No Pressure (FE).

Note

Ensure the differential pressure is zero prior to placing the AIR CONDITIONING master switch to NO PRESS.

6. Anti-icing panel — OFF (FE).

7. APU panel — Set (FE).

   a. APU CONTROL switch — START, RUN.

8. Electrical panel — Set (FE).

   a. APU generator — ON, Checked.

Note

The APU generator must be on for low-speed ground idle operation since the engine-driven generators will be off line.

   b. Dc BUS TIE switch — Tied.

Note

The main ac bus may be powered by the APU generator provided no engine-driven generator is supplying power and the ac BUS TIE switch is in the ON position.

8.18 SECURE

1. Parking brake — Set (P).

Note

Under normal conditions, the pilot will clear the loadmaster to exit the aircraft using the crew entrance door.

2. Oil cooler augmentation switches — OFF (FE).

3. Shutdown, NTS check — Complete (All).

CAUTION

During engine shutdown, do not move the condition lever from GROUND STOP to RUN while the propeller is still rotating.

CAUTION

Engine shutdown should not be accomplished when taxi speed, wind velocity, or a combination of wind velocity and taxi speed is greater than 20 knots. Engine shutdown under these conditions may damage the safety coupling. When doubt exists as to the effective speed, shutdown should be delayed.

Note

- On engine shutdown, some fuel will be seen draining from the engine drain mast. In the event of "No drip," the pilot shall wait until the propeller has ceased rotation and then motor the engine to 25-percent rpm with the starter, leaving the condition lever in GROUND STOP.
- To extend engine life, engines shall be operated in low-speed ground idle for at least 2 minutes prior to shutdown.
- Engines shall be shut down from low-speed ground idle.

a. Copilot shall place the FEATHER VALVE AND NTS CHECK switch in the NTS position.

b. Copilot shall move the condition levers to GROUND STOP.

c. Copilot and flight engineer shall observe zero fuel flow and illumination of the applicable NTS lights.

CAUTION

If zero fuel flow is not observed, move the applicable condition lever to FEATHER to mechanically shut off fuel.

d. A crewmember shall observe proper operation of each drip valve.

Note

NTS lights may not illuminate when shutting down engines from low-speed ground idle. If NTS lights do not illuminate, restart the engine and shut down from NORMAL ground idle. If the NTS lights illuminate after a NORMAL ground idle shutdown, no further action is required. If the NTS lights still do not illuminate from NORMAL ground idle, maintenance action is required prior to the next flight.

4. Unnecessary equipment — OFF (P) (CP) (FE).
5. Oxygen — Checked, OFF (All).
6. Chocks, nosepin — Installed (LM).
7. Parking brake — Released (P).
8. Hydraulic panel — Set (CP).

CAUTION

The engine pump switches shall be left on after engine shutdown. If the switch is left off, pressure buildup because of thermal expansion of the hydraulic fluid may cause the suction line hydraulic shutoff valve to fail.

a. SUCTION BOOST PUMP switches — OFF.

b. ANTI-SKID switch — OFF.

c. Auxiliary hydraulic pump switch — OFF.

d. Brake pressures — Depleted.

9. AIR CON MASTER — AUX VENT (FE).

8.19 BEFORE LEAVING THE AIRCRAFT

1. Oil cooler flaps — As Required.
2. Radar — OFF.
3. Air-conditioning — OFF.
4. Bleed air — OFF.

5. Electrical panel — Set.

   a. Engine generator switches — OFF.

   b. Inverters — OFF.

   c. BSU switches (some aircraft) — OFF.

6. Fuel panel — Set.

   a. Fuel BOOST PUMP switches — OFF.

   b. CROSSFEED VALVE switches — Closed.

7. Temperature datum valves — Null.

8. Oxygen — NORMAL/100%/OFF.

9. Hydraulic panel — Set.

10. Ac BUS TIE switch — OFF.

11. APU generator — OFF.

12. APU panel — Set.

    a. APU BLEED AIR VALVE switch — CLOSE.

    b. APU CONTROL switch — STOP.

13. Radios — OFF.

14. Wheels — Chocked.

15. Parking brake — Released.

16. Lights — Set/OFF.

17. Dc BUS TIE and BATTERY — Set.

    a. Dc BUS TIE switch — NORMAL.

    b. Dc power switch — OFF.

    c. Dc voltmeter switch — MAIN DC BUS.

Note

If the DC voltmeter switch is left in the BAT position for an extended length of time, the output of the battery will be decreased.

18. INS/GPS — OFF.

19. Emergency exit light switch — Depressed.

20. Covers, plugs — Installed.

21. Interior/exterior lights — OFF.

22. Doors and ramp — As Required.

23. SDRS — Set/OFF.

CAUTION

Never install rig pins in the control system or secure the flight deck controls as a means of locking the surfaces against wind gusts. Otherwise, damage to the hydraulic booster and/or cable system is likely to result.

8.20 CRUISE ENGINE SHUTDOWN

Engine shutdown may be performed during cruise flight to achieve optimum fuel economy to meet mission requirements. Refer to NAVAIR 01-75GAI-1.1 for range information.

WARNING

Operating in the freezing range with visible moisture present may cause icing that will prevent starting of shutdown engines.

CAUTION

- Do not place the condition levers in any position other than FEATHER, RUN, or AIRSTART during flight. Stopping or hesitating between the FEATHER, RUN, or AIRSTART positions can result in undesirable operation of the engine-propeller system.
- NTS check should be accomplished on one engine at a time.

1. Crew — Briefed (CP).

2. SYNCHROPHASE MASTER — OFF (FE).

3. Propeller governor control — Mechanical (CP).

4. FEATHER VALVE AND NTS SWITCH — VALVE (CP).

5. Airspeed — Below 180 KIAS (P).

6. NTS check — Complete (FE).

CAUTION

If NTS action is not observed by –1,860 inch-pounds, advance the throttle and return the engine to normal operation. Record the malfunction in the aircraft records. If the NTS is operative, continue the procedure for engine shutdown.

Note

Torque should decrease and the highest negative torque value should be noted. NTS action should begin at –1,260 (±600) inch-pounds as indicated by an increase in torque and the blinking of the NTS light each time the feather valve has moved to the feather position. During the NTS check, torque fluctuations to positive 500 inch-pounds (maximum) are considered normal.

a. Throttle — 4,000 Inch-Pounds or More (P).

b. WING and EMPENNAGE ANTI-ICING — ON (FE).

c. ENGINE BLEED AIR switch (engine being checked) — OVRD (FE).

d. ENGINE BLEED AIR switch (other engines) — OFF/One at a Time (FE).

e. Slowly retard the throttle observing decrease in torque value until NTS action is observed — Checked (FE).

f. Advance throttle into positive torque range — Advanced (FE).

Note

Repeat steps 6a through 6f for engines remaining as required.

g. WING and EMPENNAGE ANTI-ICING — OFF (FE).

h. ENGINE BLEED AIR switches — ON (FE).

i. NTS check — Complete (FE).

7. Throttle of engine to be shut down — FLIGHT IDLE (P).

8. BLEED AIR switches on operative engines — ON (FE).

9. SYNCHROPHASE MASTER — Reset as required (FE).

CAUTION

When pulling a condition lever to FEATHER, pull it all the way to the detent to ensure that the propeller is fully feathered. If the lever is left at midposition and the NTS is inoperative, an engine decoupling is possible.

10. Condition lever — FEATHER (CP).

11. Fuel boost pump — OFF (FE).

12. Engine generator switch — Set (FE).

    a. Generator switch (aircraft prior to 165313) — Tripped/OFF (FE).

    b. Generator switch (aircraft 165313 and up) — OFF (FE).

13. Propeller feather override button — Out (CP).

14. Throttle of engine shutdown — Full Forward (P).

15. Oil cooler flap — Closed/Fixed (CP).

16. Fuel management — Checked (FE).

8.21 AIRSTART

Before restarting an engine that has been shut down in flight, be sure that the TIT for that engine has dropped below 200 °C. Temperature higher than 200 °C will increase the likelihood of a hot start. Never move the throttle below the FLIGHT IDLE position in flight. The position of the engine condition lever is assumed to be

FEATHER. The engine will normally come up to speed more rapidly if the airspeed is reduced to 180 knots or less.

CAUTION

- Do not attempt to restart an engine that was shutdown because of fire or fire warning or any other engine malfunction unless, in the opinion of the pilot, a greater emergency exists.

- Do not attempt to restart an engine with an inoperative NTS except in case of a greater emergency. Prior to airstart of an engine on which the NTS has been previously determined to be inoperative, reduce the airspeed to 130 KIAS and the altitude to below 5,000 feet.

- If negative de-enrichment is observed, the copilot will immediately return the condition lever to FEATHER. A second start may be attempted with fuel enrichment switch in the OFF position.

1. Fire handle — In (CP).

2. Throttle — Set Approximately 1 Inch Above FLIGHT IDLE (P).

3. Fuel BOOST PUMP switch — ON (FE).

4. Oil cooler flap switch — Automatic (CP).

5. Fuel enrichment switch — NORMAL (P).

6. PROPELLER GOVERNOR CONTROL switch — MECH (CP).

7. NTS check switch — VALVE (CP).

8. TEMP DATUM CONTROL VALVE switch — AUTO (FE).

CAUTION

- If, during an airstart at 10-percent rpm, the flight engineer has not called NTS, the copilot will return the condition lever immediately to FEATHER. A second start attempt is not recommended unless, in the opinion of the pilot, a greater emergency exists.

- Normal light-off should occur by the time the engine reaches 30-percent rpm. If the engine does not light-off prior to reaching 40-percent rpm, discontinue the start and return the condition lever to FEATHER immediately.

Note

- Hold the condition lever in AIRSTART until light-off, then release to RUN. Monitor engine instruments as on a ground start. Monitor the NTS check light for an NTS indication as indicated by a blinking of the light.

- If normal airstart cannot be accomplished because of failure of the propeller to rotate and the blade angle change is indicated by illumination of the NTS light, an emergency start may be attempted by placing the BLEED AIR switch to OVRD and using the engine starter to help unlock the propeller brake.

9. Condition lever — AIRSTART (CP).

10. Generator switch — Reset/ON (FE).

11. Fuel enrichment switch — OFF (P).

12. ENGINE BLEED AIR switch — ON (FE).

13. PROPELLER GOVERNOR CONTROL switch — NORMAL (CP).

14. Engine instruments — In Limits (FE).

8.22 NIGHT FLYING

The aircraft presents no particular problems when night flying. The aircraft lighting system is excellent in the cockpit, fuselage, and exterior. In addition to the following, all procedures recommended for day VFR and IFR flights shall apply to night flying.

1. The landing lights shall be extended and on for all takeoffs and landings.

WARNING

Turn landing lights off prior to retraction. Failure to do so may result in spatial disorientation.

2. Do not remove the emergency exit lights stowed by the emergency exits for any use except an emergency. These are part of the aircraft emer–gency equipment and should always be readily available.

3. A flashlight with a red lens shall be readily available in the cockpit for all night flying.

4. During ground operation, turn on the leading edge lights to prevent personnel on the ground from inadvertently walking into the propeller.

Note

Reflections of the anticollision/strobe light on clouds may cause vertigo.

8.23 OPERATION OF THE AIR-CONDITIONING SYSTEMS

The air-conditioning systems can be operated from bleed air supplied by the APU or by the engines while the aircraft is on the ground, or an external ground compressor unit may be attached. The engines supply the bleed air for operating the air-conditioning system in flight.

CAUTION

- Do not open the TEMP CONTROL circuit breakers on the copilot lower circuit breaker panel during operation of the air-conditioning systems. Opening these circuit breakers will disable the automatic shutoff circuit and may result in damage to the air-conditioning equipment.
- Do not reset if mechanical failure of the unit is known or suspected.

Note

Either of the airflow regulators will be closed automatically to stop entry of bleed air if an overpressure condition occurs in the water separator inlet duct. In the event that either air-conditioning unit is shut down automatically, select a warmer temperature with the temperature control switch/knob for the affected system. After 3 minutes or longer, place the AIR CONDITIONING master switch to OFF and then back to the original position. After the air conditioning unit operation stabilizes, select temperature as desired.

8.23.1 Ground Air-Conditioning. Ground air-conditioning is accomplished by using either an external unit or the aircraft air-conditioning system.

8.23.1.1 Air-Conditioning With an External Unit

1. Place a ground air-conditioning adapter in the airscoop of the system to be operated.
2. Attach the hose of the ground air-conditioning unit to the adapter.
3. Position the AIR CONDITIONING master switch to AUX VENT.

Note

Airscoop adapters for ground air-conditioning are stowed on a rack aft of the right paratroop door.

8.23.1.2 Air-Conditioning with Aircraft System

1. Place the ENGINE BLEED AIR switches in the OFF position.

2. Start the APU.

3. Place the APU BLEED AIR VALVE switch in the OPEN position.

4. Check the bleed-air pressure gauge.

5. Position either the air-conditioning CARGO COMPT or FLT STA switches to NORM.

6. Position the EMERGENCY DEPRESSURIZATION switch to NORMAL.

7. Turn the AIR CONDITIONING master switch to NO PRESS.

8. Hold the temperature control switches in the COOL or WARM position as desired for 30 seconds, then return to AUTO. This procedure will position the temperature control valve to the approximately desired position more rapidly and minimize the amount of hot bleed air entering the compartment when the temperature rheostat knobs are in COOL.

9. Position the temperature rheostat knobs as desired.

Note

Use the underfloor heater fan if the LH ac bus is powered.

10. Turn the AIR CONDITIONING master switch to OFF before starting an engine.

8.23.2 In-Flight Air-Conditioning

1. Place the AIR CONDITIONING master switch in NO PRESS, AUTO PRESS, or MAN PRESS, as desired.

2. Position the temperature control switches to AUTO.

3. Position the temperature rheostat knobs as desired.

4. Position the UNDERFLOOR HEATING heat switch to ON.

8.24 OPERATION OF THE PRESSURIZATION SYSTEM

8.24.1 Pressurized Flight — Automatic Pressure Control

WARNING

To allow rapid egress in event of an emergency, do not pressurize the aircraft during taxi or takeoff operations.

8.24.1.1 Before Takeoff

1. Turn the RATE knob to MIN.

2. Set the CABIN ALT knob to desired cabin cruise altitude but never less than field elevation.

3. Set the AIR CONDITIONING master switch to AUTO PRESS.

8.24.1.2 After Takeoff Climb

1. Set the RATE knob to the desired rate. Adjust the rate setting as required during climb so that the cabin reaches the selected altitude at the same time the aircraft reaches cruise altitude. Thus, the rate-of-climb pressure change is held to a minimum. The rate-of-cabin pressure change is held constant only up to pressure controller differential limit.

Note

Monitor cabin altitude against aircraft altitude to make sure that cabin altitude stays within the isobaric range (see Figure 2-68).

8.24.1.3 Cruise. During pressurized flight, monitor the cabin differential pressure and cabin altitude. Do not allow cabin differential pressure to exceed the maximum allowable for the aircraft.

8.24.1.4 Descent

1. Set the CABIN ALT knob for the desired cabin altitude.

2. Set the RATE knob to the desired rate.

8.24.1.5 Before Landing. Check the cabin differential pressure before landing. If more than 1.5 inches of mercury is indicated, the CABIN ALT knob and the RATE knob should be adjusted to higher settings to increase the rate of depressurization.

Note

Cabin differential pressure will be zero for landing. If the differential pressure is less than 0.5 inch of mercury, no discomfort will be experienced if the AIR CONDITIONING master switch is turned to a nonpressure position.

8.24.2 Pressurized Flight — Manual Pressure Control

8.24.2.1 Before Takeoff

1. Set the AIR CONDITIONING master switch to MAN PRESS.

2. Hold the MANUAL PRESS CONT switch to the INCREASE position until a pressure indication is noted on the cabin rate-of-climb indicator.

3. Set the altitude selector knob to read 10,000 feet.

8.24.2.2 After Takeoff Climb. Hold the MANUAL PRESS CONT switch in the INCREASE position until an indication of cabin pressure is observed on the cabin vertical velocity indicator. Exercise caution during manual pressure control in order to prevent excessive rate-of-cabin pressure changes that can cause extreme discomfort to passengers and crew. Operation of the MANUAL PRESS CONT switch by momentarily holding it in the desired position and then releasing it to the OFF position will provide satisfactory control. Monitor the aircraft vertical velocity indicator, cabin vertical velocity indicator, cabin differential pressure gauge, and the cabin altimeter. Establish as closely as possible a constant cabin rate of climb by intermittently positioning the MANUAL PRESS CONT switch momentarily to the INCREASE position. By reaching the normal differential pressure at the desired cabin altitude when the aircraft reaches cruise altitude, the minimum rate of cabin pressure change will be attained.

Note

- After switching from automatic to manual pressure control, the MANUAL PRESS CONT switch must be held in the DECREASE position for approximately 40 seconds to open the outflow valve fully.

- Monitor cabin altitude against aircraft altitude to make sure that cabin altitude stays within the isobaric range (see Figure 2-68).

8.24.2.3 Cruise. When the aircraft has reached stabilized cruise conditions, adjust the outflow valve with the manual control switch to maintain a constant differential pressure and constant cabin pressure altitude. Monitor the cabin differential pressure gauge and the cabin altimeter so as not to exceed the allowable limits.

8.24.2.4 Descent. As soon as the aircraft starts the descent, position the MANUAL PRESS CONT switch momentarily to the INCREASE position in order to establish a decrease of cabin pressure altitude. Maintain a comfortable rate-of-cabin pressure change by intermittently positioning the outflow valve until the desired altitude is reached. Allow cabin differential pressure to decrease by positioning the MANUAL PRESS CONT switch to open the outflow valve.

8.24.2.5 Before Landing. Check the cabin differential pressure prior to landing. If more than 1.5 inches of mercury differential pressure exists, momentarily position the MANUAL PRESS CONT switch to the DECREASE position to control the rate of cabin depressurization.

Set the AIR CONDITIONING master switch (as required).

Note

Cabin differential pressure will be zero for landing. If cabin differential pressure does not exceed 0.5 inch of mercury, no discomfort will be experienced if the aircraft is depressurized by turning the AIR CONDITIONING master switch to a nonpressure position.

8.24.3 Nonpressurized Flight

Before takeoff:

1. Set the AIR CONDITIONING master switch to NO PRESS or AUX VENT.

8.24.3.1 Transition from Nonpressurization to Pressurization During Flight

1. Turn RATE knob to MIN.
2. Set CABIN ALT knob to desired cabin altitude.
3. Turn AIR CONDITIONING master switch to AUTO PRESS.

Allow cabin differential pressure to build up to approximately 2 inches of mercury to provide sufficient pressure for the pneumatically actuated controller to stabilize and maintain a selected rate.

4. Turn RATE knob to desired rate.

Adjust the rate setting so that the cabin reaches the selected altitude at the same time the aircraft reaches cruise altitude. The rate of cabin pressure change is thus held to a minimum.

8.24.3.2 Transition from Pressurization to Nonpressurization During Flight

1. Set RATE knob to desired rate.
2. Set CABIN ALT knob to aircraft altitude at altitudes below 10,000 feet.
3. When above 10,000 feet, turn the AIR CONDITIONING master switch to MAN PRESS and hold the MANUAL PRESS CONT switch in the DECREASE position.

   Cabin altitude will increase at the rate selected until cabin pressure equals atmospheric pressure. The differential pressure is thus reduced at a controlled rate.

4. Turn AIR CONDITIONING master switch to NO PRESS/AUX VENT (as soon as differential pressure reaches zero).

8.24.4 Pressurized Flight — Transition from Manual to Automatic Control

1. Ensure proper control and positioning of the outflow valve. Momentarily position the MANUAL PRESS CONT switch to DECREASE; check for decrease on the cabin rate-of-climb indicator. Momentarily position the MANUAL PRESS CONT switch to INCREASE to stop decrease of cabin pressure and stabilize the cabin.
2. Set the rate knob to MIN.
3. Set the CABIN ALT knob slightly below present cabin altitude. Monitor cabin rate-of-climb indicator. An indication of increase in cabin pressure indicates controller takeover.
4. Set AIR CONDITIONING master switch to AUTO PRESS.
5. Monitor cabin rate-of-climb indicator.

8.24.5 Pressurized Flight — Transition from Automatic to Manual Control

1. Position AIR CONDITIONING master switch to MAN PRESS.
2. Position MANUAL PRESS CONT switch to DECREASE. Monitor cabin rate-of-climb indicator for an indication of decrease in cabin pressure.
3. When positive control of the outflow valve is ensured, momentarily position the MANUAL PRESS CONT switch to INCREASE to stabilize the cabin pressure.
4. Set the cabin pressure controller to 10,000 feet.

8.25 CARGO DOOR AND RAMP OPERATION

ADS ramp supports (grasshopper arms), located on either side of the ramp, prevent it from lowering beyond the horizontal position in flight. When ground operations require the ramp to be lowered beyond the horizontal position, these arms may be easily disconnected at their attachment points on the ramp. During ground operation, the ADS control panel on the flight control pedestal is disabled through a touchdown relay. Interlock microswitches prevent electrical actuation of the cargo door and ramp, in flight or on the ground, when the aft anchor line arms are not in the stowed position (refer to paragraph 14.3). See Figure 2-61 for location of controls.

CAUTION

- Whenever the ramp is resting against a solid object (ground, truck bed, etc.), do not use the ramp for loading or unloading unless the handpump pressure gauge indicates a minimum of 500 psi. Serious damage may result if the locking action of the ramp cylinders is lost because of reduced pressure.
- Do not raise or lower the cargo door unless the aft anchor line arms are in the stowed position. Severe structural damage could result.
- Ensure the auxiliary hydraulic pump switches (flight station and control panel) are OFF and that the cargo door and ramp manual controls are in their neutral positions before applying electrical power to the aircraft.

8.25.1 Operation of the Cargo Door and Ramp from the Ramp Control Panel

Note

A 60-Kva power source is required to start the electric auxiliary hydraulic pump motor. The aircraft APU generator will handle the start current and may be used if a suitable external power source is not available.

Open the cargo door and ramp as follows:

1. Ensure the cargo door and ramp manual control valves are in the neutral position.
2. Place the auxiliary hydraulic PUMP switch in the ON position.
3. Hold the cargo DOOR switch in the OPEN position until the door is up and locked.
4. Hold the RAMP switch in the LOWER position until the ramp moves to the desired position. If the ramp is being lowered against a solid object, ensure the handpump pressure gauge indicates a minimum of 500 psi when the ramp is in its desired position.

Note

The ramp may be stopped in any position by releasing the RAMP switch to the spring-loaded neutral position. Stop the ramp at a position above horizontal and disconnect the ADS ramp supports if the desired final position is below the horizontal.

5. Place the auxiliary hydraulic PUMP switch in the OFF position.

Close the cargo door and ramp as follows:

1. Ensure the cargo door and ramp manual control valves are in the neutral position.
2. Place the auxiliary hydraulic PUMP switch in the ON position.
3. Hold the RAMP switch in the RAISE position until the ramp is up and locked. Visually inspect the locks for proper closure.

WARNING

If the ADS ramp supports have been disconnected, they must be reconnected prior to flight.

CAUTION

Before lowering the cargo door, visually inspect for adequate clearance from cargo or equipment loaded on the ramp.

4. Hold the cargo DOOR switch in the CLOSE position until the door is closed and locked.

WARNING

In the event the cargo door is released from the uplock by the cargo door uplock manual release, the door should be allowed to free-fall closed. Do not change the position of the DOOR switch or manual control valve handle while the door is in transit.

5. Check to ensure that the DOOR and RAMP OPEN warning lights have extinguished.

6. Place the auxiliary hydraulic PUMP switch in the OFF position.

Note

The sequence of opening the cargo door first and closing it last is important to follow. This will provide the maximum clearance for cargo loaded on the ramp.

8.25.2 Operation of Cargo Door and Ramp with Handpump Pressure

Open the cargo door and ramp as follows:

1. Move the cargo door manual control valve handle to the OPEN position. Operate the handpump until the door is up and locked.

2. Move the cargo door manual control valve handle to the NEUT position.

3. Move the ramp manual control knob to the No. 1 (unlock) position. Operate the handpump until all ramp locks are disengaged and retracted.

4. Move the ramp manual control knob to the No. 2 (lower) position. Operate the handpump until the ramp reaches the desired position. Disconnect the ADS ramp support arms if necessary. If the ramp is being lowered against a solid object, continue to operate the handpump until the handpump pressure gauge indicates a minimum of 500 psi.

5. Move the ramp manual control knob to the No. 3N (neutral) position for loading and unloading operations.

Close the cargo door and ramp as follows:

1. Move the ramp manual control knob to the No. 4 (raise) position. Operate the handpump until the ramp is closed.

WARNING

If the ADS ramp supports have been disconnected they must be reconnected prior to flight.

2. Move the ramp manual control knob to the No. 5 (lock) position. Operate the handpump until the handpump pressure gauge reads 3,000 psi and all ramp locks are visually engaged and the locking mechanism audibly snaps over center.

3. Move the ramp manual control knob to the No. 6N (neutral) position.

4. Move the cargo door manual control handle to the OPEN position.

5. Operate the handpump until the handpump pressure gauge reads 2,000 psi.

6. Pull the cargo door uplock manual release lever.

7. While the cargo door manual uplock release lever is pulled, return the cargo door manual control handle to the NEUT position.

8. Allow the door to settle toward the closed position. Release the uplock manual release handle.

9. Move the cargo door manual control handle to the CLOSE position. Operate the handpump until the cargo door is closed and locked.

10. Move the cargo door manual control valve handle to the NEUT position.

8.25.3 In-Flight Operation. See Figure 2-61 for location of controls.

WARNING

- Do not open the ramp in flight unless the ADS ramp supports are properly attached. Movement of the ramp below the horizontal position could result in the loss of control of the aircraft.
- Before opening the cargo door and ramp in flight, ensure all loose gear in the cargo compartment is properly secured. Personnel aft of the wheelwells should wear restraining harnesses or parachutes.

CAUTION

Do not open the cargo door and ramp in flight at speeds above the limiting airspeed of 150 KIAS.

If the cargo door and ramp are to be operated from the ramp control panel, proceed as follows:

1. Establish communications with the pilot. Ensure the aircraft has been depressurized and slowed to a suitable airspeed.
2. Clear the ramp area and cargo compartment of all unnecessary personnel.
3. When cleared by the pilot, operate the cargo door and ramp in the same manner as for ground operations. Use auxiliary hydraulic pump pressure, if possible. If the situation requires, the cargo door and ramp can be operated in flight using handpump pressure.

8.25.4 Operation of the Cargo Door and Ramp from the ADS Control Panel

Open the cargo door and ramp as follows:

1. Depressurize the aircraft.
2. Slow to 150 KIAS or less.
3. Establish communications with an observer in the cargo compartment. Ensure the cargo compartment is clear of all unnecessary personnel.
4. Place the cockpit auxiliary hydraulic pump switch on the hydraulic control panel to ON.
5. Move the RAMP AND DOOR CONT switch on the ADS control panel to the OPEN position.
6. Illumination of the green RAMP and DOOR OPEN light on the ADS control panel will occur when the door is up and locked and the ramp is in the aerial delivery position. When the light illuminates, place the RAMP AND DOOR CONT switch in the OFF position.

WARNING

Should the cargo door and ramp fail to open, place the ADS RAMP & DOOR and the auxiliary hydraulic pump switches to OFF prior to sending personnel aft to investigate.

7. Turn the cockpit auxiliary hydraulic pump switch to OFF.

Close the cargo door and ramp as follows:

1. Turn the cockpit auxiliary hydraulic pump switch on the hydraulic control panel to ON.
2. When the drop master signals the cargo has been dropped, and the ramp and door area is clear, move the RAMP AND DOOR CONT switch on the ADS panel to the CLOSE position.
3. The master door warning light will extinguish when the cargo door and ramp are fully closed and locked. When the light goes out, move the RAMP AND DOOR CONT switch on the ADS panel to the OFF position.
4. Turn the cockpit auxiliary hydraulic pump switch to OFF.

8.26 OPERATION OF ANTI-ICE/DEICE SYSTEMS

8.26.1 Operation of Engine Inlet Air Duct Anti-Icing Systems

1. To turn the systems on manually, position the PROP & ENGINE ANTI-ICING MASTER switch to MANUAL and the ENGINE INLET AIR DUCT ANTI-ICING switches to ON.
2. To allow the system to be turned on automatically by the ice detection system, position the PROP & ENGINE ANTI-ICING MASTER switch to AUTO and the ENGINE INLET AIR DUCT ANTI-ICING switches to ON.
3. To shut the systems off while leaving them subject to automatic control, move the PROP & ENGINE ANTI-ICING MASTER switch to RESET and let the ENGINE INLET AIR DUCT ANTI-ICING switches remain in the ON position.
4. To shut the systems off, place the ENGINE INLET AIR DUCT ANTI-ICING switches in the OFF position.

Note

If an engine is shut down during flight, the inlet duct anti-icing should be left on if icing conditions exist. However, this will not be possible if the fire emergency handle is pulled.

8.26.2 Operation of Propeller Anti-Icing and Deicing Systems

1. To turn on the anti-icing and deicing systems manually, place the PROP & ENG ANTI-ICING MASTER switch in the MANUAL position and the PROPELLER ICE CONTROL switches in the ON position.

Note

To allow the system to be turned on automatically by the ice detection system, place the PROP & ENG ANTI-ICING MASTER switch in the AUTO position and the PROPELLER ICE CONTROL switches in the ON position.

2. To turn off the systems and leave them subject to automatic control by the ice detection system, move the PROP & ENG ANTI-ICING MASTER switch to the RESET position and release it to the AUTO position.
3. To turn off the propeller anti-icing and deicing systems, place the PROPELLER ICE CONTROL switches in the OFF position.

WARNING

A hazardous condition exists if one propeller blade deicing system malfunctions and the propeller deicing is turned on after ice has accumulated on the propeller. The resultant unbalance could cause structural damage to the nacelle before the propeller could be feathered. Check the propeller blade deicing system on the ground before each mission in accordance with the preceding paragraph. If the BLADE DE-ICING ammeter reading is not within limits, abort all missions requiring flight into known or suspected icing conditions. Check the propeller blade deicing system in flight before the aircraft is flown into known or suspected icing conditions. If the BLADE DE-ICING ammeter reading falls below 65 amperes for a period not exceeding 15 seconds in each 1-minute deicing cycle (indicating one propeller malfunctioning), leave the PROP & ENG ANTI-ICING MASTER switch in MANUAL. Feather the propeller on the first indication of unusual vibration. If the BLADE DE-ICING ammeter reading falls below 60 amperes for more than 15 seconds in each 1-minute deicing cycle (indicating more than one propeller malfunctioning), do not fly into known or suspected icing conditions.

CAUTION

Do not operate the propeller anti-icing or deicing for an engine that is not running when the aircraft is on the ground. The engine must be running in order to dissipate the heat generated by the heating elements to prevent damage to the elements. Never operate the system for more than two cycles while the aircraft is on the ground. Anti-icing and deicing may be used for a propeller feathered in flight.

Note

A preflight check of propeller deicing can be made with the engines running. Turn on all the PROPELLER ICE CONTROL switches and check for continuous indications on the two deicing ammeters. If an ammeter pointer drops for a period of 15 seconds, the deicing system is not operating properly for one propeller. To determine which propeller has an inoperative phase, the propeller circuits can be energized individually and the ammeters monitored.

8.26.3 Operation of Windshield Anti-Icing System

1. When the outside air temperature is below 81 °F (27 °C), turn the NESA WINDSHIELD anti-icing switches to NORMAL before taxi.

CAUTION

Operation of NESA anti-icing when outside air temperature is above 81 °F (27 °C) will increase the possibility of delamination within the NESA panels.

Always place the NESA WINDSHIELD anti-icing switches in the NORMAL position before takeoff to reduce thermal shock and the possibility of cracking the windshield.

CAUTION

Monitor operation of the anti-icing systems by feeling the glass and observing ice formation on the panels. Turn off the system if any of the following conditions is noticed:

a. Panels feel excessively hot.

b. Electrical arcing is observed in one of the panels.

c. One of the panels containing thermistors is not heating. This might cause the other panels in the same system to overheat.

2. If ice is forming on the windshields at a rate higher than it can be removed by operating the anti-icing system in NORMAL, set the switches to HI until out of the extreme icing conditions. Do not use the HI position when turning on a system initially.

3. When ambient temperature is below –45 °F, use the COLD START switch by operating it 5 seconds on, 10 seconds off to raise the temperature of the windshields until it is above –45 °F. The system will then function to control windshield temperature automatically.

CAUTION

Do not exceed the operating limits of 5 seconds on, 10 seconds off when operating the COLD START switch. To do so might cause the windshield panels to be damaged.

8.27 OPERATION OF THE APU

The APU can be operated on the ground to supply bleed air/electrical power and in flight to supply electrical power only. It is operated from the APU control panel on the overhead control panel. The APU will start and operate at altitudes from –1,000 feet to 20,000 feet.

WARNING

During ground starting and operation of the APU, personnel must stand clear of the compressor air intake and exhaust, and plane of rotation of the turbine and the compressor. Exercise extreme care to prevent foreign material from entering the air intake, as turbine failure may be sufficiently violent to damage equipment and endanger nearby personnel.

Note

- The APU may not start or operate at altitudes above 20,000 feet.
- When operating the APU with less than 2,000 pounds of fuel in the No. 2 tank, turn the fuel boost pump on to maintain surgebox fuel level.

8.27.1 Starting the APU

1. Inspect area around APU for foreign objects to prevent FOD to the APU (ground operation).
2. Inspect APU inlet for freedom of obstruction and APU for condition (ground operation).
3. Provide adequate isolated dc power.
4. APU generator — OFF.
5. APU BLEED AIR VALVE switch — CLOSE.
6. APU CONTROL switch — START.

After the APU CONTROL switch is placed in the START position, power is supplied to open the APU inlet door. When the door opens, the APU DOOR OPEN light illuminates. When the door opens to the 15° position, power is then supplied to the starter, the start light, and to the holding circuits. When the starter brings the APU up to approximately 10-percent rpm, a switch operated by oil pressure closes to complete the fuel and ignition circuits. After light-off, the combined power of the starter and combustion gases on the power turbine continues the acceleration of the assembly.

7. APU CONTROL switch — RUN.

Release APU CONTROL switch to RUN when the start light illuminates. At approximately 35-percent rpm the 35-percent switch opens, deenergizing the starter and the start light. The APU is now under its own power, and acceleration continues. At 95-percent speed, another centrifugal switch closes and deenergizes the ignition circuit, and connects power to the BLEED AIR VALVE switch and the ON SPEED light. When full speed is reached, the governor assumes control and limits rotation to approximately 100-percent rpm. In case of governor failure, the overspeed switch prevents the turbine from exceeding 110 percent by opening the circuit to the fuel shutoff valve holding relay, which shuts off the fuel.

CAUTION

- At approximately 35-percent rpm, the START light will go out. If the light does not go out within 1 minute, move the APU CONTROL switch to STOP and wait 4 minutes before making another start attempt. The starter duty cycle is 1 minute on, 4 minutes off. Do not re-engage the starter while the turbine is rotating.
- If isolated dc power is interrupted while the APU is operating, the control circuit will be opened, causing the unit to stop. Place the APU CONTROL switch to STOP and perform the APU starting procedures.

Note

If the APU does not light off during ground start in extreme cold weather, preheat the APU with an external source of heat prior to second start attempt.

8.27.2 Loading the APU

1. Assure that the APU is on speed and warmed up for a minimum of 1 minute.
2. APU BLEED AIR VALVE switch — OPEN (ground operation).

WARNING

During ground operation, monitor the leading edge temperature indicators. A rise indicates that an anti-icing valve is open, and the APU must be shut down to prevent damage to heated surfaces.

3. Manifold air pressure — Checked (35 psi minimum) (ground operation).

4. Bleed-air duct leakage — Checked (ground operation).

5. APU generator — Checked/As Required.

CAUTION

Operation of the APU in sandy, graveled, or other loosely surfaced areas may cause foreign object ingestion.

8.27.3 Stopping the APU

1. APU BLEED AIR VALVE switch — CLOSE.

2. APU generator — OFF.

3. APU CONTROL switch — STOP.

Note

Allow the APU to stabilize a minimum of 1 minute prior to placing the APU CONTROL switch in the STOP position.

The APU will shut down and the door will close after oil pressure drops to approximately 20 psi (approximately 18-percent rpm).

4. APU DOOR OPEN, START, and ON SPEED lights are extinguished.

8.28 FUEL MANAGEMENT

Fuel management is accomplished by positioning switches on the fuel control panel. Fuel routing is governed by fuel tank selection and crossfeed valve positioning. Fuel gauges indicate quantities in each tank, and a totalizer on the fuel control panel indicates total fuel remaining in the wing tanks. An additional check of fuel quantities may be made by keeping a log based on engine fuel flow and time.

WARNING

Operating more than two engines from one main tank boost pump may result in flameout of one or more engines due to fuel starvation.

CAUTION

When the aircraft is parked with the fuel tanks more than 75-percent full, all crossfeed valves should be closed. Otherwise, low tanks may be overfilled by slow transfer of fuel through the boost pump check-valve bleed orifice from the crossfeed manifold.

Note

Usable fuel quantity (for the wing tanks) is based on 4° noseup attitude and wings level. Refer to Chapter 4 for allowable wing tank fuel when landing.

To crossfeed fuel from a heavy tank, proceed as follows:

1. Crossfeed valve (heavy tank) — OPEN.

2. Crossfeed separation valve — OPEN.

Note

The CROSSFEED SEPARATION valve switch must be placed in the flow position (open) when feeding fuel from tanks in one wing to engines on the other wing.

3. Crossfeed valve (light main tank(s)) — OPEN.

4. BOOST PUMP switch (light main tank(s)) — OFF.

When trimming is complete:

5. All main BOOST PUMP switches — ON.

6. All crossfeed valves — Closed.

7. Crossfeed separation valve — Closed.

8. Crossfeed primer button — Depressed.

8.28.1 Wing Tanks to Engines Fuel Flow. Design of the fuel system allows tank-to-engine or crossfeed-to-engine fuel flow. Tank-to-engine routing is normally used at all times when fuel is being taken from the main tanks. Crossfeed-to-engine routing is used when using fuel from the external tanks or auxiliary tanks or when trimming the aircraft. Although static head pressure is sufficient to force fuel from the wing tanks through the system under most conditions, boost pump operation is recommended at all times. The following procedures are recommended for fuel management, using only the wing tanks.

8.28.1.1 Takeoff Fuel Flow

1. Place all main tank BOOST PUMPS in the ON position.

2. Close all CROSSFEED VALVE switches (this places all engines on tank-to-engine fuel routing).

8.28.1.2 Cruise Fuel Flow. As the auxiliary fuel tanks have only one fuel pump, auxiliary fuel shall be used before external fuel on long-range overwater missions. In the event of an auxiliary tank pump failure, this procedure would ensure sufficient fuel to return to the point of departure. On short-range missions, it is recommended that fuel be used from the external tanks before the auxiliary tanks to preclude landing with fuel in the external tanks. When operating with less than 6,000 pounds of total fuel in the main fuel tanks, place the CROSSFEED VALVE switch to OPEN and the BOOST PUMP switch to ON for all tanks containing fuel. Place the CROSSFEED SEPARATION valve switch to open. When fuel quantity of any main tank is less than 1,000 pounds, the engine being fed by that tank will be placed on crossfeed operation.

8.28.1.2.1 Fuel Contamination Check

1. Open the crossfeed separation valve.

2. Turn the left auxiliary/external tank BOOST PUMP switch ON. Place the left auxiliary/external tank CROSSFEED VALVE switch to the open position. Crossfeed manifold pressure should be 28 to 40 psi.

3. Place the No. 2 engine CROSSFEED VALVE switch to the open position.

Note

When opening the main tank crossfeed valves, observe fluctuation of fuel pressure for indication that the valve has opened. Monitor TIT, torque, and fuel flow for approximately 1 minute.

4. When satisfied that the No. 2 engine is operating satisfactorily, place the No. 1 engine CROSSFEED VALVE switch to the OPEN position.

5. When satisfied that the No. 1 engine is operating satisfactorily, place the crossfeed separation valve to the closed position.

6. Repeat steps 2 through 5 for the right auxiliary/external tank and No. 3 and No. 4 engines.

7. When the desired amount of fuel has been used or when the tank empty light illuminates, place the CROSSFEED VALVE switches to the closed position.

8.28.1.3 Approach and Landing Fuel Flow

1. Place all main tank boost pumps in the ON position.

2. Close the crossfeed separation valve.

Note

Auxiliary/external fuel may be used for landing provided the crossfeed separation valve is closed.

8.28.2 Auxiliary Power Unit Fuel Flow. Fuel for operation of the APU is gravity fed from the No. 2 tank through a motor-operated shutoff valve outside the tank boundary in the No. 2 dry bay. The valve is open when the APU CONTROL switch is in the START or RUN (APU operating) positions and is closed when the APU CONTROL switch is in the STOP position or when the APU fire emergency control handle is pulled.

Note

When operating the APU with less than 2,000 pounds of fuel in the No. 2 main tank, turn that fuel boost pump ON to maintain surge-box fuel level.

8.29 PROPELLER NORMAL GOVERNING REINDEXING

Normal governing and synchrophase operation of the propeller system functions best when the normal governing rpm of each propeller is indexed as near as possible to the mechanical rpm setting of the propeller. Since throttle manipulation may cause normal governing to shift slightly, it will usually be advantageous to wait until after takeoff and in smooth, level flight before reindexing. If normal governing is out of limits or fluctuating on the ground, reindexing should be performed.

8.29.1 Reindexing Procedures

Note

If the reindexing procedure is performed on the ground, all throttles must be set for at least 8,000 inch-pounds of torque to ensure that propellers are governing. If erratic operation results, start the procedure over.

1. Place all PROPELLER GOVERNOR CONTROL switches to MECH GOV.

2. Place the SYNCHROPHASE MASTER switch to the engine nearest 100 percent (crosscheck rpm with frequency meter) and wait 15 to 30 seconds.

3. Break the shearwire on the PROP RESYNCHROPHASE switch.

4. Hold the PROP RESYNCHROPHASE switch in the RESYNC position while performing steps 5 through 7.

5. Place all PROPELLER GOVERNOR CONTROL switches to NORMAL and wait 15 to 30 seconds.

6. Place the SYNCHROPHASE MASTER switch to OFF.

7. Release the PROP SYNCHROPHASE switch to NORMAL.

8. Repeat steps 1 through 7, except place the SYNCHROPHASE MASTER switch to the other engine.

9. Place the PROPELLER GOVERNOR CONTROL switches to NORMAL.

8.30 SYNCHROPHASER CHECK

1. Set the throttles above 65° (crossover) with a minimum of 8,000 inch-pounds of torque.

2. In normal governing, select a master engine.

3. Move the throttle of the selected master engine to FLIGHT IDLE.

4. The slaved engine's rpm should follow the master if the synchrophaser system is operating. If the rpm does not follow the master, record it in the aircraft records.

5. Advance the master engine throttle as in step 1.

6. When the slave engine rpm has stabilized with the master, turnoff the SYNCHROPHASE MASTER switch.

8.31 TEMPERATURE CONTROLLING CHECKS

CAUTION

Monitor torque and TIT closely while advancing throttles to avoid exceeding limits.

1. Set the throttles for approximately 910 °C TIT and take bleed air from the engines by operating the wing and empennage anti-icing system.

CAUTION

Do not operate the wing and empennage anti-icing system on the ground for more than 30 seconds.

a. The TIT should rise slightly and then return to the previous setting.

b. If the TIT does not return to the previous setting, the electronic temperature controlling system has malfunctioned.

2. Return the throttles to GROUND IDLE.

3. If temperature controlling is inoperative, the TEMP DATUM CONTROL VALVE switch shall be placed to NULL.

CAUTION

When operating with the TEMP DATUM CONTROL VALVE switch in NULL, move the throttles slowly to prevent an overtemperature.

8.32 USE OF WHEELBRAKES

Use reverse thrust to maintain safe taxi speeds and minimize brake wear. When the antiskid system is used, shorter landing rolls are attained. Unless minimum landing roll is required, the maximum potential of the antiskid system should not be used.

The antiskid system is designed to prevent skids at high speeds under light wheel loads. When required, brakes may be applied immediately after touchdown. The antiskid system will prevent tire skidding if operating properly; however, it is not designed to perform as an automatic braking system. Continuous braking from the point of touchdown until taxi speed will cause continuous cycling of the antiskid system, accelerated brake wear and extreme heat buildup.

8.32.1 Taxiing. When taxiing, the following braking procedures will minimize brake wear and heat buildup.

1. Ensure brakes are not dragged to control taxi speed. Excessive heat will build up in the brake/wheel/tire assembly if brakes are dragged during taxi.

2. Reverse thrust and the use of low-speed ground idle are the primary means of controlling taxi speed. If taxiing downwind or downhill causes excessive oil temperature because of reverse thrust, stop the aircraft with brakes, then allow the aircraft to accelerate until brakes must be reapplied to control taxi speed. Continue this cycle as required. This will result in less heat buildup than dragging the brakes.

3. Use the brakes as little as possible when turning the aircraft on the ground.

4. Do not taxi into crowded parking areas if overheated brakes are known or suspected.

8.32.2 Landing

1. The full landing roll and propeller reversing should be used to minimize the use of brakes.

2. After excessive braking, allow 10 minutes cooling time preceding the next takeoff. This is required because critical field length increases because of heated brakes.

Note

If the runway available exceeds critical field length by a minimum of 300 feet, the 10-minute cooling time may be omitted.

3. If landing ground roll must be minimized, the following procedures provide maximum braking effect.

a. Immediately after touchdown, lower the nosegear to the runway and smoothly apply brake pedal pressure until maximum pedal travel is achieved. The brakes remain applied in this manner until the aircraft is stopped.

b. If full antiskid braking is used for landing, the gear should be left extended after an immediate subsequent takeoff for a minimum of 15 minutes before retracting the gear or before another braked landing is attempted.

c. If a landing requiring full antiskid braking is followed by engine running offload operations, aircrews must be aware of the hazards associated with heat buildup in the brake/wheel/tire assembly. Minimize use of brakes, keep personnel clear of the wheelwell area to the maximum extent possible, and be prepared to evacuate if overheating is indicated.

4. If conducting a series of full antiskid braked landings, the minimum airborne cooling interval between landings is 15 minutes. In order to operate at this minimum interval, gross weight is limited to 130,000 pounds or less, landing gear must remain extended during the traffic pattern, and no tail wind factor is permissible.

WARNING

Failure to cool the brakes could result in tire explosion or wheelwell fire.

5. A partially braked landing is defined as a smooth, 3-second brake application with steadily increasing brake pedal pressure initiated at approximately 90 KIAS. Slight braking to bring the aircraft to a full stop or to maintain taxi speed is permissible.

6. The following precautions will minimize brake wear during landings and shall be observed.

   a. If the antiskid system is inoperative, use extreme care when applying brakes immediately after touchdown and before applying reverse thrust or at anytime there is considerable lift on the wings. Heavy brake pressure can result in locking the wheels more easily if brakes are applied immediately after touchdown than if the same pressure is applied after the full weight of the aircraft is on the wheels.

Once a wheel is locked in this manner, it will not unlock when the load is increased as long as brake pressure is maintained. Stopping the aircraft is dependent on the friction of the tires on the runway. Scuffing of rubber from the tires reduces friction with the runway. Therefore if one pair of wheels locks during brake application, there is a tendency for the aircraft to turn away from the locked wheels.

Further application of brake pressure to those wheels will not correct the skid. Since the coefficient of friction goes down when a wheel begins to skid, a locked wheel will not free itself until brake pressure is reduced.

WARNING

After any full antiskid braking operation above 130,000 pounds, ensure adequate brake/tire cooling time prior to further aircraft operation. Approximate ground cooling time is 65 minutes.

CAUTION

If a takeoff is required prior to the recommended ground cooling time following a full antiskid braked landing at gross weights exceeding 130,000 pounds, and brakes are required during an aborted takeoff, brake failure, wheel and tire overheat, and/or tire deflation may occur.

Note

Three fusible plugs are installed in each main landing gear wheel. The fusible plugs function on tubeless tire installations to minimize tire blowout caused by wheelbrake overheat. When wheel rim temperature reaches 390 °F, the fusible plug core melts, allowing the tire to deflate at a safe rate.

8.32.3 Parking

1. If brake failure is indicated, brakes have been used excessively, or hot brakes are suspected, request fire department inspection of the brakes and tires. Maximum braking during landing at heavy gross weight is the most likely cause of hot brakes.

WARNING

All personnel other than those in the fire department shall evacuate the immediate area. The area on both sides of the wheel shall be cleared of personnel and equipment for at least 300 feet. Do not approach the main wheel area when extreme temperatures are suspected. If necessary, personnel approach should be from fore or aft.

WARNING

If hot brakes are known or suspected on one side only, set the opposite parking brake. Chock the nosegear and proceed with ground evacuation. If brakes on both sides are known or suspected to be overheated, do not set the parking brake, chock the nosegear, and proceed with ground evacuation.

Note

- Peak temperatures occur in the brake assembly from approximately 1 to 5 minutes and in the wheel and tire assembly from approximately 20 to 30 minutes after a maximum braking operation.
- Brake fires are less likely to occur in overheated brake assemblies if the brakes are released as soon as possible after the aircraft is parked.

2. Do not taxi or tow the aircraft for at least 15 minutes after overheated brakes have been cooled. If hot brakes are known or suspected, initiate maintenance action.

8.33 STATIC START PROCEDURE

This static start procedure is predicated on a C-130 aircraft (or equivalent) providing the air blast.

CAUTION

Prior to attempting a static start, ensure that the starter or starter shaft is removed.

1. Position C-130 or equivalent aircraft on starting area facing into wind, with the flaps up.
2. Conduct a FOD walkdown.
3. Position the aircraft as indicated in Figure 8-7. This will provide nose-to-tail clearance between the two aircraft if the aft aircraft moves during starting procedures.

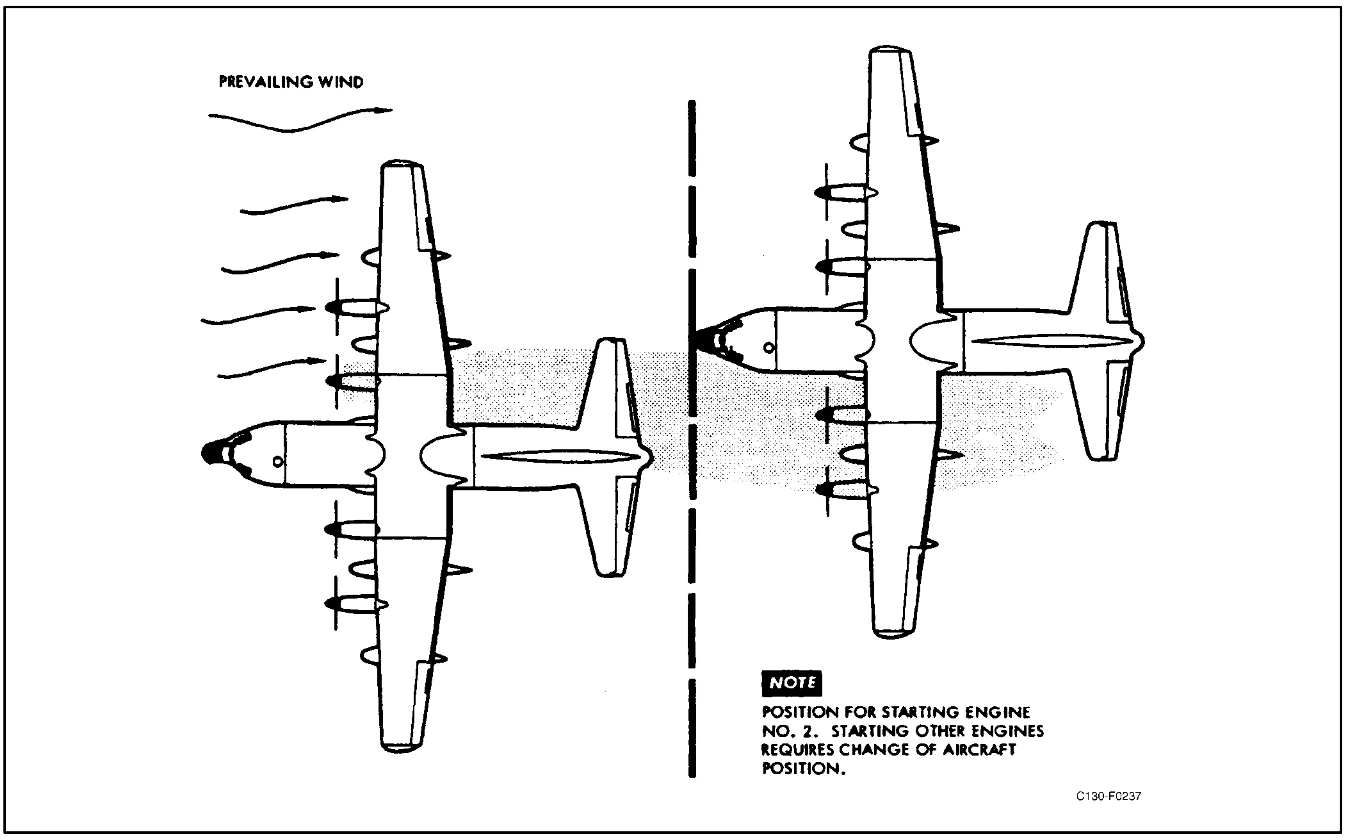


Figure 8-7. Aircraft Position for Static Start

4. Brief crews on special signals that will be used during starting, and position ground observers for visual sighting.

5. Establish communication between aircraft.

6. Complete necessary checklists.

7. Place chocks fore and aft of each forward main landing gear wheel.

8. Start one of the inboard engines for electrical power.

9. Secure APU.

10. Remove all ground equipment.

11. Position propeller blade cuff in line with island on the spinner base.

12. Place throttle at FLIGHT IDLE.

13. Close all doors, windows, and hatches.

14. Move condition lever to RUN; leave ENGINE BLEED AIR switch OFF until engine is on speed.

15. On front aircraft, upon signal from rear aircraft, increase power to 900° TIT on all engines.

16. If propeller rotation does not begin, request maximum power on front aircraft.

17. After propeller rotation starts, observe normal start sequence. When 60-percent rpm is reached, place throttle to GROUND IDLE.

18. Signal front aircraft to reduce power.

Note

- If constant acceleration fails to occur prior to 16-percent rpm, move the condition lever to the FEATHER position momentarily and return to RUN. Increased rpm and acceleration should occur. Do not move the condition lever toward FEATHER after 16-percent rpm unless a stop-start situation exists.

- In the event above procedures are ineffective, starting may be attempted by presetting propeller blade angles at an intermediate position between alignment with the spinner base island and the full-feather position. Continue start as outlined above.

8.34 WINDMILL TAXI START

CAUTION

Successive windmill taxi runs with repeated braking applications will result in hot brakes, decreased braking efficiency, and/or wheelwell fires.

Note

Use of the following procedure is not recommended when aircraft gross weight exceeds 135,000 pounds.

The following procedure can be used to start an engine if it cannot be started by normal procedures. It should be used only if mission requirements dictate. A runway length of 7,000 feet or more is recommended to ensure safety.

1. Engine — Inspected.

   a. Inspect engine to be started as necessary to ensure maximum safety.

CAUTION

Prior to attempting a windmill taxi start because of a defective starter, ensure that the starter or starter shaft is removed.

2. Propeller — Feathered.

3. Before Takeoff Checklist — Complete.

Note

The flaps will be set at 15-percent. This will provide full-rudder boost pressure without creating extra drag and lift at low speeds.

4. Auxiliary hydraulic pump switch — ON.

5. Throttle — FLIGHT IDLE.

6. Engine condition lever — RUN.

7. Align the aircraft on the runway.

8. Parking brake — Set.

9. Throttles (for operating engines) — FLIGHT IDLE.

10. Throttles (for symmetrical engines) — TAKE-OFF POWER.

11. Parking brake — Released.

12. Throttle (other operating engine) — As Required.

    a. Increase power on the other operating engine as directional control becomes available through coordinated use of nosewheel steering and rudder.

Note

- On long runways, actuation of the throttle may not be required.

- The copilot shall hold the yoke forward, maintaining positive pressure on the nosewheel and keeping the wings level. The pilot shall maintain control of nosewheel steering, throttles, and rudder.

13. Condition lever — AIRSTART.

    a. The copilot shall place the condition lever to AIRSTART at 50 KIAS and hold until light-off is achieved.

14. Throttles — GROUND IDLE.

    a. As the rpm increases to 40 percent, retard all throttles to GROUND IDLE and reverse symmetrical for the on-speed engines and apply brakes as required to stop the aircraft. Oil pressure and engine instruments shall be monitored the same as for a normal start.

CAUTION

Regardless of the progress of the windmill taxi start, decelerate to a stop when the aircraft reaches a speed of 100 KIAS or a point where 4,000 feet of runway remains, whichever occurs first.

15. Resume normal operation beginning with the Starting Engines Checklist.

8.35 EXTERNAL AIR (HUFFER) APPLICATION

1. Station huffer behind the left wing and extend air hose forward and securely couple to the external air connection forward of the left wheelwell.

Note

Ensure huffer exhaust blast clears all aircraft surfaces.

2. Station the ground observer to the left of the nose of the aircraft in full view of the crewmember occupying the pilot seat. The ground observer must have full view of the huffer operator.

3. Complete the Before Start Checklist up through item 6.

4. Direct the ground observer to relay to the huffer operator to start the huffer and apply air pressure to the aircraft.

5. The flight engineer shall observe a minimum of 25 psi manifold pressure.

6. Complete the Before Start Checklist.

7. Start the No. 3 engine (or engine requiring turn). Leave the engine in low-speed ground idle.

8. Place the ENGINE BLEED AIR switch OFF.

9. Place the AIR CONDITIONING master switch NO PRESSURE.

10. Direct the ground observer to relay to the huffer operator to secure bleed air and shut down the huffer.

11. The flight engineer shall observe zero pressure on the manifold pressure gauge.

12. Direct the ground observer to relay to the huffer operator to disconnect the external air hose and close the panel. The ground observer shall visually verify the panel closed and report that the external air unit is removed from the area.

13. The flight engineer shall place the AIR CONDITIONING master switch to OFF, ENGINE BLEED AIR switch to OVRD, and observe manifold pressure.

14. Bring the engine that was started to normal ground idle and continue the Starting Engines Checklist.

COCKPIT CHECKLIST

1. NLG PIN AND GROUND WIRE .... REMOVED
2. PROP PANEL .... SET
3. CIRCUIT BREAKERS .... CHECKED
4. FUEL PANEL .... SET
5. THROTTLES .... GND IDLE
6. CONDITION LEVERS .... GND STOP
7. SYNC MASTER .... OFF
8. TD VALVES .... AS REQUIRED

BEFORE START

1. HOT MIKE .... ON (P)(CP)(FE)
2. COCKPIT CHECKLIST .... COMPLETE (FE)
3. PASSENGERS .... BRIEFED (LM)
4. ELECTRICAL PANEL .... SET (FE)
5. RADIOS .... ON _____ PRIMARY (CP)
6. LIGHTS .... SET (FE)
7. CLEAR APU .... CLEAR (LM)
8. APU PANEL .... SET (FE)
9. APU GEN .... AS REQUIRED (FE)
10. INVERTERS .... SET (FE)
11. FUEL QTY, DIST .... CHECKED _____LBS (P)(FE)
12. OIL COOLER FLAPS .... AS REQUIRED (CP)
13. RAMP AND DOOR .... 6N, NEUTRAL (LM)
14. HYDRAULIC PANEL .... SET (CP)
15. PARKING BRAKE .... SET, REMOVE CHOCKS (P)
16. OXYGEN .... CHECKED, OFF (ALL)
17. GROUND IDLE BUTTONS .... LOW (FE)
18. FLAP LEVER .... SET (CP)
19. CHOCKS, NOSE PIN .... REMOVED (LM)
20. INS/GPS .... AS REQUIRED (CP)(FE)

STARTING ENGINES

1. CLEAR 3 .... NO. 3 CLEAR (LM) TURNING 3 (P)
2. APU GEN .... ON, CHECKED (FE)
3. DC POWER .... BATTERY, REMOVE EXTERNAL POWER (FE)
4. CLEAR 4 .... NO. 4 CLEAR (LM) TURNING 4 (P)
5. AIR COND MASTER .... NO PRESS (FE)
6. EXTERNAL POWER, GROUND EQUIPMENT ...... REMOVED, CLEAR (LM)
7. CLEAR 2 .... NO. 2 CLEAR (LM) TURNING 2 (P)
8. CLEAR 1 .... NO. 1 CLEAR (LM) TURNING 1 (P)
9. BLEED AIR .... SET (FE)
10. FUEL PANEL .... SET (FE)

BEFORE TAXI

1. WING AND EMP ANTI-ICING .... NORMAL (FE)
2. RADAR, IFF .... STBY (P)(CP)(FE)
3. COMPASSES .... CHECKED _____#1 (P) CHECKED _____#2 (CP)
4. ATTITUDE SELECT .... CHECKED _____ (P)(CP)
5. GPWS .... SET (CP)
6. FLAPS .... 50% (CP)
7. GROUND EQUIP .... CLEAR (P)(CP)(LM)
8. CREW ABOARD .... ABOARD, DOORS CLOSED, CHECKED (LM)
9. HYDRAULIC PRESSURES, QUANTITIES .... CHECKED (CP)(LM)
10. OIL COOLER AUG .... AS REQUIRED (FE)
11. PAX, CARGO, SDRS .... SET (LM)

TAXI

1. BRAKES .... CHECKED (P)(CP)
2. GENS/LOADS .... ON, CHECKED (FE)
3. ICE DETECTION .... CHECKED (FE)
4. PROP REVERSING .... CHECKED (P)(FE)

RUNUP

1. NOSEWHEEL, PARKING BRAKE .... CENTERED, SET (P)
2. ENGINE RUNUP .... COMPLETE (FE)

TAKEOFF

1. EXITS .... SECURE (ALL)
2. FUEL PANEL .... SET (FE)
3. FLAPS .... 50% (P)(CP)(LM)
4. FLIGHT CONTROLS .... CHECKED (P)(CP)
5. HYDRAULIC QUANTITIES .... CHECKED (LM)
6. TRIM .... SET (P)
7. SEATBELTS .... FASTENED (ALL)
8. CREW .... BRIEFED (P)
9. INSTRUMENTS, ALTIMETERS .... CHECKED, SET____,____(P)(CP)(FE)
10. ELECTRICAL PANEL .... SET (FE)
11. APU PANEL .... SET (FE)
12. PRESSURIZATION .... SET (FE)
13. ANTISKID .... CHECKED (FE)
14. RADAR, IFF .... AS REQUIRED (P)(CP)
15. OIL COOLER AUG .... OFF (FE)
16. OIL COOLER FLAPS .... AUTO (CP)
17. LIGHTS .... SET (CP)(FE)
18. ANTI-ICING .... SET (FE)
19. LINEUP .... COMPLETE (P)(CP)(FE)

AFTER TAKEOFF

1. GEAR, FLAPS, LIGHTS .... CHECKED (CP)(FE)
2. HYDRAULIC PANEL .... CHECKED SET (CP)
3. SYNC MASTER .... AS REQUIRED (FE)
4. PRESSURIZATION .... CHECKED (FE)
5. WINGS, AIRCRAFT INTERIOR .... CHECKED (LM)
6. LEADING EDGE ANTI-ICING ..... CHECKED, SET (FE)
7. FUEL PANEL .... AS REQUIRED (FE)
8. GALLEY FLOOR .... SET (LM)
9. HOT MIKE .... AS REQUIRED (P)(CP)(FE)

DESCENT

1. CREW .... BRIEFED (P/CP)
2. PAX, CARGO .... AS REQUIRED (LM)
3. PRESSURIZATION .... SET (FE)
4. BARO ALTIMETER .... SET _____ (P)(CP)
5. TD VALVES .... AS REQUIRED (FE)
6. GPWS .... SET (CP)

ONLY CIRCLED ITEMS NEED TO BE CHECKED AT OPERATIONAL STOPS

Figure 8-8. Normal Procedures Checklist (Sheet 1 of 2)

APPROACH

1. GALLEY FLOOR .... SET (LM)
2. FUEL PANEL .... AS REQUIRED (FE)
3. SEATBELTS .... FASTENED (ALL)
4. ALTIMETERS .... SET ___,____ (P)(CP)
5. NAV SELECT .... AS REQUIRED (P)(CP)

LANDING

1. HOT MIKE .... ON (P)(CP)(FE)
2. FLAPS .... AS REQUIRED (P)(CP)
3. LANDING GEAR .... DOWN, CHECKED, CENTERED (P)(CP)(FE)
4. HYDRAULIC PANEL .... CHECKED, SET (CP)
5. LIGHTS .... SET (CP)
6. SYNC MASTER .... OFF (FE)
7. PRESSURIZATION .... CHECKED (FE)
8. ANTISKID .... CHECKED (FE)

TOUCH AND GO LANDING

ON THE RUNWAY

1. FLAPS .... 50% (P/CP)
2. TRIM .... SET (P/CP)
3. THROTTLES .... AS REQUIRED (P/CP)

AFTER TAKEOFF

1. GEARS, FLAPS, LIGHTS .... CHECKED (P/CP)(FE)

LANDING

1. CREW .... BRIEFED (P/CP)
2. FLAPS .... AS REQUIRED (P)(CP)
3. LANDING GEAR .... DOWN, CHECKED CENTERED (P)(CP)(FE)
4. HYDRAULIC PANEL .... CHECKED (P/CP)

AFTER LANDING

1. FLAPS .... AS REQUIRED (CP)
2. OIL COOLER FLAPS, AUG .... AS REQUIRED (FE)
3. LIGHTS .... SET (CP)(FE)
4. RADAR, IFF .... STBY (P)(CP)(FE)
5. PRESSURIZATION .... NO PRESS (FE)
6. ANTI-ICING .... OFF (FE)
7. APU PANEL .... SET (FE)
8. ELECTRICAL PANEL .... SET (FE)

SECURE

1. PARKING BRAKE .... SET (P)
2. OIL COOLER AUG .... OFF (FE)
3. SHUTDOWN, NTS CHECK .... COMPLETE (ALL)
4. UNNECESSARY EQUIPMENT .... OFF (P)(CP)(FE)
5. OXYGEN .... CHECKED, OFF (ALL)
6. CHOCKS, NOSE PIN .... INSTALLED (LM)
7. PARKING BRAKE .... RELEASED (P)
8. HYDRAULIC PANEL .... SET (CP)
9. AIR CON MASTER .... AUX VENT (FE)

BEFORE LEAVING THE AIRCRAFT

1. OIL COOLER FLAPS .... AS REQUIRED
2. RADAR .... OFF
3. AIR-CONDITIONING .... OFF
4. BLEED AIR .... OFF
5. ELECTRICAL PANEL .... SET
6. FUEL PANEL .... SET
7. TD VALVES .... NULL
8. OXYGEN NORMAL/100%/OFF
9. HYDRAULIC PANEL .... SET
10. AC BUS TIE SWITCH .... OFF
11. APU GENERATOR .... OFF
12. APU PANEL .... SET
13. RADIOS .... OFF
14. WHEELS .... CHOCKED
15. PARKING BRAKE .... RELEASED
16. LIGHTS .... SET/OFF
17. DC BUS TIE AND BATTERY .... SET
18. INS/GPS .... OFF
19. EMER EXIT LT SWITCH .... DEPRESSED
20. COVERS, PLUGS .... INSTALLED
21. INT/EXT LIGHTS .... OFF
22. DOORS AND RAMP .... AS REQUIRED
23. SDRS .... SET/OFF

CRUISE ENGINE SHUTDOWN

1. CREW .... BRIEFED (CP)
2. SYNC MASTER .... OFF (FE)
3. PROP GOV CONT .... MECH (CP)
4. FEATH VALVE AND NTS SWITCH .... VALVE (CP)
5. AIRSPEED .... BELOW 180 KIAS (P)
6. NTS CHECK .... COMPLETE (FE)
7. THROTTLE OF ENGINE TO BE SHUT DOWN .... FLIGHT IDLE (P)
8. BLEED AIR SWITCHES ON OPERATIVE ENGINES .... ON (FE)
9. SYNC MASTER .... RESET AS REQUIRED (FE)
10. CONDITION LEVER .... FEATHER (CP)
11. FUEL BOOST PUMP .... OFF (FE)
12. ENGINE GENERATOR SWITCH .... SET (FE)
13. PROP FEATH OVRD BUTTON .... OUT (CP)
14. THROTTLE OF ENGINE SHUTDOWN .... FULL FORWARD (P)
15. OIL COOLER FLAP .... CLOSED/FIXED (CP)
16. FUEL MANAGEMENT .... CHECKED (FE)

AIRSTART

1. FIRE HANDLE .... IN (CP)
2. THROTTLE . SET APPROX 1″ABOVE FLIGHT IDLE (P)
3. FUEL BOOST PUMP .... ON (FE)
4. OIL COOLER FLAP .... AUTO (CP)
5. FUEL ENRICHMENT .... NORM (P)
6. PROP GOV CONT .... MECH (CP)
7. NTS CHECK .... VALVE (CP)
8. TD VALVE .... AUTO (FE)
9. CONDITION LEVER .... AIRSTART (CP)
10. GENERATOR .... RESET/ON (FE)
11. FUEL ENRICHMENT .... OFF (P)
12. BLEED AIR .... ON (FE)
13. PROP GOV CONT .... NORM (CP)
14. ENGINE INSTRUMENTS .... IN LIMITS (FE)

ONLY CIRCLED ITEMS NEED TO BE CHECKED AT OPERATIONAL STOPS

Figure 8-8. Normal Procedures Checklist (Sheet 2)

EMERGENCY PROCEDURES

ENGINE SHUTDOWN PROCEDURE

*1. CONDITION LEVER . . . . FEATHER (CP)
*2. FIRE HANDLE . . . . PULLED (CP)
*3. FIRE EXT . . . . DISCHARGE AS REQUIRED (CP)
*4. FLAPS . . . . AS REQUIRED (CP)
*5. LANDING GEAR . . . . AS REQUIRED (CP)
*6. PROPELLER . . . . FEATHERED (CP)

CLEANUP

1. BLEED AIR . . . . OFF (FE)
2. GENERATOR . . . . TRIPPED/OFF (FE)
3. FUEL BOOST PUMP . . . . AS REQUIRED (FE)
4. CROSSFEED VALVE . . . . AS REQUIRED (FE)
5. PROP GOV CONT . . . . MECH GOV (CP)
6. PROP FEATH OVRD BUTTON . . . . OUT (CP)
7. SYNC MASTER . . . . RESET AS REQUIRED (FE)
8. TD VALVE . . . . NULL (FE)
9. THROTTLE . . . . FULL FORWARD (P)
10. OIL COOLER FLAP . . . . CLOSED/FIXED (CP)

APU FIRE (ON GROUND)

*1. APU FIRE HANDLE . . . . PULLED (CP)
*2. FIRE EXT . . . . DISCHARGE AS REQUIRED (CP)
*3. APU GENERATOR . . . . OFF (FE)
4. EVACUATE AIRCRAFT . . . . (ALL)

APU FIRE (IN FLIGHT)

*1. APU FIRE HANDLE . . . . PULLED (CP)
*2. FIRE EXT . . . . DISCHARGE AS REQUIRED (CP)
*3. APU GENERATOR . . . . OFF (FE)
4. APU CONT SWITCH . . . . STOP (FE)
5. APU BLEED AIR VALVE . . . . CLOSED (FE)

WING FIRE

1. CROSSFEED VALVES . . . . CLOSED (FE)
2. HYDRAULIC PUMPS/ SUCTION BOOST PUMP . . . . OFF (CP)
3. BLEED AIR VALVES AND DIVIDER VALVE . . . . CLOSED (FE)
4. WING ELECTRICAL EQUIPMENT . . . . OFF (FE)
5. SIDESLIP AIRCRAFT . . . . AS REQUIRED (P)
6. LAND ASAP . . . . (P)

FUSELAGE FIRE/SMOKE AND FUME ELIMINATION

*1. OXYGEN . . . . ON/100% (ALL)
*2. PRESSURIZATION . . . . EMER DEPRESS (FE)
*3. DESCENT . . . . AS REQUIRED (P)
*4. EXTINGUISH THE FIRE . . . . AS REQUIRED (ALL)
5. BLEED AIR . . . . OFF (FE)
6. AIR COND MASTER . . . . AUX VENT (FE)
7. PARA DOORS/AFT HATCH . . . . OPEN (LM)
8. FLT STA ESCAPE HATCH . . OPEN AS REQUIRED (FE)

IN-FLIGHT DOOR WARNING

*1. SEATBELTS . . . . FASTENED (ALL)
*2. OXYGEN . . . . AS REQUIRED (ALL)
3. PRESSURIZATION . . . . BEGIN DEPRESS (FE)
4. DESCENT . . . . AS REQUIRED (P)
5. DOORS . . . . CHECKED (FE)(LM)
6. MASTER DOOR WARN LT SW . . . . OFF (FE)(LM)

RAPID DECOMPRESSION

*1. OXYGEN . . . . ON/100% (ALL)
*2. PRESSURIZATION . . . . AS REQUIRED (FE)
*3. DESCENT . . . . AS REQUIRED (P)

FUEL DUMPING

1. ATC . . . . ADVISE (CP)
2. FUEL PANEL . . . . MAIN TANK TO ENGINE (FE)
3. INTERCONNECT VALVE SWITCHES . . . . . . FLOW (FE)
4. DUMP VALVE SWITCHES . . . . DUMP (FE)
5. DUMP PUMP SWITCH FOR EACH TANK TO BE DUMPED . . . . DUMP (FE)
6. FUEL QTY INDICATORS . . . . MONITOR (FE)
7. FUEL DUMP SWITCHES . . . . OFF/NORM (FE)
8. INTERCONNECT VALVE SWITCHES . . . NO FLOW (FE)
9. DUMP VALVE SWITCHES . . . . NORM (FE)
10. FUEL MANIFOLD . . . . CLEAR (P/FE)

DITCHING

1. TIME TO IMPACT . . . . CREW ALERTED (CP)
2. ALTIMETERS . . . . SET _____,_____ (P)(CP)
3. PRESSURIZATION . . . . EMER DEPRESS (FE)
4. FUEL DUMP . . . . AS REQUIRED (FE)
5. CARGO JETTISON . . . . AS REQUIRED (LM)
6. DITCH HEADING . . . . CHECKED (P)(CP)
7. DITCH SPEED . . . . CHECKED (P)(CP)
8. OVERHEAD HATCHES . . . . REMOVED (FE)(LM)
9. LAND GEAR WARN LIGHT CB . . . . PULLED (FE)
10. GPWS CBS . . . . PULLED (FE)
11. EMERGENCY MSG/IFF . . . . SEND (CP)
12. FLAPS . . . . AS REQUIRED (P)(CP)
13. LANDING GEAR . . . . UP (P)(CP)(FE)
14. SEATBELTS . . . . FASTENED, LOCKED (ALL)
15. ALERT FOR IMPACT . . . . CREW ALERTED (CP)

GROUND EVACUATION

1. PARKING BRAKE . . . . SET (P)
2. TOWER/GROUND . . . . NOTIFIED (CP)
3. CREW . . . . NOTIFIED (P)
4. DC BUS TIE SWITCH . . . . TIED (FE)
5. CONDITION LEVERS . . . . FEATHER (CP)
6. FIRE HANDLES . . . . PULLED (CP)
7. AC/DC POWER SWITCHES . . . . OFF (FE)
8. ALARM BELL . . . . ONE LONG RING (CP)
9. EVACUATE AIRCRAFT . . . . (ALL)
10. CHOCK AIRCRAFT . . . . AS REQUIRED (LM)

CRITICAL ITEMS PRECEDED BY AN ASTERISK SHALL BE COMMITTED TO MEMORY

Figure 8-9. Emergency Procedures Checklist

CHAPTER 9

Functional Checkflight Procedures

9.1 GENERAL

9.1.1 Checkpilots. The most important factor in obtaining good checkflights on the aircraft is to pick experienced, conscientious checkpilots. Commanding officers will designate, in writing, those pilots within their command who are currently eligible to perform this duty.

9.1.2 Checkflights and Forms. Checkflights will be performed when directed by, and in accordance with, OPNAVINST 4790.2 series and the directions of NAVAIRSYSCOM type commanders or other appropriate authority. Functional checkflight requirements and applicable minimums are described below. Functional checkflight checklists are promulgated separately.

9.1.3 Conditions Requiring Functional Checkflights. Checkflights are required under the following conditions (after the necessary ground check and prior to release of the aircraft for operational use):

A. At the completion of aircraft rework, acceptance inspection, and when an aircraft that has not flown in 30 or more days is returned to flight status (all checkflight items required are prefixed by A).

B. After the installation or reinstallation of an engine, fuel control, major fuel system components, or any other systems/components that cannot be checked in ground operation (minimum required are prefixed by B).

C. After the installation or reinstallation of a propeller, propeller governor, or valve housing (minimum required are prefixed by C).

D. When fixed flight surfaces have been installed or reinstalled or when movable flight surfaces or flight controls have been installed or reinstalled, adjusted, or rerigged, and improper adjustment or replacement of such components could cause an unsafe operating condition (minimum required are prefixed by D).

E. When an aircraft with dual or multi-independent attitude reference sources has had the indicators/displays, attitude reference sources, subsystems, or components removed, replaced, or adjusted in two or more of the attitude reference systems. Aircraft with four or more independent attitude reference sources in which two sources are known good, and the integrity of those two sources has not been jeopardized, will not require a FCF.

Note

FCFs are not required when the maintenance action involves only the removal and reinstallation of connecting hardware without a change in adjustment or alignment to one of the above systems. However, a thorough ground functional check shall be conducted before the aircraft is released for flight. An appropriate entry noting the system disconnected and reconnected and the accomplishment of a ground functional check shall be made on a VIDS/MAF or entered in NALCOMIS.

Every effort shall be made to perform the entire profile, however, these profiles may be modified to meet specific requirements and/or aircraft configurations. It is not required to complete every step in any one profile if the steps are not applicable, certain systems are inoperative, or required NAVAIDS are unavailable. FCF crews, together with Quality Assurance, shall ensure that, as a minimum, those systems affected by maintenance action are tested.

9.2 PROCEDURES

Flight profiles for functional checkflight are depicted in Figure 9-1. 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 required checks in the most efficient and logical order, a flight profile has been established for each checkflight condition stated above and identified by the corresponding letter. The applicable letter identifying the profile prefixes each check both in the following test and in the functional checkflight checklists. Checkflight personnel will familiarize themselves with these requirements prior to the flight. NATOPS procedures will 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. A daily inspection is required prior to the checkflight.

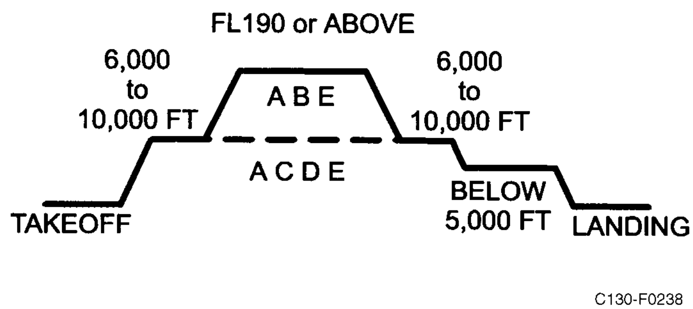


Figure 9-1. Flight Profile

PROFILE

9.2.1 Pretaxi

A D 1. Flap operation.

a. Pull FLAP CONTROL circuit breaker.

b. Override operation.

(1) Have crewmember lower flaps to 20 percent by depressing the manual override button on the down side of the flap selector valve.

(2) Have crewmember raise flaps to 0 percent by depressing the manual override button on the up side of the flap selector valve.

c. Manual operation.

(1) Set flap lever to 10 percent.

(2) Turn off the No. 1 and No. 2 hydraulic pumps, utility suction boost pump, and deplete system pressure.

(3) Have a crewmember engage the handcrank, remove the input shaft pin, and shift to MANUAL drive.

(4) Manually lower the flaps to 10 percent.

(5) Remove handcrank, shift back to NORMAL drive, and replace the input shaft pin.

(6) Turn on the utility suction boost pump and the No. 1 and No. 2 hydraulic pumps.

(7) Push in flap control circuit breaker and raise flap lever to UP.

d. Ensure that normal flap operation has been regained.

A D 2. Flight controls and boost shutoff.

a. Check ailerons, elevators, and rudder for freedom of movement with booster hydraulic system switches in the OFF position.

Note

Restrain the control column when checking elevator movement to prevent the bobweight from slamming the controls against the stops.

b. Turn utility hydraulic system switches to the OFF position and check flight for no boost operation.

c. Turn on booster hydraulic system switches and recheck flight controls.

d. Turn on utility hydraulic system switches and ascertain that all boost shutoff switches are in the ON position.

PROFILE

A B C

3. Ice detection system.

Complete engine, propeller system check as specified in the TAXI checklist, Chapter 8 of Part III, in both MANUAL and AUTO.

A D

4. Trim tabs.

a. Check trim for freedom of movement and proper travel.

b. Check elevator trim tab in EMERGENCY.

c. Check copilot elevator control.

d. Set trim tabs for takeoff.

9.2.2 Pretakeoff

A

5. Brakes.

a. Check emergency system operation by ensuring firm response upon application.

b. Check normal system with ANTI-SKID switch OFF.

c. Check normal system with ANTI-SKID switch ON.

d. Check copilot brake pedals.

A B C

6. Nosewheel steering.

a. Check nosewheel steering for smooth operation in both directions, no lag response, ease of motion, and ease of return to center.

b. An aircraft requires excessive steering control if it fails to track straight with the throttles adjusted as follows:

(1) Fuel flow — Maximum 50 lb/hr differential.

(2) Torque symmetrical.

c. A steering correction while tracking in a straight line that causes a pointer deviation outside the white radius on the steering position indicator is excessive.

A E

7. Flight instruments.

a. Check heading and turn and slip indicators for correct movement in a turn. (Check both left- and right-hand turn.)

b. Check airspeed and VSIs for proper readings.

c. Check ADIs for proper operation.

d. Check standby attitude indicator for proper operation.

PROFILE	
A B C	8. Propeller reversing.
	Reverse propeller in symmetrical pairs and check rpm and torque differential; if torque differential is greater than 1,000 pounds, compensate on subsequent reversing and record discrepancy.
A B C	9. Engine runup.
	a. Complete engine runup as prescribed in Chapter 8 of Part III.
	b. Ensure all engine instrument readings are within normal limits.

9.2.3 Climb (Profiles A, B, and E FL 190; Profiles C and D 6,000 Feet)

PROFILE	
A B C	10. NTS check.
	Perform NTS check for engines to be shut down in accordance with procedures in Cruise Engine Shutdown checklist in Chapter 8 of Part III.
A E	11. Flight instruments.
	a. Check pilot and copilot ADI and HSI for smooth operation and accuracy, one against the other.
	b. In a standard-rate turn, check turn needles for 30° turn in 10 ±1 seconds.
	c. Check airspeed indicators for a maximum differential of 6 knots.
	d. Check pilot, copilot, and navigator altimeters against each other to be within 230 feet at 10,000 feet and 340 feet at 20,000 feet.
	e. Establish a constant rate of climb. Time altimeter for 1 minute to determine actual rate of climb. Both VSIs must agree within 100 fpm.
	f. Check standby attitude indicator for smooth operation and accuracy.
A	12. Pressurization/rate of climb.
	a. Set cabin rate of climb to MIN; check climb rate 30 to 200 fpm.
	b. Set cabin rate of climb to MAX; check climb rate 1,600 to 2,900 fpm.
	c. Set rate-of-climb knob at a midposition and check rate between MIN and MAX limits.
A	13. Leading edge anti-ice system check.
	Turn on wing and empennage anti-ice system individually and check that the anti-icing valves modulate to maintain temperature within normal limits.

PROFILE

9.2.4 Level (Profiles A and B FL 190, Profiles C and D 6,000 Feet)

A

14. Auxiliary power unit check.

    a. Start APU in accordance with instructions contained in Chapter 8 of Part III. APU shall start normally and EGT shall remain in normal range.

    Note

    APU shall only be started below 20,000 feet and 200 KIAS.

    b. If APU generator was not checked previously, apply electrical load and verify frequency, voltage and load are within normal limits.

    WARNING

    Do not open the APU bleed air valve in flight.

    c. Stop the APU in accordance with instructions contained in Chapter 8 of Part III.

A

15. Air conditioning/fuselage leak check.

    a. Select MAN PRESS and ensure positive control of the outflow valves by increasing and decreasing.

    b. Hold the manual pressure switch in the increase position. The safety valve should regulate cabin pressure to 15.9 (±0.3) inches Hg. Note the pressure.

    WARNING

    Do not exceed a maximum of 16.4 inches Hg differential pressure.

    CAUTION

    Do not hold manual pressure switch for over 30 seconds to preclude burning out the valve motor.

    c. Select AUTO PRESS. The pressure should decrease slowly and the outflow valve should regulate cabin pressure to 15.4 ±0.4 inches Hg but lower than the pressure noted in step b.

    d. Select MAN PRESS and pressurize aircraft to pressure noted in step c plus 0.2 inches Hg (this will ensure that the outflow valve is closed).

PROFILE

Note

A properly functioning air-conditioning and pressurization system will exceed 15.9 inches Hg if the outflow valve is held toward closed in MAN PRESS. This will cause the safety valve to open before the outflow valve is fully closed. Beginning the check with the outflow valve partially open will result in a failed check. If this situation occurs, close engine bleed air valves as necessary, one at a time, to keep cabin pressure within limits and ensure outflow valve is fully closed prior to continuing.

e. Place the ENGINE BLEED AIR switches to OFF.

f. Time differential pressure decreases from 14 to 12 inches. Time shall be no less than 58 seconds at FL 200.

g. Place all ENGINE BLEED AIR switches to ON and repressurize to step c pressure.

h. Select AUTO PRESS.

i. Check windshield defogging for proper airflow.

j. Check control of flight deck and forward and aft cargo compartment temperature, both manually and automatically.

k. Place the flight station AIR CONDITIONING SHUTOFF switch to OFF.

l. Place FLT STA AIRFLOW switch to MIN, NORMAL, INTMED and MAX, in turn.

Note

Airflow to the flight station distribution ducts from the cargo compartment air-conditioning system should be greatest in MIN and become progressively less in each position to no flow in the MAX position.

m. Place the flight station AIR CONDITIONING SHUTOFF switch to ON.

A D 16. Flight control system (FCS 105) auto operation.

Note

Displacement of the pitch rate knob will disengage ALT except when coupled to a glideslope. Displacement of the turn control will disengage all modes if AP CPLD is engaged. Each mode can be disengaged by its individual switch.

a. With the YD and AP engage levers ENGAGED:

(1) Check that YD and AP disengage by alternately pressing the pilot and copilot autopilot release switches.

PROFILE

(2) Check that YD (on aircraft prior to 165313) and AP disengage by alternately actuating the pilot and copilot normal elevator trim tab switches.

Note

Check AP CLPD on each system. Observe operations to be normal on all modes while not coupled.

(3) Check disengagement by moving the elevator tab power selector switch out of the NORMAL position.

(4) Check that the AP DISENGAGE light illuminates with each disengagement.

(5) Check that the rate of response is relative to the amount of displacement to the turn control and the pitch control movement. When the controls are released, check that the bank angle and the pitch attitude remain constant.

(6) Check the maximum bank limits.

b. Engage the YD and AP engage levers while in a 45° bank and some amount of command bar pitch command.

(1) Check that the autopilot decreases the bank angle to the maximum autopilot bank limit and that engagement provides an initial pitch hold automatically.

(2) Level aircraft and set heading marker under lubber line.

c. Select HDG, ALT, and AP CPLD.

(1) Check the annunciator HDG, ALT, and AP CPLD lights are illuminated and that the mode selector flags indicate selected.

(2) Check turns to the desired headings and command bar response by moving the heading marker for the HSI.

(3) Check the maximum bank limits and the maximum altitude change during turns.

(4) Check that turn control will deselect all modes and that all mode lights extinguish.

(5) Check that the pitch control will deselect the ALT mode, that the ALT ON flag is removed, and the ALT HOLD light extinguishes.

Note

When the autopilot is disengaged, it will not disengage altitude hold for the other system; if the aircraft altitude is changed approximately 800 feet, the computer warning flag will appear for the system with the ALT engaged.

d. Select NAV LOC then AP CPLD.

(1) Check that the system remains in HDG by adjusting the heading selector.

PROFILE

(2) Check that the AP CPLD light and the NAV ARM light are illuminated and the NAV LOC ON flag is in view.

e. Check the capture and track of a VOR radial.

(1) Select a VOR station at least 30 miles away from present position. Adjust the heading marker on the HSI for a 60° intercept to the desired radial. When the system automatically captures the desired radial, check that the NAV CAPT light illuminates and the HDG and NAV ARM lights extinguish.

(2) Check the maximum bank-angle limits.

(3) Check tracking performance (both autopilot and flight director commands).

(4) Press the SYNC pushbutton on the side the AP is coupled. AP CPLD will disengage, and vertical modes for the appropriate system will disengage. Check that the aircraft can be maneuvered and the autopilot will hold the attitude existing when the SYNC is released.

(5) Disengage AP and YD engage levers and alternately increase and decrease pitch attitude. Press the SYNC buttons simultaneously to check that the command bars synchronize for holding the pitch angle.

f. Check vertical modes as follows while coupled to the No. 1 system:

(1) Set IAS, and change power. Commands and/or autopilot response should hold existing IAS.

Note

The speed deviation pointer should be centered when maintaining an airspeed equal to that selected on the appropriate IAS indicator, and the pointer should move fast or slow as the airspeed is varied.

(2) Select VS while changing altitude. Commands and/or autopilot response should maintain existing vertical speed.

(3) While doing the above, select an altitude on the altitude selector at least 2,000 feet in the direction used above and depress ALT SEL. The ALT ARM light should illuminate; the ALT WARN light should illuminate, and a 2-second tone should occur 1,000 feet from selected altitude; the ALT WARN light should extinguish 300 feet from selected altitude.

(4) The selected vertical mode should disengage, and the ALT HOLD light illuminates prior to reaching the selected altitude. Commands and/or autopilot response should level off and capture the selected altitude. (Altitude capture in the ALT SEL mode will be softer than if captured by depressing ALT, but after capture overshoots, the limits are the same.) ALT ARM light remains on after altitude capture if done in ALT SEL mode, and extinguishes if ALT mode is selected.

(5) When leaving a selected altitude, the ALT WARN light should come on and a 2-second tone should sound at 300 feet from the altitude. The light should remain on until the aircraft returns to less than 300 feet from the selected altitude or a new altitude is selected.

PROFILE

g. Limits.

(1) Bank-angle limits:

(a) Turn rate knob — 30° ±3°.

(b) Heading mode — 25° ±3°.

(c) VOR capture — 25° ±3°.

(d) VOR track — 8° maximum.

(e) ILS capture — 25° ±3°.

(f) ILS track — 15° ±3°.

(2) Vertical modes (ALT HOLD/ALT SEL):

(a) Engage overshoot — 7.5 percent of climb/dive (fpm).

(b) Altitude hold accuracy — ±25 feet or 0.1 percent of altitude, whichever is greater.

(c) Altitude hold in turns — ±40 feet or 0.4 percent of altitude.

(d) IAS hold — ±3 knots.

(e) VS hold — ±70 fpm at 1,000 fpm.

(f) ALT SEL-CAPTURE — ±50 feet or 7.5 percent of climb/dive rate.

(3) VOR or localizer capture.

Maximum of one overshoot. The magnitude of the overshoot may vary but never more than one dot. If maximum bank angle is not experienced, then there should be no overshoot.

(4) Maximum intercept angles.

(a) VOR/front-course ILS — 90°.

(b) Back-course ILS (localizer) — 75°.

A 17. Radios and navigation aids.

a. Obtain a two-way radio check on all transceivers.

b. Check for operation of the ICS and PA systems.

c. Check all navigation receivers for proper indications.

d. Check INS for proper operation.

e. Check for proper operation of the radar.

f. Obtain IFF check on all modes including emergency and mode C.

PROFILE

A B C

18. Engine shutdown and airstart.

    a. Complete Cruise Engine Shutdown checklist for affected engines.

    b. Prior to shutdown, each engine condition lever should be momentarily placed to GROUND STOP. The engine should continue to run.

WARNING

Should the engine flame out, immediately place the condition lever to feather.

    c. Feather cycle should complete within 10 seconds. If the feather override button fails to pop out within 4 to 5 seconds, pull it out manually.

WARNING

Should the propeller continue to rotate, slow to minimum safe control speed and follow Propeller Fails to Feather procedures outlined in Chapter 11 of Part V.

    d. Accelerate to 200 KIAS. Propeller should not rotate.

    e. Affected engine-driven hydraulic pump light on.

Note

Certain engine driven hydraulic pumps will not always cause the light to come on when the engine is shut down in flight. If the light does not come on immediately, cycle the flight controls. If the light still does not come on, turn off the other engine-driven pump for the affected system and bleed down the pressure. When the secured engine's light comes on, turn-on the engine-driven pump for the running engine and note that the light for the secured engine stays on.

    f. Perform Airstart Procedure Checklist.

    g. Repeat for the remaining engines.

A B C

19. Propeller reindexing (if required).

    a. Accomplish reindexing procedure as outlined in Chapter 8.

A B C

20. Throttle alignment.

    a. Match all TITs above crossover (one-half-knob width of each other).

PROFILE

A B C

21. Cruise power.

    a. Record all engine cruise power settings with TIT above crossover and while maintaining a constant IAS.

A B

22. Fuel jettison.

    a. Perform fuel jettison as outlined in Part V.

9.2.5 Descent/Level 2,000 Feet or Below (Profiles A and D)

A D

23. Flap operation.

    a. Reduce airspeed below 145 KIAS.

    b. Lower flaps from 0 to 100 percent; operating time should be 8 to 15 seconds.

    c. Check operation of warning horn at 80 (±5) percent with the gear up.

    d. Raise flaps from 100 to 0 percent; operating time should be 10 to 15 seconds.

A

24. Emergency depressurization/auxiliary vent system check.

    a. With aircraft pressurized to less than 3 inches Hg, place the EMERGENCY DEPRESSURIZATION switch to EMERG DEPRESS. Ensure a rapid loss of remaining pressure.

    b. Return the EMERGENCY DEPRESSURIZATION switch to NORMAL.

    c. Place the AIR CONDITIONING master switch to AUX VENT.

    d. Verify airflow through both flight station and cargo department duct and both outflow valve and safety valve are open.

    e. Reset air-conditioning as desired.

A

25. Landing gear operation.

    a. Normal operation.

        (1) Lower gear normally; all gear should indicate DOWN in 19 seconds or less.

        (2) Raise gear; all gear should indicate UP in 19 seconds or less (the NLG must take at least 3 seconds to retract).

    b. Manual override operation.

        (1) Pull LANDING GEAR CONTROL circuit breaker.

        (2) Place the landing gear lever in the DOWN position.

        (3) Have crewmember lower landing gear by depressing the override button on the down side of the landing gear selector valve.

Note

Verify that once the DOWN button is depressed, it will hold in until the extension is complete and the UP button is energized, either manually or by restoring electrical power and activating the landing gear handle to the UP position.

PROFILE

(4) Push in LANDING GEAR CONTROL circuit breaker.

(5) Raise landing gear.

c. Manual extension of the main landing gear.

(1) Pull out the LANDING GEAR CONTROL circuit breaker.

(2) Lower the landing gear lever.

(3) Deplete all utility hydraulic pressure by securing the No. 1 and No. 2 engine-driven hydraulic pumps and the utility suction boost pump.

Note

Establish communication with a crewmember stationed forward of each MLG wheelwell. The crewmember will remove the hydraulic panel cover. The crewmember will respond with “Port” and “Starboard” when an action is complete.

(4) Pull and lock port and starboard emergency locking handle.

CAUTION

Do not force the emergency engaging handle out. To do so may result in a bent manual drive clutch lever, making it difficult or impossible to engage the manual drive. It may be necessary to place the extension handcrank on the emergency extension stub shaft and rotate slightly until the manual drive gear teeth align.

(5) If the MLG does not freefall, place the handcrank on the stub shaft and extend the gear by rotating the stub shaft approximately 330 turns in the direction of the arrow above the shaft.

WARNING

- Make sure the ratchet on the handcrank is set for down rotation before placing it on the stub shaft.

- If the MLG starts to freefall after the handcrank is placed on the stub shaft, immediately remove the handcrank. The extension handle ratchet may change direction because of the rotation speed of the stub shaft.

(6) Note that the MLG indicates DOWN and LOCKED.

PROFILE

(7) Have crewmembers push emergency locking handles IN and rotate handcrank to verify disengagement.

(8) Emergency NLG extension.

(a) Position the NLG emergency extension valve to NLG EMERGENCY EXTENSION.

(b) Turn auxiliary hydraulic pump ON.

(c) Observe the NLG — DOWN and LOCKED.

(d) Position the NLG emergency extension valve to NORMAL.

(e) Turn the auxiliary hydraulic pump OFF.

(9) Push in the LANDING GEAR CONTROL circuit breaker.

(10) Turn the utility hydraulic pumps ON and note all gear DOWN and LOCKED.

(11) Raise the landing gear lever and note all gear UP and LOCKED.

d. NLG manual release.

(1) Pull LANDING GEAR CONTROL circuit breaker.

(2) Decrease airspeed to or below 120 KIAS.

(3) Pull the NLG emergency release handle.

Note

The nosegear should extend into the slip stream. Allow the nosegear to extend until the forward gear door starts to close at reduced airspeed; this may require 30 to 45 seconds. Increase airspeed as rapidly as possible not to exceed 165 KIAS. The nosegear should extend to the DOWN and LOCKED position.

(4) Position the landing gear lever DOWN.

(5) Push in the LANDING GEAR CONTROL circuit breaker.

(6) Note all gear indicators DOWN and LOCKED.

(7) Recheck normal landing gear operation.

A 26. ADS system check.

a. Position crewmember on ICS at ramp. (Ensure that ramp arms are connected and bomb rack is cocked.)

b. Place AUX PUMP switch to ON.

PROFILE

c. Open cargo door and ramp from cockpit (7 to 30 seconds).

d. Press ADS release button in cockpit; observe shackle operation on bomb rack.

e. Close cargo door and ramp from cockpit (7 to 30 seconds).

f. Place AUX PUMP switch to OFF.

9.2.6 Approach (Profiles A and D)

A — 27. Check radar altimeter.

A D — 28. Flight control system (FCS 105) approach and go-around.

a. ILS back course (if available).

(1) Select ILS frequency, set course arrow on front course bearing, and place AP and YD engage levers to ENGAGE.

(2) Set the heading marker to intercept the back course at an angle of 45° (75° is the maximum capacity). BACK LOC illuminates.

(3) Select the following modes: NAV LOC, ALT, and AP CPLD. (The autopilot should follow the heading marker command until NAV CAPT light illuminates and the HDG annunciator extinguishes.) GS flap and pointer out of view, GS ARM not illuminated. Select APR and verify glideslope disabled.

(4) Check the maximum bank angle obtained and the tracking performance.

b. ILS front course.

(1) Set the heading marker for a 45° intercept angle.

(2) Select NAV LOC then ALT and AP CPLD.

(3) The autopilot should turn to the heading marker command and the command bar should coincide. The AP CPLD, HDG, NAV ARM, and ALT HOLD light should be illuminated. When NAV CAPT is obtained, the NAV CAPT light should be illuminated and the HDG and NAV ARM lights extinguished.

(4) After NAV CAPT, select APPR and the GS ARM light should illuminate.

(5) When the GS CAPT light illuminates, the GS ARM and ALT lights should extinguish and the aircraft and flight director should follow the glideslope.

(6) Select nose up and nose down with the pitch control and the autopilot should remain coupled to the ILS.

Note

LOC should capture at least 18 miles from antenna and GS should capture at least 10 miles. (Flags should pull.)

PROFILE

c. Go-around check.

While inbound in the ILS and prior to decision height:

(1) Select the heading marker to the desired go-around heading.

(2) When reaching decision height, press the G/A (go-around) pushbutton. All modes and the autopilot should disengage and the GA light should illuminate. The command bar should command wings level and approximately 7° to pitch up.

(3) Actuate SYN pushbutton and go-around will be canceled.

9.2.7 Landing and Shutdown (Profiles A, B, C, D, E).

A B C D E

29. Landing and shutdown.

a. NTS and drip valve.

(1) Check NTS drip valve during engine shutdown.

PART IV

Flight Characteristics

CHAPTER 10

Flight Characteristics

10.1 INTRODUCTION

The aircraft was designed for cargo and passenger transport and for support and utility operations from small fields and emergency airstrips. In this, and in all other areas of flight operations including formation and instrument flying, the aircraft has satisfactory flight characteristics. The outstanding and most useful characteristic in all ground and flight operating conditions is the capability of the aircraft for rapid acceleration and its immediate and precise response to power and control applications.

10.2 STALLS

Stall warning occurs in the form of airframe buffeting. The margin of airspeed between initial warning and actual stall is from 2 to 5 knots in the landing configuration and comfortably greater in other configurations. There is little or no stall warning with gear and flaps retracted at flight idle power. Power-off staff speeds for typical configurations and flight attitudes are given in Figures 10-1 through 10-4. Use care to avoid accidental stalls. Should a stall be entered, it is recommended that recovery be made as follows:

1. If in level flight, immediately drop the nose and apply power to limit loss of altitude. Use ailerons and rudder to counteract any wing-dropping tendency. Move controls smoothly, avoiding abrupt actions. Avoid diving the aircraft, and avoid abrupt or accelerated pull-up after recovery.

2. If in climbing or banked attitude, immediately drop the nose, level the wings, and apply power to limit loss of altitude. Move controls smoothly, and avoid abrupt actions. Avoid diving the aircraft, and avoid abrupt or accelerated pull-up after recovery.

3. Heavy gross weight cruise configuration power-on stalls will be accompanied by reduction of rudder and elevator control forces. Recovery should be made by applying nose down elevator.

10.2.1 Practice Stalls. Any practice stall entry and recovery should be made at light weights (not to exceed 120,000 pounds) and with the cargo compartment empty. Practice at a minimum altitude of 10,000 feet above the ground. The aircraft should be trimmed at a speed not less than 1.4 times the stall speed for the entry configuration and weight, and should not be adjusted until recovery is completed.

During stall entry, the nose should be raised at a rate to produce an airspeed decrease of approximately 1 knot per second.

The throttle should be increased above flight idle only as necessary to prevent NTS action from occurring during entry into the stall. The synchrophase master switch should be OFF. When stall warning in the form of light airframe buffeting occurs, recovery should be initiated. Avoid abrupt control movements and avoid any control action that may result in sudden attitude change or in excessive acceleration of buffeting.

The following conditions adversely affect stall characteristics and/or performance and should be taken into consideration prior to any practice stall training.

1. High power settings

2. Asymmetric power

3. One or more engines producing negative torque or causing a negative torque signal

4. Retrimming or continually trimming the elevator nose up during stall entry

5. Changing flap deflection during stall entry or recovery

6. Increasing power during stall entry

7. Practicing stalls at too low an altitude or over an overcast

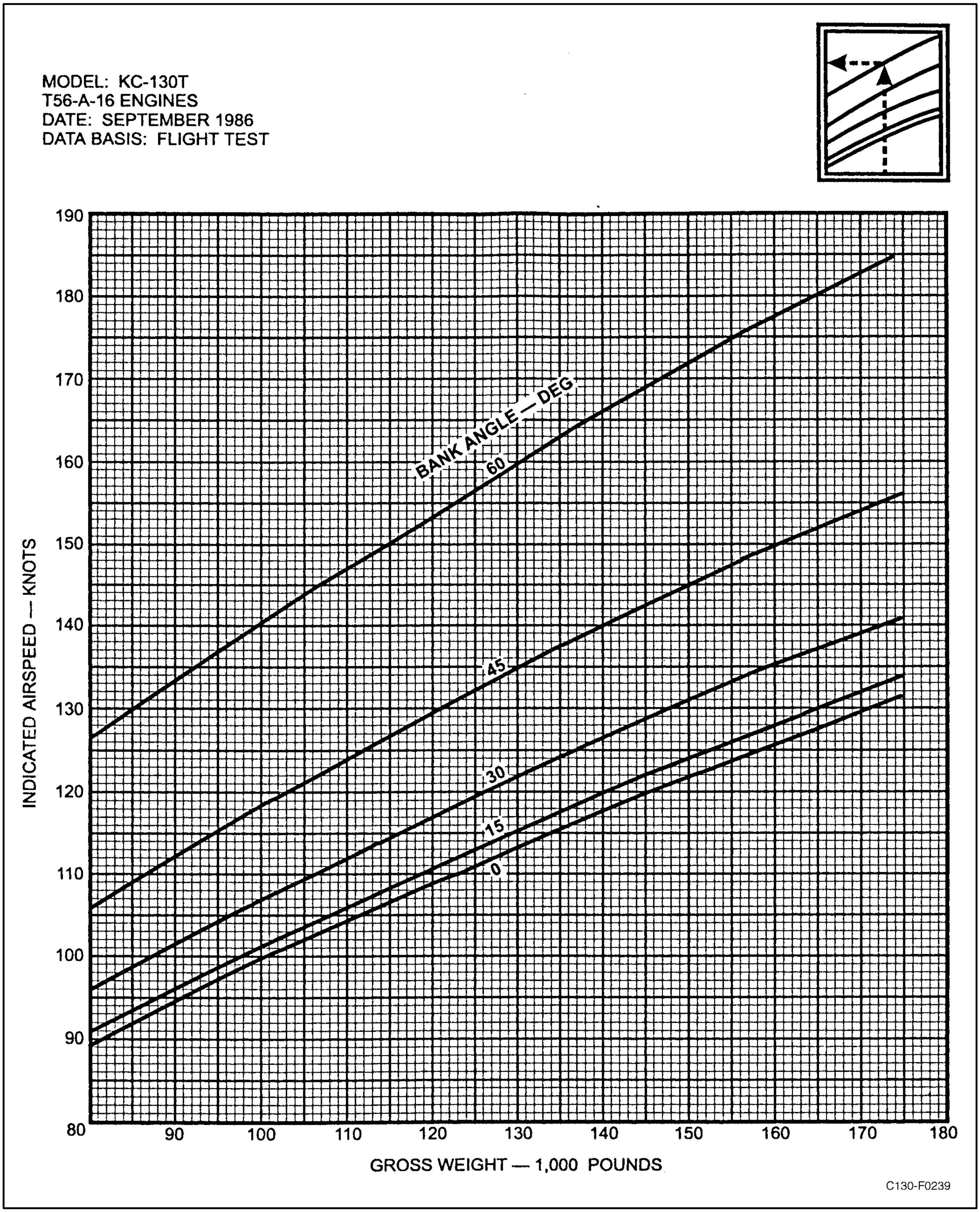


Figure 10-1. Power-Off Stall Speeds — Sea Level, ICAO Standard Atmosphere, Flaps Up

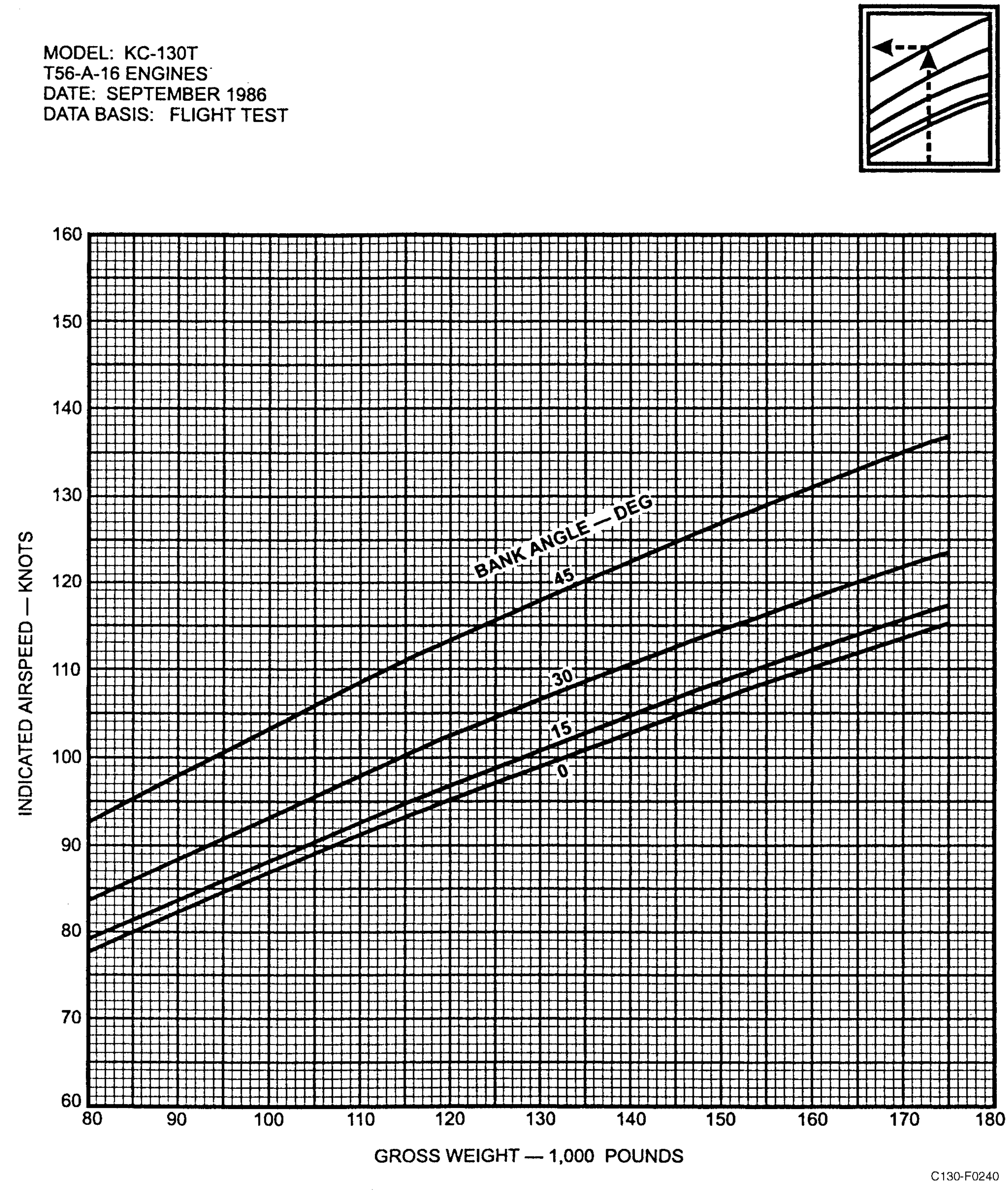


Figure 10-2. Power-Off Stall Speeds — Sea Level, ICAO Standard Atmosphere, 50-Percent Flaps

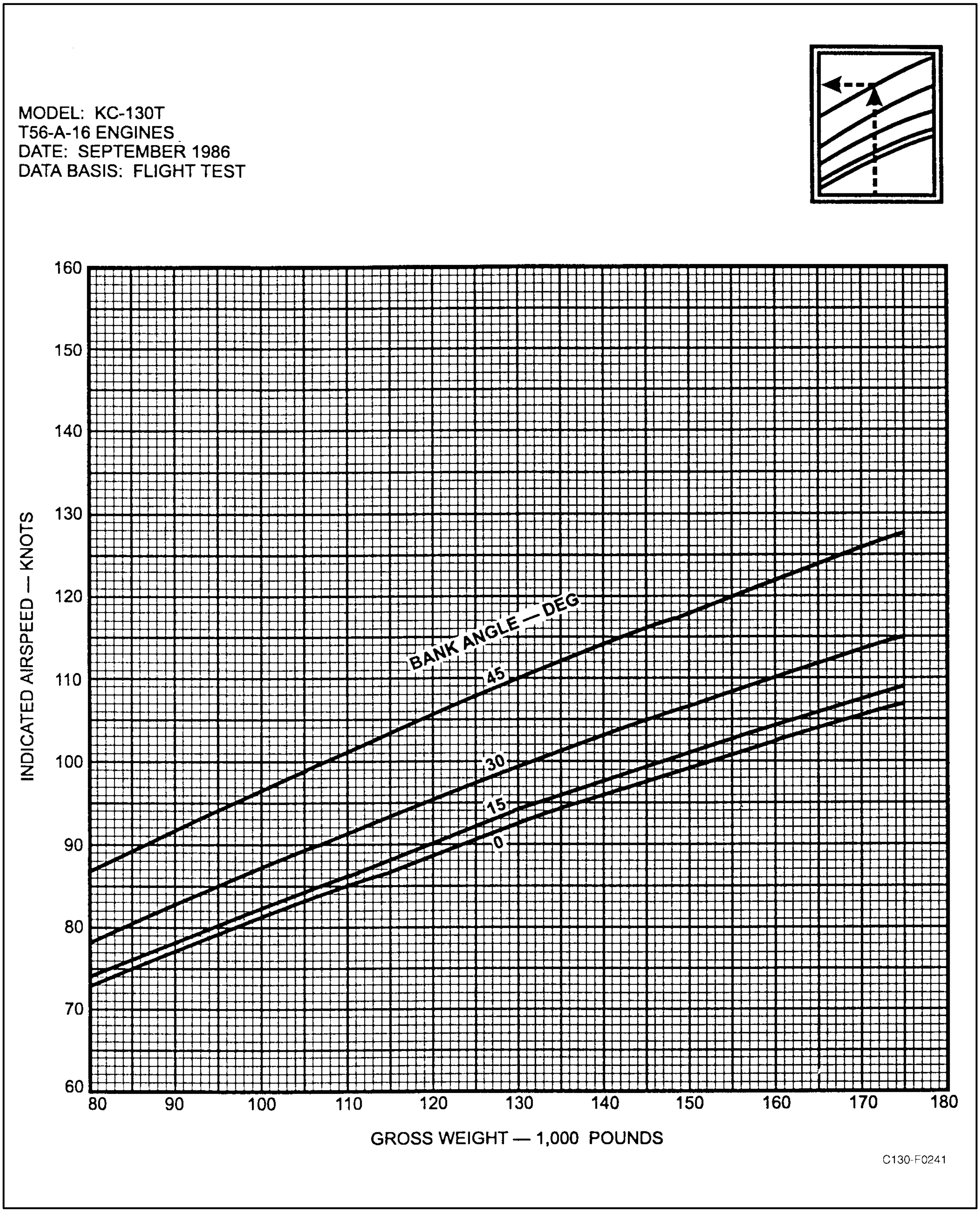


Figure 10-3. Power-Off Stall Speeds — Sea Level, ICAO Standard Atmosphere, 100-Percent Flaps

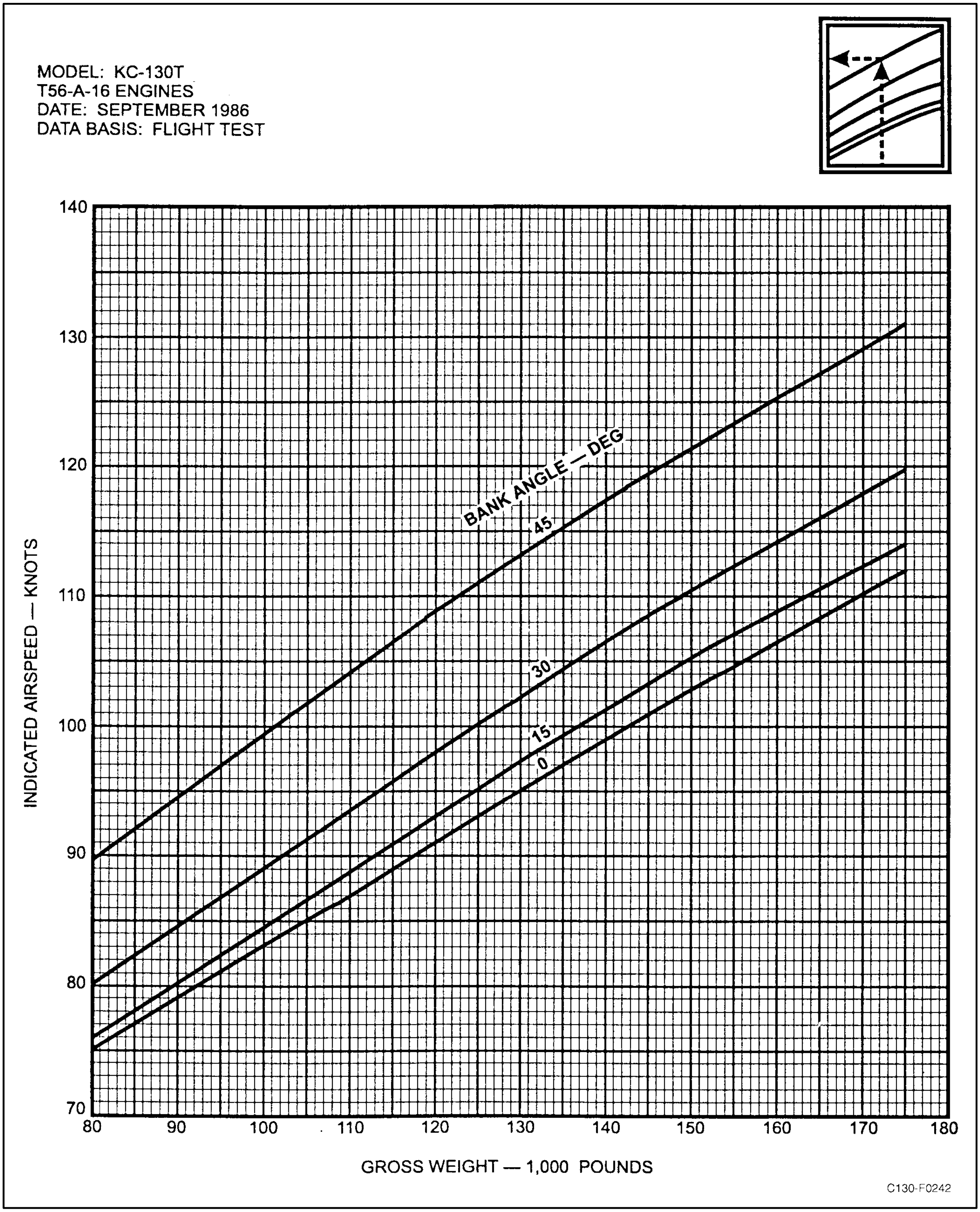


Figure 10-4. Power-Off Stall Speeds — Sea Level, ICAO Standard Atmosphere, Gear Up or Down, 70-Percent Flaps, Out of Ground Effect

8. High fuel weights-low cargo weight conditions

9. Aft center of gravity position.

WARNING

Clean-configuration stalls should be discontinued at the onset of buffet. Power-on stalls should not be attempted because of the excessively nose-high attitude required.

10.3 SPINS

Spins are a prohibited maneuver, and should never be intentionally entered. Accidental spins can be prevented by immediate recovery from any stall condition. If a spin is accidentally entered, it is anticipated that a normal recovery for multi-engine aircraft will be effective. As in any maneuvering flight, proper care should be taken to avoid exceeding the structural limits of the aircraft by a sudden pull-up.

10.4 FLIGHT CONTROLS

The flight controls are designed to be operated with hydraulic boost on at all times. With boost on, the aircraft can be controlled without undue effort by the pilot under any reasonable load, flap, and power combinations. Lighter stick forces are encountered in the power-approach configuration with aft center of gravity loadings. At airspeeds below 100 KCAS in the power-approach configuration, a less positive roll stability effect is experienced. In case of complete failure of the hydraulically powered control systems, refer to Part V.

WARNING

Landing under these conditions will be marginal if turbulence or crosswinds are encountered. Do not deliberately turn off properly functioning boost control in flight. To do so may result in an uncontrollable attitude change and acceleration.

10.5 LEVEL-FLIGHT CHARACTERISTICS

The range between slow- and high-speed flight is unusually large, but control and stability are normal for any trimmed condition. During landing at light gross weights, the aircraft has a tendency to float due to the large wing area, the propeller blade angle, and the flight idle horsepower.

10.6 MANEUVERING FLIGHT

Maneuvering flight within the category of acrobatics is prohibited. Do not make hard rudder kicks that result in large angles of yaw. Normal maneuvers may be accomplished with moderate pilot effort, since control movement is assisted by the boost system. There are no conditions of normal maneuvering flight which will produce a reversal of control pressures, and maneuvers can be accomplished with ease. In executing turns under combat conditions, remember that 60° is the maximum bank angle. The recommended speed for minimum-radius turns is the best climb speed at that altitude.

WARNING

Abrupt pushover to a negative-g condition with flaps either up or down should be avoided. This type of maneuver will result in a reduction in maneuvering longitudinal stability, in that the angle of pitch-down and the negative-g condition continue to increase even after the stick direction has been reversed. After movement of the stick toward the former position is begun, there is a time lag before the aircraft starts to reverse its pitching motion. Final recovery from the maneuver requires considerable pull force. This is due to the large pitching inertia of the aircraft and the longitudinal rotational effect on the hinge moments of the elevator. These characteristics could result in an excessive negative load factor, an uncomfortable nose-down attitude, and an excessive positive load factor because of an abrupt recovery.

10.6.1 Fin Stall

WARNING

Fin stall maneuvers are prohibited.

If the aircraft is maneuvered to abnormally high sideslip angles (15° to 20°), a fin stall resulting in large yawing transients and a loss of directional stability can be encountered. This is an unusual flight maneuver and will not result from power transients, gusts, wake turbulence or execution of normal flight maneuvers. The fin stall condition is more likely to occur during abnormal amounts of left–rudder–input maneuvers if held until fin buffet occurs. Fin stall can be encountered at all speeds between stall speed and approximately 170 KIAS in all flap configurations with power on. The susceptibility of encountering the fin stall condition is greatest at low speed with high power. Consequently, under these conditions rapid yawing maneuvers can be produced with relatively low abrupt rudder inputs or abnormally high rudder deflections. As the aircraft attitude approaches the critical sideslip angle, heavy vertical fin buffet will develop.

10.6.2 Fin Stall Recovery. Fin stall recovery must be initiated at the onset of buffet by returning the rudder to the neutral position and rolling to a wings-level attitude. If altitude and flight conditions permit, pushing the nose down to increase airspeed and/or reducing power will also assist in recovery.

Note

- Ensure that adequate flying speed is maintained at all times.
- If fin stall is entered, it will require approximately 50 to 100 pounds rudder pedal force to return the rudder to neutral.

10.7 DIVING

Conduct dives or descents within the airspeed limitations given in Part I. Avoid abrupt pullups at any time.

10.8 FLIGHT CHARACTERISTICS UNDER PARTIAL POWER CONDITIONS

The aircraft has excellent flight characteristics even when an engine is inoperative. All control surfaces are booster operated, so that no great amount of pilot force is necessary to correct the turning action caused by uneven power conditions. Some trim changes will be required. More rudder deflection will be required at low speed to counteract the unbalanced thrust. With uneven power conditions, the minimum control speed will be limited by the available rudder effectiveness. Failure of an outboard engine may require the reduction of power on the opposite outboard engine. Consult NAVAIR 01-75GAI-1.1, combined performance data manual, for recommended cruise and climb procedure for two- and three-engine operation. In the event two engines fail and a safe altitude cannot be maintained, dump fuel and jettison equipment as necessary.

10.8.1 Practice Maneuvers with One or More Engines Inoperative. Engine failures may be simulated for practice, when desired. To simulate a feathered propeller, retard one or more throttles to FLIGHT IDLE position. The checklist procedure for engine failure can be called out without actually performing the operations named. Practice maneuvers at a safe altitude. Select a base point and set up a simulated field elevation. Traffic patterns can be flown at the normal altitude above this base point.

WARNING

During takeoff, or while airborne, do not move the throttles below the FLIGHT IDLE position. Placing any propeller in the taxi range may result in immediate loss of control of the aircraft.

During practice feathering, perform engine shutdown by engine shutdown procedures. Prior to practice engine shutdown in flight, perform an NTS check as outlined in Part III.

10.8.2 Turns. Turns can be safely made in either direction with one or two engines inoperative on the same side if airspeed is maintained with sufficient margin for air minimum control speed and stall speed. Air minimum control speed is based on utilizing 5° of bank angle away from the inoperative engine(s).

Banking into the dead engine(s) increases the minimum speed at which directional control can be maintained.

10.8.3 Effect of Speed on Trim. During engine-out operation, as in all other types of operation, trim is affected by speed. After trim is set, any increase of airspeed increases the effect of the trim tabs. Conversely, any decrease of airspeed reduces the effect of trim tabs.

10.8.4 Landing and Go-Around. Landings and go-arounds with feathered engines may be simulated at altitude by flying a traffic pattern over a basic altitude. Roll out most of the trim as touchdown point is reached. During a go-around practice, note the altitude lost between the go-around decision and the time the aircraft is safely in a climb condition. Note the aircraft acceleration characteristics during these maneuvers.

PART V

Emergency Procedures

Emergency Procedures

Contents

CHAPTER 11

Emergency Procedures

11.1 INTRODUCTION

This chapter contains the procedures to be used in coping with the various emergencies that may be met during flight and landing. A thorough knowledge of these emergency procedures will enable crewmembers to perform their emergency duties in an orderly manner and to judge more quickly the seriousness of the emergency. This will permit early planning for a bailout or forced landing and will greatly increase the crew chances for survival (see Figure 11-1 for location of emergency equipment). The procedures consist of items classified as critical or noncritical. The critical items are actions that must be performed immediately to avoid aggravating the emergency and causing injury or damage. Critical items are preceded with an asterisk and must be committed to memory. Noncritical items are actions that contribute to an orderly sequence of events. After determining that an emergency exists, the pilot should immediately establish communications with a ground station. The ground station should be given a complete description of the emergency, the action taken, and an accurate position. The ground station should be further notified of any changes or developments in an emergency so that the station can alert the Aerospace Rescue and Recovery Service or other agencies to stand by, if necessary. In the checklists presented, the codes P, CP, FE, and LM stand for pilot, copilot, flight engineer, and loadmaster. This presentation does not preclude the pilot from redelegating the duties at crew briefing.

Note

Never initiate a procedure before command of the pilot.

11.1.1 Engine Shutdown Conditions. If any of the following conditions occur in flight or on the ground, shut down the affected engine when the necessary corrective action fails to remedy the adverse condition.

1. Engine fire.
2. Nacelle overheat.
3. Turbine overheat.
4. Uncontrollable rise in TIT.
5. Uncontrollable rise in oil temperature.
6. Uncontrollable drop in oil pressure.
7. Generator fails to disconnect.
8. Excessive or uncontrollable power.
9. Unusual vibration or roughness.
10. Certain propeller malfunctions (see Propeller Malfunctions, paragraph 11.4.2).
11. Start valve light illuminates.
12. Throttle control cable failure.
13. Excessive visible fluid leak.
14. Certain hydraulic malfunctions.

When it is necessary to continue operation of an engine with any of these conditions present, operate the engine with extreme caution and at the minimum power required.

Note

Before making a precautionary engine shutdown, consider performing an NTS check using the procedures in Chapter 8.

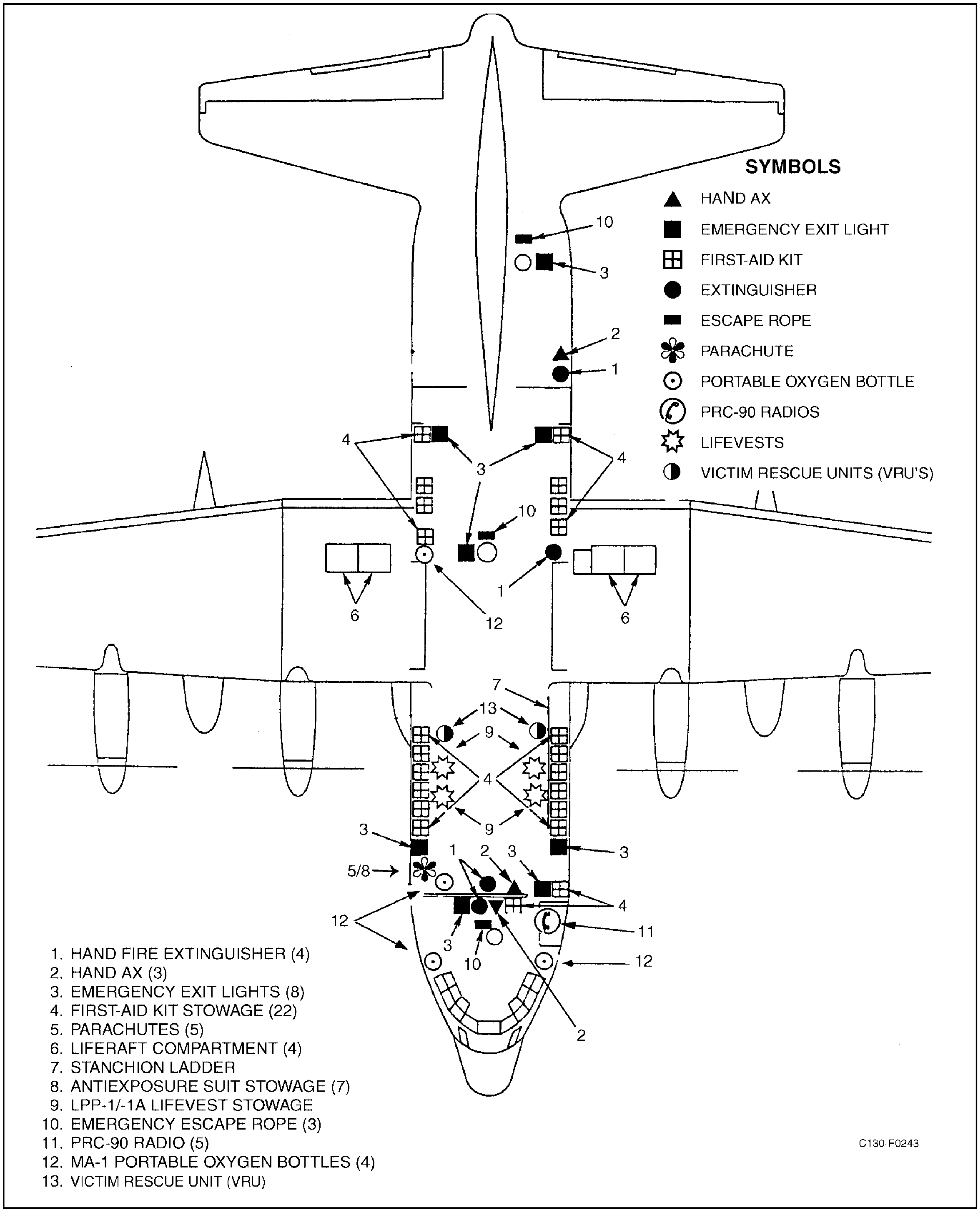


Figure 11-1. Emergency Equipment

11.1.2 Engine Shutdown Procedure

*1. Condition lever — FEATHER (CP).

CAUTION

When pulling a condition lever to FEATHER, pull it all the way to the detent to ensure that the propeller is fully feathered when the engine fuel is shut off. If the lever is left at midposition and NTS is inoperative, an engine decoupling is possible.

*2. Fire handle — Pulled (CP).

*3. Fire extinguisher — Discharge (as required) (CP).

Note

- Discharge fire extinguisher if fire or nacelle overheat indication persists.
- If fire indication condition persists, a break in the bleed-air manifold may exist.

*a. If condition persists, isolate the wing.

*b. If condition persists, discharge the remaining bottle.

*4. Flaps — As Required (CP).

*5. Landing gear — As Required (CP).

*6. Propeller — Feathered (CP).

Note

- The copilot shall verbally confirm propeller feathered with the loadmaster and visually confirm feather override button release.
- If a propeller continues to rotate, refer to Propeller Fails to Feather, paragraph 11.4.2.5.

11.1.3 Cleanup

1. ENGINE BLEED AIR switch — OFF (FE).
2. Generator switch — Set (FE).

   a. Generator switches (aircraft prior to 165313) — Tripped/OFF (FE).

   b. Generator switch (aircraft 165313 and up) — OFF (FE).

3. Fuel BOOST PUMP switch — As Required (FE).

Note

If on crossfeed, ensure source of fuel to operate engines before shutting off fuel boost pump and crossfeed valve for the affected engine.

4. CROSSFEED VALVE switch — As Required (FE).
5. PROPELLER GOVERNOR CONTROL switch — MECH GOV (CP).
6. Propeller feather override button — Out (CP).
7. SYNCHROPHASE MASTER switch — Reset as Required (FE).
8. TD VALVE switch — NULL (FE).
9. Throttle — Full Forward (P).
10. OIL COOLER FLAPS switch — CLOSED/ Fixed (CP).

Note

Performance data should be checked (refer to NAVAIR 01-75GAI-1.1, Combined Performance Data Manual).

11.2 GROUND EMERGENCIES

11.2.1 Auxiliary Power Unit Fire

*1. APU fire handle — Pulled (CP).

*2. Fire extinguisher — Discharge (as required) (CP).

*a. If condition persists, discharge the remaining bottle.

*3. APU generator — OFF (FE).

4. Evacuate (refer to Ground Evacuation procedures, paragraph 11.2.7) — (All).

11.2.2 Cargo Compartment Refrigerator Overheat Warning Light

1. Cargo compartment air-conditioning shutoff switch — OFF (FE).

2. UNDERFLOOR HEATING switch — OFF (FE).

3. APU CONTROL switch — STOP (FE).

4. Bleed-air divider valve — CLOSED (FE).

5. No. 3 and 4 ENGINE BLEED AIR switches — OFF (FE).

CAUTION

It is not recommended that any bleed-air valve be reopened once it has been closed for an overheat condition. Damage to the warning system may prevent detection of a subsequent overheat condition.

11.2.3 Start Valve Open Light Illumination. If the start valve open light illuminates other than during normal engine start:

1. Condition lever — GROUND STOP (CP).

2. ENGINE BLEED AIR switch — OFF (FE).

11.2.4 Engine Fire. Engine fires are indicated by a steady illumination in the respective fire handle and the master fire warning light on the pilot instrument panel. If an engine fire is experienced on the ground or in flight:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.2.4.1 Tailpipe Fire or Torching During Engine Start. A tailpipe fire is defined as abnormal flame or torching coming from the engine tailpipe during start.

Note

Unless taxiing, inform groundcrew of the situation so they may use ground fire extinguishers if necessary.

1. Condition lever — GROUND STOP (P).

2. Continue to motor the engine with the starter (if the switch has not been released) (P).

If flames spread beyond the tailpipe or continue:

3. Perform Ground Evacuation Procedure, paragraph 11.2.7.

11.2.4.2 Tailpipe Fire During Engine Shutdown

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

CAUTION

Tailpipe fire during engine shutdown may be caused by an oil leak in the turbine section. Do not motor the engine when a tailpipe fire exists on engine shutdown.

11.2.5 Engine Overheating. There are four indications of overheating in the engines and nacelles:

1. Turbine overheat warning light.

2. Nacelle overheat warning light.

3. High TIT.

4. High oil temperature.

11.2.5.1 Turbine Overheat Warning. If an overheat condition is indicated by the flashing of the master fire warning light and/or lights in a fire handle:

1. Throttles — GROUND IDLE (P).

2. Condition lever — GROUND STOP (CP).

11.2.5.2 Nacelle Overheat Warning. When an overheat warning is indicated by a nacelle overheat warning light on the copilot instrument panel:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.2.5.3 High Turbine Inlet Temperature. Should an overtemperature be indicated by high TIT, proceed as follows:

1. Throttle of affected engine — GROUND IDLE (P).

If this fails to eliminate the overtemperature:

2. Condition lever — GROUND STOP (CP).

11.2.5.4 High Oil Temperature. Refer to Engine Oil System Failure, paragraph 11.4.10.4.

11.2.6 Emergency Entrances. Emergency entrances are those used by ground rescue personnel (see Figure 11-2).

11.2.6.1 External Releases. The side emergency exits are each equipped with an external rotate-to-unlock-type release handle that is stowed in a flush position on the exit. Depressing the handle release button allows the handle to pop out of its stowed position so it can be rotated. Rotating the handle permits the exit to be pushed inward and entrance may be made.

11.2.6.2 Chopping Locations. Chopping locations, marked in yellow (see Figure 11-2) are painted on each side of the fuselage above the paratroop jump doors. The locations are marked on the inside and outside of the fuselage.

11.2.7 Ground Evacuation

Note

If a hot brake is suspected or a main wheelwell fire exists, set opposite brake only.

1. Parking brake — Set (P).
2. Tower/Ground — Notified (CP).
3. Crew — Notified (P)
4. Dc BUS TIE switch — TIED (FE).
5. Condition levers — FEATHER (CP).
6. Fire handles — Pulled (CP).
7. Ac/dc power switches — OFF (FE).
8. Alarm bell — One Long Ring (CP).
9. Evacuate aircraft — All.
10. Chock aircraft — As Required (LM).

WARNING

If a hot brake is suspected or a main wheelwell fire exists, chock nosegear only.

11.2.8 Brake System Malfunctions

11.2.8.1 Loss of Utility System Hydraulic Pressure. The normal brake system will be inoperative if utility system hydraulic pressure is lost. If pressure is not available to the normal brake system:

1. BRAKE SELECT switch — EMERGENCY (CP).

CAUTION

Use brakes cautiously; no antiskid protection is available on the emergency system. Avoid taxiing into congested areas because of the possibility of auxiliary hydraulic pump failure.

Note

- With antiskid off, there are approximately two brake applications available from a fully charged normal brake accumulator and approximately one application from a fully charged emergency brake accumulator.
- The auxiliary hydraulic system handpump may be used for stopping the aircraft in an emergency by holding the brake pedals down while the handpump is being operated.

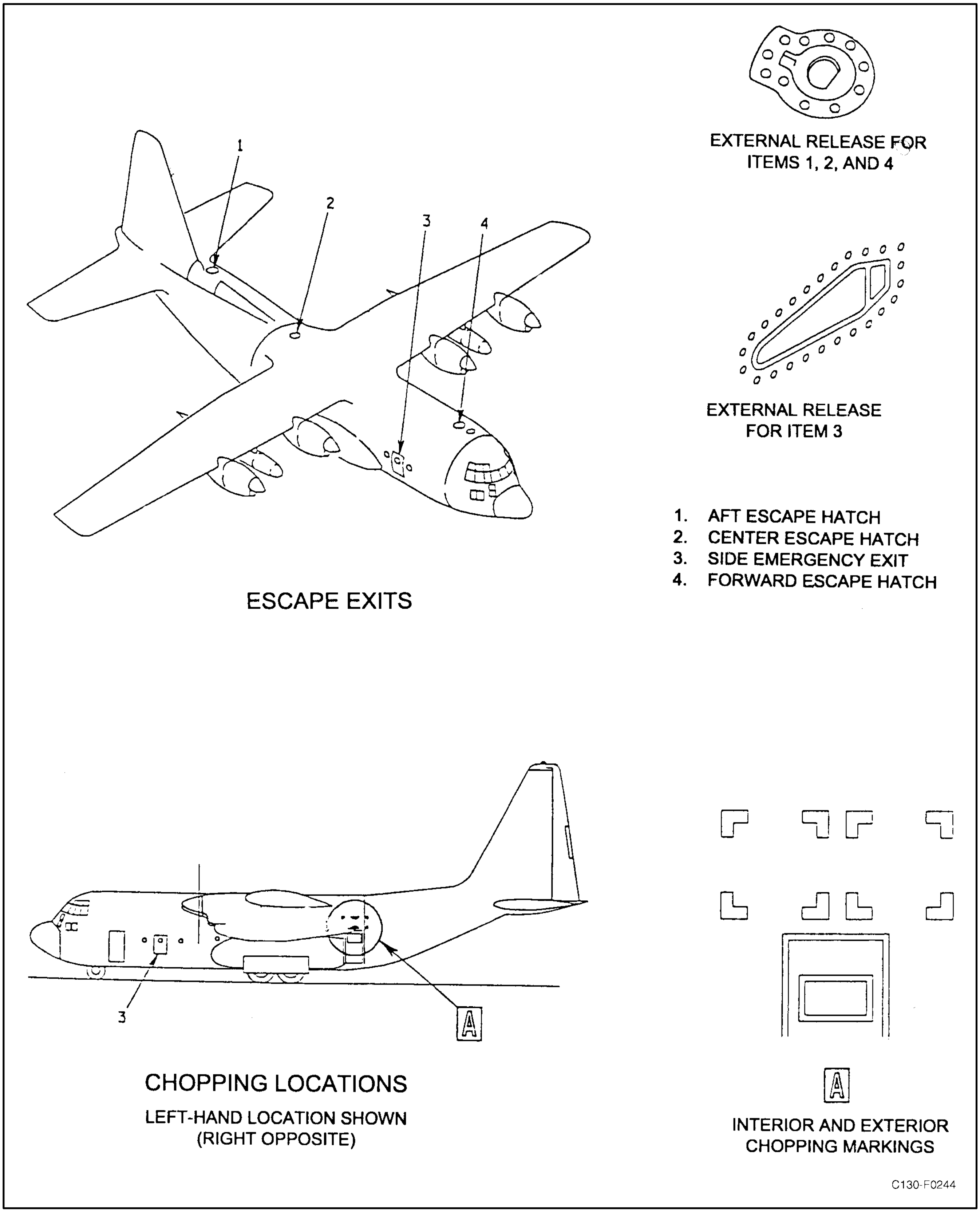


Figure 11-2. Emergency Entrances

11.2.8.2 Dragging Brake. A dragging brake may be difficult to detect. If it is not evident to the pilot, the first knowledge of the problem may be a report from the tower operator that the brake is smoking. Continued taxiing with a dragging brake will result in a brake fire. A dragging brake may be caused by improper adjustment of a new or overhauled brake or by trapped air in the brake system.

1. Stop aircraft, using reverse thrust and nosewheel steering (P).
2. Request firefighting equipment — As required (CP).

Note

Allow brake to cool and maintenance performed prior to moving the aircraft.

11.2.8.3 Brake Fire

1. Stop aircraft, using reverse thrust and nosewheel steering (P).
2. Request firefighting equipment — (CP).
3. Perform Ground Evacuation Procedure, paragraph 11.2.7 (ALL).

WARNING

- All personnel other than those in the fire department should evacuate the immediate area. The area on both sides of the wheel will be cleared of personnel and equipment for at least 300 feet. Do not approach the main wheel area when extreme temperatures because of excessive braking are suspected. If conditions require personnel to be close to an overheated brake or tire assembly, the approach shall be from the fore and aft only.
- Do not use CO_2 directly on the wheel. It may cause the wheel to shatter.

11.2.8.4 Spongy or Chattering Brakes. This condition may be caused by air in the brake system or a defective antiskid valve.

1. ANTI-SKID switch — OFF (CP).

If condition persists:

2. BRAKE SELECT switch — EMERGENCY (CP).

11.2.8.5 Fading Brakes. This condition would normally be the result of overheating caused by hard or continuous braking.

1. Avoid further braking.
2. Stop the aircraft by reversing.
3. Have a crewman exit via the crew entrance door with a chock and place the chock in front of the nosewheel.
4. If there is a brake fire, refer to Brake Fire, paragraph 11.2.8.3.

11.2.8.6 Antiskid Test Unsatisfactory. During test of the antiskid system, failure of a wheel to test properly indicates that the wheel may have braking without antiskid protection, or the wheel may rotate freely without any braking capability. Use of the antiskid system after an unsatisfactory test indication may result in uneven braking and a tendency for the aircraft to swerve when brakes are applied.

1. ANTI-SKID switch — OFF (CP).

CAUTION

Failure of certain antiskid or brake system components can result in loss of brakes or skid protection on one side of the aircraft without illuminating the ANTI-SKID INOPERATIVE light.

11.2.8.7 Antiskid System Failure. Whenever the antiskid system is not operating as an integral part of the brake system, an ANTI-SKID INOPERATIVE light will illuminate. Use of the antiskid system after the light illuminates may result in uneven braking and a tendency for the aircraft to swerve.

1. ANTI-SKID switch — OFF (CP).

Note

The parking brake handle must be completely in to extinguish the ANTI-SKID OFF warning light.

11.3 TAKEOFF EMERGENCIES

11.3.1 Abort Procedures. If a serious malfunction occurs on the takeoff roll prior to refusal speed, proceed as follows:

1. Announce — ABORT.

2. Throttles — retard smoothly to FLIGHT IDLE (P).

WARNING

If aborting because of a propeller malfunction, the affected engine shall be shut down with the condition lever, prior to retarding the throttles below FLIGHT IDLE. Directional control problems may be encountered when all throttles are placed to GROUND IDLE if a propeller malfunction prevents the affected propeller from entering the ground range.

3. Condition lever (affected engine) FEATHER — As Required (CP).

4. Throttles — GROUND IDLE (P).

5. Reverse symmetrical engines — As required (P).

6. Brakes — As required (P).

7. Perform Engine Shutdown Procedure, paragraph 11.1.2 — As required.

11.3.2 Takeoff Continued After Engine Failure. If an engine failure or fire occurs after reaching refusal speed, the takeoff should be continued.

WARNING

If a propeller malfunction is suspected, proceed with Propeller Malfunctions, paragraph 11.4.2.

1. Maintain directional control with flight controls and engine power as necessary (P).

2. Gear — Up (once safely airborne) (CP).

3. Perform Engine Shutdown Procedure, paragraph 11.1.2 (CP).

WARNING

- Obstacle clearance performance data are based on the assumption that gear retraction is initiated 3 seconds after takeoff and propeller feather is initiated 6 seconds after takeoff.

- Obtain two-engine air minimum control speed as soon as possible after takeoff and prior to raising the flaps above 15 percent.

- Flap retraction should be accomplished in 10-percent increments with airspeed increasing approximately 5 knots between retraction increments. This procedure will prevent the aircraft from settling during flap retraction at heavy gross weights.

11.3.3 Three-Engine Takeoff. This type of takeoff requires particular caution because of the possibility of losing another engine during the takeoff roll prior to reaching minimum control speed. A three-engine takeoff may be attempted only when all of the following criteria are fulfilled:

1. Permission of Commander, Fleet Logistics Support Wing.

2. Minimum essential flightcrew.

3. No passengers or cargo.

4. Fuel only as necessary for particular flight.

5. Three-engine takeoff procedures are followed.

6. Three-engine performance data are computed and used.

Note

- Although not required, ATO should be used for three-engine takeoff when it is available.

- If the inoperative engine could not be started because of a faulty starter, and if an airstart of the inoperative engine is to be made, the starter should be removed prior to takeoff.

- Place the ENGINE BLEED AIR switches to the OFF position for maximum performance.

- Before making the takeoff, the propeller for the inoperative engine must be feathered.

To make the takeoff:

1. Hold the aircraft with the brakes and advance the throttles to FLIGHT IDLE.

2. Advance the throttles for symmetrical engines to maximum power, then release the brakes and advance power for the other operative engine as directional control will permit.

3. When safely airborne and certain that the aircraft will not touch down again, raise the gear while accelerating to flap retraction speed.

4. After the gear is up, and airspeed permits, commence flap retraction. Flap retraction should be accomplished in 10-percent increments with airspeed increasing approximately 5 knots between retraction increments.

WARNING

Raising the flaps above approximately the 15-percent position will increase the minimum control airspeed because of reduction in rudder boost pressure from 3,000 to 1,300 psi.

Note

It is important to obtain two-engine air minimum control speed as soon as possible after takeoff and prior to raising the flaps above 15 percent.

5. After gear and flaps are up, continue as a normal takeoff, accelerating to three-engine climb speed.

11.4 IN-FLIGHT EMERGENCIES

11.4.1 Engine Failure. The effect of losing various combinations of engines must be understood and anticipated because related systems are integrated between the engines (see Figure 11-3). In all combinations of two-engine failures, monitor the generator loading. If generator loading is too high, shut off electrical equipment, as required, to keep the loading within the range of available output.

WARNING

- Two-engine operation above 120,000 pounds is marginal.

- Below two-engine air minimum control speed, it may be necessary to reduce power on the opposite engine to help maintain directional control.

CAUTION

In all combinations of two-engine failures, monitor generator loading to keep it within the range of available output.

ENGINES INOPERATIVE	SYSTEMS AFFECTED	
	HYDRAULIC	**ELECTRICAL**
No. 1 and No. 4	One pump each for booster and utility systems will be out. Operation of equipment will take longer.	No. 1 and No. 4 generator out.
No. 2 and No. 3	One pump each for booster and utility systems will be out. Operation of equipment will take longer.	No. 2 and No. 3 generator out. Automatic ice detection system will be out. Deicing systems may be operated manually. Synchrophaser master will be inoperative.
No. 1 and No. 2	Utility system pumps will be out. Wing flaps and main landing gear to be operated manually. Auxiliary system available for nose landing gear emergency extension and emergency brake operation. Flight controls boost to be supplied by the booster system only.* **CAUTION** Nosewheel steering and anti-skid are not operative after loss of the utility system.	No. 1 and No. 2 generator out.
No. 1 and No. 3	One pump each for booster and utility systems will be out. Operation of equipment will take longer.	No. 1 and No. 3 generator out.
No. 2 and No. 4	One pump each for booster and utility systems will be out. Operation of equipment will take longer.	No. 2 and No. 4 generator out.
No. 3 and No. 4	Booster system pumps will be out. Flight controls boost to be supplied by the utility system only.*	No. 3 and No. 4 generator out.

*Additional rudder hydraulic boost may be obtained by moving the flap lever greater than 15 percent.

Figure 11-3. Two Engines Inoperative

11.4.1.1 Four-Engine Power Loss. Loss of positive fuel boost pressure, fuel system malfunction, or non-standard fuel management techniques can cause erratic engine performance or fuel starvation resulting in decreasing amounts of power available to the engines. Low voltage on the essential ac bus or synchrophaser malfunctions can cause all four engines to lose torque. When the ac voltage is between 50 and 70 volts, the synchrophaser can malfunction causing the torque to drop 2,000 inch-pounds or more. The following steps should be taken if low-voltage or four-engine power loss is encountered:

1. Propeller governor switches — MECH GOV (CP/FE).
2. Synchrophaser Master switch — OFF (FE).
3. Fuel Panel — Main Tank to Engine (FE).
4. Generator #2 (Aircraft prior to 165313) — OFF (FE).

If a synchrophaser malfunction is suspected:

5. Synchrophaser AC and DC circuit breakers — Pulled (FE).

If condition persists:

6. Land as soon as possible (P).

WARNING

- These procedures should correct the loss of power on four engines because of low essential ac voltage or synchrophaser malfunctions, but there are other malfunctions that can cause loss of engine power such as a failure in the bleed-air system.
- When the above procedures have been completed, the crew shall check all other essential systems for proper operation.

11.4.2 Propeller Malfunctions. A propeller malfunction may be caused by electrical or synchrophaser malfunction, or hydraulic malfunction, and will be indicated by one of the following conditions:

1. Propeller LOW OIL light or visible oil leak.
2. Overspeed or underspeed.
3. Rpm surge or fluctuation.
4. Failure of propeller to feather.

Note

A tachometer generator failure will give a false indication of propeller failure when underspeeding or fluctuations occur. Refer to Tachometer Generator Failure, paragraph 11.4.10.5.

11.4.2.1 Propeller Malfunctions During Takeoff

11.4.2.1.1 Before Refusal Speed.

1. Perform Abort Procedure, paragraph 11.3.1 (P).

11.4.2.1.2 After Refusal Speed

1. Continue takeoff (P).

WARNING

Propeller malfunctions during takeoff may be difficult to analyze at this most critical phase. If the engine is shut down immediately and the propeller fails to feather, it is possible that higher than normal air minimum control speed may result. When fire is not indicated, it is recommended that the engine be allowed to run until at least two-engine air minimum control speed is reached (at least 135 KIAS).

2. Maintain directional control with flight controls and engine power as necessary (P).

WARNING

Below two-engine air minimum control speed, it may be necessary to reduce power on the opposite engine to help maintain directional control.

3. Gear — Up (CP).

4. PROPELLER GOVERNING CONTROL switch — MECH GOV (CP/FE).

If rpm stabilizes within allowable limits:

5. Continue operation in MECH GOV.

If an overspeed condition exists:

6. Accelerate to and maintain 150 KTAS (P).

7. Perform Engine Shutdown Procedure, paragraph 11.1.2, when a suitable landing area has been reached.

For all propeller malfunctions refer to In-flight Propeller Malfunctions, paragraph 11.4.2.2.

WARNING

- A go-around with a windmilling propeller should not be attempted if airspeed is below two-engine air minimum control speed (at least 135 KIAS).

- Positioning the flap lever above approximately 15 percent or operating the gear or flaps will increase the air minimum control speed because of reduction in available hydraulic pressure.

11.4.2.2 In-Flight Propeller Malfunctions

WARNING

If uncontrolled overspeed (above 105-percent rpm) occurs, reduce airspeed as rapidly as possible to the speed at which safe control of the aircraft or propeller can be maintained but not less than two-engine air minimum control speed (at least 135 KIAS). Do not adjust the throttle position for the affected engine before the malfunction is analyzed.

11.4.2.2.1 Rpm Within Allowable Limits and LOW OIL Warning Light Illuminated

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

WARNING

If continued operation of the affected propeller is required in the interest of safety, it is permissible to defer engine shutdown until landing is assured, provided moderately high power is maintained.

11.4.2.2.2 Rpm Outside Allowable Limits With LOW OIL Light Illuminated

1. Place propeller governing control switch to MECH GOV.

   a. If rpm stabilizes within allowable limits, perform Engine Shutdown Procedure, paragraph 11.1.2.

WARNING

If continued operation of the affected propeller is required in the interest of safety, it is permissible to defer engine shutdown until landing is assured, provided that moderately high power is maintained.

2. If rpm does not stabilize within allowable limits, perform Pitchlock Check Procedure, paragraph 11.4.2.3.

11.4.2.2.3 Rpm Outside Allowable Limits Without LOW OIL Light Illuminated

1. Place propeller governing control switch to MECH GOV.

   a. If rpm stabilizes within allowable limits, continue operation in MECH GOV.

   b. If rpm remains outside allowable limits, perform the following Pitchlock Check Procedure.

11.4.2.3 Pitchlock Check Procedure

1. TD valve — Locked (FE).

2. Slowly move the throttle or vary the TAS (P).

Note

If a TIT change is not noted and engine rpm is high, the engine may be on fuel control governing and throttle travel may be insufficient for rpm to follow. In this case, a change in TAS will be necessary to verify pitchlock. A reduction in TAS is recommended (not below two-engine air minimum control speed) as rpm is already on the high side.

If the rpm does not follow the throttle or TAS:

3. Perform Engine Shutdown Procedure, paragraph 11.1.2.

If the rpm follows the throttle or TAS:

4. Perform Pitchlock Propeller Operation procedure, paragraph 11.4.2.4.

11.4.2.4 Pitchlock Propeller Operation

1. Establish 96- to 98-percent rpm with the throttle and/or airspeed adjustment.

2. Continue to operate the propeller while maintaining 96- to 98-percent rpm.

3. When a suitable landing area is reached, descend at an airspeed that will allow 96- to 98-percent rpm to be maintained with throttle adjustment.

Note

- Operating a pitchlocked propeller in the underspeed range, 96- to 98-percent rpm, helps to ensure continued positive pitchlock engagement. Maintaining at least 96-percent rpm will ensure that the engine compressor bleed valves do not open with resultant loss of engine power.

- If an rpm of at least 96 percent cannot be maintained when slowing to 150 KTAS, it is reasonable to assume that the propeller is pitchlocked at a high blade angle. Shutdown at the airspeed where 96-percent rpm can no longer be maintained should give acceptable windmilling drag and rpm should the propeller fail to feather. This high-blade-angle pitchlock case is associated with propeller malfunctions at cruise speeds.

- If 96- to 98-percent rpm can be maintained at 150 KTAS, the propeller is at a low blade angle. In this case, shutdown at speeds above 150 KTAS could produce excessive drag and overspeed if the propeller does not feather.

4. During the traffic pattern, attain a speed (not below 150 KTAS) where 96- to 98-percent rpm cannot be maintained with throttle adjustment, and perform Engine Shutdown Procedure, paragraph 11.1.2.

WARNING

Regardless of the operation of the propeller in the traffic pattern, the engine shall be shut down prior to landing.

Note

Shutdown at 150 KTAS should ensure decoupling if the propeller fails to feather.

5. If propeller does not feather, a landing can be made with a windmilling propeller; however, the drag and yawing tendency will be greater than with a feathered propeller and excessive rpm and noise may be experienced. Maintain airspeed above two-engine air minimum control speed until landing is assured (at least 135 KIAS).

WARNING

- A go-around should not be attempted if airspeed is below two-engine air minimum control speed (at least 135 KIAS).

- Below two-engine air minimum control speed, it may be necessary to reduce power on the opposite engine to help maintain directional control (at least 135 KIAS).

6. If a go-around is attempted, follow the go-around procedures in this chapter. Go-around with a windmilling propeller may be marginal.

WARNING

Positioning the flap lever above 15 percent or operating the gear or flaps will increase the air minimum control speed because of reduction in available hydraulic pressure.

11.4.2.5 Propeller Fails to Feather. If the propeller rotation continues after feather has been initiated:

1. Attain 150 KTAS (if possible) (P).

Note

Slow aircraft to the minimum safe airspeed, but not less than two-engine air minimum control speed (135 KIAS minimum).

2. FEATHER and AIRSTART, EMER FEATHER, FEATHER PUMP MOTOR circuit breakers — Checked In (FE).

3. Feather Override Button — Hold in for 30 seconds, Pull Out (FE).

If propeller rotation continues:

WARNING

Restore oil only if there is no indication of a fire.

4. Fire handle — Reset (CP).

5. OIL SHUTOFF VALVE circuit breaker — Pull (FE).

6. Fire handle — Pull (CP).

WARNING

If a go-around is attempted, follow Go-around with One or Two Engines Inoperative, paragraph 11.8.2. Go-around with a windmilling propeller may be marginal.

Note

If the propeller does not feather, a landing can be made with a windmilling propeller; however, the drag and yawing tendency will be greater than with a feathered propeller, and excessive rpm and noise may be experienced.

11.4.2.6 In-Flight Decoupling of Engine and Propeller. The reduction gear section decouples from the power section of the engine if the propeller attempts to drive the power section, and the engine negative torque control system fails to operate. As negative torque builds up before decoupling of an engine takes place, aircraft yaw may be noticed. However, there may be little or no difference in aircraft feel, and the knowledge that an engine has decoupled must be gained from instrument indication. If the decoupling is caused by engine failure or flameout, torque, TIT, and fuel flow will drop to near zero and power section oil pressure will drop. Rpm may temporarily increase, then settle to normal. Hydraulic pressure, generator output, and reduction gear section oil pressure will remain normal. Extremely low TIT and fuel flow for a given throttle position, accompanied by fluctuating and near-zero torque, may be an indication of a decoupling in which the engine continued to operate. When decoupling is observed:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

CAUTION

Although it may be possible, it is not recommended that an engine restart be attempted after a known decoupling until a thorough ground inspection has been accomplished.

11.4.2.7 Throttle Control Cable Failure. If a failure occurs in the throttle control system, the malfunction could cause the propeller to enter reverse pitch resulting in uncontrollable flight. If failure occurs, the controls may go to either full power or full reverse. An additional indication may be unrelated power changes or throttle movement not pilot initiated. If throttle movement or power changes occur that are not pilot initiated, a broken throttle control cable should be suspected.

WARNING

Do not move the throttle prior to engine shutdown; to do so could cause the propeller to go into reverse pitch.

1. Fire handle — Pulled (CP).

WARNING

Do not move the condition lever if the propeller feathers following Fire Handle actuation, proceed with step 3.

2. Condition lever — FEATHER (CP).

3. Propeller — Feathered (CP/LM).

Adjust power on the remaining engines as required.

11.4.2.8 Excessive/Uncontrollable Power. A malfunction of the TD control valve system or a throttle control cable failure may cause a sudden increase or decrease in TIT with an accompanying change in torque and fuel flow indications. If these indications occur during stabilized operation, proceed as follows:

WARNING

Do not move the throttle prior to engine shutdown; to do so could cause the propeller to go into reverse pitch.

1. If the throttle is above the crossover point, activate the wing/empennage anti-icing. Monitor TIT for the engine being checked. If TIT rises and returns to its original setting as in a temperature controlling check, the TD control valve system is working normally and a throttle cable failure must be suspected. If the TIT does not return, proceed with step 3.

2. If the throttle is at or below the crossover point, do not retard the throttle.

3. Place the TD control valve switch to the NULL position. Monitor TIT closely during NULL operations as maximum TIT can often be exceeded at advanced throttle settings under these conditions.

If TIT stabilizes and returns to near normal:

4. Continue operation.

If the malfunction persists in NULL:

5. Perform the Throttle Control Cable Failure Procedure, paragraph 11.4.2.7.

11.4.3 Engine Fires. Engine fires are indicated by a steady illumination in the respective fire handle and the master fire warning light on the pilot instrument panel. The fire detection system design is such that it is unlikely that the wrong engine would be shut down. If an engine fire is experienced on the ground or in flight:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.4 Engine Overheating. There are four indications of overheating in the engines and nacelles:

1. Turbine overheat warning light
2. Nacelle overheat warning light
3. High TIT
4. High oil temperature.

11.4.5 Auxiliary Power Unit Fire

*1. APU fire handle — Pulled (CP).

*2. Fire extinguisher — Discharged (as required) (CP).

 *a. If condition persists, discharge the remaining bottle.

*3. APU generator — OFF (FE).

4. APU CONTROL switch — STOP (FE).

5. APU BLEED AIR VALVE switch — CLOSE (FE).

11.4.6 Turbine Overheat Warning. If an overheat condition is indicated by the flashing of the master fire warning light and/or by the flashing of lights in the fire handle:

1. Retard the throttle toward FLIGHT IDLE.

If the overheat condition persists:

2. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.7 Nacelle Overheat Warning. When an overheat warning is indicated by a nacelle overheat warning light on the copilot instrument panel:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.8 High Turbine Inlet Temperature. Should an overtemperature be indicated by a high TIT:

1. Retard throttle of affected engine toward FLIGHT IDLE — (P).

2. TD control switch — NULL (FE).

If this fails to eliminate the overtemperature condition:

3. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.9 High Oil Temperature. See engine oil system failure under Engine Systems Failure, paragraph 11.4.10.4.

11.4.10 Engine Systems Failure

11.4.10.1 TD Control Valve System Malfunction. A malfunction of the TD control valve system of an engine may cause a sudden increase or decrease in TIT with an accompanying change in torque and fuel flow indication. If this condition occurs during stabilized operation:

1. TD control switch — NULL (FE).

If TIT stabilizes and returns to near normal, continue operation. If the malfunction persists, other engine systems are at fault. Monitor TIT closely during null operation as maximum TIT can often be exceeded at advanced throttle settings under these conditions.

11.4.10.2 Secondary Fuel Pump Pressure Light. Illumination of the secondary fuel pump pressure light other than during the engine start cycle may be caused by failure of the engine-driven primary fuel pump or failure of the speed-sensitive control.

1. IGNITION CONTROL circuit breaker — PULL (FE).

If the light extinguishes:

2. Continue normal operation.

Note

- If the light extinguishes when the IGNITION CONTROL circuit breaker for the corresponding engine is pulled, failure of the speed-sensitive control is indicated. Ice detection is unavailable from an engine that has an IGNITION CONTROL circuit breaker pulled.
- The IGNITION CONTROL circuit breaker must be reset before normal engine shut-down on the ground.

If the light remains illuminated:

3. IGNITION CONTROL circuit breaker — RESET (FE).

CAUTION

Primary fuel pump failure is indicated. Failure of the primary fuel pump could cause metal contamination of the engine fuel system.

4. Perform Engine Shutdown Procedure — As required.

11.4.10.3 Speed-Sensitive Control Failure (Sheared Shaft). A sheared shaft on the speed sensitive control with the throttle above 65° travel may be indicated by a momentary illumination of the secondary fuel pump pressure light, fuel correction light illumination, and TIT will not exceed the start limiting temperature of 830 °C. A sheared shaft with the throttle below 65° may be indicated by momentary illumination of the secondary fuel pump pressure light, and TIT will not exceed the start limiting temperature of 830 °C. If either of the following conditions occur:

1. TD control switch — NULL (FE).
2. IGNITION CONTROL circuit breaker — Pull (FE).
3. Continue operation.

Note

- The IGNITION CONTROL circuit breaker must be reset before normal engine shutdown on the ground.
- Ice detection is unavailable from an engine that has an IGNITION CONTROL circuit breaker pulled.

11.4.10.4 Engine Oil System Failure. The indications of an engine oil system failure that may lead to engine failure are: loss of oil pressure, complete loss of engine oil, or an oil temperature increase.

11.4.10.4.1 High Oil Temperature. High oil temperature may result from failure of an oil cooler flap to function in automatic. In the event of high oil temperature:

1. OIL COOLER FLAP switch — OPEN (CP/FE).
2. Manually open or close the OIL COOLER FLAP as required to maintain normal engine oil temperature (CP/FE).

If engine oil temperature remains excessively high:

3. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.10.4.2 Low Oil Quantity Warning. The Engine LOW OIL quantity warning light glows when the oil level in a tank drops to approximately 4 gallons. In the event of a LOW OIL quantity light:

1. Monitor engine instruments with low oil quantity reading (FE).
2. No further corrective action is required as long as other engine instrument readings are within limits.

11.4.10.4.3 Loss of Oil Pressure. In case of a loss of oil pressure:

1. Perform the Engine Shutdown Procedure, paragraph 11.1.2.

CAUTION

If engine oil pressure loss was caused by a negative-g condition and the gearbox and engine oil pressures do not return to normal within 10 seconds after returning to a positive-g condition, perform Engine Shutdown Procedure, paragraph 11.1.2. After the propeller stops rotating, an airstart may be attempted according to the AIRSTART procedures in Chapter 8.

11.4.10.5 Tachometer Generator Failure. A tachometer generator failure may be indicated by the following simultaneous indications:

1. RPM decrease or fluctuation.
2. Fuel flow increase or fluctuation.
3. Torque decrease or fluctuation.

If the above occurs:

1. SYNCHROPHASE MASTER SWITCH — As required (FE).
   a. If engine is selected as master, select the unaffected master engine position.
2. PROPELLER GOVERNOR CONTROL for affected engine — MECH GOV (CP/FE).

If fluctuations persist:

3. Perform Engine Shutdown Procedure, paragraph 11.1.2 (refer to In-Flight Propeller Malfunctions, paragraph 11.4.2.2).

11.4.10.6 Start Valve Open Light. If the start valve open light illuminates other than during normal start cycle:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.10.7 Visible Fluid Leak. If excessive visible fluid leak from an engine is present and cannot be isolated:

1. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.10.8 Fuel Leaks (Drip or Running Type). Fuel leaks encountered in flight present a fire hazard if the leak is in close proximity to an engine. The possibility of a wing fire from a fuel leak is increased on landing if reverse thrust is applied. If a fuel leak is encountered near an engine, shutdown of the engine should be considered. Land at the nearest airfield that has sufficient runway to complete the landing ground roll without the use of reverse thrust. Because of the possibility of a fire, an emergency should be declared and fire suppression equipment requested.

WARNING

Do not use reverse thrust when landing with a known or suspected fuel leak. If reverse thrust is used, a fire may develop.

11.4.11 Fuel System Failure

11.4.11.1 Fuel Boost Pump Failure. In the event of a fuel boost pump failure as indicated by a low-pressure warning light/tank empty light in a tank containing fuel:

1. Check fuel pressure indicator (FE).

2. BOOST PUMP switch — OFF (FE).

3. Set up another fuel supply — As required (FE).

4. BOOST PUMP circuit breakers — Pull (FE).

If either phase A-, B-, or C circuit breakers are found popped:

5. Complete steps 2, 3, and 4 above.

WARNING

The fuel boost pump should not be turned on or the circuit breakers reset until proper inspection and repairs have been performed. Resetting of the circuit breakers and turning the switch on should be considered only to prevent fuel starvation of the engines when a landing cannot be accomplished within the range of available fuel.

Note

- Gradual power losses will occur between 12,000 feet and 20,000 feet during rapid climbout to an engine without boost pump pressure; this altitude will vary with the prevailing fuel temperature and type of fuel in the tanks (the higher the fuel temperature, the lower the altitude at which the power loss will occur). This condition results from the highly aerated condition of fuel caused by rapidly decreasing atmospheric pressure during climb, allowing entrapped air in the fuel to expand. The period of time required for the fuel to stabilize from this aerated condition will depend upon both the rate of climb and fuel temperature.

- Fuel stabilization should occur a few minutes after level off at cruise altitude once the excess air has escaped from the fuel. Maximum power settings can be maintained up to altitudes of 30,000 feet with a boost pump inoperative if noseup or nosedown attitude and rapid acceleration are avoided. Fuel aeration does not occur during descent. The loss of a boost pump may result in fuel starvation for the affected engine in an extreme nosedown attitude unless crossfeed operation is used. It is impossible to gravity feed fuel from a tank with an inoperative boost pump through the crossfeed system to another engine. If a partial tank and an empty tank are on crossfeed with the boost pump inoperative in the partial tank, the engine being fed from the empty tank will be starved by air being drawn into the fuel line.

To ensure positive fuel flow during climb with a failed boost pump:

1. Continue crossfeeding the engine from another tank (FE).

2. Allow the fuel to stabilize for several minutes (FE).

3. Switch the engine back to the tank with the inoperative boost pump (FE).

4. Monitor fuel flow, TIT, and torque (FE).

If the engine operates satisfactorily in this condition:

5. Continue the flight as planned (P).

If the engine will not operate satisfactorily in the tank-to-engine position:

6. Switch back to crossfeed operation (FE).

Note

- When operating in the tank-to-engine position with an inoperative boost pump, avoid rapid acceleration or nose-low attitudes. Descents should be made with minimum nosedown attitude. If a high rate of descent is required, it is advisable to select crossfeed operation.

- It may be necessary for the pilot to change the flight plan to avoid major fuel unbalancing and loss of range because of unavailable fuel. If the flight can be accomplished at a lower altitude, descend until the engine will run satisfactorily on tank-to-engine flow.

Note

Do not select crossfeed if a main tank boost pump has failed and crossfeed from another tank is not desired.

11.4.11.1.1 Crossfeed Utilizing a Main Tank Dump Pump. The affected tank dump pump may be used to feed the engine from a tank with an inoperative boost pump by use of the following procedure:

1. Main tank CROSSFEED switches — CLOSED (FE).

2. Affected tank DUMP PUMP switch — DUMP (FE).

3. Respective external tank CROSSFEED switch — OPEN (FE).

4. CROSSFEED SEPARATION switch — OPEN (FE).

5. CROSSFEED PRIMER button — Press for 1 minute (FE).

6. Affected tank CROSSFEED switch — OPEN (FE).

7. Monitor crossfeed fuel pressure (FE).

Note

When tank quantity approaches approximately 1,600 pounds in No. 1 and 4 tanks and 1,500 pounds in No. 2 and 3 tanks, dump pump cavitation will occur.

11.4.11.2 Fuel Strainer BYPASS OPEN Light

1. If possible, select an alternate source of fuel.

2. Monitor the engine instruments for further indications of malfunction.

3. Consideration should be given to possible contamination, the amount of usable fuel remaining, wing fuel balance, and possible diversion to the nearest suitable landing field.

11.4.11.3 Fuel Quantity Indicator Failure. This system is designed as an electrically inert capacitance system specifically designed to eliminate the possibility of arcing from electrically charged components within the aircraft fuel tank system. The cockpit fuel quantity indicator requires 115 volts 400 Hz power for proper operation. With the appropriate sequence of failures, the fuel probes, coaxial cable, and associated wiring can operate as a vehicle for the introduction of high-voltage power into the aircraft fuel system.

The fuel quantity indicator, electrical connectors, fuel probes and associated wiring should be operative before the aircraft is released for flight. If any of these components are inoperative by incomplete maintenance action, or in the event that a fuel quantity indicator goes blank or the display is unusable, the following action shall be complied with:

1. Pull and tag the FUEL QUANTITY INDICATOR circuit breaker for that associated tank.

WARNING

The fuel quantity indicator must not be swapped or the circuit breaker reset until proper inspection and repairs are made. The aircraft may be flown on a subsequent flight with a malfunctioning indicator, provided the circuit breaker remains pulled and the breaker pin lock is installed.

11.4.11.4 Main Tank Dump Pump/Dump Valve Failure. If a main tank dump pump or dump valve fails to operate, fuel may be dumped by use of the following procedures:

CAUTION

Fuel dumping will be at a greatly reduced rate. Caution must be exercised to maintain proper wing distribution.

1. Aft External Tank Pump circuit breakers (on affected side) — PULL (FE).

2. Main tank BOOST PUMP switch — ON (FE).

3. Main tank CROSSFEED VALVE switch — OPEN (FE).

4. Auxiliary tank CROSSFEED VALVE switch — OPEN (FE).

5. BYPASS VALVE switch (on affected side) — OPEN (FE).

6. External tank DUMP PUMP switch (on affected side) — ON (FE).

7. INTER CONN valve switch — FLOW (FE).

8. DUMP VALVE switch — OPEN (FE).

9. Monitor fuel dumping (CP/FE).

10. DUMP PUMP switches — OFF (FE).

11. INTER CONN valve switches — NO FLOW (FE).

12. DUMP VALVE switches — NORM (FE).

CAUTION

When returning the DUMP VALVE switches to the NORM position, press firmly on the top of the switch guard until the maximum resistance is felt. This will ensure that the switch toggle has returned to NORM.

Note

This procedure may be used in reverse by using the auxiliary tank dump system and the external tank crossfeed valve.

11.4.11.5 External or Auxiliary Tank Crossfeed Valve Failure. If an external or auxiliary tank crossfeed valve fails to open when crossfeed operation from a tank is desired, fuel can be crossfed through the BYPASS valve and the operative external or auxiliary crossfeed valve.

1. BYPASS valve — OPEN (FE).

2. Operative external or auxiliary CROSSFEED valve — OPEN (FE).

11.4.11.6 External or Auxiliary Tank Dump Valve Failure. If an external or auxiliary tank dump valve fails to open when fuel dumping from that tank is desired, the fuel may be dumped through the bypass valve and the operative dump system for the external or auxiliary tank on that side.

1. BYPASS valve — OPEN (FE).
2. Operative external or auxiliary CROSSFEED valve — OPEN (FE).
3. FUS TANK CROSSFEED switch — OPEN (FE).

11.4.11.7 External Tank Boost Pump Failure. If an external tank empty light illuminates when its respective quantity gauge indicates fuel aboard, it can be because of failure of the pump or one of several other components. To locate the failure, proceed as follows:

1. Alternate tank pump switch — ON (FE).
2. Tank pump switch in use — OFF (FE).

If tank empty light goes out, failure of previously selected pump is indicated.

3. Continue normal operation.

If tank empty light remains ON:

4. Main tank to engine — All engines (FE).
5. Verify external pump pressure (FE).
   a. Crossfeed separation valve — OPEN.
   b. All crossfeed valves except for the external tank being checked — CLOSED.
   c. Check pressure from each of the pumps in the external tank.
   d. The crossfeed prime button may be used to bleed the crossfeed pressure to zero between checks.

If a pressure of approximately 28 psi is indicated, the pumps are operating properly and the external tank empty light pressure-sensing switch has malfunctioned.

6. Continue flight (P/CP).
7. Monitor fuel quantity gauge to determine empty condition (FE).

If a pressure of less than 28 psi is indicated on a single boost pump, this is an indication of a possible failure of the external tank boost pump.

8. Operation continued with caution (P).

Note

Other boost pumps supplying pressure to the same manifold must be turned off to allow the tank with the lower boost pressure to dominate.

If no pressure is indicated, both pumps are inoperative:

9. Refer to Chapter 4 for allowable fuel unbalance (FE).

Note

Fuel remaining in that tank will not be available and the flight shall be altered accordingly.

11.4.12 Fuel Dumping. A fuel dump system is provided to enable all fuel (except approximately 1,600 pounds each from the No. 1 and No. 4 wing tanks, 1,500 pounds each from No.2 and No. 3 wing tanks, 65 pounds from each external tank, and 1,008 pounds from the fuselage tank, if installed) to be dumped overboard. Should it become necessary to dump fuel in preparation for an emergency landing, to reduce gross weight in an emergency, or to provide for additional buoyancy in a ditching operation, follow the procedure outlined below.

11.4.12.1 Dumping Precautions

1. Do not dump fuel below 6,000 feet above the terrain. This will prevent the possibility of a ground source igniting the fuel vapors.
2. Do not dump in a circular pattern; this will prevent turning into the dumped fuel.
3. Do not transmit on HF radios.
4. After the dumping operation, inspect the aircraft for fumes.

11.4.12.2 Dumping Procedures

1. ATC — Advise (CP).

2. Fuel Panel — Main Tank to Engine (FE).

WARNING

If the fuel dump switches for the auxiliary or external tanks are placed in the DUMP position while those tanks are supplying fuel to the engines, the respective tank crossfeed valves are automatically closed, shutting off fuel flow to the crossfeed manifold.

3. INTER CONN valve switches — FLOW (FE).

4. DUMP SHUTOFF VALVE switches — DUMP (FE).

5. DUMP PUMP switches — DUMP (FE).

Note

Dump opposite tanks at the same time in order to maintain lateral balance.

6. Monitor the fuel quantity indicators (FE).

When dumping is complete:

7. DUMP PUMP switches — OFF/NORM (FE).

8. INTER CONN valve switches — NO FLOW (FE).

CAUTION

When returning the dump valve switches to the NORM position, press firmly on the top of the switch guard until the maximum resistance is felt. This will ensure that the switch toggle has returned to NORM.

9. DUMP valve switches — NORM (FE).

Note

With all eight fuel dump switches in the DUMP position, fuel will be dumped at a rate of approximately 3,400 pounds per minute (see Figure 11-4). If the external tank forward boost pumps are switched on manually, the rate increases to approximately 3,900 pounds per minute.

10. Clear fuel manifold (P/FE).

Note

After completing fuel dumping and if time permits prior to landing, the fuel dumping manifold should be cleared of residual fuel. Cross-controlling the aircraft and ensuring a wing-low attitude with slight skid will deplete all residual fuel except that located at low points in the manifold. This will minimize the fire hazard of excessive fuel drainage coming from the fuel dump mast because of normal wing deflections and attitudes during taxi or while the aircraft is parked.

11. Check for negative fuel flow and fumes (LM).

APPROXIMATE WING FUEL DUMP TIME				
POUNDS FUEL TO BE DUMPED	MINUTES TO DUMP			
	4 PUMPS OPERATING	6 PUMPS OPERATING	8 PUMPS OPERATING	10 PUMPS OPERATING
5,000	3.0	2.0	1.5	1.3
10,000	6.0	3.5	3.0	2.5
20,000	12.0	7.0	6.0	5.0
30,000	18.0	10.5	9.0	8.0
40,000	23.5	14.0	11.5	10.0
50,000	29.5	17.5	14.5	13.0

Figure 11-4. Approximate Wing Fuel Dump Time

11.4.13 Electrical Systems Failure

With modern complex aircraft, it is extremely difficult to anticipate all the possible electrical failures and to plan corrective action and procedure for each failure. However, a broad analysis of the situation indicates that failures fall into three possible categories:

1. Loss of one or more of the primary power sources.

2. Faults on the main bus or distribution system.

3. Faults within equipment items.

Faults in the distribution system and load circuits should be controlled through protective devices such as circuit breakers, fuses, and current limiters. Should one of these devices fail to operate, considerable smoke can result and some emergency action on the part of the crew may be needed.

WARNING

Do not operate the aircraft without a serviceable battery. Power would not be available to operate the fire extinguishing system, alarm bells, or emergency depressurization.

CAUTION

Circuit breakers, after popping, may be reset once, except as noted in this chapter. Clamp and tag any circuit breaker that will not be reset. Any circuit breaker that pops shall be recorded for maintenance action.

Loss of the essential ac bus is unlikely. Loss of one or more primary power sources, however, will require the crew to take prompt action by closely watching electrical load so that the remaining power sources will not be overloaded.

11.4.13.1 Loss of Essential AC Bus. A loss of one phase of the essential ac bus may occur with or without illumination of the essential ac bus off light. The malfunction is most likely to occur during high load conditions of the essential ac bus and may be indicated by one of the following conditions:

1. Failure of ANTI-SKID.

2. Illumination of pilot and copilot PITOT HEAT OFF lights.

3. Erratic autopilot operation (if in use).

4. Loss or malfunction of heading indication.

5. Auxiliary hydraulic pump failure.

6. Illumination or flickering of the No. 2 fuel boost pump LOW PRESS warning light.

7. Illumination of the Hydraulic suction boost pump light(s).

8. Essential ac bus-off light which remains illuminated after the affected generator is turned off (another generator does not assume the bus load).

9. Loss of propeller synchrophaser.

10. Malfunctioning navigation/communication equipment.

Note

On aircraft 165313 and up, loss of the essential or main ac bus will not affect the items powered by the essential avionics buses. The bus switching system continues to supply power to the avionics buses from alternative sources. Items on the essential avionic bus, controlled through BSU 1, could be receiving power from either the essential ac or main ac bus.

11.4.13.2 Partial Essential AC Bus Failure. A loss of one phase of the essential ac bus may occur with or without illumination of the essential ac bus-off light. The malfunction is most likely to occur during high load conditions of the essential ac bus and may be indicated by the same conditions as stated in paragraph 11.4.13.1.

11.4.13.3 Partial Loss of Essential AC Bus. If partial loss of the essential ac bus occurs or is suspected, proceed as follows:

WARNING

Land as soon as possible regardless of the success of the corrective action.

1. PROPELLER GOVERNOR CONTROL switches — MECH GOV (CP).

Note

If all four PROPELLER GOVERNOR CONTROL switches are not placed in MECH GOV prior to restoring power to the essential ac bus, a significant power fluctuation may be experienced.

2. GENERATOR switch (for the generator that was supplying the bus) — OFF (FE).

3. Monitor generator indications (FE).

If generator indications are subsequently lost:

4. Perform Generator Out Light procedures, paragraphs 11.4.14.1 and 11.4.14.2.

If power is restored to the essential ac bus:

5. GENERATOR switch — OFF (FE).

6. Continue operation.

7. PROPELLER GOVERNOR CONTROL switches — NORMAL (CP).

If power is not restored, proceed as follows:

8. ANTI-SKID switch — OFF (CP).

9. Autopilot — Disengage (P).

WARNING

Do not change the position of the attitude select switch with the autopilot engaged. A violent pitch maneuver may result in structural damage.

10. Attitude select switches — GYRO ATT (P) (CP).

11. INVERTER switches — STANDBY (dc bus) position (FE).

12. Reduce load on the essential ac bus (FE).

Note

Do not operate the auxiliary hydraulic pump.

13. Check and reset all A-, B-, and C-phase essential ac bus circuit breakers on the pilot side circuit breaker panel and on the main ac distribution panel at FS 245 (FE).

If the circuit breakers will not reset or trip again:

14. APU — START/RUN (FE).

15. APU generator switch — ON/CHECKED (FE).

16. Again attempt to reset the tripped A-, B-, and C-phase essential ac bus power circuit breakers (FE).

If the breakers still will not reset or trip again:

17. Perform the Bus Isolation procedure (Essential AC bus), paragraph 11.4.14.8.

11.4.13.4 Battery Discharge Light. The BAT DISCH light on indicates that the battery charge is being depleted by the isolated dc bus loads because of failure of the reverse current relay. Illumination may be caused by momentary high dc loads. After approximately 30 seconds, the BAT DISCH light should extinguish. If light does not extinguish, proceed as follows:

1. Shut down all equipment possible that receives power from the isolated dc bus.

2. Land as soon as practical.

11.4.13.5 AC Bus-Off Light (Aircraft Prior to 165313). When an ac bus-off light illuminates, check the frequency, voltage, and load of the affected generator.

1. If the frequency, voltage, and load are within limits, leave the generator on.

2. If the frequency, voltage, and load are not within limits, place the respective generator switch to the OFF position.

   a. Monitor the voltage and frequency indications closely. If the three-phase average voltage of a generator drops below approximately 96 volts or if any one of the phases of the bus drops below approximately 90 volts, the bus-off light will illuminate. If the frequency remains normal, the contactor will remain energized, the generator will continue to power its respective bus, and the bus-off light will be illuminated until the generator switch is placed to the OFF position. With this condition, place the generator switch to the OFF position to prevent damage to aircraft equipment because of low voltage and allow another generator to assume that bus.

   b. Monitor the loadmeter for the generator assuming the load. The low-voltage condition may have been caused by a malfunctioning voltage regulator, generator, or bus fault. Monitor the FAILED BRG light. Upon illumination of this light, perform Generator Disconnect Procedures, paragraph 11.4.14.4.

3. If the failed bus cannot be returned to normal operation, follow the Bus Isolation Procedures for the respective failed bus.

11.4.13.6 AC Bus-Off Light (Aircraft 165313 and Up)

1. If the affected generator-out light is also illuminated, place the generator control switch to OFF/RESET. Monitor the FAILED BRG indicator for the generator that was turned OFF.

2. If the affected generator-out light is not illuminated and systems associated with the failed bus are operating normally, verify normal voltage, frequency, and load indications for the affected generator.

   a. If voltage, frequency, and load are normal, continue operation. The bus-off indicator is the result of a failed bus-off indicator relay.

   b. Monitor the affected generator and the systems associated with the ac bus for any further indications of a failure.

3. If the affected generator-out light is not illuminated and systems associated with the failed bus are malfunctioning, the failed bus cannot be returned to normal operation. Chapter 2 should be reviewed to ascertain what systems have been lost.

Note

Loss of the essential or main ac bus will not affect systems powered by the essential and main avionics ac buses. The bus switching units will continue to supply power to the avionics buses from the primary/alternate source.

4. If the failed bus cannot be returned to normal operation, follow the Bus Isolation Procedures for the respective failed bus.

11.4.13.7 SEL PWR OUT Light (Aircraft 165313 and Up). If the essential avionics ac bus SEL PWR OUT light illuminates:

1. Place the affected BSU switch to OFF to place the BSU in the bypass mode. If the avionics bus caution light (SEL PWR OUT) extinguishes, continue normal operation. If the avionics bus caution light (SEL PWR OUT) remains illuminated and the associated problem is with the essential avionics bus, place the copilot inverter in the dc (horizontal) position and proceed with step 2.

CAUTION

Prior to placing the copilot AC INSTR & ENG switch to the dc (horizontal) position, select GYRO ATT and disengage all flight director modes.

2. Check to see if systems powered by the essential avionics ac bus are operating normally. If so, the failed bus indication is the result of a failed bus-off indicator relay. Continue with normal operations. If systems powered by the failed bus are malfunctioning, continue with step 3.

3. Check the BSU input power circuit breaker on the primary ac bus. If the circuit breaker is open, reduce load on the affected avionics bus and attempt to reset the circuit breaker. If power is restored, continue operation with reduced load and, if the initial problem was the essential avionics ac bus, land as soon as possible. If power cannot be restored, leave the avionics bus isolated and, if the initial problem is associated with the essential avionics ac bus, land as soon as possible.

11.4.13.8 Avionics AC Bus-Off Light (Aircraft 165313 and Up). If the essential avionics (ESS AV) or main avionics (MAIN AV) bus-off light illuminates:

1. Place the affected BSU switch to OFF to place the BSU in the bypass mode. If the avionics bus light extinguishes, continue normal operation. If the avionics bus light remains illuminated, proceed with step 2.

2. Check to see if systems powered by the avionics bus are operating normally. If so, the failed bus indication is the result of a failed bus-off indicator relay. Continue with normal operation. If systems powered by the failed bus are malfunctioning, leave the avionics bus isolated and land as soon as possible.

3. Check the BSU input power circuit breaker on the primary ac bus. If the circuit breaker is open, reduce load on the affected avionics bus and attempt to reset the circuit breaker. If power is restored, continue operation with reduced load and, if the initial problem is associated with the essential avionics bus, land as soon as possible.

11.4.13.9 Copilot's AC Instrument SEL PWR OUT Light (Aircraft Prior to 165313). Illumination of copilot's ac instrument SEL PWR OUT light may indicate loss of power to the copilot's ac instrument power system. Actual loss of power to this system will result in failure of both flight director gyros and attitude indicators with corresponding warning flags. Illumination of the SEL PWR OUT light with no corresponding system failure indicates failure of the COPILOTS AC INST POWER FAILURE RELAY. If copilot's ac instrument SEL PWR OUT light illuminates, perform the following steps:

CAUTION

Prior to placing the COPILOTS AC INST switch to STANDBY, select GYRO ATT and disengage all flight director modes.

1. If loss of both flight director gyros and attitude indicators is indicated, place COPILOTS AC INST switch to STANDBY position, check inverter voltage and frequency, and verify proper operation of flight director gyros and attitude indicators is regained.

2. If proper operation is regained and light remains out, continue flight at discretion of aircraft commander.

3. If proper operation is regained but light remains on, there are dual malfunctions of both the copilot's ac instrument power system and indicating system.

4. If proper operation of the flight director gyros and attitude indicators cannot be regained or inverter fails to operate properly, utilize standby attitude indicator, attempt to maintain VFR flight and land as soon as possible.

11.4.13.10 AC Instrument and Engine Fuel Control SEL PWR OUT Light (Aircraft Prior to 165313). Illumination of ac instrument and engine fuel control SEL PWR OUT light may indicate loss of power to the ac instrument and engine fuel control bus and the associated indicating systems that receive power from that bus. Actual loss of power to the bus will result in failure of most engine indicators, certain engine control systems, all pressure indicators, fuel quantity indicator system, and anti-skid system with corresponding warning flags. If the ac instrument and engine fuel control SEL PWR OUT light illuminates, perform the following steps:

If light illuminates with AC INST and ENG SWITCH in standby position:

1. Check voltage and frequency of inverter and affected system components for operation.

2. If inverter output checks good and system components are operating, failure of the NORMAL POWER FAILURE relay is indicated.

   a. Place AC INST and ENG switch to NORMAL position and verify light goes out.

3. If inverter output checks bad and system components are operating, the inverter has failed and automatic switching has occurred.

   a. Place AC INST and ENG switch to NORMAL position and verify light goes out.

   b. Check essential dc bus, AC INST and ENG FUEL CONTROL INVERTER and AC INST and ENG FUEL CONT INV PWR circuit breakers for malfunctions. If malfunction is cleared, reattempt operation in STANDBY as required.

   c. If malfunction cannot be cleared, continue flight at aircraft commander's discretion.

4. If inverter output checks bad and system components are not operating, the inverter has failed and either automatic switching system or normal ac power source is malfunctioning.

   a. Place AC INST and ENG switch to NORMAL position and verify light goes out.

   b. If system operation cannot be regained in either NORMAL or STANDBY, land as soon as practical.

If light illuminates with AC INST and ENG switch in NORMAL position, check essential ac bus and systems components for proper operation. Perform the following steps:

1. If no malfunctions are found, failure of the STANDBY POWER FAILURE RELAY is indicated. Monitor system components for proper operation and continue flight at the discretion of the aircraft commander.

2. If any malfunctions are found, place AC INST and ENG switch in STANDBY position. Verify light goes out and system components are operating correctly.

3. If system operation cannot be regained in either NORMAL or STANDBY, land as soon as practical.

11.4.14 Generator Failure. Generator malfunctions can result from mechanical failure or electrical faults within the generating system. Electrical faults that disconnect the generator from the bus will be indicated by illumination of the generator-out light when voltage is below approximately 70 volts on any phase (aircraft prior to 165313) and 95 volts on any phase (aircraft 165313 and up).

11.4.14.1 Generator-Out Light (Aircraft Prior to 165313). Check for the frequency, voltage, and load of the affected generator.

1. Frequency, voltage, and load normal:

   a. This indicates the power indicator relay or the transformer rectifier unit within the generator control panel has failed.

   b. Leave the generator control switch in the ON position and monitor the frequency, voltage, and load of the generator.

Note

If the generator switch is turned OFF, it may not be possible to utilize power from the generator because the power to energize the generator contactor relay is supplied by the transformer rectifier unit within the generator control panel.

   c. Upon loss of indications, perform the procedures listed in step 2 or 3, as applicable.

2. Frequency and voltage normal with no indication of load:

   a. This indicates the generator contactor for that generator is not energized.

   b. Place the generator control switch to the OFF position and monitor voltage and frequency.

c. Upon loss of indication, perform the procedures listed in step 3, as appropriate.

3. Frequency, voltage, and load zero:

a. Place the generator control switch to RESET, then OFF.

b. If frequency and voltage are normal on all three phases, resume normal operation.

c. If frequency and voltage are not indicated on all three phases, it can be assumed that the generator has failed. Monitor FAILED BRG light. Upon illumination of this light, perform Generator Disconnect procedures, paragraph 11.4.14.4.

d. If frequency and voltage are indicated after placing the switch to RESET but voltage is observed to momentarily peak above normal and return to zero, it can be assumed an overvoltage or generator feeder fault condition caused illumination of the light. In this case, place that generator switch to FIELD TRIP, then to OFF position. Monitor FAILED BRG light. Upon illumination of this light, perform Generator Disconnect procedures, paragraph 11.4.14.4.

e. If frequency and voltage are normal after placing the generator switch to RESET but are lost when normal operation is attempted, place the generator switch to RESET and leave it off line. Monitor frequency and voltage.

11.4.14.2 Generator-Out Light (Aircraft 165313 and Up). Check for frequency, voltage, and load of the affected generator.

1. If frequency, voltage, and load are normal, leave generator on. Continue operation.

2. If frequency and voltage are normal, but no load is indicated, place the generator to OFF/RESET and monitor the generator FAILED BRG indicator. If FAILED BRG indicator illuminates, perform Generator Disconnect procedures, paragraph 11.4.14.4.

3. If no frequency, voltage, or load are indicated, place the generator switch to OFF/RESET and then to ON.

a. If frequency and voltage are normal, resume normal operation.

b. If no frequency, voltage or load are indicated, place the generator switch to OFF/RESET. Monitor generator FAILED BRG indicator.

11.4.14.3 Generator FAILED BRG Light. This light indicates the possibility of a generator mechanical failure. To prevent further generator damage:

1. Perform Generator Disconnect procedures, paragraph 11.4.14.4.

11.4.14.4 Generator Disconnect. The generator can be mechanically disconnected from the engine. Firing of the disconnect mechanism is indicated by the illumination of the DISC FIRED light. Once disconnected, a generator cannot be reconnected in flight.

1. GEN DISC switch — DISC (hold for 2 seconds) (FE).

If generator fails to disconnect:

2. Perform Engine Shutdown Procedure, paragraph 11.1.2.

11.4.14.5 Loss of Electrical Systems. The possibility of the loss of all electrical systems is very remote. In the event of a complete loss of electrical power, the following systems will be operable:

1. Flight instruments

a. Copilot altimeter.

b. Airspeed indicator needle.

c. Magnetic compass.

d. Attitude director indicator (slip indicator portion).

e. Vertical velocity indicator.

f. Accelerometer.

2. Engines and propellers

   a. Engine shutdown can be accomplished by placing the condition lever to FEATHER.

   b. Full throttle control (no TD control system).

   c. Tachometer.

   d. Propellers will go to mechanical governing.

3. Flight controls

   a. Normal boost (rudder boost pressure reduced to low boost).

   b. Wing flaps (hydraulic override only).

Note

Because of the loss of power to the trim tab system, a no-flap landing is recommended.

4. Fuel available from main tanks.

5. Normal brake system.

6. Nosewheel steering.

7. Landing gear system (hydraulic override only).

8. Emergency lights.

9. Oxygen system.

10. Cargo door and ramp system (manual).

11.4.14.6 Fuselage Fire/Smoke and Fumes Elimination. In the event a fire is near an oxygen component or there is a possibility that the oxygen could increase the fire, consideration should be given to closing the oxygen manual shutoff valve, providing portable oxygen bottles are adequate for the situation.

Any crewmember detecting fire, smoke or fumes shall immediately alert the flight station. The pilot will direct crewmembers to fight the fire as required. Upon alert, notify the crew/passengers and proceed as follows:

*1. Oxygen — ON/100% (ALL).

*2. Pressurization — Emergency Depressurize (FE).

WARNING

If oxygen equipment is not available for all crewmembers/passengers, descend to a lower altitude before actuating the emergency depressurization switch. If the emergency depressurization switch fails, pull the emergency depressurization control handle.

*3. Descent — As Required (P).

Note

Good judgement should be exercised before deciding on an emergency descent in case of fuselage fire. When oxygen is provided for the entire crew/passengers, staying at high altitude and depressurizing may help to control fuselage fires.

*4. Extinguish the fire — As Required (ALL).

5. ENGINE BLEED AIR switches — OFF (FE).

After depressurization is completed, proceed as follows:

6. AIR-CONDITIONING MASTER switch — AUX VENT (FE).

7. Paratroop doors/aft escape hatch — OPEN (LM).

WARNING

- If flammable fumes are present, electrical equipment not required to complete the above procedure should not be turned on or off until fumes are eliminated.

- The loadmaster shall wear a restraining harness when opening the paratroop doors.

Note

If additional ventilation is required, open the air deflectors and paratroop doors.

8. Flight station emergency escape hatch — OPEN (as required) (FE).

11.4.14.7 Electrical Fire

WARNING

Because of the important part electrical controls play in the operation of this aircraft, electrical power should not be shut off until the pilot is reasonably certain that it is, or will be, a contributing factor to smoke or fire, and the loss of electrical controls will not be a greater hazard than the smoke or fire.

In the event a fire is near an oxygen component or there is a possibility that the oxygen could increase the fire, consideration should be given to closing the oxygen manual shutoff valve, providing portable oxygen bottles are adequate for the situation. The manual shutoff valve is mounted on the right side of the cargo compartment forward bulkhead above the air-conditioning unit.

If fire, smoke, or overheat of electrical equipment occurs, every attempt should be made to locate the malfunctioning unit(s)/bus. If able to locate the source of the malfunction, isolate by turning off/pulling circuit breaker(s)/removing the electrical connector(s).

1. Isolate affected equipment by pulling circuit breaker and turning switch OFF (ALL).

If unable to locate the malfunctioning unit(s), proceed as follows:

With APU generator:

2. APU control switch — START/RUN (FE).

3. APU generator switch — ON/CHECKED (FE).

4. All engine generator switches — OFF (FE).

If the situation stabilizes:

5. Again attempt to locate and isolate affected equipment by pulling circuit breaker and turning switch OFF (ALL).

If condition persists, proceed as follows:

6. Autopilot — OFF (P).

7. Attitude select switches — GYRO ATT (P), (CP).

8. Copilot ac instrument switch — STANDBY (DC BUS) (FE).

WARNING

Operating the copilot bus with inverter (STBY) power while INS is selected as an attitude reference for either pilot or copilot may cause oscillation of the associated ADI and/or erroneous attitude information to be displayed.

9. Oil cooler flap switches — OPENED/FIXED (CP).

10. APU generator and APU control switches — OFF/STOP (FE).

WARNING

When power is removed from the essential dc bus, the engine bleed-air regulators will close, shutting off the airflow to both air-conditioning systems, thus depressurizing the aircraft.

Without APU generator:

1. Autopilot — OFF (P).

2. Attitude select switches — GYRO ATT (P), (CP).

3. Copilot ac instrument switch — STANDBY (DC BUS) (FE).

WARNING

Operating the copilot bus with inverter (STBY) power while INS is selected as an attitude reference for either pilot or copilot may cause oscillation of the associated ADI and/or erroneous attitude information to be displayed.

4. Oil cooler flap switches — OPEN/FIXED (CP).

5. Radar — OFF (P/FE).

6. All generators switches — OFF (FE).

WARNING

When power is removed from the essential dc bus, the engine bleed-air regulators will close, shutting off the airflow to both air-conditioning systems, thus depressurizing the aircraft.

Note

The BATT DISCH light indicates the battery charge is being depleted by the isolated dc bus.

7. Three main ac bus current limiters at station 245 (upper main distribution panel) — REMOVED (FE).

8. Any operating engine generator — ON (FE).

If the situation stabilizes:

9. Isolate affected equipment by pulling circuit breakers and turning switches OFF (ALL).

If the condition persists, proceed as follows:

10. Remaining engine generator — OFF (FE).

If the condition persists:

11. Perform Isolated Dc Bus Isolation Procedures (see Figure 11-5).

11.4.14.8 Bus Isolation Procedure

WARNING

High voltage is present on the upper main ac distribution panel. Use extreme caution with the access cover open.

Note

The bus isolation procedure (see Figure 11-5) should be used as a last resort when the malfunctioning unit(s) cannot be located, but the malfunctioning bus is known. The purpose of this procedure is to allow a return to normal operation of the unaffected buses. If a bus must be isolated, refer to Chapter 2 to ascertain which systems have been lost.

11.4.15 Cargo Compartment Refrigerator Overheat Warning Light. When the cargo compartment refrigerator overheat warning light illuminates, immediate steps to correct the overheat must be taken as follows:

1. Cargo Compartment Air Conditioning Shutoff switch — OFF (FE).

2. UNDERFLOOR HEAT switch — OFF (FE).

If the warning light does not go out within approximately 1 minute:

3. Bleed-air divider valve — CLOSED (FE).

4. No. 3 and No. 4 ENGINE BLEED AIR switches — OFF (FE).

This will isolate the ducts to the cargo compartment and should eliminate the overheat condition.

CAUTION

It is not recommended that any air valve be reopened once it has been closed for an overheat condition. Damage to the warning system may prevent detection of a subsequent overheat condition.

<table>
<tr><th>BUS</th><th>ISOLATION PROCEDURE</th></tr>
<tr><td>LH Ac</td><td>Remove the three LH ac bus power current limiters at the upper main ac distribution panel.</td></tr>
<tr><td>RH Ac</td><td>Remove the six current limiters (three RH ac bus power and three deicing power) at the upper main ac distribution panel.</td></tr>
<tr><td>Main Ac</td><td>Remove the three main ac bus power current limiters at the upper main ac distribution panel.</td></tr>
<tr><td>Main Dc</td><td>Pull the six MAIN DC BUS TRANS RECT circuit breakers on the copilot upper circuit breaker panel and the DC MAIN BUS GRD CONT circuit breaker on the copilot lower circuit breaker panel.

Note

When pulling the TR circuit breakers, pull all three circuit breakers in A, B, C, order for one TR unit, then pull all three circuit breakers in A, B, C, order for the other TR unit.</td></tr>
<tr><td>Essential Ac</td><td>Pull the nine essential ac bus power circuit breakers at the upper main ac distribution panel and the nine essential ac bus power circuit breakers on the pilot side circuit breaker panel.</td></tr>
<tr><td>Essential Dc</td><td>Pull the six MAIN DC BUS TRANS RECT circuit breakers on the copilot upper circuit breaker panel and the six DC ESS BUS TR 1 and TR 2 circuit breakers on the pilot side circuit breaker panel. Do not tie the bus tie switch after landing.

WARNING

Anytime power is removed from the essential dc bus, the engine bleed-air regulators will close, shutting off airflow to both air-conditioning units, thus depressurizing the aircraft.

CAUTION

Prior to pulling the essential DC BUS TR circuit breakers, ensure that the OIL COOLER FLAP switches are OPEN and FIXED.</td></tr>
<tr><td>Isolated Dc</td><td>Pull the six MAIN DC BUS TRANS RECT circuit breakers on the copilot upper circuit breaker panel, the six DC ESS BUS TR 1 and TR 2 circuit breakers on the pilot side circuit breaker panel, and turn the dc power switch to the OFF position.

WARNING

On aircraft prior to 164993, anytime power is removed from the isolated dc bus, there will be no power for the ADI regardless of the power source selected.</td></tr>
<tr><td>Battery Bus</td><td>The battery is powered anytime the battery is connected. There is no isolation procedure for the battery bus.</td></tr>
<tr><td colspan="2">Note

Any time the Main AC BUS TRANS RECT and DC ESS BUS TR circuit breakers have been pulled as a method of isolating a dc bus, the battery is powering the remaining dc buses and is not being charged from the ac buses.</td></tr>
</table>

Figure 11-5. Bus Isolation Procedure

11.4.16 Bleed-Air Ducting Failure/Overheat Detection System (ODS) Warning Lights. A rupture of the bleed-air manifold may be indicated by illumination of ODS indicator lights with corresponding audible warning, and/or simultaneous loss of torque on all engines supplying bleed air, depending on the location of the rupture. Additional indications may include the master fire warning light, an unsafe gear indication, or visible evidence of fire in the wheelwell or wing area. If a combination of these conditions indicates a bleed-air duct failure, proceed as follows:

WARNING

If bleed-air ducting failure or ODS warning occurs, the aircraft shall be landed as soon as possible regardless of the apparent success of the corrective action.

1. Isolate the affected duct. For ODS warning alarm, see Figure 11-6.

If leaky duct cannot be determined, proceed as follows:

2. Close the bleed-air divider valve and shut off wing bleed air to isolate the leak.

WARNING

- Positive closing of the engine bleed-air regulators must be determined by observing torque increase when closing the corresponding engine bleed-air valve.
- If an engine bleed-air regulator fails to close, it may be necessary to follow Engine Shutdown Procedures (paragraph 11.1.2) for that engine to prevent fire in the area of the leaking or blown duct.

If suspected wing cannot be isolated or ODS warning alarm persists, proceed as follows:

3. Shut off engine bleed air for all engines.

WARNING

Shutting off all engine bleed air will shut off air supply to both air-conditioning units and depressurize the aircraft.

CAUTION

Do not re-open any bleed-air valve or operate any affected system until the cause of the malfunction has been determined. Damage to the warning system may prevent detection of a subsequent overheat condition.

Note

It may take some time for ODS sensing elements to cool.

4. If visible evidence of a fire exists, those crewmembers not required to control the aircraft shall immediately begin to fight the fire. Perform Fuselage Fire/Smoke and Fume Elimination procedures (paragraph 11.4.14.6).
5. Perform in-flight controllability check if structural damage is suspected. Land as soon as possible.

11.4.17 Emergency Operation of Cabin Pressurization System. Two types of pressurization system failures may occur. One type can result only from failure of the outflow valve in a closed or nearly closed position when it cannot be opened either by automatic or manual control methods. In this case, cabin pressure might increase at an excessive rate and could not be reduced by normal means. If this condition is encountered, proceed as follows:

1. Immediately shut off engine bleed air, one engine at a time, until the rate of pressure increase is at a safe value.
2. Control pressure by using engine bleed air as necessary to vary the amount of conditioned air supplied for pressurization.

ALARM SIGNAL	ACTION REQUIRED	SYSTEMS AFFECTED
1. Left Wing Area (LH OUTER, LH CENTER, LH INNER WING Indicator Lights)	1. Isolate Left Wing	LH Wing and Empennage Anti-icing, Auto Pressurization, Flight Station Air Conditioning
2. Right Wing Area (RH OUTER, RH CENTER, RH INNER WING Indicator Lights)	1. Isolate Right Wing	RH Wing Anti-Icing, Underfloor Heating, Cargo Compartment Air Conditioning
3. TRANSFUSELAGE and FWD FUSELAGE Indicator Lights	1. Isolate Left Wing 2. If it can be positively determined that the overheat condition originated from the small section right of the bleed-air divider valve, restore bleed air to the left wing, then isolate the right wing. **WARNING** Bleed air is extremely hot, use caution during inspection. 3. If previous actions do not correct the situation, close all bleed-air valves and the bleed-air divider valve. **WARNING** Shutting off all engine bleed air will shut off air supply to both air-conditioning units and depressurize the aircraft. **Note** It may take some time for the element to cool.	With LH wing isolated, same as Alarm 1. With RH wing isolated, same as Alarm 2.
4. AFT FUSELAGE Indicator Light	1. Isolate Left Wing	Same as Alarm 1.
5. APU Indicator Light	During ground operation: 1. Close APU BLEED AIR VALVE and isolate the left wing. During flight: 1. APU fire handle — PULL 2. Isolate Left Wing.	During ground operations, APU bleed air will not be available. Other systems same as Alarm 1. During flight, same as Alarm 1.
6. AIR CONDITION Indicator Light	1. Isolate Right Wing.	Same as Alarm 2.

Figure 11-6. ODS Warning Alarm Procedures

3. If necessary for further control when descending, one of the air-conditioning systems can be shut down to expedite depressurization of the aircraft.

The other type of pressurization system failure is loss of ability to pressurize or maintain pressurization on either automatic or manual control and may result from any of several causes. If this situation is encountered, proceed as follows:

1. The crew should don oxygen masks immediately while instituting a descent.
2. Descend to or maintain an aircraft altitude where oxygen is not required.
3. Check for excessive cabin leakage by checking doors, windows, hatches, and the safety valve.

WARNING

Do not attempt to lock or unlock any window, door, or hatch while the aircraft is pressurized. First, depressurize the aircraft, then turn the AIR CONDITIONING MASTER switch to AUX VENT.

4. Check the bleed-air system for excessive external leakage. Turn off all pneumatic systems and observe the bleed-air pressure gauge. Shut off all engine bleed air, and time the bleed-air pressure drop from 65 to 35 psi. The time required for the pressure drop from 65 to 35 psi shall not be less than 30 seconds.

11.4.18 Emergency Operation of Air-Conditioning Systems. If a system is leaking hot bleed air into the aircraft, it shall be shut down immediately. If the system cannot be shut off because of regulator malfunctioning and it is leaking bleed air, the engine bleed air shall be shut off to depressurize the bleed-air system.

11.4.19 Emergency Operation of Leading Edge Anti-Icing System. An emergency condition arises if any of the leading edge anti-icing regulators malfunction so that they allow an overtemperature condition. This condition is indicated by the anti-icing temperature indicators and overheat warning lights.

11.4.19.1 Wing Leading Edge Overheat

1. Wing anti-icing switch — OFF (FE).
2. If the affected leading edge section temperature indicators do not return to normal readings with system off or the overtemperature warning light does not go out within approximately 1 minute, close the affected wing engine bleed air and close the bleed-air divider valve.

WARNING

- Shutting off all engine bleed air will shut off the air supply to both air-conditioning units and depressurize the aircraft.
- Prolonged leading edge overheat may result in a wing fire.

3. If anti-icing is necessary, engine bleed air may be used as necessary, providing the leading edge temperatures do not go above the normal operating range. After landing, an inspection is required for heat damage.

11.4.19.2 Empennage Leading Edge Overheat

1. Empennage anti-icing switch — OFF (FE).
2. If the empennage temperature indicator does not return to normal reading with system off or the overtemperature warning light does not go out within 1 minute, close the bleed-air divider valve and No. 1 and No. 2 engine bleed air.

WARNING

Shutting off all engine bleed air will shut off the air supply to both air-conditioning units and depressurize the aircraft.

3. If anti-icing is necessary, engine bleed air may be used as necessary, providing the leading edge temperatures do not go above the normal operating range. After landing, an inspection is required for heat damage.

11.4.20 Wing Fire. If a fire develops in the wing, attempt to extinguish, control, or contain the fire as follows:

1. Fuel crossfeed valve switches — CLOSED (FE).

2. Engine hydraulic pumps and suction boost pump for the affected wing — OFF (CP).

3. Bleed-air divider valve and bleed-air valves for engines on that wing — CLOSED (FE).

4. Wing electrical equipment — OFF (FE).

5. If necessary, sideslip the aircraft to keep the fire away from the fuselage (P).

6. Land the aircraft as soon as possible (P).

11.4.20.1 Oxygen Flow Degradation. The capability of the liquid oxygen heat exchangers to provide breathable 100-percent oxygen for the entire crew can be exceeded when large consumption demands are placed on the system. When this occurs, the temperature of the oxygen to the masks will be lowered markedly and the gas pressure at the oxygen regulators will be reduced. In extreme cases, a near total lack of oxygen pressure and flow can occur. Reducing or eliminating demand will allow the system to warm and the flow of oxygen to return to normal.

If oxygen flow degradation occurs, check the oxygen system integrity and immediately reduce the need for oxygen by performing one or more of the following:

1. Move the diluter levers at the regulators from 100-percent oxygen to normal (if possible).

2. Change altitude to reduce oxygen flow demand (if possible).

3. As a last resort, selectively remove crewmembers from the aircraft oxygen system to the portable oxygen bottles.

WARNING

Portable oxygen bottles can provide only temporary relief. They are of limited capacity and may have to be recharged from the internal aircraft oxygen system. Recharging portable oxygen bottles while experiencing oxygen flow degradation will further degrade the flow of oxygen.

11.4.21 In-Flight Door Warning. When the door warning light illuminates, notify crew/passengers and proceed as follows:

*1. Seatbelts — Fastened (ALL).

*2. Oxygen — As Required (ALL).

3. Pressurization — Begin Depressurization (FE).

4. Descent — As Required (P).

Note

If range is an important consideration, the pilot may elect to have the flightcrew go on oxygen, the aircraft depressurized, and the door inspection made at altitude.

5. Doors — Checked (FE) (LM).

WARNING

If any crewmember observes an individual door warning light, the crewmember will notify the pilot which light has illuminated. If it is not determined which light illuminated or if the light goes out during depressurization, the aircraft shall be completely depressurized before making a door check. If it is determined that the light illuminated for a paratroop door or a cargo door, complete depressurization will be at the discretion of the pilot.

a. Cargo door. Ensure the door lock on each side is fully engaged. If fully engaged, check microswitch integrity at each aft door lock.

b. Cargo ramp. Ensure all 5 locks on each side are fully engaged. If fully engaged, check microswitch integrity of the adjacent corresponding ramp locks on the end of the ramp.

c. Paratroop door. Ensure all 4 latch pins are fully engaged. If fully engaged, check microswitch integrity on the upper forward latch pin.

d. Crew entrance door. Ensure the “J” hooks contact the eyebolts. If fully engaged, check microswitch integrity on the 2 micro switches (1 is located on the door linkage on the bellcrank assembly, and the other is located on the upper aft edge of the crew entrance door).

6. Master door warning light switch — OFF (FE) (LM).

WARNING

Do not unlock any door with the aircraft pressurized. After depressurization, place the AIR CONDITIONING MASTER switch to AUX VENT. The flight engineer and loadmaster will check the doors wearing a parachute or restraining harness. The restraining harness shall be worn to check the crew entrance door. If it cannot be determined what caused the door light to illuminate, the flight may be continued with partial pressurization (below the point where the light illuminates) and with all personnel secured by a safety belt at the discretion of the pilot. If the doors are secure and the trouble is determined to be a limit switch, the aircraft may be fully pressurized.

Note

When utilizing the low-pressure portable oxygen bottle, duration will vary with physical activity level and cabin altitude. See Figure 11-7.

11.4.22 In-Flight Release of Liferaft. If severe vibration occurs in flight, cause unknown, proceed as follows:

1. Airspeed — Reduce (P).
2. Flaps — Extend as required (CP).
3. Visual Inspection — (2LM/LM).

Note

The absence of a liferaft should be noticeable through one of the inspection windows provided on the lower sides of the liferaft compartments.

If a raft has released and lodged on the tail:

4. Fish tail the aircraft slightly or execute a shallow banking maneuver right or left (P).
5. Land as soon as practical (P).

11.4.23 Windshield and Window Failure. If the inner or outer pane of the windshield or aft compartment windows crack during flight:

1. Cabin differential pressure — 10 inches of mercury or less (FE).

If both panes of the windshield crack:

2. Continue at 10 inches of mercury or less (FE).

If both panes of an aft compartment window crack or a wing leading edge light lens cracks:

3. Cabin differential pressure to zero (FE).

WARNING

With Nesa anti-icing inoperative, limit aircraft speed to 187 KIAS below 10,000 feet.

REGULATOR SETTINGS	CABIN ALTITUDE	PHYSICAL ACTIVITY LEVEL	
		MODERATE	PASSIVE
NORMAL	Sea level to 12,000 feet	4 Minutes	10 Minutes
	12,000 to 20,000 feet	7 Minutes	16 Minutes
	20,000 to 30,000 feet (1)	10 Minutes	23 Minutes
30M	30,000 to 40,000 feet (1)	14 Minutes (2)	30 Minutes (2)
	40,000 to 42,000 feet (1)	17 Minutes (2)	28 Minutes (2) (3)
42M (4)	42,000 to 45,000 feet (1)	19 Minutes (2)	23 Minutes (2) (3)
EMER (4)	42,000 to 45,000 feet (1)	20 Minutes (2)	20 Minutes (2) (3)

(1) Flight rules governing cargo-passenger aircraft require immediate descent to below 25,000-foot altitude upon complete loss of cabin pressurization.

(2) These duration times do not provide for leakage around the facemask seal.

(3) Physical stress limit for individuals not conditioned to pressure breathing.

(4) Do not use smoke mask PN 53C3971-1 or PN 651-110 in aircraft designed to operate above 30,000 feet. Rapid depletion of the MA-1 system will result (less than 1 minute depletion).

Figure 11-7. Portable Oxygen Bottle Duration

11.4.24 Rapid Decompression. If pressure loss is uncontrollable, notify crew and proceed as follows:

*1. Oxygen — ON/100% (ALL).

*2. Pressurization — As Required (FE).

*3. Descent — As Required (P).

WARNING

A crewmember should make an inspection of the fuselage during descent (using a walk-around oxygen bottle and wearing a parachute or restraining harness) to determine what caused the decompression and the extent of any damage.

CAUTION

Type of descent is dependent upon degree of structural damage; use rapid descent (gear and flaps up) without structural damage, or rapid descent (gear and flaps down) when structural damage necessitates. If pressure loss occurred because of structural failure, the flight will be completed at a safe speed determined by the pilot. Any suspected or known structural failure may cause aircraft control problems and will require a check of aircraft controllability prior to landing.

11.4.25 Hydraulic Systems Failure. If the utility, boost, or auxiliary hydraulic systems fail, the equipment served by that system can be operated either by an alternate source of hydraulic power or by means of mechanical linkage. The only exceptions are the nosegear steering system and the antiskid system, for which there are no alternates. Hydraulic system failures are discussed in the following paragraphs.

11.4.25.1 Hydraulic System Warning Lights. Hydraulic system warning lights will illuminate for a loss of system pressure and/or an engine-driven pump failure. The engine-driven hydraulic pump is geared to the gearbox of the engine, and if the shear neck of the pump drive spline does not separate, the pump can generate enough heat to cause a fire. Because of this hazard, pilot discretion should be exercised as to the need of continued engine operation.

1. Switches for the affected system — OFF (CP).

CAUTION

When an engine-driven hydraulic pump warning light is illuminated with a visible hydraulic leak on the engine nacelle, an engine shutdown is necessary.

2. Check fluid level in reservoir (LM).

3. Isolate unit causing trouble, if possible.

If unit is isolated:

4. Restore system pressure.

If unit cannot be isolated:

5. Refer to Figure 11-8.

6. Switches for affected system — As required (CP).

11.4.25.2 System Overpressure. If the pressure of the utility or booster hydraulic system is greater than 3,500 psi, proceed as follows:

CAUTION

Do not place any hydraulic pump switches to the OFF position.

1. Check the direct reading gauge on the affected hydraulic accumulator sight gauge in the cargo compartment.

2. Check the fluid level of the affected system. Check for boiling or spewing.

3. If fluid loss is noted or system pressure is above 3,900 psi, shut down either engine of the affected system in accordance with the cruise engine shutdown procedure.

Note

- Utility or booster hydraulic pressure in excess of 3900 psi indicates failure of an engine driven pump pressure regulating system and that the associated hydraulic system relief valve is in the full open position.

- There is no method to determine which pump is the source of overpressure. Shut down one engine, beginning with the inboard engine. If the overpressure is not corrected, restart the secured engine and shut down the other engine with the condition lever.

11.4.25.3 Electric Suction Boost Pump Failure. In-flight loss of hydraulic boost pump operation will be indicated by illumination of the suction boost pump pressure-off light and the only noticeable difference in hydraulic system operation will be that pressure will drop approximately 100 to 200 psi below normal and that additional time will be required to cycle controls.

Should the suction boost pump warning light illuminate:

1. Immediately turn off all pumps for the affected system only.

2. Check the hydraulic fluid level in the reservoir.

   a. If loss of fluid is indicated, perform the Hydraulic System Warning Light procedure, paragraph 11.4.25.1.

   b. If no loss of fluid is indicated:

      (1) Check pump motor for an overheat condition or, if the boost pump has failed internally resulting in noisy operation, leave suction boost pump off.

      (2) Turn on both engine-driven hydraulic pumps and continue flight.

HYDRAULIC FLUID LEVEL IN RESERVOIR CHECKED

LOSS OF FLUID IS INDICATED.

1. Reservice reservoir.
2. Check for fluid loss at units supplied by the affected system. Isolate affected unit if possible.
3. Turn on suction boost pump.
4. Check for further fluid loss.

NOTE

Fluid level could decrease and then stablize due to the refilling of the depleted hydraulic lines.

NO LOSS OF FLUID IS INDICATED.

1. Suction boost pump on.
2. Unsuspected pump on.
3. Shutdown suspected engine at the discretion of the pilot.

LOSS OF FLUID IS INDICATED.

1. Turn off suction boost pump.

NOTE

Continued operation of the affected system will be based on the fluid level in the reservoir when the INITIAL check was made

a. If fluid was remaining in the reservoir continue engine operation.
b. If fluid was depleted, the pilot may elect to shut down the affected engines and restart them at a later time when conditions necessitate, since no indications exist of fluid remaining, if any, in the system of either engine.

NO LOSS OF FLUID IS INDICATED.

1. Turn on unsuspected pump.
2. Check for further fluid loss.

LOSS OF FLUID IS INDICATED.

1. Turn off unsuspected pump.
2. Turn on suspected pump.
3. Check for further fluid loss.

NO LOSS OF FLUID IS INDICATED.

1. Shut down the suspected engine at the discretion of the pilot.

NOTE

This condition indicates a defective engine-driven hydraulic pump system.

LOSS OF FLUID IS INDICATED.

1. Turn off suspected pump.
2. Turn off the suspected suction boost pump.
3. Check for further fluid loss.

NOTE

Loss of fluid with either engine driven pump on indicates a leak on the output side of the engine driven boost pump downstream of the one way isolation check valves.

NO LOSS OF FLUID IS INDICATED.

1. Shut down the unsuspected engine at the discretion of the pilot.

NOTE

This allows continued use of the hydraulic system, provided normal pressure is indicated.

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Figure 11-8. Hydraulic Fluid Level Check

11.4.25.4 Utility System Failure. Failure of the utility hydraulic system will result in loss of normal landing gear extension and retraction, flap retraction and normal extension, normal brake supply, nosewheel steering, antiskid, in-flight refueling reel control, and half the power supplied to the flight controls. In each case, alternate provisions are made for essential operations, see Landing Gear System Failure, Flap System Failure, Flight Controls System Failure, and Brake System Failure in this chapter.

11.4.25.5 Booster System Failure. Failure of the booster hydraulic system affects only the flight controls systems. See Flight Controls Systems Failure for information on emergency management.

11.4.25.6 Auxiliary System Failure. Failure of the motor-driven pump in the auxiliary hydraulic system results in the loss of hydraulic pressure for normal in-flight operation of the cargo door, loss of electrically controlled emergency hydraulic pressure for emergency brakes, and loss of electrically controlled emergency hydraulic pressure for extension of the nose landing gear. If circumstances require opening the cargo door, supplying emergency brake pressure manually, or lowering the nose landing gear without electrically controlled hydraulic system pressure, the handpump may be used. If both utility and auxiliary pressure are lacking for the brakes, stopping and taxiing control must be accomplished with reverse thrust, differential power application, and normal and emergency system accumulator. Stop the aircraft as soon as possible. Taxiing the aircraft under its own power without brakes is not recommended.

11.4.25.7 Flight Control Systems Failure

WARNING

Never purposely remove the hydraulic assistance from the flight control boosters to simulate complete loss of boost assistance to the flight controls. To remove the assistance would result in an immediate pitch change and the requirement for high manual forces to move the flight controls.

Note

If a hydraulic leak develops in any of the flight control booster units, it may be isolated by placing the respective control boost shutoff valve switch to the OFF position.

Failure of only one control booster unit may indicate a leak or other malfunction within the unit. It should be examined immediately, if possible, to determine corrective action. Loss of hydraulic assistance for movement of the flight controls will result in loss of ability to move these controls in flight, except at low airspeeds. Maneuvering the aircraft at cruising speeds under these conditions must be accomplished with the trim tabs. Landing the aircraft without hydraulic assistance is a marginal operation and requires skillful handling of the trim tabs and engine power, plus coordinated efforts of the pilot and copilot on the flight controls. When possible, avoid crosswinds, short fields, or narrow runways since the chances of making a successful landing will be decreased. When a landing without hydraulic assistance for the flight controls is necessary, proceed as follows:

1. Reduce the weight of the aircraft as much as possible.
2. With elevator hydraulic assistance failure, land with minimum flaps.
3. Make a long, flat approach to reduce the amount of flaps necessary and fly the aircraft onto the ground.
4. After landing, use reverse thrust with caution to prevent loss of directional control as nosewheel steering is not available.

WARNING

If a control boost unit is suspected of having failed in a hard-over position, turn the respective control boost switches to OFF (verified by the cockpit control matching the hard-over maneuver being experienced). Greatly increased forces will be required to move the control for which the hydraulic assistance has been turned off.

11.4.25.8 Elevator Failure. If elevator control should fail (hydraulic assistance lost) or become erratic, the elevators can be moved manually but only at a reduced airspeed and with greatly increased effort. Increasing airspeeds will require increased pilot effort on the controls. The use of inboard engines will facilitate pitch changes. Adding power on the inboard engines will cause the aircraft to pitch up, and reducing power will have the opposite effect. Leaving the inboard engines at a constant power setting and increasing power on the outboard engines will allow for an increase in airspeed with minimal change in pitch attitude, and reducing power on the outboards will have the opposite effect.

11.4.25.9 Aileron Failure. The ailerons are powered concurrently by both the utility and the booster hydraulic system. Should both hydraulic systems fail, the ailerons can be moved manually but only at a reduced airspeed and with greatly increased effort. Increasing airspeeds will require increased pilot effort on the controls.

11.4.25.10 Rudder Failure. The rudder is powered concurrently by both the utility and booster hydraulic system. Should both hydraulic systems fail, the rudder can be moved manually but only at a reduced airspeed and with greatly increased effort. Increasing airspeeds will require increased pilot effort on the controls.

11.4.25.11 Aileron Trim Tab System Failure. Failure or “run away” of the aileron trim tab will not cause a serious control problem. Should the aileron trim tab “run away,” proceed as follows:

1. Hold the AILERON TRIM TAB switch in the opposite direction (P).

2. Pull the AILERON TRIM TAB circuit breaker on the pilot side circuit breaker panel (FE).

11.4.25.12 Rudder Trim Tab System Failure. Directional control cannot be maintained at high airspeeds if the rudder trim tab runs away to an extreme position. If this occurs, airspeed should be reduced until directional control is regained. Should the rudder trim tab run away, proceed as follows:

1. Hold the RUDDER TRIM TAB switch in the opposite direction (P).

2. Pull the RUDDER TRIM TAB circuit breaker on the pilot side circuit breaker panel (FE).

11.4.25.13 Elevator Trim Tab System Failure. In the event of runaway elevator trim:

1. Elevator trim tab switch — Trim Opposite (P/CP).

2. Elevator Tab Power Switch — OFF (P/CP).

3. Elevator Tab Power Switch — EMER (P/CP).

If condition persists:

4. Elevator Tab Power Switch — OFF (P/CP).

Note

- The elevator tab switches on the control wheels will not operate the emergency system. Emergency operation is controlled only by the pedestal-mounted switch.

- When the autopilot operation and the ELEV TAB power selector switch are in the OFF or EMER position, the elevator servo is disconnected from the autopilot and the elevator must be controlled manually.

- If failure results in uncontrollable nose-up condition, slow aircraft in a turn extending flaps as structural limits permit. For uncontrollable nose-down condition, reduce power and airspeed to reduce force required to overpower trim condition and maintain control.

11.4.25.14 Flap System Failure. Flap system failures may be classified as follows: electrical control system failure, failure of the utility hydraulic system, an asymmetrical positioning of the wing flaps, or a cocked flap causing obstructions to aileron movement. The flap system is normally powered by the utility hydraulic system and is controlled electrically. Protection against asymmetrical extension or retraction of the flaps is provided only when Main dc power and utility hydraulic pressure are simultaneously available for the flap system. A manually operated wing-flap selector valve, located on the left hydraulic panel in the cargo compartment, provides flap control if the flap electrical control system fails. Also, a system is provided for mechanical operation of the flaps in the event that utility hydraulic pressure is lost.

WARNING

During normal flap operations, failure of certain components in the jackscrew area may cause a split-flap condition resulting in change in trim about the roll axis and can cause aileron binding. Under these conditions, if it is possible to control the aircraft, no attempt should be made to move the flaps. If movement of the flaps must be attempted, move the controllable flaps in increments of 10 percent toward the condition of the uncontrollable flap. During flap movement, check aileron control constantly. If it is noted that binding increases, stop the flap movement immediately.

Note

In the event flap movement stops during normal flap actuation without a change of aircraft attitude around the roll axis, immediately reposition the flap lever to correspond to the flap position.

11.4.25.15 Flap Electrical Control Failure. If the WING FLAP CONTROL circuit breaker is in or if resetting the WING FLAP CONTROL circuit breaker does not clear the trouble:

1. Pull the WING FLAP CONTROL circuit breaker.
2. Place the flap handle in the desired position (this will give proper rudder boost pressure).
3. Station a crewmember at the forward face of the left wheelwell, and establish communications with the flight station by means of an intercommunication extension cord.
4. Remove the left-hand hydraulic panel cover and remove the electrical connector from the flap selector valve.
5. Reset the WING FLAP CONTROL circuit breaker to prevent unnecessary loss of asymmetrical protection.
6. Depress the raise or lower button on the flap selector valve for about 1 second so the flaps move only at an increment of about 10 percent. Proceed with successive increments only if there is no change in roll trim and as directed by the pilot.

WARNING

Failure of the flaps to move may be caused by asymmetry protective actuation of the emergency flap brakes, which must not be released in flight. Such asymmetric protection will not be available if electrical power through the WING FLAP CONTROL circuit breaker is lost or if a bad connection occurs in the asymmetry detection circuit. Therefore, should a change in trim about the roll axis occur during any flap actuation, do not attempt any further in-flight movement of the flaps.

11.4.25.16 Loss of Hydraulic Pressure. Normal operation of the flaps will cause a loss of utility hydraulic pressure as long as the flaps are in motion. A leak in the flap system hydraulic plumbing will be indicated by a rapid loss of pressure while the flaps are operating and by slower than normal flap movement. Under these conditions, proceed as follows:

1. Ensure the flap lever corresponds to the flap position and place the utility hydraulic pump switches to the OFF position.
2. Pull the WING FLAP CONTROL circuit breaker on the copilot lower circuit breaker panel.
3. Remove the utility hydraulic panel cover and establish communications between the flight station and a crewmember stationed at the forward face of the left wheelwell.
4. Turn on the utility hydraulic pumps one at a time, while making an inspection for plumbing leaks, breaks, and any other faults.

If fault is corrected:

5. Reset the WING FLAP CONTROL circuit breaker and proceed with normal flap operations.

If fault is not corrected:

6. Place the utility hydraulic pump switches to the OFF position and deplete the utility system pressure.

7. Remove the handcrank (see Figure 11-9) from the stowed position in the special equipment compartment. Engage the handcrank on the input shaft and hold the crank firmly to prevent rotation.

8. Remove the pin from the input shaft. It may be necessary to rotate the crank slightly in either direction to relieve binding on the pin.

9. Pull the manual shift handle (see Figure 11-9) to its stop, then rotate the manual shift handle counterclockwise against its stop to engage the manual extension system. The handle will lockout after it is pulled.

10. Operate the flaps to the desired position (approximately 650 turns for full extension) as shown on the flap position indicator. A slip clutch is provided in the manual gearbox to prevent the operator from overloading the drive system. Slippage of the clutch indicates the screwjack nuts are bottomed and the flaps are full up or full down or that interference will not permit flap operation.

WARNING

Protection against asymmetrical operation is provided only during normal hydraulic flap operation. Should a failure of the flap drive torque tubes occur during manual operation, resulting in a change in trim about the roll axis, stop flap movement immediately. Manually return the controllable flaps to the position assumed by the uncontrollable flaps.

11. Replace the pin in the input shaft to hold the flaps in the selected position.

12. Remove the crank and return to the stowed position.

13. Leave the manual shift handle out.

14. Turn the No. 1 and No. 2 engine-driven hydraulic pumps on if available and no leaks are evident.

11.4.25.17 Shift From Manual to Hydraulic Flap Drive. The shift from manual back to hydraulic drive after an actual in-flight failure normally would be accomplished on the ground. However, after practice manual extension or recovery of hydraulic pressure, use the following procedure to shift back to hydraulic drive:

1. Rotate the manual shift handle clockwise against its stop and push the handle back in place to disengage the manual extension system (LM).

2. Remove the pin in the input shaft and then rotate the shaft with the handcrank. The shaft should turn freely, indicating that the manual drive has disengaged (LM).

3. Replace the pin in the input shaft and remove the handcrank and return it to the stowed position (LM).

4. Place the flap lever to correspond with the position of the flaps (LM).

5. Reset the WING FLAP CONTROL circuit breaker (FE).

CAUTION

When the wing-flap control lever is first moved after shifting from manual to hydraulic actuation, observe the utility hydraulic system pressure and the wing-flap position indicator. A drop in pressure with no result in flap movement indicates failure of the flap drive to re-engage. If this happens, immediately return the wing-flap lever to its original position and pull the WING FLAP CONTROL circuit breaker. If these steps are not observed, serious damage to the wing-flap drive could result.

11.4.25.18 Flap Selector Valve Failure. If the flap selector valve fails because of internal leakage, as

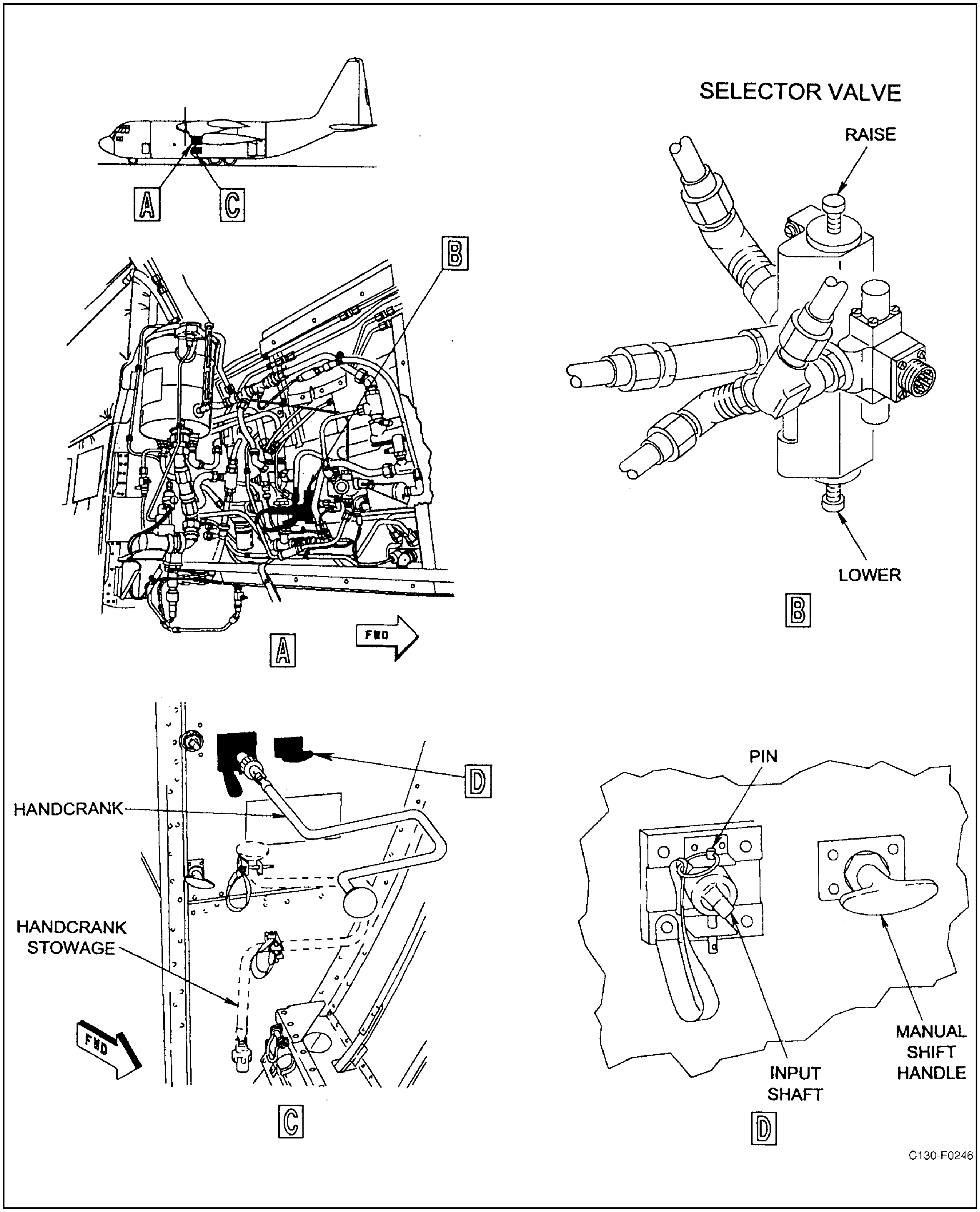


Figure 11-9. Wing-Flap Emergency Controls

indicated by a continuous cycling of the flaps, the following steps should be accomplished:

1. Deplete the utility system pressure by turning the utility system pumps off and cycling the flight controls.
2. Disconnect the electrical connector plug from the flap selector valve.
3. Rotate the manual shift handle in the cargo compartment counterclockwise to its stop and pull (approximately 2 inches) to engage the manual extension system.
4. Restore pressure to the utility system.
5. When needed, crank flaps up or down as desired. Asymmetrical flap protection is available because of the flap hydraulic system being pressurized.

11.4.25.19 Asymmetrical Flaps. Should flap movement stop before the flaps have reached the position desired, failure of the flaps to move in either direction may be because of engagement of the emergency flap brake.

1. Flap handle — Correspond to flap position (CP).
2. No further in-flight movement of the flaps should be attempted.

WARNING

While the aircraft is in flight, do not release the manual override on the emergency flap brake valve after an asymmetrical condition of the flap. This manual override is for ground use only.

11.4.25.20 Wing-Flap Position Indicator Failure. If no change in flap position is shown on the wing-flap position indicator after movement of the flap lever, the trouble may be in the indicator rather than in the flap system. This trouble may be identified by observing hydraulic pressure and by observing the pitch attitude of the aircraft. Immediately after selecting a change in flap position, a pressure drop in the utility hydraulic system indicates either that the flaps are moving or that there is a hydraulic leak or failure in the actuating system. If the flaps are moving, this will be indicated by a change in the pitch attitude of the aircraft. During flap extension, the pilot may direct a crewmember to make a visual inspection of the flap position. Also, while in the cargo compartment, check the TABS AND FLAPS POSITION INDICATOR circuit breaker on the aft fuselage junction box.

11.4.26 Landing Gear System Failure. Emergency operation of the landing gears is accomplished by means of the landing gear lever, overriding controls, and manually actuated controls.

Note

Pressure-sealed doors are provided in the wheelwell bulkheads to permit access while in flight to inspect the two gearboxes and hydraulic brake assemblies and the vertical torque shafts in the event of a malfunction of the MLG system. A nose landing gear inspection window is provided to permit visual inspection in flight. The emergency extension handcranks fit the nuts on the MLG pressure-sealed doors and on the NLG inspection window. Depressurize the aircraft before removing the pressure-sealed doors or windows.

11.4.26.1 Emergency Extension. If the main and nose landing gears fail to extend after normal operation of the landing gear control lever, attempt to identify the malfunction before making further attempts to lower the gear. Check circuit breakers, utility hydraulic pressure, and hydraulic fluid quantity. Check for evidence of hydraulic leaks. If a hydraulic leak is the cause of the malfunction, further attempts to extend the gear hydraulically may serve only to deplete the utility hydraulic system. If the fault is not located and there is no evidence of leaks, proceed to lower the gear by emergency operation.

11.4.26.2 Overriding the Utility Hydraulic Control Valve. If the landing gears fail to extend while using utility hydraulic system pressure because of failure of the control valves to operate (no evidence of hydraulic pressure loss), proceed to extend them by overriding the utility hydraulic control valve.

1. Pull the LANDING GEAR CONTROL circuit breaker located on the copilot lower circuit breaker panel.

2. Place the landing gear lever in the DOWN position.

3. Direct a crewmember to establish communications with the flight station by means of the intercommunications extension cord and go to the left wheelwell.

4. Remove the left hydraulic panel cover.

5. Depress the down button on the aft side of the landing gear selector valve (see Figure 11-10) to lower the landing gear.

CAUTION

- If the landing gear does not extend, depress and hold the down button until the main and nose landing gear are extended. If the button requires holding to lower the gear, the mechanical detent in the landing gear selector valve has failed.

- If the nosewheel steering is required, the button must be held in. If nosewheel inspection window is removed, do not allow it to be blown through the opening.

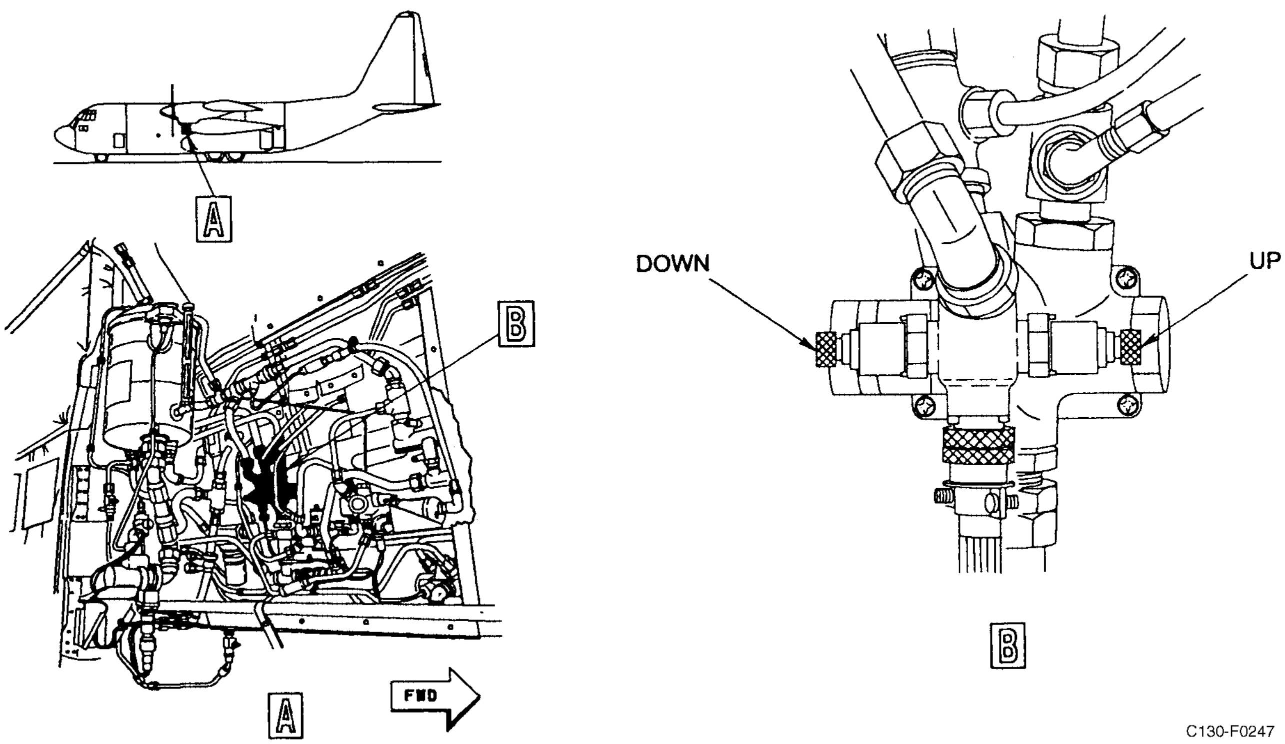


Figure 11-10. Landing Gear System Selector Valve

Note

The landing gear position indicators should continue to operate regardless of landing gear malfunction. The pilot should inform the crewmember when a down position is indicated so that the crewmember will know when to release the manual override button. If a malfunction of the landing gear position indicator is suspected, observe the main landing gear position through the glass panels on the wheelwells and the nosegear position through the nosewheel inspection window.

11.4.26.3 Manual Gear Extension. If the landing gear fails to extend and lock after the manual override control valves are used, manually extend the gear as follows:

1. Pull the LANDING GEAR CONTROL circuit breaker located on the copilot lower circuit breaker panel.
2. Place the landing gear control handle in the DOWN position.
3. Deplete the utility hydraulic pressure by turning off the No. 1 and No. 2 engine-driven hydraulic pumps and operating the flight controls.

11.4.26.4 Main Landing Gear Manual Extension

1. Remove the extension handcrank from the stowed position. Pull the emergency engaging handle (see Figure 11-11) to its stop, then rotate the emergency engaging handle counterclockwise to its stop to engage the manual extension system. The handle will lock out after it is pulled.

CAUTION

Do not force the emergency engaging handle out. To do so may result in a bent manual drive-clutch lever, making it difficult or impossible to engage the manual drive. It may be necessary to place the extension handcrank on the emergency extension stub shaft and rotate slightly until the manual drive gear teeth align.

If the main landing gear does not free fall:

2. Place the extension handcrank on the emergency extension stub shaft.
3. Extend the landing gear by rotating the extension stub shaft approximately 330 turns in the direction of the arrow above the shaft.

WARNING

- Make sure the ratchet on the handcrank is set for down rotation before placing it on the emergency extension stub shaft.
- If the main landing gear starts to free fall after the handcrank is placed on the emergency extension stub shaft, immediately remove the handcrank. The extension handle ratchet may change direction because of the rotation speed of the emergency extension stub shaft.

4. Make sure the landing gear is down and locked.
5. After manual operation, return the emergency engaging handle to the disengaged position by rotating clockwise to its stop and pushing in.
6. Verify proper disengagement by rotating the handcrank one turn in each direction.

Note

If the manual extension mechanism does not disengage, pull the emergency engaging handle again and rotate the handcrank in each direction.

7. Reset the LANDING GEAR CONTROL circuit breaker.
8. Turn on the utility suction boost pump and No. 1 and No. 2 hydraulic pumps to obtain hydraulic pressure (when available) for operation of flaps, normal brakes, and nosewheel steering.
9. Check that the landing gear stays in the down position.

Note

If the landing gear returns to the up position, place the utility hydraulic switches in the OFF position and crank the landing gear down manually.

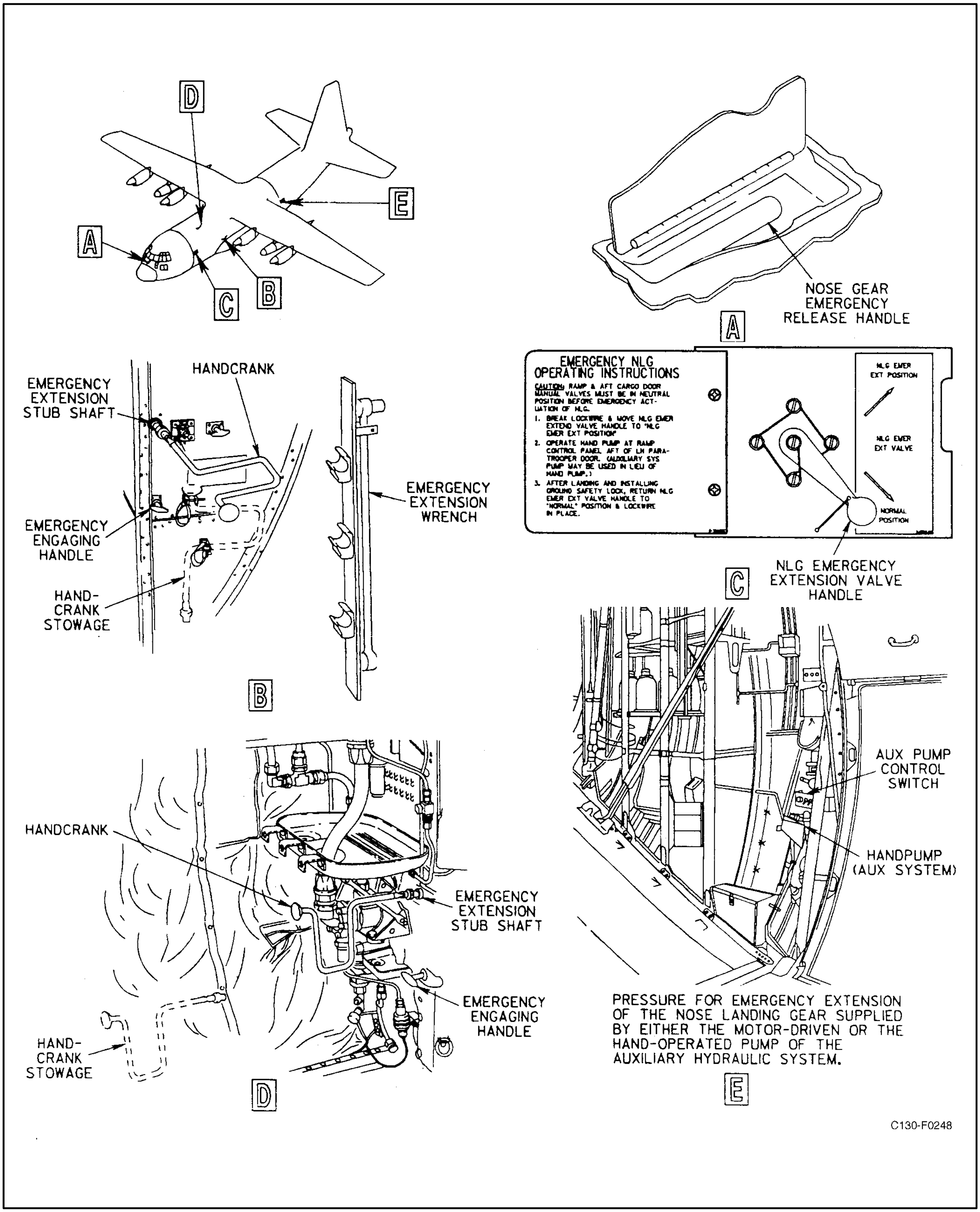


Figure 11-11. Landing Gear Emergency Extension Controls

11.4.26.5 Nose Landing Gear Manual Extension. Determine that the manual controls for the ramp and cargo door control valves (see Figure 11-11) are in the 6N and NEUT positions, respectively. Move the nose landing gear emergency extension valve handle, just aft of the cargo compartment forward bulkhead on the left-hand side (see Figure 11-11), to the NLG EMER EXT position. Operate either the auxiliary system hydraulic pump or the auxiliary system hand-pump until the landing gear is down and locked.

CAUTION

Do not move the nose landing gear emergency extension valve handle from the NLG EMER EXT position until after the aircraft lands and the ground safety lock is installed. Maintain hydraulic pressure on the system.

If complete electrical failure occurs, the nosegear emergency release handle (see Figure 11-11), recessed into the flight station floor at the left of the copilot seat, may be used to release the nose landing gear uplock. This will permit the nosegear to free fall to the down, but not necessarily locked, position. Use the auxiliary system handpump to position the nose landing gear to the down-and-locked position.

Note

Dropping the nose landing gear by using the emergency release handle may allow air to enter the hydraulic system and may require bleeding before normal operation can be restored.

11.4.26.6 Emergency Nosegear Extension

1. Position the landing gear handle to the DOWN position.

2. Decrease airspeed to or below 120 KIAS.

3. Pull the nosegear emergency release handle.

Note

The nosegear should extend into the slip-stream. Allow the nosegear to extend until the forward gear door starts to close at a reduced airspeed; this may require 30 to 45 seconds.

4. Increase airspeed (not to exceed 170 KIAS) as rapidly as possible.

Note

The nosegear should extend to the down-and-locked position.

11.4.26.7 Main Landing Gear Extension After Normal and Emergency System Failure. A malfunction that locks any component of the main landing gear extension system may also lock the remainder of the system. In such a case, if the lower universal joint companion flanges on the vertical torqueshaft are disconnected, the landing gear may free fall to the down position. If the landing gear does not free fall, each landing gear strut can be extended by using the emergency extension wrench. The emergency extension wrench is stowed on a litter stanchion forward of the left wheelwell bulkhead (see Figure 11-11). Use this procedure to lower the main landing gear only after all other normal and emergency procedures have failed. See Figure 11-12 for access doors.

CAUTION

Extend the aft strut first. The main landing gear doors are opened by a mechanical connection to the aft strut, and damage to the doors could result if the forward strut is extended first.

Note

The vertical torqueshaft lower universal joint companion flanges are connected by a single-knurled quick-disconnect coupling nut (see Figure 11-12).

1. Leave the main landing gear manual extension system engaged, the utility hydraulic system depleted, and the LANDING GEAR CONTROL circuit breaker pulled.

2. Depressurize the aircraft. Place the AIR CONDITIONING MASTER switch to AUX VENT.

3. Remove the two polyfoam covers from the forward side of each of the wheelwells.

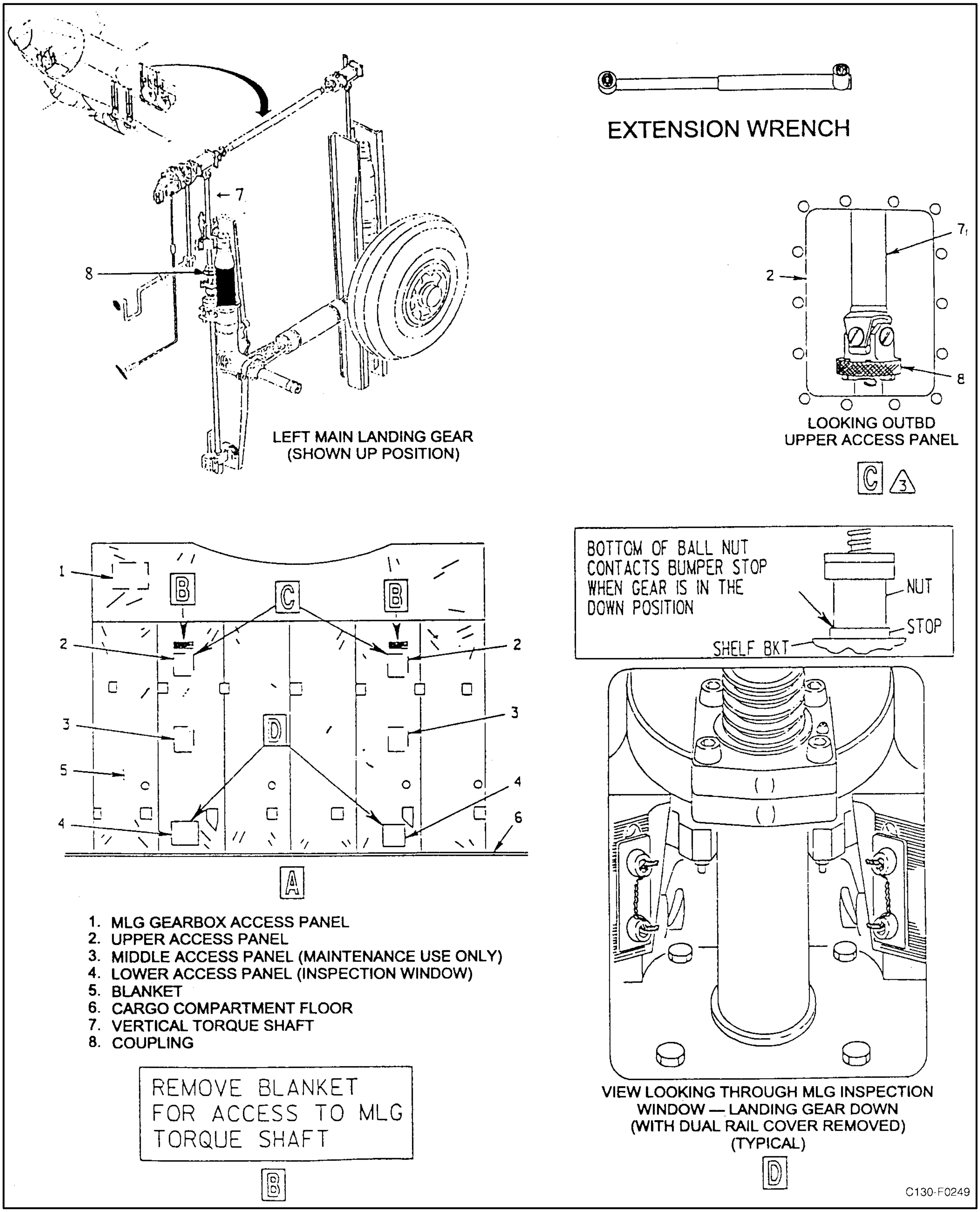


Figure 11-12. Main Landing Gear Access and Tiedown (Sheet 1 of 3)

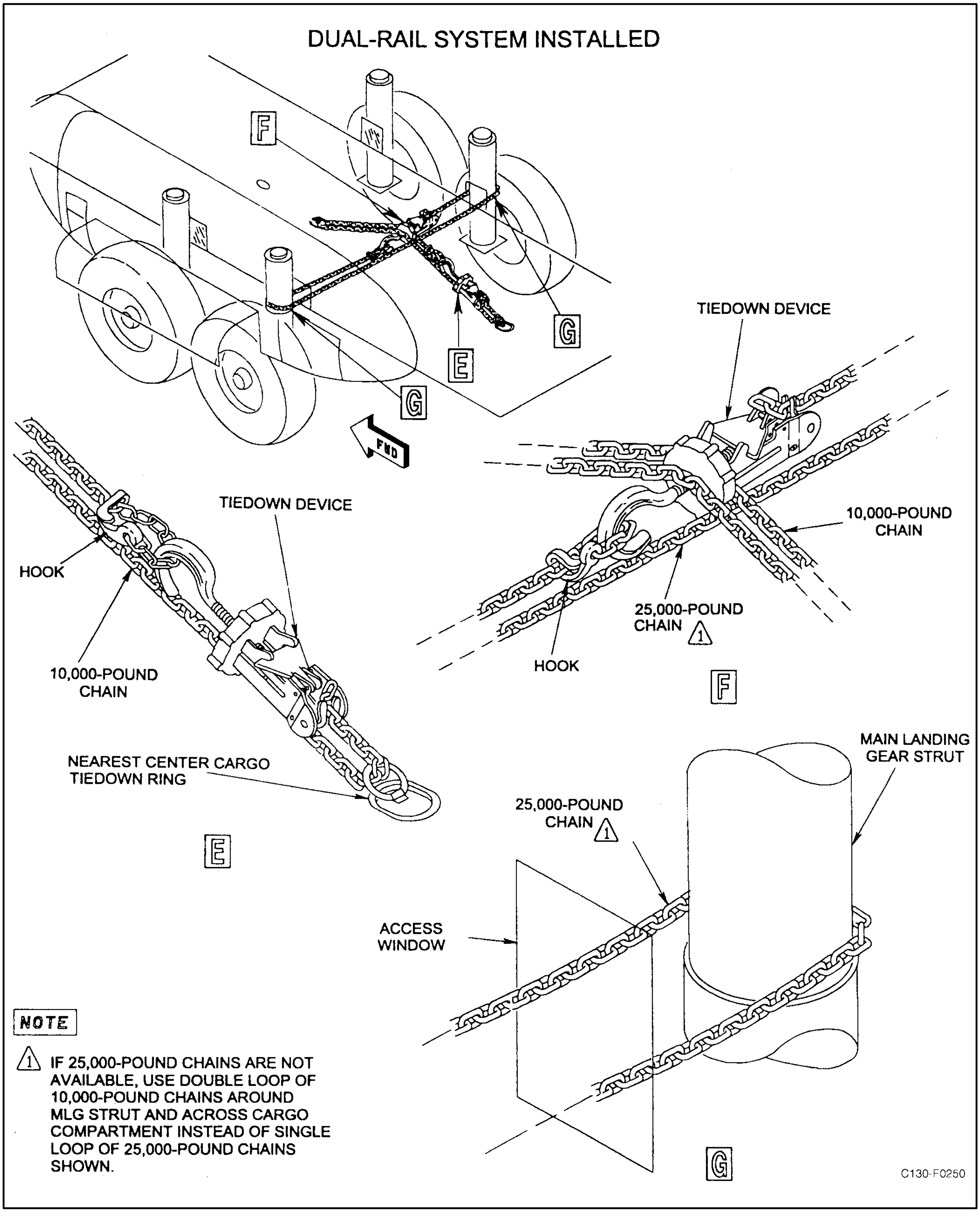


Figure 11-12. Main Landing Gear Access and Tiedown (Sheet 2)

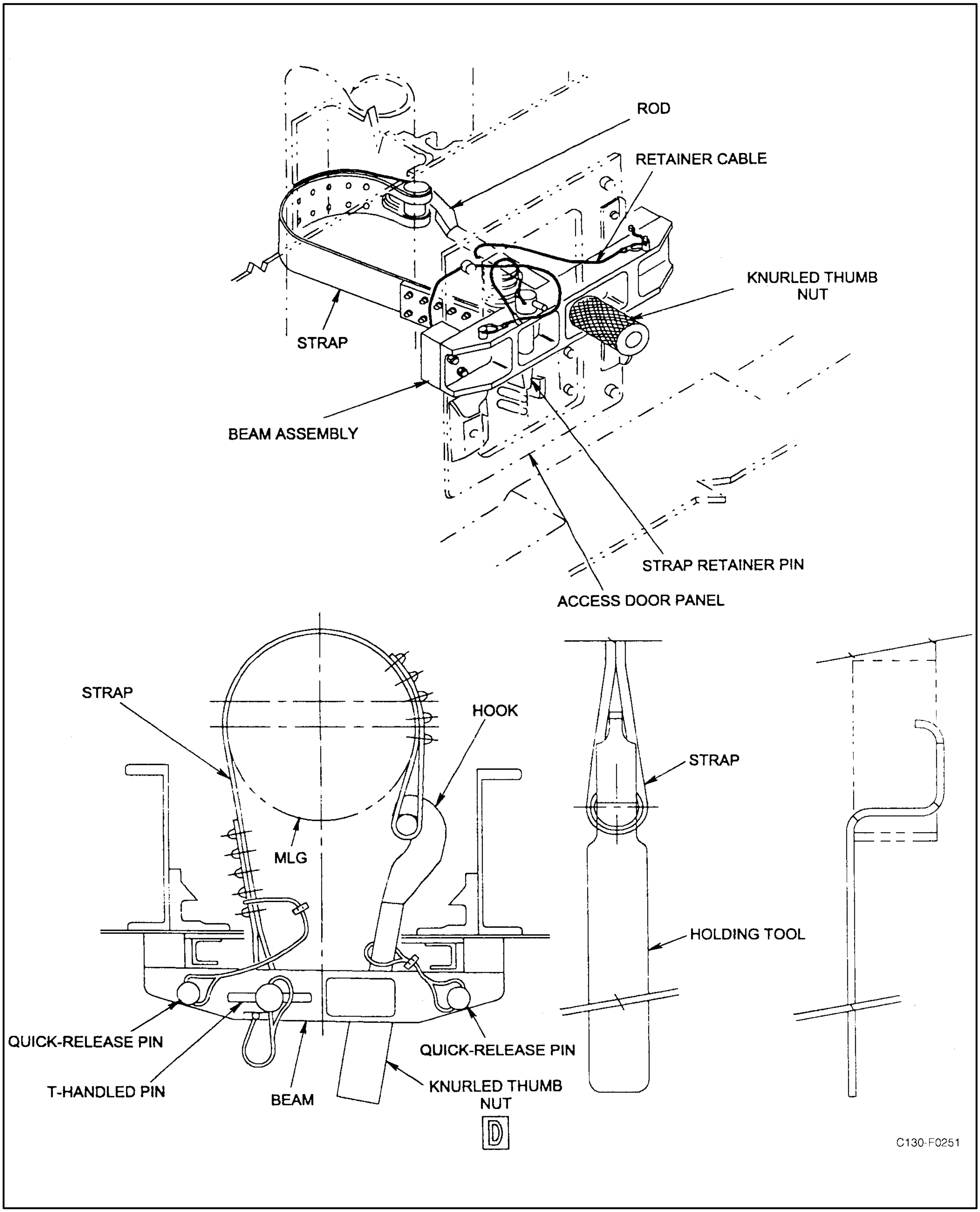


Figure 11-12. Main Landing Gear Access and Tiedown (Sheet 3)

4. Remove the upper access doors with the emergency extension handcrank.

WARNING

The weight of the landing gear may cause the gear to extend rapidly when released. If the above steps are not followed in proper sequence, serious injury to the hands may result when the gear falls.

5. At the aft strut, cut and remove the two safety wires from the vertical torque strut lower universal joint quick-disconnect coupling nut.

6. Place a screwdriver against the coupling nut lugs and tap counterclockwise to loosen and remove the nut.

Note

One-quarter to one-half turn is sufficient to allow the coupling nut to drop free of the companion flanges.

7. Place the tip of a blade-type screwdriver into one of the slots between the companion flanges and pry the flanges apart until the lower flange pins disengage from the upper flange. Immediately withdraw the screwdriver once the pins are disengaged.

WARNING

The weight of the landing gear may cause the gear to extend rapidly when released. If the above steps are not followed in proper sequence, serious injury to the hands may result when the gear falls.

Note

If the strut does not free fall, application of g forces may aid in extending the strut.

8. If the aft strut free falls approximately halfway down, attempt to extend the forward strut using the manual extension system (extension wrench). The horizontal torque strut will prevent the aft strut from fully extending until the forward strut is extended.

If the landing gear does not extend using the above procedure, extend the struts using steps 9 through 11.

Note

It may be necessary to partially retract the aft strut to relieve the binding before the forward strut can be extended.

9. Move the vertical torqueshaft clear of the companion flange on the upper end of the ball screw.

10. At the aft strut, slip the companion flange off the splines on the upper end of the ball screw.

11. Using the emergency extension wrench, engage the splines on the upper end of the ball screw. Rotate the ball screw counterclockwise approximately one-half revolution. Application of g forces may aid in extending the strut.

Note

- Use the fixed end of the wrench to start the ball screw. If the strut has not extended, rotate the ball screw counterclockwise to extend the strut halfway down.

- Use the rachet end of the emergency extension wrench to rotate the ball screw. The handcrank may be installed in the square drive of the wrench to extend the strut more rapidly.

12. Extend the forward strut using the above procedure. Fully extend the aft strut.

11.4.26.8 Emergency Retraction. If the landing gear lever will not move to the UP position because of a malfunction of the touchdown switch or downlock, manually release the downlock by pushing the lock release button on the landing gear lever panel. If either or both of the main gear fail to retract, an emergency retraction may be attempted at the discretion of the pilot. Investigation of the system should be made prior to manual retraction. To accomplish emergency retraction proceed as follows:

1. Pull the LANDING GEAR CONTROL circuit breaker located on the copilot lower circuit breaker panel.
2. Remove the left hydraulic panel cover.
3. Depress and hold the UP button on the landing gear selector valve until the landing gears are retracted and the doors are closed. Release the button.

If the main landing gear fails to retract after operation of the manual override of the landing gear selector valve, proceed as follows:

4. Pull the LANDING GEAR CONTROL circuit breaker located on the copilot lower circuit breaker panel.
5. Place the landing gear control handle in the UP position.
6. Deplete the utility hydraulic pressure by turning off the No. 1 and No. 2 engine-driven hydraulic pumps and operating the flight controls.
7. Rotate the emergency engaging handle (see Figure 11-11) counterclockwise to its stop and pull while rotating the handcrank until the force required for rotation indicates engagement of the manual extension system. The handle will lock out after it is pulled.
8. Retract the main landing gears with the handcranks, reversing the rotational direction used in extending the gears.
9. After retraction, return the emergency engaging handle to the disengage position by rotating clockwise to its stop and pushing in.
10. Verify handle in disengaged position by rotating the handcranks one revolution each way. Handcrank will rotate with no resistance when disengaged.
11. Check visually that the main landing gears are up.

CAUTION

- When removing the inspection door and window, do not allow them to be blown through their respective openings.
- Do not attempt a takeoff with a known or suspected landing gear malfunction.

Note

No provisions exist for manual retraction of the nose landing gear.

11.4.26.9 Main Landing Gear Tiedown

Note

Variable pallet configurations preclude jettisoning loads under some circumstances. Outsized and bulky cargo on pallets will cause the aircrew to secure the questionable gear by any means available.

Before landing with a broken shelf bracket or drag pins not engaged in the shelf bracket, the following procedure will be used to tie down the landing gear. If utilizing 25,000-pound chains and devices, two 25,000-pound connectors (tiedown devices), six 25,000-pound chains, two 10,000-pound chains, and two 10,000-pound devices are required. One loop of three chains is required for each pair of struts.

If utilizing 10,000-pound chains and devices only, 6 10,000-pound connectors and 14 10,000-pound chains are required. Two loops of three chains are required for each pair of struts.

See Figure 11-12 for the arrangement of the chains.

1. Depressurize the aircraft and place the AIR CONDITIONING MASTER switch to AUX VENT.
2. Remove the main landing gear inspection windows in the appropriate wheelwell.

Note

Securing a piece of safety wire to the end of the chain will make it easier to guide the chain around the strut.

3. Pass the ends of two 10,000-pound segments (or the end of a single 25,000-pound chain segment) around the applicable strut and back through the inspection opening. Repeat this for the opposite strut.

4. Fasten two other 10,000-pound chain segments (or a single 25,000-pound chain segment) between the ends of the chains placed around the struts.

5. Install connectors between the remaining loose ends of the chains around the struts and tighten the connectors.

6. Pass the end of a 10,000-pound chain through the center cargo tiedown rings. Join the chain with a connector to form an aft-forward loop across the chains between the struts. This will remove any possible slack in the cross chains.

7. Repeat the process for the other pair of opposite struts, if necessary.

WARNING

Move all personnel to the forward and aft ends of the cargo compartment to prevent injury if a chain should break.

8. Land the aircraft in a normal manner after notifying the control tower of the difficulty and requesting that the crash equipment be alerted. Do not attempt to taxi the aircraft after landing.

CAUTION

Do not attempt a takeoff with a known or suspected landing gear malfunction.

11.4.26.10 Main Landing Gear Tiedown Using Emergency Tiedown Fixture. If emergency tiedown fixtures are available, they may be used in lieu of standard cargo tiedown chains. Before landing with a broken shelf bracket or drag pins not engaged in the shelf bracket, the following procedure will be used to tie down the main landing gear (see Figure 11-12).

1. Depressurize the aircraft.

2. Pull the LANDING GEAR CONTROL circuit breaker.

3. Remove the main landing gear inspection windows in the appropriate wheelwell.

4. Attach strap and hook to the steel beam by means of the quick-release pins and cable.

5. Insert hook retaining pin end of strap through the lower end of the access window and guide around the strut with the help of the holding tool.

6. Insert strap retainer pin through strap and steel beam.

7. Insert hooked rod through steel beam and engage the hook retaining pin in the loop at the short end of the strap.

Note

The steel beam feet must be in direct contact with the wheelwell bulkhead.

8. Install knurled thumb nut on hooked rod, align steel beam on bulkhead, and tighten nut securely by hand.

9. Land the aircraft in the normal manner, after notifying the control tower of the difficulty and requesting that the crash equipment be alerted. Do not attempt to taxi or turn the aircraft after landing.

11.4.26.11 Unsafe Nose Landing Gear Indication

1. Depressurize the aircraft.

CAUTION

When removing the inspection door and window, do not allow them to be blown through their respective openings.

Note

Because of the configuration of the nose landing gear on these aircraft, tiedown is not necessary, nor is it practicable.

2. Remove the nosegear inspection panel. Visually check the pin that protrudes from the aft end of the actuator and operates the down-and-locked indicator switch. If indicator groove is visible on the pin, the downlock is engaged. If this band is not visible, the downlock is not engaged. In either case, maintain pressure on the down side of the nose landing gear hydraulic system.

3. During landing, hold the nosewheel off the ground as long as possible but touch down while elevator effectiveness allows gentle lowering of the nose. Do not attempt to taxi the aircraft. Set the parking brake. Place chocks in front of the nosewheels, or jack the nose of the aircraft, and then install the ground lockpin. Chock the main landing gear fore and aft.

11.5 CARGO JETTISON

11.5.1 Cargo Jettison Procedure. Detailing of emergency procedures is not practical because of the many variables. The following provides a basic procedure applying to emergency jettison of palletized cargo on rollers but must be supplemented by sound pilot judgement for the specific conditions.

WARNING

Before attempting to jettison, the loadmaster should compute the aircraft cg to ensure that normal cg would be maintained within normal limits for landing and the cargo is jettisonable in accordance with NA 01-75GAA-9 Section V.

Note

- Ensure all pallet D-rings are secured to prevent binding with the dual rail system.
- Ensure all vertical restraint flanges are retracted.

1. Alert the crew — Alerted (CP).

2. Passengers — Secured Forward of Cargo (LM).

3. Descend — As Required (P).

WARNING

Without supplemental oxygen for all crew and passengers, descend below 10,000 feet if possible.

4. Pressurization — Begin Depressurization (FE).

Note

When depressurized, place the AIR CONDITION MASTER switch to AUX VENT.

5. Airspeed — Reduce to Below 150 KIAS (P).

6. Flaps — As Required (P, CP).

7. Parachutes/restraining harness — On/Adjusted (LM).

8. Pressurization — AUX VENT (FE).

CAUTION

Ensure area aft of cargo is clear of obstructions.

9. Auxiliary pump switch — ON (CP).

10. Ramp and door — Clear to Open (LM).

CAUTION

Do not open the ramp and door when airspeed is above 150 KIAS. To do so can cause severe buffeting.

Note

The flight engineer shall open ramp and door from ADS panel, upon concurrence with the pilot.

11. Ramp and Door — OPENED (FE).

WARNING

During cargo jettison, move the elevator controls slowly, smoothly, and no more than is necessary to avoid the possibility of exceeding structural limits.

Note

- Establish a noseup attitude (10°) to obtain a component of gravity for the extraction force.
- Apply power to accelerate the aircraft and increase the effective extraction force.
- After cargo has been jettisoned, add power as needed while setting flaps to 50 percent; do not exceed 150 KIAS.

12. Jettison cargo — As Required.
13. Flaps — 50% (P, CP).
14. Ramp and door — Clear to Close (LM), Closed (LM).
15. Auxiliary pump switch — OFF (CP).

11.6 BAILOUT PROCEDURES

In-flight evacuation exits are shown in Figure 11-13. See Figure 11-21 for parachute operation. If time and aircraft control permit, proceed as follows:

1. Give bailout warning over the public address system, interphone, and three short rings on the alarm bell.
2. Depressurize the aircraft.
3. Place the AIR CONDITIONING MASTER switch in the AUX VENT position.
4. If possible, head the aircraft toward an isolated area and engage the autopilot.

Note

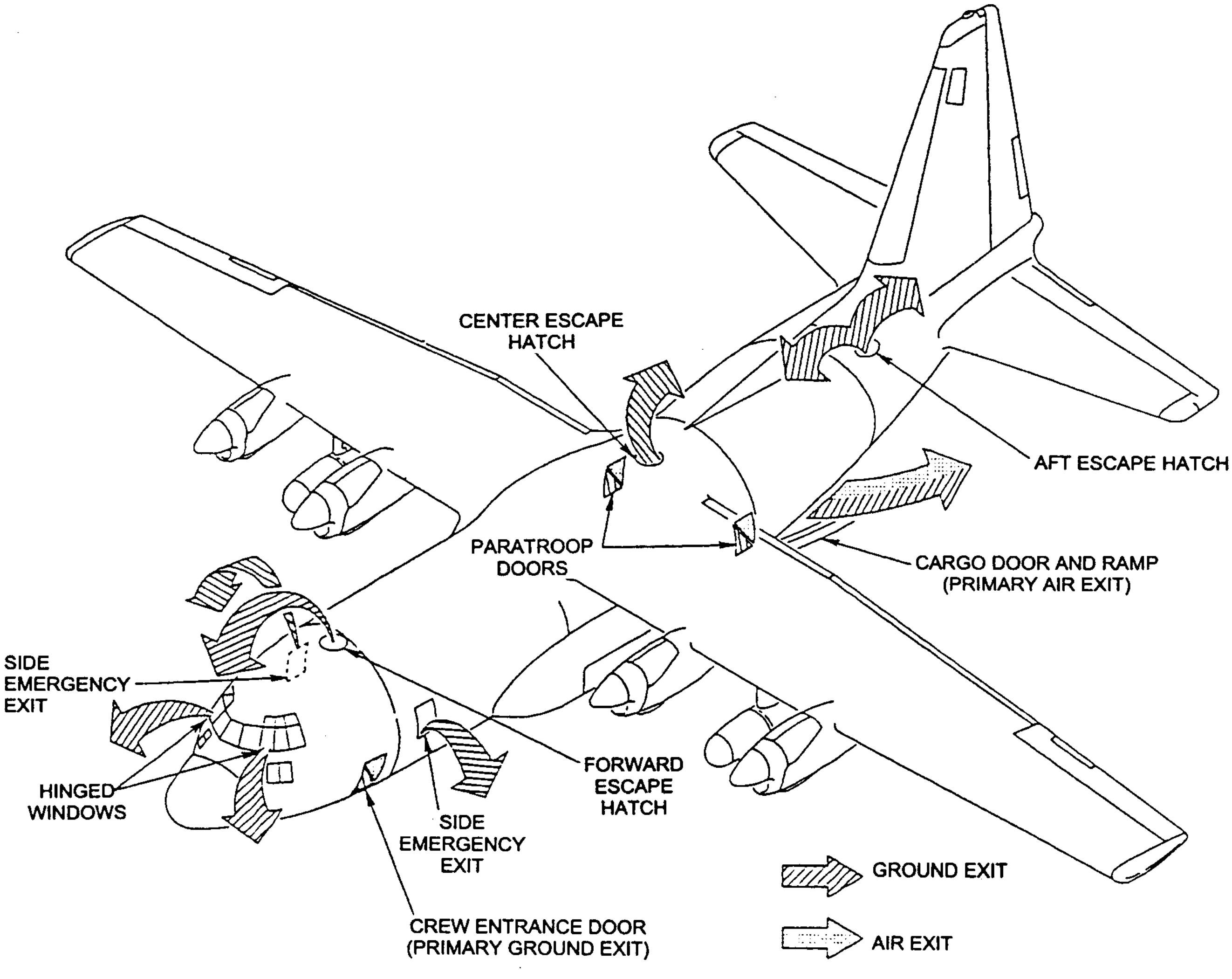
Thorough consideration should be given to the consequences of scattering flightcrew-members over a large area of ocean without the benefit of liferafts. Bailout should be conducted with the aircraft circling to avoid widespread separation of crewmembers.

5. Turn on the auxiliary hydraulic pump at the copilot hydraulic control panel.
6. Reduce airspeed to below 150 KIAS if possible. If the airspeed can be reduced to below 150 KIAS, the priority of emergency exits is as follows:
   a. Cargo ramp and door.
   b. Paratroop doors.
   c. Forward crew door.

WARNING

If the airspeed cannot be reduced to below 150 KIAS, the cargo door will be the primary means of escape.

7. When airspeed is below 150 KIAS:
   a. Open the air-deflector and paratroop doors.
   b. Give the abandon aircraft signal over the public address system, interphone, and by one long ring on the alarm bell.
   c. Evacuate the aircraft.
8. If the airspeed is above 150 KIAS or the paratroop doors will not open:
   a. Open the cargo door by placing the manual control valve in the OPEN position.
   b. Give the abandon aircraft signal over the public address system, interphone, and by one long ring.
   c. Evacuate the aircraft.



WARNING

DO NOT LOCK FLIGHT ENGINEER AND NAVIGATOR SEATS IN A POSITION THAT WILL BLOCK THE COPILOT EVACUATION ROUTE. MAKE SURE THAT THE GALLEY FLOOR IS UP AND LOCKED.

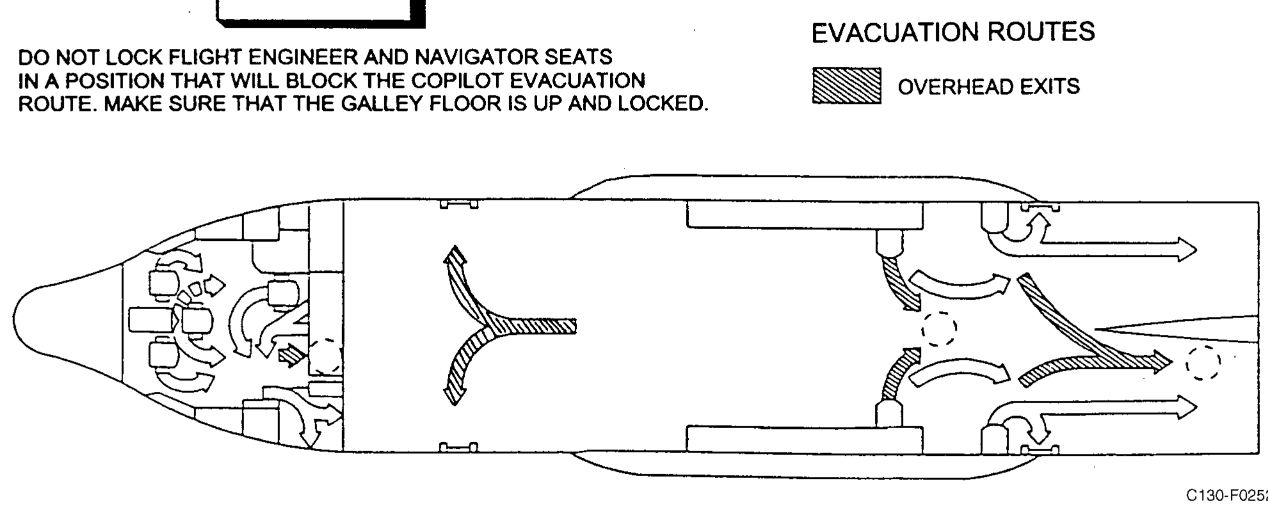


Figure 11-13. Emergency Exits — Air and Ground

9. When time and aircraft control do not permit crew use of the paratroop doors or the ramp door, proceed as follows:

WARNING

Number 2 engine should be secured prior to jettisoning crew door.

   a. Give bailout warning over the public address system, interphone, and by three short rings on the alarm bell.

WARNING

Ensure parachute and applicable equipment are passed to the flight deck and the door area is clear prior to jettisoning the crew entrance door.

   b. Jettison the crew door by pulling the emergency release handle just forward of the flight station emergency escape hatch release.

Note

It may not be possible to jettison the crew entrance door at a pressure differential greater than 3.1 inches of mercury because of the load on the door hinge and the latching mechanism.

   c. Reduce airspeed if possible.

WARNING

Bailout from the crew entrance door is not recommended at airspeeds above 150 knots or with the landing gear extended.

   d. Give abandon-aircraft signal over the public address system, interphone, and by one long ring on the alarm bell.

   e. Bail out of the crew entrance door from a squatting position at the rear.

Push head first outward and downward, using the rear edge of the door frame for leverage. Do not attempt to exit feet first or in a spread position.

11.6.1 NB-8 Personnel Parachute. The C-130T is equipped with five NB-8 personnel parachute assemblies. The NB-8 is a back-type parachute, consisting of a 28-foot diameter, flat, multicolored nylon canopy. The canopy is packed in a container and secured to the aircrewmember by a harness assembly.

Executing Bailout with NB-8 Personal Parachute:

Note

The parachute should fit tightly, high on the back and snug in the seat. All pocket objects should be removed and stowed. Gloves should be worn. Minimum recommended altitude for bailout is 3,000 feet AGL. Bailout should not be attempted below 1,000 feet AGL.

1. Depart aircraft in a quick orderly fashion at one second intervals. Exit forcefully to ensure separation from aircraft, keeping feet together.

2. When clear of aircraft, grip ripcord handle and pull to maximum length of travel to allow for complete release of pins from parachute pack.

3. Immediately following opening shock, check for proper deployment and condition of parachute canopy.

4. Consider activating four-line release system to reduce oscillation and provide an optional method of maneuvering the parachute to an optimal landing site. Grasp release lanyard loops, located on the inside of the rear risers, and break release ties by a sharp pull. This action frees the rear four suspension lines allowing canopy to form a lobe in the rear center and permit a steady escape of air, reducing oscillation and providing minimal directional control by pulling on the respective release lanyard.

WARNING

Four-line release should not be activated if a damaged canopy or broken suspension lines are observed.

5. Attempt to turn into the wind by pulling on the left riser to turn left or the right riser to turn right in order to avoid being caught under the parachute canopy after landing.

6. To prepare for water entry, grasp left side of parachute harness with right hand. Unfasten chest strap and left leg strap with left hand. With left hand, grasp right harness and place right hand on right leg strap.

7. Upon water entry, unfasten right leg strap with right hand and roll free of parachute harness.

8. If trapped under parachute canopy in the water, remove it by finding a panel seam and pulling from the head toward the feet along a panel seam toward the nearest edge. Do not kick feet until clear of canopy and suspension lines.

11.7 CONTROLLABILITY

11.7.1 Controllability Check. A controllability check is conducted to determine the minimum safe airspeed to maintain during approach and landing. If suspected or actual in-flight damage, fuel imbalance, or differential airspeed occurs, the following procedure should be used as necessary to determine the extent of the damage and controllability for landing. Maintain careful control of the aircraft at all times throughout the procedure. If at any time it becomes apparent that you will be unable to land the aircraft, consider bailout procedure while controlled flight is still possible.

1. Conduct a preliminary check for aircraft damage and personnel injuries.

2. Attempt climb to 10,000 feet AGL.

3. Consider dumping fuel to lighten aircraft.

4. Complete the descent checklist.

5. Configure the aircraft for landing.

WARNING

- The speed must never be decreased to the point at which full control deflection is required since there may be no recovery capability beyond this point. Control and configuration changes should be input gradually.

- With structural damage, there is a possibility of a split-flap condition occurring when the flaps are lowered.

6. Gradually slow the aircraft in 5-knot increments while evaluating the control capabilities in turns and simulated landing approaches. Any impending control problems are indicated by an excessive rolling, yawing, or pitching moment. The airspeed is decreased until the desired landing speed is attained or an undesirable control problem is approached.

7. If a stall buffet occurs, immediately accelerate the aircraft to a safe flying speed. If a stall buffet occurs, plan touchdown speed to be 1.2 times speed at buffet for the selected flap setting. The landing flare requirement can be decreased by making a low, flat landing approach.

11.8 LANDING EMERGENCIES

11.8.1 Landing With Engines Inoperative. For the effect of various engine losses on aircraft systems, see Figure 11-3. In addition to declaring an emergency and completing the engine shutdown procedure and Landing Checklists, the following items shall be briefed prior to any engine(s) out landing.

1. System degradation

   a. Hydraulic

   b. Electrical

   c. Other.

2. Trim — Trim tab coordination

   a. Rudder

   b. Elevator (as required)

c. Aileron (as required).

3. Airspeed — Airspeed adjustment/increase.

4. Reverse — Reverse using symmetrical engines.

5. Swerve — Direction of swerve.

6. Go-around — Waveoff intentions.

a. Five-degree wing up

b. Power setting on operating engines.

11.8.1.1 Landing With One Engine Inoperative. The approach for landing with one engine inoperative is made in the same manner as for a normal landing except flaps should not be extended more than 50 percent until landing is assured. Below 97 KIAS, during flareout, the combined flight idle thrust on the side with two operating engines will tend to turn the aircraft into the side with only one operating engine. Above 97 KIAS, the aircraft will tend to turn into the side with two engines operating because of the negative thrust or drag produced with propellers at the low pitch stop. These characteristics are particularly noticeable when a landing is made with a propeller feathered on an outboard engine. Reference Figure 11-14 for flight-idle thrust factors affecting low-speed landing characteristics.

CAUTION

- Reverse thrust on asymmetrical engines may cause the aircraft to veer to one side.
- Copilot must hold the wheel firmly on the ground and the wings level.

Note

At light gross weights, counteracting the crosswind effect by adding power to the side with the dead engine will contribute to floating and consequent overshooting. After nosewheel touchdown, retard throttles to GROUND IDLE and use reverse thrust from symmetrical engines.

11.8.1.2 Landing With Two Engines Inoperative. After loss of two engines, attempt to decrease aircraft weight, if necessary, dumping fuel and/or jettisoning equipment before landing.

CAUTION

If both the No. 1 and No. 2 engines are inoperative, additional time is required to extend gear and flaps.

1. Downwind leg

a. 160 KIAS minimum

b. Gear and flaps as required.

2. Base leg

a. 160 KIAS

b. Gear and flaps as required.

3. Turn to final

a. 150 KIAS minimum.

4. Final approach

a. Maintain 150 KIAS, or approach speed, whichever is higher, until landing is assured

b. Extend gear and flaps, as required.

WARNING

A go-around is not recommended after flaps are lowered. Do not extend full flaps until landing is assured. When landing with two engines inoperative, ensure firm nosewheel contact before reversing and use reverse thrust only as needed. With symmetrical power available, use maximum inboard power as control is available.

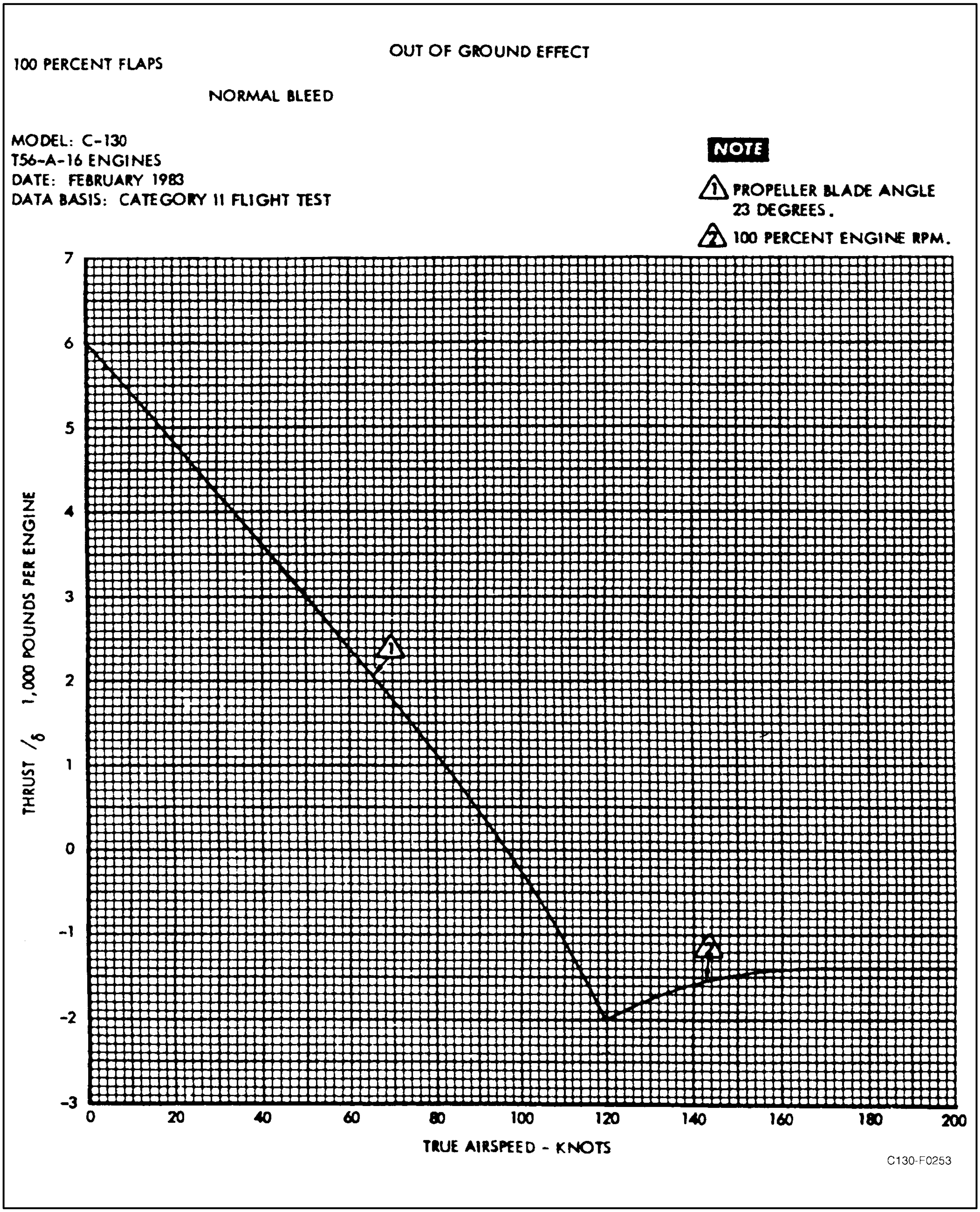


Figure 11-14. Low-Speed Flight-Idle Thrust

11.8.2 Go-Around With One or Two Engines Inoperative

WARNING

The use of 5° of bank away from the inoperative engine is required to maintain directional control when power is applied during go-around. Go-around with two engines inoperative is not recommended. Every precaution should be taken so as not to let a situation develop that necessitates a go-around under these conditions. Descents below safe, comfortable altitudes and airspeeds should not be made until absolutely assured of landing.

1. Alert crew by giving command, “Go-around.”

2. Begin the go-around at or above minimum control airspeed.

3. Advance throttles for all operating engines to maximum power as directional control will permit. Power applied to the asymmetrical engines will depend on the airspeed of the aircraft at initiation of go-around.

4. Give command to copilot to raise flaps to 50 percent.

CAUTION

Raising the flap handle prematurely above approximately the 15-percent position or raising the gear will increase the minimum control speed because of reduction in available hydraulic pressure.

5. Raise the gear when certain that the aircraft will not touch down.

6. Continue to raise flaps as airspeed and altitude permit.

Note

- At low airspeeds, raise flaps in 10-percent increments with airspeed increasing approximately 5 knots between retraction increments.

- Two-engine minimum control speed must be obtained as soon as possible after initiation of go-around.

7. After gear and flaps are up, continue as a normal take-off, using three-engine climb speeds.

11.8.3 Landing With Tire Failure

11.8.3.1 Nose Landing Gear Tire Failure. If one nosewheel tire is flat at the time of landing, a normal landing may be made. If both nosewheel tires are flat at the time of landing, keep the nosewheels off the ground as long as possible. After nosegear contact, use maximum reverse thrust and minimum braking. This procedure gives minimum nosewheel loading. Taxiing is not recommended.

11.8.3.2 Main Landing Gear Tire Failure. If a main landing gear tire is flat at the time of landing, touch down the nosegear as soon as possible and use maximum reverse thrust. Taxiing is not recommended. If both tires of the main landing are flat, there will probably be a tendency to swerve toward that side. Line up and land on the side of the runway with the good tires. Touch down the nosegear as soon as possible, hold full forward on the control column, and assure directional control with the nosewheel steering system. Use wheelbrakes (on the side opposite the flat tires only) to assist the nosegear in maintaining directional control. Use reverse thrust cautiously but to the fullest extent possible to reduce landing roll to a minimum. Do not attempt to taxi.

11.8.4 Landing Gear Retracted

11.8.4.1 Landing With One or Both Main Gears Retracted. If one main landing gear cannot be extended, the recommended procedure is to retract the other main gear and land with only the nose landing gear down, or to land with all gears retracted (refer to Gear-Up Landing, paragraph 11.8.4.3).

11.8.4.2 Landing With Nosegear Retracted and Main Gear Down. If the nosegear fails to respond to normal and emergency operating procedure, an emergency landing may be accomplished, holding the nose of the aircraft up as long as possible. Use the following procedure to make a nosegear-up landing.

1. Give warning over the public address system and the interphone and give six short rings on the alarm bell. Reduce weight to minimum practical gross weight. Manually activate emergency exit lights.

2. Request foam on the runway (20 feet wide, 3,000 feet long, beginning 2,000 feet from the approach end of the runway). Request removal of arresting gear.

3. Stow or secure all loose equipment. If cargo can be safely moved, shift cargo aft to a cg of not more than 30 percent.

4. Depressurize the aircraft and place all ENGINE BLEED AIR switches to OFF. Pull GPWS ESS AC and DC circuit breakers. Pull LANDING GEAR WARNING LIGHT circuit breaker.

5. Open overhead emergency escape hatches and paratroop doors.

6. Turn off all unnecessary electrical equipment.

7. Close the oxygen manual shutoff valve located on the aft side of the flight station bulkhead.

8. Take crash position, passengers behind cargo.

9. Lock shoulder harness inertial reel.

WARNING

Ensure that all controls that cannot be easily reached are properly positioned before locking the harness.

10. Assume a normal landing attitude using 100-percent flaps.

11. Upon main gear touchdown, retard throttles to FLIGHT IDLE, maintain level attitude, do not use wheelbrakes, do not allow nose to fall through, and decelerate aerodynamically to 97 KIAS.

12. Upon reaching foam, lower nose to runway.

13. Upon nose touchdown, apply reverse thrust, maintain nose in light contact with runway and do not use wheelbrakes (except to avoid over run).

14. Upon stop, execute ground evacuation procedures. Use caution exiting the aircraft; the exits may not be at their normal height above the ground and the crew door may not fully open.

11.8.4.3 Gear-Up Landing. Before making a gear-up landing, perform the following operations:

1. Give warning over the public address system and the interphone. Manually activate the emergency exit lights.

2. Request foam on the runway (20 feet wide and 3,000 feet long, beginning 1,500 feet from the approach end of the runway).

3. Stow or secure all loose equipment.

4. Depressurize the aircraft and place all ENGINE BLEED AIR switches to OFF. Pull GPWS ESS AC and DC circuit breakers.

5. Consider cargo jettison and dump or consume all unnecessary fuel (refer to paragraph 11.4.12).

6. Open overhead emergency escape hatches and paratroop doors.

7. Close the oxygen manual shutoff valve located on the aft side of the flight station bulkhead.

8. Pull the LANDING GEAR WARN LIGHT circuit breaker on the copilot lower circuit breaker panel.

9. Turn off all unnecessary electrical equipment.

10. Take the crash position.

11. Fasten shoulder harness and inertial reel lock.

WARNING

Ensure that all controls that cannot be easily reached are properly positioned before locking the harness.

12. Assume a normal landing attitude using 100-percent flaps.

13. Touch down on foam, applying reverse thrust.

14. Upon stop, execute ground evacuation procedure. Use caution exiting the aircraft; the exits may not be at their normal height above the ground and the crew door may not fully open.

15. Evacuate the aircraft as soon as possible.

11.8.4.4 No-Flap Landing

1. Place the GPWS switch to OVERRIDE.

2. Fly a slightly wider, slightly longer pattern to compensate for the higher no-flap airspeeds.

3. Do not flare but, rather, allow the aircraft to fly onto the runway.

CAUTION

If the touchdown is lower than the charted speed, it is possible for the aft end of the fuselage to contact the ground.

4. When applying reverse thrust at high speed, pull the throttles into reverse slowly.

5. Longer ground rolls will result from the higher touchdown speeds.

11.8.5 Landing on Soft Ground or Unprepared Runways. If it becomes necessary to land on soft ground or an unprepared runway, it is recommended that the landing gear stay extended. However, the final decision to land with the landing gear up or down must be made by the pilot.

11.8.6 Loss of Nosewheel Steering During Landing. Whenever a loss of nosewheel steering is indicated by an immovable pilot steering wheel, no further attempt will be made to "force" the wheel to turn, as this might prevent the nosewheel from castering. Under this condition, the pilot will pull back on the control column to relieve pressure on the nosewheel and maintain directional control of the aircraft through the coordinated use of flight controls, differential power, and differential brakes according to the prevailing circumstances of speed, crosswinds, engine out, and runway conditions.

11.8.7 Landing With a Cocked Nosewheel. Basically, the procedure for landing with a cocked nosewheel is the same as landing with loss of nosewheel steering, with the following additions. Request foam on the runway (20 feet wide, 3,000 feet long, beginning 1,500 feet from the approach end of the runway).

11.8.8 Nosewheel Shimmy. Nosewheel shimmy is an indication of an unbalanced condition of one or both of the nosewheel tires or failure of the steering system. If this occurs during takeoff, the decision regarding whether to abort or to continue will depend on the severity of the shimmy and whether the refusal point has been passed. If shimmy occurs during the landing roll, decelerate gradually and apply up-elevator to keep as little load as possible. In landing with a known shimmy condition, keep nosewheel off the ground as long as possible but touch down while elevator effectiveness allows gentle lowering of the nose.

11.9 DITCHING

Under ideal conditions of wind and sea, and by skillful execution of the recommended techniques, the ditching of transport-type aircraft can usually be accomplished with a high degree of success. However, because of the high-wing configuration of this aircraft, the fuselage may be expected to settle after touchdown with consequent flooding of the cargo compartment. Consideration of various unfavorable factors involved in an overwater bailout limits the decision recommending bailout to several specific instances; namely, when near to land or adequate surface help; when wind and sea conditions are such as to preclude ditching; or when fire or loss of control makes ditching impossible. Therefore, it is considered better to ditch if circumstances permit, since this makes available the additional liferafts and survival equipment carried in the aircraft. In any event, the decision to ditch or bail out must be made by the pilot in view of the existing circumstances. This decision should never be delayed until the fuel supply is exhausted, since the most effective ditching approach is made with power on at a speed slightly above the power-off stall speed. A minimum of 2,000 pounds of fuel should remain at time of descent from altitude to allow for jettisoning of cargo, assessment of sea condition, communication with or maneuvering around surface vessels when present, and to establish a landing pattern to the smoothest surface condition.

11.9.1 Ditching Characteristics. Actual experience in ditching the C-130 is limited; however, NACA-controlled ditching tests of models similar to the C-130 configuration indicate that there is a reasonably high probability that the aircraft can be landed on water without major collapse of structure or a sudden rush of water into occupied compartments. On the basis of limited experience and the NACA tests, it is concluded that the following results can be expected upon ditching.

CAUTION

- These characteristics assume a power-on approach, approximately 7° nose-high pitch attitude with full flaps extended, landing gear retracted, and touchdown at 10 KIAS above stall speed. Any speed above full flap approach speed will result in additional structural damage on touchdown.

- Actual ditchings of other aircraft have indicated that excessive airspeed will cause control problems once on the water and increase the likelihood of nose-section failure. Extremely rapid flooding of the aircraft would follow.

1. Upon contact with the water, moderate bottom damage may occur in the area immediately forward of the cargo loading ramp hinge. The bottom damage will tend to stabilize the aircraft directionally during the ditching run, maintaining the wings in an essentially level attitude. Wing dipping or water looping are not expected.

2. During the initial portion of the ditching run, the taildown portion of the cargo door may be damaged. The damage probably will not affect either the ditching run or the sinking rate since the location of the door is such that it will be above the waterline when the nose settles during the latter part of the run. It is very unlikely that the ramp will open. The crew door, the side emergency exit(s), and the paratroop doors, which will be out of the water during the taildown portion of the ditching run, probably will not experience any damage during the ditching run.

3. During the tail-low initial contact with the water, the water-drag forces on the aircraft will tend to bring the nose down. Continued up-elevator force should be applied. This nosedown tendency plus possible damage to the elevator will result in the aircraft assuming a nosedown, tail-high attitude and could generate porpoising. If in this nosedown attitude a wave or swell of large magnitude is encountered, considerable damage to the radome and nose of the aircraft will occur, with probable rupture of the forward bulkhead and immediate flooding of the flight station. Some damage may occur in the area of the cargo door and ramp, but expect the primary flooding to occur in the forward portion of the aircraft if the ditching is in a heavy sea.

WARNING

- If porpoising occurs, do not try to catch the aircraft but maintain backyoke and keep the nose out of the water. If control is reestablished, continue to keep the aircraft in a trim-up attitude. Hold the nose up as long as possible. Do not drop it.

- As the nose settles during the final part of the ditching run, the fuselage will fill with water fairly fast. The aircraft will sink to the wings, then float.

11.9.2 Preparation for Ditching. Plans for ditching cannot be made without taking the wind direction into consideration. Waves move downwind, and the spray from wave crest is blown downwind. Swells, however, do not always indicate wind direction and can be very large even when the wind is calm. Swells are the result of underwater disturbances. Over a sea, a pilot must be more exacting and alert when judging height.

11.9.3 Ditching Procedures. The ditching chart outlines duties of personnel prior to and during ditching (see Figure 11-17). Figure 11-15 illustrates the water emergency exits and evacuation routes used during ditching. Figure 11-18 illustrates the liferaft releases.

The following are the standard alarm signals for ditching:

1. Six short rings — Prepare for Ditching.
2. One long ring — Brace for Impact.

11.9.3.1 Normal Power-On Ditching. Best results will be obtained by following the procedures outlined below:

1. Ditch while power is available. Power will allow the pilot to choose the spot for ditching and the most favorable landing position and attitude.
2. Use 100-percent flaps with landing gear up.
3. Ditch at 10 knots above power-off stall speed. This will give an approximate angle of ditching slightly above level flight. Under no circumstances should the aircraft be stalled, since this will result in severe impact and cause the aircraft to nose into the water.
4. In daylight, it is recommended that the aircraft be ditched along the top of the swell, parallel to the rows of swells, if the wind does not exceed 30 knots. In high winds, it is recommended that ditching be conducted upwind to take advantage of lowered forward speed. However, it must be remembered that the possibility of ramming nose-on into a wave is increased, resulting in failure of the nose of the aircraft and immediate flooding of the flight deck. Also, there is the possibility of striking the tail on a wave crest and nosing in.

11.9.3.2 Partial-Power Ditching. When ditching with one or more engines inoperative, the following should be borne in mind:

1. With the engines inoperative on the same side of the aircraft, use power on the inboard engine only.
2. If power is available from the No. 2 and 4 engines or the No. 1 and 3 engines, considerable power may be used to control the aircraft.
3. Use power as required to give the flattest approach.
4. In final approach, it is advisable to hold speed 20 knots above power-off stall speed until flare-out, at which time speed will be reduced to 10 knots above power-off stall speed.

11.9.3.3 Crosswind Ditching. The basic rules for ditching listed in Normal Power-On Ditching, paragraph 11.9.3.1, will still apply, in addition to the following:

1. Keep the wings level and crab the aircraft to kill the drift. It may be advantageous to permit some drift to maintain a parallel relationship with a wave.
2. Land on the downward side of the swell or wave.

11.9.3.4 Upwind Ditching. The basic rules for ditching listed in Normal Power-On Ditching, paragraph 11.9.3.1, will still apply, in addition to the following:

1. Maintain noseup condition; avoid the nose striking wave surface.
2. Touch down immediately behind the crest of a rising wave; avoid the face of the wave.
3. Hold nose up after impact.

11.9.3.5 Night Ditching. Night ditching will be conducted with the aid of instruments to establish the proper attitude of the aircraft.

1. Make an instrument approach, holding airspeed 20 knots above power-off stall speed. At 500 to 700 feet above the water (use radar altimeter if available), set up approximately 200 fpm rate of descent, and establish an airspeed 10 knots above power-off stall speed with full flaps.
2. Use landing lights as necessary.
3. Hold wings level to avoid digging a wing into the water and cartwheeling the aircraft.
4. Ditch at 10 knots above power-off stall speed.
5. Use 100-percent flaps with landing gear up.

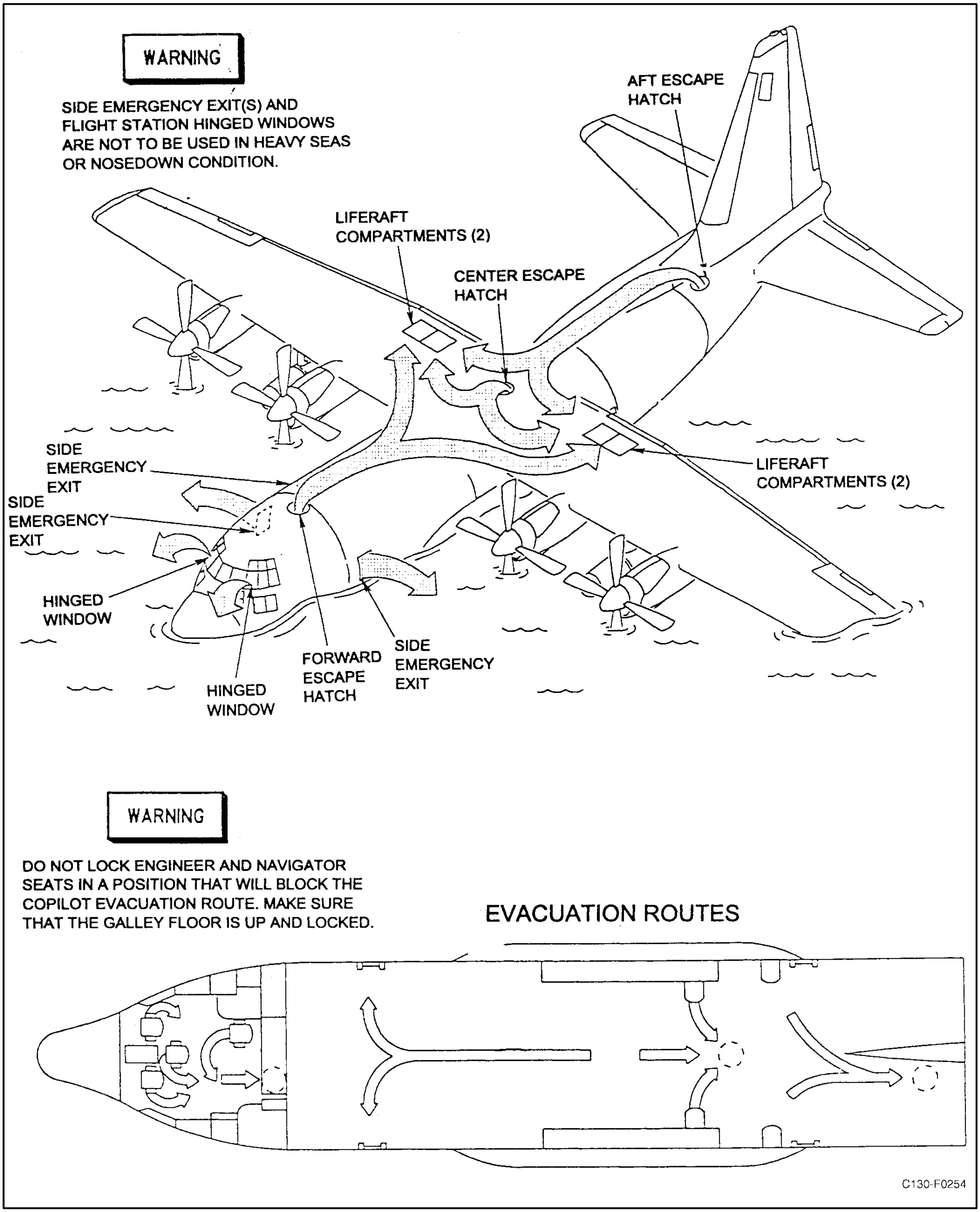
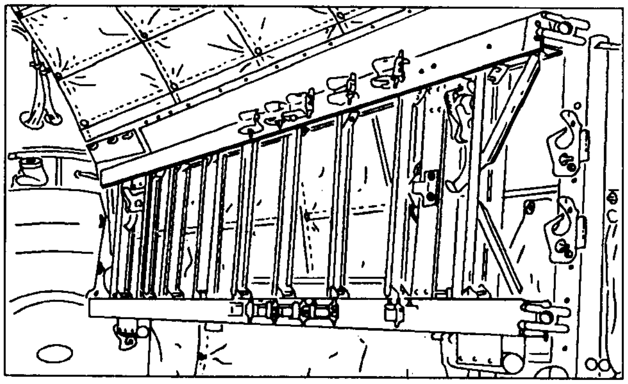


Figure 11-15. Emergency Exits — Water

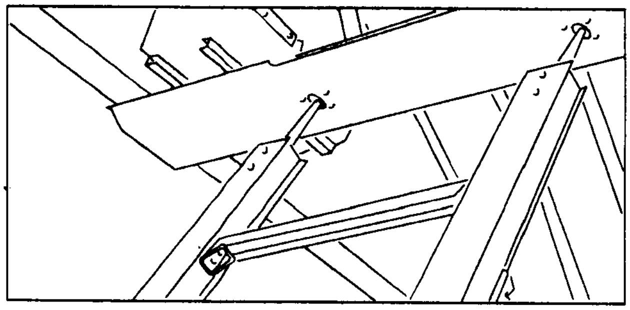
STEP 1

REMOVE THE LADDER FROM ITS STOWED POSITION ON THE LEFT SIDE OF THE CARGO COMPARTMENT.



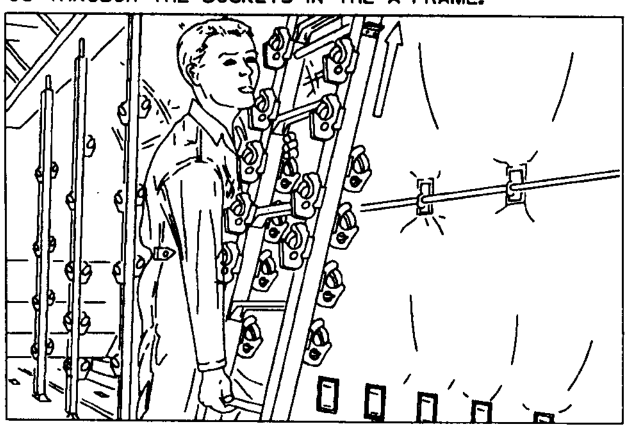
STEP 2

INSERT THE UPPER ENDS OF THE LADDER INTO THE A-FRAME SOCKETS MARKED "LADDER", DIRECTLY BELOW THE ESCAPE HATCH IN THE TOP OF THE FUSELAGE, JUST AFT OF THE WING CENTER SECTION. THE LADDER MUST BE INSERTED AT AN ANGLE WHICH WILL ALLOW ITS LOWER END TO CLEAR THE FLOOR.



STEP 3

PUSH THE LADDER UPWARD SO THAT THE UPPER ENDS GO THROUGH THE SOCKETS IN THE A-FRAME.

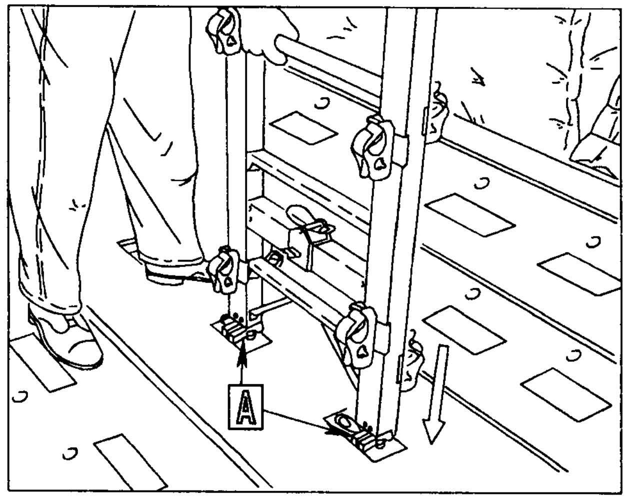


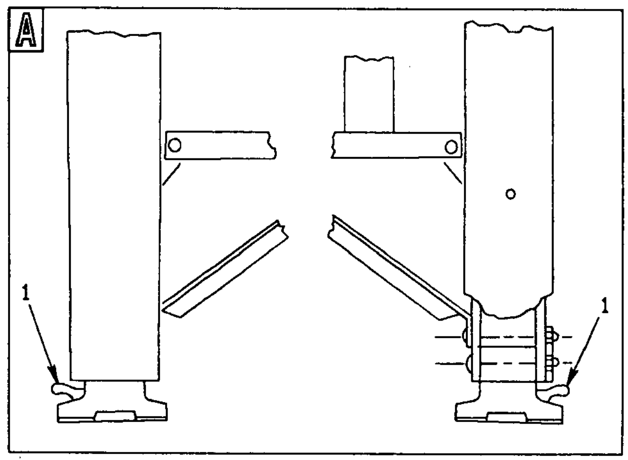
STEP 4

SWING THE LADDER TO VERTICAL, AND CENTER IT OVER THE PROPER TIEDOWN STUDS.

STEP 5

LOWER THE LADDER UNTIL THE LATCHES (1) ENGAGE THE TIEDOWN STUDS.





C130-F0255

Figure 11-16. Center Escape Ladder Installation

CREW-MEMBER	FIRST ACTION	DITCHING IMMINENT (10 MINUTES LEFT)	AFTER DITCHING
PILOT DUTIES	1. Order crew to prepare for ditching, giving approximate time remaining. Order crew to start emergency procedures. Each crewmember will acknowledge. 2. Direct copilot to send distress signal. 3. Advise flightcrew to reduce fuel quantity/gross weight and jettison cargo, as necessary. 4. Obtain flashlight and PRC-90. 5. Don antiexposure suit and lifevest. Fasten shoulder harness and safety belt.	1. Alert cargo compartment personnel with interphone and six short rings on the alarm bell. 2. Direct copilot to transmit final distress signal. 3. Order all crewmembers and passengers to assume the ditching position. 4. Lock shoulder harness. 5. Immediately before ditching, warn personnel over the interphone to "Brace for impact," and order copilot to give one long ring on the alarm bell.	1. If possible, check flight station and cargo compartment to ensure that all personnel and emergency equipment have been evacuated. 2. Exit through forward escape hatch and inflate lifevest. 3. Board left inboard liferaft and receive emergency equipment.
COPILOT DUTIES	1. Acknowledge pilot's order to prepare for ditching. 2. Upon order from pilot, send distress signal. 3. Select emergency on transponder. Upon order from pilot, transmit emergency signal on HF radio followed as soon as possible by emergency message. 4. Obtain flashlight and PRC-90. 5. Don antiexposure suit and life vest, fasten shoulder harness and safety belt.	1. Upon order from pilot, transmit final distress and intentions of pilot as to ditching. 2. Lock shoulder harness. 3. On orders from pilot, give one long ring on alarm bell.	1. Exit through forward escape hatch. 2. Inflate lifevest and board right inboard liferaft.
FLIGHT ENGINEER DUTIES	1. Acknowledge pilot's order to prepare for ditching. 2. Upon order from pilot, dump fuel as required. Close dump valves. 3. Depressurize aircraft; place ENGINE BLEED-AIR switches to OFF. 4. Obtain flashlight, PRC-90, and hand ax. 5. Don antiexposure suit and lifevest.	1. Remove and stow forward escape hatch. 2. Secure loose articles. 3. EMERGENCY DEPRESSURIZATION switch — NORMAL; AIR CONDITIONING MASTER switch — AIR COND MAN PRESS; hold MANUAL PRESS CONT switch to INCREASE pressure for 90 seconds. 4. Pull the GPWS circuit breakers on the copilot upper circuit breaker panel. 5. Pull the LANDING GEAR WARN LIGHT circuit breaker on the copilot lower circuit breaker panel. 6. Turn the seat to face forward and lower seat to full-down position. 7. Fasten safety belt and lock shoulder harness.	1. Pull liferaft release handles in flight station. 2. Exit through forward escape hatch with container of water if possible. 3. Inflate lifevest; check liferaft and radio and discard hand ax. 4. Board right outboard liferaft.

Figure 11-17. Ditching Chart (Sheet 1 of 2)

CREW-MEMBER	FIRST ACTION	DITCHING IMMINENT (10 MINUTES LEFT)	AFTER DITCHING
LOADMASTER & SECOND LOADMASTER DUTIES	1. Acknowledge pilot order to prepare for ditching. 2. Advise aft crewmembers and passengers of impending emergency. 3. Complete cargo jettison procedures (as required). 4. Remove and stow hatches. Install center escape ladder. 5. Obtain flashlight and PRC-90. 6. Distribute lifevests to crew and passengers. Do not inflate. Don lifevest. Don anti-exposure suit (as required). 7. Rebrief passengers on the crash position, evacuation routes, and liferaft boarding. 8. Notify pilot when cabin is prepared for ditching.	1. Ensure that aft crewmembers and passengers are behind cargo if possible and properly seated with belts fastened. 2. Ensure that the light by each emergency exit is on. 3. Extend emergency escape ropes to nearest person to be used as an escape assistance in reaching the hatch. 4. Fasten safety belt. Upon one long ring of the alarm bell, assume the crash position.	1. Pull liferaft release handles aft of the right paratroop door. 2. Ensure that passengers have exited the aircraft. 3. Obtain portable emergency exit lights/flashlight, first-aid kit, and water jugs. Exit through the aft escape hatch and inflate lifevest. 4. Board left outboard liferaft.

Figure 11-17. Ditching Chart (Sheet 2)

11.9.4 Abandoning Aircraft. Evacuation of the aircraft after ditching should be accomplished in an orderly manner in the shortest time possible. This cannot be done well without practice, and, in the event that the fuselage is dark and filling with water, further difficulty can be expected.

WARNING

The crew and/or passengers must not leave ditching positions until it is ascertained that the aircraft has stopped forward movement. Serious injuries can occur as the result of personnel unfastening safety belts prior to the aircraft coming to a full stop.

Immediately after the aircraft comes to a stop, additional emergency equipment may be collected and distributed to each crewmember. The crewmembers must carry out their after ditching duties (see Figure 11-17) and then evacuate the aircraft through the hatch previously assigned to them. They must also see that each piece of equipment for use in the liferaft is secured by lines to prevent its being lost overboard.

WARNING

- Ensure that personnel are outside of the aircraft and clear of the escape hatches prior to inflating life vests.
- Liferaft release handles (see Figure 11-18) must be pulled through their full travel for complete ejection and inflation of the liferaft.
- In an emergency, the pilot and copilot side windows may be used as emergency exits; however, heavy flooding may occur.

11.9.4.1 Emergency Ditching Exits (Flightcrew). See Figure 11-15 for emergency exits. Normally, crewmembers on the flight deck will use the forward escape hatch for exit after ditching. Crewmembers in the cabin will use the center or aft escape hatch for exit after ditching. If cargo permits, the center escape hatch ladder should be installed prior to takeoff. If cargo prevents this installation, personnel in the cabin should be instructed on how to install this ladder after

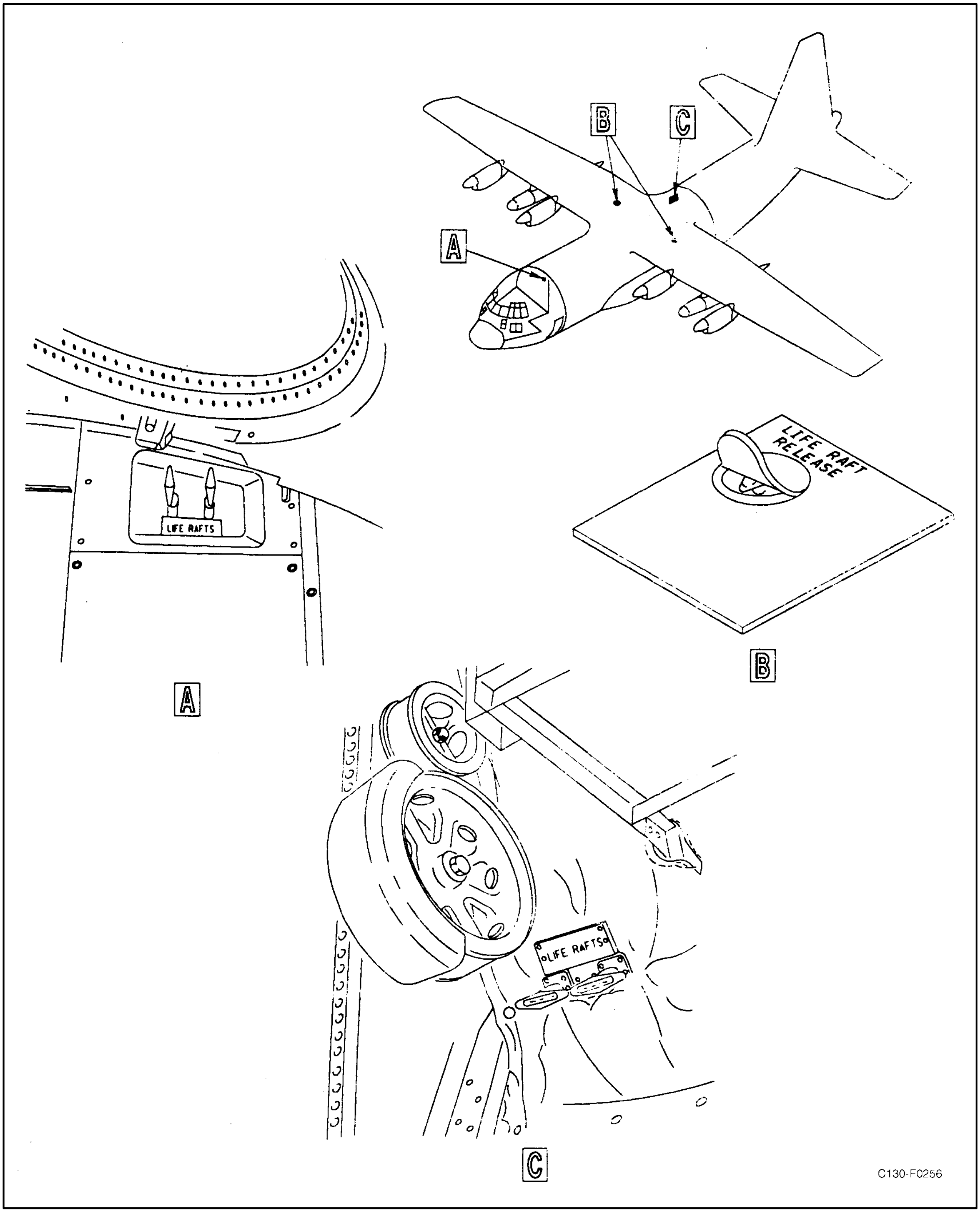


Figure 11-18. Liferaft Releases

cargo is jettisoned (see Figure 11-16). All crewmembers will normally board the assigned liferaft as shown in Figure 11-17.

11.9.4.2 Ditching Exits (Passengers). Passengers will be briefed on the use of emergency equipment and assigned exits prior to flight. They should be divided into groups corresponding to the capacity of the available rafts.

11.9.5 Emergency Ditching Equipment. Ditching equipment should be in readiness at all times when flying over water. Prior to each overwater flight, the pilot will ensure that the necessary equipment is aboard, in serviceable condition, and stowed in the proper places. If possible, seats and safety belts should be provided in the cabin aft of the wheelwells for all personnel on board except for the pilot, copilot, and flight engineer. The cabin is the safest area with the greatest possibility of escape during ditching; therefore, the number of personnel on the flight deck should be kept to a minimum because of the probability of immediate flooding of the flight deck.

11.9.5.1 Liferaft. The C-130T is equipped with four LRU-15/A (Mk 20) liferaft assemblies. The liferaft is constructed of polychloroprene-coated cloth with an inflation assembly (CO_2 cylinder, inflation valve and cover.) The liferaft consists of two single-compartment circular tubes connected by an equalizer tube, a noninflatable floor, and a boarding ramp. The floor is provided with a built-in inflatable floor support. The raft is equipped with a sea anchor, inner lifeline, boarding handles, a heaving line, and emergency survival equipment.

The liferaft assembly is automatically ejected from the wing compartments when the liferaft handles have been pulled or the liferaft compartment door has been released. The liferaft inflates within 1 minute and is always right-side-up after inflation. The CO_2 assembly inflates the circular tubes and boarding ramps only. In the event the inflation assembly does not function properly, the equalizer tube distributes gas equally between each circular tube. After boarding, the floor support is inflated manually with the handpump provided in the accessory container. The circular tubes may be topped-off if necessary. See Figure 11-19 for liferaft assembly.

11.9.5.2 Life Preserver

WARNING

The LPP-1, -1A life preserver assembly is not suitable for use by small children in naval aircraft.

Note

The LPP-1, -1A life preservers are identical with the exception of the mechanical inflation assemblies.

The LPP-1, -1A life preserver assembly weighs 3 pounds and provides a minimum of 29 pounds of buoyancy. The life preserver consists of a single-compartment, yoke-type flotation assembly, a pouch and belt assembly, an inflation assembly, and a storage container. The preserver is constructed of polychloroprene-coated nylon, equipped with an oral inflation tube, a valve stem, survival locator light attachments, a whistle pocket, a belt loop, and an inspection record. See Figure 11-20.

The LPP-1, -1A is manually inflated by pulling the inflation lanyard down. In an emergency situation, the oral inflation valve should be used to top off an inflated preserver, maintain inflation of a leaky preserver, or to inflate a preserver that malfunctioned.

Note

The pouch must be opened and the flotation assembly unrolled prior to inflation through the oral inflation valve or via the carbon-dioxide inflation assembly.

11.9.5.3 AN/PRC-90 Radio Set. The C-130T is equipped with five PRC-90's that help SAR aircraft and ground rescue parties locate downed aircrewmembers during rescue operations, frequencies are 243.0 MHz and 282.8 MHz frequency. Once the beacon tone is received by SAR personnel, two-way voice communication will follow. See Figure 11-21.

Use of the ear plug is optional. When used, the ear plugs are clipped to the two earphone jacks on top of the radio.

To use the PRC-90 as a Morse-code transmitter, set the frequency selector at the 6-o'clock position (243.0 MHz). Press the MCW button on top of the radio to signal; hold for dash, click for dot. The Morse code alphabet is inscribed on the back of the radio.

When two-way voice contact has been established, do not point the antenna directly toward the oncoming SAR aircraft (cone of silence) or allow the antenna to touch the body or other objects. Any such contact reduces the signal.

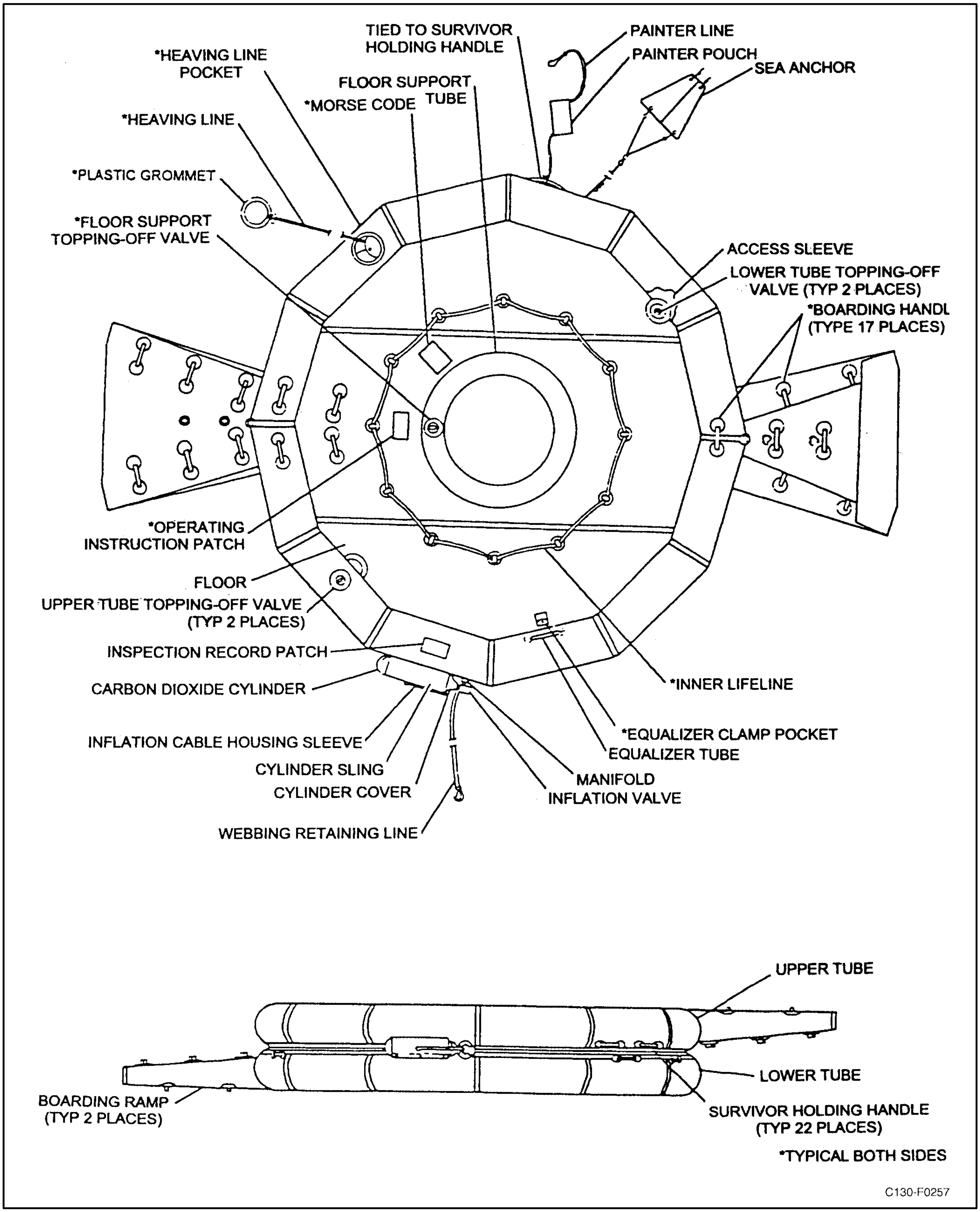
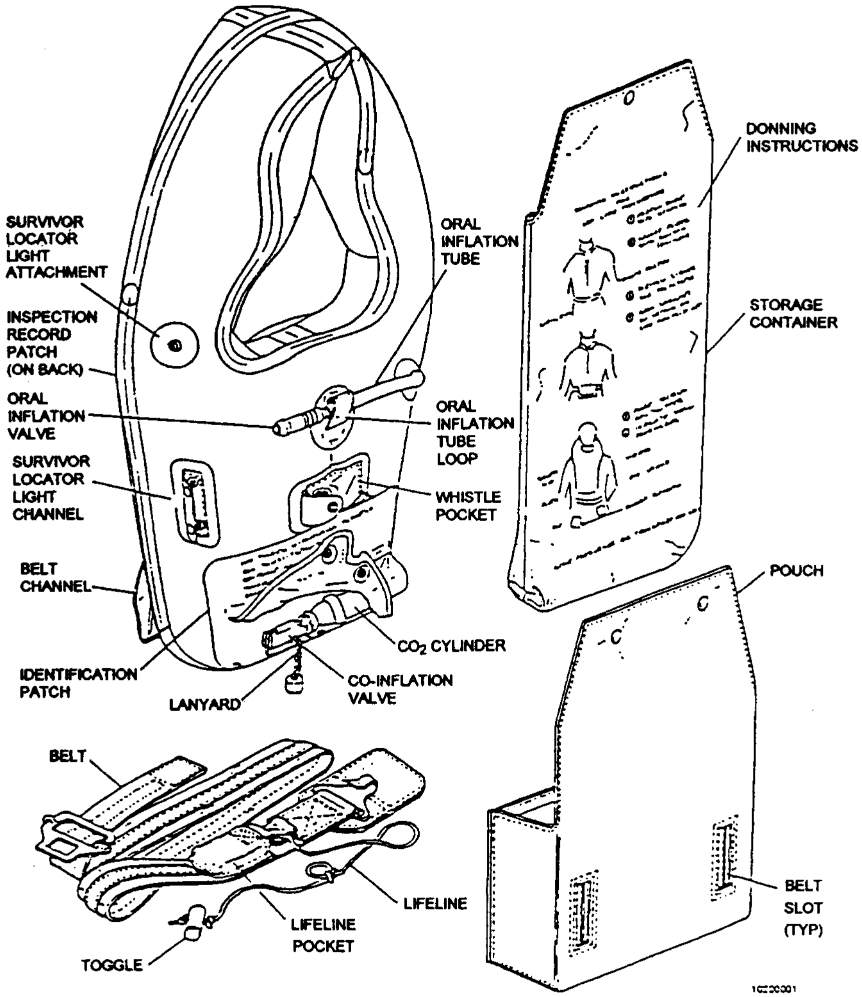
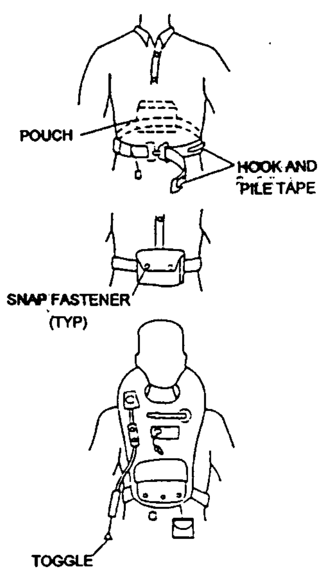


Figure 11-19. LRU-15/A Liferaft Assembly



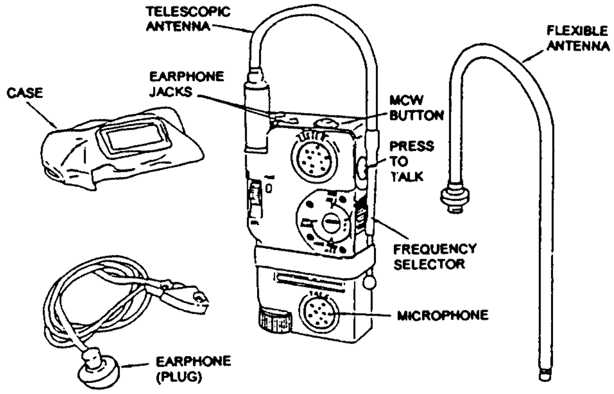
DONNING INSTRUCTIONS FOR LPP-1, 1-A LIFE PRESERVERS



1. REMOVE PRESERVER FROM STORAGE CONTAINER.
2. FASTEN BELT ADAPTERS IN FRONT WITH POUCH IN REAR.
3. ADJUST BELT TO SIZE. SECURE EXCESS BELT BY MATING HOOK AND PILE TAPE.
4. ROTATE POUCH TO FRONT AND READJUST BELT.
5. OPEN SNAP FASTENERS ON POUCH AND UNFOLD LIFE PRESERVERS.
6. PLACE DEFLATED PRESERVER OVERHEAD.
7. PLACE THIS STORAGE CONTAINER INTO POUCH AFTER DONNING LIFE PRESERVER.
8. LIFT LOWER END OF PRESERVER OUT OF POUCH.
9. INFLATE PRESERVER BY PULLING TOGGLE DOWN.

C130-F0258

Figure 11-20. LPP-1, -1A Life Preserver



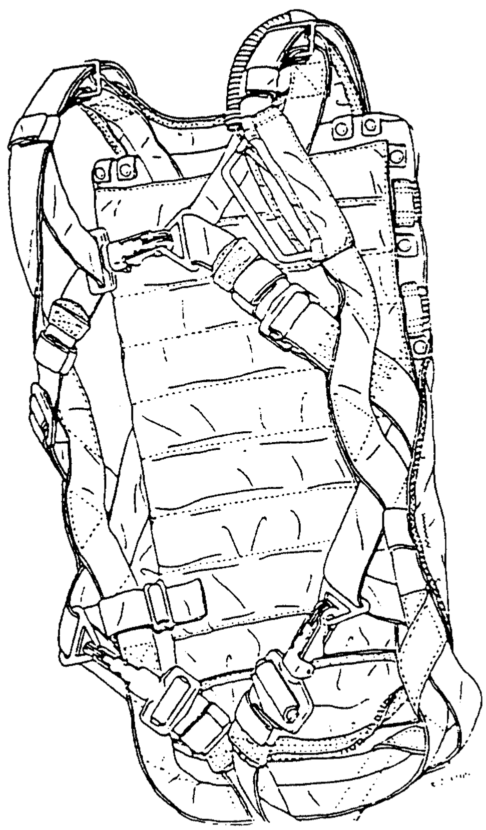


Figure 11-21. Emergency Radio and Parachute

PART VI

All-Weather Operations

CHAPTER 12

All-Weather Operations

12.1 INTRODUCTION

This chapter contains only those procedures that differ from or are in addition to the normal operating instructions covered in Part III, except for some repetition necessary for emphasis, clarity, or continuity of thought. References in this section to operation of the aircraft component systems or auxiliary equipment mean the operation described in Part I.

12.2 INSTRUMENT FLIGHT PROCEDURES

The aircraft is completely equipped for the use of all standard radio navigational and flight aids. It is the responsibility of the pilot to ensure that each crewmember is thoroughly briefed on the exact procedures expected to be followed during all phases of aircraft operation. In planning IFR flights, remember that fuel requirements at low altitudes are greater than at higher altitudes. If required to land under IFR conditions, additional allowance must be made for letdown and holding procedures. Follow the normal takeoff and cruise procedures in Chapter 8 and the NATOPS Instrument Flight Manual, NAVAIR 00-80T-112, for instrument flight procedures. During takeoff, use a 4° to 7° noseup pitch attitude on the ADI to allow the aircraft to fly off the ground.

12.2.1 Holding. Conduct holding operations at 170 KIAS. If maximum endurance is required, conduct holding operations at maximum-endurance airspeed plus 20 KIAS according to instructions from the airway traffic controller. This airspeed permits holding to be accomplished at a constant power setting and allows turns to be executed with little, if any, loss of airspeed. Any loss of airspeed may be regained when level flight attitude is resumed.

12.2.2 Penetrations. Penetrations may be accomplished in this aircraft, making certain that the current airspeed limitations in Chapter 4 are adhered to. Handling characteristics are very good, and pitch attitude is not extreme. A typical penetration is shown in Figure 12-1.

The recommended procedure is as follows:

1. Before or upon reaching fix, complete the Approach Checklist.

2. Begin the penetration at holding airspeed from the appropriate radio fix, in the clean configuration, by retarding throttles to FLIGHT IDLE and smoothly establish descent at least 4,000 fpm until reaching the penetration airspeed.

Note

During penetration, turbulence may be encountered without warning.

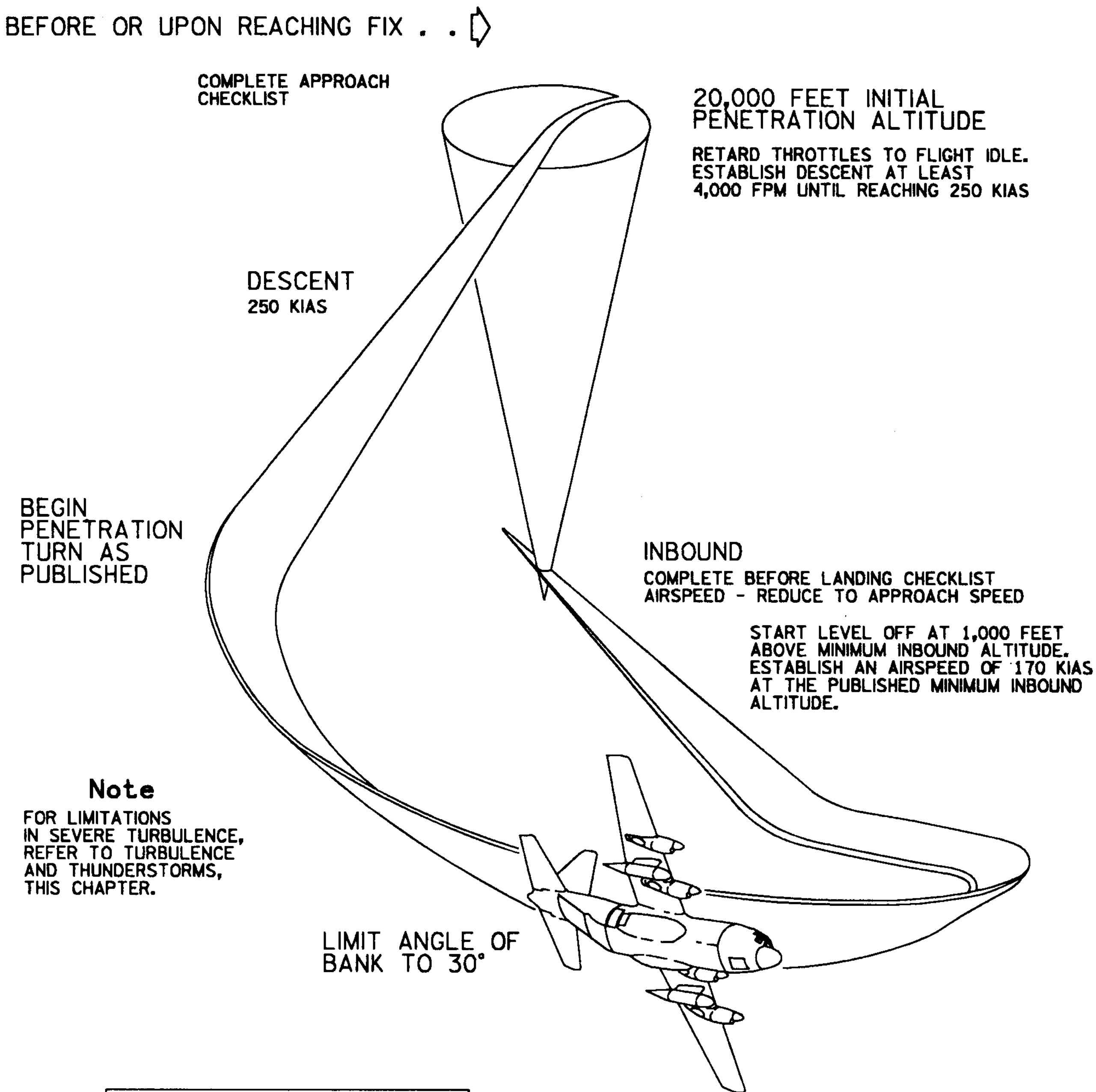
3. Follow the published penetration procedure.

4. Start level-off 1,000 feet above the published minimum inbound altitude and establish an airspeed of 170 KIAS.

5. Complete the Before Landing Checklist prior to reaching the fix. Allow the airspeed to decrease to approach speed and execute an approach as depicted in Figures 12-3 through 12-10.

12.2.3 Instrument Approaches. All conventional systems of instrument approach may be used. Flight characteristics during instrument approaches do not differ from those encountered during normal visual flight. Normally, 170 KIAS is used for entry. Airspeed after the Before Landing Checklist is initiated will be commensurate with the approach and aircraft gross weight. Do not reduce to approach airspeed until on final approach to the station or fix. See Figures 12-3 through 12-10 for typical approaches.

12.2.3.1 Circling Approach. The penetration and approach procedures are based on straight-in approach speeds. In the event it becomes necessary to make a circling approach to align the aircraft with the runway,



TEARDROP PENETRATION	
INITIAL ALTITUDE	20,000
Time (Min)	8
Fuel (Lbs)	360
Distance (NM)	14

PROCEDURE TURN PENETRATION	
INITIAL ALTITUDE	20,000
Time (Min)	8
Fuel (Lbs)	400
Distance (NM)	14

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Figure 12-1. Typical Penetration

maintain 150 KIAS or computed approach speed, whichever is higher until on final approach. When on final approach, select the desired final flap setting and proceed with a normal landing. One of the following runway offset methods may be used (see Figure 12-2).

1. 270° method — The 270° method may be used when it is practical to cross the runway at 90° from the low-approach course of the aircraft. The runway is crossed at a 90° angle. Fly this heading for approximately 13 seconds, then make a standard-rate turn to the runway heading.

2. 45° method — The 45° method consists of a standard-rate turn to a heading 45° from the downwind heading for 40 seconds and then make a standard-rate turn to the runway heading.

3. 80° to 260° method — The 80° to 260° method consists of a standard-rate turn of 80° from the downwind heading, then rolling out of this turn and into a standard-rate turn to the runway heading.

4. Boxing runway method — Boxing the runway is basically a closed-traffic pattern made by flying down the runway, making a standard 180° turn, and then another 180° turn to the runway heading.

12.3 ICING CONDITIONS

Avoid icing conditions whenever possible. The biggest danger caused by ice accumulation is the reduced aerodynamic efficiency of the aircraft. Increased drag and diminished lift because of airfoil deformation and loss of thrust because of lowered propeller efficiency and engine power are typical results. Specifically, ice accumulation may have the following effects:

1. Increased lift-off speed and increased stalling speed. Higher take-off, landing, and minimum flight speeds are then required.

2. Reduced rate-of-climb ability of the aircraft.

3. Increase power requirement, causing increased fuel consumption and decreasing range and endurance.

4. Impaired control response.

5. Reduced engine power caused by obstruction of engine inlet air duct.

If cruise must be made in icing conditions, consideration must be given to the effect of using bleed air from the engines for anti-icing system. Use of bleed air for anti-icing will reduce speed, and thus range, for any power setting. Refer to NAVAIR 01-75GAI-1.1 Combined Performance Data Manual Figure 5-3 for cruise performance with anti-icing systems in operation. Meanwhile, it is recommended that altitude be changed, when possible, until icing no longer occurs. If climbing to a non-icing altitude is not possible, a check of fuel flow versus groundspeed should be made to determine if range or radius of action will complete the mission. Although the leading edge is capable of full evaporative, continuous anti-icing, it has been found more satisfactory to use the system exclusively as a deicing system by operating it periodically to remove accumulated ice. The empennage system is exclusively an anti-icing system. Operation in this manner presents no problem with "run-back". The aircraft can penetrate icing conditions if the procedure given below is followed:

1. Select the least severe altitude, from the standpoint of icing conditions, consistent with mission objectives and the traffic or combat conditions. Consider OAT, nature of clouds, type of icing (rime, clear) anticipated or being encountered, and the duration of icing.

Note

New radomes are manufactured without anti-icing capabilities. As old radomes are replaced, radome anti-icing will no longer be available. Monitor radar returns for degradation and climb or descend out of icing conditions as soon as possible.

2. Fly with the PROP & ENGINE ANTI-ICING MASTER switch in the AUTO position.

3. Place the PROPELLER ICE CONTROL switch in the ON position.

4. Place the ENGINE INLET DUCT ANTI-ICING switch in the ON position.

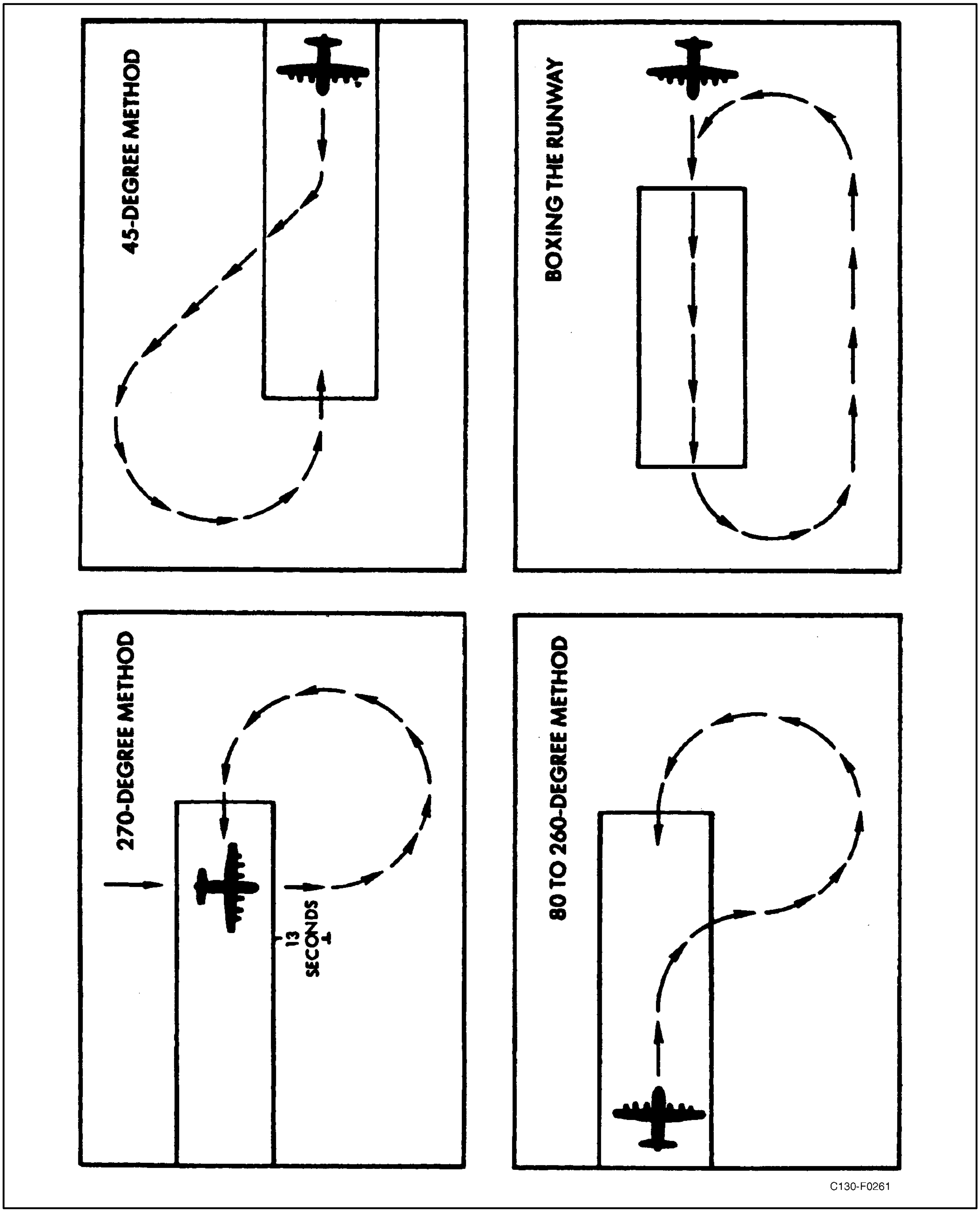


Figure 12-2. Circling-Approach Runway Offset Methods

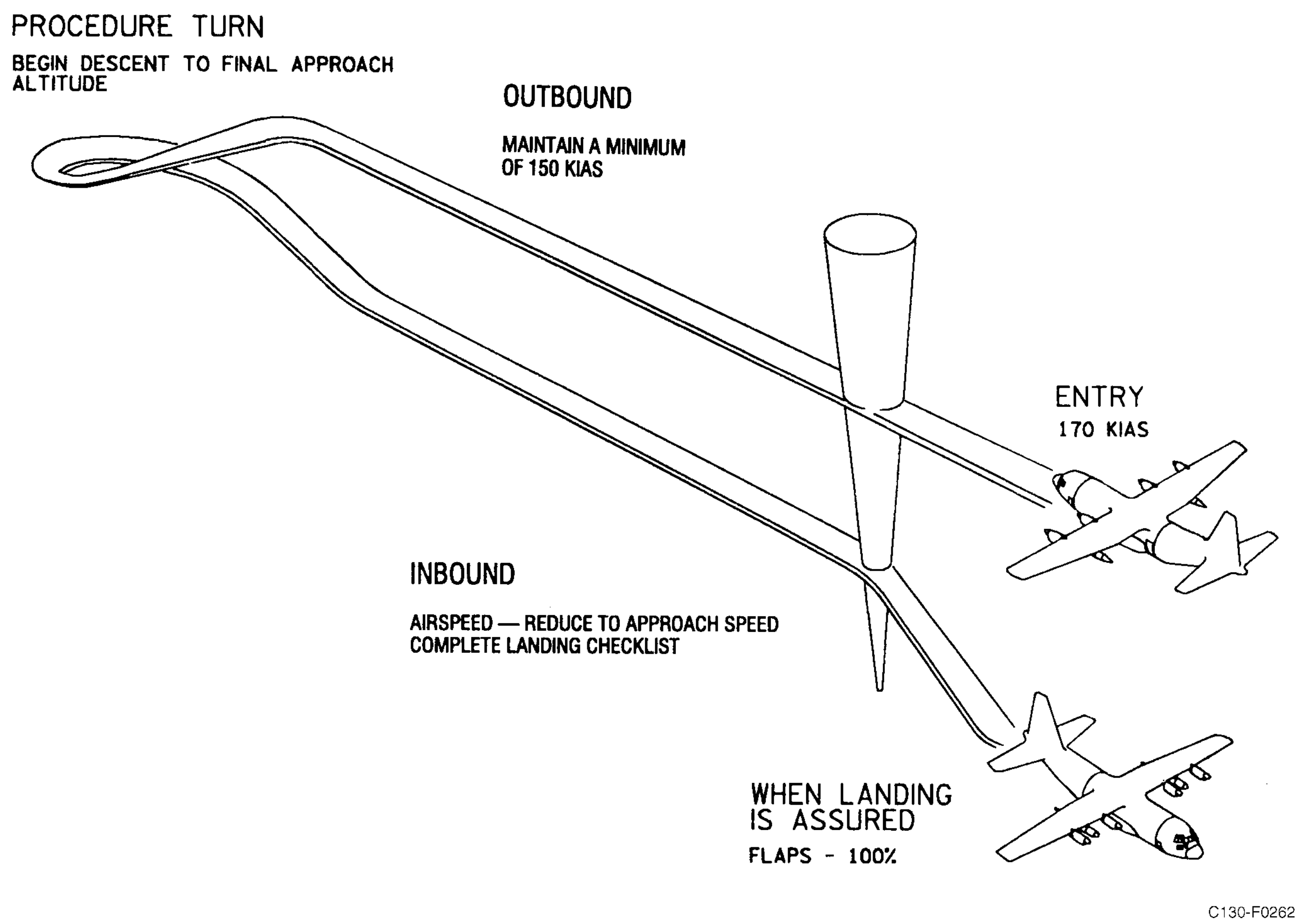


Figure 12-3. Typical Instrument Approach — Four or Three Engines — NDB, VOR, or Range Procedures

Note

When icing conditions are encountered, the anti-icing system for the above operates automatically, providing steps 2 through 5 have been accomplished. When the warning icing condition ON light is illuminated, make frequent visual checks of wing leading edges.

5. Deice the wing leading edges whenever the ice appears to be 3/8 to 3/4 of an inch thick, although little performance penalty has been noted when far heavier loads of ice have been allowed to build up. Deicing switches should be turned on until wing leading edges are clean, then turned off. This will normally require 20 seconds or less of on time. For the empennage, leave the switch on as an anti-icing system. The use of bleed air from only one or two engines is not recommended.

6. When icing conditions no longer exists, turn the PROP & ENG ANTI-ICING MASTER switch to the RESET position. When turned to the RESET position, all anti-icing systems except wing and empennage are turned off automatically. The WING and EMPENNAGE ANTI-ICING switches must be manually turned off.

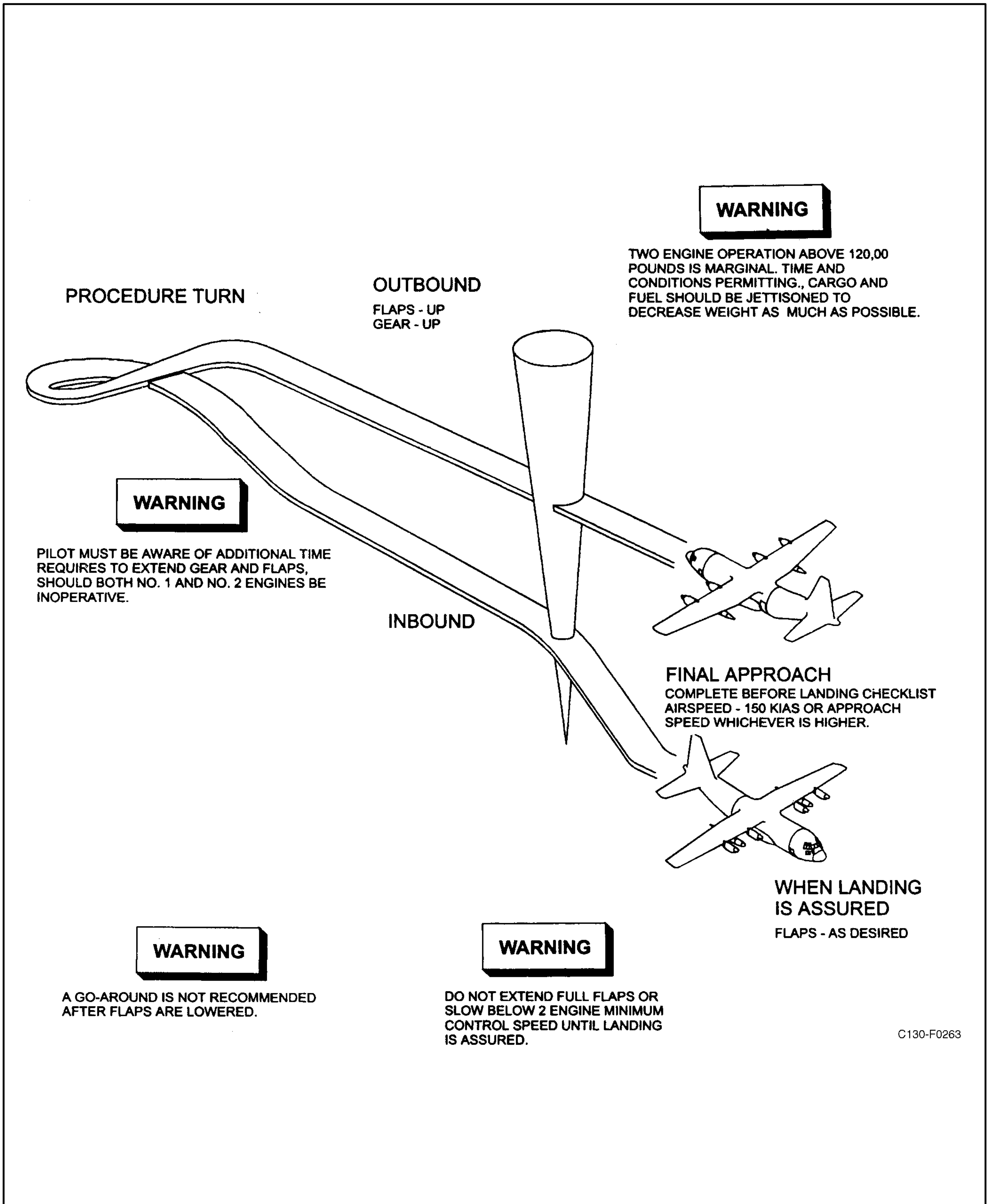


Figure 12-4. Typical Instrument Approach — Two Engines — NDB, VOR, or Range Procedures

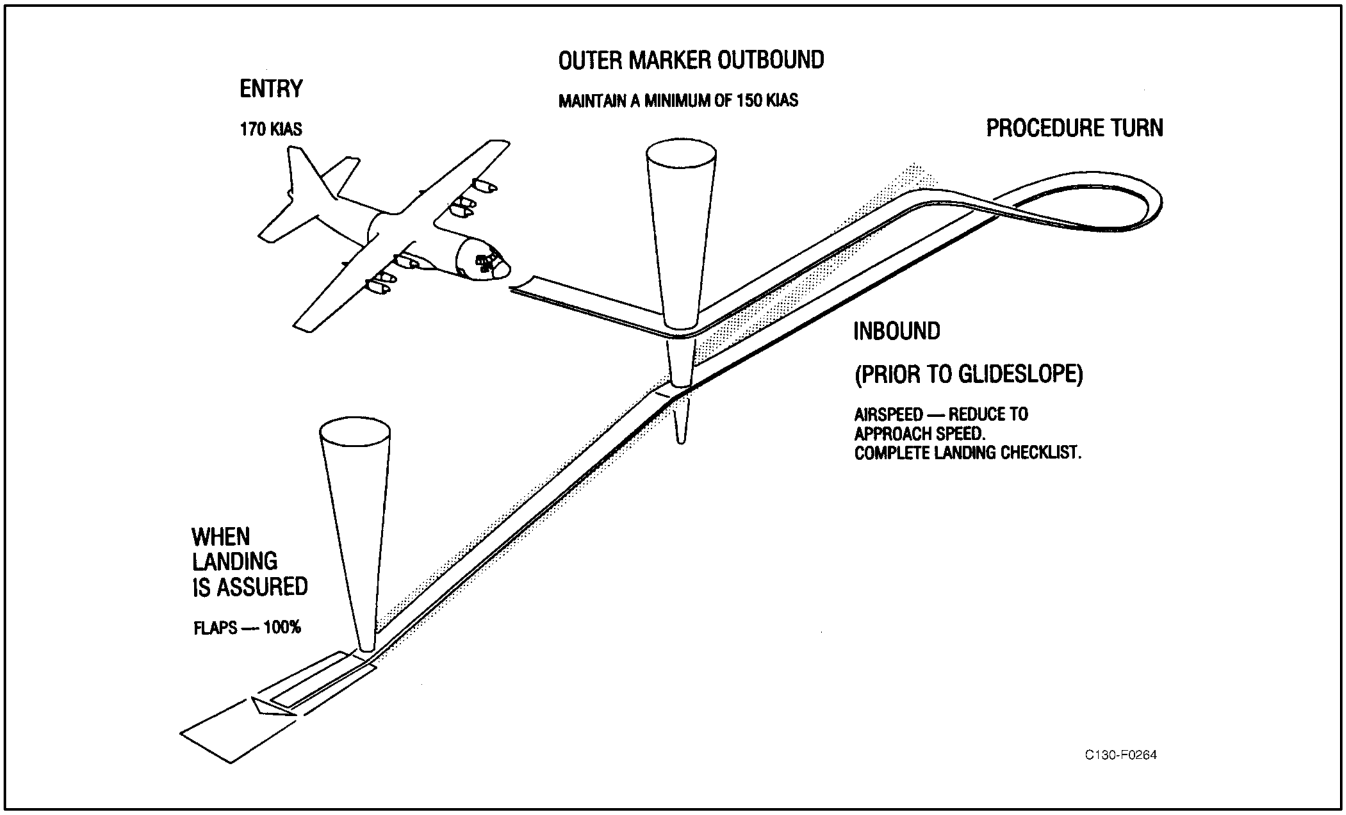


Figure 12-5. Typical ILS — Four or Three Engines

CAUTION

Avoid high angles of attack during periods of transition from icing to melting conditions and/or ice shedding for the center wing section. Maintain a straight and level flight-path until all ice has been shed from the center wing section. If ice is shed from the center wing section when the aircraft is at high angles of attack, it is very likely the shedding ice will strike the horizontal stabilizer and possibly cause extensive damage to the stabilizer leading edge.

7. Delay extension of flaps and landing gear until absolutely necessary. This will help to avoid excessive ice accumulation on the flaps and landing gear. While flying through icing conditions, watch the leading edge anti-icing current indicators to make certain that the anti-icing equipment is working properly. Make frequent visual checks of wing leading edges, engine inlet air duct leading edges, and propeller. If leading edge anti-icing/deicing is seen to be inadequate for preventing ice accumulation, seek a less severe icing level.

WARNING

If possible avoid prolonged flight in freezing rain, particularly at low airspeeds with corresponding higher angles of attack, as there is a possibility of ice accretion on the upper inside surface of the engine inlet air ducts and other areas that are not normally exposed and that are not anti-iced. Ice may accumulate on areas of the wing that are not anti-iced in quantities sufficient to cause loss of control.

12.3.1 Clear-Air Icing. Engine inlet air duct icing in clear air is possible in some combinations of temperature and humidity, depending on the engine power setting and the airspeed. This icing is caused by the sudden drop in temperature resulting from pressure loss in the engine inlet air duct. Such icing

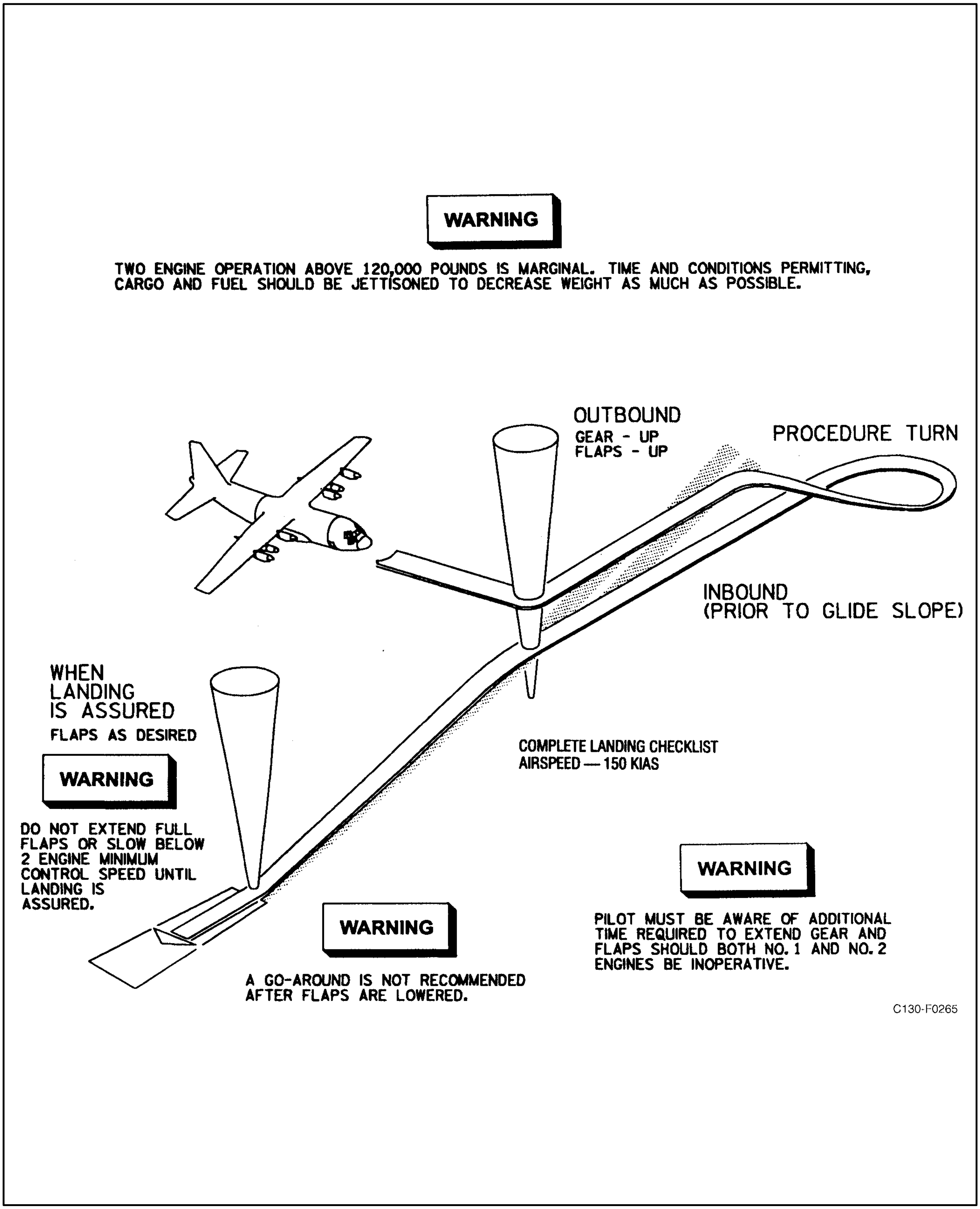


Figure 12-6. Typical ILS — Two Engines

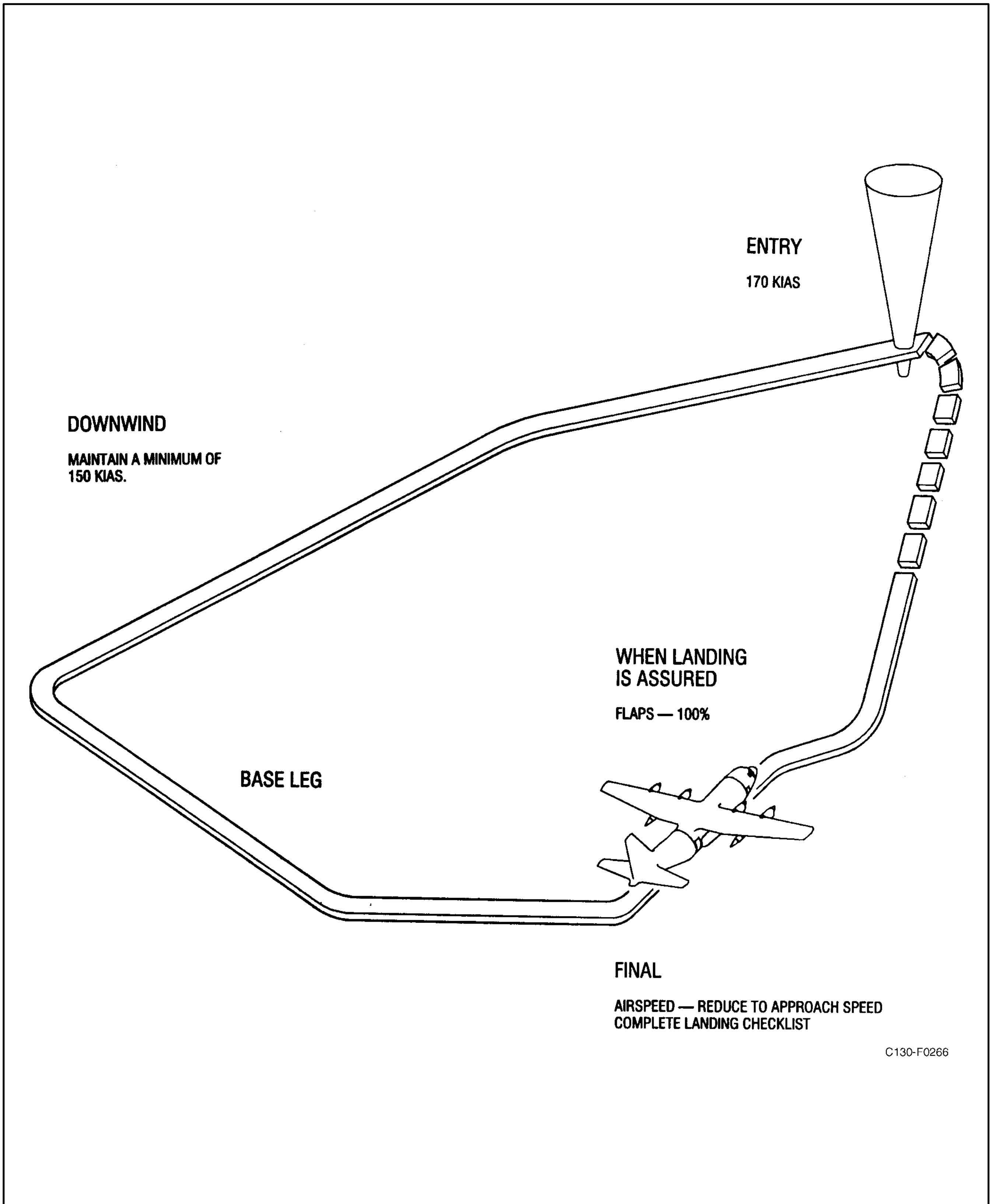


Figure 12-7. Typical Radar Approach Pattern — Four or Three Engines

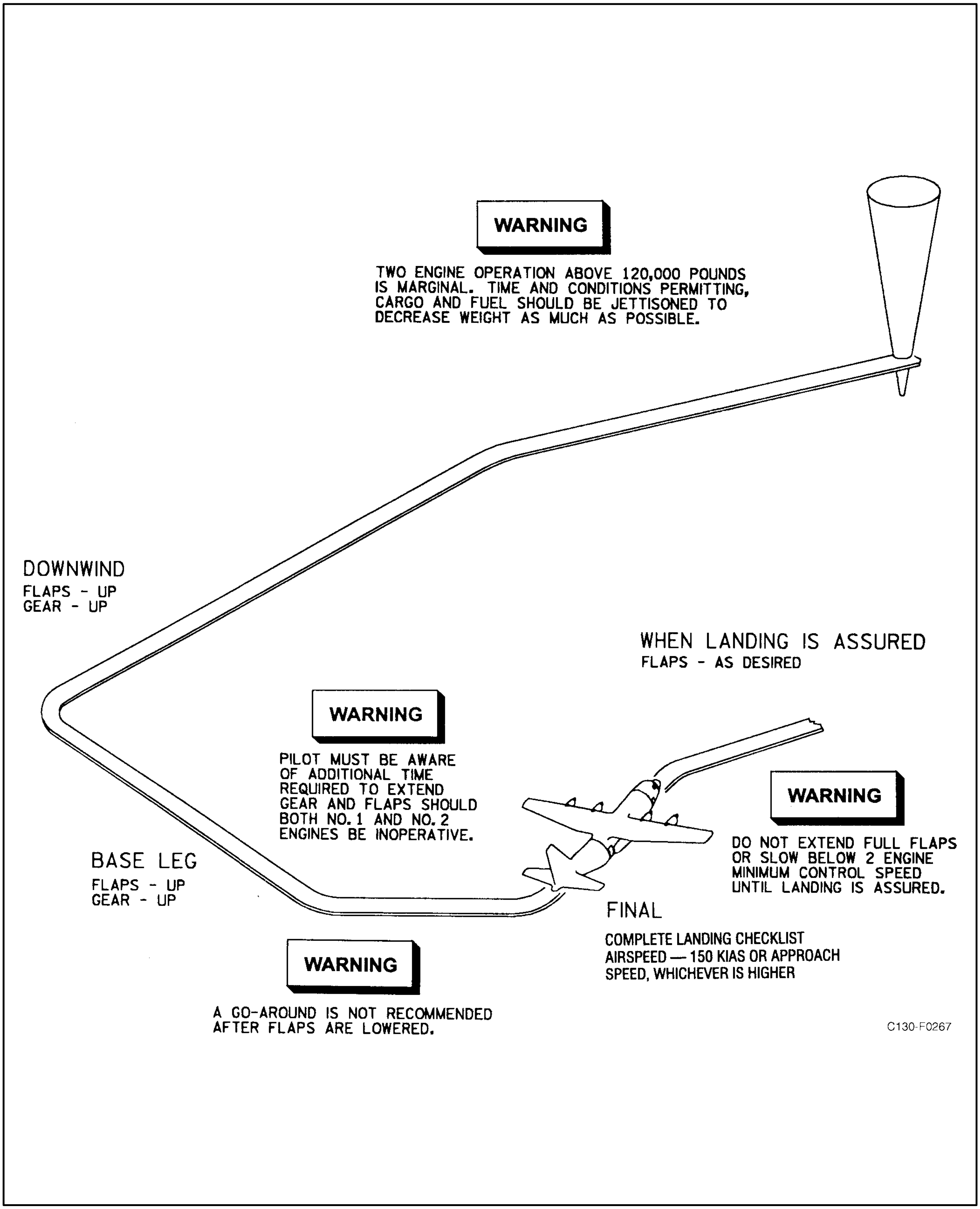


Figure 12-8. Typical Radar Approach Pattern — Two Engines

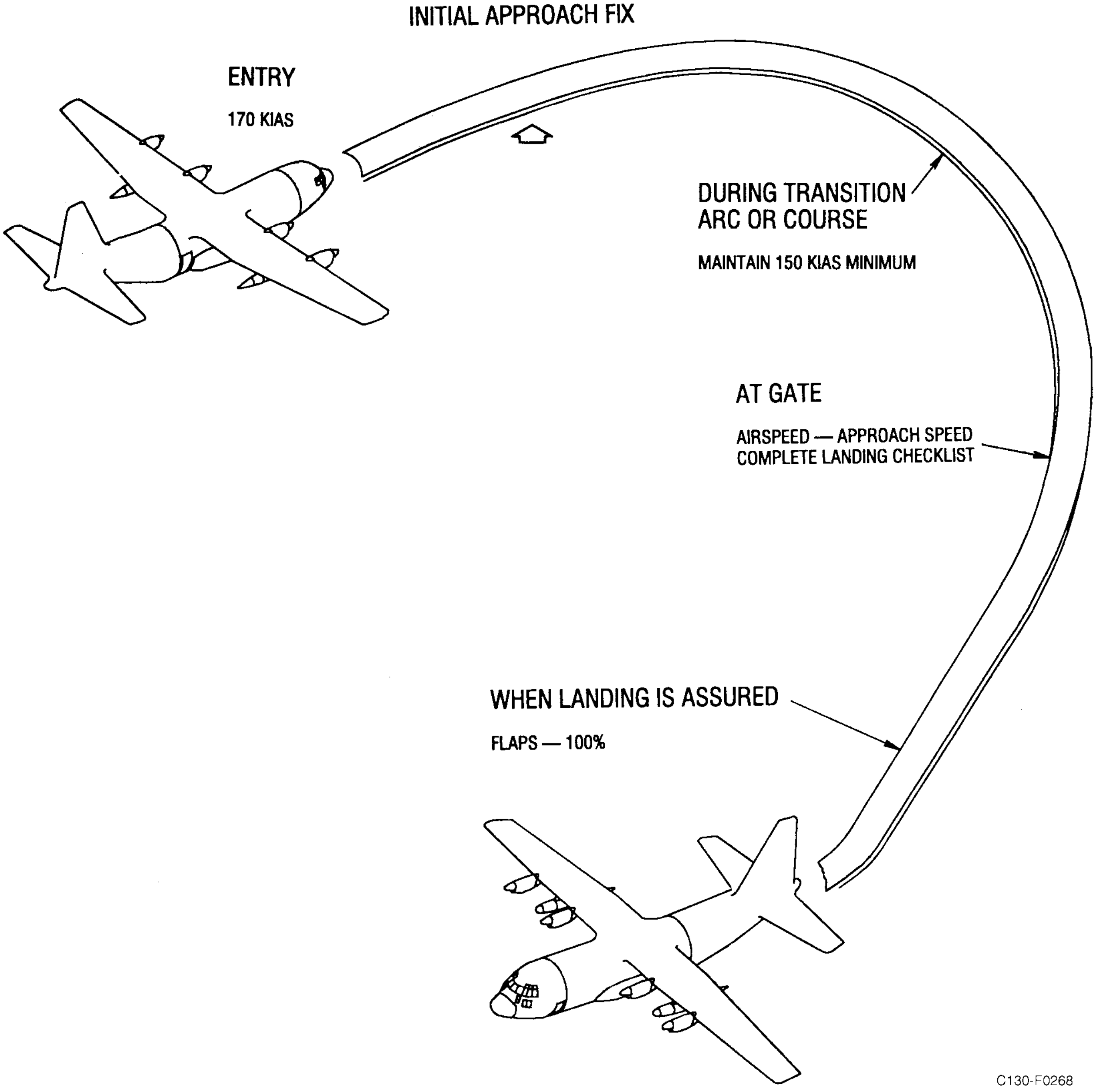


Figure 12-9. Typical Tacan Pattern — Four or Three Engines

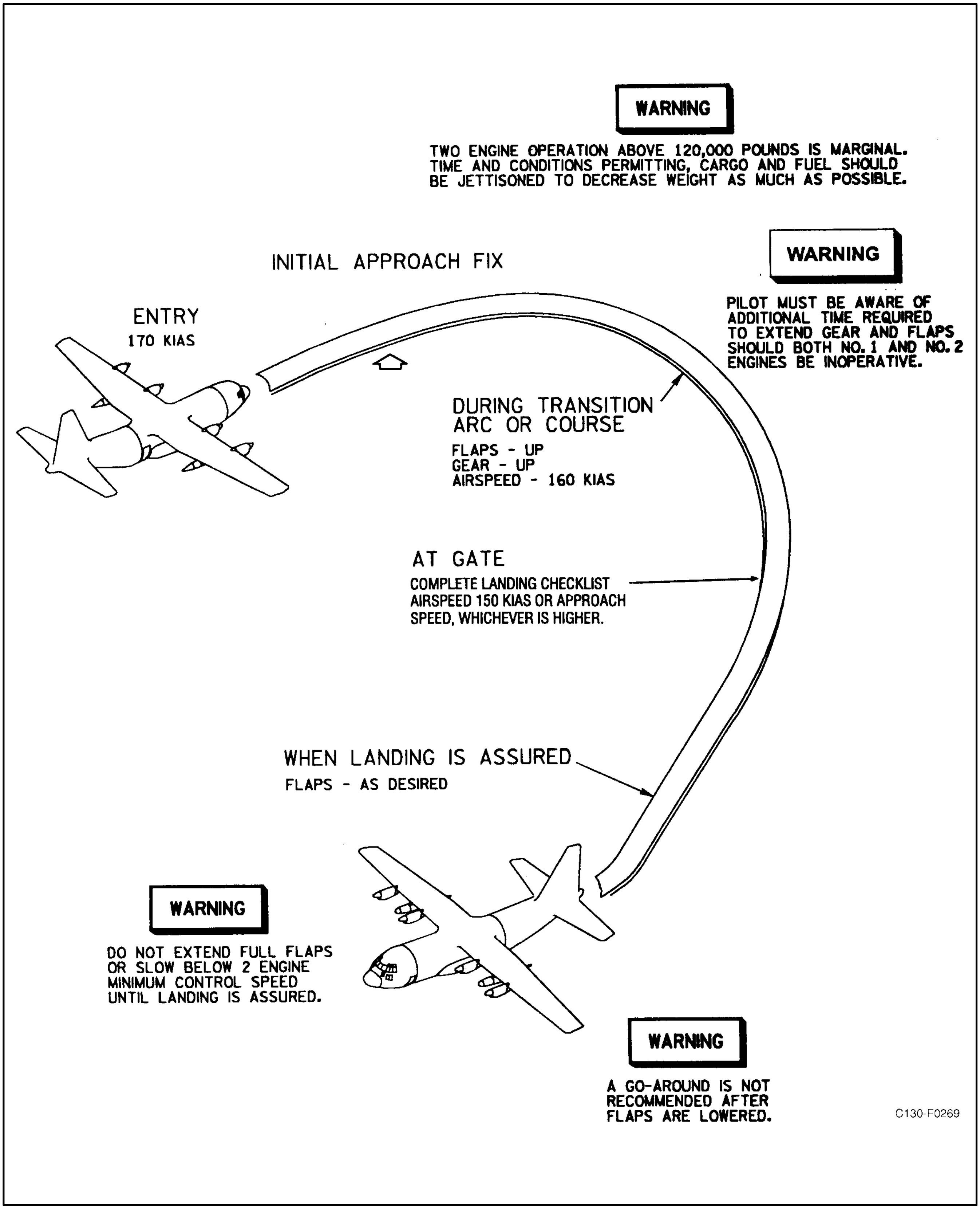


Figure 12-10. Typical Tacan Pattern — Two Engines

is indicated by a falling torquemeter indication. If torquemeter indication falls for no apparent reason, assume that engine inlet air duct icing is occurring. Turn the PROP & ENGINE ANTI-ICING MASTER switch to the MANUAL position, place the ENGINE INLET AIR DUCT ANTI-ICING switch in the ON position, and take the following action immediately.

1. Increase airspeed to the maximum consistent with continuous operation, to increase ram pressure in the air duct.

2. Seek an altitude that is less likely to produce air duct icing.

12.4 TURBULENCE AND THUNDERSTORMS

Rain has no appreciable aerodynamic effects on the aircraft. At cruise speeds, however, visibility through the windshields will be reduced by streaking as the windshield wipers are ineffective at speeds above approximately 180 KIAS.

Flying under conditions of extreme turbulence, such as through thunderstorms, must be avoided whenever possible. When flying under conditions of low visibility, clear passage around or between thunderstorms can usually be found with the navigation and search radar. The possibility remains, however, that a storm cannot be dodged or that flight through a storm may be a matter of military necessity.

WARNING

Flight through thunderstorms or other conditions of extreme turbulence should be avoided whenever possible.

Recommended airspeed for penetration into thunderstorms is 65 knots above power-off stall speed, not to exceed 180 KIAS.

Note

The autopilot may be used and, in some cases, is desirable. The altitude hold mode should be disengaged and the autopilot not assisted or overpowered in the autopilot mode. If autopilot cannot control attitude, disengage and fly manually.

12.5 COLD-WEATHER PROCEDURES

Extreme cold causes general bad effects on aircraft materials. Rubber, plastic, and fabric materials stiffen and may crack, craze, or even shatter when loads are applied. Oils and lubricants congeal. Adjoining metals contract differentially and could result in adverse variations in tolerances. Moisture, usually from condensation or melted ice, freezes in critical areas. Tire, landing gear strut, fire extinguisher bottle, and accumulator air pressures decrease with a temperature decrease. Extreme diligence on the part of both groundcrews and flightcrews is required to ensure successful cold-weather operation. The procedures and precautions outlined here pertain to operating unhangared aircraft in cold weather and are in addition to the normal procedures given in Part III.

Note

Arrange the preheating period, whether by portable ground heaters or the APU, so that aircraft components will be warmed and inspected prior to starting the engines.

12.5.1 Before Entering the Aircraft. Perform a normal preflight inspection of the aircraft as outlined in paragraph 8.2. In particular, check the following:

1. Check for removal of all exterior protective covers and shields.

2. Check for ice, snow, heavy frost, and any remaining moisture from the entire aircraft.

WARNING

Do not attempt takeoff with ice, snow, or frost on the wings or empennage. The roughness caused by ice and snow on the surfaces varies the airfoil shape with a resulting loss of efficiency. Takeoff run is increased, and rate of climb is decreased. Stall speed is increased, and stall characteristics are unpredictable.

CAUTION

- Ensure that moisture from melted ice is not allowed to remain in critical areas where it may refreeze.
- Do not attempt to scrape or chip ice from flight surfaces or fuselage. Exercise care to prevent personnel injury from slipping and falling.

Note

If anti-icing compound has not been used on the crew door telescoping rod, frozen condensation may prevent full opening until the rod is heated.

3. Check that fuel tank vents, fuel drains, filters, static ports, and pitot tubes are free of ice and snow.
4. Check for proper inflation of landing gear struts, tires, and hydraulic accumulators.
5. Check that landing gear strut extensions have been wiped with a hydraulic-fluid-soaked cloth to remove ice and dirt.
6. Check that a warm, well-charged battery has been installed.
7. Check that dry bays are free of hydraulic fluid and fuel seepage.

12.5.2 Before Starting Engines. In addition to the normal procedures outlined in paragraph 8.4, perform the following checks:

1. If isopropyl alcohol has been used to remove frost from the aircraft, check the interior of the aircraft for alcohol leaks and fumes. This condition may create a fire hazard.

WARNING

During the application of deicing fluid, the APU and air-conditioning units should be shut down and all doors and hatches closed. Deicing fluid or mist can enter the APU inlet. The resulting fumes entering the aircraft through the bleed-air system are toxic and an extreme eye and lung irritant.

2. If external ac power is available, energize the Nesa windshields. Bring temperature up gradually to prevent cracking glass. As ice and frost begin to melt, operate the windshield wipers to help clear the windshield. Other windows may be cleared by portable ground heaters.

Note

Either portable ground heaters or the APU may be used to heat the interior of the aircraft during the interior inspection. In extreme cold weather, it may be necessary to preheat the APU before it can be started. During starting, torching may be observed. After start, allow approximately 4 minutes warm-up before applying load.

3. After the APU is started and warmed up, check operation of the emergency brake system. Operate brake pedals with light pressure several times before locking the parking brake. Have an inspection made of each main wheel for evidence of hydraulic leakage after full pressure has been applied to the brake pedals. Seeps and moderate leaks caused by hardened O-rings can often be stopped by direct application of hot air from a ground heater for a few minutes.

CAUTION

- Do not attempt to taxi if evidence of hydraulic leakage is found in any main landing gear area. Danger of fire and loss of brakes exists when hydraulic fluid contacts hot brakes.
- Do not statically change the blade angle of a propeller that has been exposed to prolonged temperatures of 0 °C (32 °F) or below. Warm the propeller hub oil by using warm air or by running the engine at ground idle until engine oil temperature is within 60 to 80 °C. Propeller blade seal damage and oil leakage may occur if this is not observed.

CAUTION

Nacelle preheat (if installed) should be used only when the ambient temperature is below 0 °F and only when necessary to remove frost or ice from equipment in the nacelle or facilitate engine starting. The bleed air for nacelle preheating is at approximately 600 °F when supplied by the engine or 400 °F when supplied by the APU. Air at this temperature can quickly bake electrical cables and damage electronic components in the nacelle. Closely monitor the nacelle overheat warning light. If it illuminates, place the NACELLE PREHEAT switch to the OFF position.

4. Before starting engines, remove all ground heater ducts from the aircraft.

5. In extreme low temperatures, the crew door seals may stiffen, thus making it impossible to close the door from inside the aircraft. When groundcrewmen are not available to assist in closing this door, it may be necessary to have one or more flightcrewmembers assist in closing the door from outside, and then enter the aircraft through one of the paratroop doors.

12.5.3 Starting Engines. Start the engines by following the procedures in paragraph 8.5.

CAUTION

When attempting a start with JP-5/JP-8 and kerosene-type fuels at ambient temperatures below approximately –32 °C (–25 °F) the TIT and rpm should be closely monitored since stall and overtemperature may be experienced during the start.

12.5.4 Before Taxi. If not already accomplished with external power, energize the Nesa windshields, bringing temperature up gradually to prevent cracking the glass. As ice and frost begin to melt, operate the windshield wipers to help clear the windshield. Other windows may be cleared by airblast from the defogging ducts.

CAUTION

Do not overheat anti-icing systems on the ground. Do not operate propeller anti-icing and deicing systems unless engines are running.

Note

During extremely low temperatures, refer to Operation of Windshield Anti-Icing System in Part III.

12.5.5 Taxiing Instructions. At the start of taxiing on snow or ice, visually check the landing gear to assure that the wheels are rotating. The combination of increased engine power at low temperatures and slippery ramp surfaces because of ice and snow require that utmost caution be used during taxiing operations. Ground-handling characteristics of the aircraft on loose or compacted snow at temperatures below 0 °F are good and braking action is fair to good. However, as temperatures rise toward freezing, snow-covered surfaces become more slippery and increasing caution must be exercised. Use of antiskid is recommended during all taxiing in cold weather.

WARNING

In cold weather, make sure all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments during taxiing.

CAUTION

Nosewheel steering becomes ineffective when abrupt turns are attempted on slippery surfaces. Use nosewheel steering, differential braking, and differential power for best directional control. Maintain safe taxi speeds by use of brakes and partial application of reverse thrust. Excessive reverse thrust will cause loss of visibility when taxiing over loose snow.

When operating on snow or slushy surfaces, use Nesa and pitot heat prior to and during propeller reversing.

12.5.6 Ground Tests. Select the area that has the best available surface for braking and conduct the engine and propeller checks outlined in Part III. Avoid parking aircraft close together or near obstructions when performing ground tests.

Note

Surfaces covered with loose snow generally provide better braking than surfaces covered with compacted snow.

A modification of normal procedures may be required when making runup on slippery surfaces. Engines and propellers may be checked in symmetrical pairs while using reverse thrust on the other pair to prevent the aircraft from sliding forward. When runup must be conducted on snow-covered surfaces, do not attempt to make full power checks until the aircraft is lined up on the runway and ready for takeoff.

12.5.7 Takeoff. If the aircraft starts to slide before takeoff power is reached, release the brakes and begin the takeoff run. Continue the power check during the early part of the run.

CAUTION

Under low ambient temperature conditions, never place throttles in the TAKEOFF position without monitoring the torquemeters. At these temperatures, it is possible to exceed maximum allowable torque without exceeding the maximum allowable TIT. In addition, increasing ram effect during the takeoff will increase torque for any fixed TIT. This means either that torque must be set below the maximum allowable when setting power for takeoff or that power must be reduced as airspeed builds up.

After takeoff from slushy runways, cycle the landing gear to reduce the possibility of doors freezing in the closed position.

Note

During operation of the propeller anti-icing system, there is a possibility that an indicator "jitter" may occur in the TIT indicators, the torquemeters, tachometers, and fuel flow gauges. This needle "jitter" may make monitoring the affected instruments difficult. If this condition occurs, momentarily turn the PROP & ENGINE ANTI-ICING MASTER switch to RESET; then read the indicators.

12.5.8 Landing. Make a normal pattern and landing as outlined in Part III. Use nosewheel steering gently. Use reverse thrust during the early part of the landing roll. As forward speed decreases, decrease reverse power. If reverse thrust is used at slow speeds on snow- or slush-covered surfaces, complete loss of visibility may occur. Use Nesa and pitot heat during landing and be prepared to turn on windshield wipers.

Note

During use of maximum braking on slippery surfaces, cycling of the antiskid system will be felt on the brake pedals.

12.5.9 Landing on Icy Runways. Refer to Landing on Icy Runways, paragraph 8.15.11.

12.5.10 Stopping Engines. Make a normal engine shutdown, as outlined in paragraph 8.18.

12.5.11 Before Leaving the Aircraft. Perform normal Before Leaving the Aircraft Checklist, as outlined in paragraph 8.19, and the following steps:

1. Remove ice and dirt from shock struts.
2. Install all exterior protective covers and shields.
3. If the aircraft is to remain outside more than 4 hours at temperatures below –29 °C (–20 °F), remove the batteries and store them in a heated area.
4. Close all doors and hatches.

12.6 HOT-WEATHER PROCEDURES

Hot-weather operation, as distinguished from desert operation, generally means operation in a hot, humid atmosphere. High humidity usually results in the condensation of moisture throughout the aircraft. Possible results include malfunctioning of electrical equipment, fogging of instruments, rusting of steel parts, and the growth of fungi in vital areas of the aircraft. Further results may be pollution of lubricants and hydraulic fluids and deterioration of nonmetallic materials. The procedures essential to operation and maintenance under such conditions are given in the following paragraphs.

12.6.1 Before Entering the Aircraft. Perform a normal preflight inspection as outlined in paragraph 8.2. Give special attention to the following:

1. Cool the flight station and special equipment compartments with portable coolers, if available.

2. Inspect for freedom of corrosion or fungus at joints, hinge points, and similar locations.

3. Check for hydraulic leaks, as heat and moisture may cause seals and packings to swell.

4. Inspect the shock struts for cleanliness.

5. Inspect tires for proper inflation.

6. Remove all protective covers and shields.

12.6.2 Before Starting Engines. Continue the normal preflight inspection, as outlined in paragraph 8.2. Give special attention to the following:

1. If instruments, equipment, and controls are moisture coated, wipe them dry with a clean, soft cloth.

12.6.3 Taxiing Instructions. Taxi the aircraft as directed in paragraph 8.7. Use brakes as little as possible, to avoid overheating.

CAUTION

To preclude the possibility of ongoing bog down/flameout when operating in high ambient temperatures, turn off the oil cooler augmentation prior to shifting from normal to low-speed ground idle or from low-speed to normal ground idle.

12.6.4 Takeoff. Execute normal takeoff and climb, as outlined in paragraphs 8.9 and 8.10.

Note

Takeoff run is considerably increased, and rate of climb decreased, in high temperatures. Refer to the appropriate performance charts.

12.6.5 Cruise. Follow normal procedures for the operation of the aircraft, as outlined in Chapter 8.

Note

Fuel densities will decrease as the ambient temperature rises, resulting in a decrease in operating range. In addition, the boiloff rate will increase, and it may be necessary to restrict rate of climb of the aircraft at altitude. Refer to Fuel in Part I.

12.6.6 Landing. Execute normal approach and landing, as outlined in paragraphs 8.13, 8.14, and 8.15. Make a normal engine shutdown as outlined in paragraph 8.18. As soon as the aircraft is parked, chock wheels and release brakes in order to avoid possible damage to brake components from excessive heat generated when taxiing.

12.6.7 Before Leaving the Aircraft. Make a normal postflight inspection as outlined in paragraph 8.19 and complete the following steps:

1. Have appropriate protective covers installed for protection from the sun.

2. When weather conditions permit, leave flight station windows and compartment doors open to ventilate the aircraft.

12.7 DESERT PROCEDURES

Desert operation generally means operation in a very hot, dry, dusty, often windy atmosphere. Under such conditions, sand and dust will often be found in vital areas of the aircraft, such as hinge points, bearings, landing gear shock struts, and engine cowling and intakes. Severe damage to the affected parts may be caused by the dust and sand. Position the aircraft so that propwash will not expose other aircraft, personnel, and ground equipment to blown sand or dust. The necessary operations under such conditions are given in the following paragraphs.

12.7.1 Before Entering the Aircraft. Perform a normal preflight inspection as outlined in paragraph 8.2. Give special attention to the following:

1. Cool the flight station and special equipment compartments with portable coolers, if available.

Note

Use of the APU for ground air-conditioning may pull in quantities of sand and dust.

2. Inspect all control surface hinge and actuating linkage for freedom of sand and dust.

3. Inspect tires for proper inflation.

4. Inspect shock struts for cleanliness.

5. Remove all protective covers and shields.

12.7.2 Before Starting Engines. Continue the normal preflight inspection of the aircraft, as outlined in paragraph 8.2. Give special attention to the following:

1. Inspect instrument panels, switches, and controls for freedom of sand and dust.

2. Operate all controls through at least two full cycles to ensure unrestricted operation.

12.7.3 Taxiing Instructions. Taxi the aircraft as directed in paragraph 8.7, using care to avoid blowing sand or dust on other aircraft, personnel, or equipment. Use brakes as little as possible to prevent overheating. The use of reverse thrust may blow sand and dust into the air directly in front of the engine intakes. In deep sand, use differential power, rather than nosewheel steering, for directional control. Minimize ground operation to avoid excessive sand and dust intake by the engines.

12.7.4 Takeoff. Execute normal takeoff and climb as outlined in paragraphs 8.9 and 8.10. Avoid takeoff during sand or dust storms, if possible. Sand and dust will cause damage to internal engine parts. Takeoff run is considerably increased and rate of climb decreased in high atmospheric temperatures. Refer to the appropriate performance charts.

Note

When takeoff performance is not critical, use a rolling takeoff whenever possible in order to decrease time in adverse conditions.

12.7.5 Cruise. Follow normal procedures for the operation of the aircraft, as outlined in Part III. Avoid flying through dust or sand storms, when possible. Excessive dust and grit in the air will cause considerable damage to internal engine parts.

12.7.6 Landing. Execute a normal approach and landing as outlined in Part III. Therefore, on very hot days, follow traffic and landing procedures strictly and anticipate a longer landing roll. Avoid the use of reverse thrust, since reverse thrust may blow sand and dust into the air directly in front of the engine intakes.

12.7.7 Stopping Engines. Make normal engine shutdown as outlined in Part III. As soon as the aircraft is parked, chock the wheels and release the brakes to avoid damage to brake components because of excessive heat generated while taxiing.

12.7.8 Before Leaving the Aircraft. Make a normal Before Leaving the Aircraft inspection, as outlined in Part III, giving special attention to the following:

1. Have all protective covers and shields installed.

2. Except in dust or rainy weather, leave flight station windows and compartment doors open to ventilate the aircraft.

PART VII

Communication Procedures

CHAPTER 13

Communication Procedures

13.1 INTRODUCTION

The primary means of communications in the aircraft is voice radio. It is, of course, limited by the condition of the equipment, frequencies and channels available, and operating conditions. Radio equipment carried on the aircraft is described in detail in Chapter 2. It is essential that all pilots know and understand the use of the equipment. Operation of the equipment will be in accordance with current applicable directives, depending on the type of flight and the area in which the flight will be conducted. Communication procedures are outlined in Federal Aviation Regulations, FLIP Publications, Flight Information Manual, ICAO Regulations, Air Traffic Control Procedures, OPNAV Instructions, and ACP and JANAP publications.

13.2 RADIO COMMUNICATIONS

The aircraft commander is responsible for all communications transmitted from the aircraft and shall ensure compliance with all procedures to which reference is made in this action. The aircraft commander is responsible for a continuous watch to be maintained on appropriate radio frequencies, and that position reporting procedures and requirements outlined in appropriate directives, or as required by the agency controlling the flight, are complied with.

13.3 VISUAL SIGNALS

The aircraft is equipped with an Aldis lamp to transmit visual signals. The running lights and landing lights may be used as signals by utilizing the on-off switches.

13.4 LOST COMMUNICATION AND EMERGENCY COMMUNICATION PROCEDURES

Emergency situations are so varied that exact rules to be followed cannot be established for each situation. However, when an emergency is encountered in a flight condition, the pilot is expected to act in accordance with the procedures set down in the aforementioned referenced manuals.

PART VIII

Special Missions

CHAPTER 14

Special Missions

14.1 FORMATION FLYING

Formation flying in this aircraft is similar to formation flying in any other aircraft; however, you must recognize the restrictions inherent because of the aircraft size and weight. Figure 14-1 depicts standard formation wing position.

14.1.1 Tactical Formation Procedures

14.1.1.1 Formation Taxiing. Formation taxiing will be accomplished utilizing four engines prior to takeoff and after landing. Taxiing distance between the tail of the preceding aircraft and the nose of following aircraft will be two aircraft lengths.

14.1.1.2 Runway Positioning. When hard-surface runways permit, one section of aircraft may be positioned on the runway simultaneously. When gravel, dust, or loose debris is prevalent, aircraft will be fed individually onto the runway. Aircraft will alternate positioning on the sides of the runway, remaining two aircraft lengths behind the preceding aircraft on the same side. This separation is applicable to "section positioning" as well as to feeding onto runway. Normally, a section will position on the runway simultaneously. In the event runway conditions warrant feeding single aircraft onto the runway, a determination to this effect will be made by the mission commander and will be adequately covered at mission briefing.

14.1.1.3 Takeoff. Takeoff interval should not be less than 30 seconds if dual runways are used, or 1 minute if a single runway is used, provided the aircraft ahead has completed its takeoff roll and commenced its climb.

14.1.1.4 Joinup After Takeoff. Joinup after takeoff shall be accomplished on a prebriefed assembly heading or track. After taking off and commencing a climb, the flight leader shall reduce power and establish climb speed as briefed, consistent with mission requirements. This climb power and airspeed should be held until completion of the formation joinup. Joining aircraft should use power as necessary to accomplish the joinup expeditiously, joining in their respective en route positions. The last aircraft to join up should call the flight leader when in position, and the flight leader may then add power as necessary to complete the climb, using climb-schedule airspeeds. The end-of-climb speed should be modified to suit the heaviest aircraft gross weight.

14.1.1.5 Joinup Over a Geographical Point. Joinup over a geographical point shall be accomplished at a prebriefed altitude and airspeed, the formation leader holding 170 KIAS. Normally, the rendezvous can best be accomplished in a gentle orbit to allow joining aircraft the advantage of relative motion in addition to airspeed. Departure on course may be commenced at the discretion of the flight leader, maintaining reduced airspeed until joinup is complete.

14.1.1.6 Climb. Climb under VFR conditions as outlined in the paragraph above. Under IFR conditions, an individual takeoff and climb, utilizing departure control, should be made. After becoming VFR on top, the flight leader should reduce power and hold a prebriefed heading or proceed to a prebriefed fix for the rendezvous. The interval between aircraft should be the minimum allowed by departure control. One-minute separation will provide adequate lateral and altitude separation to satisfy the dictates of flight safety.

14.1.1.7 En Route Procedures. The basic en route formation is a division made up of two independent sections. The second section is free to cruise on either side of the formation leader, with sufficient separation to allow use of the autopilot as a measure to reduce crew fatigue. The sections themselves may spread out in the same manner. In the event that penetration of weather becomes necessary (see Figure 14-2), the following procedures shall be used and should be accomplished prior to entering IFR conditions. It is the responsibility of the flight leader to

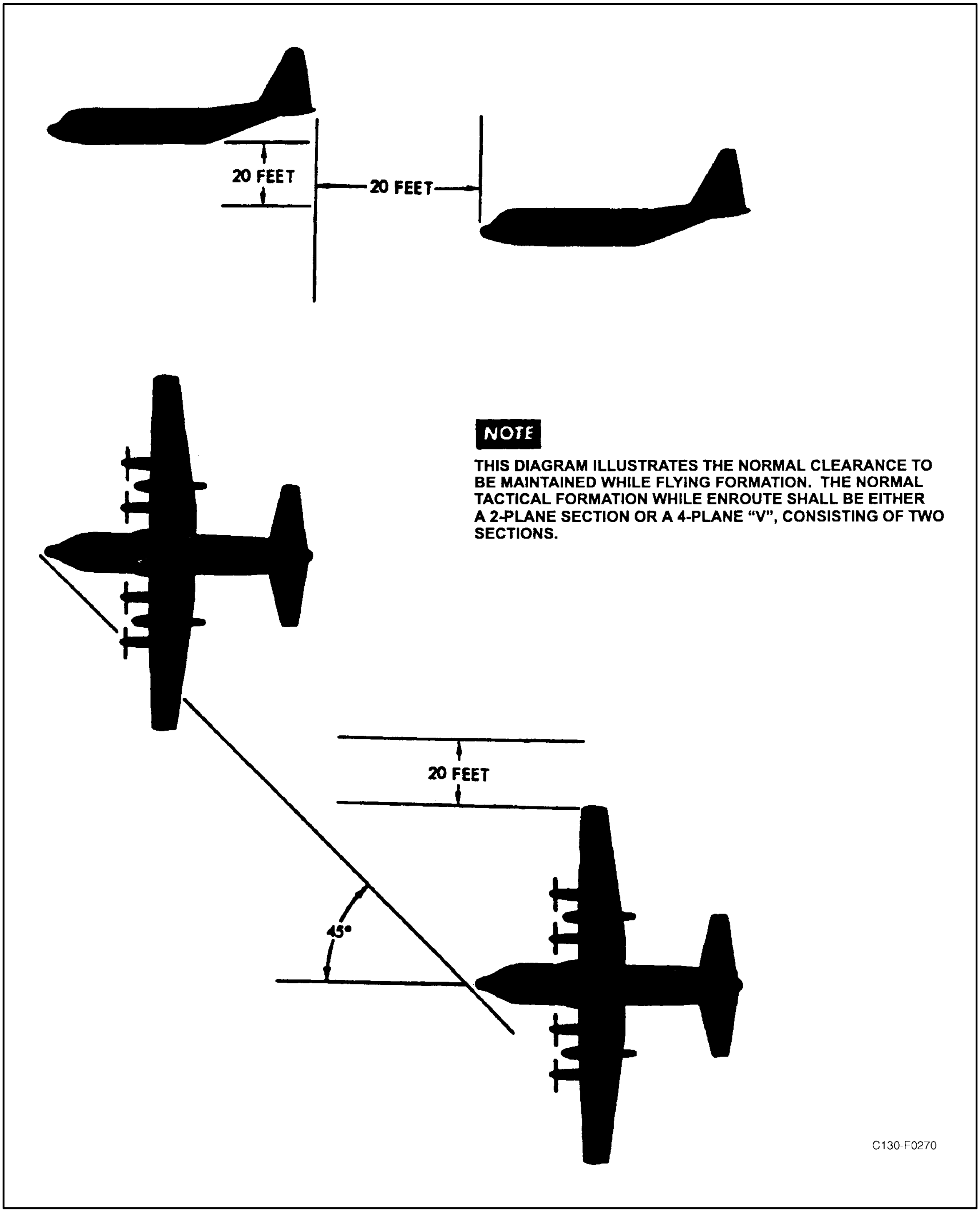
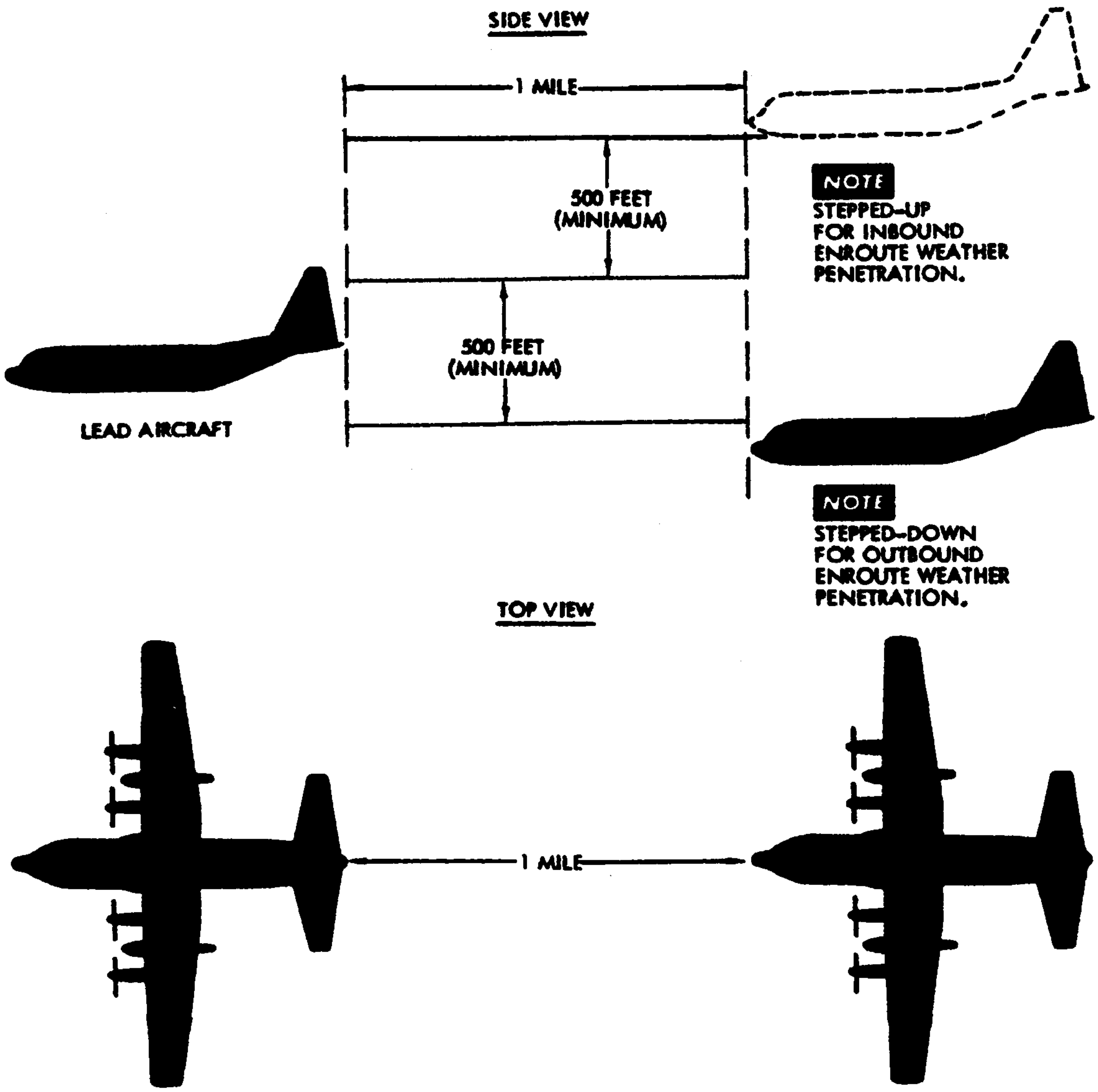


Figure 14-1. Formation Flying — Normal Wing Position



NOTE

1. WHEN AN OUTBOUND ENROUTE WEATHER PENETRATION IS ANTICIPATED, THE FORMATION COMMANDER SHALL DIRECT THE FORMATION INTO A TRAIL (STEPPED-DOWN-) WITH ONE-MILE INTERVAL BETWEEN AIRCRAFT, UTILIZING AIR-TO-AIR TACAN AND RADAR.
2. THE FORMATION COMMANDER SHALL ASSIGN INDIVIDUAL AIRCRAFT ALTITUDES USING MAXIMUM SEPARATION COMPATIBLE WITH BLOCK ALTITUDE ASSIGNMENTS. MINIMUM VERTICAL SEPARATION BETWEEN AIRCRAFT SHALL BE 500 FEET.
3. INDIVIDUAL AIRCRAFT COMMANDERS SHALL ACKNOWLEDGE ALTITUDE ASSIGNMENTS AND REPORT IN POSITION AT ASSIGNED ALTITUDES.
4. THE NUMBER ONE (LEAD) AIRCRAFT COMMANDER SHALL REPORT ALL HEADINGS AND TRUE AIRSPEED CHANGES AND RECEIVE ACKNOWLEDGEMENT FROM INDIVIDUAL AIRCRAFT IN FORMATION.
5. WHEN AN INBOUND WEATHER PENETRATION IS ANTICIPATED, FORMATION COMMANDER SHALL DIRECT THE FORMATION INTO TRAIL (STEPPED-UP) WITH ONE-MILE INTERVAL BETWEEN AIRCRAFT, UTILIZING AIR-TO-AIR TACAN AND RADAR, FOLLOWING PROCEDURES SET FORTH IN STEPS 2, 3, AND 4 ABOVE. A STEPPED-UP TRAIL FORMATION IS DESIRABLE APPROACHING DESTINATION TO FACILITATE INDIVIDUAL INSTRUMENT APPROACHES.

C130-F0271

Figure 14-2. En Route Weather Penetration obtain clearance from the appropriate controlling agency prior to commencing breakup to weather penetration formation. A base-altitude airspeed and heading must be established by the formation leader and rigidly adhered to by the wingmen to provide separation as necessary. The radar of the last aircraft in the formation should be utilized to keep track of the formation while IFR. After passing through weather and becoming VFR, the flight leader should reduce to 170 knots until assembly is complete. The other aircraft should add power to climb or descend to base altitude and accomplish the rendezvous as rapidly as possible on the base heading.

14.1.1.8 Descent. VFR descent may be made in any formation deemed necessary by the flight leader. The flight leader should exercise care not to reduce power to the point that a wing position becomes difficult or impossible to hold. About 3,000 inch-pounds of torque is the minimum power setting to allow wingmen to maintain position without radical throttle and/or control movements. IFR descents must be made on an individual basis, and it is the responsibility of the flight leader to obtain clearances for the aircraft in the flight and to place the formation in trail to allow safe individual departures from the formation when under approach control.

14.1.1.9 Break and Landing. Break and landing shall be accomplished from an echelon, utilizing a 10-second break interval and a 30-second landing interval.

14.1.1.10 Formation Techniques. Formation procedures suitable for fighter aircraft are readily adaptable to this aircraft. It is normally easier to fly on the starboard side of the leader because of cockpit construction and visibility restrictions. En route, the autopilot may be easily used to maintain formation position. It should be engaged when steady in position, and minor changes of power or heading should be made as necessary. Normally, when en route and flying on autopilot, it is more comfortable to move out from a normal wing position to a three- to four-wing span distance.

Note

Close formation flying should be held to a minimum to reduce effects of thermal shock on turbines because of constant power lever movement.

14.1.1.11 Formation Lighting. During day formation flights, all aircraft in the formation shall have their top and bottom anti-collision/strobe on. The lights for night formation are as shown in Figure 14-3.

Note

In addition to lights prescribed above, leading edge lights shall be used as follows: (1) By division leaders from takeoff until joint-up is completed, to assist succeeding aircraft in recognizing the assembly turn. (2) By all aircraft after break to assist in determining interval.

LIGHT	POSITION	INTENSITY	FORMATION POSITION
Cabin	On	Dim/clear	All
Formation	On	Bright	All
Navigation (for assembly)	On/flash	Dim	Section leaders
Navigation (for assembly)	On/steady	Dim	Wing aircraft
Navigation (en route)	On/steady	Dim	Section leaders
Navigation (en route)	On/flash	Dim	Wing aircraft
Navigation (landing)	On/flash	Bright	All (on break)
Anticollision (assembly)	On		All
Anticollision (en route)	On		Last aircraft each section
Anticollision (land)	On		All (on break)
Landing Lights	As required		All

Figure 14-3. Formation Lighting

14.2 ASSISTED TAKEOFF SYSTEM

Provisions are made for external mounting of eight solid-fuel ATO units of 1,000-pound thrust each, which supply additional thrust when it is desired to shorten takeoff distance. The system is electrically controlled and operated from the ATO control panel (see Figure 14-4) on the flight control pedestal. The units are fired simultaneously and give thrust until the propellant is exhausted. After firing, the expended ATO units may be jettisoned to reduce aircraft weight and drag.

14.2.1 Mounting of the Assisted Takeoff Units. The mounting provisions for the ATO units are the air deflectors in front of the paratroop doors (see Figure 14-4). Four units can be mounted on each deflector. Each ATO unit is supported by a mounting hook at the forward end and by a mounting channel at the aft end. The mounting hook remains extended at all times, while the mounting channel is normally held flush with the air deflector skin by two springs. When an ATO unit is to be installed, the channel is turned out to the extended position and is held out by a spring-and-latch arrangement. The ATO unit forward attachment fitting pin is locked in the mounting hook by a spring-loaded latch. This latch is operated to release the ATO unit by movement of a cam. One part of the cam engages the inboard end of the latch, while the other portion of the cam contacts a roller. The cam is connected by a cable to a release handle in the cargo compartment and to the latch that holds the mounting channel in the extended position. As the release cable is pulled, the cam and latch rotate. The cam rotates to retract the spring-loaded latch on the mounting hook. When the spring-loaded latch is retracted, the cam slips off the roller and the pull of the release cable causes the hook to rotate so that the ATO unit is pushed aft, to free it from the mounting channel. The ATO unit then falls away from the mounting hook and channel. When the ATO unit is pushed aft, the latch rotates to release the mounting channel, which is pulled to the flush position by springs.

14.2.2 Assisted Takeoff System Storage and Operating Temperature. ATO storage and operating limits for units usable with this system, are as follows:

UNIT	UPPER LIMIT	LOWER LIMIT
15-KS-1,000 Mk 6, Mod 0 with Mk 165, Mod 0 Igniter	140 °F	–65 °F

14.2.3 Assisted Takeoff System Controls. The flight station controls and the indicator for the ATO system are located on the ATO panel on the flight control pedestal (see Figure 14-4). The jettison handles for the ATO system are located in the cargo compartment forward of the paratroop doors (see Figure 14-4).

14.2.3.1 ARMED-SAFE Switch and Ready Light. The ARMED-SAFE switch, located on the ATO control panel (see Figure 14-4), is a two-position toggle switch designed to prevent accidental operation of the ATO system. When the switch is in the SAFE position, the 28-Vdc ATO CONTROL circuit is open and the system will not operate. When the switch is in the ARMED position, the ATO CONTROL circuit is completed to the fire switch. A press-to-test READY light illuminates when the system is armed and ready to fire. The ARMED-SAFE switch and READY light receive 28-Vdc power from the main dc bus through the ATO CONTROL circuit breaker on the copilot lower circuit breaker panel.

14.2.3.2 FIRE Switch. The pushbutton FIRE switch, located on the ATO control panel, controls the operation of the ATO ignition circuits. When the ARMED-SAFE switch is in the ARMED position and the FIRE switch is depressed, 28-Vdc power from the ATO CONTROL circuit breaker energizes the ignition relay. Actuation of the ignition relay applies 28-Vdc power from the main dc bus, through the ATO IGNITION circuit breaker on the copilot lower circuit breaker panel, to the ATO igniters.

14.2.3.3 ATO Jettison Handles. Four manually actuated ATO release handles (see Figure 14-4) are located in the cargo compartment on the fuselage structure forward of each paratroop door.

Each set of handles is reached through a zippered flap in the insulation. Pulling a handle mechanically releases the ATO bottle.

14.2.3.4 Ignition Control. The ignition control circuit is arranged so that all the ATO units are ignited at the same time. An ignition relay in the main dc distribution box closes the parallel circuits to apply voltage from the main dc bus through an ATO IGNITION circuit breaker to the igniters. The control circuit for the relay includes limit switches actuated by the two air deflectors, an arming switch, and a fire

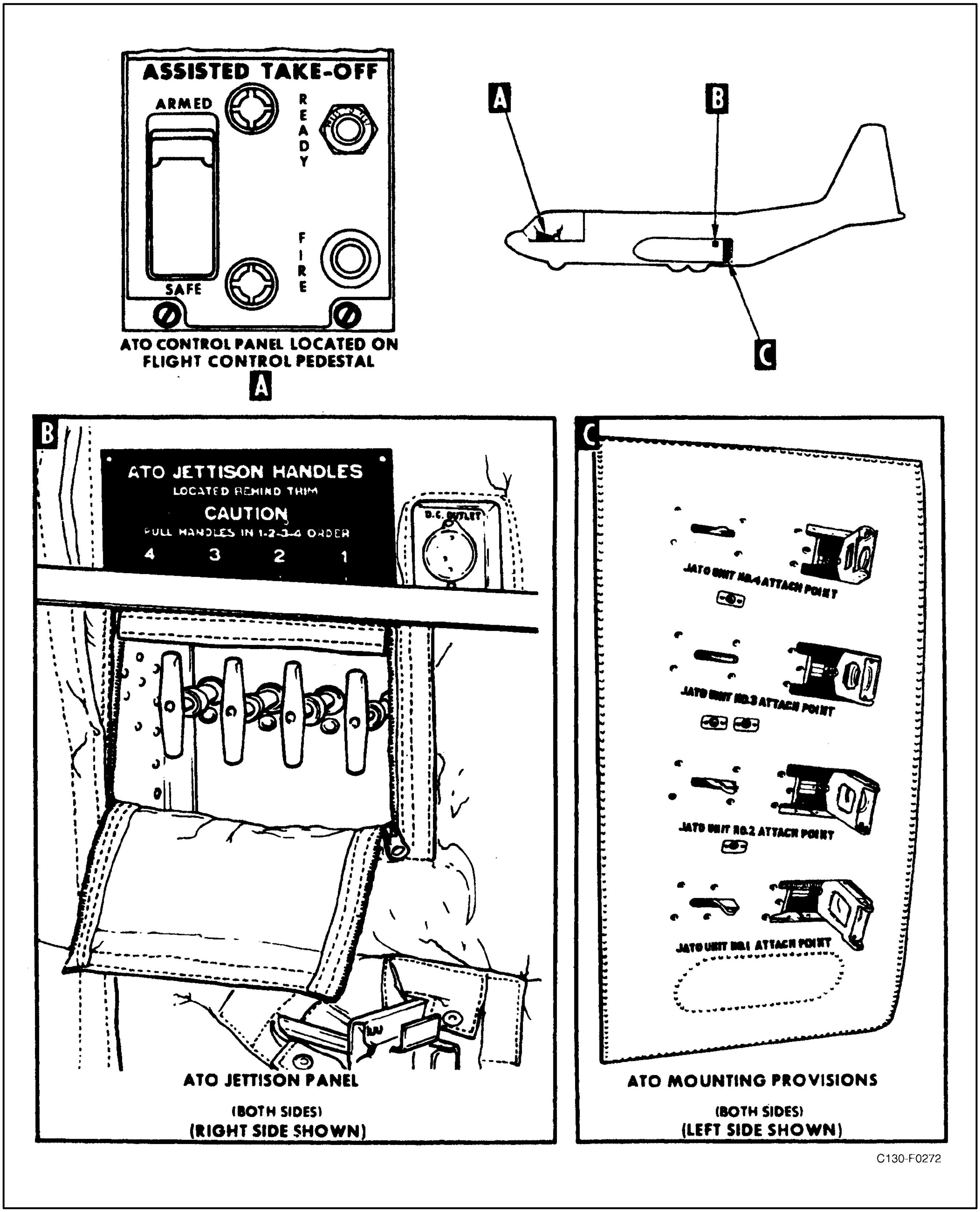


Figure 14-4. Assisted Takeoff System

switch connected in series with the relay coil. If the air deflectors are closed, the two limit switches are closed. The control circuit is then closed from the main bus through the ATO IGNITION circuit breaker, an ATO control circuit breaker, and the two air-deflector limit switches to the arming switch. Operation of the guarded arming switch then closes the circuit to the fire switch and completes a circuit to energize a ready light next to the switch. If the FIRE switch is then pushed, the circuit is completed to energize the ignition relay coil. The ignition relay cannot be energized unless both air deflectors are closed and both the arming and firing switches are operated. The READY light indicates that the deflectors are closed when the arming switch is actuated. The wiring of the ignition circuit on the aircraft terminates at quick disconnect fittings on the air deflectors. One fitting is placed in a recess next to each of the ATO unit supports. Each fitting is a ball-type receptacle. The plugs on the igniter leads with the ATO units fit the ball receptacles. The circuit through each igniter squib is completed to ground through the igniter case. The air-deflector limit switch for each deflector is mounted in the deflector recess and is actuated by the deflector as it closes. The effect of temperature on the ignition interval is shown in Figure 14-5.

14.2.4 Effect of Temperature on Assisted Takeoff Performance. Variations in ATO performance because of differences in temperatures are shown in Figure 14-5.

14.2.5 Inspection of Assisted Takeoff Units. Before installation, the ATO units and igniters must be inspected for serviceability.

14.2.5.1 ATO Unit Inspection. If any of the following defects or conditions are noted upon inspection of the entire external surface of the ATO unit, that unit must not be used:

1. Damaged or cracked welds on the attachment fittings
2. Damaged or loose attachment and/or fitting pins
3. Excessive rust or corrosion of the attachment fittings and pins
4. Obstruction of the nozzle orifice (other than normal plastic closure)
5. Damage resulting from blows or dropping.

Visual inspection of the interior walls of the chamber and nozzle is not possible. The following observations can be made, and an ATO unit with any of the following defects must not be used:

1. Extensive rust on interior surfaces
2. Rust particles or other foreign materials, except slight paint scales, on the surface of the propellant
3. Moisture on the surface of the propellant
4. Cracks in the surface of the propellant or broken pieces of propellant.

14.2.5.2 Igniter Inspection. Upon removal of igniter assemblies from the packing, they must be inspected. An igniter with one of the following defects must not be used:

1. Signs of moisture within the polystyrene case container that houses the black powder element
2. Damaged threads that would prevent proper assembly to the ATO unit
3. Corrosion on the contact electrode where the igniter cable attaches
4. Broken or cracked polystyrene case container.

Note

If the polystyrene case is broken during igniter installation and powder has been spilled into the ATO unit chamber, both the igniter and the unit must be rejected and not used.

5. The seating on the chamber boss is not firm when assembled in the ATO unit.

14.2.6 Assisted Takeoff System Installation and Removal

14.2.6.1 Installation of ATO Units on the Aircraft

1. Make an operational test of the aircraft ATO provisions.
2. Make sure that the hook openings of each channel and hook fitting, and each ball receptacle, are

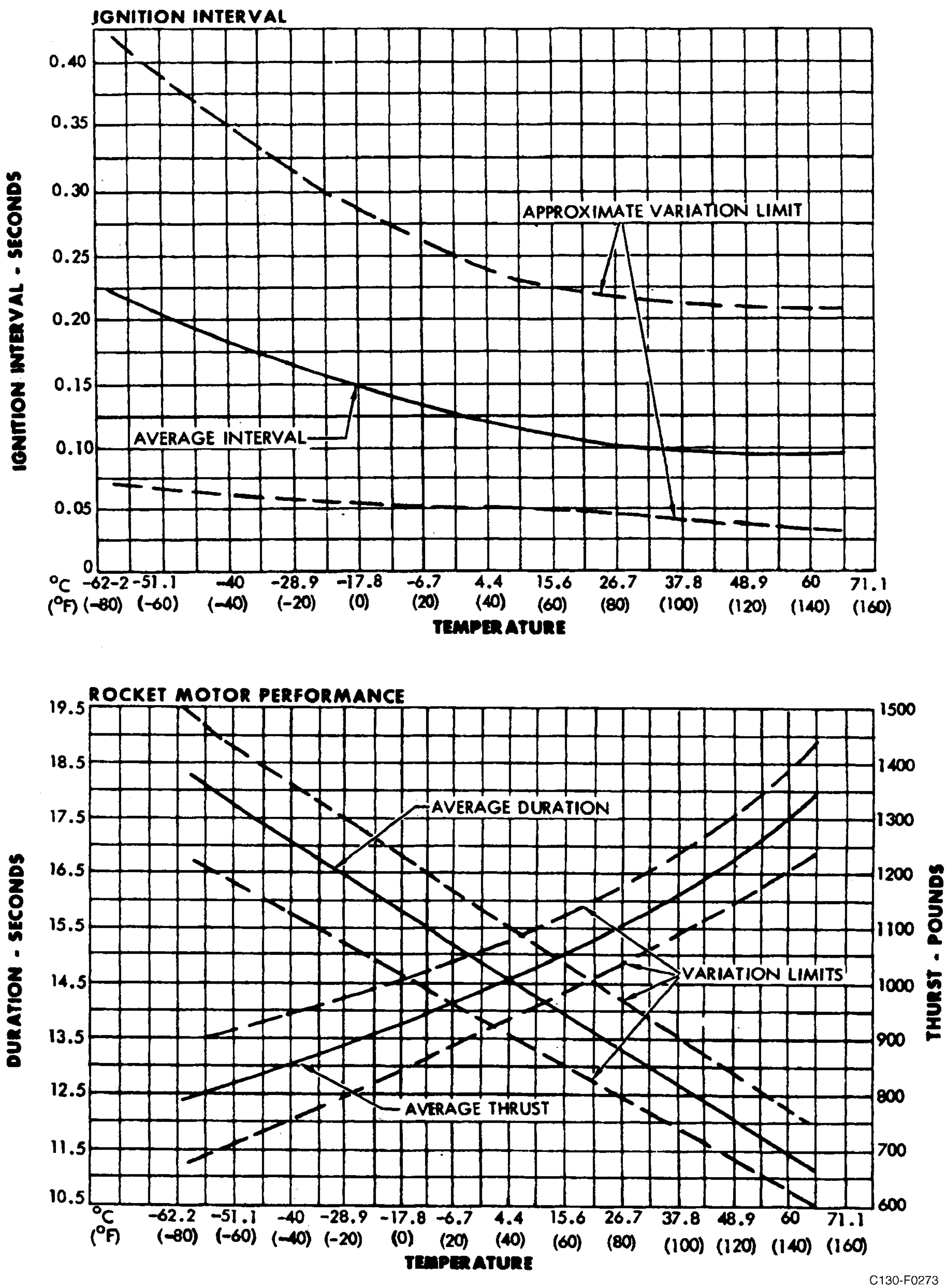


Figure 14-5. Typical Effect of Temperature on ATO

bright and clean. Clean with light sanding, if necessary, to ensure good electrical contact.

3. Inspect each ATO unit. Do not use a unit with any of the following defects:

   a. Damaged or cracked welds on attachment fittings.

   b. Damaged or loose attachment pins.

   c. Dented or distorted case.

   d. Moisture, dust, or dirt within the case. (Inspect the case through the igniter opening after removing the plug.)

4. Pull out the aft mounting channels on each air deflector until the channels latch.

5. Make sure that the attachment pins on the ATO units are bright and clean.

6. Lift each ATO unit into position so that the attachment pins engage the forward and aft hooks of the mount. Make sure that the forward attachment pin is locked in the hook by the latch.

WARNING

Do not activate the air-deflector doors after the ATO units have been installed. Binding release cables can cause the forward hook latch to retract and the latch to disengage, thereby jettisoning the ATO units.

7. After all ATO units are mounted, inspect the igniters. Reject an igniter with any of the following defects:

   a. Cracked powder case

   b. Evidence of moisture in powder case

   c. Corroded electrical contactor

   d. Incorrect type.

8. Immediately after inspection of an igniter, install it in an ATO unit. Remove the plug from the forward end of the unit and thread the igniter into the opening. Make sure that the igniter seats against the boss after tightening.

WARNING

After the igniters are installed, stay clear of the area aft of the ATO bottles. Do not connect ignition leads until ready to start engines. When ignited, the units eject high-temperature exhaust gases. Do not approach a unit for at least 10 minutes after a misfire because the unit remains hot for that length of time.

9. Make sure that the ATO arming switch is in the SAFE position then connect the igniter electrical leads. Remove the plastic cover from each igniter, disconnect the lead from the shorting terminal, and connect it to the ball receptacle on the door next to the ATO unit.

14.2.6.2 Postflight Removal of ATO Units. Do not attempt to remove an ATO unit within 30 minutes after it has been fired. Remove each unit by operating the release mechanism while supporting the unit. Wash off any deposits of powder left on the aircraft skin by gases from the units.

14.2.7 Assisted Takeoff. When the variables influencing takeoff lengths, acceleration, and obstacle clearance indicate a marginal takeoff, the use of ATO is required. When considering the use of ATO, first consider the objective for a particular takeoff condition. The objectives, acceleration to nosegear lift-off speed, acceleration to takeoff speed, or minimum roll to clear obstacles will dictate when to actuate the ATO fire switch. The 12- to 15-second duration of the ATO units will accomplish the objective when fired at a preselected airspeed in consideration of the objective. The ATO cut-in speed charts in the performance data sections will furnish the necessary information to determine the point at which the ATO units should be fired; they are predicated on the basis of burnout at 50-foot altitude. The units will be fired by the copilot at the command of the pilot.

Failure of the ATO units to fire on one side will produce momentary yaw, which is easily controlled with proper application of rudder. The acceleration effect when ATO is fired does not produce extreme abnormal stresses on either flightcrew or cargo.

If it is possible, jettison the ATO bottles prior to landing to prevent additional stress on the attaching fittings. Open the air deflectors to prevent the bottles from striking the fuselage. The ATO bottles should be jettisoned at the command of the pilot.

CAUTION

When jettisoning the ATO bottles, pull handles in 1-2-3-4 order to prevent upper ATO units from dropping into lower units and jamming the release system. Do not jettison ATO units while they are producing thrust.

14.3 AERIAL DELIVERY SYSTEM

Provisions for aerial delivery of equipment are made by an in-flight ramp operating system, a pendulum release system, and miscellaneous aerial delivery system accessories that are carried as loose equipment. The in-flight ramp operating system and the pendulum release system provide control of the ramp system and ejection of the extraction parachute. The miscellaneous accessories of the ADS are stowed in an ADS flyaway stowage box. For detailed information on the installation of miscellaneous equipment, refer to NAVAIR 01-75GAA-9.

14.3.1 Crew Requirements. The minimum crew for aerial delivery operations should be an airdrop qualified TAC, copilot, flight engineer, and two loadmasters.

14.3.2 Pendulum Release System. The pendulum type extraction parachute ejector is mounted overhead at the aft end of the ramp. The extraction parachute may be attached to one or both of the bomb rack tangs, depending on the size of extraction parachute used. The bomb rack tangs are cocked by pulling down on the tee handle attached to the cocking cable. Pressing the chute release switch or pulling the emergency chute release handle allows the parachute to swing down, aft, and out of the aircraft. The windblast strips off the bag pack, allowing the extraction parachute to deploy and extract the cargo from the aircraft over the aft end of the ramp.

14.3.3 Static Line Anchor Cables. Two static line anchor cables are stowed on reels mounted on the left and right side of the aft fuselage over the aft cargo door. These are used for anchoring the static lines of parachutes during airdrops. The cables are installed by attaching one end to the hooks on the aft anchor arms and the other end to hooks on the cargo compartment forward bulkhead.

14.3.4 Static Line Retrievers. Two motor-operated static line retrievers are mounted on the cargo compartment forward bulkhead to facilitate the recovery of parachute static lines after an airdrop. The retrievers operate from 28-Vdc power through the STATIC LINE RETRIEVER circuit breakers on the copilot lower circuit breaker panel and the STATIC LINE RETRIEVER MOTOR fuses on the right-hand distribution panel.

14.3.5 Aerial Delivery System Controls. Controls for operating the ramp system are on the ADS control panel on the flight control pedestal. Controls for the aft anchor arms and static line retrievers are in the cargo compartment.

14.3.5.1 Ramp and Door Control Switch. The ramp and door control switch is a three-position (CLOSE, OFF, OPEN) toggle switch located on the ADS control panel (see Figure 2-61) that controls operation of the ramp system during flight. When the switch is in the OPEN position, electrical power through the RAMP and ADS CONTROL circuit breaker on the aft fuselage junction box is supplied through a touchdown relay to energize the cargo door and ramp system. The cargo door rises and the ramp lowers to the aerial delivery position. When the switch is placed in the CLOSE position, power is applied to the aft cargo door and ramp system, and the cargo door and ramp move to the closed position.

WARNING

Install the ADS ramp supports prior to operation of the ramp in flight to permit the ramp to extend only to a horizontal position.

14.3.5.2 Chute Release Switch. The chute release switch is located on the ADS control panel (see Figure 2-60) on the flight control pedestal. It is a press-to-actuate-type switch that controls the ease of the extraction parachute on the extraction parachute ejector. When the switch is pressed, electrical power through the RAMP and ADS CONTROL circuit breaker on the aft fuselage junction box and a touchdown relay energizes a solenoid-operated latch on the ejector, allowing the parachute to swing down, aft, and out of the aircraft.

14.3.5.3 Extraction Parachute Manual Release Handle. An emergency manual release handle is connected to the release mechanism on the extraction parachute ejector through an overhead cable and pulleys. The handle is located below the aft side of the aft flight station bulkhead, inboard of the flight station ladder. Pulling this handle releases the extraction parachute and allows it to swing out of the aircraft over the aft edge of the ramp.

CAUTION

The manual release handle should be used to eject the extraction parachute only in case of failure of the chute release switch.

14.3.5.4 RAMP AND DOOR OPEN Light. A RAMP AND DOOR OPEN light is located on the ADS control panel (see Figure 2-61) on the flight control pedestal. This is a green press-to-test-type light that goes on when the cargo door is fully open and the ramp is lowered to the airdrop position. This light is energized through the RAMP and ADS CONTROL circuit breaker on the aft fuselage junction box.

14.3.5.5 Aft Anchor Line Arm Controls. Controls for the aft anchor line arms are on the cargo compartment forward bulkhead (see Figure 14-6). The controls consist of two three-position (UP, OFF, DOWN) switches, one for each anchor arm. When the

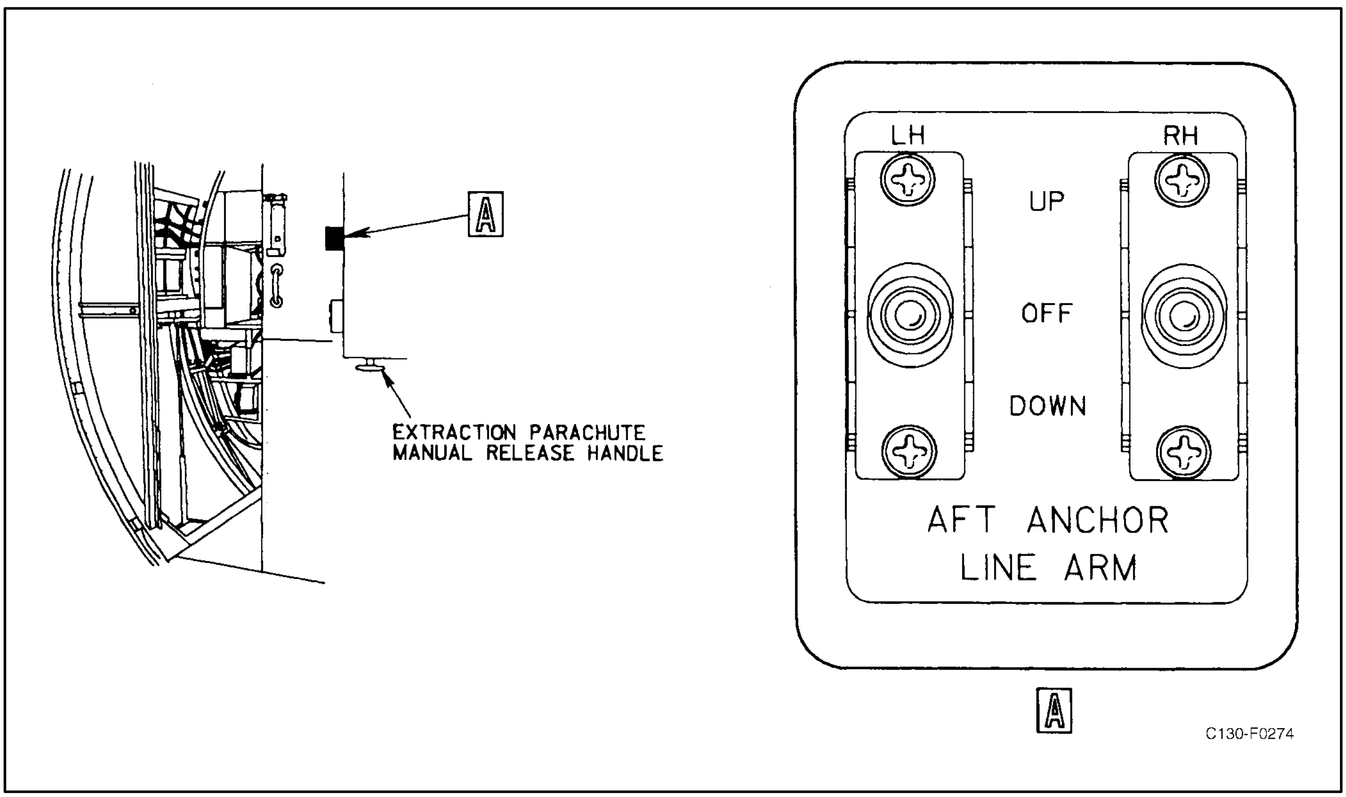


Figure 14-6. Paratroop Anchor Line Support Controls

switches are placed in the DOWN position, electrical power is supplied to two actuators that lower the arms into position for airdrops. The UP position raises the arms to the stowed position, and the OFF position removes power from the actuators. Power for operation of the anchor arm actuators is supplied from the main dc bus through the AFT ANCHOR LINE ARM circuit breakers on the copilot lower circuit breaker panel.

CAUTION

Do not lower the anchor arms while the cargo door is being raised or lowered. Severe structural damage could result.

14.3.5.6 Static Line Retriever Control Switches.

Controls for the static line retrievers are in the cargo compartment (see Figure 14-7). Two control panels, one for each retriever, are mounted on the cargo compartment forward bulkhead; a pistol-grip control handle for each retriever is hung aft of each paratroop door. Each control panel on the cargo compartment forward bulkhead has two switches: one with UNWIND and OFF positions and one with REWIND and OFF positions. The UNWIND switch is spring loaded to the center neutral position and the REWIND switch is spring loaded to the OFF position. When the UNWIND switch is placed in the UNWIND position, power is supplied through a holding circuit to the retriever to unwind the retriever cable. Momentary contact of the switch in the UNWIND position is all that is necessary to start the retriever. The retriever will continue to operate until the retriever cable is completely unwound; then a limit switch on the retriever is actuated to open the circuit. The retriever can be stopped at any intermediate position by momentarily holding the UNWIND switch in the OFF position or by actuating the trigger switch on the control handle at the paratroop door. To rewind the retriever cable, the REWIND switch must be held in the REWIND position. A limit switch will stop the retriever when the cable is rewound. Each of the pistol-grip control handles at the paratroop doors has a trigger-type switch and a thumb-operated three-position (OUT, OFF, IN) switch spring-loaded to the OFF position. When the trigger switch is actuated, the circuit to the thumb-operated switch is completed and the controls at the

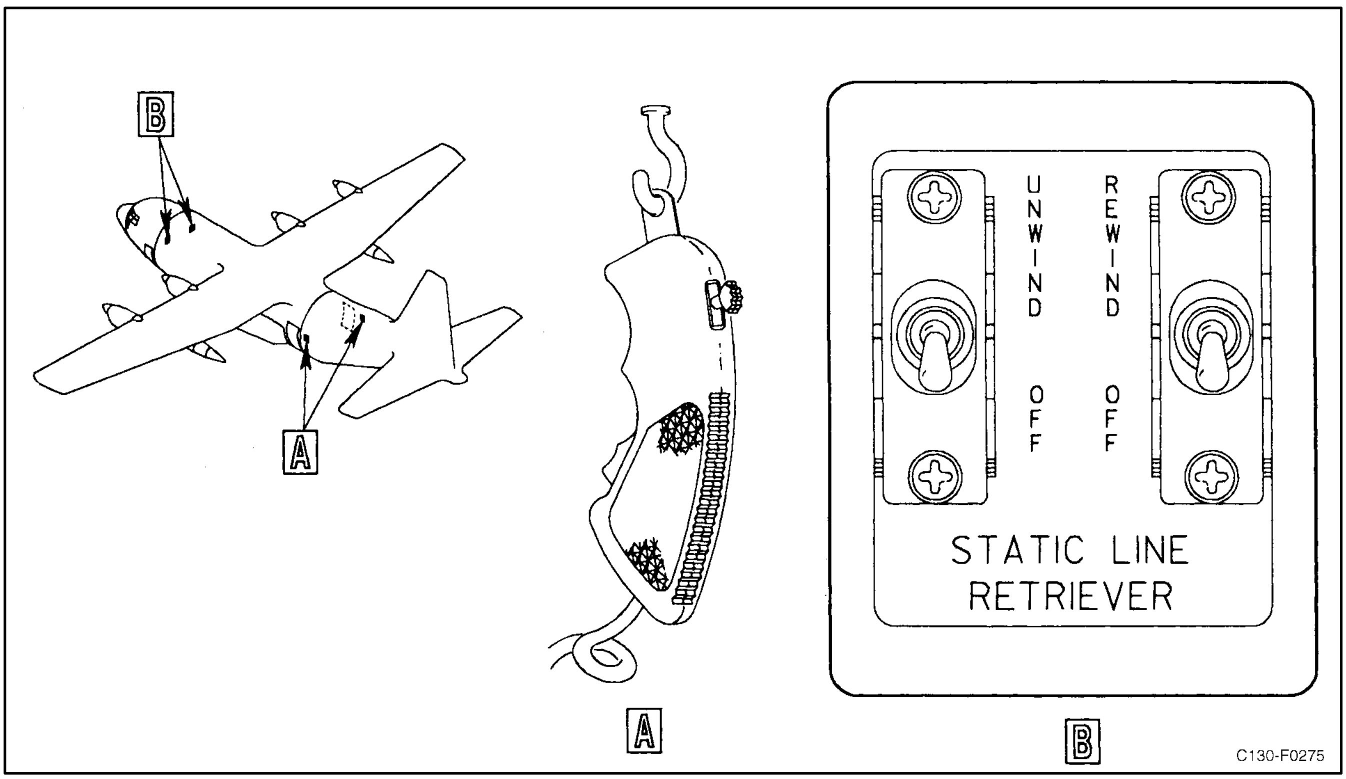


Figure 14-7. Static Line Retriever Control Panels

cargo compartment forward bulkhead are overridden. When the thumb-operated switch is placed in the OUT position, the cable will unwind. The IN position rewinds the cable, and the OFF position stops either operation in any intermediate position.

14.3.6 Operation of Aerial Delivery System. For operation of the ADS during an airdrop mission, refer to NAVAIR 01-75GAA-9.

14.4 EXPEDITIOUS OFFLOAD

Expeditious offload provides a means of offloading ramp, single and multiple pallets without the use of handling equipment. Unit commanders may authorize expeditious offloads when conditions warrant. Expeditious offload procedures should only be utilized as a last resort when no other means to off-load is available. Permission from the user or lift requestor should be obtained if possible.

Note

Offloading married pallets (T2, T3, etc.) is prohibited.

14.4.1 Expeditious Offload Procedures. Cargo pallets can be offloaded without damage to the aircraft with the cargo ramp positioned 12 inches above the ground. The maximum weight for a pallet to be expeditious offloaded across the ramp is 10,000 pounds. Pallets may be offloaded in a train like fashion or one-by-one as the situation dictates. A taxiway or ramp at least 500 feet long is required; however, 1,000 feet is desired to provide a margin of safety. When pallets are offloaded one at a time, use a longer taxiway based on the number to be offloaded. Fragile items that might be damaged by expeditious offload shall not be offloaded without user concurrence. When offloading multiple pallets, it is recommended that each pallet be tied together to prevent them from falling over (tomb stoning) as they roll out the aircraft. The paratroop doors shall not be used for expeditious offloading.

All crewmembers participating in the offload will refer to the following checklist. Prior to commencing expeditious offload operations, the TAC will brief each crewmember. The loadmaster will maintain constant ICS contact with the TAC and is the only crewmember authorized to operate the dual rail locks during combat offload operations. Passengers should be offloaded to a safe area prior to commencing expeditious offload procedures.

WARNING

- Many explosive items have specific “drop” criteria that, if exceeded, render the item useless or dangerous to the user. With the exception of small arm ammunition (hazard class or division 1.4), explosives and munitions shall not be expeditious offloaded without approval of the Wing Commander.
- During the entire offload operation, no one is permitted behind or beside the load unless the loadmaster checks that all rail locks are locked and engaged in the pallet detents or secures each pallet to aircraft tiedown rings to ensure positive aft restraint.

CAUTION

When offloading on excessively rough surfaces, damage to the aircraft ramp may occur. Reducing forward taxi speed on these surfaces will reduce aircraft oscillation. The TAC must determine if the offload area will permit the offload operation to be conducted without damage to the aircraft or equipment.

14.4.2 Expeditious Offload Checklist

1. Crew Brief — Complete (P)
2. Interphone/Hot Mike — Checked (All)
3. Ramp and Door — Clear to Open (P/FE)
4. Aircraft — Positioned and stopped (P)
5. Ramp and Door — Open (LM)

6. Safety Observer — Set (LM)

WARNING

A safety observer will take position at the bottom of the flight deck steps and transmit verbal warnings to any personnel over ICS.

7. Offload Preparation Checks — Complete (LM)

CAUTION

A safety chain shall be secured across the cargo compartment attached to the dual rail forward of the pallets or platforms. This will prevent the pallets or platforms from rolling forward in case of a dual rail failure.

8. Taxi Clearance — Cleared to taxi (CP)

Note

Notify the airport tower and request taxi clearance prior to offload.

9. Brakes — Set (P)

To unload ramp pallets:

Note

If no ramp pallet is aboard, proceed to step 18.

10. Right-hand ramp lock and flanges — Released/ Retracted, handle stowed, stowage pin installed (LM)

CAUTION

Always maintain forward restraint with the right-hand locks.

11. Power — Set (P/CP, FE)

Note

Advance power to approximately 5,000 inch/lbs. of torque. This setting will vary depending upon surface condition, slope, wind, aircraft weight, and cargo weight.

12. "READY TO TAXI" (LM)

Note

The loadmaster will indicate ready for offload by stating "Ready to Taxi." Upon hearing the loadmaster state "Ready to Taxi", the pilot will release the brakes.

13. Brakes — Released (P)

CAUTION

Taxi the aircraft in a straight line. Any attempt to turn the aircraft during offload may damage the aircraft.

14. Left-hand ramp lock and flanges — Released/ Retracted (LM)

Note

Release left-hand ramp lock and flanges when the pilot releases brakes and the aircraft starts to accelerate

15. "LOAD CLEAR" (LM)

WARNING

Do not stop aircraft until loadmaster reports "LOAD CLEAR".

16. Brakes — Set (P)

17. Left-hand ramp lock handle — Stowed/Pin Installed (LM)

To unload remaining pallets:

WARNING

Do not proceed to step 18 before ensuring the area behind and beside cargo is clear of personnel and obstructions.

Note

If only the ramp pallet is to be offloaded, proceed to step 28.

18. Loadmaster positioned at FS245.

19. Right-hand Master Control Handle — EMERGENCY POSITION (LM).

CAUTION

Always maintain forward restraint with the right-hand locks.

20. Power — Set (P/CP, FE)

Note

Advance power to approximately 5,000 inch/lbs. of torque. This setting will vary depending upon surface condition, slope, wind, aircraft weight, and cargo weight.

21. "READY TO TAXI" (LM)

Note

The loadmaster will indicate ready for offload by stating "Ready to Taxi." Upon hearing the loadmaster state "Ready to Taxi", the pilot will release the brakes.

22. Brakes — Released (P)

CAUTION

Taxi the aircraft in a straight line. Any attempt to turn the aircraft during offload may damage the aircraft.

23. Left-hand locks — Released (as required)

Note

Release left-hand locks when the pilot releases brakes and the aircraft starts to accelerate. If all pallets on the cargo floor are to be offloaded, place left-hand simul control handle in the aft restraint release position. For less than a complete offload, use sequential lock/unlock control handle and unlock only those locks for pallets to be off-loaded. Pallets not intended to be off-loaded shall be restrained for 1g aft restraint from available floor/wall tiedowns.

24. "LOAD CLEAR" (LM)

WARNING

Do not stop aircraft until loadmaster reports "LOAD CLEAR".

25. Brakes — Set (P)

Note

Repeat steps 20 through 25 for remaining pallets

After last pallet is offloaded:

26. Right-hand master control handle — CHECK, then NORMAL position (LM)

WARNING

Before proceeding aft of any remaining pallets, visually inspect each left-hand dual rail lock to ensure positive aft restraint.

27. Left-hand dual rail locks — Extended/checked (LM)

28. Interphone/Hot Mike — Off (P, CP, FE)

29. Ramp and door — Closed and Locked (LM).

14.5 DANGEROUS OR HAZARDOUS CARGO

Transportation of passengers with hazardous cargo aboard is normally prohibited. Exceptions to this policy will be found in the current edition of NAVSUPPUB 505, Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft.

14.6 HOSPITAL AIR EVACUATION

The following safety requirements and procedures are considered essential to air evacuation aircraft carrying litter patients. These precautions or procedures shall be followed, where applicable, prior to each landing, takeoff, refueling, loading, and unloading operation. Aircraft commanders shall make appropriate requests in order that these procedures will be followed as far as practicable.

1. Notify the control tower to alert the crash rescue unit to stand by on landing.
2. Crash equipment will follow the taxiing aircraft until it is spotted and chocked. The crash unit will remain as long as litter patients are being off-loaded or loaded.
3. When litter patients are aboard during refueling, one member of the firefighting unit shall stand by in the cabin with a fire extinguisher.
4. Prior to refueling the aircraft, the refueling crew shall ascertain that all grounding devices are properly connected and that the necessary ramps are in position for the exit of patients should the need arise. One medical attendant shall remain in the aircraft with the patients.
5. The gas truck shall be parked in a position downwind from the aircraft being refueled.
6. A tractor with a towbar attached to the aircraft shall be ready to move the aircraft in the event of a fire in the refueling unit.
7. Prior to takeoff, the crash rescue unit shall follow the aircraft to the warmup position and remain in position until the aircraft is airborne.
8. Fire and crash protection shall be requested if the aircraft is experiencing even minor difficulty.

14.7 SINGLE-POINT REFUELING WITH AUXILIARY POWER UNIT OR ENGINE RUNNING

The aircraft may be refueled with the APU or an engine running to furnish electrical power only when all of the following conditions exist:

1. A satisfactory external power source is not available. The aircraft battery charge is too low to permit refueling with battery power.
2. The mission requirements of local conditions do not allow sufficient ground time to charge the aircraft battery and then refuel with battery power.
3. Local existing regulations permit this method of refueling.

WARNING

When refueling with the APU or an engine running, use single-point refueling only. Gravity refueling through the wing filler ports is prohibited because of the increased possibility of fuel spillage and the release of fuel vapor in proximity to the APU or the engine exhaust stream and hot section.

14.7.1 Preparation for Refueling. Perform the following steps prior to refueling the wing tanks or fuselage tanks:

1. If the APU is to be used, start the APU prior to shutting down all engines. Check APU generator voltage and frequency for indication within limits. Check for normal power on the ac instrument and engine fuel control bus and on the main dc bus. Monitor APU operation throughout refueling.
2. If an engine is to be used, shut down all engines except No. 2. This engine is preferable to No. 1 because of the wing tank vent outlet near the No. 1 engine exhaust area. Operate No. 2 engine in normal ground idle throughout refueling and monitor engine instruments for operation within the limits shown in Chapter 4. Check voltage and frequency of the operating engine generator for indication within limits. Check for normal power on the ac instrument and engine fuel control bus and on the main bus.

WARNING

Restrict movement of personnel and equipment along the left side of the aircraft. Close all doors on the left side if this does not seriously hinder other essential operations.

3. Ensure that adequate fire protection equipment is available in the refueling area.

4. Do not operate the aircraft air-conditioning system during refueling.

5. Make sure that all electrical and electronic equipment not required for refueling is turned off at all crew stations.

6. Locate the refueling unit on the right side of the aircraft. Connect static ground wires from a common ground point to the aircraft nose static fitting on the right side of the fuselage aft of the radome, to the refueling panel static ground fitting, and to the refueling unit.

7. Connect the refueling nozzle ground wire to the refueling panel ground wire. Uncap the refueling receptacles and connect a refueling nozzle to one or both receptacles.

14.7.2 Refueling Wing Tanks. Refuel wing tanks as follows:

1. Place the MASTER switch in the REFUEL & GRD TRANS position; place the tank selector switches, for the tanks to be refueled, in the OPEN position and open the offload valve.

WARNING

Maintain a fuel balance in accordance with Chapter 3.

2. Establish fuel flow.

3. Within the first minute, place the MASTER switch in the PRE-CHK PRIM position and observe the fuel truck flow meter and the quantity gauges. Flow should stop within 15 seconds.

4. Return the MASTER switch to the REFUEL & GRD TRANS position and observe that flow resumes; then place the switch in the PRE-CHECK SEC position. Flow should stop within 15 seconds.

WARNING

If flow into any tank did not stop in at least one of the PRE-CHK positions, do not rely on automatic shutoff at full capacity. Proceed with caution and stop the refueling unit pump in ample time to avoid overflow or wing structural damage. Fuel spillage would create a serious hazard with an engine or the APU running.

5. Return the MASTER switch to the REFUEL & GRD TRANS position.

6. After refueling is complete, place all tank selector switches in the CLOSE position, the OFF LOAD VALVE switch in the CLOSE position, and the MASTER switch in the OFF position.

Note

When less than full capacity is planned, and flow into a tank does not stop when the selector switch is placed in the CLOSE position, shut down the refueling unit pump if the planned total fuel load is not aboard. If further total fuel is required, continue refueling but shut down the pump before reaching full capacity of the affected tank, then transfer fuel as necessary after at least two engines have been started.

7. Perform the securing after refueling steps in paragraph 14.7.3.

14.7.3 Securing After Refueling. Perform the following steps after refueling the wing tanks or fuselage tank.

1. Shut down the refueling unit pump, disconnect the nozzles from the receptacles, and then disconnect the nozzle ground wire.

2. Cap the refueling receptacles.

3. Place the MASTER switch in the DRAIN position for 5 minutes, then turn it to the OFF position.

Note

The manual drain valve must be opened while operating the drain pump.

4. Disconnect the ground wire from the panel static ground fitting.

5. Close and lock the refueling panel door.

6. Drain the refueling receptacles through the manual drain valve. Close and secure the drain valve door.

7. Remove ground wires and refueling equipment before starting the engines from the operating engine or APU.

14.8 SINGLE-POINT DEFUELING WITH APU OR ENGINE RUNNING

The safety precautions, location of defueling unit, and static grounding of the aircraft are the same for defueling with an engine running as for refueling with the APU or an engine running.

With the defueling unit positioned and the aircraft and the defueling unit static grounded as directed in paragraph 14.7, proceed as follows:

1. Operate APU and ac bus tie only. Throughout defueling, monitor APU instruments for operation within the limits shown in Chapter 4. Check voltage and frequency of the APU generator for indication within limits. Check for normal power on the essential and main ac and dc buses and on the ac instrument and engine fuel control bus.

2. Operate No. 1 engine only in normal ground idle. Throughout defueling, monitor engine instruments for operation within the limits shown in Chapter 4. Check voltage and frequency of the operating engine generator for indication within limits. Check for normal power on the essential and main ac and dc buses and on the ac instrument and engine fuel control bus.

3. Determine the total weight of fuel to be offloaded, and divide this weight between all tanks that are to be defueled. From this and the present gauge readings for these tanks, calculate the final desired fuel load in each affected tank. This fuel loading must be compatible with normal fuel loading between tanks for flight operation.

4. Connect the defueling nozzle ground wire to the refueling panel ground wire. Uncap one or both refueling receptacles and connect defueling nozzles as required.

5. Place the refueling panel MASTER switch in the DEFUEL position and place the OFF LOAD VALVE switch in the OPEN position.

6. Place all crossfeed switches on the main fuel control panel (see Figure 2-23) to the no-flow position. Use the fuselage tank crossfeed switch for fuselage tank defueling.

7. Place the dump switch on the main fuel control panel to the DUMP position for each tank to be defueled. Monitor the quantity gauges and place the dump switches in the OFF position as the desired remaining fuel quantity in each tank is reached. If all fuel is to be defueled, use the crossfeed system and wing tank boost pumps. At least two engines must be running with both generators operating.

Note

If offloading of any tanks is to be continued down to the dump pump cutoff point, somewhat more fuel will remain in the tanks with the aircraft on the ground than would remain after in-flight dumping.

8. When defueling is completed and all dump pumps have been shut down, place the MASTER switch in the OFF position.

9. Disconnect the nozzles from the receptacles and then disconnect the nozzle ground wires.

10. Cap the refueling receptacles.

11. Place the MASTER switch in the DRAIN position for 5 minutes, then turn it to the OFF position.

Note

The manual drain valve must be opened while operating the drain pump.

12. Disconnect the ground wire from the panel static ground fitting.

13. Close and lock the refueling panel door.

14. Drain the refueling receptacles through the manual drain valve. Close and secure the drain valve door.

15. Remove ground wires and defueling equipment.

16. Resume normal operation of all four engines.

PART IX

Crew Responsibilities and Coordination

CHAPTER 15

Flightcrew Responsibility and Coordination

15.1 CREW RESPONSIBILITIES

15.1.1 Pilot in Command. The pilot in command shall be in command of the aircraft and responsible for the safe and orderly conduct of the flight. This responsibility exists from the time the PIC enters the aircraft preparatory to flight until relieved from duty by proper authority. The authority and responsibility of the pilot in command for the flight is independent of the crew or passenger's seniority except as stated in Article 1329, 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 pilot in command shall be thoroughly familiar with this manual, squadron manuals and directives, and all other directives from higher authority.

The pilot in command has the authority to delay or discontinue a flight when, in his or her opinion, conditions are unsafe for starting or continuing a flight.

15.1.2 Copilot (T2P). The copilot is second-in-command and is responsible for assisting the pilot in command in the performance of his or her duties and such other duties as may be assigned.

The copilot may control the aircraft and may make instrument climbs, descents, landings, and takeoffs, day or night, consistent with his or her instrument qualification. The pilot in command shall use his or her discretion in each case of adverse weather or emergencies encountered in deciding if the copilot is capable of executing a safe departure or approach.

When in control of the aircraft, in the absence of the pilot in command from the cockpit, the copilot will ensure the safe conduct of the flight and will notify the pilot in command immediately of any unusual events or circumstances.

In the event of disability of the pilot in command during flight, the copilot with the highest designation will take command of the flight and assume the authority, duties, and responsibilities of the pilot in command to the next en route station or a closer alternate as the situation warrants.

The copilot shall monitor all maneuvers being performed by the pilot, bringing to his or her attention any deviation from normal operation. When, in his or her opinion, an unsafe or potentially unsafe condition exists, it is the copilot's responsibility to inform the pilot, regardless of designations or rank.

15.1.3 Flight Engineer

Note

The flight engineer is the senior enlisted aircrew regardless of rank or rate. All other enlisted crewmembers shall directly report any abnormalities or areas of concern to the flight engineer. The following items are duties of the flight engineer.

1. Computes takeoff, climb, cruise, and landing data; adjusts engine controls in coordination with the pilot to maintain required power during climb and cruise flight conditions. Maintains power-plant cruise control data.

2. Operates system controls; regulates electrical system.

3. Controls cabin air to provide proper cabin ventilation, pressurization, and temperature.

4. Operates all anti-icing and deicing systems.

5. Operates APU and APU generator as required.

6. Operates external light panel.

7. May operate cargo door and ramp in flight.

8. Observes engine instruments, systems indicators, and control devices.

9. Continually monitors inlet temperature indicators, tachometers, and torquemeters and reports unusual conditions to pilot.

10. Monitors circuit breakers, fuel flow, temperature and pressure indicators, electrical voltage and loads, and cabin pressure control and altitude indicators.

11. Observes warning lights and fire detector indicators.

12. Reports abnormal conditions to pilot and recommends corrective action.

13. Operates navigator station equipment.

14. Performs preflight and postflight inspections.

15. Inspects turboprop engine for general condition of turbine blades and for absence of fuel leaks.

16. Troubleshoots malfunctioning aircraft systems in flight.

17. May supervise the removal and replacement of all aircraft system components if qualified maintenance personnel are not available.

18. Performs fuel management.

19. Controls and operates the aircraft auxiliary fuel control panel for dumping procedures.

20. Initiates emergency procedures/actions as required by the flight manual and/or the pilot.

21. If qualified, may perform low-/high-power turns.

15.1.4 Loadmaster. The loadmaster assists the flight engineer in the interior inspection of the cargo compartment in addition to items, included on the normal procedure checklist. The loadmaster will complete the following checklist.

1. Emergency equipment — Checked.

    a. Antiexposure suits and LPAs.

    b. Personal equipment.

Note

Crewmembers are responsible for their own personal equipment.

2. Seat and safety belts — Installed as Required.

3. Roller conveyor and dual rail system — Checked.

Note

Refer to Part II of the applicable loading manual for system check.

4. Loading aids — Checked.

    a. Auxiliary ground loading ramp — Stowed.

    b. Snatch blocks — Checked.

    c. Wheeled prybars — Stowed.

    d. Twenty-five-thousand-pound tiedown fittings — Stowed.

    e. Chains, straps, and devices — Stowed.

    f. Portable winch — Checked in Accordance With the Applicable Loading Manual.

5. Weight and balance form — Complete.

6. Supervise loading and securing cargo.

    a. Prior to loading:

        (1) Load planning — Complete.

        (2) Cargo door and ramp — Position as Required.

        (3) Cargo and passenger manifest — Check Manifest Against Cargo for Items That Require Special Handling and Ensure Accurate Passenger Count.

        (4) Cargo inspection — Check General Condition and Hazardous Material and Contaminated Items.

    b. Loading — Refer to the Applicable Loading Manual and Other Appropriate Manuals for Handling, Loading Instructions, and Limitations.

c. After loading:

(1) Cargo door and ramp — Closed, Locks Checked, ADS Arms Connected.

(2) Loose equipment — Stowed.

(3) Maintenance ladder — Stowed.

(4) Load restraint — Completed and Checked.

(a) Dual rail locks — Engaged.

(b) Cargo tiedown equipment — Computed and Checked.

(5) Logistics flight record — As Required.

7. Give emergency instructions to passengers when required.

8. Make periodic checks of the wings and engines for fuel, oil, and hydraulic leaks; reservoir quantities; and cargo security. Ensure passenger comfort and maintain cleanliness within the aircraft during flight.

15.1.5 Second Loadmaster

The Second Loadmaster assists the Loadmaster with the interior inspection of the cargo compartment in addition to items included on the normal procedures checklist.

1. Assist in rigging and unrigging seats.

2. Provision aircraft with water, coffee, box-lunches, etc., if required.

3. Assist in loading and securing cargo.

4. Give emergency instructions to passengers when required.

5. Ensure passenger comfort during flight.

6. Maintain cleanliness within the aircraft during flight.

7. Be responsible for administrative documents appropriate to the position.

8. Make periodic checks of wings and engines for fuel, oil, and hydraulic leaks; reservoir quantities; and cargo security. Ensure passenger comfort and maintain cleanliness within the aircraft during flight.

9. Emergency equipment — Checked.

a. Anti exposure suits and LPAs.

b. Personal equipment.

Note

Crewmembers are responsible for their own personal equipment.

10. Roller conveyer and dual rail system — Checked.

Note

Refer to Part II of the applicable loading manual for system check.

11. Loading aids — Checked.

12. After loading checks.

a. Cargo door and ramp — Closed, Locks Checked ADS Arms Connected.

b. Loose equipment — Stowed.

15.2 CREW COORDINATION

15.2.1 Takeoff Phase. Figure 15-1 is provided to clearly show the proper division of crew duties and procedures for normal takeoff and may further be referenced as “Standard Crew Brief.” (Refer to paragraphs 8.9 and 8.10.)

The following explanation is provided for amplification of the guide.

1. Takeoff power can be applied either before releasing the brakes or during the takeoff roll. The appropriate performance charts assume that takeoff power is applied prior to releasing the brakes. However, if passengers are being carried and runway length permits, a smooth takeoff can and should be made by applying power during the roll. The pilot’s hand should remain on the throttles until well established in the climb and climb power has been set. Under low-temperature conditions, never place throttles to full takeoff

power without monitoring torquemeters. It is possible to exceed the maximum allowable torque limitations without exceeding allowable TIT. Takeoff power limitations are outlined in Part I. Any crewmember observing any discrepancy during the takeoff will immediately notify the pilot.

2. Nosewheel steering should not be necessary after 50 to 60 KIAS has been reached since rudder control is adequate to steer the aircraft above this speed. The pilot's hand shall remain on the nosewheel steering until rudder control is sufficient to steer the aircraft. The point at which the hand is transferred from the nosewheel steering to the yoke is at pilot discretion, but, in all cases, this transfer shall be completed by air minimum control speed (one engine inoperative).

Note

If the aircraft is loaded to an aft center of gravity, forward pressure on the yoke may be necessary to aid in steering effectiveness.

3. Keep the nosewheel on the ground while continuing acceleration to takeoff speed.

CAUTION

Pilots should be aware that the aircraft will fly at speeds considerably lower than the recommended takeoff speeds. If the nosewheel is raised off the ground before air minimum control speed (one engine inoperative) has been reached, it is possible to become airborne before air minimum control speed (one engine inoperative).

Note

If air minimum control speed (one engine inoperative) is greater than takeoff speed, use air minimum control speed (one engine inoperative) for takeoff speed.

4. For most normal operations, runways are of sufficient length to permit a safe abort on the remaining runway at speeds up to takeoff speed. This means that the refusal speed under these conditions would be equal to or greater than the takeoff speed. If these conditions exist, use the takeoff speed for refusal speed. Also, when these conditions exist, the crew need only be concerned with air minimum control speed (one engine inoperative) and takeoff speed.

TAKEOFF GUIDE		
PILOT	**COPILOT**	**FLIGHT ENGINEER**
1. Advances throttles to takeoff power.	Monitor instruments and flies yoke to maintain wings level.	Monitors engine instruments.
2. Steers with nosewheel during initial takeoff roll until rudder control speed is reached, then with rudders.	Monitors instruments and continues flying yoke.	Monitors instruments.
3. Takes over yoke no later than air minimum control speed (one engine inoperative) and begins raising nosewheel slightly.	Monitors instruments.	Monitors instruments.
4. Notes refusal speed has been reached and continues takeoff.	Calls out refusal speed, if required.	Monitors instruments.
5. Commences rotation.	Calls out “Rotate” at rotate speed.	Monitors instruments.
6. Orders “Gear up” when safely airborne.	Verifies positive rate. Repeats “Gear up” and retracts gear.	Monitors instruments.

Figure 15-1. Crew Duties and Procedures for Normal Takeoff

5. The takeoff should be aborted if any emergency condition develops before takeoff speed has been reached. The takeoff should be continued if a controllable emergency condition, such as engine failure, develops after takeoff speed has been reached.

6. Should the takeoff be made on a shorter runway where refusal speed is less than takeoff speed, continue acceleration after reaching refusal speed to takeoff speed or air minimum control speed (one engine inoperative), whichever is greater, before becoming airborne.

7. Flaps should not be raised until the gear is fully retracted, a minimum of 20 KIAS above takeoff speed has been reached, and the aircraft is clear of all immediate obstacles. When the flaps are retracted and the aircraft is well established in the climb, reduce the climb power and complete the Climb Checklist.

Note

The pilot should keep his/her hand on the throttles until the aircraft is well established in the climb and climb power has been set. The loss of an outboard engine at any time when full power is being used creates a high differential in power, resulting in control difficulty; however, sufficient differential in power resulting in control is available if airspeed is above air minimum control speed (one engine inoperative). A slight reduction in power on the opposing outboard engine will serve to reduce the asymmetrical power condition and aid in controllability. This procedure should be used only if conditions allow a reduction in power or if the need for precise directional control is of greater importance than all other factors.

PART X

Evaluation

CHAPTER 16

Evaluation

16.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating the aircraft. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for comparability with various operational commitments and missions of Navy units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS evaluation program is achieved only through the vigorous support of the program by commanding officers as well as the flightcrewmembers.

16.2 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating Navy aircraft. The various categories of flightcrewmembers desiring to attain/retain qualification in the C-130T shall be evaluated in accordance with the current OPNAV Instruction 3710.7. Individual and unit NATOPS evaluations will be conducted periodically; however, instruction and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS coordinators, evaluators, and instructors shall administer the program as outlined in the current OPNAV Instruction 3710.7. Crewmembers 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 evaluation flight is satisfactorily completed.

16.3 DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

1. NATOPS evaluation — A periodic evaluation of individual flightcrewmembers standardization to consist 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 the ground examinations or the evaluation flight. Only those areas in which an unsatisfactory level was noted need be observed during a reevaluation.

3. Qualified — 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.

4. Conditionally Qualified — That degree of standardization demonstrated by a flightcrewmember who meets the minimum acceptable standards. The flightcrewmember is considered safe enough to fly as a pilot in command or to perform normal duties without supervision, but more practice is needed to become Qualified.

5. Unqualified — That degree of standardization demonstrated by a flightcrewmember who fails to meet minimum acceptable criteria. The flightcrewmember should receive supervised instruction until he has achieved a grade of Qualified or Conditionally Qualified.

6. Area — A routine of preflight, flight, or postflight.

7. Subarea — A performance subdivision within an area that is observed and evaluated during an evaluation flight.

8. Critical area/subarea — 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.

9. Emergency — An aircraft component or system failure or a condition that requires instantaneous recognition, analysis, and proper action.

10. Malfunction — An aircraft component or system failure to a condition that requires recognition and analysis but permits more deliberate action than that required for an emergency.

16.4 GROUND EVALUATION

Prior to commencing the flight evaluation, each flightcrewmember must achieve a minimum grade of Qualified on the open- and closed-book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS instructors may use questions from the sample banks in preparing portions of the written examination. Each individual examination phase shall contain questions represented by all applicable areas of the NATOPS flight manual.

16.4.1 Open-Book Examination. The number of questions on the open-book examination will not exceed 100, or be less than 25. The purpose of the open-book examination portion of the written examination is to evaluate crewmember knowledge of appropriate publications and the aircraft. The maximum time for this examination should not exceed 24 hours. Questions for the open-book examination are contained in this manual. A grade of 3.5 is Qualified.

16.4.2 Closed-Book Examination. Up to 50 percent of the closed-book examination may be taken from the sample question banks. The remainder shall be taken from the appropriate master question bank and shall include questions concerning normal procedures and aircraft limitations. The number of questions on the closed-book examination will not exceed 50, or be less than 25. Questions designated as critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of Unqualified for the examination. A grade of 3.3 is Qualified.

16.4.3 Oral Examination. An oral examination shall be administered to each crewmember. 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. They will normally cover emergency procedures relative to the appropriate crew position and will ensure that an aircraft commander being evaluated is fully aware of his/her responsibilities and authority as established by this publication and other directives.

16.4.4 Grading Instructions. Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of Qualified or Unqualified.

16.5 FLIGHT EVALUATION

The number of flights required to complete a flight evaluation should be kept to a minimum, normally one flight. The areas and subareas to be observed and graded on an evaluation flight are outlined in paragraph 16.6. Subarea grades will be assigned in accordance with the grading criteria. These subareas shall be combined to arrive at the overall grade for the flight. Area grades, if desired, shall also be determined in this manner. NATOPS flight evaluation worksheets will be utilized for the flight.

16.6 FLIGHT EVALUATION GRADING CRITERIA

Only those subareas provided or required will be graded. The grades assigned for a subarea shall be determined by comparing the degree of adherence to standard operating procedures with adjective 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 crewmember applies prompt corrective action. (An asterisk (*) before an item indicates a critical area or subarea.) A grade of CQ shall not be given in a critical area. A grading tolerance must be given between aircraft commander and T2P. Deviations of additional ±5 knots, or ±5°, or ±100 feet in addition to those listed are allowable for T2P.

16.6.1 Aircraft Commander/T2P

*1. Predeparture

*a. Takeoff performance computations

(1) Qualified — Accurately utilized governing charts to ascertain air minimum control speed (one engine inoperative), takeoff distance, takeoff speed, refusal speed, and takeoff crew briefing.

(2) Conditionally Qualified — Computed takeoff performance with minor errors not serious enough to affect safety of flight. Missed some items on takeoff crew briefing.

(3) Unqualified — Made mistakes that, if followed, would jeopardize safety of flight.

*b. Fuel planning

(1) Qualified — Complied with and was familiar with governing directives concerning required fuel and fuel computations.

(2) Conditionally Qualified — Omitted minor items not affecting safety of flight.

(3) Unqualified — Was not familiar with governing directives and/or made erroneous computations that could affect safety of flight.

*c. Weight and balance

(1) Qualified — Checked accuracy of weight and balance against fuel required, cargo, and/or passengers aboard.

(2) Conditionally Qualified — Minor errors that would not affect the safe completion of the mission.

(3) Unqualified — Did not meet the criteria of Conditionally Qualified.

*d. Preflight inspection

(1) Qualified — Completed thorough aircraft inspection. Inspected data sheets of previous discrepancies and preflight inspection form.

(2) 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 or preflight inspection form.

(3) Unqualified — Failed to conduct aircraft inspection properly and omitted important items that would affect the safety of the proposed flight.

2. Runup and taxi

*a. Starting procedures

(1) Qualified — Used checklist and proper starting procedures.

(2) Conditionally Qualified — Used checklist, but deviated from proper starting procedures without jeopardizing safety.

(3) Unqualified — Failed to use checklist and/or used improper starting procedures.

b. Taxi

(1) Qualified — Procedures required by the NATOPS flight manual were complied with. Taxi signalmen were utilized; power and speeds regulated closely; watches were properly posted when required; all lights and taxi aids were utilized as necessary. Checklists were accomplished without omission or discrepancy. Smooth use of power levers and brakes, and proper compliance with tower instructions were demonstrated.

(2) Conditionally Qualified — Procedures required by the NATOPS flight manual accomplished with omissions, deviations, or discrepancies that did not either adversely affect successful completion of the mission, jeopardize safety, or cause undue delay.

(3) Unqualified — Any omission or discrepancy that either precluded successful completion of the mission, jeopardized safety, or caused excessive delay. Taxied in a rough and hazardous manner; improper use of checklist.

*c. Runup procedure

(1) Qualified — Accomplished engine runup checks in accordance with standard procedures.

(2) Conditionally Qualified — Satisfactorily completed engine runup checks but with minor deviations or in improper sequence.

(3) Unqualified — Attempted engine runup in an area that was not clear. Too preoccupied with other duties to notice movement of aircraft. Runup procedures were not in accordance with NATOPS flight manual.

d. ATC clearance

(1) Qualified — Used proper voice procedures and initiated timely clearance request. Checked clearance against planned route of flight, if different than filed.

(2) Conditionally Qualified — Utilized nonstandard radio voice procedures but understood clearance.

(3) Unqualified — Unable to copy or understand ATC clearance.

*e. Radio management

(1) Qualified — Set up radios in accordance with those facilities needed for initial climbout and on-course navigation. Checked all communications/navigation equipment in accordance with the best means available. Operated equipment in accordance with NATOPS flight manual and appropriate directives. Fully utilized available radios and NAVAIDs.

(2) Conditionally Qualified — Tuned but did not identify radio signals or use radio navigational aids for backup.

(3) Unqualified — Radio equipment needed for flight not properly tuned or set prior to takeoff.

*f. Crew briefing

(1) Qualified — Thoroughly briefed crew on normal and emergency cockpit procedures, aircraft performance (i.e., speeds including air minimum control speed (one engine inoperative), takeoff, and refusal speeds), and emergencies after takeoff, reviewed ATC clearance, assured radios were tuned to facilities associated with initial climbout and/or emergency return.

(2) Conditionally Qualified — Same as qualified, but omitted some minor items in the crew briefing.

(3) Unqualified — Omitted one or more items from the crew briefing.

*3. Takeoff

a. The following criteria shall apply to normal, short-field, and crosswind takeoff:

(1) Qualified — Performed normal, short-field, and crosswind takeoff in a smooth manner according to prescribed procedures. Made smooth application of power, noting air minimum control speed (one engine inoperative), refusal speed, and takeoff speed. Made smooth transition to flight.

(2) Conditionally Qualified — Same as qualified except for minor deviations and technique not detrimental to flight safety.

(3) Unqualified — Failure to note air minimum control speed (one engine inoperative), refusal speed or takeoff speed. Erratic control on takeoff with a tendency to compromise safety. Made rough transition to flight below takeoff speed with marginal control of aircraft.

*b. Emergency return (includes abort)

(1) Qualified — Maintained positive control of the aircraft; completed emergency checklists and securing procedures in accordance with standard procedures; and effected smooth transition to final approach and landing. Ensured adequate briefing was given crew, passengers, and traffic controller.

(2) Conditionally Qualified — Carried out items listed in Qualified but with some delay in executing checks.

(3) Unqualified — Jeopardized flight safety by failing to cope with emergency in timely fashion or used improper sequence of checks causing confusion in cockpit, and resulting in compound of emergency.

*4. Climb to level-off

*a. ATC clearance execution

(1) Qualified — Successfully accomplished the approved instrument departure procedure or, if radar vectored, complied with all altitude and heading assignments. Navigated by aircraft instruments to arrive over designated fixes on ETA and assigned altitude.

(2) Conditionally Qualified — Adhered to clearance limitations but required repeat radio transmissions. Slow to react to instructions/clearances and had difficulty establishing and maintaining desired track.

(3) Unqualified — Proceeded without being certain of clearance or broke clearance limitations.

b. Climbout procedures

(1) Qualified — Proper use of climb checklist. Aircraft checks completed and crew reports received. Maintained correct climb power setting. Climb airspeed maintained within ±5 knots. Prescribed headings within ±5°.

(2) Conditionally Qualified — Aircraft checks completed but reports not received. Established but did not maintain correct climb power setting. Climb airspeed maintained with ±10 knots. Prescribed headings within ±10°.

(3) Unqualified — Failed to complete climb checklist. Did not establish correct climb power. Failure to satisfy requirements listed under Conditionally Qualified.

*5. Cruise procedures

a. Qualified — Aircraft checks were completed. Headings were maintained within ±5°. Airspeed was maintained within ±5 knots. Cruise power setting was properly maintained.

b. Conditionally Qualified — Cruise airspeed maintained within ±10 knots, headings within ±10°.

c. Unqualified — Failed to satisfy requirements listed under Conditionally Qualified.

*6. Airwork

a. Normal and steep turns

(1) Qualified — Demonstrated coordinated turns with smooth reversals. Angles of bank up to 45° utilized for 180° and 360° turns. Altitude variation should be less than ±100 feet. Angle of bank should be within 5° of that prescribed.

(2) Conditionally Qualified — Maintained altitude within 200 feet and angle of bank within 10°.

(3) Unqualified — Unable to meet above criteria.

b. Partial panel

(1) Qualified — Maintained altitude within 100 feet, airspeed within 10 knots, and heading within 10 percent of amount of turn. Executed timed turns with an error less than 1 percent of amount of turn.

(2) Conditionally Qualified — Maintained altitude within 200 feet, airspeed within

15 knots, and heading within 15°. Executed timed turns with an error of more than 10 percent but less than 15 percent of amount of turn.

(3) Unqualified — Unable to meet above criteria.

c. Unusual attitudes and recovery

(1) Qualified — Demonstrated ability to effect a successful recovery expeditiously and with a minimum loss of altitude, observing all aircraft operating limitations.

(2) Conditionally Qualified — Somewhat slow to comprehend the aircraft position in relation to the horizon, resulting in a more severe aircraft attitude before recovery was effected.

(3) Unqualified — Unable to recover in a safe flight attitude within the aircraft limitations.

d. Approach to stalls

(1) Qualified — Initiated proper recovery technique and recovered with less than 100-foot loss of altitude.

(2) Conditionally Qualified — Minor deviations in entering and recovery techniques. Recovered with less than 200-foot loss of altitude.

(3) Unqualified — Improper technique and/or loss of more than 200 feet of altitude.

*7. Holding

a. Qualified — Demonstrated a thorough knowledge of holding procedures by entering the pattern properly, maintaining correct airspeed, making the proper correction for winds, using the proper voice procedure, and adjusting the pattern to depart properly and on time.

b. Conditionally Qualified — Did not correct properly for winds, causing greater adjustment requirements in the turns. Used nonstandard voice procedures. Did not adjust the pattern properly to depart on time.

c. Unqualified — Entered the pattern by making a wrong initial or subsequent turn. Failed to maintain proper altitude or airspeed control. Did not make required voice reports.

8. Deleted.

*9. Penetrations

a. Qualified — Smoothly transitioned to penetration and complied with procedures outlined in the NATOPS flight manual.

b. Conditionally Qualified — Complied with procedures as outlined in the NATOPS flight manual with minor variations not compromising safety.

c. Unqualified — Did not follow NATOPS flight manual procedures and/or flew penetration in an unsafe manner. Exceeded aircraft limitations.

*10. Instrument approach

a. through e. PAR/ASR/ILS/ADF/VOR/tacan

(1) Qualified — Followed procedures as published. Complied with approach control instructions. Maintained airspeed within 5 knots. Did not descend below minimum altitudes, as published. Minor deviations in glideslope and alignment. Demonstrated good tracking technique. Indicated time over station was within 20 seconds. Expeditiously executed missed-approach procedures as published. Maintained field altitude minimums.

(2) Conditionally Qualified — Followed procedures as published and complied with approach control instructions. Maintained airspeed within 10 knots. Tracking was erratic and no apparent corrections for wind were applied. Indicated time over airport was within 30 seconds. Large deviations in glideslope and alignment but could have completed a successful

approach. Slow to execute missed-approach procedures with some minor deviations.

(3) Unqualified — Unsafe procedures and/or failed to comply with approach control instructions. Failed to meet airspeed, altitude, and time criteria specified above. Deviated from missed-approach procedure to the extent that the safety of crew and aircraft were jeopardized. Descended below field altitude minimums.

*f. Missed approaches

(1) Qualified — Prepared for missed approach (to the extent that reference to published procedure was not required or did not interrupt necessary acts); timely, correct power applications; raised gear and flaps properly following power; did not descend below minimums. No deviation from published procedures.

(2) Conditionally Qualified — Not adequately prepared for missed approach (requiring excessive references to published procedure). Incorrect power application; improper sequence of power, gear, and flaps; did not descend below minimums; satisfactorily carried out published procedures.

(3) Unqualified — Descended below minimum, erratic use of power, unsatisfactory completion of published procedures.

*g. Low visibility

(1) Qualified — Properly executed NATOPS flight manual procedures for low-visibility approach, keeping within the minimums of the instrument approach procedure used to arrive over the landing area. Positive control of the aircraft was maintained while maneuvering at these low altitudes, with extreme caution being used not to broach safety of flight by excessive angles of bank.

(2) Conditionally Qualified — Some deviations from established procedures evidenced, but no unsafe conditions noted.

(3) Unqualified — Failed to meet the criteria of Conditionally Qualified.

*h. Transition to landing

(1) Qualified — Entered and flew traffic pattern in accordance with the appropriate governing directives. Proper execution of Approach and Before Landing Checklists. Flew the traffic pattern within altitude and airspeed range.

(2) 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 checklist. Flew traffic pattern with minor deviations in altitude and/or airspeed range.

(3) Unqualified — Deviated from prescribed pattern and interfered with other traffic or jeopardized safety. Failed to call for or complete Before Landing Checklist. Exceeded limitations for Conditionally Qualified.

*11. VFR landing pattern

*a. Normal

(1) Qualified — Maintained positive control of speed, power, and rate of descent. Aircraft aligned with runway 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.

(2) Conditionally Qualified — Had minor difficulty with transition. Handled aircraft roughly and used poor technique in either flare, landing, or rollout. Left excessive power on or made flat touchdown in first third of runway.

(3) Unqualified — Had serious difficulty with transition. Failed to maintain positive control of aircraft during either flare, landing, or rollout. Did not touch down in first third of runway. Landed hard. Jeopardized safety.

*b. Crosswind

(1) Qualified — Properly executed crosswind technique, maintaining positive directional control throughout the flare, touchdown, and rollout. Reverse thrust was used to best advantage to slow aircraft while transition to nosewheel steering gave assurances of continued positive directional control.

(2) Conditionally Qualified — Insufficient measures to correct slight drift on final approach or touchdown. Improper technique used to maintain directional control, or aircraft landed in slight skid.

(3) Unqualified — Safety of flight endangered by poor judgment of crosswind situation, or dangerous drift existed on touchdown.

*c. 50-percent flap/no-flap landings

(1) Qualified — Maintained correct altitude, pattern, and airspeed.

(2) Conditionally Qualified — Altitude, pattern, and airspeed correct except for minor deviations.

(3) Unqualified — Pattern too wide/close in. Unsatisfactory control of airspeed/ altitude resulting in a go-around.

d. Short field

(1) Qualified — The approach was made in accordance with recommended procedures as outlined in the NATOPS flight manual. Touchdown was made on the centerline of the runway within 500 feet of the approach end. Reverse pitch and brakes were applied immediately and controlled so as to maintain directional control and minimum roll commensurate with the length of the runway. Maintained complete control of the aircraft at all times.

(2) Conditionally Qualified — Minor deviations from above criteria. Safe approach and landing. Landed long but within limits to make a safe stop.

(3) Unqualified — Approach and landing deviated from the recommendations as outlined in the NATOPS flight manual. Touchdown was short or so long that stopping within limits was doubtful. Poor control maintained during roll, and uncoordinated applications of reverse and brakes caused erratic landing roll. Overall handling of landing tended to compromise safety.

*e. Landing with emergency (engine, hydraulic, etc.)

(1) Qualified — Emergency analyzed correctly. Instant corrective action so as to assure safe approach and landing.

(2) Conditionally Qualified — Minor discrepancies in handling emergency situation, but safe approach and landing were accomplished.

(3) Unqualified — Incorrect technique in handling emergency, unsafe approach, or landing.

12. Secure and postflight procedures

(1) Qualified — Completed appropriate checklist without omissions; visual exterior inspection conducted; completed necessary logs and forms. Assured that flight plan was closed out.

(2) Conditionally Qualified — Omitted checklist items and exterior inspection, and failed to note obvious maintenance discrepancy, none of which were considered unsafe.

(3) Unqualified — Major checklist items omitted; improper knowledge and use of postflight forms. No postflight inspection.

*13. Emergencies (the following criteria applies to all emergencies)

(1) Qualified — Demonstrated proper technique, coordination, and/or knowledge of aircraft emergency and distress procedures.

(2) Conditionally Qualified — Same as qualified except for minor deviations.

(3) Unqualified — Inadequate knowledge and/or poor technique of handling emergency or distress procedures.

14. Crew coordination

(1) Qualified — Crew was well-coordinated and pilot was aware of the duties and responsibilities of each crewmember. Crew performance as a team reflected pilot emphasis on conformance to standard procedures by all crewmembers.

(2) Conditionally Qualified — Crew was coordinated in actions and pilot was generally aware of crew duties and responsibilities. Performance as a team did not jeopardize safety or crew ability to complete mission. Did not require crew to perform tasks in accepted manner.

(3) Unqualified — Crew performance showed complete lack of coordination by the pilot. Tasks were performed in violation of accepted publications.

*15. Use of checklists

(1) Qualified — Checklists called for at proper times and executed correctly.

(2) Conditionally Qualified — Late calling for or completing checklist. Minor deviations or omissions noted.

(3) Unqualified — Failed to call for or complete checklist in time.

16. Aerial delivery (if applicable)

a. Knowledge of system

(1) Qualified — Had complete knowledge of system capabilities and restrictions.

(2) Conditionally Qualified — Deviated from procedures and terminology as outlined in appropriate directives. Such deviations were minor and would not interfere with safe completion of the mission.

(3) Unqualified — Incomplete knowledge of the system. More study needed to avoid compromising safe operations.

b. Procedures and terminology

(1) Qualified — Procedures and terminology utilized were as outlined in appropriate directives.

(2) Conditionally Qualified — Deviated from procedures and terminology as outlined in appropriate directives. Such deviations were minor and would not interfere with safe completion of the missions.

(3) Unqualified — Deviated from approved procedures and terminology. Procedures used compromised safety.

c. Emergencies

(1) (See item 13 for grading criteria.)

16.6.2 Flight Engineer

1. Flight planning and preparation

a. Professional equipment

(1) Qualified — Had all necessary personal and professional equipment. Displayed positive knowledge of the proper use, care, and operation of such equipment.

(2) Conditionally Qualified — Marginal knowledge of the proper use, care, and operation of personal and professional equipment.

(3) 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 is doubtful.

b. Knowledge of weight and balance

(1) Qualified — Displayed positive knowledge in computing and filling out Form F. Minor errors in planning commitment for loading.

(2) Conditionally Qualified — Completed Form F with minor deviations from established procedures. Such deviations did not compromise safe operations.

(3) Unqualified — Unable to complete Form F, or the computation was such that, if flown, safety of flight would be compromised. Unfamiliar with weight and balance of an aircraft.

*2. Preflight

*a. Aircraft servicing

(1) Qualified — Displayed positive knowledge of requirements and proficiency in the servicing of engine, oxygen, and hydraulic system components as outlined in approved manual and directives. All safety precautions were heeded.

(2) Unqualified — Servicing of engine, oxygen, and hydraulic system components was not accomplished or not done in an approved manner. Safety precautions were partially or completely disregarded, thereby endangering aircraft and/or personnel.

*b. Preflight inspection and duties

(1) Qualified — Accomplished all necessary paperwork and conducted a thorough and proficient inspection, utilizing approved checklist. Possessed positive knowledge of inspection requirements.

(2) Unqualified — Did not accomplish required paperwork and/or failed to complete exterior inspection or utilize approved checklist. Inspection was such that safe operation was doubtful.

c. Internal power unit operation

(1) Qualified — Accomplished APU start, operation, and required checks in the prescribed manner as outlined in approved manuals and directives. Possessed positive knowledge of emergency procedures. All safety precautions were heeded.

(2) Conditionally Qualified — Accomplished APU start, operation, and required checks with minor deviations of approved manuals and directives. Deviations did not compromise safety.

(3) Unqualified — Errors were made during start and operation so as to endanger the aircraft. Doubtful of or definitely did not know APU procedures. Safety precautions were partially or completely disregarded.

d. Taxi ability (not applicable)

*3. Pretakeoff

*a. Engine start

(1) Qualified — Accomplished engine start in the prescribed manner, used approved checklist, observed all limitations, and operated all switches and controls properly. Accomplished required checks. Possessed knowledge of normal and emergency procedures during starts. Start was accomplished in professional manner.

(2) Unqualified — Errors were made during start with use of switches and controls so as to endanger the aircraft. Doubtful of or definitely did not know start limitations and/or procedures. Checklist was not utilized.

*b. Before taxi and taxi

(1) Qualified — Accomplished all system checks in accordance with prescribed procedures in a positive manner. Knowledge of required system and checks was displayed so as to indicate a highly professional crewmember.

(2) Unqualified — All or some checks were ineffective and/or incomplete. Limited knowledge of required checks or corrective action, if malfunctions occurred. Procedure used could cause malfunction or damage to aircraft.

*c. Engine runup

(1) Qualified — Demonstrated positive knowledge and proficiency in engine runup procedures, limitations, and required checks.

(2) Unqualified — Failed to accomplish checks or accomplished them in other than approved manner. Did not interpret instrument indications properly; displayed lack of knowledge of systems when performing checks; doubtful determination of status of systems. Failed to notify pilot of malfunction.

*4. Takeoff

(1) Qualified — Monitored engine and system indicators. Complied with pilot briefing and approved remedial actions.

(2) Unqualified — Did not monitor engine or system indicators. Failed to comply with pilot briefing and/or approved remedial action.

*5. Climb

(1) Qualified — Completed all items on the checklist in proper sequence and complied with instructions with no deviations. Systems knowledge, management, and procedures were outstanding.

(2) Unqualified — Did not comply with checklist or instructions. Displayed a lack of knowledge of systems and their management and/or of approved procedures. Displayed an unsafe performance.

*6. Cruise — The following grading criteria shall be used for individual evaluation of the:

a. Fuel system and management

b. Hydraulic system

c. Pneumatic systems

d. Electrical system

e. Anti-icing and deicing systems

f. Propellers

g. Engines

h. Power charts (cruise performance charts)

i. Fuel log

j. Instrumentation

(1) Qualified — Positive knowledge of systems and system management and/or operation. Accomplished all necessary paperwork. Operated systems in a professional manner.

(2) Unqualified — Did not understand all the systems or their management. Operation of various components in the system(s) could cause possible damage to the aircraft or injury to personnel.

*7. Emergency and malfunction procedures — The following grading criteria will be utilized for individual evaluation of the listed emergencies and malfunctions:

a. Engine failure

b. Propeller failure

c. Fuselage fire

d. Smoke and fume elimination

e. In-flight door warning

f. Ditching and bailout

g. Fuel system

h. Electrical system

i. Hydraulic system

j. Pneumatic system

(1) Qualified — An obvious understanding of the corrective action for existing malfunctions. Explained in detail all necessary actions and limitations. Conducted corrective action in a highly professional manner.

(2) Unqualified — Did not display a positive knowledge of all corrective actions for existing malfunctions. Knowledge and actions were not up to standards for professional approach to malfunctions and emergencies. Actions indicated doubt as to whether actual emergencies could be handled. Needs supervision and instruction.

*8. Descent and landing

(1) Qualified — Completed all checklist items in proper sequence. Demonstrated positive knowledge of required systems management and operating procedures.

(2) Unqualified — Did not utilize checklist. Management and procedures were unapproved and bordered on or were unsafe. Needs supervision and instruction.

*9. Postflight

a. Inspection

(1) Qualified — Extremely thorough and competent in accomplishing required inspections. No deviations from manuals or other directives. Advised pilot on aircraft discrepancies so that a complete and accurate aircraft status was determined.

(2) Unqualified — Did not or was unable to perform postflight inspection. Failed to advise pilot of aircraft discrepancies; consequently, the true status of the aircraft was unknown. Possibly needs supervision and/or further instruction.

*b. Servicing and securing

(1) 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.

(2) 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. Requires supervision and/or further instruction.

10. General

a. Use of forms

(1) Qualified — Accomplished all necessary paperwork as outlined in approved manuals and directives in a professional manner.

(2) Conditionally Qualified — Accomplished all necessary paperwork as outlined in approved manuals and directives with minor errors.

(3) Unqualified — Did not accomplish required paperwork as outlined in approved manuals and directives.

b. Cockpit discipline

(1) Qualified — Coordinated actions smoothly and effectively with all crewmembers. Anticipated demands upon crew position. The overall performance of the crew was enhanced by continual alertness to the needs of others in the performance of their assigned duties.

(2) Conditionally Qualified — Attempted to coordinate actions/requirements but lacked the desired effect. Intercommunications discipline at times interfered with crew. Responses to checklist items were made with only minor deviations. Did not jeopardize mission accomplishment or other crewmembers' duties.

(3) Unqualified — Displayed undesirable traits in crew coordination and discipline. Intercommunication discipline was nonexistent. Responses to checklist were vague or improper. Performance hindered the smooth accomplishment of the mission.

c. Ability to perform major/minor repairs (when observed)

(1) Qualified — Displayed positive knowledge in the requirements and proficiency of repairs utilizing approved manuals for limitations and procedures. Coordinated repair actions with maintenance departments smoothly and effectively. All safety precautions were followed.

(2) Conditionally Qualified — Displayed good knowledge in the requirements and proficiency of repairs, utilizing approved manuals but with minor deviations. Coordination with maintenance department lacked desired effect. Deviations or coordination did not compromise safety.

(3) Unqualified — Displayed undesirable traits in the requirements of repair and failed or did not fully use approved manuals. No coordination with the crew or local maintenance department. Safety precautions were partially or completely disregarded thereby endangering aircraft and/or personnel. Definite need of supervision and instruction.

d. Ability to perform preventive maintenance (when observed)

(1) Qualified — Displayed positive knowledge of requirements and proficiency, utilizing approved manuals and directives. Had a continual alertness to the needs of preventive maintenance. All safety precautions were followed.

(2) Conditionally Qualified — Marginal knowledge of requirements or proper procedures. Utilized approved manuals and directives but with minor errors. Errors did not compromise safety.

(3) Unqualified — Did not or was unable to perform preventive maintenance. Failed to advise maintenance of discrepancies; consequently, the true status of the aircraft was unknown. Needs supervision and instruction.

e. Troubleshooting capability (when observed)

(1) Qualified — Extremely thorough and competent in professional approach to malfunctions. No deviations from manuals or other directives. All safety precautions were heeded.

(2) Conditionally Qualified — Good approach to malfunctions with added cost of man hours. Minor deviations from manuals and directives. Deviations did not compromise safety.

(3) Unqualified — Did not or was unable to troubleshoot because of lack of system knowledge and/or failed to utilize manuals or directives. Safety precautions were partially or completely disregarded.

*f. Aircraft and system knowledge

(1) Qualified — Positive knowledge of system and operation. Explained in precise detail their functions and limitations.

(2) Unqualified — Did not understand all the systems' functions and/or limitations. Lack of knowledge could cause possible damage to the systems, and/or explanations of operating the system were unsafe.

16.6.3 Loadmaster Evaluation

1. Preflight duties

   a. Survival/professional equipment use and location

      (1) Qualified — Obtained all personal, professional, and survival equipment. Displayed an outstanding knowledge of the proper use, care, location, and operation of such equipment.

      (2) Conditionally Qualified — Marginal knowledge of the proper use, care, location, and operation of personal, professional, and survival equipment.

      (3) Unqualified — Did not ensure the required personal, professional, and survival equipment was on board. The lack of this gear and proper knowledge could cause compromise of safe operation.

   b. Inspection and duties

      (1) 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 flight attendant equipment was aboard and that coffee and water had been obtained.

      (2) Conditionally Qualified — Completed aircraft inspection/duties with omissions in minor areas. Did not cause delay or affect the safety of the proposed flight.

      (3) Unqualified — Failed to conduct proper aircraft inspection and/or omitted important items that would affect the safety of flight. Failed to ensure all flight attendant equipment, coffee, and water had been obtained.

   c. Passenger brief

      (1) Qualified — Briefed the passengers completely concerning the use of seatbelts and emergencies. Ensured passenger manifest/paperwork was attained prior to departure.

      (2) Conditionally Qualified — Same as Qualified but omitted some items or incompletely briefed on any one item.

      (3) Unqualified — Gave incomplete briefing. Omitted most items that should have been covered. Did not ensure that passengers manifest/paperwork was aboard prior to departure.

   d. Baggage handling

      (1) Qualified — Ensured passenger baggage was properly manifested, handled, and placed aboard.

      (2) Conditionally Qualified — Same as qualified but made minor mistakes in manifesting or handling of passenger baggage.

      (3) Unqualified — Did not manifest baggage and mishandled baggage resulting in damaged or destroyed passenger baggage.

2. Cargo loading/offloading procedures

   a. Terminal operation procedures

      (1) Qualified — Ensured that all documentation and services were obtained or arranged, which resulted in a smooth loading/offloading evolution.

      (2) Conditionally Qualified — Made minor mistakes in obtaining the proper documentation from the terminal. Made minor errors in obtaining the required terminal services that did not affect a proper loading/offloading evolution.

      (3) Unqualified — Did not obtain the proper documentation required for the mission. Failed to ensure that terminal services were available resulting in delays and/or an unsatisfactory loading/offloading evolution.

*b. Loadplanning/weight and balance

(1) Qualified — Ensured that scheduled passengers/cargo were loadplanned resulting in a satisfactory aircraft center of gravity. Checked proper computations of weight and balance to ensure aircraft was within allowable operating limits. Compared weight and balance form with actual cargo/passenger load.

(2) Unqualified — Failed to ensure that passengers/cargo were loadplanned correctly, resulting in a condition exceeding allowable limits of the aircraft. Failed to check weight and balance forms with applicable passenger/cargo manifest. Made major errors in computations, resulting in improper cabin load or exceeding allowable limits of the aircraft.

*c. Hazardous cargo procedures

(1) Qualified — Ensured proper documentation was obtained and hazardous cargo was inspected prior to loading. Loadplanned the hazardous cargo for accessibility in flight in the event of leakage, smoke and fumes, fire, etc. Notified the aircraft commander of type and quantity of hazardous cargo.

(2) Unqualified — Did not inspect hazardous cargo prior to flight and/or did not ensure the proper documentation was obtained. Did not loadplan for accessibility during flight, resulting in a dangerous condition should the cargo leak, spill, etc.

d. Loading/offloading crew briefing

(1) Qualified — Ensured the loading/offloading crew was briefed of all hand signals or alternate signals resulting in a safe and efficient loading/offloading evolution.

(2) Conditionally Qualified — Made minor errors in ensuring loading/offloading crew was properly briefed. Crewmember acknowledged mistake and quickly corrected the deficiency resulting in a safe and efficient loading/offloading evolution.

(3) Unqualified — Did not brief loading/unloading crew, ensuring cargo onload/offload was unsafe and inefficient.

*e. Cargo loading/offloading safety precautions

(1) Qualified — Demonstrated thorough knowledge of loading/offloading and safety procedures.

(2) Unqualified — Used improper and/or unsafe loading/offloading procedures.

*f. Cargo loading/offloading procedures

(1) Qualified — Completed the loading/offloading procedure safely and proficiently. Was knowledgeable in all aspects of cargo loading/offloading procedures.

(2) Unqualified — Incorrectly performed duties associated with the cargo loading/offloading evolution. Made mistakes that affected safety of flight.

g. Care and use of equipment

(1) Qualified — Demonstrated correct use of all equipment applicable to cargo loading/offloading.

(2) Conditionally Qualified — Same as qualified but could be more careful in handling of equipment.

(3) Unqualified — Inadequate knowledge or improper utilization of equipment.

*h. Cargo restraint criteria/application

(1) Qualified — Demonstrated thorough knowledge of cargo restraint criteria and application of tiedown equipment.

(2) Unqualified — Demonstrated lack of knowledge of cargo restraint criteria. Failed to properly place and/or operate tiedown equipment.

*i. Mail/classified material handling

(1) Qualified — Adhered to prescribed regulations governing security and accountability of mail and classified material. Ensured that proper authorities were notified at destination.

(2) Unqualified — Failed to provide security for mail and classified material. Did not ensure proper authorities were notified upon arrival at destination.

j. Limitations

(1) Qualified — Properly demonstrated excellent knowledge of cargo deck, loading aid, and equipment limitations.

(2) Conditionally Qualified — Same as qualified but with minor deviations.

(3) Unqualified — Failed to provide knowledge of prescribed limitations that would have resulted in injury to personnel or damage to equipment.

3. Mission requirements

a. Checklist procedures

(1) Qualified — Performed checklists accurately and without delay. Noticed existing or potential problems and communicated with the flight station to correct/prevent further damage and/or injury.

(2) Conditionally Qualified — Performed checklist with minor deviations. Noticed unsafe conditions and notified flight station accordingly.

(3) Unqualified — Incorrectly replied to applicable checklist items. Did not communicate potential problems with flight station resulting in an unsafe ground/flight evolution.

b. Care of passengers

(1) Qualified — Ensured passengers were properly and safely loaded, briefed, and seated. Ensured toilet facilities were rigged during flight.

(2) Conditionally Qualified — Same as qualified but with minor deviations.

(3) Unqualified — Loaded passengers in an unsafe manner. Did not ensure passengers were seated correctly with seatbelts fastened. Did not rig toilet during flight.

c. Aircraft/equipment checks

(1) Qualified — Ensured all cargo remained secure throughout duration of flight. Ensured aircraft cargo compartment, engines, and wings were routinely checked (once every hour) for fluid leaks, smoke, fires, etc.

(2) Conditionally Qualified — Same as qualified but did not notice slack in restraint devices and minor aircraft/equipment leaks.

(3) Unqualified — Did not secure loose and/or unrestrained cargo. Did not perform aircraft security checks routinely (once every hour).

4. General

a. Aircraft knowledge

(1) Qualified — Demonstrated thorough knowledge of aircraft systems and components.

(2) Conditionally Qualified — Same as qualified, but with minor discrepancies in knowledge.

(3) Unqualified — Did not understand the systems or components. Performance bordered on or was unsafe.

*b. Crew coordination

(1) Qualified — Utilized other crewmembers to expeditiously handle assigned loads at en route stops. Readily assisted other crewmembers in completion of assigned tasks.

(2) Unqualified — Failed to utilize other crewmembers, resulting in delay. Uncooperative.

c. First aid

(1) Qualified — Possessed excellent knowledge of the basic fundamentals of first aid. Knew the location and use of all first-aid equipment.

(2) Conditionally Qualified — Same as qualified but with minor discrepancies in knowledge.

(3) Unqualified — Little or no knowledge of the basic fundamentals of first aid. Did not know the location or use of the first-aid equipment.

d. Customs/agriculture procedures

(1) Qualified — Ensured that all necessary forms were completed, obtained, and/or submitted and that aircraft was properly disinfected when required. Was familiar with customs, regulations, and foreign clearance guide requirements.

(2) Conditionally Qualified — Complied with agriculture requirements but committed minor errors in preparation of forms.

(3) Unqualified — Failed to satisfactorily complete, obtain, and/or submit necessary forms.

e. Supervisory ability

(1) Qualified — Demonstrated leadership and professionalism resulting in an efficient and safe flight evolution.

(2) Conditionally Qualified — Occasionally failed to demonstrate leadership and professionalism.

(3) Unqualified — Routinely failed to demonstrate leadership and professionalism resulting in frequent delays and unsafe conditions.

f. Forms/paperwork

(1) Qualified — Thoroughly completed and filed all paperwork/forms.

(2) Conditionally Qualified — Completed all required forms but with minor omissions that did not adversely affect required procedures.

(3) Unqualified — Failed to satisfactorily complete necessary forms and filing procedures.

5. Emergency procedures

*a. Fuselage fire/smoke and fumes elimination

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

*b. In-flight door warning

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

*c. Rapid decompression

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

d. Bailout

(1) Qualified — Understood/demonstrated the procedure completely. Explained precisely all necessary action.

(2) Conditionally Qualified — Understood the procedure satisfactorily. Weak in explaining necessary actions.

(3) Unqualified — Did not display a positive knowledge of procedure.

*e. Cargo jettison procedures

(1) Qualified — Understood the procedure and action precisely that should be taken. Explained/demonstrated in detail the steps to be taken.

(2) Unqualified — Did not display a positive knowledge of procedure.

f. Ditching procedures

(1) Qualified — Demonstrated a thorough knowledge of ditching procedures. Explained, in detail, all the actions required for ditching in proper sequence. Was able to execute the drill expeditiously, safely, and correctly, requiring no supervision.

(2) Conditionally Qualified — Same as qualified except for minor deviations.

(3) Unqualified — Did not know ditching procedures or left doubt that crewman would survive ditching if left to his/her own devices.

*g. General emergency procedures

(1) Qualified — Demonstrated knowledge of emergency procedures/equipment. Displayed alertness at all times and remained calm and efficient under stress.

(2) Unqualified — Did not know emergency procedures. Displayed a lack of awareness of in-flight emergency procedures. Became disturbed to the degree of jeopardizing the safety of the flight when subject to stress.

6. Postflight

a. Aircraft secured as required

(1) Qualified — Ensured aircraft cargo compartment was cleaned prior to securing. Secured cargo compartment doors and hatches and assisted crew in securing aircraft as required.

(2) Conditionally Qualified — Same as qualified except for minor deviations.

(3) Unqualified — Made little effort to ensure the aircraft was properly cleaned and secured.

7. CRM

(1) Qualified — Displayed knowledge of requirements and proficiency, using approved manuals and directives.

(2) Unqualified — Did not or was not able to perform and/or identify the necessary CRM skills.

16.6.4 Second Loadmaster Evaluation

1. Preflight duties

a. Professional/survival equipment use and location

(1) Qualified — Obtained all personal, professional, and survival equipment. Displayed an outstanding knowledge of the proper use, care, location, and operation of such equipment.

(2) Conditionally Qualified — Marginal knowledge of the proper use, care, location, and operation of personal, professional, and survival equipment.

(3) Unqualified — Did not ensure the required personal, professional, and survival equipment was on board. The lack of this gear and proper knowledge could cause compromise of safe operation.

b. Inspection and duties

(1) 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 flight attendant equipment was aboard and that food, coffee, and water had been obtained.

(2) Conditionally Qualified — Completed aircraft inspection/duties with omissions in minor areas that did not cause delay or affect the safety of the proposed flight.

(3) Unqualified — Failed to conduct proper aircraft inspection and/or omitted important items that would affect the safety of flight. Failed to ensure all flight attendant equipment, food, coffee, and water had been obtained.

c. Passenger brief

(1) Qualified — Briefed the passengers completely concerning the use of seatbelts and emergencies. Ensured passenger manifest/paperwork was attained prior to departure.

(2) Conditionally Qualified — Same as qualified but omitted some items or incompletely briefed on any one item.

(3) Unqualified — Gave incomplete briefing. Omitted most items that should have been covered. Did not ensure that passenger manifest/paperwork was aboard prior to departure.

d. Baggage handling

(1) Qualified — Ensured passenger/crew baggage was properly manifested, handled, and placed aboard.

(2) Conditionally Qualified — Same as qualified but made minor mistakes in manifesting or handling of passenger/crew baggage.

(3) Unqualified — Did not manifest baggage and mishandled baggage resulting in damaged or destroyed passenger/crew baggage.

2. Mission requirements

a. Checklist procedures

(1) Qualified — Performed checklists accurately and without delay. Noticed existing or potential problems and communicated with the flight station to correct/prevent further damage and/or injury.

(2) Conditionally Qualified — Performed checklists with minor deviations. Noticed unsafe conditions and notified flight station accordingly.

(3) Unqualified — Incorrectly replied to applicable checklist items. Did not communicate potential problems with flight station resulting in an unsafe ground/flight evolution.

b. Care of passengers

(1) Qualified — Ensured passengers were properly and safely loaded, briefed, and seated. Ensured toilet facilities were rigged during flight.

(2) Conditionally Qualified — Same as qualified but with minor deviations.

(3) Unqualified — Loaded passengers in an unsafe manner. Did not ensure passengers were seated correctly with seatbelts fastened. Did not rig toilet during flight.

c. Aircraft/equipment checks

(1) Qualified — Ensured all cargo remained secure throughout duration of flight. Ensured aircraft cargo compartment, engines, and wings were routinely checked (once every hour) for fluid leaks, smoke, fire, etc.

(2) Conditionally Qualified — Same as qualified but did not notice slack in restraint devices and minor aircraft/equipment leaks.

(3) Unqualified — Did not secure loose and/or unrestrained cargo. Did not perform aircraft security checks routinely (once every hour).

3. General

a. Aircraft knowledge

(1) Qualified — Demonstrated thorough knowledge of aircraft systems and components.

(2) Conditionally Qualified — Same as qualified, but with minor discrepancies in knowledge.

(3) Unqualified — Did not understand the systems or components. Performance bordered on or was unsafe.

*b. Crew coordination

(1) Qualified — Utilized other crewmembers to expeditiously handle assigned loads at en route stops. Readily assisted other crewmembers in completion of assigned tasks.

(2) Unqualified — Failed to utilize other crewmembers resulting in delay. Uncooperative.

c. First aid

(1) Qualified — Possessed excellent knowledge of the basic fundamentals of first aid. Knew the location and use of all first aid equipment.

(2) Conditionally Qualified — Same as qualified but with minor discrepancies in knowledge.

(3) Unqualified — Little or no knowledge of the basic fundamentals of first aid. Did not know the location or use of the first-aid equipment.

d. Supervisory ability

(1) Qualified — Demonstrated leadership and professionalism resulting in an efficient and safe flight evolution.

(2) Conditionally Qualified — Occasionally failed to demonstrate leadership and professionalism.

(3) Unqualified — Routinely failed to demonstrate leadership and professionalism, resulting in frequent delays and unsafe conditions.

e. Forms/paperwork

(1) Qualified — Thoroughly completed and filed all paperwork/forms.

(2) Conditionally Qualified — Completed all required forms but with minor omission that did not adversely affect required procedures.

(3) Unqualified — Failed to satisfactorily complete necessary forms and filing procedures.

f. Care and use of equipment

(1) Qualified — Demonstrated correct use of all equipment applicable to cargo loading/offloading.

(2) Conditionally Qualified — Same as qualified but could be more careful in handling of equipment.

(3) Unqualified — Inadequate knowledge or improper knowledge or improper utilization of equipment.

*g. Cargo restraint criteria/application

(1) Qualified — Demonstrated thorough knowledge of basic cargo restraint criteria and application of tiedown equipment.

(2) Unqualified — Demonstrated lack of knowledge of basic cargo restraint criteria. Failed to properly place and/or operate tiedown equipment.

*h. Mail/classified material handling

(1) Qualified — Adhered to prescribed regulations governing security and accountability of mail and classified material. Ensured that proper authorities were notified at destination.

(2) Unqualified — Failed to provide security for mail and classified material. Did not ensure proper authorities were notified upon arrival at destination.

4. Emergency procedures

*a. Fuselage fire/smoke and fumes elimination

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

*b. In-flight door warning

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

*c. Rapid decompression

(1) Qualified — Completely explained/demonstrated memory item(s) and all procedures pertaining to emergency.

(2) Unqualified — Incorrectly explained/demonstrated memory item(s).

d. Bailout

(1) Qualified — Understood/demonstrated the procedure completely. Explained precisely all necessary actions.

(2) Conditionally Qualified — Understood the procedure satisfactorily. Weak in explaining necessary action.

(3) Unqualified — Did not display a positive knowledge of procedure.

e. Ditching procedures

(1) Qualified — Demonstrated a thorough knowledge of ditching procedures. Explained, in detail, all the actions required for ditching in proper sequence. Was able to execute the drill expeditiously, safely, and correctly, requiring no supervision.

(2) Conditionally Qualified — Same as qualified except for minor deviations.

(3) Unqualified — Did not know ditching procedures or left doubt that crewman would survive ditching if left to his/her own devices.

*f. General emergency procedures

(1) Qualified — Demonstrated knowledge of emergency procedures/equipment. Displayed alertness at all times and remained calm and efficient under stress.

(2) Unqualified — Did not know emergency procedures. Displayed a lack of awareness of in-flight emergency procedures. Became disturbed to the degree of jeopardizing the safety of the flight when subject to stress.

5. Postflight

a. Aircraft secured as required

(1) Qualified — Ensured aircraft cargo compartment was cleaned prior to deplaning. Secured cargo compartment doors and hatches and assisted crew in securing aircraft as required.

(2) Conditionally Qualified — Same as qualified except for minor deviations.

(3) Unqualified — Made little effort to ensure the aircraft was properly cleaned and secured.

16.7 FLIGHT EVALUATION GRADE DETERMINATION

The following procedure shall be used in determining the flight evaluation grade.

A grade of Unqualified in any critical area or 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 equivalents to the adjective grade for each subarea. Only the numerals 0, 2, or 4 will be assigned in subareas. No interpolation is allowed.

Unqualified — 0.0

Conditionally Qualified — 2.0

Qualified — 4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grade shall then be determined on the basis of the following scale:

0.0 to 2.19 — Unqualified

2.2 to 2.99 — Conditionally Qualified

3.0 to 4.0 — Qualified

Example: (added subarea numerical equivalents)

4+2+4+2+4/5 = 16/5 = 3.20 Qualified.

16.8 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 a grade of Conditionally Qualified or Qualified is achieved on a reevaluation.

16.9 RECORDS AND REPORTS

A NATOPS evaluation report (OPNAV Form 3710-7) 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 permanently. In addition, an entry shall be made in the pilot/NFO flight log book under "Qualifications and Achievements" as follows:

QUALIFICATION	DATE	SIGNATURE
NATOPS EVAL (Aircraft Model) (Crew Position)	(Date)	(Authenticating Signature) (Unit that Administered Eval)

In the case of enlisted crewmembers, an entry shall be made in the administrative remarks of the personnel record upon satisfactory completion of the NATOPS evaluation as follows:

(Date) Completed a NATOPS Evaluation in (Aircraft Designation) as (Flightcrew position) with an overall grade of ( ).

16.10 NATOPS EVALUATION WORKSHEETS

In addition to the NATOPS evaluation report, NATOPS Flight Evaluation Worksheets (OPNAV Forms 3710/11, 11A, 11B, 11C, 11E, and 11F) are available for use by the evaluator/instructor during the evaluation flight.

PART XI

Performance Data

Refer to NAVAIR 01-75GAI-1.1 for Performance Data

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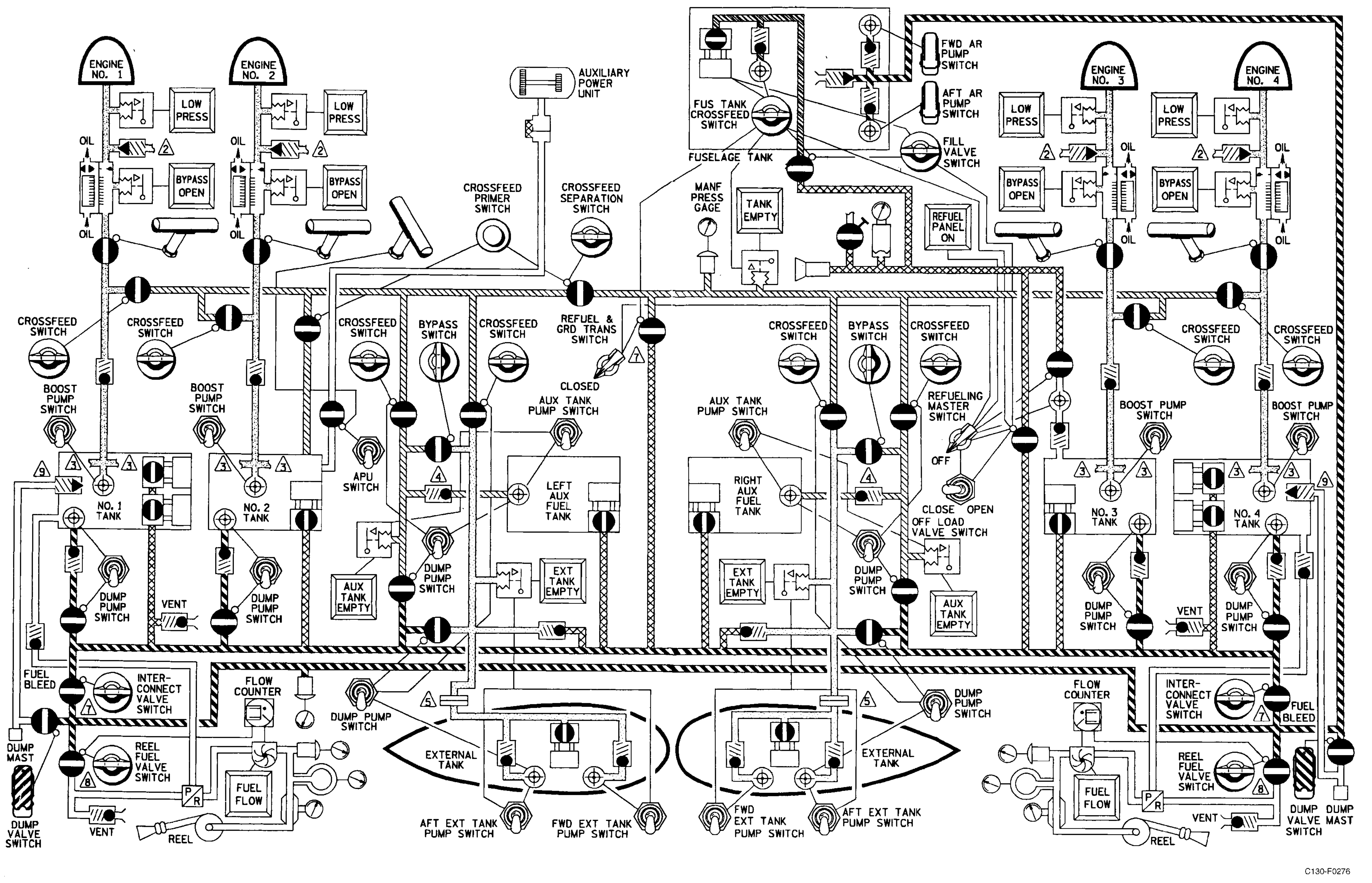

NOTE

1. REFER TO STANDARD SYMBOLS FIGURE FOR IDENTIFICATION OF SYMBOLS.

2. OVERBOARD DRAIN LINE.

3. WATER REMOVAL SYSTEM.

4. FIXED OPEN WHEN EXTERNAL TANKS ARE NOT INSTALLED.

5. LINES CAPPED WHEN EXTERNAL TANKS ARE NOT INSTALLED.

6. REFUELING, DEFUELING AND INTERNAL FUEL TRANSFER ARE POSSIBLE ONLY AS GROUND OPERATIONS, EXCEPT INFLIGHT FUEL TRANSFER INTO FUSELAGE TANK IS A NORMAL OPERATION.

7. BOTH INTERCONNECT VALVES WILL CLOSE AND THE GROUND TRANSFER VALVE WILL OPEN WHEN EITHER AR PUMP SWITCH IS IN THE ON OR EMER POSITION.

CODE

- TANK TO ENGINE FLOW
- SPR FLOW
- JETTISON FLOW
- CROSSFEED FLOW
- EXTERNAL TANK FLOW
- FUSELAGE TANK FLOW
- ELECTRICAL ACTUATION

Fuel System

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
Original	1 (Reverse Blank)
Original	3 (Reverse Blank)
Original	5 (Reverse Blank)
Original	7 (Reverse Blank)
Original	9 (Reverse Blank)
Original	11 thru 35 (Reverse Blank)
Original	37 thru 45 (Reverse Blank)
Original	1-1 thru 1-17 (Reverse Blank)
Original	2-1 thru 2-348
Original	3-1 thru 3-5 (Reverse Blank)
Original	4-1 thru 4-34
Original	47 (Reverse Blank)
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Original	49 (Reverse Blank)
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Original	13-1 (Reverse Blank)
Original	61 (Reverse Blank)
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Original	16-1 thru 16-22
Original	67 (Reverse Blank)
Original	Index-1 thru Index-16
Original	FO-1 (Reverse Blank)
Original	LEP-1 (Reverse Blank)